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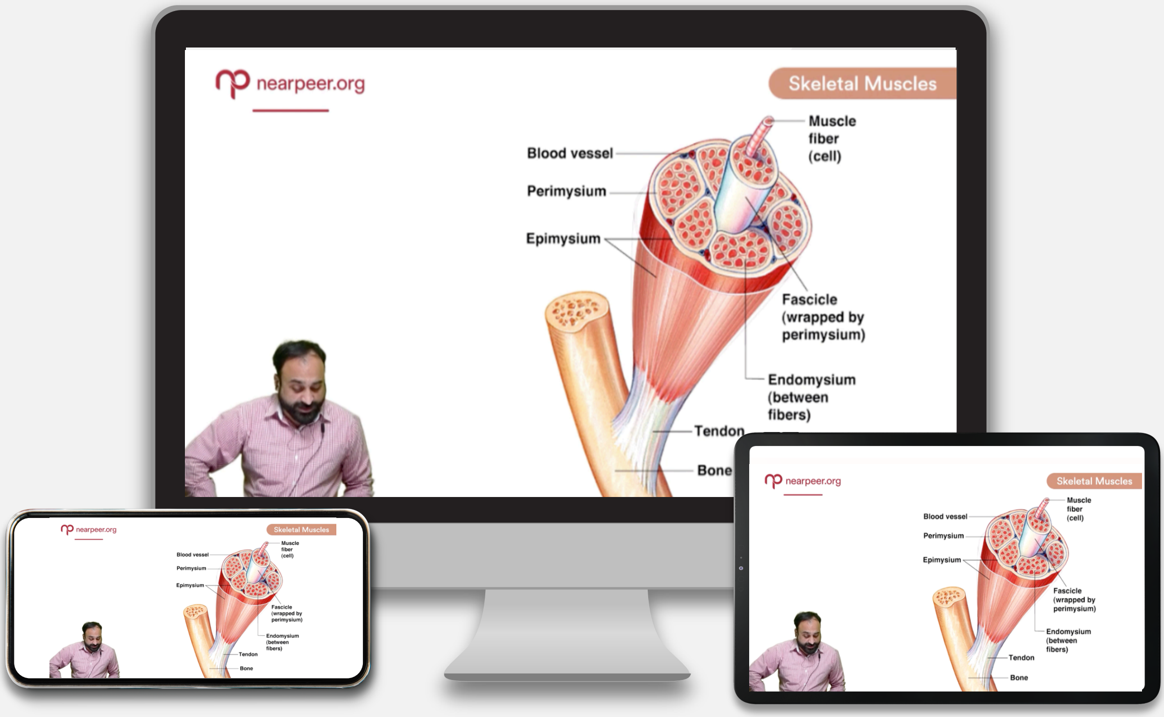
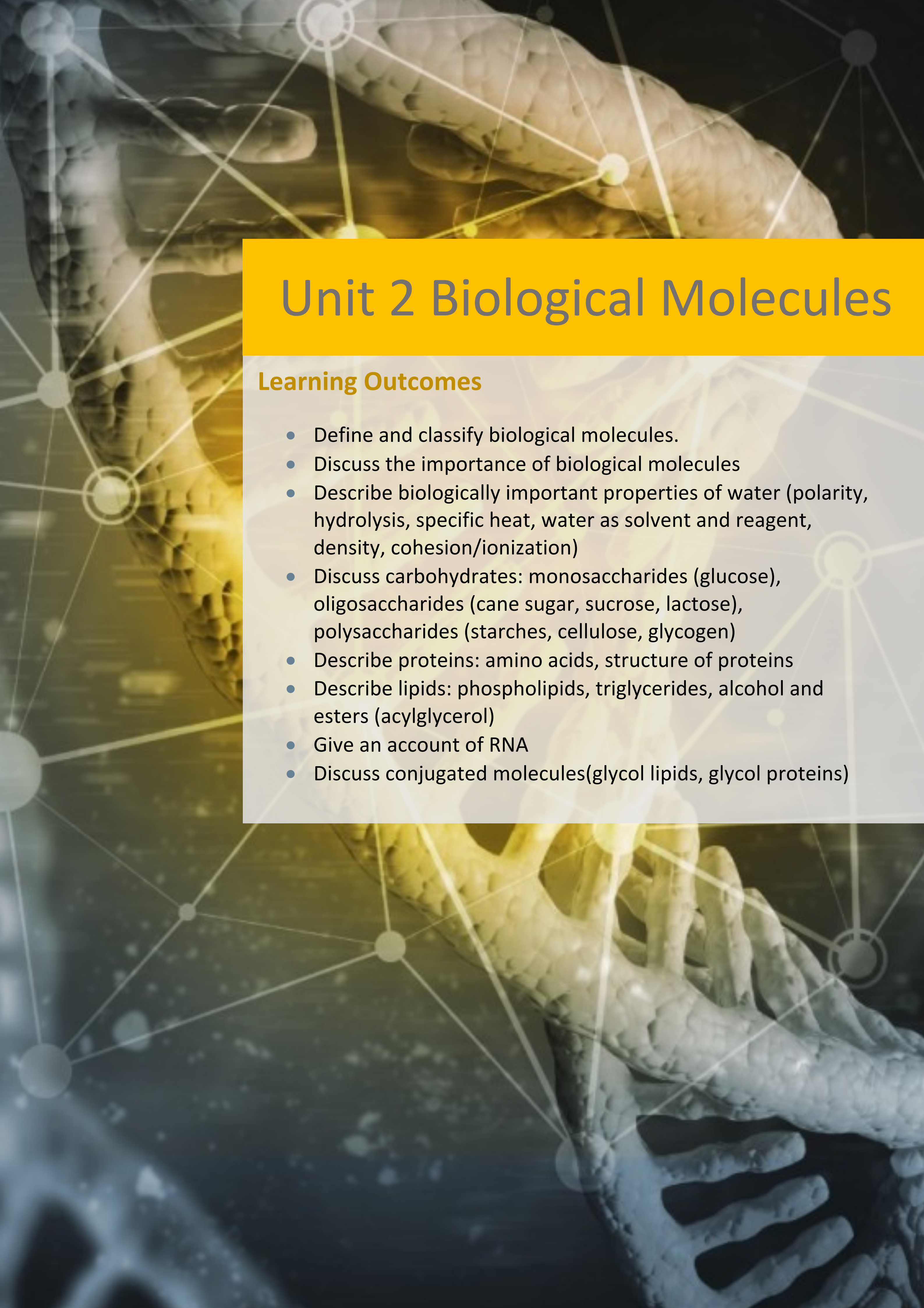




Unit 2 Biological Molecules

Learning Outcomes

- Define and classify biological molecules.
- Discuss the importance of biological molecules
- Describe biologically important properties of water (polarity, hydrolysis, specific heat, water as solvent and reagent, density, cohesion/ionization)
- Discuss carbohydrates: monosaccharides (glucose), oligosaccharides (cane sugar, sucrose, lactose), polysaccharides (starches, cellulose, glycogen)
- Describe proteins: amino acids, structure of proteins
- Describe lipids: phospholipids, triglycerides, alcohol and esters (acylglycerol)
- Give an account of RNA
- Discuss conjugated molecules(glycol lipids, glycol proteins)

Biochemistry

- Biochemistry is a branch of biology which deals with the study of chemical components and the chemical processes in living organisms.
- All living organisms are made of organic and inorganic compounds.
- Inorganic substances in living organisms are water, carbon dioxide, acids, bases, and salts etc.

CHEMICAL COMPOSITION		% Total Cell Weight	
		Bacterial Cell (prokaryote)	Mammalian Cell (Eukaryote)
(i)	Water	70	70
(ii)	Proteins	15	18
(iii)	Carbohydrate	3	4
(iv)	Lipids	2	3
(v)	DNA	1	0.25
(vi)	RNA	6	1.1
(vii)	Other organic molecules (enzymes, hormones, metabolism)	2	2
(viii)	Inorganic ions ($Na^{+,}$ K^+, Ca^{++}, Mg^{++}, Cl^-, SO etc.)	1	1

Some Basics Of Biochemistry

- Living organisms contain macromolecules formed from a small number of simple molecules.
- These simple molecules suggest that all life had a common origin.
- The characteristics of an organism are determined by the information contained in its DN.
- The DNA contains information that the cell can use to make proteins. Many proteins are enzymes, which control the physical and chemical activities of an organism.
- The chemical activities that go on inside an organism can organism can be given the general term metabolism.
- Metabolic reactions can be divided into two general categories: anabolic and catabolic. Anabolic reactions build up large molecules from smaller ones. While: catabolic reactions do the reverse, breaking down larger molecules.
- Anabolic reactions usually involve condensation reactions ill which building-block molecules are joined together and a water molecule is released.
- Catabolic reactions, such as those that occur during digestion, usually involve hydrolysis reactions in which larger molecules are split as they react with water.
- In photosynthesis, plants use the energy from sunlight to build up organic molecules such as sugars from simple ones such as carbon dioxide and water.
- All organisms need a supply of energy, which they obtain via respiration. In respiration organic molecules are oxidized into simpler molecules, usually carbon dioxide and water. The resulting energy is used to fuel many energy-requiring processes within the organism.

Water Importance

- Water is the medium of life.
- It is the most abundant compound in all organisms. It varies from 65 to 89 percent in different organisms.
- Human tissues contain about 20 per cent water in bone cells and 85 per cent in brain cells.
- Almost all reactions of a cell occur in the presence of water. It also takes part in many biochemical reactions such as hydrolysis of macromolecules.
- It is also used as a raw material in photosynthesis.
- Ionic substances when dissolved in water, dissociate into positive and negative ions.
- Non-ionic substances having charged groups in their molecules are dispersed in water.
- When in solution, ions and molecules move randomly and are in a more favorable state to react with other molecules and ions. It is because of this property of water that almost all reactions in cells occur in aqueous media. In cells all chemical reactions are catalyze by enzymes which work in aqueous environment.
- Non-polar organic molecules, such as fats, are insoluble in water and help to maintain membranes, which make compartments in the cell.
- Water has great ability of absorbing heat with minimum of change in its own temperature.
- The specific heat capacity of water – the number of calories required to raise the temperature of 1g of water from 15 to 16°C is 1.0. This is because much of the energy is used to break hydrogen bonds. Water thus works as temperature stabilizer for organisms in the environment. Protects living material against sudden thermal changes.
- Water absorbs much heat as it changes from liquid to gas. *"Heat of vaporization is expressed as calories absorbed per gram vaporized."* The specific heat of vaporization of water is 574 Kcal/kg, which plays an important role in the regulation of heat produced by oxidation.
- It also provides cooling effect to plants when water is transpired.

Due to its polarity, water is an excellent solvent for polar substances.

To animals when water is perspired. Evaporation of only two ml out of one liter of water, lowers the temperature of the remaining 998 ml by 1°C.

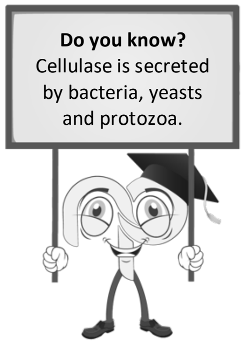
$$H_2O \rightleftharpoons H^+ + OH^-$$

- The water molecules ionize to form H^+ and OH^- ions:
- This reaction is reversible but an equilibrium is maintained. At 25°C the concentration of each of H^+ and OH^- ions in pure water is about 10^{-7} mole/litre.
- The H^+ and OH^- ions affect, and take part in many of the reactions that occur in cells
- Water is effective lubricant that provides protection against damage resulting from friction.
- Tears protect the surface of eye from the rubbing of eyelids.
- Water also forms a **fluid cushion** around organs that helps to protect them from trauma.

Carbohydrates

- Carbohydrates are polyhydroxy aldehydes or ketones, or complex substances which on hydrolysis produce polyhydroxy aldehyde or ketone subunits.
- Three major groups of Carbohydrates are: Monosaccharides, Oligosaccharides & Polysaccharides.
- General formula for Carbohydrates is $C_x(H_2Q)_y$. General formula for monosaccharides is $(CH_2O)_n$. General formula of oligosaccharides is $Cx(H_2O)_y$ – General formula of polysaccharides is $Cx(H_2O)_y$ –.
- **Monosaccharides:** These are generally Trioses, Tetroses, Pentoses. Hexoses & Heptoses. Examples of trioses are dihydroxy acetone and glyceraldehyde's. These are also intermediates in respiration and photosynthesis. Examples of Hexose", Glucose, Galactose, Fructose etc.
- Oligosaccharides: These have 2 – 10 Monosaccharides. If two Monosaccharides then it is a Disaccharide. Examples of Disaccharides are: Maltose, Lactose and Sucrose etc.
- **Polysaccharides:** These have more than ten Monosaccharides. Examples are Cellulose. Starches and Glycogen etc. Most abundant polysaccharide is Cellulose.
- Polysaccharides are usually branched.
- Cellulose present in wood, cotton and paper.
- Starches present in cereals and root tubers etc.
- In biology the most important hexose is glucose. Our blood normally contains 10.08 % glucose.
- For the synthesis of 10 g of glucose 717.6 Kcal of solar energy is used.

Carbohydrate	Types	Sources	Function
Monosaccharide	Glucose, fructose, Galactose	fruits and Vegetable	Provide energy converted to glycogen for storage
Disaccharide (double/complete sugar)	Sucrose, Maltose, Lactose	Sugar cane, Beat root, Milk	Excess is stored as fat
Polysaccharide	Starch, Cellulose, Glycogen	Rice, Cereal, Bread	Used in synthesis of many complex molecules



Glucose is aldose sugar. Fructose is ketose sugar. Fructose is sweeter as compared to glucose

Starch

- Starch is compact, insoluble and IS a mixture of two compounds, amylase and amlyopectin.
- Amylose is an un-branched polymer in which glucose monomers are joined by α-1 4-glycosidic linkages. They are soluble in hot-water.

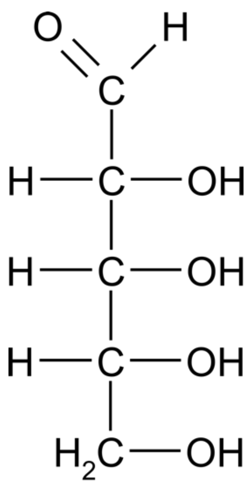
- Amylopectin molecule α-1, 4-glycosidic linkages and α-1, 6-glycosidic linkages. This allows branching. They arc "Insoluble in hot or cold water.

Glycogen

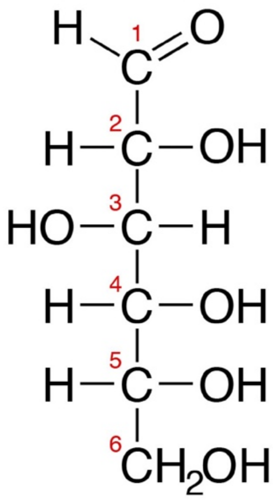
- In humans, glycogen is the main storage carbohydrate. Its structure is similar to amylopectin, but it is even more frequently branched.
- In humans, glycogen is stored in large amounts in the liver and the muscles. During prolonged exercise, when the immediate supply of glucose is used up, the body restores its supplies by breaking down glycogen.
- If an average person goes without food, his or her glycogen stores last for about a day. When glycogen runs out, the body turns to using its lipid store. This is why eating less while taking more exercise is the quicker way to lose weight.
- One of the major changes associated with improving fitness is an increase in the amount of the enzyme glycogen synthetase in the muscles. This allows glycogen to be built up faster after it has been used.

Cellulose

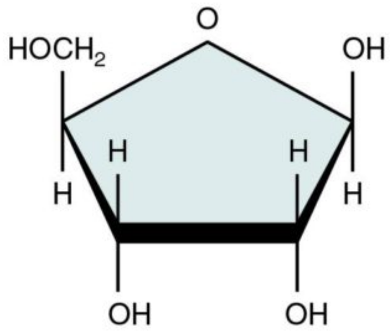
- Cellulose is a structural polysaccharide. It gives strength and rigidity to plant cell walls.
- Individual cellulose molecules are long un-branched chains containing many β-1, 4-glycosidic linkage. The molecules are straight, side by side and are called microfibrils.
- Cellulose is probably the most abundant structural chemical on Earth but few animals can digest it because they do not make the necessary enzyme, cellulose. Herbivorous animals, whose diet contains large amounts of cellulose, can deal with it because they have cellulose-producing microorganisms in their digestive system.



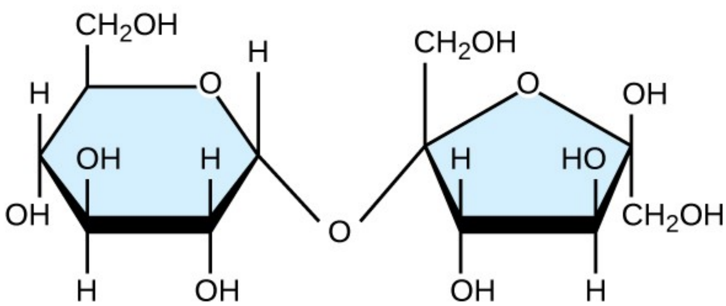
Ribose



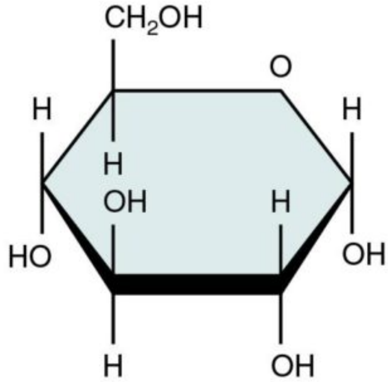
Glucose



Ribose



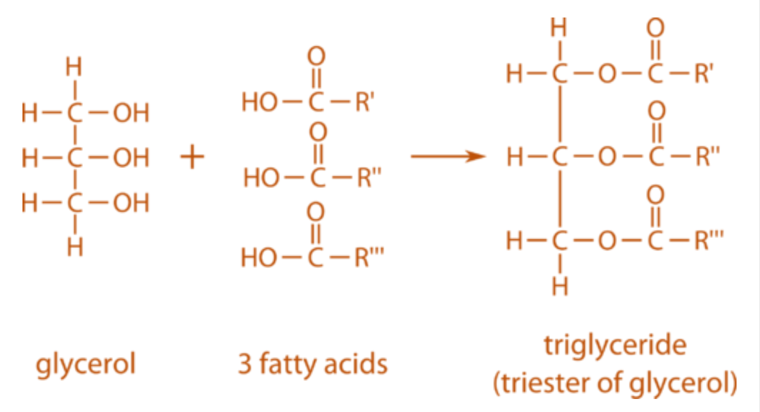
sucrose



Glucose

Lipids

- Lipids are heterogeneous group of compounds that include fats and oils.
- As they are non-polar molecules, most lipids are insoluble in water but soluble in nonpolar solvents such as alcohol and ether. Important exceptions are phospholipids, which have polar heads,
- Lipids contain the elements carbon, hydrogen, oxygen and sometimes phosphorus and nitrogen.
- They are intermediate-sized molecules that do not achieve the giant sizes of the polysaccharides, proteins and nucleic acids.



Lipid Structure And Function

- The triglycerides, which act mainly as energy stores in animals and plants, are a large important group of lipids.
- Triglycerides consist of one molecule of glycerol and three fatty acids.
- The glycerol molecule is common to all triglycerides and so the properties of different triglycerides depend on the nature of the fatty acids. Monounsaturated fatty acids possess one C=C bond and polyunsaturated contain more than one.

Table: Some common fatty acids

Fatty Acids	No. of Carbon Atoms	No. of Double Bonds	Abundant In	Melting Point / $^{o}C^{+}$
Palmitic acids	16	0	Palm oil	63.1
Stearic acids	18	0	Cocoa	69.6
Lauric acids	12	0	Coconut, Palm oil	44.2
Oleic acids	18	1	Olive, Rapeseed	13.4
Linoleic acid	18	2	Sunflower, Maze	– 5.0

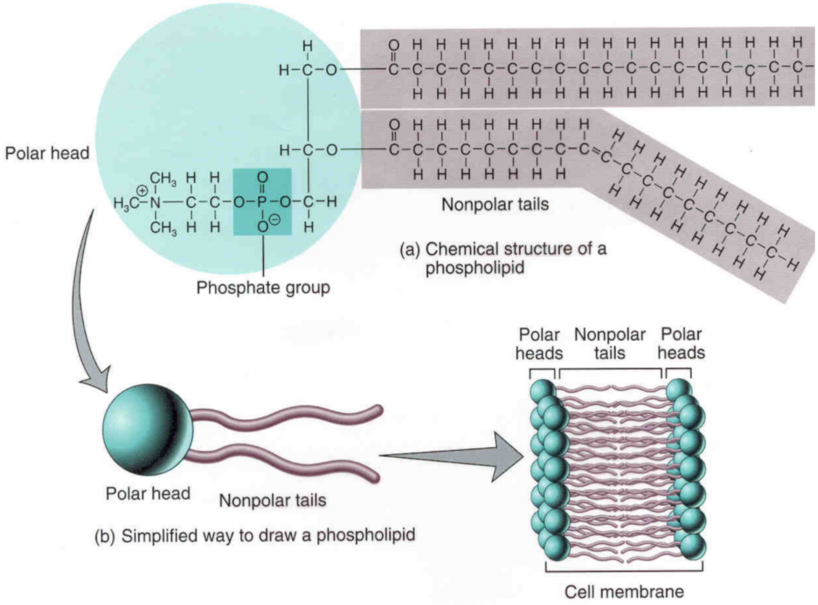
Phospholipids

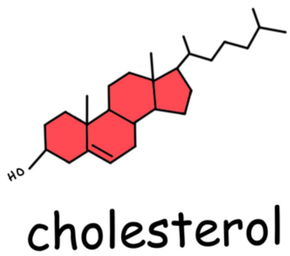
- Phospholipids are derivatives of phosphatidic acid. The phosphatidic acid is composed of glycerol, fatty acids and phosphoric acid.
- Phosphatidylcholine is one of the common phospholipids.
- Phospholipids have a similar structure to triglycerides but one of the fatty acids is replaced by polar phosphoric acid.

- This gives the molecule a polar head and a non-polar tail. When placed in water, phospholipids arrange themselves with their hydrophobic (water-hating) tails pointing inwards and their hydrophilic (water-loving) heads pointing outwards. This is very important because it results in double layers called bilayers. Phospholipid bilayers form the basis of all biological membranes.

Cholesterol

- This lipid is a normal component of every cell in our body. As well as eating food that contains cholesterol, we can also synthesis cholesterol in the liver.
- The more there is in the diet the less the liver needs to make.
- Vegetarians who eat no animal products are easily able to make all the cholesterol they need.





Steroid Hormones

- Steroid hormones have a similar structure to the cholesterol from which they are made.
- They include testosterone, progesterone and the estrogens.

Waxes

- Waxes are lipids that are often used to waterproof surface, so preventing water loss.
- The cuticle of a leaf and the protective covering on an insect's body are both waxes.
- Waxes are mixtures of long chain alkanes (C_{25} to C_{35} odd numbers), alcohols, ketones and esters of long chain fatty acids.
- They have no nutritional value because they cannot be digested by lipases (lipid digesting enzymes).

Summary of Lipids

1. Lipids are a heterogeneous group of compounds related to fatty acids.
2. Lipids are classified as acylglycerols, waxes, phospholipids, sphingolipids, glycolipid and terpenoid lipids (including carotenoids and steroids).
3. Acylglycerols are esters of fatty acids and alcohol.

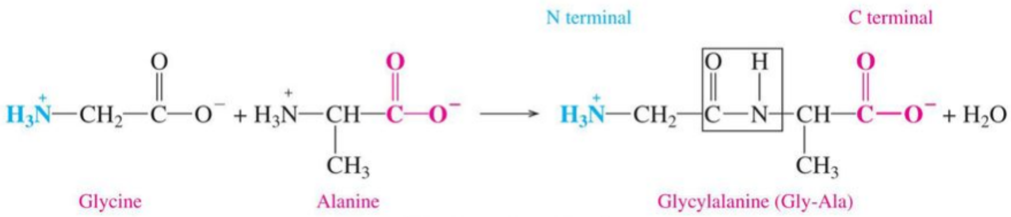
4. An ester is produced as a result of a reaction of an alcohol with an acid and a water molecule is released.
5. Fatty acids having no double bond are called saturated fatty acids while the fatty acid having double bonds between carbon atoms are called unsaturated fatty acids.
6. Palmitic acid (C_{16}) is much more soluble in the organic solvent than butyric acid (C_4)·
7. Fats and oils are lighter than water and have a specific gravity of about 0.8.
8. Higher fat contents of food cause slower movements of feces through the bowels. Bacteria in food convert the undigested fats into cancer causing compounds.
9. Terpenoids is a large group of compounds which are made up of simple repeating isoprenoid units (C_5H_8).

Fats	Sources	Function
Saturated	• Butter, Animal Fat	• Provides energy
		• Medium for intake of vitamin A, D, E and K
Unsaturated	• Fish Oil, vegetable Oil	• Synthesis of cell membrane
		• Insulation layer under skin
		• Protects organs from physical injury

Proteins

1. Proteins are polymers of amino acids. the compounds containing carbon, nitrogen, oxygen and hydrogen.
2. Proteins are the most abundant organic compounds in cells. They are over 50 of total dry weight of the cell.
3. About 170 types of amino acids are present in the cells and tissues of these about 25 types are involved in the formation of proteins. However, most of the proteins are made of 20 types of amino acids.
4. The linkage between C of carboxyl group of one amino acid and N of amino group of next amino acid is called peptide bond.
5. Glycylalanine has two amino acids and is called dipeptide.

Formation of peptides (an amide linkange)



6. Each protein has specific properties which are due to: Number of amino acids. Kinds of amino acids specific sequence of amino acids and the shape of protein molecule.
7. Sanger was the first scientist who determined the sequence of amino acids in a protein molecule.
8. Insulin is composed of 51 amino acids in two chains. One with 21 amino acids and the other with 30 amino acids. Both the chains are linked by disulphide bonds.

Hemoglobin is composed of four chains two alpha and two beta chains. Each alpha chain contains 141 amino acids which each beta chain contains 146 amino acids.

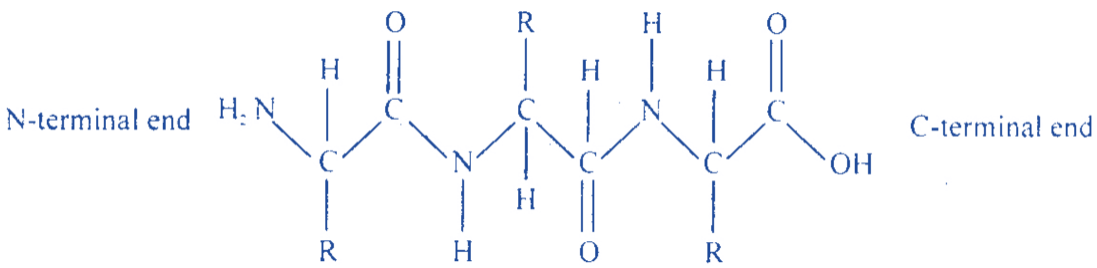
10. There are over 10.000 proteins in the human body. These are formed by the specific arrangements of 20 types of amino acids.
11. The sequence of amino acids is determined by the order of nucleotides in the DNA.
12. In the sickle cell hemoglobin only one amino acid (Glutamic acid) in each beta chain out of the 574 amino acids does not occupy the normal place in the proteins.
    Actually, glutamic acid is replaced by valine. Therefore, hemoglobin fails to carry sufficient oxygen. The result is the death of the patient.
13. Secondary structure of proteins is the coiling of primary polypeptide chains.
14. α helix is very uniform geometric structure with 3.6 amino acids in each turn of the helix
15. Tertiary protein structure is formed when a polypeptide chain bends and folds upon itself forming a globular shape.
16. Quaternary proteins are polymers of several tertiary structures.
17. All enzymes are proteins (e.g. amylase, lipase, pepsin etc). Enzymes control the cell metabolism.
18. Some hormones are proteins (e.g. insulin). Hormones regulate metabolic processes.
19. Antibodies (Immunoglobulins) are proteins which protect the body from pathogens.
20. Blood clotting proteins (like fibrinogens) prevent the loss of blood from the body after injury.
21. Movement of organs and organisms are caused by proteins (e.g. actin and mysosin et. are involved).
22. Movement of chromosomes during anaphase of cell division, are caused by proteins (tubuis are involved).
23. The term protein is for the finished, functional molecule.
24. Some proteins consist of one polypeptide, others consist of two or more than two hemoglobin for example, contains four polypeptides.
25. Amino acids join together in long chains to form proteins by means of peptide bond. This is an example of a condensation reaction.

Four Levels of Protein Structure

All proteins are complex molecules and biochemists look at their structure at their different levels; primary, secondary, tertiary and quaternary.

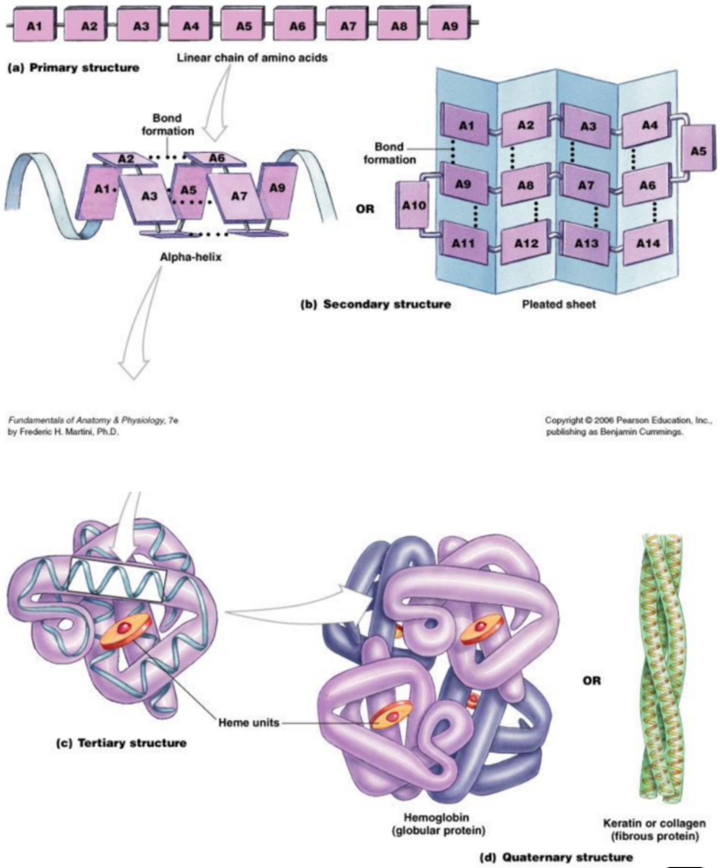
Primary Structure

- The primary structure of proteins depends upon the number, kind (types) and sequent of amino acids in a protein molecule.
- Real proteins usually consist of a lot more than five amino acids. The hormone insulin for example for example the relatively small protein has 51 amino acids.
- The code for the primary structure of any protein is contained in the gene. This code determines the order in which amino acids are assembled. This order then dictates the way they will twist and turn to produce the three-dimensional shape that allows the protein to carry out its specific function.



Secondary Structure

- The first level of three-dimensional twisting is described as the secondary structure of the protein.
- When combinations of amino acids join together in a chain they fold into particular shapes and patterns (such as spirals).
- These shapes form because the amino acids twist around to achieve the most stable arrangement of hydrogen bonds. The main types of secondary structure in proteins are:
- The α-helix, a spiral, is the most common type of secondary structure. The hydrogen bonds stabilize the α-helix.
- The β-pleated sheet, a flat structure that consists of two or more amino acid chains running parallel to each other, linked by hydrogen bonds.
- The secondary structure of a protein depends on its amino acid sequence; some amino acids produce α-helices. Others usually make β-pleated sheets.



Q. What is the difference between primary and secondary structure of proteins?

Tertiary Structure

- The tertiary structure of a protein is its overall three-dimensional shape and is produce as a result of the following:
- The sequence of amino acids that produces a-helices &β-sheets bends at particular places.
- The hydrophobic nature of many amino acid side chains. Globular proteins are surrounded by water and so the hydrophobic side chains tend to point inwards.
- Tertiary structure is maintained by ionic bonds, hydrogen bonds and disulfide (-S-S-) bonds.
- Functional proteins, such as enzymes and antibodies, must have an exact shape-and sometimes the ability to change shape - to fulfill their role in the organism.
- Many structural proteins depend on their tertiary structure for strength. The large number of disulphide bridges in keratin, of example, makes body structures such as hair and nails very tough.
- If a protein consists of only one polypeptide, the tertiary structure is the final shape of the molecule. If, however, the protein has more than one, it has a further, quaternary level of structure.

Quaternary Structure

Quaternary proteins are polymers of several tertiary structures.

In quaternary structure, the highly complex polypeptide tertiary chains are aggregated held together by:

(i) hydrophobic interactions

(ii) hydrogen bonds and

(iii) ionic bonds

Fibrous And Globular Proteins

- The final three-dimensional structure of proteins results in two main classes of protein - fibrous and globular.
  - Fibrous proteins contain polypeptides that bind together to form long fibers or sheets. They are physically tough and are insoluble in water.
  - Globular proteins are usually individual molecules with complex tertiary and quaternary structures. They are spherical, or globular in shape, hence the name. Most are soluble in water and they have a biochemical function.

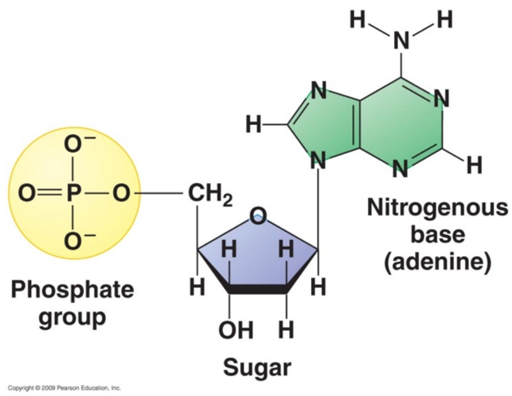
Stability of Proteins

- As the final shape of globular proteins is maintained by relatively weak molecular interactions such as hydrogen bonds, proteins are very sensitive to temperature increases and other changes in their environment.
- As the temperature goes up beyond 40° C, molecular vibration increases and bonds that· are holding together the tertiary or quaternary structure break, changing the shape of the molecule. This is known as denaturation.
- Different proteins are denatured at different temperatures. Some begin to be denatured after about 40-45o C or even below but many are not totally denatured until 60° C or even higher.
- It is an oversimplification to say organisms die at temperatures over 44° C because their proteins become denature. In practice organisms die because of a metabolic imbalance caused when enzymes work at different rate.
- Proteins can also be denatured by adverse chemical conditions. Chemicals that affect weak bonds change the overall structure. Even a slight change in protein shape mean loss of function, some proteins are particularly sensitive to changes in pH

Nucleic Acids

- Nucleic acids are so called because they are slightly acidic and present mainly in the nucleus.
- The two types of nucleic acid, DNA and RNA both contain carbon, hydrogen, oxygen, nitrogen and phosphorus.
- Nucleic acids are polymers of nucleotides.
- Nucleotides are the building blocks of nucleic acids. A nucleotide consists of three units:
  - A sugar (ribose or deoxyribose)
  - A phosphate group
  - A nitrogen-containing base

- In a typical nucleotide the nitrogenous base is attached to position 1 of pentose sugar, while phosphoric acid is attached to carbon at position 5 of pentose sugar.
- DNA has nucleotides in which the sugar is deoxyribose, while RNA contains the sugar ribose.



Deoxyribonucleic Acid (DNA)

- A German chemist, Friedrich Miescher, discovered DNA in 1869. Miescher extracted a, white substance from the nuclei of human cells and fish sperm. He called this substance nuclein because it was associated with the nucleus. Since nuclein was acidic, it was called as nucleic acid.
- Most of the DNA in a eukaryotic cell is in the nucleus and in very less amount in Mitochondria and Chloroplasts.
- The nucleotides in DNA contain the nitrogenous (nitrogen-containing) bases which are adenine, guanine, cytosine or thymine.
- Names of four nucleotides of DNA are:
  - d-adenosine monophosphate (d-AMP)
  - d-guanosine monophosphate (d-GMP)
  - d-cytidine monophosphate (d-CMP)
  - d-thymidine monophosphate (d-TMP)
- When DNA replicates (copies itself), it makes new strands by adding nucleotides. These are available as free molecules in the cytoplasm. Generally, cells can synthesize their own nucleotides.

Genetic Code
DNA has two remarkable characteristics:
- It is a store of genetic information.
- It can copy itself exactly, time after time.

Base pair

- Adenine and guanine are purines (large/double ring) while thymine and cytosine are pyrimidines (small/single ring).
- Because of the shape of the two types of molecules, each purine always bonds with only one pyrimidine. So, in DNA, adenine always bonds with thymine, and cytosine with guanine. In RNA, cytosine bonds with guanine and adenine bonds with uracil:

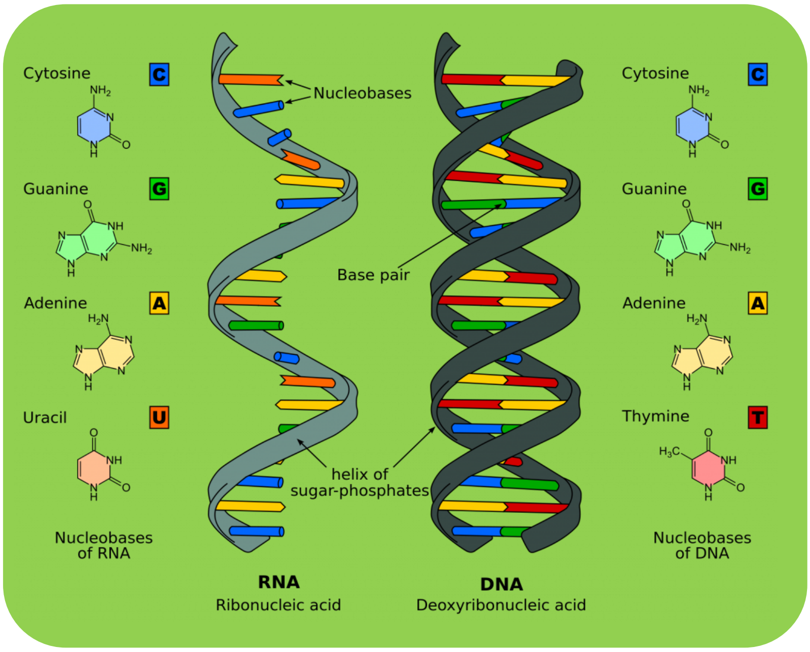
DNA:	A = T	**RNA:**	A = U
	G = C		G = C

- The base pairs are held together by hydrogen bonds. There are two H-bonds between A and T (or U) and three between C and G.
- A nucleotide has ester bond. A polynucleotide chain has phosphodiester bonds.
- In phosphodiester linkage, one phosphate group is linked to the two sugars by means of a pair of esters (P-O-C) bonds.
- According to Erwin Chargaff the quantity of A and T are almost equal. Similarly, the quantity of G and C are almost equal. It means A with T and G with C in DNA double strand.

- British Chemist Rosalind Franklin carried on an X-ray diffraction analysis of DNA in the Lab of Maurice Wilkins.
- Maurice Wilkins (British biochemist) prepared DNA fibers.
- The diffraction pattern suggested that the DNA molecule had a shape of a helix with a diameter of2 nm and a complete helical turn every 3.4 nm.
- James Watson and Francis crick proposed structure of the DNA molecule.

- In DNA the sides are formed by alternating sugar-phosphate units, while the base pairs form the cross-bridges, like the rungs of a ladder. Each base pairing causes a twist in the helix and there is a complete 360o turn every 10 base pairs.
- DNA & Histones form Eukaryotic chromosomes.
- A gene is a unit of biological inheritance.
- The E. coli genome consists of 4,639,221 base pairs. It codes for about 4288 proteins.
- The first microbe whose genome is completely sequenced is Haemophilus influenza. It was published in July 28, 1995.

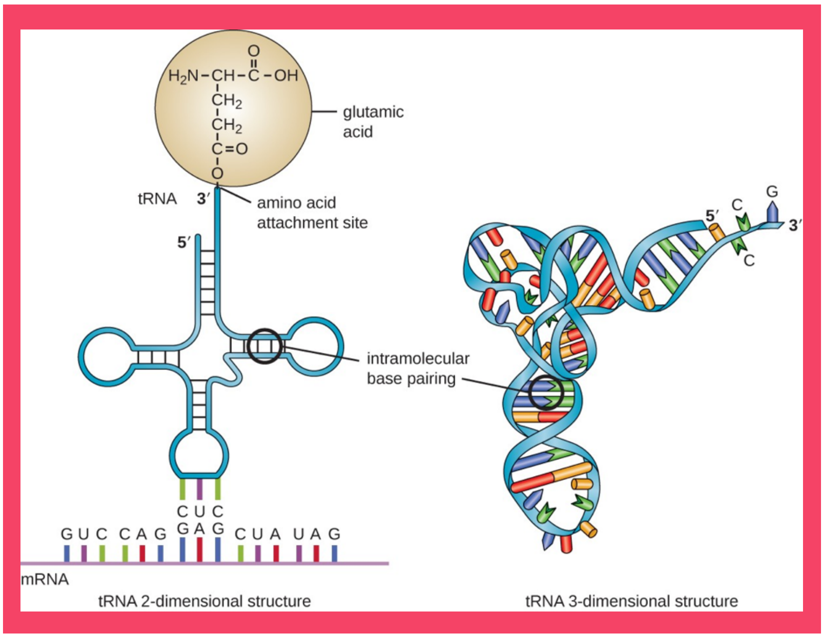
Ribonucleic Acid (RNA)



- RNA is synthesized 'by DNA in a process known as transcription.
- RNA is present in the Nucleus/nucleolus, ribosomes, cytosol and in smaller amounts in other parts of the cell.
- The RNA molecule has single strand. It may fold back on itself to give double helix.
- ATP is highly unstable nucleotide. It is used as energy currency by the cell.
- All types of RNA’s are synthesized' from DNA in the nucleus and then are moved out in the cytoplasm to perform their specific functions.
- Three of the bases in RNA - adenine guanine and cytosine - are the same as those it DNA. The fourth is different: RNA contains uracil instead of thymine.
- RNA molecules are much smaller than DNA molecules.
- DNA can consist of over 300,000,000 nucleotides. RNA usually consists of a few hundred.
- RNA is also less stable.
- DNA molecules are the permanent store for genetic information and last for many years. In contrast, RNA molecules have a short-term function and are easily replaced.
- There are three forms of ribonucleic acid (RNA) in the cell:
- Small lengths of mRNA are assembled in the nucleus using a single gene within the DNA as a template. When a complete copy of the gene has been produced the mRNA moves out of the nucleus to the ribosome, where the protein is synthesized according to the

code taken from the DNA. For a protein molecule of 1000 amino acids, the length of mRNA will be 3,000 nucleotides. The mRNA is about 3to 4 % of the total RNA in the cell.

- Transfer RNA is found in the cytoplasm and is a carrier molecule, bringing amino acids to the ribosomes for assembly into a new amino acid chain according to the order specified on the mRNA code. There is one specific tRNA for each kind of amino acid. So there are at least 20 kinds of tRNAs in the cell. tRNAs are about 10 to 20% of the total RNA in the cell. Human cells contain about 45 different kinds of tRNA molecules.
- Ribosomal RNA makes up part of the ribosome. Ribosomal RNA is up to 80 % of the total RNA in the cell. In ribosome, rRNA is 40 – 50 %. During translation, rRNA provides the site where polypeptides arc assembled.



Practice Questions
Assessment 1

1. The richest source of energy is:
    a. Glucose
    b. Fructose
    c. Fats
    d. Proteins
2. Examples of structural lipids are:
    a. Phospholipids
    b. Glycolipid
    c. Sterols
    d. all of these
3. Which one is odd?
    a. Glucose
    b. Fructose
    c. Galactose
    d. Lactose
4. Which is nitrogen base?
    a. Choline
    b. ethanol amine
    c. serine
    d. all of these
5. The viscosity of protoplasm is comparable with that of:
    a. Glycerol
    b. Glycerin
    c. Light machine oil
    d. all of these
6. The property of contraction and relaxation of cytoplasm is attributable to special type of:
    a. Carbohydrates
    b. Lipids
    c. Proteins
    d. nucleic acids
7. Amount of water in living cells varies from:
    a. 75 – 89
    b. 70 – 89
    c. 60 – 89
    d. 65 – 89
8. Histones are:
    a. Single protein
    b. Different kinds of proteins
    c. Conjugated molecules
    d. carbohydrates
9. 3-D proteins are due to:
    a. Primary structure
    b. Tertiary structure
    c. Secondary structure
    d. Both A and C
10. Primary product of photosynthesis:
    a. Carbohydrates
    b. Proteins
    c. Lipids
    d. Nucleotides

Assessment 2

1. Total number of amino acids in insulin is:
    a. 61
    b. 41
    c. 71
    d. 51
2. Amino acids of hemoglobin are arranged in two dimmers, contains
    a. 574 amino acids
    b. 287 amino acids
    c. 141 amino acids
    d. 146 amino acids
3. A chain containing two amino acids is known as:
    a. Dipeptide
    b. Peptide
    c. Amino-peptide
    d. Di amino acid
4. The simplest amino acid is:
    a. Alanine
    b. Lysine
    c. Glycine
    d. aspartic acid
5. The essential amino acid means:
    a. formed within the body
    b. enter from outside the body
    c. can change from one to another kind of amino acid
    d. 20 kinds of amino acids

6. The simplest fatty acid is:
    a. acetic acid
    b. butyric acid
    c. Palmitic acid
    d. oleic acid
7. The Nucleotide with single ring is:
    a. Adenine
    b. Guanine
    c. Cytosine
    d. both a and b
8. Histone present in:
    a. DNA
    b. RNA
    c. Chromosome
    d. glycolipids
9. Number of Nucleotides in ATP:
    a. 1
    b. 2
    c. 3
    d. 4
10. Most diverse macromolecules in a cell:
    a. Carbohydrate
    b. Protein
    c. Lipid
    d. DNA

Assessment 3

1. Choline is ______:
    a. Monosaccharide
    b. Disaccharide
    c. Nitrogenous base
    d. Nucleotide
2. Number of Nucleotides in NADP:
    a. 1
    b. 2
    c. 3
    d. 4
3. Which one is conjugated molecule?
    a. Protein
    b. Carbohydrate
    c. Glycoprotein
    d. Lipid
4. Amylopectin not abundant in:
    a. Wheat
    b. Maize
    c. both a and b
    d. Pulses

5. Most abundant fruit sugar is usually:
    a. Glucose
    b. Sucrose
    c. Maltose
    d. Lactose
6. Example of vitamin/nucleotide/co-enzyme is:
    a. FAD
    b. NAD
    c. NADP
    d. All of these
7. Base pairs in E. coli:
    a. 4288
    b. 14000
    c. 4639221
    d. Four
8. What is unique of DNA?
    a. Replication
    b. Organic
    c. Has nitrogenous bases
    d. all of these
9. Reverse of Dehydration synthesis is:
    a. Hydrolysis
    b. Oxidation
    c. Reduction
    d. Oxidation-Reduction
10. Phospholipids are:
    a. Polar
    b. non-polar
    c. Polar on one end and non-polar on the other end
    d. Sometimes polar and sometimes non polar

Assessment 4

1. Glyceraldehyde is:
    a. Tetrose
    b. Triose
    c. Heptose
    d. Pseudoheptalose
2. Glycerol is the backbone molecule for:
    a. disacchardies
    b. DNA
    c. triglycerides
    d. ATP
3. All the information for the structure and functioning of a cell is stored in:
    a. DNA
    b. tRNA
    c. mRNA
    d. rRNA
4. Basic unit of DNA is:
    a. nucleotide
    b. amino acid
    c. nucleic acid
    d. double helix
5. Second most abundant compound in living organisms is:
    a. protein
    b. lipids
    c. DNA
    d. Carbohydrate
6. Tetroses are rare in nature and occur in:
    a. Some bacteria
    b. Few bacteria
    c. Bacteria
    d. Most Bacteria
7. Evaporation of only two ml out of one liter of water lowers the temperature of the remaining 998 ml by ___________ ^oC.
    a. 0.01
    b. 0.1
    c. 1.0
    d. 2.0
8. Generally all the organic compounds contain the elements except:
    a. iron and oxygen
    b. carbon and oxygen
    c. carbon and hydrogen
    d. Carbon and nitrogen
9. Potential source of energy for cell activities:
    a. C – H
    b. H – H
    c. C – O – C
    d. C – C
10. At 25° C the concentration each of H^+ and OH ions in pure water is about:
    a. 10^{-7} ml/litre
    b. 10^{-7} mole/litre
    c. 10^{-7} mg/litre
    d. 10^{-7} moles/ml

Key

Assessment 1

1. c
2. d
3. d
4. d
5. a
6. c
7. d
8. b
9. b
10. a

Assessment 2

11. d
12. a
13. a
14. c
15. b
16. a
17. c
18. c
19. a
20. b

Key

Assessment 3

21. c
22. d
23. c
24. d
25. a
26. d
27. c
28. d
29. a
30. c

Assessment 4

31. b
32. c
33. a
34. a
35. a
36. a
37. c
38. a
39. a
40. b