

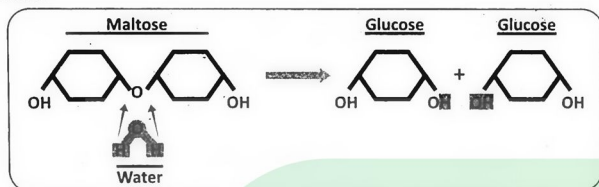
Unit 4: Biomolecules

Short Questions

SHORT ANSWER QUESTIONS EXERCISE

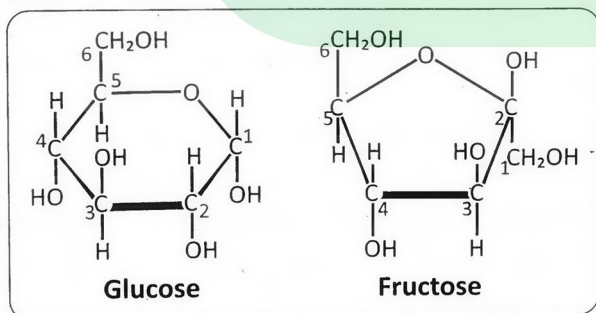
Q1. Draw a sketch of hydrolysis reactions.

Ans.



Q2. Draw the ring structures of glucose and fructose.

Ans.



Q3. Define isomers and stereoisomers.

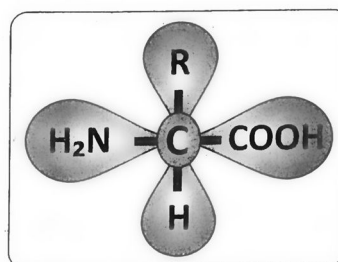
Ans. Isomers: The molecules which have the same number of atoms (same molecular formula) but differ in how the atoms are

arranged (different structural formula) are called isomers of each other. For example, glucose is not the only monosaccharide with the formula $C_6H_{12}O_6$. Fructose and galactose also have the same molecular formula but their structural formulas are different.

Stereoisomers: Stereoisomers are compounds with the same molecule formula but differ in the arrangement of atoms in three-dimensional space e.g., glucose and galactoses are stereoisomers at C-4.

Q4. Draw the sketch of amino acid.

Ans.

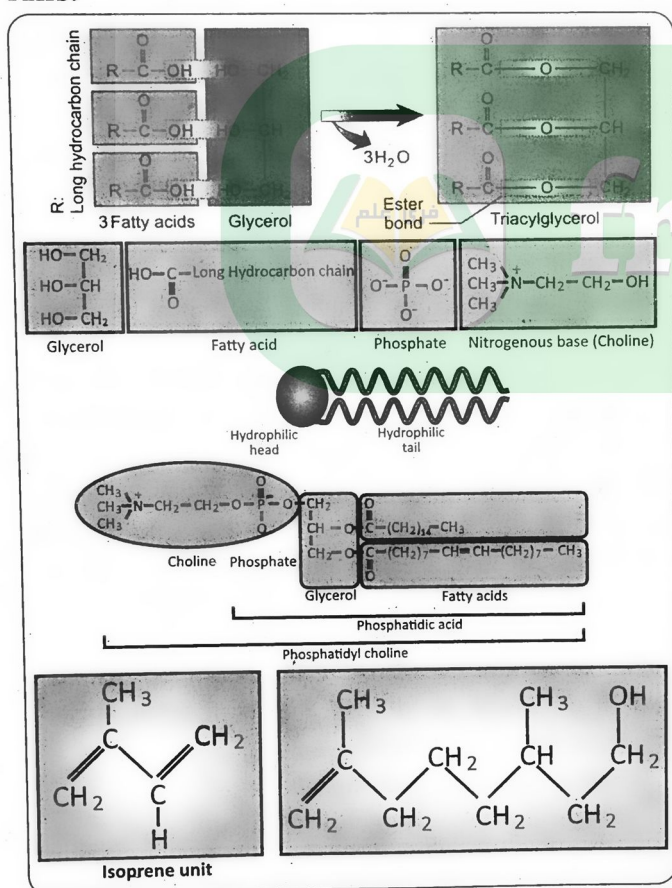


Q5. Outline the synthesis of peptide linkages.

Ans. A covalent bond that links two amino acids is known as a peptide bond. Each amino acid has an amino group at one end and a carboxyl group at the other end. When two amino acids are brought closer, dehydration synthesis occurs between the amino group of one and the carboxyl group of second amino acid. It results in the release of a molecule of water and formation of a peptide bond between "N" and "C" of adjacent amino acids.

Q6. Draw the sketch of acylglycerol, phospholipid and terpene.

Ans.



Q7. Differentiate between nucleoside and nucleotide.

Ans. A nucleotide is made up of a nucleoside and phosphoric acid. A nucleoside is made of a nitrogen base and a pentose sugar

Q8. Illustrate the formation of phosphodiester bond.

Ans. In one nucleotide, phosphoric acid has an ester linkage at C-5 of pentose sugar. This phosphoric acid develops another ester linkage at C-3 of pentose sugar of another nucleotide. In this way, each phosphoric acid has two ester linkages with two pentose sugars (one at C-5 and other at C-3). The two ester linkages developed by phosphoric acid with two pentose sugars are known as phosphodiester linkage. This linkage joins two nucleotides.

Q9. State the central dogma of gene expression.

Ans. All organisms use the same basic mechanism of reading and expressing genes, which is often referred to as central dogma.

- The first step of central dogma is the transfer of information from DNA to RNA, which occurs when an RNA copy of the gene is produced. The process is called transcription.
- The second step of the central dogma is the transfer of information from RNA to proteins, which occurs when the information contained in the RNA is used to direct the synthesis of proteins. This process is called translation. In this way DNA controls the properties and activities of a cell.

SLO BASED SHORT QUESTION ANSWERS

Q10. Define biochemistry. Why the basic knowledge of it, is important to understand life?

Ans. Biochemistry is the study of chemical components and chemical process, occurring in living organisms. As all structures of living organisms have **biochemical organization** and all functions occurring in them are due to biochemical processes, taking place in this organization. Therefore, the basic knowledge of biochemistry is helpful to understand anatomy and physiology of living organisms.

Example: For example, photosynthesis, respiration, digestion, contraction etc can be described in biochemical terms.

Q11. Define metabolism write its types.

Ans. All the chemical reactions taking place within a cell are collectively called metabolism. The processes in metabolism may be either anabolism or catabolism.

- In **anabolism**, simpler substances are combined to form complex substances.
- In **catabolism** complex molecules are broken down into simpler ones.

Biological Molecules

Q12. Compare the percentage composition of major organic molecules that make 93% of dry mass of living organisms.

Ans.

Percentage of major organic molecules In the dry mass of living organisms	
Group Name	% Dry mass
Proteins	50
Nucleic Acids	18
Carbohydrates	15
Lipids	10

Q13. Define the term "polymer". How does the structure of polymer is formed in living cells?

Ans. A polymer is a molecule consisting of many identical molecular units, called monomers. Many macromolecules are in the form of polymers. Most of the organic molecules are large in size and biologists call them macromolecules. Important macromolecules like carbohydrates, proteins, and nucleic acids are the polymers of simple monomers i.e., sugars, amino acids and nucleotides respectively.

Types of Bond in Biology

Q14. Describe the significance of carbons tetravalency in forming organic molecules and bonds.

Ans. Carbon is the basic element of organic molecules. It is tetravalent and can react with many other known elements like H, O, N, P and S.

- Carbon and hydrogen bond (C-H bond) is the potential source of chemical energy for cellular activities.
- **Carbon-oxygen association** in glycosidic linkages provides stability to the complex carbohydrate molecules.
- **C-N bond:** Carbon combines with nitrogen in amino acid linkages to form peptide bonds and forms proteins which are very important due to their diversity in structure and functions.

Q15. Compare and contrast covalent and ionic bond in terms.

- How they are formed
- Their relative strengths
- Their roles in biological molecules

Ans.

Covalent Bonds	Ionic Bonds
• Covalent bonds form when two atoms share electrons. • These are less strong than ionic bond.	• Ionic bonds are formed when one atom donates an electron (becomes a positive ion, or cation) and another atom accepts the

- These bonds are often found in organic molecules like proteins and nucleic acids, providing stability to the molecules.

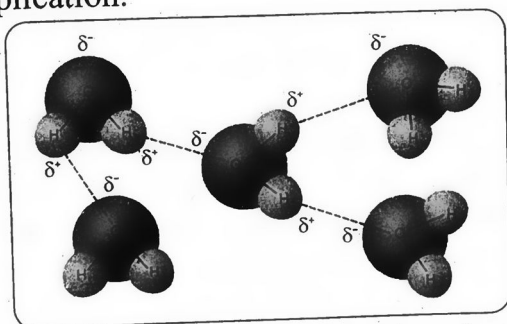
electron (becomes a negative ion, or anion). The electrostatic attraction between these oppositely charged ions forms the ionic bond.

- Ionic bonds are relatively strong in the solid state.
- They are formed mostly in inorganic molecules like sodium chloride.

Q16. Why are hydrogen bonds considered to be weak individually but crucial for maintaining the structures of cells?

Ans. Hydrogen bonds are weak attractions that occur between a hydrogen atom and an electronegative atom (such as oxygen or nitrogen).

- These bonds are important in maintaining the structure of large molecules like proteins and nucleic acids, as well as in various biological processes like DNA replication.



Hydrogen bonds between water molecules

Q17. Describe hydrophobic interactions. How do these interactions differ from hydrophilic interactions?

Ans. Hydrophobic interactions occur between nonpolar molecules and polar molecules (like water). Nonpolar molecules tend to cluster together in aqueous

environments to minimize contact with water molecules.

- This phenomenon is crucial for the folding of proteins and the formation of lipid bilayers in cell membranes.

Hydrophilic interactions occur between polar molecules and water molecules. These interactions are essential for the dissolution of polar and ionic compounds in water.

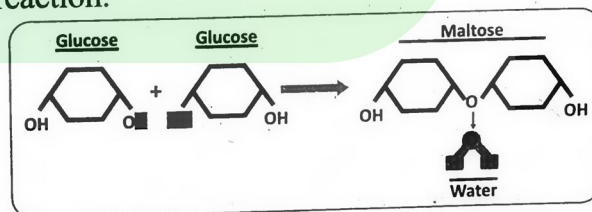
- These interactions help in various biological processes such as nutrient transport and chemical reactions within cells.

Condensation and Hydrolysis

Q18. Discuss the process of dehydration synthesis using the example of maltose formation.

Ans. During condensation, an -OH group is removed from one monomer and a -H atom is removed from another monomer. It is also known as dehydration synthesis because the removal of OH and H groups means the removal of a water molecule.

The formation of maltose by two glucose monomers is an example of a condensation reaction.



Proteins, nucleic acids, carbohydrates, and lipids are assembled from different kinds of monomers. All these biomolecules join their monomers by condensation or dehydration process.

Importance of Water

Q19. Describe how hydrogen bonding between water molecules enables the dissolution of other polar molecules? / Describe the solvent properties of water. / What will happen if there is no hydrogen bonding in water?

Ans. Solvent Properties

1. The ability of water to dissolve a wide variety of substances is due to its two properties, the polarity of water molecules

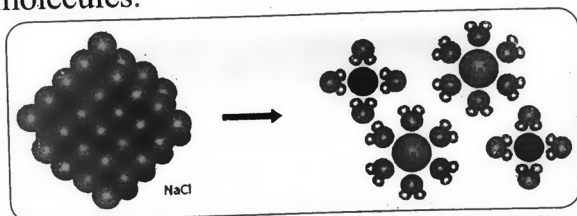
and the ability of water molecules to form hydrogen bonds.

- The water molecule has distinct ends, each with a partial charge. Hydrogen atom is **partially positive** and oxygen atom is **partially negative**. Such molecules are called polar molecules.
- Partial negative charge at one end of a water molecule is attracted to partial positive of another water molecule. This weak attraction is called a hydrogen bond. Water forms a network of such bonds. Many of the properties of water are due to hydrogen bonds in water.
- If water lacked H-bonds, it would have existed as a gas, and the properties like high boiling point, surface tension, and other properties would disappear and it will be difficult for life to exist.

Q20. How does polar nature of water molecules help in dissolution of NaCl and glucose? Water provides a medium for metabolism justify?

Ans. Due to the polar nature of water molecules, they gather around any other molecule that has an electrical charge, whether in the form of full charge (ions) or partial charge (polar molecules).

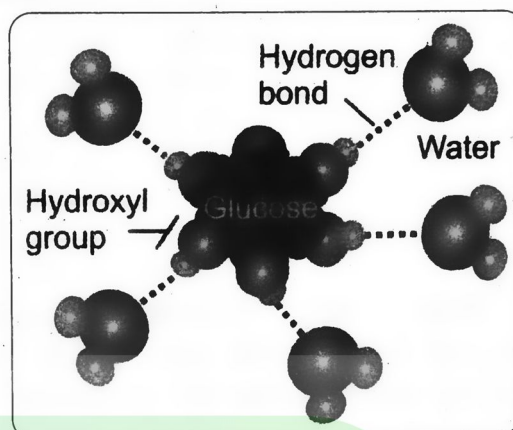
- For example**, when sodium chloride (a salt) is placed in water, it breaks into positive (Na^+) and negative (Cl^-) ions. These ions are surrounded by opposite polar ends of water molecules.



Water as solvent of inorganic molecules (NaCl)

- Similarly, when a glucose is placed in water, the molecules of water form **hydrogen bonds with polar hydroxyl groups of glucose** molecules. In this way,

glucose dissolves in water (Figure 4.8). It means that charged or polar molecules are soluble in water. In the state of solution, ions and molecules can react with each other easily. So, water provides a medium for chemical reactions i.e., metabolism of cells.



Water as a solvent of organic molecules (glucose)

★Q21. Differentiate between hydrophilic and hydrophobic molecules.

Ans. Hydrophilic: Polar molecules such as salts, sugars, and amino acids dissolve readily in water and are called hydrophilic (water-loving).

Hydrophobic: Uncharged or non-polar molecules such as lipids do not dissolve in water and are called hydrophobic (water-hating).

Q22. Why non-polar or uncharged molecules are insoluble in water? Describe hydrophobic exclusion? / Why lipids are insoluble in water?

Ans. Non-polar or uncharged molecules are insoluble in water because water molecules **do not make hydrogen bonds** with them. When they are placed in water, water molecules move them out. The insoluble molecules make hydrophobic associations with one another.

For example, lipid molecules are insoluble in water. When they are excluded from water, they make strong associations among

themselves. Therefore, lipids help to maintain membranes of cells.

Q23. Define heat capacity. How does water work as temperature stabilizer?

Ans. Definition: Specific heat capacity is defined as the number of calories (amount of heat) required to raise the temperature of 1 gram of a substance from 15°C to 16°C (i.e., 1°C).

Heat capacity of water: Water has a high specific heat capacity i.e., **4.184 Joules**. It means that water has great ability to absorb and releasing heat with minimum change in its own temperature.

Water as temperature stabilizer: Most of the heat energy absorbed by water is used to break hydrogen bonds between its molecules. Due to this **breakage of hydrogen bonds**, individual water molecules start moving more freely and temperature of water rises.

- Due to high specific heat capacity, water **heats up more slowly**. Similarly, when it is given a cooler environment, it holds its temperature longer. Water thus works as temperature stabilizer not only for organisms' internal environment but also for their external environment.

Q24. Define heat of vaporization. What is the benefit of this property of water to living organisms?

Ans. Definition: It is the amount of heat required to change a liquid to gas.

Heat of vaporization of water: Water has high heat of vaporization. It absorbs much heat while changing from liquid state to gas. Its heat of vaporization is **574 Kcal/kg** which means a considerable amount of heat energy (574 Kcal) is required to change 1kg of liquid water into vapours.

Cooling Effect: Due to this property, Earth's temperature is kept moderate. It also provides cooling effects to plants and

animals when they transpire and perspire (sweat).

- Every gram of water that evaporates from plant or animals' body surface removes 574 calories of heat from the body.

Q25. Define cohesion. How it is important for living world? How strider walks on water?

Ans. Hydrogen bonds among water molecules enable them to "**stick together**". This type of attraction between same type of molecules is called cohesion.

- Inside water, molecules have high cohesion. The cohesion of water is important for living world.
- **Plants** depend on cohesion among water molecules for the transport of water and nutrients from roots to leaves. The evaporation of water from a leaf exerts a pulling force on water within xylem vessels of the leaf. As a result, water rises against the force of gravity.
- **High surface tension:** Hydrogen bonds also give water high surface tension. Water behaves as if it were coated with some invisible film. The insect **water-strider** walks on water without breaking surface.

Q26. Briefly describe ionization of water and its significance.

Ans. Ionization of water: When the covalent bonds among the atoms of water molecule break, water is ionized to form hydrogen ions (H^+) and hydroxyl ions (OH^-). At normal conditions, this reaction is reversible and equilibrium is maintained. At room temperature (25°C), in a litre of water **one molecule out of each 550 million** is ionized and thus the concentration of each of H^+ and OH^- in pure water remains at 10^{-7} moles/litre.

Significance: H^+ and OH^- ions take part in many chemical reactions in the cells e.g.,

hydrolysis of macromolecules. Relative concentrations of H^+ and OH^- ions determine the acidity and alkalinity of medium i.e., pH of medium. The pH affects the biochemical reactions. Enzymes work best at specific pH.

Q27. What is the effect of temperature on density of water? How it is beneficial for sustaining aquatic life?

Ans. Effect of temperature on density

Water exhibits its **maximum density at $4^\circ C$** . Its density **decreases** when the temperature **lowers**. It is because of the hydrogen bonds which keep water molecules relatively far apart. When temperature **falls to $0^\circ C$** , water freezes but the resulting ice is less dense than liquid water, because at this temperature, hydrogen bonding keeps water molecules further apart than in liquid water.

Significance for aquatic life: In rivers, streams or lakes, ice is formed on the surface water due to falling of temperature. As **ice is less dense than water**, it floats on surface. It acts as an insulator and does not

allow heat to escape from the water beneath it. In this way aquatic organisms are protected.

Carbohydrates

Q28. Define carbohydrates. Write their empirical formula and classify them.

Ans. Carbohydrate are naturally occurring organic compounds. The word "carbohydrate" literally means "hydrated carbon". Carbohydrates are synthesized as the primary products of photosynthesis. During photosynthesis, when reduction of CO_2 occurs, the resulting carbohydrate molecule contains carbon, hydrogen and oxygen in the molar ratio of 1:2:1.

Empirical formula: Their empirical formula is $C(H_2O)_n$ where 'n' is the number of carbon atoms.

Classification of Carbohydrates

Carbohydrates are classified into three groups:

1. Monosaccharides
2. Disaccharides
3. Polysaccharides.

Q29. Characterize and classify monosaccharides with examples.

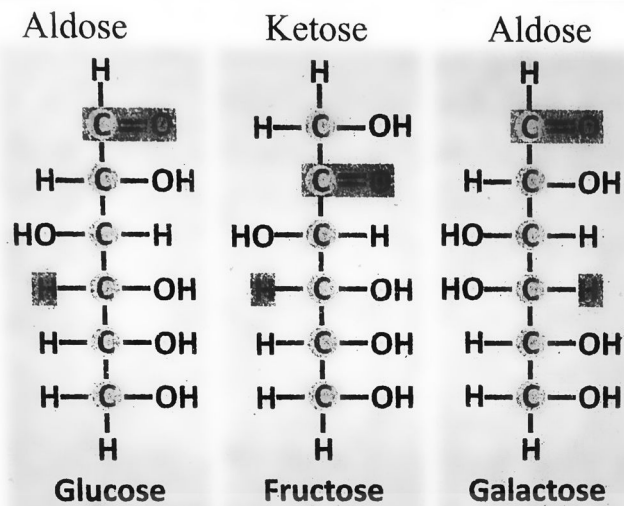
Ans. Monosaccharides: Monosaccharides (simple sugars) are made of single sugar molecule. They are easily soluble in water. They may have 3 – 7 carbon atoms. They are further classified into subgroups on the basis of number of carbon atoms.

Classification of monosaccharides

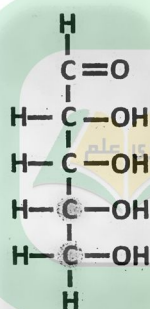
Monosaccharides	Carbon atoms	Formula	Examples
Trioses	3	$C_3H_6O_3$	Glyceraldehyde, Dihydroxyacetone
Tetroses	4	$C_4H_8O_4$	Erythrose, Erythulose (intermediate in photosynthesis in bacteria)
Pentoses	5	$C_5H_{10}O_5$	Ribose, Deoxyribose ($C_5H_{10}O_4$), Ribulose
Hexoses	6	$C_6H_{12}O_6$	Glucose, Fructose, Galactose
Heptoses	7	$C_7H_{14}O_7$	Rare in nature (intermediate in photosynthesis)

Q30. Draw the Fischer projections of glucose, fructose, galactose and ribose.

Ans.



Aldose



Ribose

Q31. Differentiate between alpha D-glucose and Beta D glucose. / Starch and cellulose both are the polymers of glucose, then why they are different molecules / polysaccharides.

Ans. There are two forms of D-glucose i.e., **alpha D-glucose** and **beta D-glucose**. They differ only in the direction of OH groups on carbon 1.

α-D-glucose: The α-D-glucose has OH group on the lower side.

β-D-glucose: The β-D-glucose has OH on above side.

When many alpha D-glucose molecules join together, they form a polymer called starch.

When many beta D-glucose molecules join together, they form a polymer called cellulose.

Q32. Compare the Fischer and Haworth projections. / Which two ways are used to represent the structure of sugar molecules?

Ans. Fischer and Haworth projections are two ways to represent the structure of sugar molecules.

Fischer projection: The Fischer projection was devised by German chemist Emil Fischer in 1891, In a Fischer projection the carbohydrate is shown in its **open chain** form, rather than a cyclical one.

Haworth projection: The Haworth projection is named after British Chemist Sir Norman Haworth. It shows sugars in their **cyclic forms**.

Q33. Define disaccharides. How disaccharides are formed? Name physiologically important disaccharides.

Ans. Disaccharides: They are made from two monosaccharides by the process of dehydration synthesis.

Glycosidic bond: The covalent bond between two monosaccharides is called glycosidic bond.

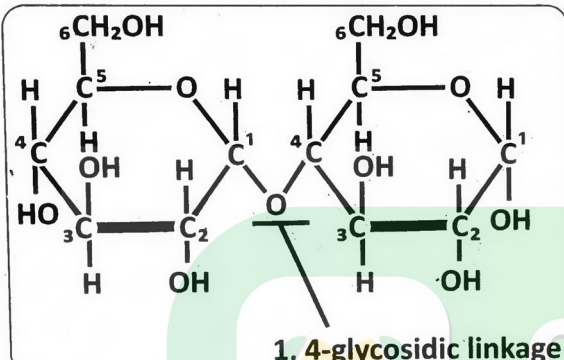
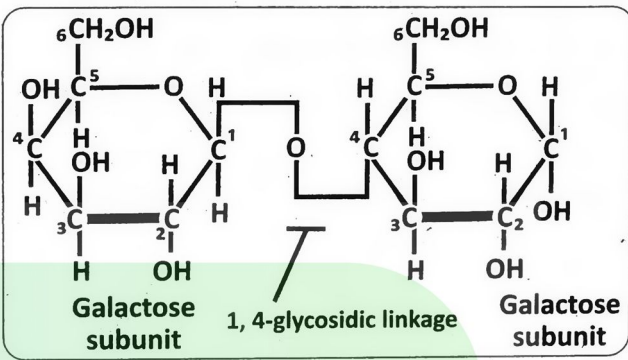
Hydrolysis: On hydrolysis, they yield monosaccharide monomers, of which they are made.

Solubility: As compared to monosaccharides, they are less soluble in water. Physiologically important disaccharides are:

- i. Maltose (Malt Sugar)
- ii. Lactose (Milk Sugar)
- iii. Sucrose (Cane Sugar)

Q34. Differentiate between maltose and lactose.

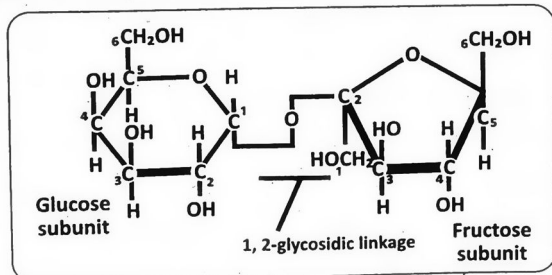
Ans.

Maltose	Lactose
- It is made up of two glucose monomers. - The glucose molecules are attached by 1,4-glycosidic bond between carbon 1 of one and carbon 4 of the other glucose. - It is found in many cereals (wheat, corn etc.) and is also formed (as an intermediate product) during the digestion of starch.	- It is made up of one glucose and one galactose subunit. - It is galactose 1-4 glucose. - It is found only in mammalian milk, and is the main source of energy for infant mammals.
 1, 4-glycosidic linkage	 Galactose subunit 1, 4-glycosidic linkage Glucose subunit

Q35. Draw the structure of sucrose. Also write its formula and importance.

Ans. Composition: It is made up of **one glucose and one fructose** subunits i.e., it is **glucose 1, 2-fructose**.

Structure: It is the most familiar disaccharide and is also known as **table sugar**. It acts as a **sweetener** in our food.



Formula: Its molecular formula is $(C_{11}H_{22}O_{11})$.

Importance: It is found in **phloem vessels** of higher plants where it acts as a **transport product** for the conduction of glucose to and from different parts of plant. That is

why it is also known as transport disaccharide.

★Q36. High-fructose corn syrup is better than sucrose extract. Justify?

Ans. High fructose corn syrup is better than sucrose extract because it is cheaper and sweeter. In 1980's a method was developed to convert the glucose of corn starch into fructose which is sweeter than sucrose. Now this syrup is widely being used in food and soft-drinks.

Q37. What are polysaccharides? Name some important polysaccharides.

Ans. The type of polysaccharides which upon hydrolysis yield many (more than 10) monosaccharide subunits are called polysaccharides.

Characteristics

- They are most complex and most abundant carbohydrates.
- Tasteless and sparingly soluble in water.

Important polysaccharides: Important polysaccharides include starch, glycogen, cellulose, pectin, lignin, chitin, agar and murein.

Q38. Differentiate between amylose and amylopectin. Why are they broken down at different rates?

Ans.

Amylose	Amylopectin
• Amylose is a chain made of glucose monomers (with 1,4-glycosidic linkages). • It is straight and unbranched. However, it tends to coil up into a helix.	• Amylopectin is also a chain of glucose monomers (with 1,4-glycosidic linkages). • It has branches (with 1,6-glycosidic linkages).

Both amylase and amylopectin are broken down by **amylase** at different rates because of their structure. Amylopectin being is **branched** having more ends, that's why it is broken more quickly by amylases as compared to unbranched amylose.

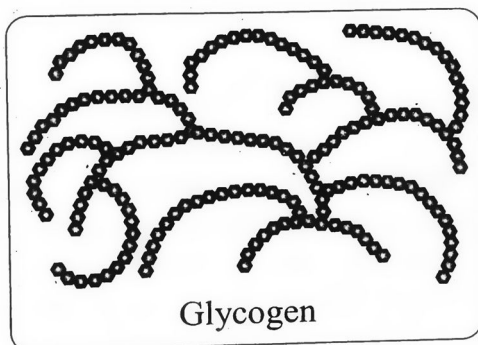
Q39. Glycogen is similar in structure to amylopectin. Justify? Write its occurrence.

Ans. Similarity with amylopectin

It is similar in structure to amylopectin. It is a chain of glucose monomers (with 1,4-glycosidic linkages) with branches (with 1,6-glycosidic linkages).

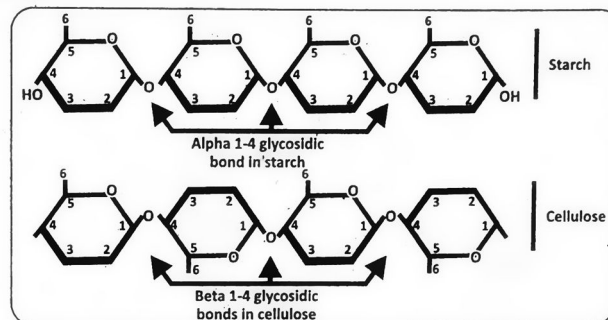
Occurrence: It is made by animals as their **storage polysaccharide**, and is found mainly in muscles and liver.

Breakdown: Because it is so highly branched, it can be broken down to glucose very quickly.



Q40. Draw the structure of starch and cellulose.

Ans.



Q41. Starch forms granules while cellulose make fibrils. Comment.

Ans. The **alpha 1-4 glucose polymer** in starch coils up to form granules. On the other hand, the **beta 1-4 glucose polymer** in cellulose forms **straight chains**. Hundreds of these chains are linked together by **hydrogen bonds** to form **cellulose microfibrils**. These **microfibrils** make **cellulose fibrils**.

Significance: They are very strong and rigid, and give strength to plant cells, and therefore to young plants and also to materials such as paper, cotton etc.

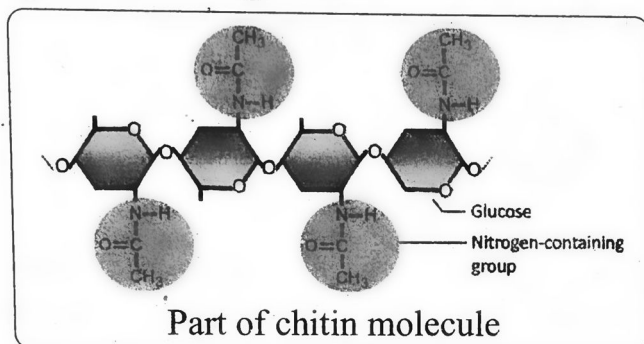
★Q42. Starch and cellulose are formed by glucose monomers, then why does amylase cannot break / act on cellulose?

Ans. The **beta-glycosidic bond** cannot be broken by amylase. It requires a specific **cellulase** enzyme. Some bacteria and some protozoans are only organisms that possess cellulase enzyme. Herbivore animals, like cows and termites whose diet is mainly cellulose, have mutualistic bacteria in their guts. These bacteria digest their cellulose. Humans cannot digest cellulose, and it is referred to as dietary fibre.

Q43. Chitin has glucose monomers and same glycosidic linkage, as in cellulose. Then why are they different?

Ans. Like cellulose, chitin is also a polymer of glucose. The linkage between

glucose monomers is also like that found in cellulose. However, in chitin **each glucose molecule has been modified** by the addition of a nitrogen-containing group. Only few organisms can digest it.



Proteins

Q44. Define proteins. Who coined the term protein?

Ans. Proteins are the most abundant organic compounds in cell, which are defined as the polymers of amino acids.

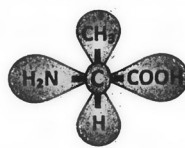
J. Berzelius (in 1938) coined the term "protein" (Greek "Proteios"- **molecules of the first rank**) to emphasize the importance of this group.

Q45. Draw the structures of glycine and alanine.

Ans. Glycine



Alanine



Q46. Differentiate between essential and non-essential amino acids?

Ans.

Essential Amino acids	Non-essential Amino acids
The amino acids which are not synthesized by our body are called essential amino acids. The nine amino acids cannot make	Out of 20 amino acids, our bodies can make eleven amino acids . These are called non-essential amino acids alanine, arginine,

our bodies on its own and must obtain these amino acids by eating various foods. These are called **essential amino acids**. methionine, valine, tryptophan, isoleucine, leucine, lysine, threonine, phenylalanine and histidine (necessary only for babies).

asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine.

Q47. Name 11 essential and 9 non-essential amino acids.

Ans. Non-Essential amino acids

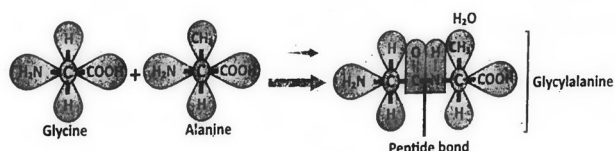
Alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine and tyrosine.

Essential amino acids

Methionine, valine, tryptophan, isoleucine, leucine, lysine, threonine, histidine and phenylalanine.

Q48. How glycylalanine is formed?

Ans. The amino acids, which are linked by peptide bond, are called **peptides**. A dipeptide is formed by the linkage of two amino acids. For example, glycylalanine (a dipeptide) is formed by the linking of glycine and alanine.



Formation of peptide bond between glycine and alanine

Q49. Differentiate between peptide, dipeptide, polypeptide and protein.

Ans. Peptide: The amino acids which are linked by peptide bond are called peptides.

Dipeptide: When two amino acids are linked by peptide bond, it is called a dipeptide e.g. glycylalanine.

Polypeptide: Addition of amino acids in a dipeptide (because both ends of dipeptide are reactive) ultimately leads to the formation of a chain, is called polypeptide chain.

Protein: When one or more polypeptide chains assume different shapes on the basis of number, types and sequence of amino acids, forms protein molecule.

Q50. How a protein attains its primary structure? Why does the primary structure play a crucial role in functioning of a protein?

Ans. The primary structure of a protein molecule is formed by the **linear arrangement of amino acids**. It represents the **number and sequence of amino acid** molecules in a polypeptide chain.

- All protein molecules (whether simple or complex) have specific primary structures.
- **Crucial role:** The number, sequence and types of amino acids is highly specific in the primary structure of a protein, for its proper functioning. This specificity in primary structure is determined by the order of nucleotides in DNA. Any change results in abnormal protein that fails to carry out its normal function, e.g., in sickle cell anemia occurs due to problem in primary structure of β -chain of hemoglobin.

Q51. How sickle cell anaemia is caused? At which level mistake / mutation occurs?

Ans. **Sickle cell haemoglobin** is formed by a mistake in the arrangement of only one amino acid in position **six** in each **beta chain**. In sickle cell haemoglobin, amino acid **valine** is present in the place of **glutamic acid**. Due to sickle cell

haemoglobin, red blood cells get sickle shapes and abnormal haemoglobin cannot transport sufficient oxygen. This disease is known as **sickle cell anaemia**.

Q52. Describe the secondary structure of proteins. Which bond plays crucial role in maintaining secondary structure?

Ans. In many proteins, **folding or coiling patterns** occur within a polypeptide chain. This structure is called **secondary structure**.

Coiling of a polypeptide chain results in **alpha helix** while **folding** makes a pleated sheet. Both these structures are maintained by **hydrogen bonds** between amino and carboxyl groups of nearby amino acids in the chain.

Q53. How a protein attains tertiary level or organization? Name the bonds which maintain tertiary structure.

Ans. When the **secondary structure** further **folds up** and gets a complicated globular shape, it is called the **tertiary structure of protein**. These are more complex proteins. The globular shape is maintained by **ionic, hydrogen and disulphide bonds**.

Q54. How tertiary structure of proteins is made stable?

Ans. Amino acids in a polypeptide chain interact with water to give the most stable tertiary structure in the form of a globular shape. These are hydrophilic and hydrophobic interactions. The hydrophobic (non-polar) amino acids aggregate in such a way that they disrupt hydrogen bonding of water molecules and so are buried inside. At the same time the hydrophilic (polar) amino acids turn out, towards the surface of water.

Q55. Elaborate the quaternary structure of proteins. Name the bonds which maintain it.

Ans. When two or more polypeptide chains with **tertiary structures** are held together by **hydrophobic interactions**, **hydrogen bonds** and **ionic bonds**, they

form most complex proteins. This aggregation of tertiary structures makes the quaternary structure of protein.

Q56. Compare fibrous and globular proteins in terms of.

i) Shape ii) Structure iii) Role iv) Examples

Ans.

Characteristics of Fibrous and Globular Proteins		
Characteristics	Fibrous Proteins	Globular Proteins
Shape	In the form of fibrils	Spherical or ellipsoidal
Structure	Primary or secondary	Tertiary or quaternary
Role	Structural	Functional
Examples	Silk fibre – form the webs of silk worm and spider Actin in muscle cells Fibrin – in blood clots Keratin – in nails, hairs, beak, skin etc Collagen – in matrix of connective tissues	Enzymes – biocatalyst Antibodies – active against invading antigens Hormones – regulate body's activities Haemoglobin – oxygen carrying protein

Lipids

★ **Q57. Define ester. Classify lipids.**

Ans. An ester is the compound produced as the result of a chemical reaction of an **alcohol with an acid** and a water molecule is released.



Classification of lipids: Acylglycerols, waxes, phospholipids, terpenes, steroids and prostaglandins.

Q58. Differentiate between fats and oils also write their occurrence. / Why animal fats contain more energy than do plant oils?

Ans. Animals fats have more energy than plant oils because, they have more number of saturated fatty acids, so more the number of CH-bonds, hence more energy than unsaturated fatty acids with lower number of CH-bonds in plant oils.

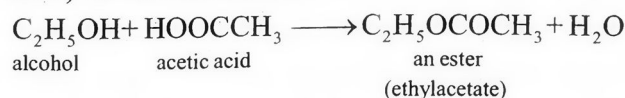
Fats

Oils

- | | |
|--|---|
| <ul style="list-style-type: none"> • The acylglycerols which are solid at room temperature, are called fats. • In animals, most acylglycerols are fats e.g., butter, meat and fat. | <ul style="list-style-type: none"> • The acylglycerols which are liquid at room temperature, are called oils. • In plants, most acylglycerols are oil: for example, peanut oil, corn oil, castor oil. |
|--|---|

Q59. Define acylglycerols. Name the acylglycerol found most widely.

Ans. Chemically, acylglycerols are the esters of fatty acids and alcohol. They are synthesized through dehydration synthesis (H is released from alcohol and OH from an acid) as shown below.



The most widely found acylglycerols are **triacylglycerol** (triglycerides), also called **neutral lipids**. In triacylglycerols, three

molecules of fatty acid (same or different) are joined to a single glycerol backbone.

Q60. Define fatty acids and glycerol.

Ans. Glycerol: It is a 3C alcohol and each of its carbon bears a hydroxyl group. The 3 carbons of glycerol form the **backbone of acylglycerol molecule**, to which three fatty acids are attached.

Fatty acids: These are **responsible for all the characteristics of acylglycerols**. Fatty acids are long hydrocarbon chains (with carbon in **even number 4 – 30**), ending in a carboxyl (-COOH) group. They vary in length and may be as straight chains (in animals) or branched or ringed (in plants).

Q61. between saturated and unsaturated fatty acids.

Ans.

Saturated fatty acids	Unsaturated fatty acids
• Saturated fatty acids contain no double bond in their hydrocarbon chain. • In saturated fatty acids, all internal carbon atoms possess hydrogen side- groups. • These fatty acids make straight chains, and have a high melting point e.g., butyric acid, palmitic acid.	• Unsaturated fatty acids have double bonds (6 maximum) between one or more pairs of carbon atoms. • The double bonds replace some of the hydrogen atoms. Therefore, unsaturated fatty acids contain fewer number of hydrogen atoms. • These fatty acids form bent chains, and have a low melting point.

Q62. Write only examples of fibrous and globular proteins.

Ans.

Characteristics	Fibrous Proteins	Globular Proteins
Examples	Silk fibre -form the webs of silk and spider Actin in muscle cells Fibrin – in – skin etc. Collagen – in matrix of connective tissues	Enzymes – biocatalyst antibodies – active against invading antigens. Hormones – regulate body's activities. Haemoglobin – oxygen carrying protein

Q63. Describe the role of sodium potassium pump in a cell.

Ans. Channel proteins in the membranes of cells control the movement of materials in and out of cells. For example, proteins make sodium– potassium pump in the cell membrane of neurons. This pump controls the movement of **Na⁺ and K⁺ ions** in and out of **nerve cell**.

Q64. Which class of proteins are involved in transport of materials? Justify with examples.

Ans. Some globular proteins work to transport different materials throughout the

body. For example; **haemoglobin** and **myoglobin** transport O₂ and some CO₂, and **cytochromes** work in electron transport chain as electron carriers.

★Q65. How blood ferritin levels are significant as a diagnostic tool of anaemia?

Ans. Blood ferritin levels are measured in patients as a diagnostic tool of anaemia. If **ferritin is high**, there is iron in excess. If **ferritin is low**, there is a risk for lack of iron which sooner or later could lead to **anaemia**.

Q66. Write down the functions of proteins given below.

- (i) Repressors (ii) Antibodies
(iii) Albumin (iv) Fibrinogen

Ans. (i) **Repressors** are the proteins that **regulate gene action** by preventing the synthesis of RNA. These proteins allow genes to work where and when required.

(ii) **Antibodies** are important proteins. They **recognize** and combine with foreign substances (**antigens**) and convert them into harmless products.

(iii) **Ion-binding proteins** store ions in different parts of body. For example, ferritin is the main intracellular iron storage protein. Similarly, casein is a milk protein that stores potassium and calcium ions.

(iv) **Blood clotting** is important to prevent the loss of blood after an injury.

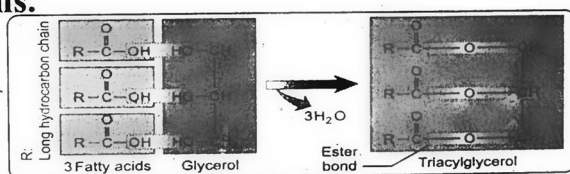
(v) **Fibrinogen** protein is present in blood. When an injury occurs, fibrinogen is activated into fibrin. The fibrin makes fibres and a clot is formed.

Q67. What is the difference between mono-unsaturated and poly-unsaturated fatty acids?

Ans. If a fatty acid has one double bond it is called mono-unsaturated e.g., oleic acid. If there are more than one double bond, it is called poly-unsaturated e.g., linoleic acid.

Q68. Write an equation showing the formation of triacylglycerol.

Ans.



Dehydration synthesis of a triacylglycerol

Q69. Write the chemical composition of waxes.

Ans. They are mixtures of

- Long chain alkanes (with carbon atoms in odd number; 25-35),
- Alcohols (other than glycerol), ketones
- Long chain fatty acids.

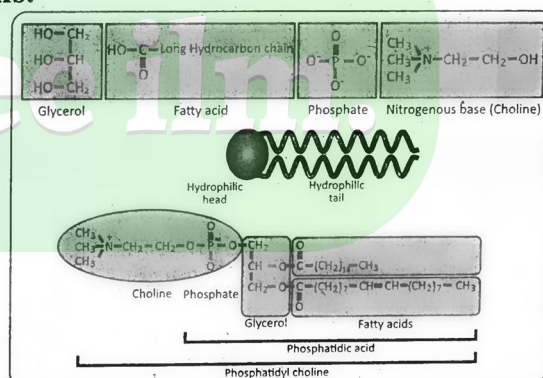
Q70. Describe the roles of waxes played in living organisms.

Ans. Waxes are chemically **inert**. Like other lipids, waxes are strongly hydrophobic. They act as **protective coverings** and **water barriers** for living organisms. Waxes are widespread as protective coatings on fruits and leaves. Some animals like insects, birds, sheep etc. also secrete waxes over their skin.

Waxes are used to **waterproof paper** and **cards**. Waxes are also used in wax polishes for furniture, footwear and vehicles. Waxes are also used to make candles. Waxes with coloured pigments are used in making crayons and coloured pencils.

Q71. Draw the structure of Phosphatidylcholine.

Ans.



Q72. Define phospholipids. Write their common examples.

Ans. Chemically they are the **derivatives** of **phosphatidic acid**. Phosphatidic acid is composed of **one glycerol**, **two fatty acids** and **one phosphoric acid (phosphate)**. Any nitrogenous base e.g., choline, ethanolamine or serine attaches with its phosphoric acid and makes phospholipid.

Examples: Common examples are phosphatidyl choline (lecithin), phosphatidyl ethanolamine and phosphatidyl serine. Phosphatidyl choline forms lipid bilayer in plasma membranes.

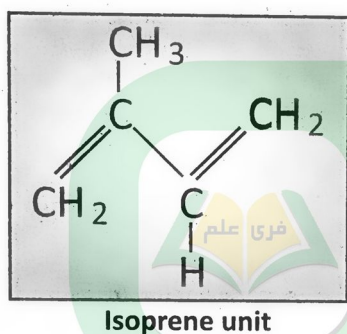
Q73. What are terpenes? Write its molecules formula and importance.

Ans. It is a very large and diverse group of lipids. All terpenes are made of **isoprene units**. An isoprene unit is a **branched unsaturated hydrocarbon** chain with the formula $\text{CH}_2=\text{C}(\text{CH}_3)-\text{CH}=\text{CH}_2$.

Importance: Terpenes form many biologically important pigments, such as chlorophyll in plants and retinal pigments in eyes. **Vitamin A** and rubber are also terpenes.

Q74. Draw the structure of an isoprene unit.

Ans.



Q75. Write few lines about steroids.

Ans. Steroids: Steroids are lipids whose **carbon skeleton** is bent to form four fused rings. All steroids have the same ring pattern i.e., three 6-cornered rings and **one 5-cornered ring**. **Cholesterol** is a common steroid in animal cell membranes. Animal cells also use it for making other steroids e.g., male and female sex hormones.

★Q76. Why anabolic steroids are banned today?

Ans. In 1950s some pharmaceutical companies produced **anabolic steroids** for the **treatment of general anaemia**. Some athletes began using anabolic steroids to build-up their muscles quickly and enhance their performance. Today, anabolic steroids are banned. Anabolic steroids can cause serious physical and mental problems e.g.,

deep depression, liver damage sweating, insomnia rest less.

Q77. What are prostaglandins? Write their important functions.

Ans. Prostaglandins are a group of lipids that are **modified fatty acids**, with **non-polar tails** attached to a **five-carbon ring**.

Importance: They occur in many tissues of vertebrates, where they act as **local chemical messengers**. Some of them **stimulate smooth muscles** to contract and relax; others constrict or expand the diameter of blood vessels. They are also involved in **inflammatory response** to infection.

Q78. Discuss some important roles of lipids in life.

Ans. Lipids are important sources of energy (ATP).

In fact, lipids are the most energy rich of all nutrients. **One gram** of lipids provides **9.5 kilocalories** of energy. The same amount of protein provides **5.6 kilocalories** while that of carbohydrate provides **4.1 kilocalories**.

- Lipids are **essential components** of all **cellular and subcellular membranes**. They serve as **biological carriers** for the absorption of fat-soluble vitamins A, D, E and K.
- Lipids are a **source of fatty acids**, which are essential for various metabolisms. Lipids play a role as a **mechanical cushion/support** for vital body organs.
- The lipids (fats) present beneath skin, insulate the body from extreme temperatures.

Q79. Quote some important biological functions of steroids. / Write important functions of cholesterol.

Ans. Steroids perform a wide range of important biological functions. For example, **cholesterol** is involved in the maintenance

of membranes. It also helps in lipid transport. It is a precursor of vitamin D, bile acids and steroid hormones (androgens, estrogens), adrenal hormones and corticosteroids.

Nucleic Acids

Q80. Write down the location of RNA and DNA.

Ans. DNA is found mainly in **chromosomes**, with small amounts in mitochondria and **chloroplasts**.

RNA is found in **nucleolus, ribosomes** and **cytosol**.

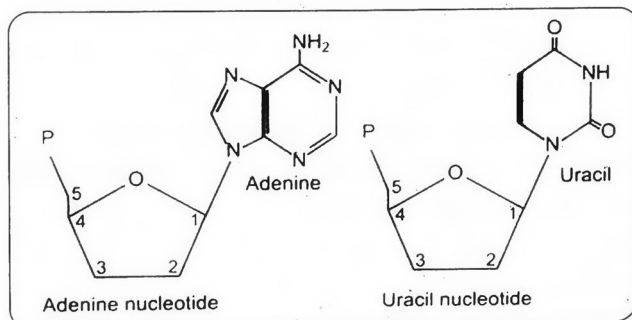
Q81. Differentiate between purines and pyrimidines.

Ans.

Pyrimidine	Purines
Pyrimidine is a single ringed nitrogenous base. There are three pyrimidine bases in nucleic acids. Cytosine (C) is present in both DNA and RNA, thymine (T) is present only in DNA, and uracil (U) is present only in RNA.	Purine is a double ring nitrogenous base. Both DNA & RNA contain two purine bases i.e., adenine (A) and guanine (G).

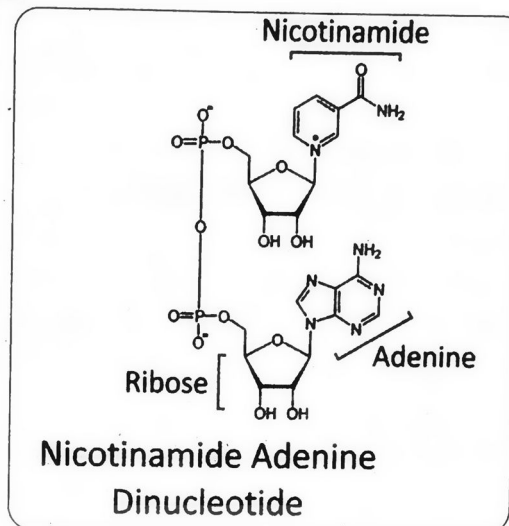
Q82. Draw the sketch of adenine and nucleotide.

Ans.



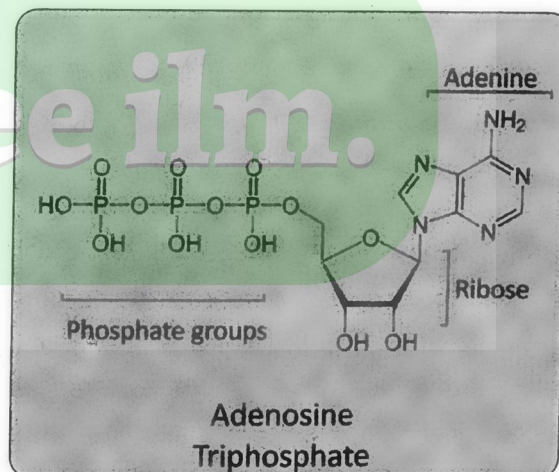
Q83. Sketch a dinucleotide. / Sketch NAD (Nicotinamide Adenine Dinucleotide)

Ans.



Q84. Draw the sketch of ATP.

Ans.



Q85. What do you know about NAD? Give its importance.

Ans. Nicotinamide Adenine Dinucleotide (NAD) is a co-enzyme. It acts as a **hydrogen acceptor** in oxidation-reduction reactions in cell.

Q86. Briefly describe Watson and Crick model of DNA.

Ans. Watson and Crick's Model of DNA suggests the following points:
DNA is made of **two polynucleotide chains** or strands.

- The two strands are **coiled** around each other and make a double helix.
- The double helix is like a **ladder**. Its **poles** are made of sugars and phosphate groups. Its **rungs** are made of nitrogenous base pairs.
- Each base pair (rung) is made of one **purine** (A or G) and one **pyrimidine** (C or T) base.
- Two strands are held together by **weak hydrogen bonds between** their bases.

Q89. Differentiate between mRNA and tRNA.

Ans.

Messenger RNA (mRNA)	Transfer RNA (tRNA)
• It consists of a single strand of ribonucleotides. • Its sequence of nucleotides is complimentary to the sequence of nucleotides of one of the strands of DNA. • mRNA is about 3-4% of the total amount of RNA in cell. • It carries the genetic message of DNA to ribosomes to form particular protein.	• It is comparatively small. • It is a helical structure and its molecule resembles a clover leaf. • It consists of 10-15% of the total amount of RNA in cell. • tRNAs transport amino acids to ribosome and mRNA, in the process of protein synthesis.

Q90. What is ribosomal RNA? Write its importance.

Ans. It is synthesized by the DNA of nucleoli. After its synthesis, ribosomal RNA is joined with ribosomal protein and ribosomes are formed. It comprises about 80% of the total RNA in cell. rRNA acts as the machinery for synthesis of proteins in ribosomes.

Q91. Differentiate between transcription and translation.

Ans. Transcription: The transfer of information from DNA to RNA, which occurs when an RNA copy of the gene is produced. The process is called transcription.

Translation: The second step of the central dogma is the transfer of information from RNA to proteins, which occurs when the information contained in the RNA is DNA

★Q87. Which information was provided by Erin Chargaff?

Ans. In 1951 Erwin Chargaff provided an informative data and it was found that adenine and thymine are equal in **ratio in DNA** and so are guanine and cytosine.

Q88. Define a gene.

Ans. A gene is a sequence of nucleotides of DNA which codes for the formation of a particular polypeptide.

controls the properties and activities of a cell.

Conjugated Molecules

Q92. How conjugated molecules are formed?

Ans. Conjugated molecules are formed by the combination of two or more molecules belonging to different categories. Some important conjugated molecules are as follows.

- Glycoproteins (e.g., They are formed by covalent linkage between a protein and a carbohydrate polymer.)
- Glycolipids (e.g., They are formed by a covalent linkage between a lipid and a carbohydrate.)
- Lipoproteins
- Nucleoproteins

Q93. Compare glycoproteins and glycolipids in terms of definition and functions.

Ans. Glycoproteins

They are formed by **covalent linkage** between a **protein** and a **carbohydrate** polymer. They occur widely in nature as integral structural component of membranes; in blood serum; as cellular secretions; and in cartilage, eyes, skin etc.

Glycolipids

They are formed by a **covalent linkage** between a **lipid** and a **carbohydrate**. They are an integral structural component of membranes.

Q94. Define Lipoproteins. Describe their importance in cells.

Ans. They are a class of biomolecules which are formed by hydrophobic interactions (not covalent or ionic bonds) between lipids and proteins.

Importance: Lipoproteins are the basic structural framework of all types of plasma membranes. Lipids are transported in blood as very low-density lipoproteins.

Q95. How nucleoproteins are formed? Describe their roles in cells.

Ans. They are formed by ionic bonds between chromosomal DNA and proteins.

- **For example,** histone proteins are bound to DNA to form nucleosomes.
- **Role:** They stabilize chromosomal structure in eukaryotes and also play an important role in the **regulation of gene expression.**

LONG QUESTIONS (EXERCISE)

Q1. Distinguish carbohydrates, proteins, lipids and nucleic acid as the four fundamental biological molecules.

Ans. See Q5., Q9., Q13., and Q16. of theory.

Q2. Describe and draw sketches of dehydration synthesis reactions.

Ans. See Q3. of theory.

Q3. Explain how the properties of water make it the medium of life

Ans. See Q4. of theory.

Q4. Distinguish the properties of water make it the medium of life.

Ans. See Q5. of theory.

Q5. Compare the properties and roles of monosaccharides and classify them.

Ans. See Q6. of theory.

Q6. Compare the structural isomers and stereoisomers of glucose.

Ans. See Q7. of theory.

Q7. Define proteins and amino acids and outline the synthesis and breakage of peptide linkages.

Ans. See Q9. of theory.

Q8. Justify the significance of the sequence of amino acids through the example of sickle cell haemoglobin.

Ans. See Q10. of theory.

Q9. Describe the properties and role of acylglycerols, phospholipids, terpenes and waxes.

Ans. See Q13. of theory.

Q10. Describe the molecular level structure of nucleotide.

Ans. See Q17. of theory.

Q11. Explain the double helical structure of DNA as proposed by Watson and Crick.

Ans. See Q18. of theory.

Q12. Explain the general structure of RNA and differentiate between the three types of RNA.

Ans. See Q20. of theory.

Q13. Define conjugated molecules and describe the roles of common conjugated molecules.

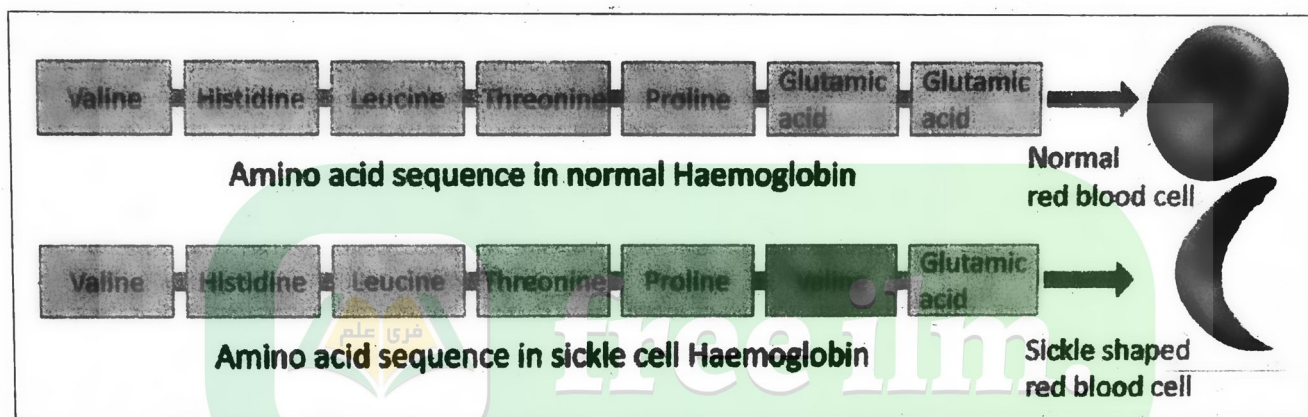
Ans. See Q22. of theory.

INQUISITIVE QUESTIONS

Q1. What happens if even one amino acid is substituted for another in a polypeptide chain? Provide a specific example.

Ans. The number, sequence and types of amino acids is highly specific in the primary structure of a protein, for its proper functioning. This specificity in primary structure is determined by the order of nucleotides in DNA. Any change results in abnormal protein that fails to carry out its normal function.

For example, sickle cell haemoglobin is formed by a mistake in the arrangement of only one amino acid in position **six in each beta chain**. In sickle cell haemoglobin, amino acid valine is present in the place of glutamic acid. Due to sickle cell haemoglobin, red blood cells get sickle shapes and abnormal haemoglobin cannot transport sufficient oxygen. This disease is known as sickle cell anaemia.



Q2. How does the three dimensional structure of a protein relate to its function?

Ans. The structure of a protein depends upon number of amino acids, sequence of amino acids and the final shape it attains after folding, which is maintained by chemical bonds. Amino acids in a polypeptide chain interact with water to give the most stable tertiary structure in the form of a globular shape. These are hydrophilic and hydrophobic interactions. The hydrophobic (non-polar) amino acids aggregate in such a way that they disrupt hydrogen bonding of water molecules and so are buried inside. At the same time the hydrophilic (polar) amino acids turn out, towards the surface of water.

Q3. How do nucleic acids encode genetic information and how is this information translated into proteins?

Ans. Central Dogma: All organisms use the same basic mechanism of reading and expressing genes, which is often referred to as **central dogma**.

- **First step:** The first step of central dogma is the transfer of information from DNA to RNA, which occurs when an RNA copy of the gene is produced. The process is called transcription.
- **Second step:** The second step of the central dogma is the transfer of information from RNA to proteins, which occurs when the information contained in the RNA is used to direct the synthesis of proteins. This process is called translation. In this way DNA controls the properties and activities of a cell.