Life Component

All living organisms are made up of cells. The cells are made up of different kinds of molecules. These molecules are basic and essential to the life. Thus, these molecules are called bio-molecules. These molecules are found naturally in living cells and determine structure and function of cells.

The bio-molecules vary in size and composition from simple and small to complex and large. The smaller molecules are soluble, easily transported and frequently enter into the general chemical activity of cells. Large molecules tend to be used for structural purpose and some others as information molecules, carries genetic information, etc.

There are present various kinds of bio-molecules in cytoplasm of a cell which is called cellular pool. The cellular pool composed inorganic to organic molecules.

Bio-molecules are of two types.

1. **Organic bio-molecules:** They may be small, simple to large, complex and composed of different elements. They contain carbon, hydrogen, nitrogen and oxygen as basic components. These elements join in various combinations and form several types of compounds as carbohydrates, proteins, lipids, nucleic acids, etc. They have one or more functional groups.

   The organic bio-molecules are divided into two groups on the basis of its size.

   A. **Micro-molecules:** The bio-molecules which are comparatively smaller in size and simpler in structure are called micro-molecules. They basically contain carbon, hydrogen, oxygen, nitrogen etc. eg: monosaccharides, amino-acids, fatty-acids etc.
   B. **Macro-molecules:** The bio-molecules which are larger in size and complex in structure are called macro-molecules. eg: polysaccharides, proteins, nucleic acids etc.
2. **Inorganic bio-molecules:** They are small, simple and composed of different elements. They do not have any basic components.

   Depending upon the amount required by organism, they are of two different types.

   A. **Micro-minerals:** These are the minerals that need in less or trace amount. eg: iron, manganese, iodine, copper, molybdenum, zinc etc.
   B. **Macro-minerals:** These are the minerals that need in large quantity. eg: carbon, hydrogen, nitrogen, oxygen, calcium, sulphur, phosphorus, magnesium etc.

Types of bio-molecules

On the basis of chemical composition, the bio-molecules are of following types.

1. Carbohydrates:

Carbohydrates are very important bio-molecules of living organism. These are made up of carbon, hydrogen and oxygen. Hydrogen and oxygen are generally occurring in the ratio of 2:1. Thus is known as hydrates of carbon. The general formula of carbohydrates is $C_nH_{2n}O_n$.

Carbohydrates are known as saccharides (Gk: saccharin – sugar). They are the aldehyde and ketone derivatives of polyhydroxy alcohol.

On the basis of complexity of chemicals; carbohydrates are divided into three groups.

A. Monosaccharides: Carbohydrates that contain only one sugar molecule in it. Hence is known as simple sugars. They cannot be hydrolysed into smaller carbohydrate. They are highly soluble in water and sweet in taste. eg: glucose, fructose, galactose etc.

B. Oligosaccharides: Carbohydrates that contain 2-10 same or different sugar molecules in it. They are easily hydrolysed to give rise monosaccharides. They are soluble in water and sweet in taste. eg: sucrose, maltose, lactose etc.

C. Polysaccharides: Carbohydrates that contain more than 10 sugar molecules in it. They produce large number of sugars on hydrolysed. They are insoluble in water and not sweet in taste. eg: starch, cellulose, glycogen etc.

Glycosidic bond: The covalent bond that joins carbohydrate molecule with another group by release one molecule of water is called glycosidic bond.

Functions of Carbohydrates

a. It is a good source of energy. About 60% of total energy is provided by the breakdown of carbohydrate.
b. They are the structural components of polysaccharides and nucleic acids.
c. It forms the outermost layer of the plant cell.
d. They act as reserve food in various forms.

2. Amino acids:

Amino acids are colourless, crystalline solid. They are soluble in water and insoluble in organic solvents. They may be sweet or bitter in taste.

They are made up of carbon, hydrogen, oxygen and nitrogen. They may also contain sulphur and phosphorus. These are an important organic compounds having both acidic and basic group. The acidic group is carboxylic acid group (-COOH) and basic group is amino group ($-NH_2$).

There are 20 different amino acids that help in protein synthesis.

On the basis of requirement, amino acids are divided into two groups.

A. Essential amino acids: The amino acids which are not synthesized in the body are known as essential amino acids. They are supplied from externally through regular diet. eg: leucine, isoleucine, lysine, methionine etc.

B. Non-essential amino acids: The amino acids which are synthesized in the body are known as non-essential amino acids. They are not supplied from externally. eg: glutamic acid, aspartic acid, glycine, serine etc.

Functions of amino acids

a. They are building blocks of protein.
b. They serve as storage of nitrogen in the form of amides.
c. They are important components of vitamins, hormones, pigments etc.
d. Tyrosine is involved in the formation of thyroxine, melanine and adrenaline hormone.

3. Proteins:

They are the most complex nitrogenous organic compound. They are formed due to the combination of large number of amino acids (at least 20 amino acids). The amino acids of proteins are interlinked by peptide bond. Hence, proteins are known as polypeptides.

On the basis of chemical nature, they are divided into three groups.

A. Simple proteins: These produce only amino acids on complete hydrolysis. eg: histone, albumin, globulin etc.

B. Conjugated proteins: These are proteins formed by the combination of various protein and non-protein compounds. eg: glycoprotein (glucose + protein), lipoprotein (lipid + protein), nucleoprotein (nucleic acid + protein), phosphoprotein (phosphorus + protein), chromoprotein (colour pigments + protein) etc.

C. Derived proteins: These are formed by the derivation of simple and conjugated proteins. eg: peptones, peptides, proteoses etc.

On the basis of structures, they are divided into two groups.

A. Globular proteins: They are spherical or oval in shape. They are tertiary in their structure and contain 4 different bonds like hydrogen bond, ionic bond, disulphide bond and hydrophobic bond. eg: albumin, globulin etc.

B. Fibrous proteins: They have more length than that of breadth. They possess secondary structure and contain hydrogen bond only. They appear like a fibre due to inter molecular hydrogen bonding. eg: keratin of hair and skin, collagen of tendon etc.

Peptide bond: The bond between two amino acids where acidic group of one amino acid join with basic group of another amino acid with releasing one molecule of water is called peptide bond.

Functions of proteins

a. Structural proteins build and repair the tissue. They are essential for growth and development.
b. They are good source of energy.
c. They are responsible to produce hormones.
d. Proteins present in blood help in blood clotting.
e. Proteins present in blood help in transportation.
f. Snake venom is a type of toxic protein.

4. Enzymes:

They are proteins that are capable to increase the chemical reaction inside the cell. They are catalyst which alters the rate of reaction without changing itself. Hence, it is also known as biocatalyst. The chemicals on which enzyme may act are known as substrate and the final chemicals which formed by enzyme are called product.

On the basis of type of reactions, the enzymes are classified into seven groups (2018).

A. Oxidoreductases: It is an enzyme that catalyzes the transfer of electrons from one molecule, the reductant to another, the oxidant. This group of enzymes usually utilizes NADP+ or NAD+ as cofactors.
B. Transferases: It is an enzyme that catalyses the transfer of specific functional groups from one molecule to another.
C. Hydrolases: It is an enzyme that commonly functions as biochemical catalysts that use water to break a chemical bond.
D. Lyases: It is an enzyme that catalyzes the removal of groups from substrates by mechanisms other than hydrolysis, leaving double bond.
E. Isomerases: It is an enzyme that converts a molecule from one isomer to another. It facilitates intramolecular rearrangements in which bonds are broken and formed.
F. Ligases: It is an enzyme that can catalyzes the joining of two molecules by froming a new chemical bond.
G. Translocases: It is an enzyme that catalyzes the movement of ions or molecules across membranes or their separation within membranes.

Functions of Enzymes

a. It helps to break down larger complex molecules into smaller molecules.

b. It helps in replication of DNA during cell division.
c. It helps to break down toxins in the body.

5. Lipids:

Lipids are the esters of an alcohol and fatty acids. They are amorphous and heterogenous organic compounds. They are usually insoluble in water but soluble in organic solvent. It basically contains carbon, hydrogen and oxygen.
A lipid molecule is made up of two parts: fatty acid and alcohol.

On the basis of chemical nature, they are divided into three groups.

A. Simple lipids: These are the esters of fatty acids and alcohol only. eg: fats, oils, waxes etc.
B. Conjugated lipids: These are the lipids having another substance with fatty acids and alcohols. eg: glycolipids, phospholipids, lipoprotein etc.
C. Derived lipids: These are formed by the derivation of simple and conjugated lipids. eg: cholesterol, diosgenin etc.

Functions of lipids

a. They are good source of energy.
b. They are reserve food materials in animals and plants.
c. They act as heat insulator in animals.
d. They are good organic solvent.
e. Structural lipids are component of cell membrane.
f. They form a layer around eyes, kidneys and absorb shock.

6. Nucleic Acids:

They are very important molecule of life. They are complex, long chained compounds. They are larger than most of the proteins. They contain carbon, hydrogen, oxygen, nitrogen and phosphorus. They occur in nucleus as well as in cytoplasm.
Generally nucleic acids are defined as long chain of nucleotides. Hence, they are the polymers of nucleotides. Here, nucleotides are bind with each other by phosphodiester bond. They are regards as most important bio-molecule as they express genetic information.
They are made up of pentose sugar, nitrogenous bases and phosphoric acid.

a. Pentose sugar: It is the sugar molecule that contains 5 carbons in its ring. Among 5 carbons, 4 of them give rise ring structure where 1 lies in the form of tail. It is again two types. They are ribose sugar and deoxyribose sugar.
b. Nitrogenous base: It is aromatic cyclic compound which contain nitrogen and carbon in its ring. It is divided into two groups.

i. **Pyrimidine:** It is single ring structure. It is similar to benzene ring where nitrogen presents in its 1 and 3 position. It is of three types. They are cytosine, thymine and uracil.
ii. **Purine:** It is double ring structure where pyrimidine ring fused with another imidazole ring. It is of two types. They are adenine and guanine.

c. Phosphate group: It is derived from phosphoric acid. It is only the inorganic portion of nucleotide.

Phosphodiester bond: The bond between two sugar molecules and a phosphate group such forms sugar - phosphate - sugar back bone of nucleic acids.
Nucleosides: The molecules formed by the combination of pentose sugar with nitrogenous base.
Nucleotides: The molecules formed by the combination of nucleoside with phosphate group.

On the basis of structure, chemical composition and functions, the nucleic acids are of following types.

A. Deoxyribose Nucleic Acid (DNA): It is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms. The main role of DNA molecules is storage of information. The DNA segments that carry this genetic information are called genes.

DNA consists of two long polymers of simple units called nucleotides with backbones made up of sugars and phosphate groups joined by ester bonds. These two strands run in opposite directions to each other and are therefore antiparallel.

Within cells, DNA is organized into long structures called chromosomes, nucleolus, mitochondria and chloroplast.

Structure of DNA:

Watson and Crick proposed the model of B-DNA by using all the information that was available at that time. They used the data obtained from experiments carried out on DNA.

The important features of this model are:

a. The DNA molecule is a double helix with single polynucleotides running in opposite directions.
b. The double helix is right handed.
c. The double helix has two different grooves.
d. The nitrogenous bases are stacked towards the inside of the helix.
e. Bases of the two polynucleotides interact by hydrogen bonding. An adenine always adjacent to thymine; guanine is always adjacent to cytosine.

f. Ten base pairs occur per turn of the helix. The height or pitch of the helix is 34A^{o}. The space between two base pairs to opposite strand is 8.4A^{o} and has an angle of 36^{o}.
g. The diameter of the helix is 20A^{o}.

Figure:

On the basis of number of nitrogenous bases, the DNA is divided into following types.

i. **A-DNA:** DNA having 11 nitrogenous base pairs in a complete rotation.
ii. **B-DNA:** DNA having 10 nitrogenous base pairs in a complete rotation.
iii. **C-DNA:** DNA having 9 nitrogenous base pairs in a complete rotation.
iv. **D-DNA:** DNA having 8 nitrogenous base pairs in a complete rotation.
v. **Z-DNA:** DNA having 12 nitrogenous base pairs in a complete rotation.

Function of DNA:

a. It acts as a carrier of genetic information from generation to generation.
b. It synthesizes ribonucleic acid (RNA).
c. It acts a prime molecule during protein synthesis.
d. It controls off the biological activities of cell.
e. DNA has autocatalytic function which directs the synthesis of its own copy.

B. RNA (Ribose Nucleic Acid): It is a nucleic acid that contains a polymer of ribonucleotides of adenine, uracil which are joined together by phosphodiester bond. It is found in nucleolus, ribosomes, mitochondria, chloroplast and cytoplasm.

Structure:

a. A molecule of RNA has only one polynucleotide chain.
b. The polynucleotide chain is made up of ribonucleotides attached to each other by 3'-5' phosphodiester bond.
c. The backbone of the strand is made up of pentose sugar and phosphate while the nitrogen bases form backbone towards the axis.
d. Pentose sugar is ribose.
e. An RNA molecule may contain self complementary sequences that allow parts of the RNA to fold and pair with itself to form double helices.

Figure:

On the basis of structure and function, RNA is of following types.

i. **Ribosomal RNA (r-RNA):** It is the most stable and abundant RNA. It comprises about 70% to 80% of total cellular RNA. It is associated with

ribosome. It is synthesized from DNA by transcription in presence of RNA polymerase I.

ii. **Messenger RNA (m-RNA):** It is the longest RNA. It comprises about 3% to 10% of total cellular RNA. It is synthesized from DNA by transcription in presence of RNA polymerase II.

iii. **Trasnfer RNA (t-RNA):** It is the smallest RNA. It comprises 10% to 20% of total cellular RNA. It is synthesized from DNA by transcription in presence of RNA polymerase III.

Functions of RNA

a. They are the genetic materials of some viruses as TMV, HIV, etc.
b. They help to synthesise proteins.
c. They bring amino acids and read the genetic code.
d. They play a structural and catalytic role during translation.

7. Water:

It is very important component of living organism. It is the main component of protoplasm. It occupies about 70-90% of the weight of most of the organism. It may occur in free or combined form.

A water molecule consists of two hydrogen atoms and one oxygen atom which are combined with covalent bond.

General Properties:

a. It is colourless, odourless and tasteless liquid.
b. It has higher specific heat capacity.
c. The density of water decreases on freezing.
d. It is also regards as universal solvent.
e. It maintains the pH of living cells.
f. It carried out various metabolic activities inside the cell.

Functions of water

a. It is a raw material of photosynthesis.
b. It helps in various metabolic reactions occurs inside the cell.
c. It helps for the transportation of various organic compounds within and between cells.
d. It can dissolve almost all of the solutes.
e. It helps in opening and closing of stomata.
f. It acts as temperature buffer which retain the body temperature of living organism.

8. Minerals:

These are naturally occurring solid chemicals formed by biogeochemical processes. They are wide range in their composition from pure and simple elements to complex.

They are essential for growth and survival of living organism which cannot be replaced by another element. Hence, are also called essential elements.

There are about 25 different minerals.

Functions of minerals

a. It helps in proper growth and development of organism.
b. They are the important constituent of cell membrane.
c. They help to form different proteins, enzymes, vitamins etc.
d. They also help in immunity of organism.
e. They are important part of skeleton system.
f. They help to form reserve food material.
g. They help in internal transport of organism.