

EXERCISE

SHORT QUESTIONS

2. How would you describe biochemistry?

Ans: Biochemistry:

Biochemistry is the branch of biology that deals with Biological molecules or biomolecules. It also deals with various chemical reactions (metabolism) of living beings Biochemistry helps biologists to understand anatomy, physiology, pharmacology, biotechnology, bioinformatics etc.

3. What are bio elements?

Ans: Bio elements:

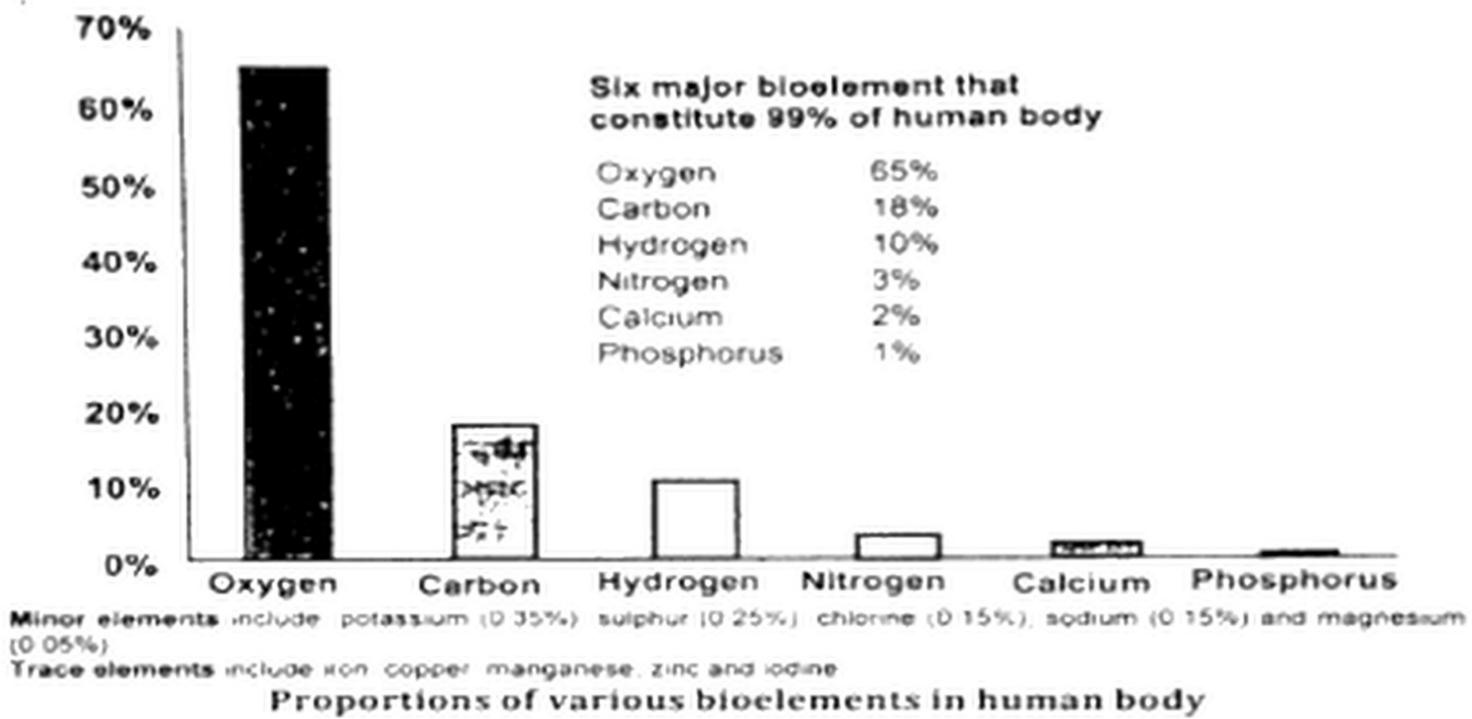
Approximately 25 elements out of 92 naturally occurring elements of earth are found in living beings. These are called biogenic or bio elements.

However, human body is composed of only 16 of these bio elements. These elements can be classified on the basis of their proportions in organisms.

The six commonest bio elements that constitute 99% of protoplasm are called major bio elements.

Minor bio elements are those that are found as less than 1% whereas those that are found as less than 0.01% of the protoplasm are called trace elements.

The proportions of these elements are given in the fig: Some trace elements such as iron are needed by all forms of life. Others are required only by certain species.



The bio elements are combined with each other and can form thousands of different biomolecules which may be inorganic (water and minerals) and organic (carbohydrates, lipids, proteins and nucleic acids). The proportions of these biomolecules are given in the table.

Table: Proportions Of various biomolecules in bacterial and mammalian cells:

Biomolecules	Bacterial cell	Mammalian cell
Water	70%	70%
Protein	15%	18%
Carbohydrates	3%	4%

Lipids	2%	3%
DNA	1%	0.25%
RNA	6%	1.1%
Other organic molecules enzymes, hormones, metabolites	2%	2%
Inorganic ions (Na ⁺ , K ⁺ , Ca ⁺⁺ , Mg ⁺⁺ , Cl ⁻ , SO ₄ ⁻)	1%	1%

4. Describe the chemical composition of protoplasm.

Ans: Chemical Composition of Protoplasm:

Generally, the protoplasm consists of oxygen, carbon, hydrogen and nitrogen. Approximately the oxygen is 62%, carbon 20%, hydrogen 100/0 and nitrogen 3%. The remainder of 5% part contains about thirty elements. Of which calcium (Ca), iron (Fe), magnesium (Mg), chlorine phosphorus (P), potassium (K), Sulphur (S) etc, are important ones. In addition to these, boron (B), copper (Cu), fluorine (F), manganese (Mn) and silicon (Si) are found in small traces. In certain special cells alcohol, cobalt (co) and zinc (Zn) are also found.

All these elements are found in ionic state or essentially found in adenosine triphosphate (ATP). All chemical reactions gang on in the protoplasm obtain energy for their performance from ATP. The protoplasm contains 67-75% of water. Moreover, certain gases such as carbon-dioxide and oxygen remain dissolved in it.

The protoplasm of each cell contains several organic substances of which carbohydrates, fats, proteins, and nucleoproteins are important ones. These organic substances make protoplasm by molecular combination.

5. What are the four fundamental kinds of biological molecules? Explain.

Ans: The four fundamental kinds of biological molecules are carbohydrates, Proteins, lipids and nucleic acids.

i. Carbohydrates:

Carbohydrates are present in the inclusions of the cells and provide fuel for the metabolic activities of the cell.

ii. Proteins:

Proteins are present in the membranes, ribosomes, cytoskeleton and enzymes of the cell.

iii. Lipids:

Lipids are present on the membranes Of Golgi complex and inclusion of the cell. Lipids provide a reserved energy source, shape, protect and insulate the cells.

iv. Nucleic Acid:

The nucleic acid DNA is present in the chromosome. It controls the cell activity. The nucleic acid RNA is present in the nucleoplasm and cytoplasm. It transmits genetic information, and takes part in protein synthesis.

6. Why is the covalent bond in water polar?

Ans: In the case of water, however the sharing of electrons between oxygen and hydrogen is not completely equal so the covalent bond is polar A polar covalent bond is a chemical bond in which shared electrons are pulled closer to the more electronegative atom, making it partially negative and the other atom partially positive Thus, in H₂O. the O atom actually has a slight negative charge and each H atom has a slight positive charge, even though H₂O as a

whole is neutral Because of Its polar covalent bonds, water IS a polar molecule i.e., It has a slightly negative pole and two slightly positive ones.

7. Why water is regarded as universal solvent?

Ans: This Is polarity of water molecules that makes It an excellent or universal solvent for polar substances. Ionic compound or electrolytes can be easily dissolved in water, non-polar substances having charged groups in their molecules can also be dissolved in water Such compounds when dissolved In water dissociates into positive and negative Ions and are In more favorable state to react with Other molecules and ions. This is the reason why all chemical reactions in living beings occur in aqueous medium.

8. What is the importance of hydrogen bonding?

Ans: Importance of Hydrogen Bonding:

Because of hydrogen bonding, water is a liquid at temperatures suitable for life. The high cohesion and adhesion force of water is due to the presence of hydrogen bonds in water, which in turns makes water as transport medium

OR (Second Answer)

Importance of Hydrogen Bonding:

Water is the best example of hydrogen bonding. We all know that how much water is important in our life. So, hydrogen bonding is very important for sustaining life. Water is recognized as a natural solvent. Because without hydrogen bond water would not be formed. Hence hydrogen bonding is essential for sustaining life. Some of the important role of-hydrogen bond IS given below.

1. It is helpful in making wood fibers more rigid and hence for making wood article like furniture
2. It is used to determine the structure of various substances like protein.
3. Most of our food consists hydrogen bonding like carbohydrates, sugar.
4. The fact that ice is less dense than liquid water is due to a crystal structure stabilized by hydrogen bonds.
5. High water solubility of many compounds such as ammonia is explained by hydrogen bonding with water molecules.

9. Why very large amount of heat can increase very little temperature in water?

Ans: High specific heat:

Heat capacity can be defined as the amount of heat required for minimum increase (1°C or 1°K) in temperature of a substance. The specific heat capacity of water can be represented as number of calories required to raise the temperature of 1g of water up to 1°C i.e., 1 Calorie (4.18 Joules). Water has relatively a very high heat capacity than any other substance due to its hydrogen bonding, because much of the heat absorbed by water is utilized in the breakdown of hydrogen bonding therefore it does not manifest itself to raise the temperature of water.

Hence, very large amount of heat can increase very little in temperature in water. Due to its high heat Capacity water works as temperature stabilizer or regulator for organisms in the hot environment and hence protects the living material against sudden thermal changes.

10. How water protects living things against sudden thermal change?

Ans: Very large amount of heat can increase very little in temperature in water. Due to its high heat capacity water works as temperature stabilizer or regulator for organisms in the hot environment and hence protects the living material against sudden thermal changes.

11. What is the importance of high heat of vaporization of water to animals?

Ans: This is high heat of vaporization of water that gives animals an efficient way to release excess body heat in a hot environment. When an animal sweats, body heat is used to vaporize the sweat thus cooling the animal. Due to this property of water, evaporation of only 2 ml out of one liter of water lowers the temperature of the remaining 998 ml water by 1°C.

12. What is the importance of ionization to the living organism?

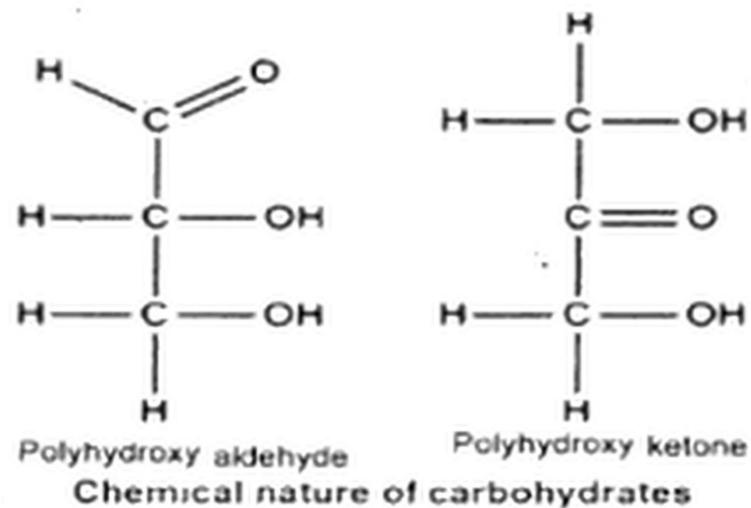
Ans: The H^+ and OH^- ions affect and take part in many of the reactions that occur in cells. e.g. It helps to maintain or change the pH of the medium.

13. Explain what carbohydrates are.

Ans: Carbohydrates:

Carbohydrates are the compounds of carbon, hydrogen and oxygen. Literally word carbohydrate means "hydrates of carbon" i.e., a carbon associated with water or any compound composed of carbon, hydrogen and oxygen and in which hydrogen and oxygen are found in the same ratio as they are found in water (2:1), can be called carbohydrate. Although this definition is applied on many carbohydrates like glucose ($C_6H_{12}O_6$), sucrose ($C_{12}H_{22}O_{11}$) and the starches and cellulose ($(C_6H_{10}O_5)_n$) but some compounds containing hydrogen and oxygen in the same ratio as they are found in water

(2:1), are actually not carbohydrates e.g. acetic acid ($C_2H_4O_2$) and lactic acid ($C_3H_6O_3$).



Moreover, there are also some carbohydrates, such as rhamnose ($C_6H_{12}O_5$)_n which do not contain hydrogen and oxygen in the ratio of water. Hence the classical concept of carbohydrates as hydrates of carbon is now supposed to be incorrect and a more valid definition of these compounds is suggested as;

"Polyhydroxy aldehyde or polyhydroxy ketone or those compounds which upon hydrolysis yield such compounds (derivatives) are called carbohydrates"

14. Describe Of carbohydrates.

Ans: Classification of Carbohydrates:

Carbohydrates are commonly known as sugars because more familiar carbohydrates have sweet taste. In Greek, "sakcharon" Word is used for sugars. So, the term saccharide is derived from this word Therefore carbohydrates are also called saccharides. A polyhydroxy aldehyde or polyhydroxy ketone IS supposed to be single saccharide units, whereas, the derivative carbohydrates are composed of more than one saccharide units.

Classification Of carbohydrates is based upon number of saccharide units. Carbohydrates are generally classified into three group i.e. monosaccharides, oligosaccharides and polysaccharides.

Comparison Of characteristics of carbohydrates:

Monosaccharides	Oligosaccharides	Polysaccharides
They consist of Single saccharide unit.	They are composed of 2 to 10 saccharide units.	They are composed of more than 10 saccharide units
They are simplest carbohydrates; therefore, they cannot be hydrolyzed.	They have less complex structure, so upon hydrolysis they yield at least 2 and maximum 10 monosaccharides	They have highly complex structure, so upon hydrolysis they therefore, they yield at least 11 monosaccharides
They are highly soluble in water.	They are less soluble in water	They are generally Insoluble In water
They are sweetest among all carbohydrates	They are less sweet in taste	They are tasteless

15. Describe the classification of monosaccharides?

Ans: Classification Of monosaccharides:

Classification of monosaccharides is based upon functional group and number of carbon atoms. On the basis of functional group the

monosaccharides containing aldehyde are called aldoses while those containing ketone are called ketoses.

On the other hand, monosaccharides are classified into five groups based upon number of carbon atoms i.e. trioses (3C), tetroses (4C), pentoses (5C), hexoses (6C) and heptoses (7C).

Examples and functions of monosaccharide:

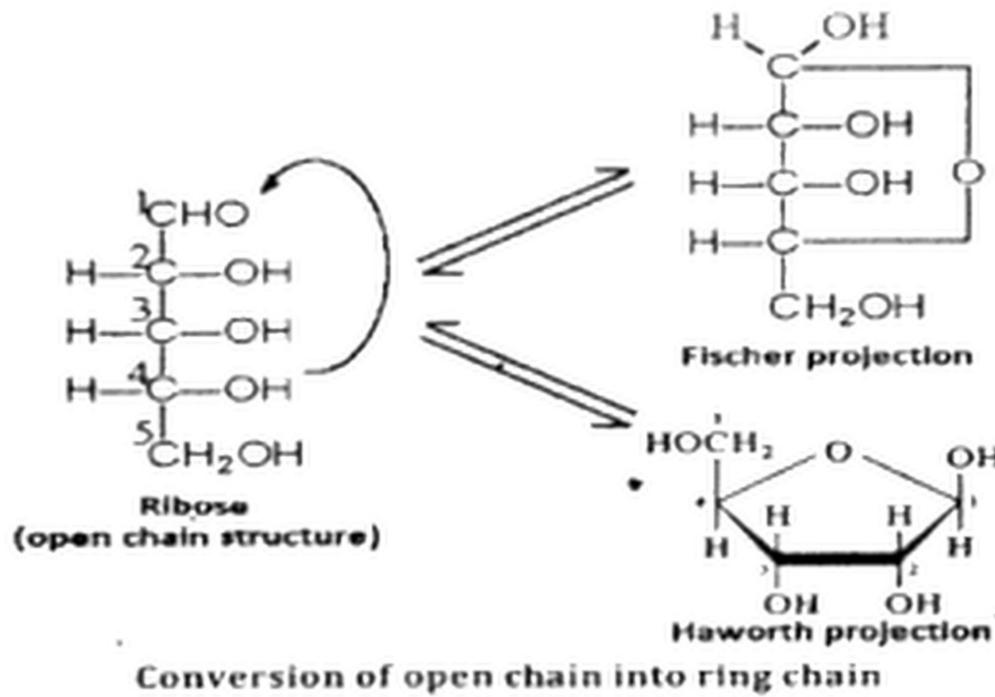
Class	Formula	Aldoses	Ketoses	Function
Trioses (3C)	$C_3H_6O_3$	Glyceraldehyde	Dihydroxy acetone	Intermediates in photosynthesis and cellular respiration.
Tetroses (4C)	$C_4H_8O_4$	Erythrose	Erythrulose	Intermediates in bacterial photosynthesis
Pentoses (5C)	$C_5H_{10}O_5$	Ribose Deoxyribose ($C_5H_{10}O_4$)	Ribulose	Ribose and deoxyribose are components of RNA and DNA respectively is an intermediates in photosynthesis.

Hexoses (6C)	$C_6H_{12}O_6$	Glucose, Galactose	fructose	Glucose is respiratory fuel (initial substrate) Fructose is an intermediate in respiration Galactose is the component of milk sugar
Heptoses (7C)	$C_7H_{14}O_7$	Glucoheptose	Sedoheptulose	Intermediates in photosynthesis

16. Describe the conversion of open chain of ribose into ring chain.

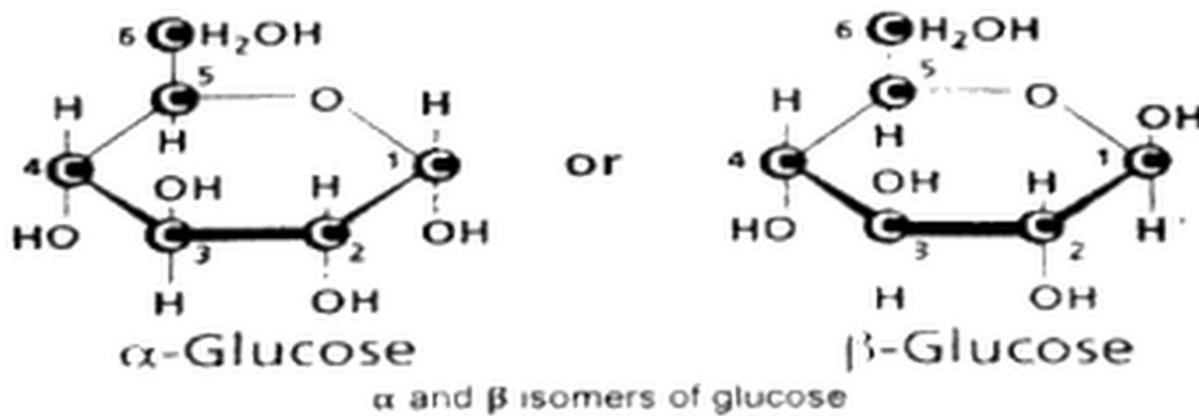
Ans: Let us understand it by taking ribose as an example Ribose is an aldopentose, with the molecular formula $C_5H_{10}O_5$. It can exist in open chain structure in dried form but It exists in furanose ring in aqueous medium When It is dissolved in water, the oxygen atom from aldehyde group reacts With penultimate carbon (second last carbon i.e. C4 in case of ribose) in this way oxygen atom forms a link between C1 and C4 while the OH group of C4 is shifted to C1. After this modification ring structure of ribose is formed.

The ring structure demonstrated by Emil Fischer is called Fischer projection (a two dimensional representation of ring structure) while that represented by an English chemist Norman Haworth is called as Haworth projection (a three dimensional representation of ring structure)



17. Draw and label the ring forms of Alpha and beta glucose.

Ans:

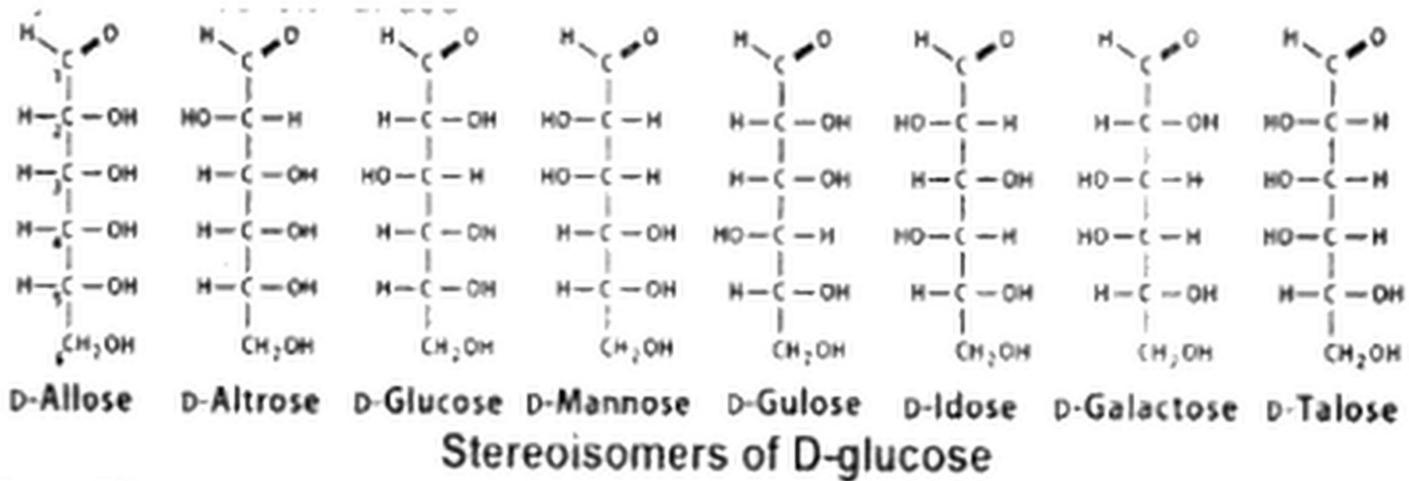


18. Justify that the Laboratory Manufactured Sweeteners are "left handed" sugars and cannot be metabolized by the "right handed" enzymes.

Ans: **Laboratory Manufactured (Artificial) Sweeteners:**

Laboratory manufactured Sugars such as tagatose, sucralose etc. are left- handed forms (L Sugars) on the other hand the naturally occurring sugars in bodies are D Sugars. Proteins and cell receptors are designed to react only with particular enantiomers for example the enzymes in your

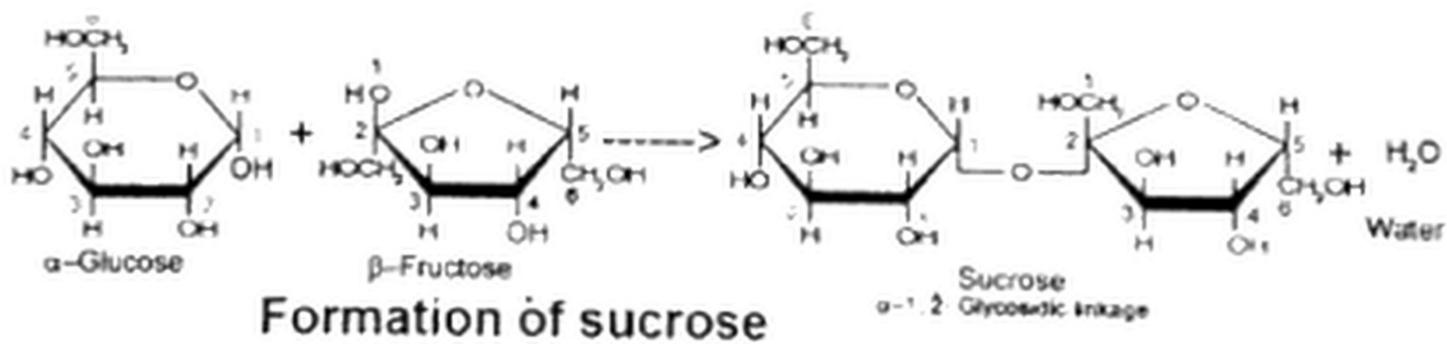
stomach can digest only right-handed sugars. Likewise, left-handed sugars cannot be metabolized by right-handed enzymes. Just as the glove fits only on the proper hand, a right-handed enzyme cannot fit on or react with a left-handed substrate. The substrate must fit on the proper active site of the enzymes. So far, the left-handed substrate sweetener the enzymes must be left-handed.



19. Illustrate the formation and breakage of (a) sucrose (b) maltose (c) lactose.

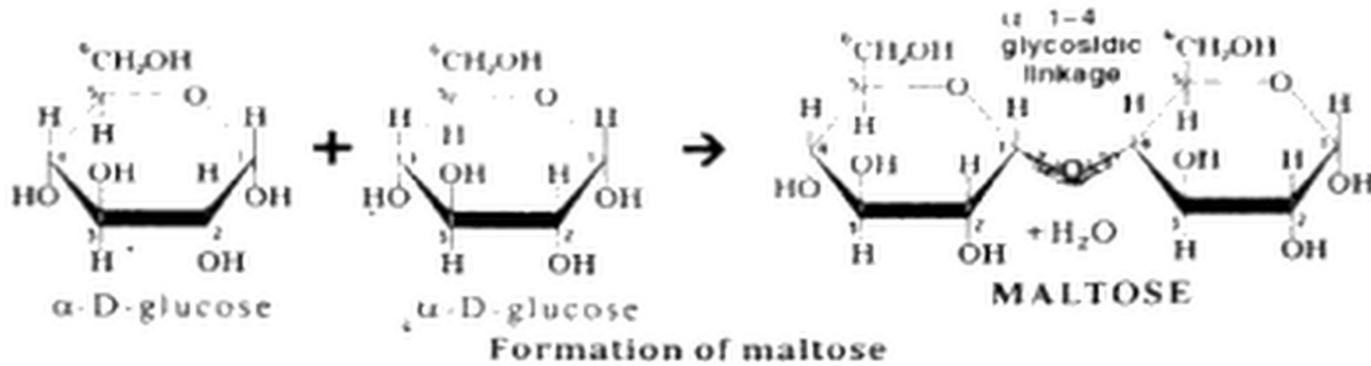
Ans: (a) sucrose:

The sucrose formed by the condensation of glucose and fructose. In this reaction, the —OH group at C-1 of glucose reacts with the —OH group at C-2 of fructose, liberating a water molecule and a linkage is formed between C-1 of glucose and C-2 of fructose known as α -1,2-glycosidic linkage.



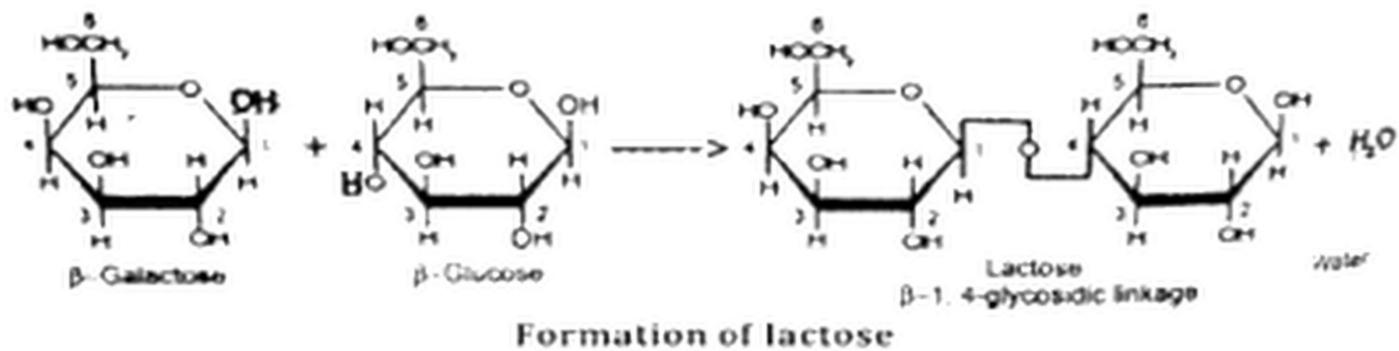
(b) maltose:

The maltose is formed by the condensation of α -glucoses. In this reaction, the —OH group at C-1 of one glucose reacts with the —OH group at C-4 of other glucose. Liberating a water molecule and a linkage is formed between C-1 of one glucose and C-4 of other glucose known as α -1, 4-glycosidic linkage.



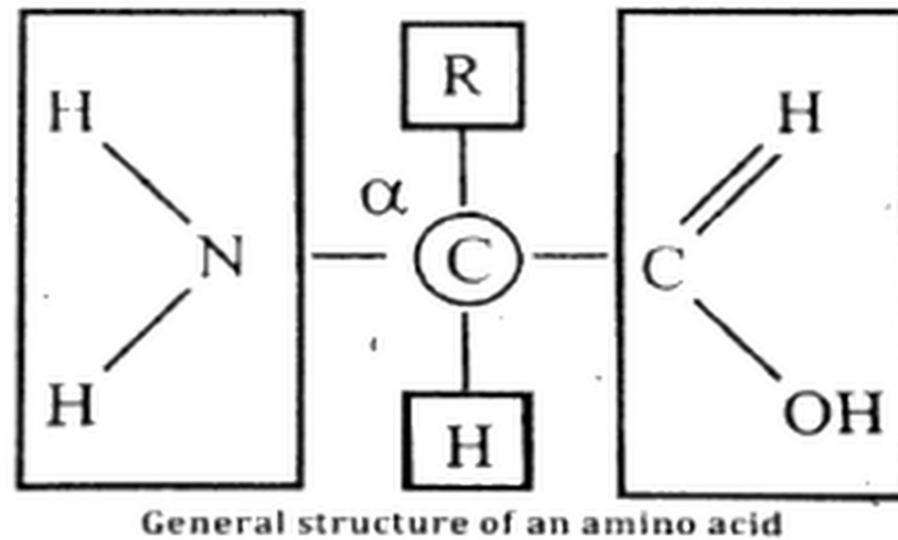
(c) lactose:

The lactose is formed by the condensation of β -galactose and β -glucose. In this reaction, the —OH group at C-1 of galactose reacts with the —OH group at C-4 of glucose, liberating a water molecule and a linkage is formed between C-1 of galactose and C-4 of glucose, known as 4-glycosidic linkage.



20. Draw the structural formula of amino acids.

Ans:



21. Describe the synthesis of peptide bond.

Ans: The peptide bond is synthesized when the carboxyl group of one amino acid molecule reacts with the amino group of the other amino acid molecule, causing the release of a molecule of water (H₂O), hence the process is a dehydration synthesis reaction (also known as a condensation reaction), and usually occurs between amino acids.

22. Describe the four types of structure of proteins.

Ans: Structural conformations in proteins:

i. Primary Structure:

A linear polypeptide with a specific sequence and number of amino acid is called primary structure. It is shown by all proteins at the time of their synthesis on ribosomal surface. After synthesis a protein does not remain in its primary structure but can be changed into some other structural conformations (particular form, shape or structure)

ii. Secondary Structures:

A helical (α-helix) or flattened sheets (β-pleated sheet) like structures which are established by H-bonding between opposite charge

bearing groups of different amino acids are called secondary structures

iii. Tertiary Structure:

In some proteins the linear polypeptide is changed into α -helix, then α -helix fold again and again by ionic bonds and disulfide bridges to form a globular shaped structure the tertiary structure

iv. Quaternary Structures:

Some proteins exist in very complex structure in which more than one globule is attached together by hydrophobic interaction. Such structures are called quaternary structures

23. What are the structural roles of proteins?

Ans: List of Structural Roles of Proteins:

Types	Roles of proteins
Collagen	It establishes the matrix of bone and cartilages
Elastin	Elastin provides support for connective tissues such as tendons and Ligaments.
Keratin	It strengthens protective coverings such as hair, nails, quills, feathers, horns, and beaks
Histone	It arranges the DNA into the chromosome.

24. What are the functional roles of proteins?

Ans: List of Functional Roles of Proteins:

Types	Roles of proteins
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Enzymes	The most of enzymes are protean which control metabolism i.e., the s the biochemical reactions
Hormones	Some hormones are protein in nature which are involved in the regulation of physiological activities such as regulation of glucose level, calcium level, digestion and blood pressure etc.
Antibodies	These proteins are produced by WBCs in response to antigen (a foreign article) and provide immunity.
Hemoglobin	It is found in RBCs and is involved in the transport of oxygen mainly and carbon dioxide to some extent
Fibrinogen	It is found in blood plasma and IS Involved in blood clotting process
Ovalbumin and Casein	Ovalbumin is found in egg whites and casein is a milk-based protein. Both of them are involved in the storage of amino acids.

25. Describe (a) globular proteins (b) fibrous protein.

Ans: (a) globular proteins:

These proteins have spherical or globules like shape. Therefore, they exist in tertiary or quaternary structure during function. These proteins are soluble in aqueous medium, inelastic in nature and can be crystalized.

Examples are: enzymes, hormones, antibodies, channel proteins.

(b) fibrous protein:

These proteins have fiber or filament like shape Therefore, they exist in secondary structure during function. These proteins are insoluble in aqueous medium, elastic in nature and cannot be crystalized.

Examples are: collagen, fibrinogen, actin, myosin and keratin

26. Describe the classification of lipids.

Ans: Classification of Lipids:

Lipids are broadly classified into simple, complex and derived, which are further subdivided into different groups.

Simple Lipids:

Simple lipids are esters of fatty acids with various alcohols e.g. acylglycerols (fats and Oils) and waxes.

Compound/ Complex Lipids:

The compound/complex lipids Contain other groups in addition to an alcohol and a fatty acid e.g. phospholipids, glycolipids and lipoproteins.

Derived Lipids:

Derived lipids are the derivatives of simple and complex lipids e.g., terpenes, steroids, prostaglandins and cholesterols. Some examples such as acylglycerol, waxes, phospholipids, terpenes, prostaglandin and steroids are discussed here.

27. What role do lipids play in living organisms?

Ans: Lipids:

Lipid is the collective name for variety of organic compounds such as fats, Oils, waxes and fat-like molecules (steroids) found in the body. Therefore

it is defined as a heterogeneous group of organic compounds which are insoluble in water (hydrophobic) but soluble in organic solvent such as acetone, alcohol, and ether etc.

Lipids are composed of carbon, hydrogen and oxygen as carbohydrates. However, they have relatively less oxygen in proportion to carbon and hydrogen than do carbohydrates. For instance, tristearin is a simple lipid which shows molecular formula as $C_{57}H_{12}O_6$. Due to high contents of carbon and hydrogen, they contain double amount of energy than carbohydrates.

In general lipids are components of cell membranes (phospholipids and cholesterol), act as energy stores (triglycerides), chemical messengers (steroid) and are also involved in protection, waterproofing, insulation and buoyancy.

OR (Second Answer)

Lipids perform several biological functions.

Some of them are:

- i.** Lipids such as triglycerides are storage compounds for the reserve energy of the body
- ii.** Lipids are important component of the plasma membrane structure in eukaryotic cells and regulate membrane permeability
- iii.** They serve as a source of fat soluble vitamins (A, D, E, and K)
- iv.** In nerve fibers, the myelin sheath contains lipids which act as electrical insulators
- v.** Lipids occur as components of some enzyme systems.
- vi.** Lipids are important as cellular metabolic regulators (Prostaglandins and steroid hormones)
- vii.** Cholesterol is found in the cell membrane of many organisms and in blood and bile.

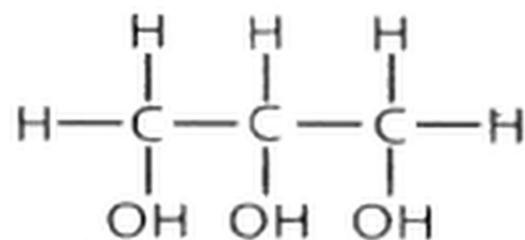
28. Explain the structure of glycerol.

Ans: Glycerol is a trihydroxy alcohol which contains three carbons, each bears an

OH group. A fatty acid is a type of organic acid containing one carboxylic acid group attached to a hydrocarbon. Fatty acids contain even number of carbons from 2 to 30. Each fatty acid is represented as R-COOH, where R is a hydrocarbon tail. When a glycerol molecule combines chemically with one fatty acid, a monoacylglycerol (monoglyceride) is formed. When two fatty acids combine with a glycerol, a diacylglycerol (diglyceride) is formed and when three fatty acids combine with one glycerol molecule, a triacylglycerol (triglyceride) is formed.

Formula of Glycerol: $C_3H_8O_3$

Structure of Glycerol:

**29. What are the properties and types of fatty acids?**

Ans: Properties of Fatty Acids:

About 30 different fatty acids are found. Fatty acids vary in length. Acetic acid (2C) and butyric acid (4C) are simplest fatty acids, whereas palmitic acid (16C) and stearic acid (18C) are most common fatty acids. Some properties of fatty acids are increased with an increase in number of carbon atoms, such as melting point, solubility in organic solvent and hydrophobic nature.

Types of Fatty Acids:

i. Saturated Fatty Acids:

Fatty acids are either saturated or unsaturated Fatty acids in which all of the internal carbon atoms possess hydrogen side groups are said to be saturated fatty acids because they contain the maximum number of hydrogen atoms that are possible, e.g. palmitic acid. Saturated fatty acids tend to be solid at room temperature (higher melting point) and are more common in animal lipids (fats)

ii. Unsaturated Fatty Acids:

Unsaturated fatty acids have one or more pairs of carbon atoms joined by a double bond. They therefore not fully saturated with hydrogen, e.g. oleic acid. Unsaturated fatty acids are liquids at room temperature (lower melting point) and are more common in plants (oils). Triglycerides containing hydrocarbon chains melt at a low temperature. This is useful for living things.

Common types of fatty acids:

Name	Typical sources	No. of Carbon	Condensed formula	Melting point (°C)
Saturated				
1. Lauric	Coconut oil	12	$\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$	44
2. Myristic	Butter fat	14	$\text{CH}_3(\text{CH}_2)_{12}\text{COOH}$	58
3. Palmitic	Most fats and oils	16	$\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$	63
4. Stearic	Most fats and oils	18	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$	70

Unsaturated				
5. Oleic	Olive oil	18	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	4
6. Linoleic	Vegetable oils	18	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	-5
7. Linolenic	Soybeans and canola oils	18	$\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{CH}_2\text{OH}$	-11
8. Arachidonic	Lard (present in chicken etc)	20	$\text{CH}_3-(\text{CH}_2)_4-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}=\text{CH}-(\text{CH}_2)_3-\text{COOH}$	-50

30. What is the function and uses of waxes?

Ans: Uses of Waxes:

Synthetic waxes are generally derived from petroleum or polyethylene and consist of mixtures of long-chain hydrocarbons (alkanes), alcohols, aldehydes, ketones and fatty acids e.g., paraffin wax which is used to make candles, wax paper, lubricants, and sealing materials.

31. Why phospholipids form a thin layer on the surface of an aqueous solution?

Ans: A phospholipid is formed when phosphatidic acid combines with one of the four organic compounds such as choline (a nitrogenous base), ethanolamine (an amino alcohol), inositol (an amino alcohol) and serine (an amino acid). A phosphatidic acid molecule is most similar to diglyceride that

it contains a glycerol, two fatty acids esterified with first and second OH groups of glycerol and a phosphate group esterified with third OH group of glycerol. Most common type of phospholipid is phosphatidylcholine also called lecithin in which choline is attached to phosphate group of phosphatidic acid, one end of the phospholipid molecule, containing the phosphate group and additional compound is hydrophilic i.e. polar and readily soluble in water. The other end containing the fatty acid side chains, is hydrophobic i.e. non-polar and insoluble in water. These phospholipids are major constituents of lipid bilayer of cell membrane.

OR (Second Answer)

Phospholipids have a hydrophilic head and two hydrophobic tails each. When phospholipids are exposed to water, they arrange themselves in a bi-layer sheet with the tails facing towards the center of the sheet, and away from the water.

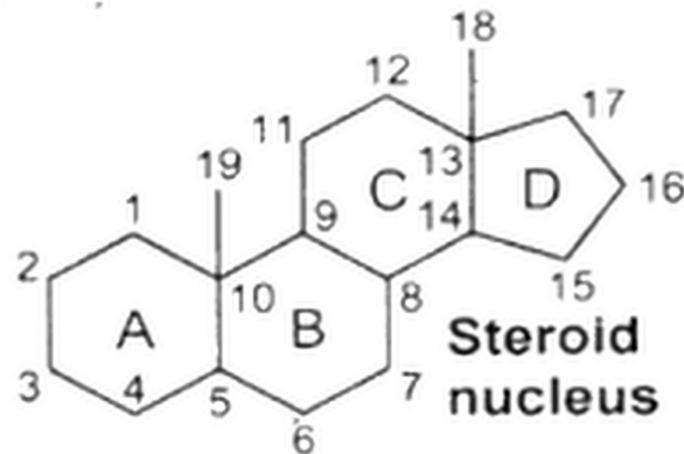
32. What is isoprene unit? Explain.

Ans: Isoprene Unit:

Terpenes are the types of derived lipids. All the terpenes are synthesized from a five-carbon building block known as isoprene unit. This unit condenses in different ways to form many compounds. Two isoprene units form a monoterpene e.g., menthol, four form a diterpene e.g. Vitamin A, phytol (chlorophyll tail) and six form a triterpene e.g. ambrein. Natural rubber is a polyterpene.

33. Describe a steroid nucleus.

Ans: The steroid nucleus is a three-dimensional structure, and atoms or groups are attached to it by spatially direction bonds.



34. What are the functions of prostaglandins?

Ans: Functions of Prostaglandins:

Prostaglandins are derived from arachidonic acid (a tetra unsaturated 20C fatty acid). Their functions vary widely depending on the tissue. Some reduce blood pressure, whereas others raise it in the immune system, various prostaglandins help to induce fever and inflammation and also intensify the sensation of pain. They also help to regulate the aggregation of platelets an early step in the formation of blood clots. Those synthesized in the temperature-regulating center of the hypothalamus Cause fever. In fact, the ability of aspirin to reduce fever and decrease pain depends on the inhibition of prostaglandin synthesis.

35. Describe the structure of a nucleotide.

Ans: Nucleotide Structure:

The nucleotide In DNA consists of a sugar (deoxyribose), one of four bases (cytosine (C). thymine (T), adenine (A), guanine (G)), and a phosphate.

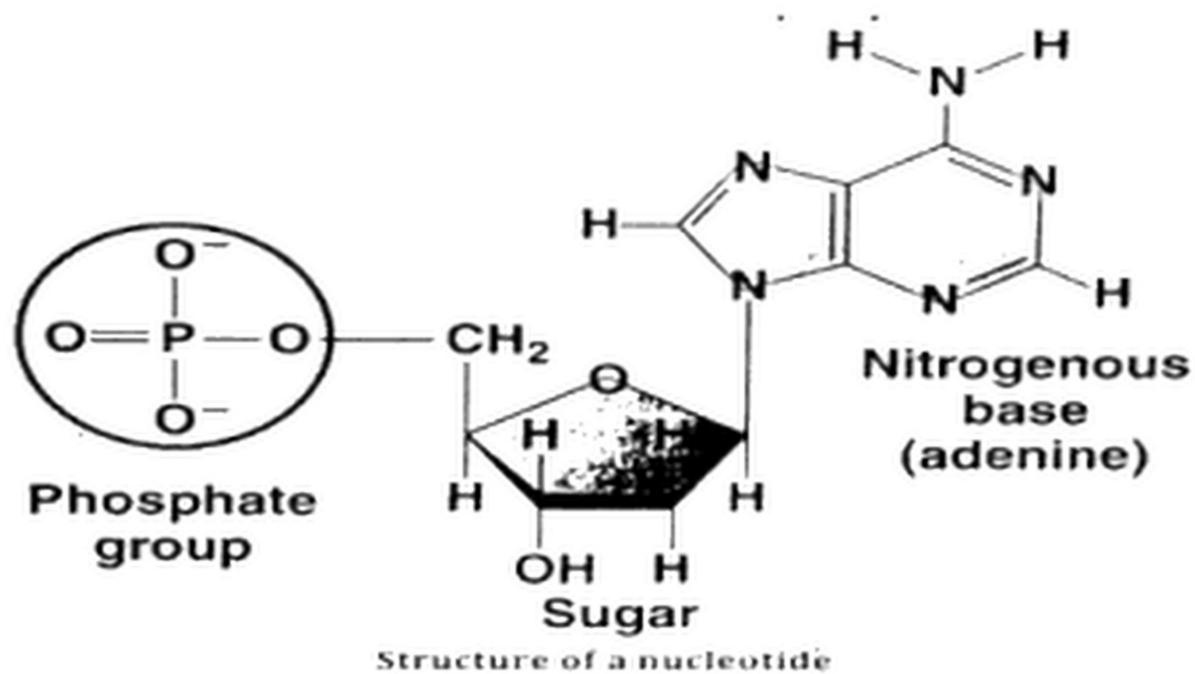
Cytosine and thymine are pyrimidine bases, while adenine and guanine are purine bases. The sugar and the base together are called a nucleoside.

Composition of a nucleotide:

Nucleotides of DNA are called deoxyribonucleotides and of RNA are known as ribonucleotides. Each nucleotide consists of pentose sugar, a phosphate and a nitrogen containing ring structure called base.

The pentose sugar in deoxyribonucleotides is deoxyribose and in ribonucleotides is ribose. Phosphoric acid is a common component of both nucleotides which provides acidic properties to DNA and RNA. The nitrogen containing ring structures are called bases because of unshared pair of electrons on nitrogen atoms, which can thus acquire a proton. There are two major classes of nitrogenous bases i.e., single ring pyrimidine and double ring purines. Pyrimidine bases are of three types i.e., cytosine (C), thymine (T) and uracil. Thymine is only found in DNA while the uracil is only found in RNA. On the other hand, the purine bases are also of two types i.e., adenine (A) and guanine (G).

During the formation of a nucleotide, first nitrogenous base is linked with 1' carbon of pentose sugar. Such combination is called nucleoside. When a phosphoric acid is linked with 5' carbon of pentose sugar of nucleoside, the nucleotide is formed. A nucleotide with one phosphoric acid is called nucleoside triphosphate.



The nucleotides which take part in the formation of DNA or RNA must contain three phosphates but during their incorporation into DNA or RNA polymer each nucleotide loses its two terminal phosphates.

36. How might an error in the DNA of an organism affect protein function?

Ans: Deoxyribonucleic acid (DNA) transcription occurs at a rate of around 1000x per second alone in a single-cell. Errors in these processes are typically checked and corrected by special enzymes. However, errors in DNA transcription can result in protein synthesis with deleted amino acids which at best can be harmless. At worst, the deletion (or defective synthesis) of proteins can create fatal cancers through localized cell mutations.

37. Describe the structure of ATP.

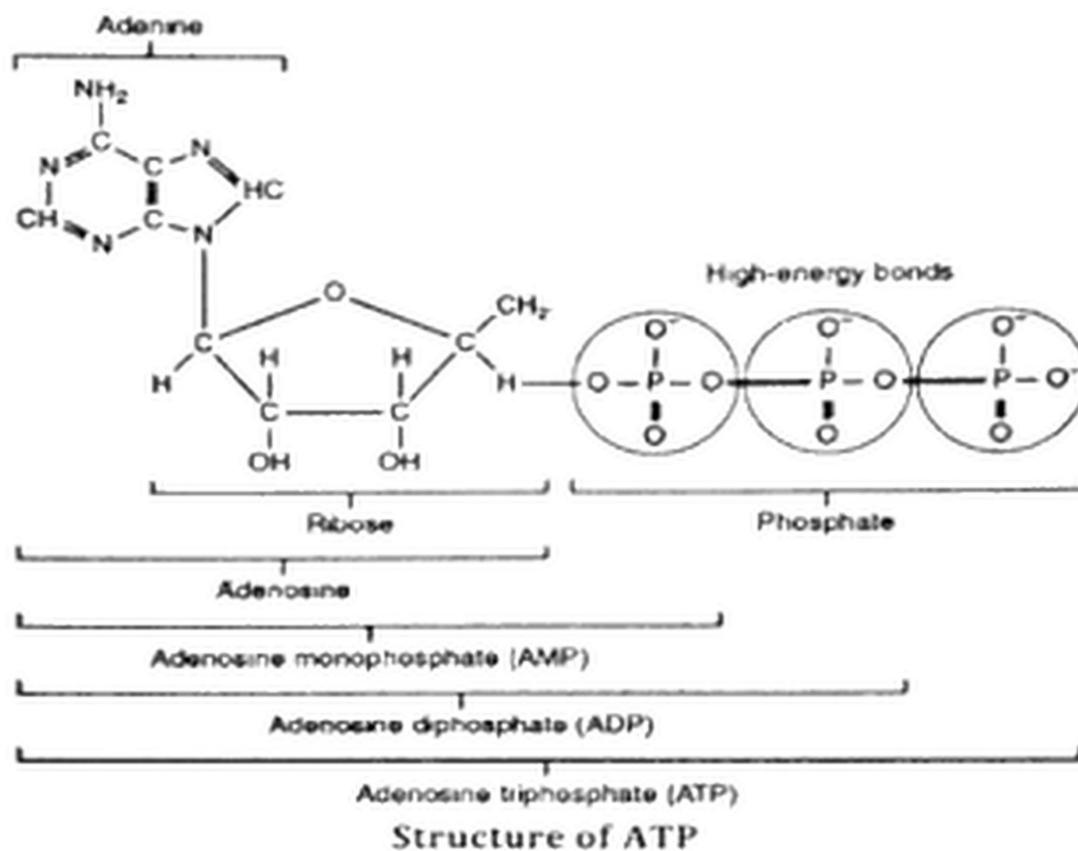
Ans: Structure of ATP:

Adenosine triphosphate (ATP) is a mononucleotide.

ATP has three parts, connected by covalent bonds: (a) adenine, a nitrogen base, (b) ribose, a five-carbon sugar, (c) three phosphates. The two

covalent bonds linking the three phosphates together are called high-energy bonds. ATP can be converted to ADP and inorganic phosphate (iP) by hydrolysis. ATP is known as the energy currency of cells.

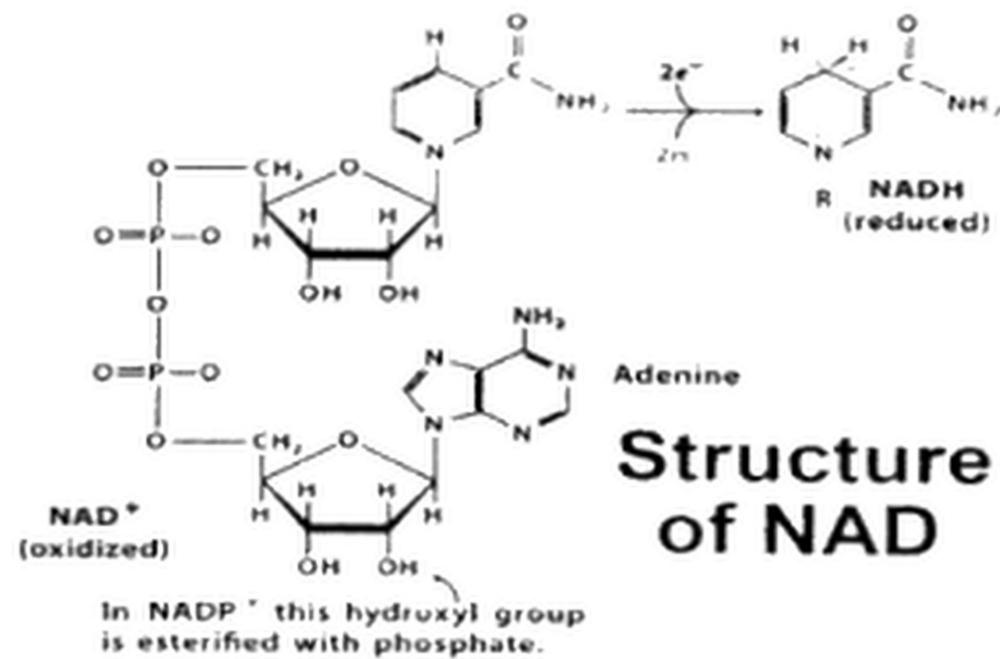
ATP is made from the oxidation of organic molecules during respiration, since the energy to add the phosphate to ADP comes from oxidation, the process is known as oxidative phosphorylation. Most of the ATP in the cell is made in mitochondria.



38. Describe the structure of NAD.

Ans: Structure of NAD:

Nicotinamide adenine dinucleotide (NAD) consists of two nucleotides. One nucleotide consists of base-nicotinamide, sugar and phosphate. Other nucleotide consists of base-adenine-sugar and phosphate. The two nucleotides are joined by their phosphate group forming a dinucleotide. NAD is a coenzyme, it works with dehydrogenases as oxidizing agent. Its reduced form is $\text{NADH} + \text{H}^+$ (NADH_2).



39. Define gene is a sequence of nucleotides as part of DNA, Which codes for the formational of a polypeptide.

Ans: Gene:

A gene is region of DNA which is made up of nucleotides. It is the physical and functional unit of heredity. Each gene contains the Information required to build specific proteins needed in an organism, such as they contain the instructions for our individual characteristics — like eye and hair color. In order to make proteins, the gene from the DNA is copied into messenger RNA. The mRNA moves out of the nucleus and uses ribosomes to form the polypeptide that finally folds and configures to form the protein. Genes possess the data to build and maintain cells and pass genetic information to offspring.

OR (Second Answer)

A gene can be defined as a piece of DNA sequence coding for a special polypeptide chain. Recall that in sickle cells Glutamic acid is replaced by valine at 6th position of polypeptide chain. The genetic code for glutamic acid is GAA (or GAG) If there IS any change in the code It becomes GUA, then

valine will be formed instead of glutamic acid, as a result the structure and function of the polypeptide chain is also changed. Thus gene is a sequence of nucleotides as part of DNA, which codes for the formation of a polypeptide.

40. Define/ Describe/ Explain briefly:

carbohydrates, monosaccharides, oligosaccharides, starch, cellulose, stereoisomers, enantiomers, diastereoisomers, epimers, proteins, amino acids, lipids, nucleic acids, nucleoside, peptide bond, phosphorylation, oxidative phosphorylation,

Ans: Carbohydrates:

Carbohydrates are the compounds of carbon, hydrogen and oxygen. Literally word carbohydrate means "hydrates of carbon" i.e., a carbon associated with water or any compound composed of carbon, hydrogen and oxygen and in, which hydrogen and oxygen are found in the same ratio as they are found in water (2:1), can be called carbohydrate.

Although this definition IS applied on many carbohydrates like glucose ($C_6H_{12}O_6$), sucrose ($C_{12}H_{22}O_{11}$) and the starches and cellulose ($(C_6H_{10}O_5)_n$) but some compounds containing hydrogen and oxygen in the same ratio as they are found in water (2:1), are actually not carbohydrates e.g. acetic acid ($C_2H_4O_2$) and lactic acid ($C_3H_6O_3$). Moreover, there are also some carbohydrates, such as rhamnose ($(C_6H_{12}O_5)_n$) which do not contain hydrogen and oxygen in the ratio of water.

Hence the classical concept of carbohydrates as hydrates of carbon is now supposed to be incorrect and a more valid definition of these compounds is suggested as:

"Polyhydroxy aldehyde or polyhydroxy ketone or those compounds which upon hydrolysis yield such compounds (derivatives) are called carbohydrates".

Monosaccharides:

Monosaccharides are true carbohydrates which are either polyhydroxy aldehydes or polyhydroxy ketones. The range of number of carbons in monosaccharide is 3 to 7. All the carbon atoms in a monosaccharide except one, have a hydroxyl group (-OH) while the remaining carbon atom is either the part of aldehyde or ketone. The general formula for the representation of monosaccharides is $C_nH_{2n}O_n$, where, n is the number of carbon atoms in monosaccharides.

Oligosaccharides:

This group consists of derivatives of monosaccharides. Those carbohydrates which upon hydrolysis yield 2 to 10 saccharide units are called oligosaccharides. On the basis of number of saccharide units, the oligosaccharides are classified into disaccharides, trisaccharides, tetrasaccharides and so on, the most common among these are disaccharides.

Starch:

Starch is a homopolysaccharides which is formed by the condensation of hundreds of α -glucoses, it is storage carbohydrate of plants. It is mainly stored in root, stem and seeds. Cereal grains and potato tubers are rich sources of starch in human diet. Starch is digested in oral cavity and in small intestine by the enzyme amylase upon hydrolysis it yields maltose first and then maltose is further digested by maltase enzyme and yields glucoses. The presence of starch in a given sample can be confirmed by iodine test as it gives blue color with iodine solution. There are two types of starches i.e. amylose and amylopectin.

Cellulose:

Cellulose is most abundant carbohydrate on earth. It is also a homopolysaccharide but unlike starch and glycogen it is formed by the condensation of hundreds of β -glucoses. It is structural carbohydrate of plants as it is major constituent of plant cell wall. Cotton and paper are the pure forms of cellulose. Cellulose shows no color with iodine solution. Structure of cellulose resembles with amylose starch in such a way that it has un-branched structure but it has β -1, 4-glycosidic linkages between glucose residues. Therefore, in a cellulose chain, the β -glucoses are alternatively arranged in upright and inverted manner.

Stereoisomers:

Those isomers in which —H and —OH groups are arranged in different pattern to the asymmetric carbon atoms are called stereoisomers.

An asymmetric carbon atom is that which makes bonds with four different atoms around it.

For example, in glucose, the C-2, C-3, C-4 and C-5 are asymmetric carbon atoms. In monosaccharide the number of stereoisomers, actually depends upon the number of asymmetric carbons in its structure and can be calculated by the formula 2^n , where n is the number of asymmetric carbon atoms so glucose has 16 stereoisomers.

OR (Second Answer)

Stereoisomer molecules that have the same molecular formula, the same sequence of bonds, but different spatial arrangements. Geometric isomers and optical isomers are both types of stereoisomers.

Enantiomers:

Those stereoisomers which are non-superimposable mirror images of one another are called enantiomers. An example of an enantiomer is the D and L isomers of glucose.

Diastereomers:

Those stereoisomers which have different arrangement of —H and —OH groups at more than one asymmetrical carbon atoms are called diastereoisomers. Unlike an enantiomer, diastereoisomers are not mirror images.

For example, the two carbohydrates that are diastereoisomers are D — Glucose and D — Altrose.

Epimers:

Those stereoisomers which have different arrangement of —H and —OH groups at only one asymmetrical carbon atom are called epimers. D — Glucose and D — Mannose are an example of an epimer.

Proteins:

Proteins are the main structural components of the cell. All proteins contain C, H, O and N, while some contains P, S. Few proteins have Fe, I and Mg incorporated into the molecule.

Chemically proteins can be defined as polymers of amino acids or polypeptide chains. A protein may consist of a single polypeptide or more than one polypeptide.

Amino acids:

Amino acids are the building blocks of proteins. There are many amino acids known to occur, but only 20 are commonly found in proteins. The amino acids are built on a common plan. Each contains a carbon atom. It is called a (alpha) carbon to this a hydrogen atom, an amino group (—NH₂), a carboxyl

group ($-\text{OOH}$) and a variable group known as $-\text{R}$ group are attached. The R group has a different structure in each of the 20 biologically important amino acids and determines their individual chemical properties, two simplest amino acids i.e., glycine and alanine.

Lipids:

Lipid is the collective name for variety of organic compounds such as fats, Oils, waxes and fat-like molecules (steroids) found in the body. Therefore, it is defined as a heterogeneous group of organic compounds which are insoluble in water (hydrophobic) but soluble in organic solvent such as acetone, alcohol, and ether etc.

Lipids are composed of carbon hydrogen and oxygen as carbohydrates. However, they have relatively less oxygen in proportion to carbon and hydrogen than do carbohydrates. For instance, tristearin is a simple lipid which shows molecular formula as $\text{C}_{57}\text{H}_{110}\text{O}_6$. Due to high contents of carbon and hydrogen, they contain double amount of energy than carbohydrates. In general lipids are components of cell membranes (phospholipids and cholesterol), act as energy stores (triglycerides). Chemical messengers (steroid) and are also involved in protection, waterproofing, insulation and buoyancy.

Nucleic acids:

Nucleic acids were first reported in 1869 by a SWISS physician when he isolated a new compound from the nuclei of pus cells (white blood cells). This compound was neither a protein nor lipid nor a carbohydrate, therefore, it was a novel type of biological molecule. He named this molecule as nuclein, because it was located in the nucleus, in 1920 the basic structure and chemical nature of nuclein was determined and was renamed as nucleic acid because of its acidic nature.

Nucleoside:

During the formation of a nucleotide, first nitrogenous base is linked with 1' carbon of pentose sugar. Such combination is called nucleoside. When a phosphoric acid is linked with 5' carbon of pentose sugar of a nucleoside, the nucleotide is formed. A nucleotide with one phosphoric acid is called nucleoside monophosphate, with two phosphoric acids is called nucleoside diphosphate, and with three phosphoric acids is called nucleoside triphosphate.

Nucleotides:

Now it has been cleared that nucleic acids are of two types i.e. deoxyribo nucleic acid (DNA) and ribo nucleic acid (RNA). Both nucleic acids are linear un-branched polymers. The monomers of the nucleic acid are called nucleotides.

Peptide bond:

During the translation process, when an amino acid reacts with another amino acid, the —OH from carboxylic acid group of one amino acid and —H from amino group of other amino acid are liberated and form a water molecule, as a result a bond is established between C of carboxylic acid group and N of amino group of two amino acids called peptide bond.

Phosphorylation:

Phosphorylation is an important mechanism by which the activity of proteins can be altered after they are formed. A phosphate group (PO_3^{4-}) is added to a protein by specific enzymes called kinases. This phosphate group is usually provided by ATP, the energy carrier of the cell.

Oxidative phosphorylation:

Oxidative phosphorylation is the metabolic pathway in which cells use enzymes to oxidize nutrients, thereby releasing energy which is used to

produce adenosine triphosphate (ATP). Almost all aerobic organisms carry out oxidative phosphorylation.

OR (Second Answer)

ATP is made from the oxidation of organic molecules during respiration. Since the energy to add the phosphate to ADP comes from oxidation, the process is known as oxidative phosphorylation.

41. Write a brief notes on: Polarity Of water molecules, Hydrogen bonding, High specific heat Of water, High heat of vaporization Of water, Cohesion and adhesion of molecule, Hydrophobic exclusion, Ionization, Lower density Of ice, Enantiomers, Diastereoisomers, Epimers, Sucrose, Maltose, Lactose, Starch, Glycogen, Cellulose, Chitin, Acylglycerol, Terpenes, Steroids, Prostaglandins, Composition Of nucleotide, ATP, NAD, mRNA, tRNA, Sickle cell anaemia, Conjugated molecules.

Ans: (i) Polarity of water molecules:

Covalent Bonds:

The bonds which are formed by the mutual sharing of electrons between two atoms are called covalent bonds.

Nonpolar:

Normally the sharing of electrons between two atoms is fairly equal and the covalent bond is nonpolar.

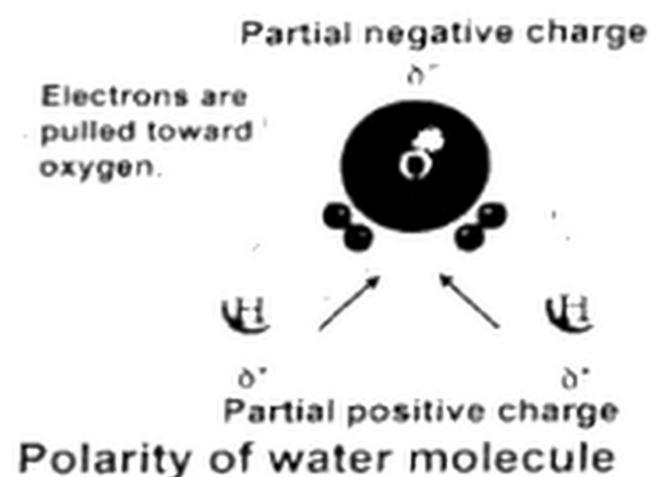
Polar:

In the case of water, however the sharing of electrons between oxygen and hydrogen is not completely equal so the covalent bond is polar.

A polar covalent bond is a chemical bond in which shared electrons are pulled closer to the more electronegative atom, making it partially negative and the other atom partially positive. Thus, in H_2O , the O atom actually has a slight negative charge and each H atom has a slight positive charge, even though H_2O as a whole is neutral. Because of its polar covalent bonds, water is a polar molecule it has a slightly negative pole and two slightly positive ones.

Water Use as Universal Solvent:

This is polarity of water molecules that makes it an excellent or universal solvent for polar substances, ionic compound or electrolytes can be easily dissolved in water, non-polar substances having charged groups in their molecules can also be dissolved in water. Such compounds when dissolved in water dissociates into positive and negative ions and are in more favorable state to react with other molecules and ions. This is the reason why all chemical reactions in living beings occur in aqueous medium.

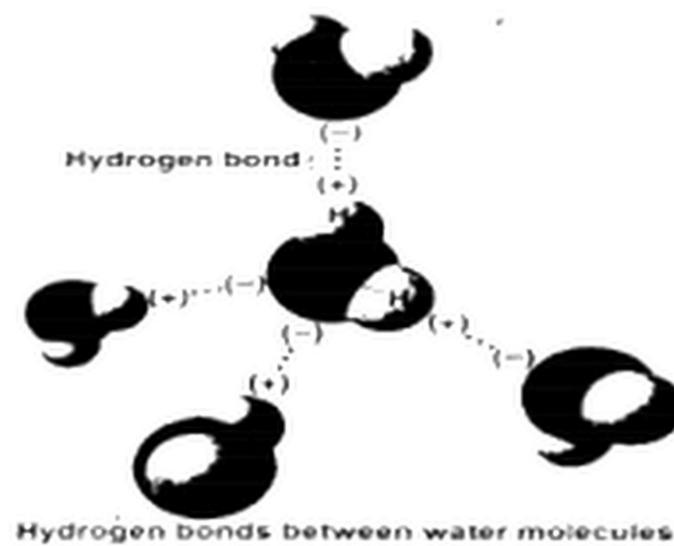


(ii) Hydrogen bonding:

The polarity of water molecules makes them interact with each other. The charged regions on each molecule are attracted to oppositely charged regions on neighboring molecules, forming weak bonds. Since the positively charged region in this special type of bond is always an H atom, the bond is called a hydrogen bond. This bond is often represented by a dotted line because a hydrogen bond is easily broken.

Importance of Hydrogen bonding in Water:

Because of hydrogen bonding, water is a liquid at temperatures suitable for life. The high cohesion and adhesion Hydrogen bonds in water, which in turns makes water as transport medium.



(iii) High specific heat of water:

Heat capacity can be defined as the amount of heat required for minimum increase (1°C or 1°K) in temperature of a substance. The specific heat capacity of water can be represented as number of calories required to raise the temperature of 1g of water up to 1°C i.e. 1 Calorie (4.18 Joules). Water has relatively a very high heat capacity than any other substance due to its hydrogen bonding, because much of the heat absorbed by water is utilized in the breakdown of hydrogen bonding therefore it does not manifest itself to raise the temperature of water.

Hence, very large amount of heat can increase very little in temperature in water.

Importance of High Specific Heat:

Due to its high heat capacity water works as temperature stabilizer or regulator for organisms in the hot environment and hence protects the living material against sudden thermal changes.

(iv) High heat of vaporization of water:

Heat of vaporization is the amount of heat required to convert a unit mass of a liquid into gaseous form. Heat of vaporization of water is represented as number of calories absorbed per gram vaporized. Water has high heat of vaporization i.e. 574 calories per gram. The high heat of vaporization means that a large amount of heat can be lost with minimal loss of water from the body.

Importance of High Heat of Vaporization:

This is high heat of vaporization of water that gives animals an efficient way to release excess body heat in a hot environment. When an animal sweats, body heat is used to vaporize the sweat thus cooling the animal. Due to this property of water, evaporation of only 2 ml out of one liter of water lowers the temperature of the remaining 998 ml water by 1°C.

(v) Cohesion and adhesion of water molecule:

Cohesion is the attraction among the water molecules which enables the water molecules to stick together.

Water flows freely due to cohesion. Water molecules also have attraction to polar surfaces. This attraction is called adhesion.

Both cohesion and adhesion are due to hydrogen bonds among water molecules. These properties of water enable it to circulate in living bodies and to act as transport medium.

(vi) Hydrophobic exclusion:

Hydrophobic exclusion can be defined as reduction of the contact area between water and hydrophobic substances which are placed in water.

For example, if you place few drops of oil on the surface of a water solution, the oil drops will tend to coalesce (to unite into one whole) into a single drop.



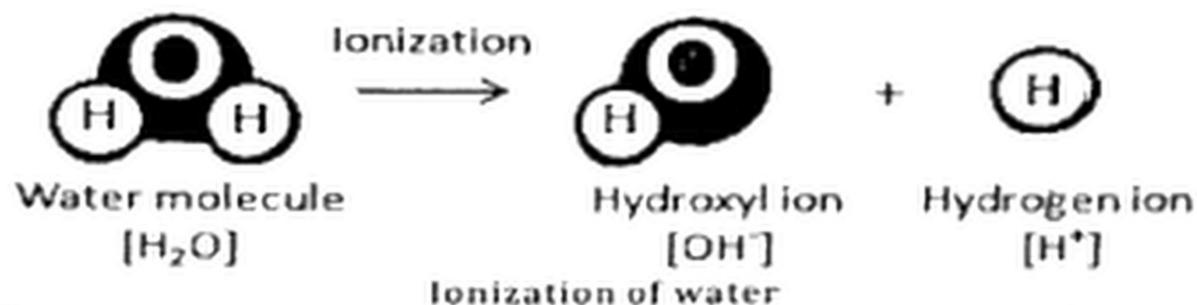
Importance of Hydrophobic Exclusion:

Hydrophobic exclusion biologically, hydrophobic exclusion plays key roles in maintaining the integrity of lipid bilayer membranes.

(vii) Ionization:

The dissociation of a molecule into ions is called ionization. When water molecule ionizes, it releases an equal number of positive hydrogen and negative hydroxyl ions.

Importance of Ionization:



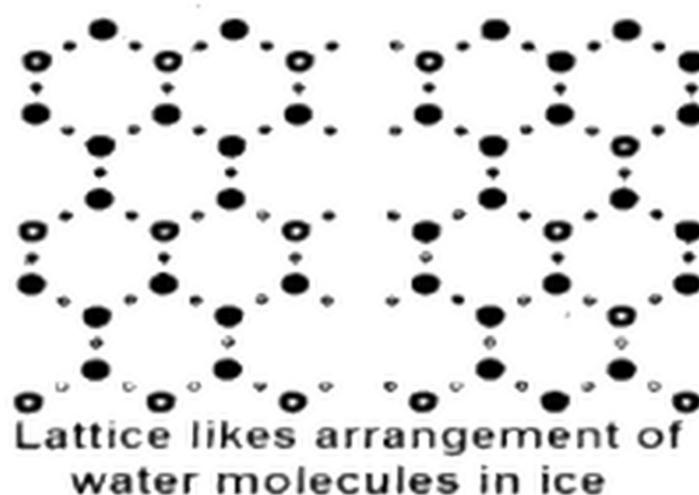
This reaction is reversible but equilibrium is maintained at $25^{\circ}C$. The H^+ and OH^- ions affect and take part in many of the reactions that occur in cells, e.g. it helps to maintain or change the pH of the medium.

(viii) Lower density of ice:

Ice floats on water. This is because ice is less dense than water. The reason is that ice has a giant structure and show maximum number of hydrogen bonding among water molecules, hence, they are arranged like a lattice.

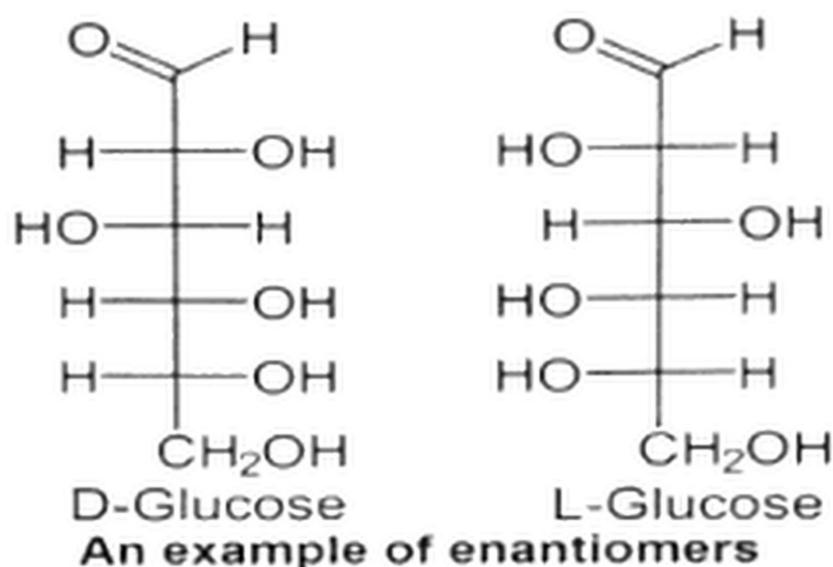
Importance of Lower Density of Ice:

In freezing weather, ice forms on the surface of ponds and lakes forming an insulating layer above the, water below. This provides a living environment for some organisms until the ice melts. Organisms can also live under the ice.



(ix) Enantiomers:

Those stereoisomers which are non-superimposable mirror images of one another are called enantiomers. An example of an enantiomer is the D and L isomers of glucose, as shown in figure. In D isomers (also called right handed form) the asymmetric carbon atom farthest from aldehyde group (second last carbon or C- 5 in case of glucose also called penultimate carbon) has —OH group on right side whereas in L isomers (also called left handed form), the —OH group is projected on left side at penultimate Carbon atom. Out of 16 stereoisomers of glucose, 8 are enantiomers of other 8.

**(x) Diastereoisomers:**

Those stereoisomers which have different arrangement of —H and —OH groups at more than one asymmetrical carbon atoms are called diastereoisomers. Unlike an enantiomer, diastereoisomers are not mirror images. For example, the two carbohydrates that are diastereoisomers are D-Glucose and D-Altrose.

(xi) Epimers:

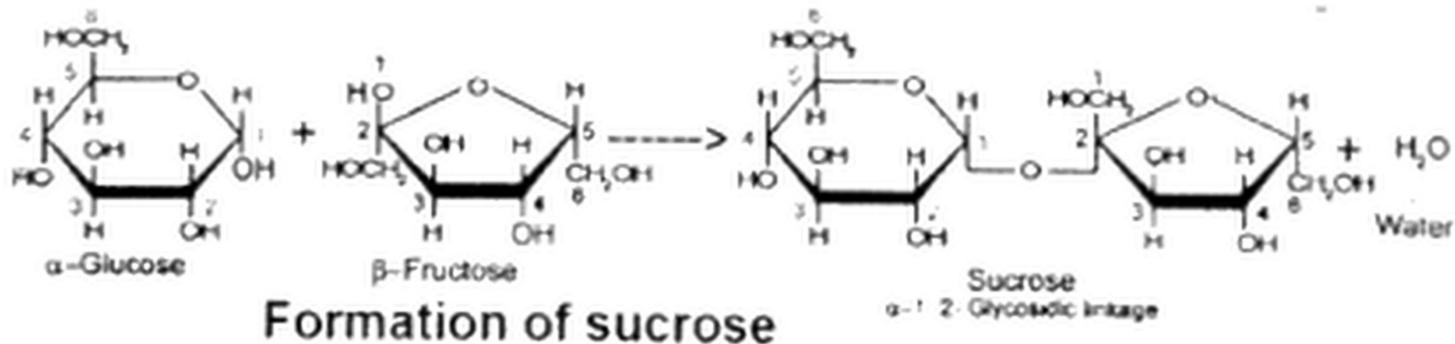
Those stereoisomers which have different arrangement of —H and —OH groups at only one asymmetrical carbon atom are called epimers. D — Glucose and D — Mannose are an example of an epimer.

(xii) Sucrose:

It is commonly known as cane sugar because it occurs abundantly in sugarcane beside it many other plants also have sucrose in considerable amount like sugar beet, pine apple, sorghum and all sweet fruits. It is widely used as sweetener at homes for making sweet dishes. In plants sucrose is also called transport disaccharide as prepared food in plants is transported in the form of sucrose, upon hydrolysis sucrose yields a molecule of α -glucose and a molecule of β -fructose.

Formation of Sucrose:

Therefore, the sucrose is formed by the condensation of glucose and fructose. In this reaction, the —OH group at C-1 of glucose reacts with the —OH group at C-2 of fructose, liberating a water molecule and a linkage is formed between C-1 of glucose and C-2 of fructose known as α -1, 2-glycosidic linkage.

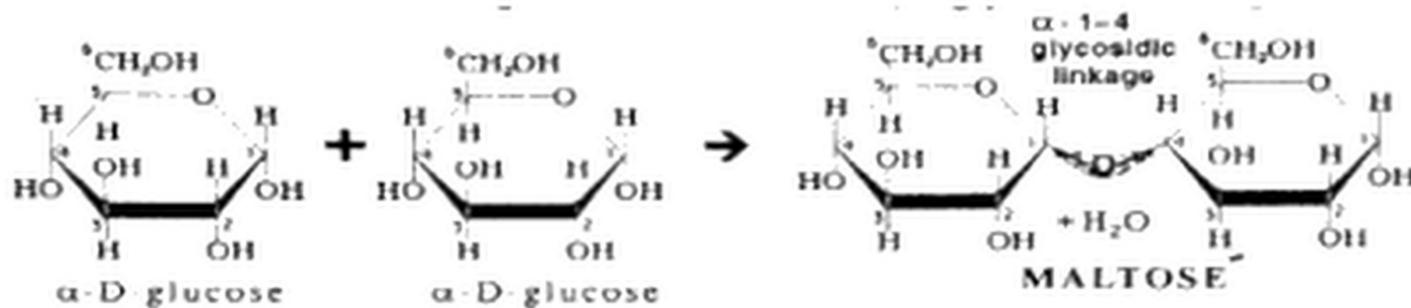


(xiii) Maltose:

It is commonly known as malt sugar. It is an Intermediate disaccharide produced during the breakdown of starch and glycogen. Maltose is generally found in germinating seeds. In brewing industry, the maltose is produced from the breakdown of barley starch by the help of amylase enzyme. This process is known as malting upon hydrolysis it yields two molecules of α -glucoses.

Formation of Maltose:

Therefore, the maltose is formed by the condensation of α -glucoses. In this reaction, the —OH group at C-1 of one glucose reacts with the —OH group at C-4 of Other glucose, liberating a water molecule and a linkage is formed between C-1 of one glucose and C-4 of Other glucose, known as α -1, 4-glycosidic linkage.

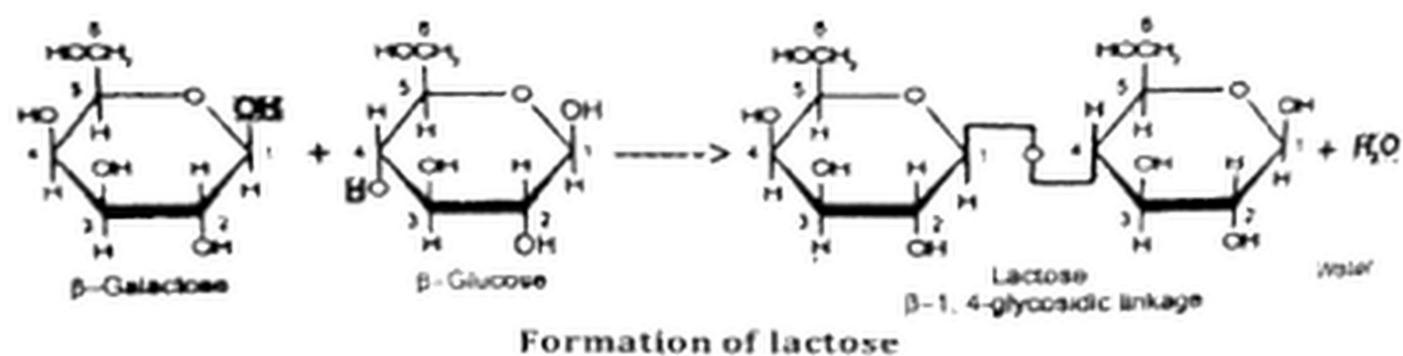


(xiv) Lactose:

It is commonly known as milk sugar as it is found in milk of mammals i.e., 4- 6% in cow's milk and 5-8% in human milk. It is also a byproduct in the manufacture of cheese. Upon hydrolysis It yields a molecule of β -galactose and a molecule of α - glucose.

Formation of Lactose:

Therefore, the lactose is formed by the condensation of β -galactose and β - glucose. In this reaction, the $-\text{OH}$ group at C-1 of galactose reacts with the $-\text{OH}$ group at C-4 of glucose, liberating a water molecule and a linkage is formed between C-1 of galactose and C-4 of glucose, known as β -1, 4-glycosidic linkage.



(xv) Starch:

Starch is a homopolysaccharides which is formed by the condensation of hundreds of α -glucoses.

Storage of in Plants:

It is storage carbohydrate of plants. It is mainly stored in root, stem and seeds.

Role of Starch:

Cereal grains and potato tubers are rich sources of starch in human diet. Starch is digested in oral cavity and in small intestine by the enzyme amylase. Upon hydrolysis it yields maltose first and then maltose is further digested by maltase enzyme and yields glucoses. The presence of starch in a

given sample can be confirmed by iodine test as it gives blue color with iodine solution.

Types of Starch:

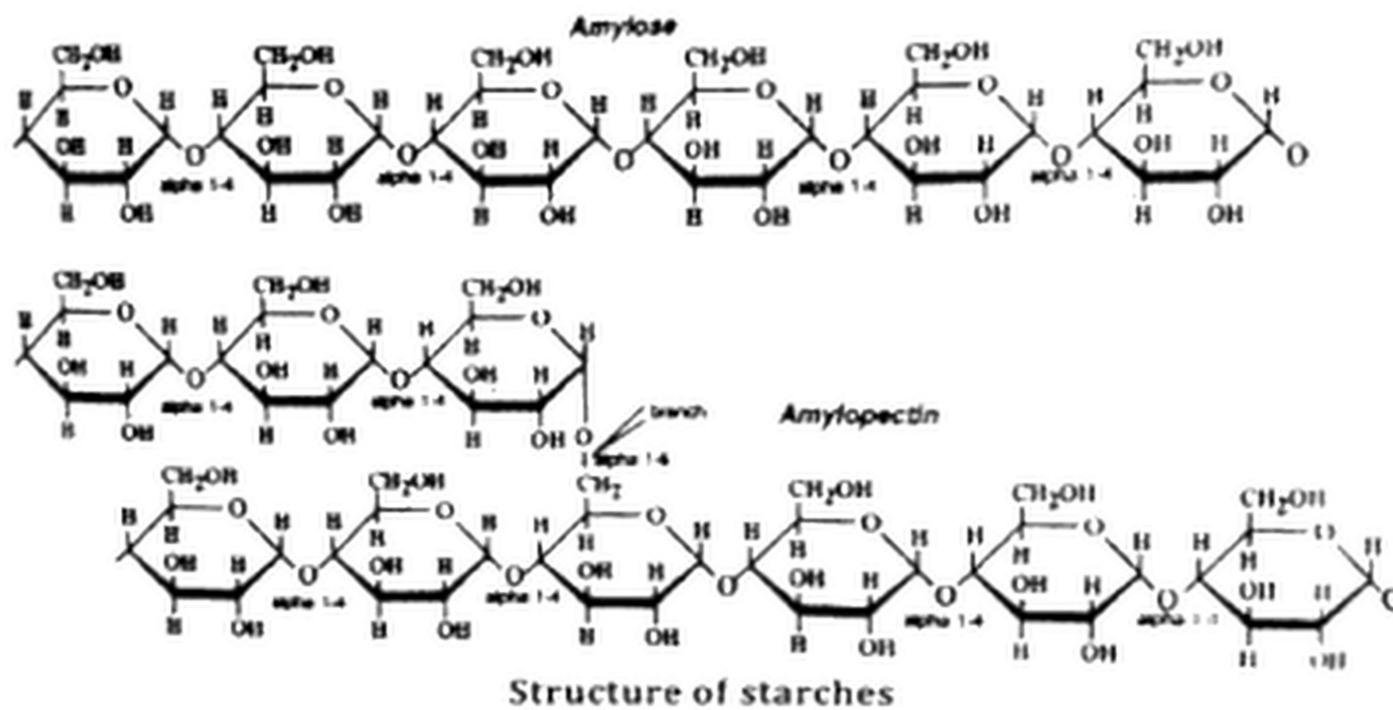
There are two types of starches i.e. amylose and amylopectin.

Amylose:

Amylose is un-branched i.e., a linear chain of glucoses in which glucoses are attached together by α -1, 4-glycosidic linkages. It is soluble in hot water only.

Amylopectin:

On the other hand, amylopectin has branched structure [e.g. a linear chain of glucoses but more chains of glucoses in the form of branches are also attached by α -1, 6-glycosidic linkages. It is completely insoluble in water.



(xvi) Glycogen:

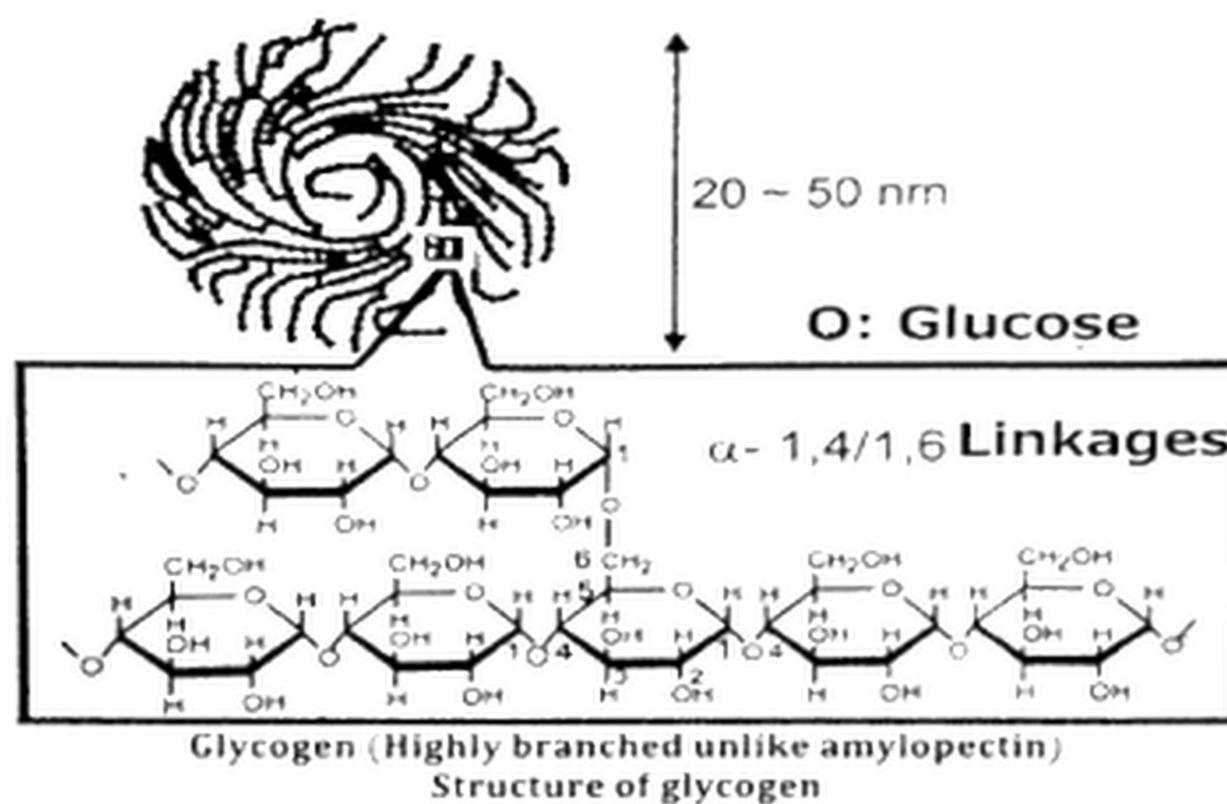
Like starch, glycogen is also a homopolysaccharides composed of α -glucoses.

Storage of Glycogen in Animals:

It is storage carbohydrate of animals. It is mainly stored in liver and muscles. Therefore it is also known as animal's starch. The digestion of glycogen is also quite similar to that of starch. The presence of glycogen in a given sample can also be confirmed by iodine test as it gives red color with iodine solution.

Structure of Glycogen:

Structure of glycogen resembles with amylopectin starch but glycogen has much more branching than amylopectin.



(xvii) Cellulose:

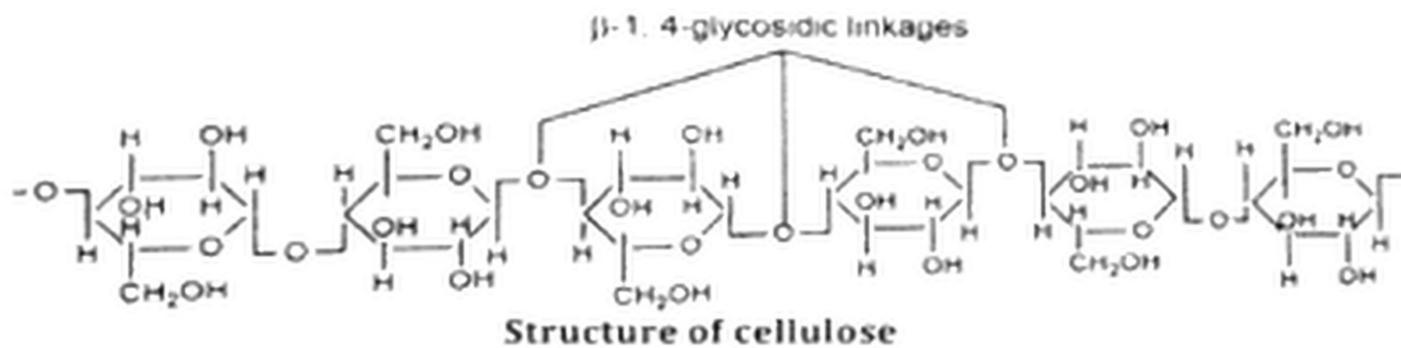
Cellulose is most abundant carbohydrate on earth. It is also a homopolysaccharides but unlike starch and glycogen it is formed by the condensation of hundreds of β -glucoses.

Examples of Cellulose:

It is structural carbohydrate of plants as it is major constituent of plant cell wall. Cotton and paper are the pure forms of cellulose. Cellulose shows no color with iodine solution.

Structure of Cellulose:

Structure of cellulose resembles with -amylose starch in such a way that it has un-branched structure but it has β -1, 4-glycosidic linkages between glucose residues. Therefore, in a cellulose chain, the β -glucoses are alternatively arranged in upright and inverted manner.



(xviii) Chitin:

Chitin is the second most abundant organic molecule on earth.

Role of Chitin:

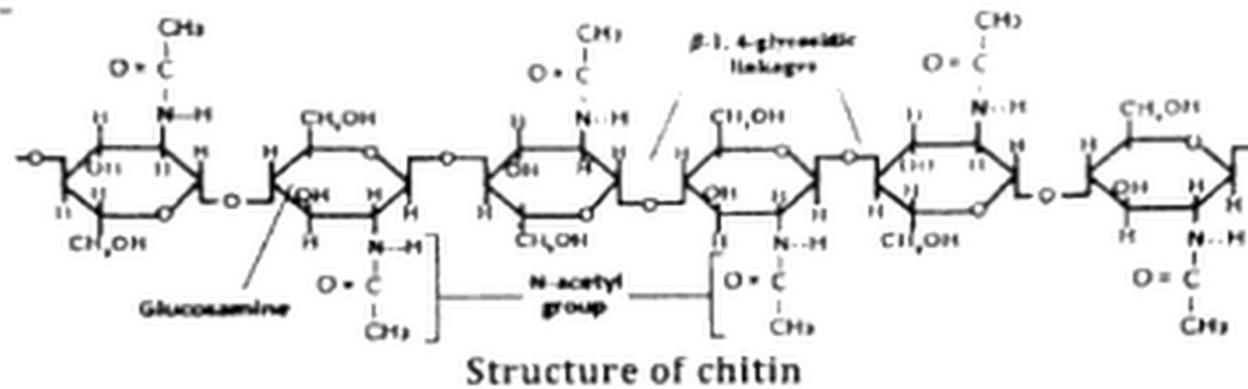
It is also a homopolysaccharides. It is a structural carbohydrate found in the cell walls of fungi and in the exoskeleton of arthropods. Due to the occurrence of chitin in fungal cell wall, it is also known as fungal cellulose.

Formation of Chitin:

Chitin is the derivative of N-acetyl glucosamine which is a modified form of glucose.

Structure of Chitin:

It has an un-branched structure like cellulose in which alternative upright and inverted N-acetyl glucosamine residues are linked together by β -1, 4-glycosidic linkages.

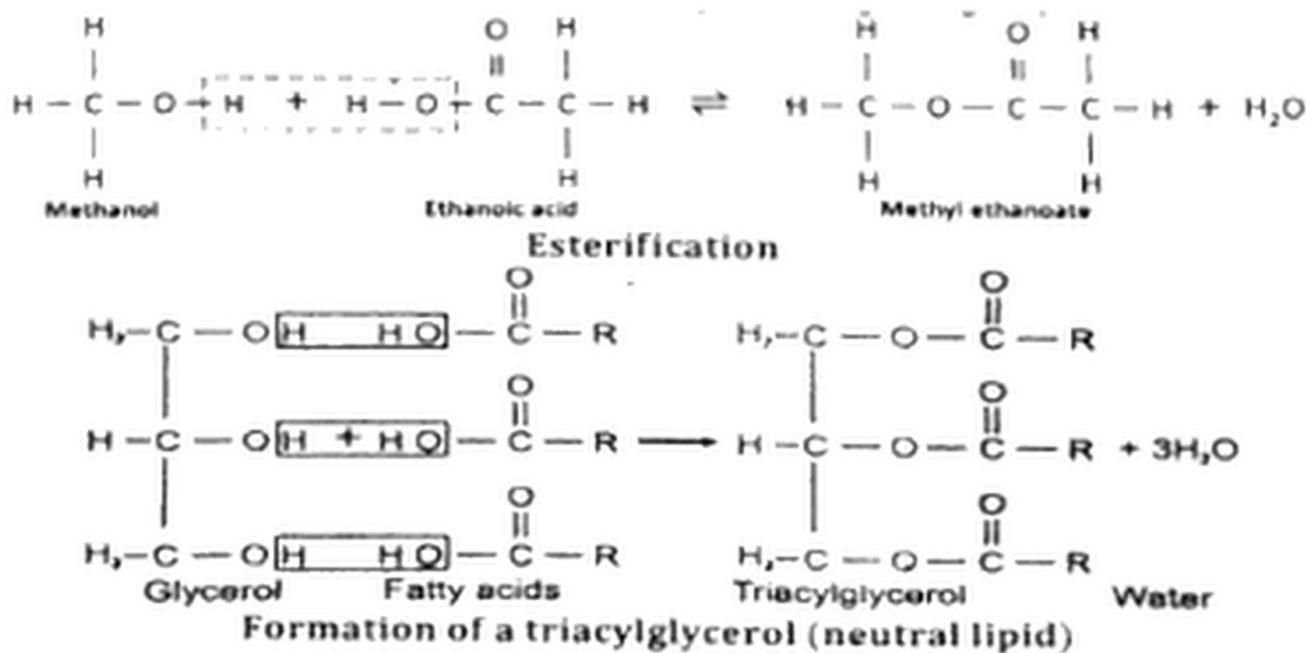


(xix) Acylglycerol:

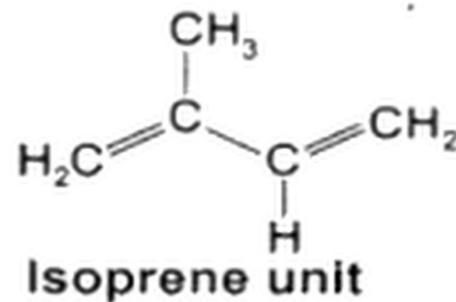
The most abundant lipids in living things are acylglycerol. Chemically, acylglycerols can be defined as esters of glycerol and fatty acids. An ester is the compound produced as the result of a chemical reaction of an alcohol with acid and a water molecule is released such a reaction is called esterification.

Glycerol is a trihydroxy alcohol which contains three carbons, each bears an OH group. A fatty acid is a type of organic acid containing one carboxylic acid group attached to a hydrocarbon. Fatty acids contain even number of carbons from 2 to 30. Each fatty acid is represented as R-COOH, where R is a hydrocarbon tail. When a glycerol molecule combines chemically with one fatty acid, a monoacylglycerol (monoglyceride) is formed, when two fatty acids combine with a glycerol a diacylglycerol (diglyceride) is formed and when three fatty acids combine with one glycerol molecule a triacylglycerol (triglyceride) is formed.

Triacylglycerols are also called neutral lipid as all three OH groups of glycerol are occupied by fatty acids and charge bearing OH group is left.

**(xx) Terpenes:**

Terpenes are the types of derived lipids. All the terpenes are synthesized from a five-carbon building block known as isoprene unit. This unit condenses in different ways to form many compounds. Two isoprene units form a monoterpene menthol, four form a diterpene e.g., vitamin A, phytol (chlorophyll tail) and six form a triterpene e.g., ambrein. Natural rubber is a polyterpene.

**(xxi) Steroids:**

Steroids are lipids of high molecular weight which can be crystalline.

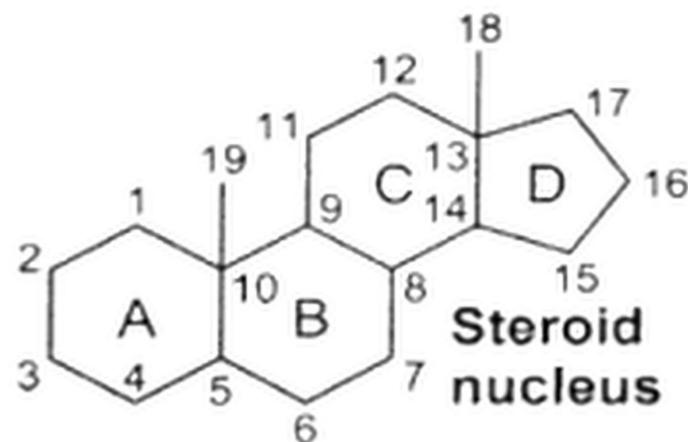
Composition of steroid:

A steroid consists of 17 carbon atoms arranged in four attached rings, three of the rings contain six carbon atoms, and the fourth contains five. The length and structure of the side chains that extend from these rings

distinguish one steroid from other steroids. These structures are synthesized from isoprene units.

Role Of steroid in Living Organisms:

Cholesterol is a structural component of cell membrane. Cholesterol is the precursor of a large number of equally important steroids which include the bile acids, male sex hormone testosterone, female sex hormone progesterone and estrogen etc. Bile salts which emulsify fats and Vitamin D, which helps to regulate calcium metabolism are also steroid.

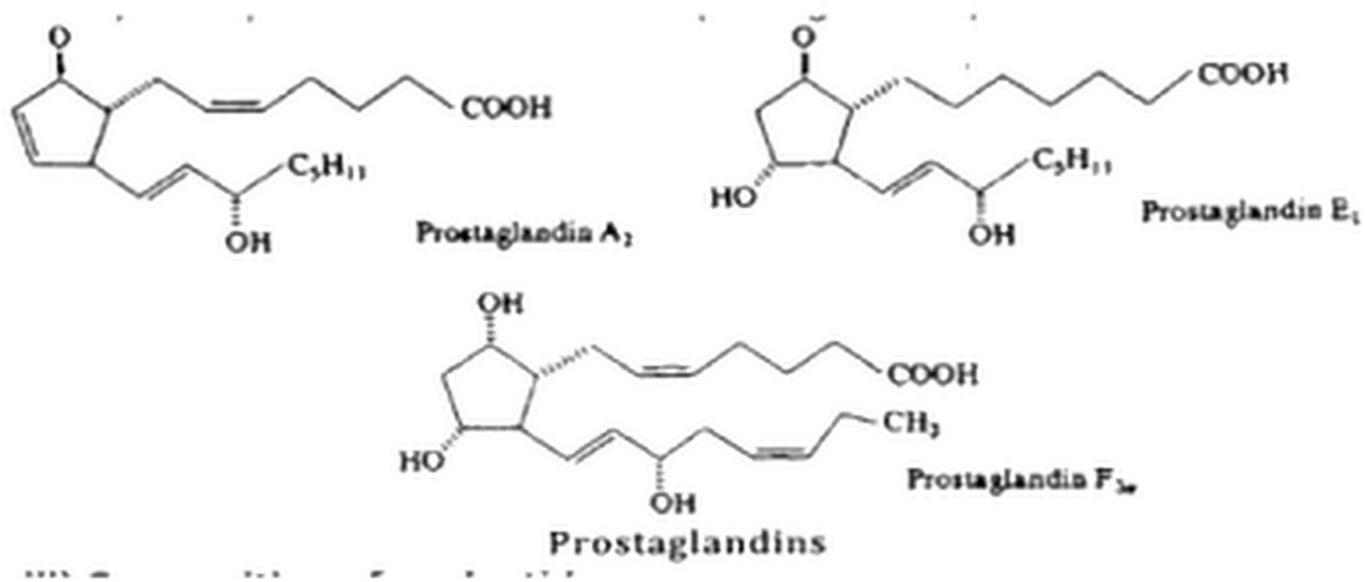


(xxii) Prostaglandins:

Prostaglandins exist in virtually every mammalian tissue, acting as local hormones. Prostaglandins are derived from arachidonic acid (a tetra unsaturated 20C fatty acid).

Role of Prostaglandins in Living Organisms:

Their functions vary widely depending on the tissue. Some reduce blood pressure, whereas others raise it. In the immune system, various prostaglandins help to induce fever and inflammation and also intensify the sensation of pain. They also help to regulate the aggregation of platelets an early step in the formation of blood clots. Those synthesized in the temperature-regulating center of the hypothalamus cause fever. In fact, the ability of aspirin to reduce fever and decrease pain depends on the inhibition of prostaglandin synthesis.



(xxiii) Composition of nucleotide:

Now it has been cleared that nucleic acids are of two types i.e. deoxyribo nucleic acid (DNA) and ribo nucleic acid (RNA). Both nucleic acids are linear un-branched polymers the monomers of the nucleic acid are called nucleotides.

Composition of a nucleotide:

Nucleotides of DNA are called deoxyribonucleotides and of RNA are known as ribonucleotides. Each nucleotide consists of pentose sugar, a phosphate and a nitrogen containing ring structure called base.

Pentose sugar:

The pentose sugar in deoxyribonucleotides is deoxyribose and in ribonucleotides is ribose.

Phosphoric acid:

Phosphoric acid is a common component of both nucleotides which provides acidic properties to DNA and RNA.

Nitrogenous bases:

The nitrogen containing ring structures are called bases because of unshared pair of electrons on nitrogen atoms, which can thus acquire a proton. **Classes of Nitrogenous Bases:**

There are two major classes of nitrogenous bases i.e., single ring pyrimidine and double ring purines.

i. Pyrimidine bases:

Pyrimidine bases are of three types i.e. cytosine (C), thymine (T) and uracil (U) Thymine is only found in DNA while the uracil is only found in RNA.

ii. Purine bases:

On the Other hand, the purine bases are also of two types i.e. adenine (A) and guanine (G).

During the formation of a nucleotide, first nitrogenous base is linked with 1' carbon of pentose sugar. Such combination is called nucleoside When a phosphoric acid IS linked with 5' carbon of pentose Sugar Of a nucleoside, the nucleotide is formed. A nucleotide with one phosphoric acid is called nucleoside monophosphate with two phosphoric acids is called nucleoside diphosphate and with three phosphoric acids is called nucleoside triphosphate.

The nucleotides which take part in the formation of DNA or RNA must contain three phosphates but during their incorporation into DNA or RNA polymer each nucleotide losses, its two terminal phosphates. Different terms used for nucleosides and nucleotides are given in the table.

(xxiv) ATP:

Adenosine triphosphate (ATP) is a mononucleotide. ATP has three parts, connected by covalent bonds: (a) adenine, a nitrogen base; (b) ribose, a five carbon sugar, (c) three phosphates. The two covalent bonds linking the three phosphates together are called high-energy bonds. ATP can be converted to ADP and inorganic phosphate (iP) by hydrolysis. ATP is known as the energy currency of cells. ATP is made from the oxidation of organic molecules during respiration. Since the energy to add the phosphate to ADP

comes from oxidation, the process is known as oxidative phosphorylation. Most of the ATP in the cell is made in mitochondria.

(xxv) NAD:

Nicotinamide adenine dinucleotide (NAD) consists of two nucleotides. One nucleotide consists of base-nicotinamide, sugar and phosphate. Other nucleotide consists of base-adenine-sugar and phosphate. The two nucleotides are joined by their phosphate group forming a dinucleotide. NAD is a coenzyme. It works with dehydrogenases as oxidizing agent. Its reduced form is NADH+H (NADH₂).

(xxvi) mRNA:

mRNA consists of a single strand of variable length. Its length depends upon the size of the gene, as well as the protein for which it is taking message. For example, for a protein molecule consisting of 100 amino acids, the mRNA will have the length of 300 nucleotides.

Actually every three nucleotides in mRNA encode a specific amino acid, such triplets of nucleotides along the length of mRNA are called codons of genetic codes, mRNA is about 3 to 4% of the total RNA in the cell, and mRNA takes the genetic message from the nucleus to the ribosome in the cytoplasm to form particular protein. It is transcribed from DNA template i.e., the base of sequence of mRNA is according to the base sequence of DNA. It becomes attached to the ribosome. At ribosome, amino acids are attached one by one to form a polypeptide chain as per base sequence of mRNA. This process is known as translation.

(xxvii) tRNA:

It is the smallest of the RNA molecules that it consists of 75 to 90 nucleotides. A tRNA is single stranded molecule but it shows a duplex appearance at its some regions where complementary bases are bonded to

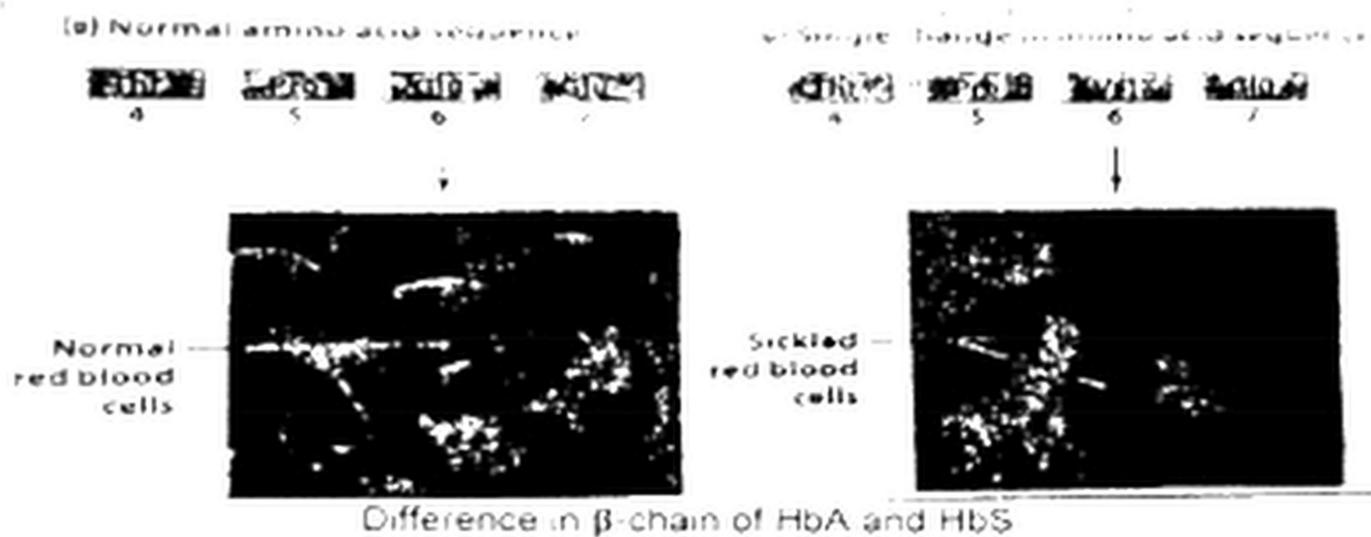
one another. It shows a flat cloverleaf shape in two dimensional views. Its 5' end always terminates in Guanine base while the 3' end always is the base sequence of ACC. Amino acid is attached to tRNA at this end. The nucleotide sequence of the rest of the molecule is variable tRNA has three loops. The middle loop in all the tRNA is composed of 7 bases, the middle three of which form the anticodon: it is complementary to specific codon of mRNA for example, a tRNA that has anticodon GAA binds to the codon CUU and carries amino acid Leucine. The D loop recognizes the activation enzyme Theta (θ) loop recognizes the specific place on the ribosome for binding during protein synthesis. There is at least one tRNA molecule for each of the 20 amino acids found in proteins. Sixty tRNA have been identified. However, human cells contain about 45 different kinds of tRNA molecules each transports a specific amino acid from cytoplasm to the surface of ribosome for protein synthesis.

(xxviii) Sickle cell anaemia:

Sickle cell anemia is a serious disorder in which the body makes sickle or crescent shaped red blood cells. Sickle cells contain abnormal hemoglobin called sickle haemoglobin (HbS). Sickle haemoglobin causes the cells to develop a sickle, or crescent shape. Sickle cells are stiff and sticky. They tend to block blood flow in the blood vessels of the limbs and organs Blocked blood flow can cause pain and organ damage.

Causes of Sickle cell anemia:

Sickle cell anemia is caused by a point mutation in β -globin gene in which only one nucleotide is replaced by another which causes a change in amino acid sequence of β -chain of hemoglobin. Sickle cell haemoglobin (HbS) shows only one difference from HbA i.e. glutamic acid as replaced by valine at position number six in β -chain.



(xxix) Conjugated molecules:

Molecules when joined by other kinds of molecules are called conjugated molecules. The examples are glycolipids, glycoproteins, lipoproteins and nucleoproteins.

42. Write the differences between:

- a) major and minor bio elements
- b) dimer and polymer
- c) polar and nonpolar covalent bond
- d) polyhydroxy aldehyde and polyhydroxy ketone
- e) furanose and pyranose
- f) Fischer projection and Haworth projection
- g) alpha and beta glucose
- h) D-glucose and L-glucose
- i) enantiomers and diastereoisomers
- j) diastereoisomers and epimers
- k) amylase and amylopectin
- l) amylopectin and glycogen
- m) primary and secondary structure of proteins
- n) tertiary and quaternary structure of proteins

- o) purine and pyrimidine
- p) saturated and unsaturated fatty acids
- q) DNA and RNA
- r) oxidative phosphorylation and photophosphorylation

Ans: a) major and minor bio elements:

Major Bioelements

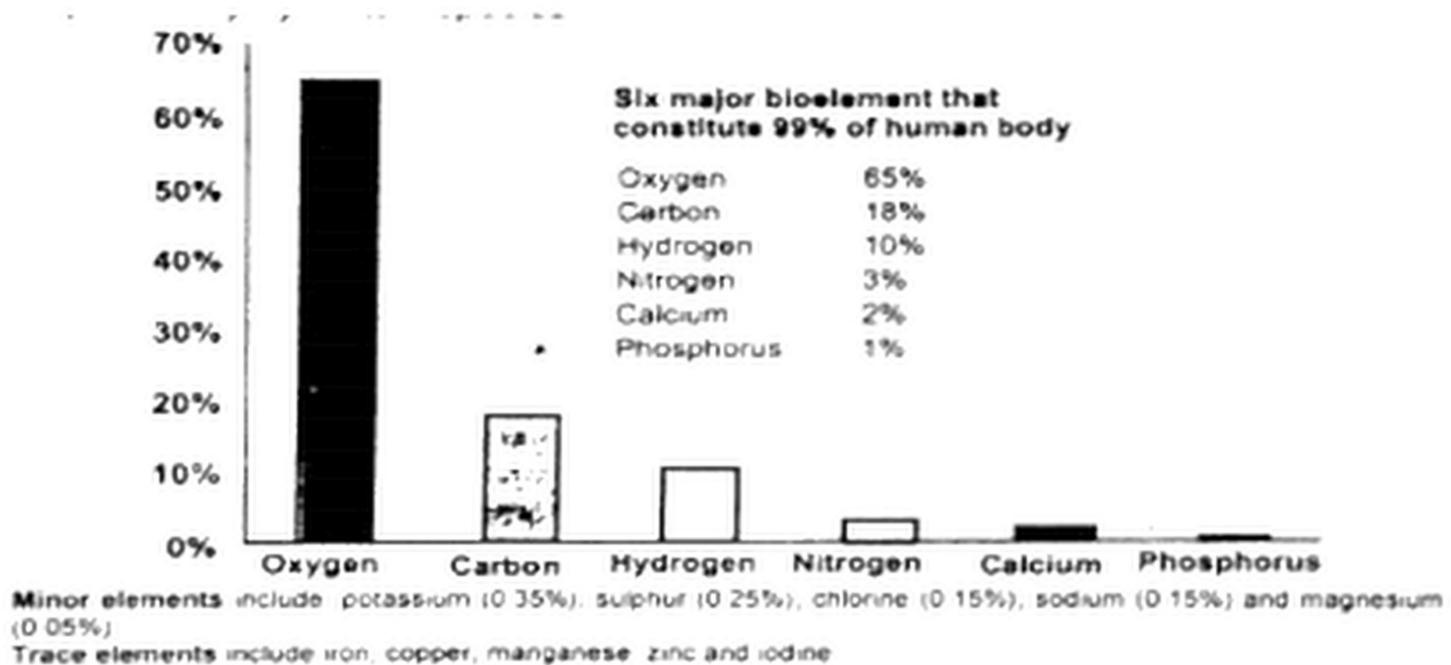
The six commonest bioelements that constitute 99% of protoplasm are called major bioelements.

Minor Bioelements

Minor bioelements are those that are found as less than 1% whereas those that are found as less than 0.01% of the protoplasm are called trace elements.

The proportions of these elements are given in the figure.

Some trace elements such as iron are needed by all forms of life. Others are required only by certain species.



OR (Second Answer)

Chemical elements are divided up into two groups – major and minor

Major Bioelements	Minor Bioelements
<ul style="list-style-type: none"> • Nitrogen (N) • Phosphorus (P) • Potassium (K) • Sulphur (S) • Calcium (Ca) • Magnesium (Mg) • Sodium (Na) 	<ul style="list-style-type: none"> • Boron (B) • Iron (Fe) • Manganese (Mg) • Copper (Cu) • Zinc (Zn) • Molybdenum (Mo) • Chlorine (Cl) • Cobalt (Co) • Selenium (Se) • Iodine I
<ul style="list-style-type: none"> • The tissues of plants and animals are made up of Carbon (C), Hydrogen (H), and Oxygen (O) and about 15 mineral elements. • The elements C, H and O along With Nitrogen (N), Phosphorus (P) and Sulphur (S) make up the living matter in plants and animals, with Calcium and Phosphorus forming animal skeletal bones. • The Other elements are used in various body systems of plants and animals driven by enzymes and for nervous functions. • An enzyme is a chemical used in a biological process but remains chemical unchanged 	

(b) dimer and polymer:

Dimer	Polymer
During condensation, when two monomers join, a hydroxyl ($-\text{OH}$) group is removed from one monomer and a hydrogen ($-\text{H}$) is removed from the	If the same reaction is repeated several times the resulting molecule will be a polymer.

Other to make water and as a result, a bond is synthesized between the monomers the product of such reaction IS called a dimer.	
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OR Second Answer

Dimer	Polymer
A molecule consisting of two identical halves, formed by joining two identical molecules, sometimes with a single atom acting as a bridge.	A long or larger molecule consisting of a chain or network of many repeating units, formed by chemically bonding together many identical or similar small molecules called monomers. A polymer is formed by polymerization, the joining of many monomer molecules.

OR (Second Answer)

A monomer is a non-repeating structure. A dimer is two monomers attached to each other. A polymer is many monomers attached to each other.

Think chain links. A single chain link is a monomer, two chain links hooked together is a dimer, and a 20 foot length of chain is a polymer.

(c) Polar and non-polar covalent bond:

Polar Bond	Non polar Covalent Bond
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Polar covalent bonding is a type of chemical bond where a pair of electrons is unequally shared between two atoms.	Nonpolar covalent bonds are a type of chemical bond where two atoms share a pair of electrons With each other.
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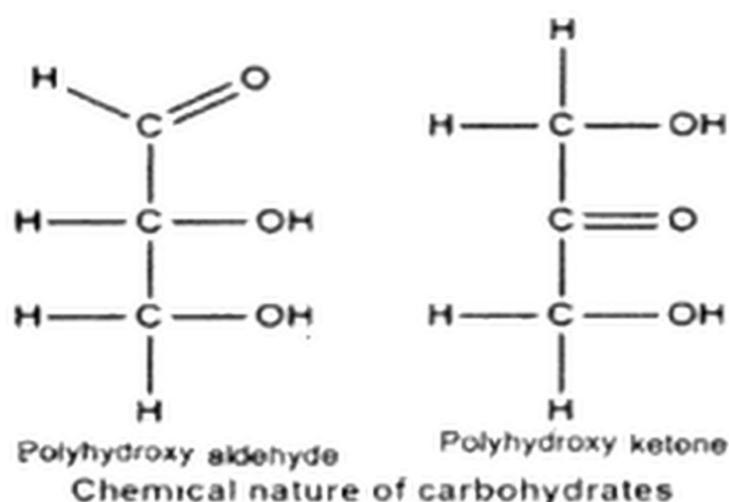
OR (Second Answer)

	Polar	Non-polar
Definition	Polar substances have a positive and a negative charge on the atom.	Non-polar substances do not have large charges on the atom attached.
Movement	They have electrical dipole movement	They do not have any dipole movement
Charge separation	There is charge separation	There is no charge separation
Interaction	They interact with other polar substances	They do not interact with other polar substances
Example	Water, alcohol and Sulphur.	Oil

(d) Polyhydroxy aldehyde and polyhydroxy ketone:

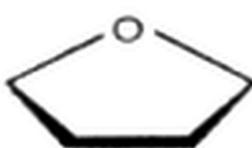
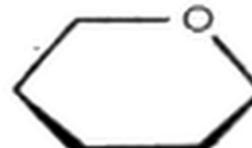
So Polyhydroxy aldehydes and ketones and their anhydrides describes carbohydrates, as molecules that contain an aldehyde or a ketone and have many OH groups and may be connected together with the removal of water. Basically, all of this is just a chemical way of saying "sugars" and "polysaccharides" (like starch).

"Polyhydroxy aldehyde or polyhydroxy ketone or those compounds which upon hydrolysis yield such compounds (derivatives) are called carbohydrates".



A polyhydroxy aldehyde or polyhydroxy ketone supposed to be single saccharide units, whereas, the derivative carbohydrates are composed of more than one saccharide units.

(e) furanose and pyranose:

Furanose	Pyranose
Furanose is a five membered ring in which one oxygen atom and four carbon atoms are found, oxygen atom is linked with C1 and C4. All pentoses and ketohexoses are converted into furanose ring.	Pyranose is a six membered ring in which one oxygen atom and five carbon atoms are found, oxygen atom is linked with C1 and C5. Only aldohexoses are converted into pyranose ring.
 Furanose ring	 Pyranose ring
Types of rings in monosaccharides	

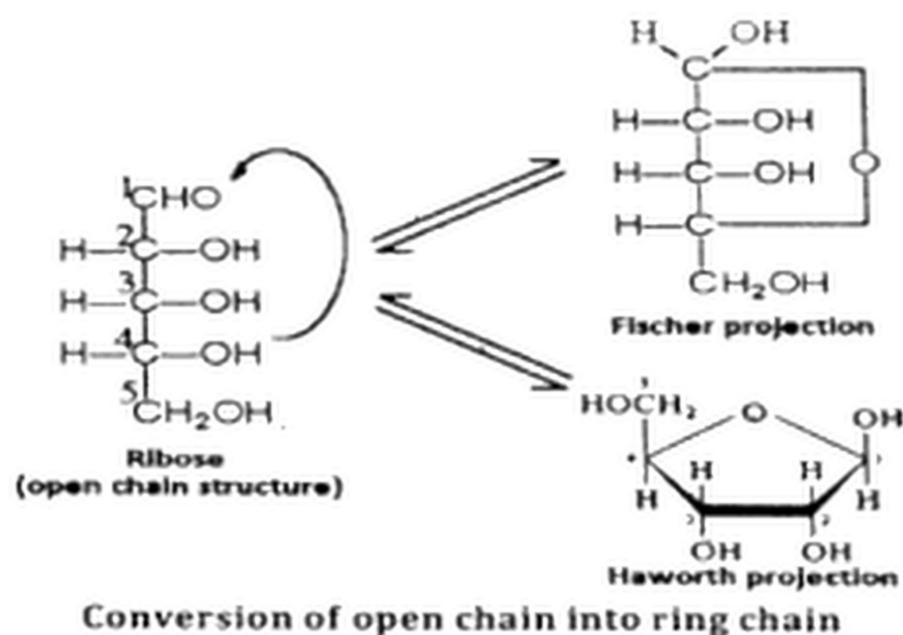
OR (Second Answer)

Pyranoses and furanoses are carbohydrates, but they are differing in their chemical structure i.e., pyranoses include six membered ring consists of five carbon atoms and one oxygen atom. Furanoses includes five membered ring consists of four carbon atoms and one oxygen atoms.

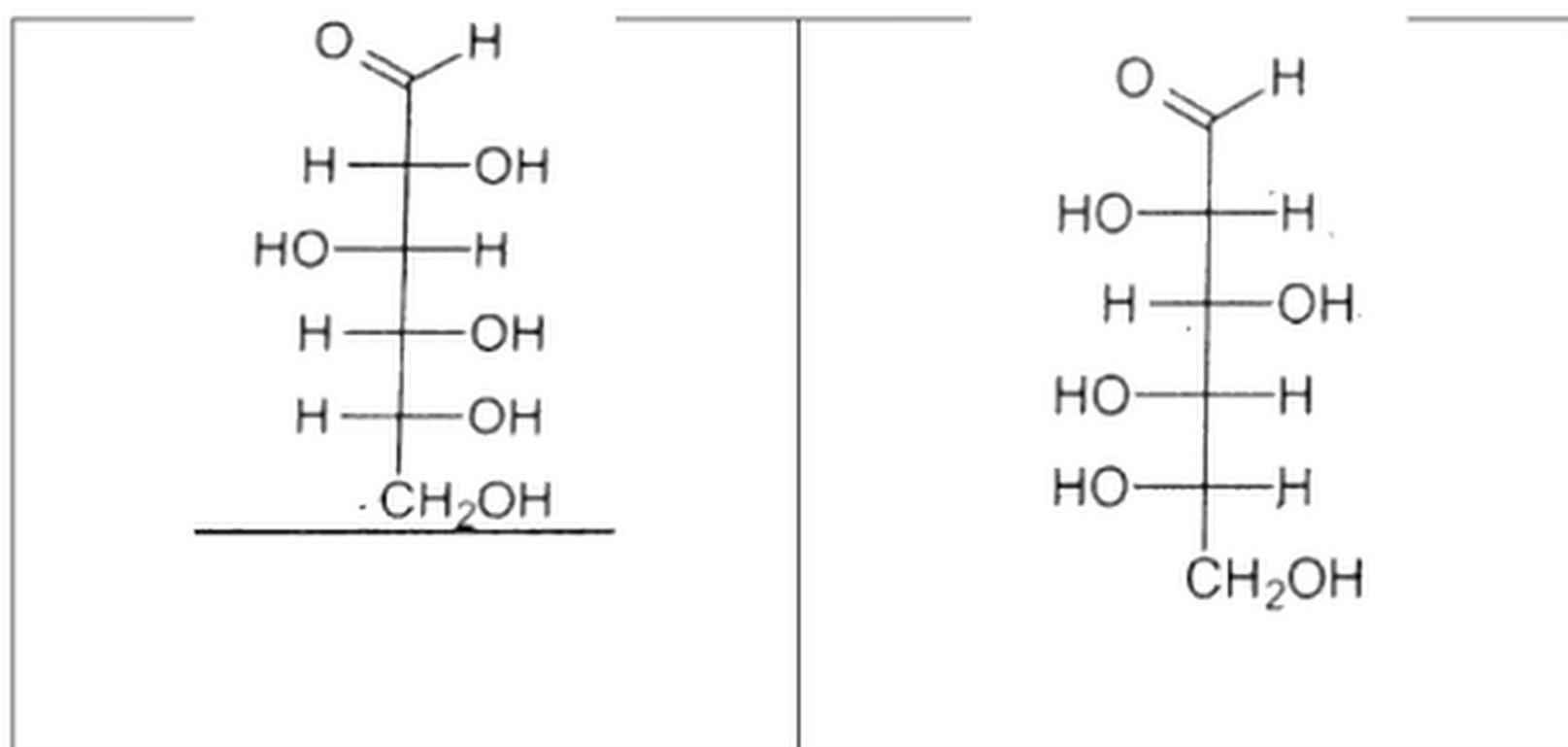
(f) Fischer projection and Haworth projection:

Ribose is an aldopentose, with the molecular formula $C_5H_{10}O_5$. It can exist in open chain structure in dried form but it exists in furanose ring in aqueous medium. When it is dissolved in water, the oxygen atom from aldehyde group reacts with penultimate carbon (second last carbon i.e., C4 in case of ribose) in this way oxygen atom forms a link between C1 and C4 while the OH group of C4 is shifted to C1 After this modification ring structure of ribose is formed.

The ring structure demonstrated by Emil Fischer is called Fischer projection (a two dimensional representation of ring structure) while that represented by an English chemist Norman Haworth is called as Haworth projection (a three dimensional representation of ring structure).



(g) alpha and beta glucose:



i. enantiomers and diastereoisomers:

(a) Enantiomers:

Those stereoisomers which are non-superimposable mirror images of one another are called enantiomers. An example of an enantiomer is the D and L isomers of glucose. In D isomers (also called right handed form) the asymmetric carbon atom farthest from aldehyde group (second last carbon or C-5 in case of glucose also called penultimate carbon) has —OH group on right side whereas in L isomers (also called left handed form), the —OH group is projected on left side at penultimate carbon atom. Out of 16 stereoisomers of glucose, 8 are enantiomers of other 8.

(b) Diastereoisomers:

Those stereoisomers which have different arrangement of —H and —OH groups at more than one asymmetrical carbon atoms are called diastereoisomers. Unlike an enantiomer, diastereoisomers are not mirror images. For example, the two carbohydrates that are diastereoisomers are D-Glucose and D-Altrose.

OR (Second Answer)

Differences between the enantiomers and the diastereomers:

Enantiomers	Diastereomers
They are mirror images of each other and are non-superimposable.	They are not mirror images of each other and are non-superimposable.
Their molecular structures often designed with R and S to distinguish them.	One molecule mimics the enantiomer structures whereas the other has the same configuration. So, there is no need to use the naming to differentiate them.
Have the same chemical and physical properties but different properties optical properties.	Have different chemical and physical properties.
Have one or more stereocenter	Have two stereocenters
All enantiomers possess optical active although they rotate activity light in opposite directions. Those ones rotating light anti-clockwise are known as levorotary, and those rotating clockwise are known as dextrorotary but when the other has the same dextrorotary and levorotary amounts of rotation, it is considered a race mixture and thus optically inactive.	Not all diastereomers possess optical activity.

(j) diastereoisomers and epimers:

Diastereoisomers	Epimers
Those stereoisomers which have different arrangement of —H and —OH groups at more than one asymmetrical carbon atoms are called diastereoisomers. Unlike an enantiomer, diastereoisomers are not mirror images.	Those stereoisomers which have different arrangement of —H and —OH groups at only one asymmetrical carbon atom are called epimers.
For example, the two carbohydrates that are diastereoisomers are D-Glucose and D-Altrose.	D-Glucose and D-Mannose are an example of an epimer.

(k) amylose and amylopectin:

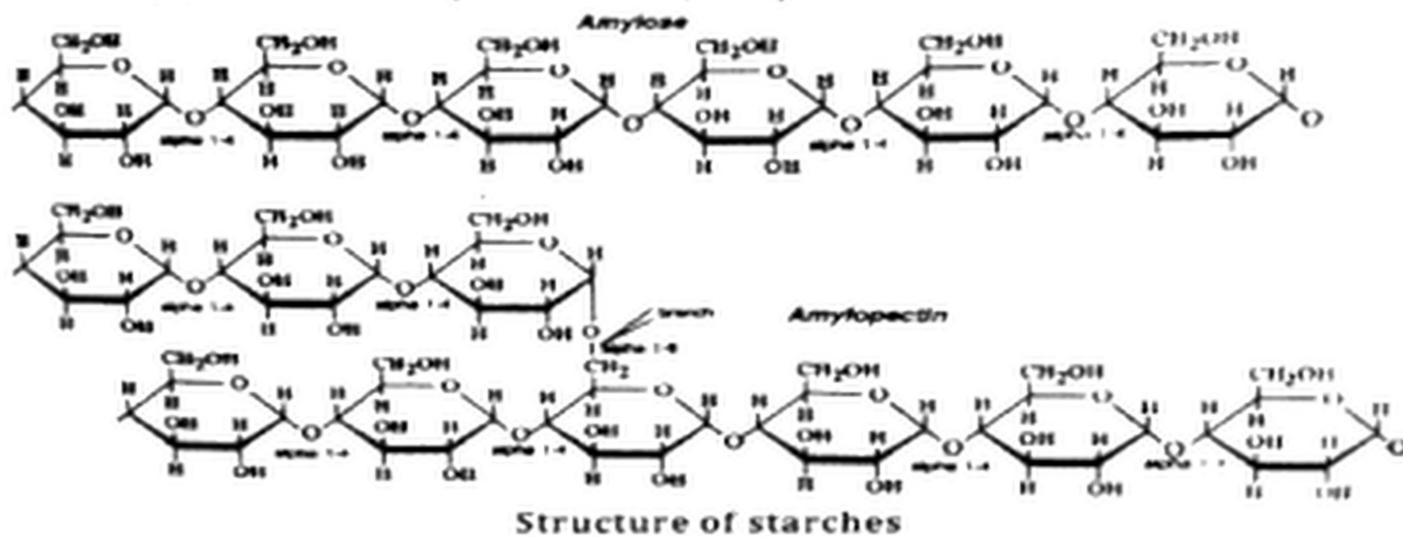
Amylose is a glucose polymer with long chain-like molecules, while amylopectin consists of larger highly branched molecules (1 to 6).

Amylose	Amylopectin
It is a linear polymer of α -glucose	It is a branched chain polymer of α -glucose
It is water-soluble	It is water-insoluble
It constitutes about 10-20% of the starch.	It constitutes about 90-80% of the starch.
It forms blue color with iodine	It forms red color with iodine
It has 60-300 glucose units.	It has 300-600 glucose units
It forms β C ₁ — C ₄ glycosidic linkage.	It forms β C ₁ — C ₆ glycosidic linkage

Soluble in hot water but does not form starch gel or paste	Soluble in hot water with swelling.
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(l) Amylopectin and glycogen:

On the other hand, amylopectin has branched structure i.e., a linear chain of glucoses but more chains of glucoses in the form of branches are also attached by α -1, 6-glycosidic linkages. It is completely insoluble in water.



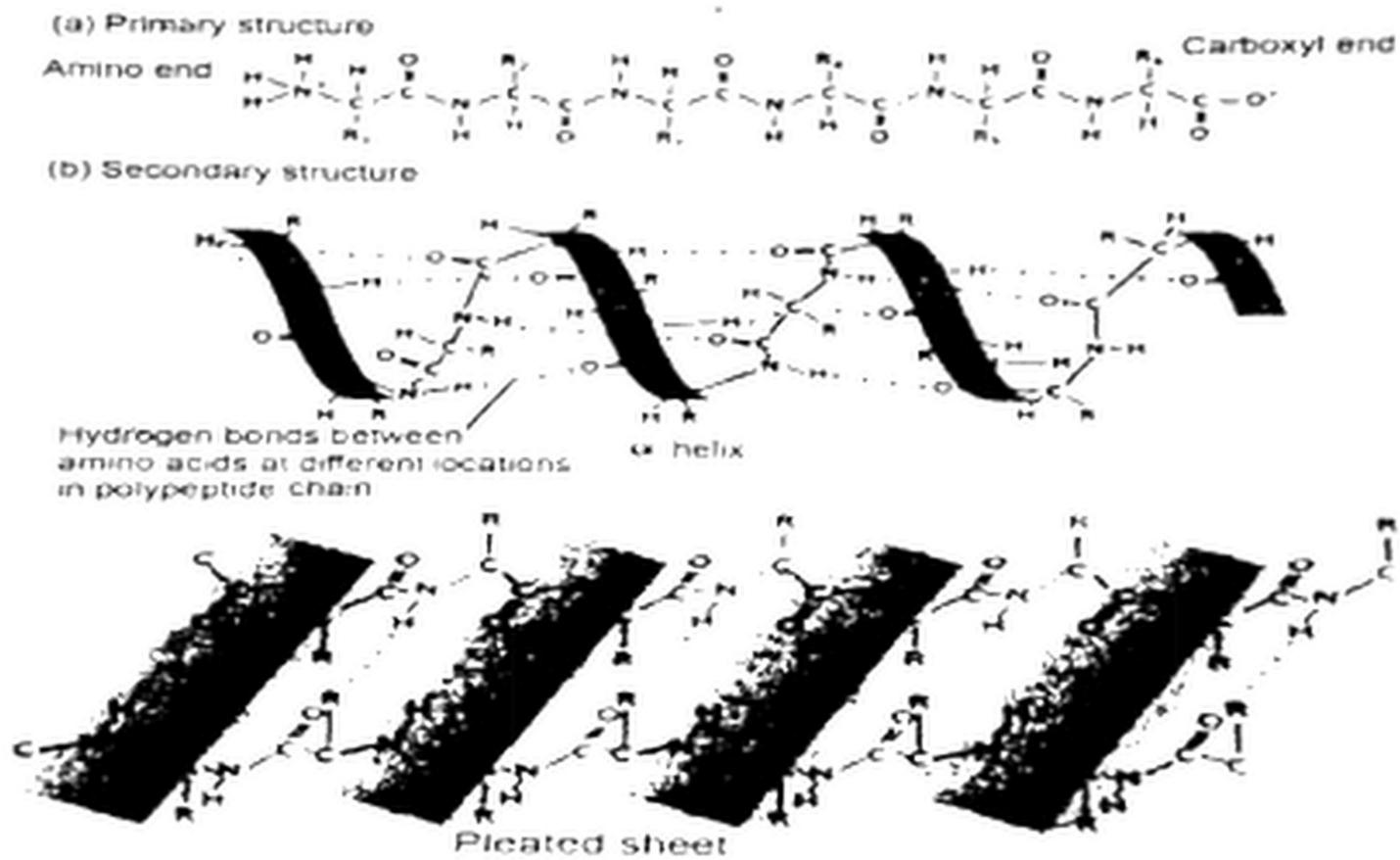
Glycogen:

Like starch, glycogen is also a homopolysaccharides composed of α -glucoses, it is storage carbohydrate of animals. It is mainly stored in liver and muscles. Therefore, is also known as animal's starch. The digestion of glycogen is also quite similar to that of starch. The presence of glycogen in a given sample can also be confirmed by iodine test as it gives red color with iodine solution. Structure of glycogen resembles with amylopectin starch but glycogen has much more branching than amylopectin.

(m) Primary and secondary structure of proteins:

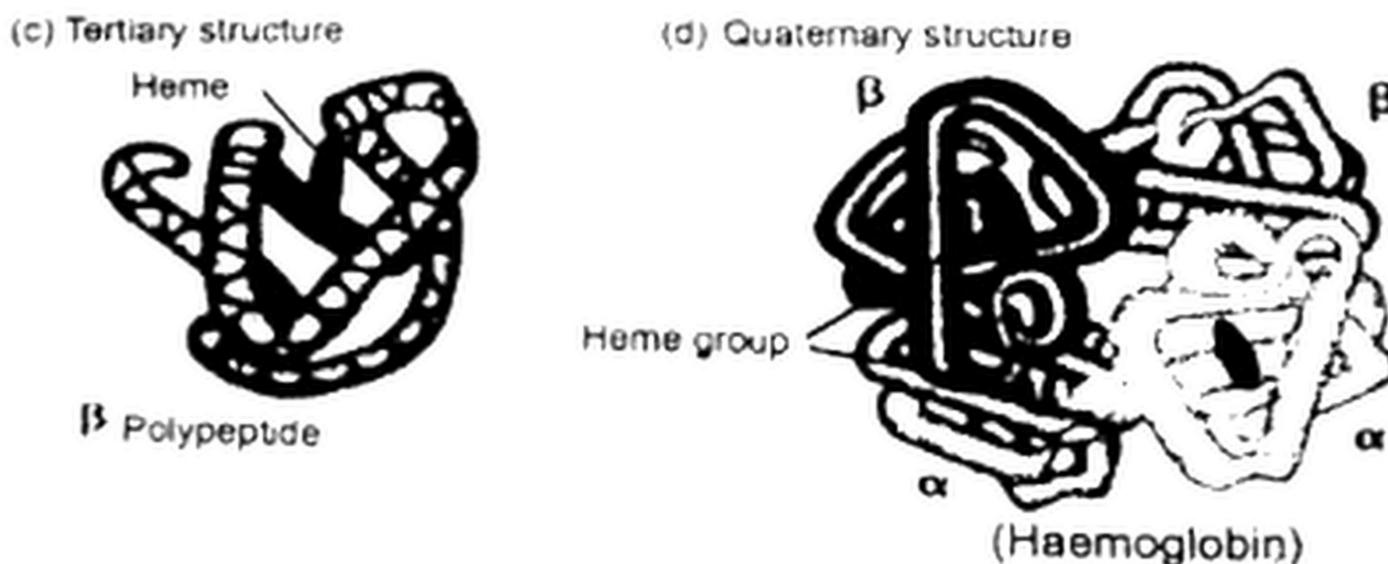
A linear polypeptide with a specific sequence and number of amino acids is called primary Structure, it is shown by all proteins at the time of their synthesis on ribosomal surface After synthesis a protein does not remain in its

primary structure but can be changed into some other structural conformations (particular form, shape or structure) A helical (α -helix) or flattened sheets (β -pleated sheet) like structures which are established by H-bonding between opposite charge bearing groups of different amino acids are called secondary structures.



(n) Tertiary and quaternary structure of proteins:

In some proteins the linear polypeptide is changed into α -helix, then α -helix fold again and again by ionic bonds and disulfide bridges to form a globular shaped structure, the tertiary structure. Some proteins exist in very complex structure. In which more than one globule is attached together by hydrophobic interaction. Such structures are called quaternary structures.



Structural conformations in proteins

(o) Purine and pyrimidine:

Purine	Pyrimidine
Purines are heterocyclic aromatic organic compounds, consisting of a pyrimidine ring fused to an imidazole ring.	pyrimidines are heterocyclic aromatic organic compounds
Contain two carbon-nitrogen rings and four nitrogen atoms	Contain a single carbon-nitrogen ring and 2 nitrogen atoms
Contain comparatively high melting and boiling points	Contain comparatively low melting and boiling points
Synthesized by Traube Purine synthesis	Synthesized by Biginelli Reaction
Catabolism produces uric acid	Catabolism produces beta amino acids, carbon dioxide, and ammonia.

(p) Saturated and unsaturated fatty Acids:

Saturated fatty Acids	Unsaturated fatty Acids
Has only single bonds.	Has both single bonds and double bonds
Not further dived into subcategories	Subdivided into two categories. monounsaturated & polyunsaturated
Have a solid consistency at room temperature	Have a liquid consistency at room temperature
Most animal-derived fats are considered to be saturated fats.	Most plant-derived fats are considered to be unsaturated fats
Not susceptible to further oxidation and rancidity when exposed to the atmosphere	Susceptible to further oxidation and rancidity when exposed to the atmosphere
High amount of saturated fats can be harmful to health	Unsaturated fats are associated with various health benefits

(q) DNA and RNA:

	DNA	RNA
Stands For	Deoxyribo Nucleic Acid	Ribo Nucleic Acid
Definitions	A nucleic acid that contains the genetic instructions used in the development and	The information found in DNA determines which trans are to be created, activated, or

	functioning of all modern living organism's DNA's genes are expressed, or manifested, through the proteins that its nucleotides produce with the help of RNA.	deactivated, while the various forms Of RNA do the work.
Functions	The blueprint of biological guidelines that a living organism must follow to exist and remain functional. Medium of long-term, stable storage and transmission of genetic information.	Helps carry out DNA's blueprint guidelines. Transfers genetic code needed for the creation of proteins from the nucleus to the ribosome.
Structure	Double-stranded. It has two nucleotide strands which consist of its phosphate group, five-carbon sugar (the stable 2-deoxyribose), and four nitrogen-containing nucleobases_ adenine, thymine. cytosine, and guanine	Single-stranded, Like DNA, RNA is composed of its phosphate group, five-carbon sugar (the less stable ribose), and 4 nitrogen-containing nucleobases: adenine, uracil (not thymine), guanine, and cytosine.
Base pairing	Adenine links to thymine (AT) and cytosine links to guanine (C-G)	Adenine links to uracil (A-U) and cytosine links to guanine (C-G).

Location	DNA is found in the nucleus of a cell and in mitochondria.	Depending on the type of RNA, this molecule is found in a cell's nucleus, its cytoplasm, and its ribosome.
Stability	Deoxyribose sugar in DNA is less reactive because of C-H bonds. Stable in alkaline conditions. DNA has smaller grooves, which makes it harder for enzymes to "attack".	Ribose Sugar is more reactive because of C-OH (hydroxyl) bonds. Not stable in alkaline conditions RNA has larger grooves, which makes it easier to be "attacked" by enzymes.
Propagation	DNA is self-replicating.	RNA is synthesized from DNA when needed
Unique Features	The helix geometry of DNA is of B-Form. DNA IS protected in the nucleus, as it is tightly packed DNA can be damaged by exposure to ultra-violet rays.	The helix geometry Of RNA is of A-Form, RNA strands are continually made, broken down and reused RNA is more resistant to damage by Ultra-violet rays.

OR (Second Answer)

Differences between DNA and RNA:

Comparison	DNA	RNA
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Name	DeoxyriboNucleic Acid	RiboNucleic Acid
Function	Long-term storage of genetic information, transmission genetic information to make other cells and new organisms	Used to transfer the genetic code from the nucleus to the ribosomes to make proteins. RNA is used to transmit genetic information in some organisms and may have been the molecule used to store genetic blueprints in primitive organisms.
Structural features	B-form double helix. DNA is double-stranded molecule consisting of a long chain of nucleotides.	A-form helix RNA usually is single-strand helix consisting shorter chains nucleotides.
Composition of bases and sugars	deoxyribose sugar phosphate backbone adenine, guanine, cytosine, thymine bases	ribose sugar phosphate backbone adenine, guanine, cytosine, uracil bases
propagation	DNA is self-replicating	RNA is synthesized from DNA on an as-needed
Base pairing	AT (adenine-thymine) GC (guanine-cytosine).	AU (adenine-uracil) GC (guanine-cytosine)
Reactivity	The C-H bonds in DNA make it fairly stable, plus the body destroys enzymes that would	The O-H bond in the ribose of RNA makes the molecule more reactive, compared with DNA. RNA

	attack DNA. The small grooves in the helix also serve as protection, providing minimal space for enzyme to attach.	is not stable under alkaline conditions, plus the large grooves in the molecule make it susceptible to enzyme attack. RNA is constantly produced used, degraded, and recycled.
Ultraviolet damage	DNA is susceptible to UV damage.	Compared with DNA, RNA is relatively resistant to UV damage.

(r) Oxidative phosphorylation and photophosphorylation:

Oxidative phosphorylation	Photophosphorylation
1. Occurs during respiration	1. Occurs during photosynthesis
2. Occurs inside mitochondria.	2. Occurs inside chloroplast
3. Pigment systems are not involved	3. Pigment systems {PS-I and PS-II} are involved.
4. ATP is produced from ADP and inorganic phosphate by utilizing energy released during electron transport.	4. Sunlight is the external energy source for photophosphorylation.
5. Molecular Oxygen is required for terminal Oxidation	5. Molecular oxygen is not required for photophosphorylation.

<p>6. The ATP molecules produced are released into the cytoplasm and this energy molecules are used to carry out various metabolic reactions of the cell.</p>	<p>6. The ATP molecules produced is used to fix CO_2 to carbohydrates in dark reaction.</p>
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