

1. CARBOHYDRATES

Definition:

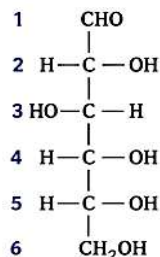
Polyhydroxy aldehydes or ketones or substances that on hydrolysis give such compounds.

Classification

Monosaccharides (One unit)	Disaccharides (Two units)	Polysaccharides (Many units)
e.g., Glucose, Fructose	e.g., Sucrose, Maltose, Lactose	e.g., Starch, Cellulose, Glycogen

Important Monosaccharide: Glucose (Aldohexose)

Open Chain Structure of D-Glucose



Unit-10 BIOMOLECULES

IMPORTANT REACTIONS OF GLUCOSE

1. Reduction (To sugar alcohol)	Glucose $\xrightarrow[\text{or NaBH}_4]{\text{H}_2/\text{Ni}}$	Sorbitol (Glucitol)
2. Mild oxidation	Br_2 water / Tollens' reagent / Fehling's solution	→ Gluconic acid
3. Strong oxidation	(Conc. HNO_3)	→ Saccharic acid (Glucaric acid)
4. Cyanohydrin formation	HCN	→ Glucose cyanohydrin
5. Addition of NaHSO_3	NaHSO_3	→ Sodium bisulphite addition compound
6. Esterification	Excess CH_3COOH / dry HCl	→ Penta-acetyl glucose
7. Formation of osazone	Phenylhydrazine	→ Glucosazone
8. Deoxygenation (HI)	HI (excess)	→ n-Hexane
9. Fermentation (Yeast)	Zymase	→ Ethanol + CO_2
10. Formation of glycosides	ROH / dry HCl	→ Glucosides

2. VITAMINS

Definition:

Organic compounds required in small amounts in diet for normal growth and health.

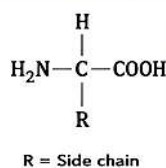
DEFICIENCY DISEASES

Vitamin	Deficiency Disease
Vitamin A	Xerophthalmia (hardening of cornea of eye), Night blindness
Vitamin B ₁ (Thiamine)	Beriberi
Vitamin B ₂ (Riboflavin)	Cheilosis
Vitamin B ₆ (Pyridoxine)	Convulsions
Vitamin B ₁₂ (Cobalamin)	Pernicious anaemia
Vitamin C (Ascorbic acid)	Scurvy (bleeding gums)
Vitamin D (Calciferol)	Rickets, Osteomalacia
Vitamin E (Tocopherol)	Fragility of RBCs and muscular weakness
Vitamin K (Phylloquinone)	Increased blood clotting time

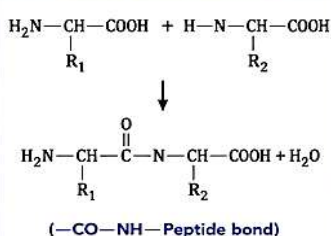
3. PROTEINS

Definition: High molecular weight natural polymers of α-amino acids linked by peptide bonds.

Amino Acid (General Structure)



Peptide Bond Formation



Levels of Protein Structure

Primary (Linear sequence of amino acids)
↓
Secondary (α-helix / β-sheet stabilized by H-bonds)
↓
Tertiary (Overall 3D shape due to R-group interactions)
↓
Quaternary (Association of two or more polypeptide chains)

Types of Bonding / Interactions in Proteins

1. Peptide Bond (-CO-NH-) Primary structure	2. Hydrogen Bond Between -C=O and -N-H (Stabilizes 2° str.)	3. Disulphide Bond (-S-S-) Between cysteine residues	4. Ionic Bond Between opposite charged R-groups	5. Hydrophobic Interactions Between nonpolar R-groups	6. Van der Waals Forces (Weak interactions)
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Functions of Proteins: Structural support, Enzymes (catalysts), Transport, Hormones, Immunity, Movement, Storage.

4. HORMONES

Definition: Chemical messengers produced by endocrine glands; act on specific target organs.

1. Protein / Polypeptide Hormones

- **Insulin** – Secreted by pancreas; controls blood sugar levels.
- **Glucagon** – Secreted by pancreas; increases blood sugar levels.
- **Pituitary Hormones** – e.g., Growth Hormone (GH), Vasopressin.

2. Steroid Hormones

- **Oestrogen (Estrogen)** – Responsible for female sexual development.
- **Progesterone** – Regulates menstrual cycle.
- **Testosterone** – Primary male sex hormone.
- **Cortisol** – Adrenal cortex hormone involved in stress response.

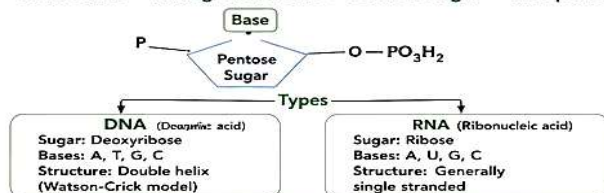
3. Amino Acid Derivatives

- **Adrenaline (Epinephrine)** – Secreted by adrenal gland; "Fight or Flight" hormone.
- **Thyroxine** – Secreted by thyroid gland; regulates metabolism.

5. NUCLEIC ACIDS

Definition: Biopolymers of nucleotides; store and transmit genetic information.

Nucleotide = Nitrogenous base + Pentose sugar + Phosphate



Important Points

- Besides glucose, carbohydrates include:
 Monosaccharides: Glucose, Fructose, Galactose
 Disaccharides: Sucrose, Maltose, Lactose
 Polysaccharides: Starch (storage in plants), Glycogen (storage in animals), Cellulose (structural)
- General formula (monosaccharides): $(\text{CH}_2\text{O})_n$
- Reducing sugars have free -CHO or -CO- group.
- Glycosidic linkage joins monosaccharides.

Functions of Carbohydrates

- Primary source of energy
- Storage (Starch, Glycogen)
- Structural (Cellulose, Chitin)

SECTION - A (1 MARKS)

Q.1 Which of the following is a water-soluble vitamin ? **(2026)**

- (A) Vitamin K (B) Vitamin A (C) Vitamin B (D) Vitamin D

Q.2 Which of the following statements is not true about glucose?

- (a) It is an aldohexose. (b) On heating with HI, it forms n-hexane.
(c) It is present in furanose form. (d) It does not give 2,4-DNP test.

Q.3 a-helix structure refers to:

- (A) primary structure of protein (B) secondary structure of protein **(2025)**
(C) tertiary structure of protein (D) quaternary structure of protein

Q.4 Which of the following base is not present in RNA?

- (a) Adenine (b) Uracil (c) Thymine (d) Cytosine

Q.5 Which of the following B group vitamins can be stored in our body?

- (a) Vitamin B1 (b) Vitamin B2 (c) Vitamin B6 (d) Vitamin B12

Q.6 On hydrolysis, which of the following carbohydrates give glucose and fructose?

- (a) Sucrose (b) Starch (c) Lactose (d) Maltose

Q.7 Curdling of milk is an example of

- (a) breaking of peptide linkage (b) hydrolysis of lactose
(c) breaking of protein into amino acid (d) denaturation of protein

Q.8 Nucleosides are composed of

- (a) a pentose sugar and phosphoric acid
(b) a nitrogenous base and phosphoric acid
(c) a nitrogenous base and a pentose sugar
(d) a nitrogenous base, a pentose sugar and phosphoric acid

Q.9 Which of the following naturally occurring α - amino acids is optically inactive?

- (a) Glycine (b) Alanine (c) Leucine (d) Valine

Q.10 Which carbon atoms of pentose sugar of nucleotides are Phosphodiester linkages present?

- (a) 5' and 3' (b) 1' and 5' (c) 5' and 5' (d) 3' and 3'

ASSERTION – REASON BASED QUESTIONS

Read the Assertion and Reason statements and choose the appropriate option from below:

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true and R is not the correct explanation of A
(c) A is true but R is false (d) A is false but R is true

Q.11 Assertion (A): Maltose is a reducing sugar.

Reason (R): One of the two glucose units can open to expose free aldehydic group in solution. .

Q.12 Assertion: Glycine must be taken through diet.

Reason: It is a non-essential amino acid.

Q.13. Assertion : Polysaccharides are called non-sugars.

Reason : Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides.

Q.14 Assertion: Purine bases present in DNA are adenine and guanine

Reason: The base thymine is present in RNA while base uracil is present in DNA.

Q.15 Assertion: Two strands of DNA are complementary to each other.

Reason: Adenine form hydrogen bond with guanine whereas cytosine form hydrogen bond with thiamine.

Answer key:

Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10
C	C	B	C	D	A	D	C	A	A
Q.11	Q.12	Q.13	Q.14	Q.15					
A	D	B	C	C					

SECTION -B(2 MARKS)

Q.1 Identify the main sugar found in milk and name the monosaccharide units it contains.

(Hint: Lactose, monomers- β -D-Glucose and β -D-Galactose)

Q.2 Sucrose is dextrorotatory but the mixture obtained after hydrolysis is laevorotatory. Explain.

(Hint: Invert Sugar)

Q.3 Compare (i) Nucleotides and Nucleosides (ii) Essential and Non-essential amino acids.

(Hint: refer to the summary of chapter)

Q.4 The iodine test is used to detect the presence of starch. Why does iodine specifically bind to starch, and how does this interaction lead to the characteristic blue-black coloration?

hint: Iodine molecules fit into the helical structure of amylose, a component of starch. This inclusion forms a starch-iodine complex, which absorbs light at specific wavelengths

Q.5 In which part of body and tissue fat soluble vitamins are stored?

{Hint: liver (adipose tissues)}

SECTION -C (3 MARKS)

Q.1 Which moieties of nucleosides are involved in the formation of phosphodiester linkages present in di-nucleotides? What does the word diester in the name of linkage indicate? Which acid is involved in the formation of this linkage?

(Hint: 3' -OH of one sugar and 5' - phosphate of the next sugar. phosphodiester linkage, acid involved Phosphoric acid.)

Q.2 I) The primary structure of a protein determines its three-dimensional shape. Evaluate how changes in the primary structure can lead to alterations in the protein's function.

II) Name the disease caused when valine replaces glutamic acid at the sixth position of the beta-globin chain of the haemoglobin.

Hint i) denaturation of protein; ii) sickle cell anemia

Q.3 Activation energy for the acid catalysed hydrolysis of sucrose is 6.22 kJ mol^{-1} , while the activation energy is only 2.15 kJ mol^{-1} when hydrolysis is catalysed by the enzyme sucrase. Explain.

Hint-enzymes are bio catalyst, reduce the magnitude of activation energy.

Q.4 I) Structures of glycine and alanine are given below. Show the peptide linkage in glycylalanine.



ii) α -Helix is a secondary structure of proteins formed by twisting of polypeptide chain into right handed screw like structures. Which type of interactions are responsible for making the α -helix structure stable?

Hint i) refer summary ii) hydrogen bonding

Q5 i) Why does glucose not give a 2,4-DNP test despite having an aldehyde group?

ii) Why is fructose a reducing sugar despite being a ketose?

Hint-i) glucose's aldehyde group is involved in the ring structure

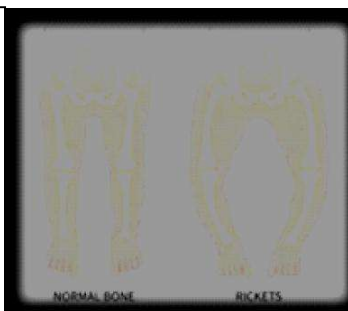
ii) Fructose contains a free aldehyde group

Case Based Questions (4 Marks)

Q1.

Meena lives in a region with limited sunlight during winter. Over time, she started feeling bone pain and muscle weakness. Her doctor diagnosed her with rickets, a disease related to bone development. The doctor explained that this condition is due to Vitamin D deficiency, often occurring when people don't get enough sunlight or consume insufficient vitamin D-rich foods like fish oil and fortified milk

(i) Id
(ii) Is



(iii) Name one deficiency disease caused by the lack of Vitamin D in adults and Suggest two food sources rich in Vitamin D.

Hint: (i). Calciferol. (ii). fat soluble

*(iii). Osteomalacia ,Food sources: **Fish liver oil and mushroom***

Q2. Living systems are made up of various complex biomolecules like carbohydrates, proteins, nucleic acids, liquids, etc. Carbohydrates are optically active polyhydroxy aldehydes or ketones or molecules which provide such units on hydrolysis. They are broadly classified into three groups – monosaccharides, oligosaccharide, and polysaccharide. Monosaccharides are held together by glycosidic linkages to form disaccharides like sucrose, maltose, or polysaccharides like starch and cellulose.

Another biomolecule: proteins are polymers of alpha-amino acids which are linked by peptide bonds. Ten amino acids are called essential amino acids. Structure and shape of protein can be studied at four different levels i.e. primary, secondary, tertiary and quaternary, each level being more complex than the previous one. **(2023)**

Answer the following questions:

- (i) What is the difference between a glycosidic linkage and peptide linkage?
- (ii) Which amino acids are called essential amino acids?
- (iii) What are the common types of secondary structures of proteins?
Write any two forces which stabilize the secondary and tertiary structures of protein.

OR

(iii) Define denaturation of protein with an example. During denaturation which structure of protein lose their biological activity?

(Hints: ref. to theory)

LONG ANSWER TYPE QUESTIONS (5 MARKS)

1. Questions: Give the Product of the Following Reactions of Open Chain Glucose

- 1. D-(+)-Glucose + HI (excess), heat →
- 2. D-(+)-Glucose + Br₂ water —
- 3. D-(+)-Glucose + conc. HNO₃ —
- 4. D-(+)-Glucose + HCN →
- 5. D-(+)-Glucose + excess CH₃COOH / dry HCl —

Hint. Refer theory

Q2. A. Write two differences between Amylose and Amylopectin components of starch. (2+3)(2025)

Feature	Amylose	Amylopectin
1. Structure	Linear polymer	Branched polymer
2. Glycosidic linkage	α -1,4 linkage only	α -1,4 and α -1,6 linkages(branches)
3. Solubility	Less soluble in water	More soluble due to branching

B. Differentiate between:

- (a) Essential amino acids and Non-essential amino acids
- (b) Peptide linkage and Glycosidic linkage
- (e) Fibrous protein and Globular protein

Hints. Peptide vs Glycosidic linkage

Peptide: Protein, CO–NH bond

Glycosidic: Sugar, C–O–C bond

Tip: “Peptide = Protein link, Glyco = Glucose link”

(c) Fibrous vs Globular protein

Fibrous: Thread-like, insoluble, structural → e.g., keratin, collagen

Globular: Spherical, soluble, functional → e.g., enzymes, hemoglobin

Mnemonic: "Fibrous = Frame, Globular = Go-function"

Q3 a. Each polypeptide in a protein has amino acids linked with each other in a specific sequence and it is this sequence of amino acids that is said to be :

(A) primary structure of proteins (B) secondary structure of proteins

(C) tertiary structure of proteins (D) quaternary structure of proteins

b. What is the effect of denaturation on the structure of proteins ? What are the common types of secondary structures of proteins ?

Hints. The specific sequence of amino acids in a polypeptide chain is called the primary structure of proteins.

Correct Answer: (A) Primary structure of proteins

b. Effect of denaturation on proteins:

Denaturation disturbs the natural shape of proteins due to heat, chemicals, change in pH, etc. It destroys the secondary and tertiary structures, causing loss of biological activity, but the primary structure usually remains unchanged.

Common types of secondary structures of proteins:

α -Helix

β -Pleated sheet

