Role and types of biomolecules in the human body

Complex organic compounds which governs the common activities of living organisms are called as biomolecules. Living systems are made up of various complex biomolecules like carbohydrates, proteins, nucleic acids, lipids, etc. In addition to that some simple molecules like vitamins and mineral salts also play an important role in the functions of organisms.

DIFFERENT TYPES OF BIOMOLECULES:

CARBOHYDRATES:

Carbohydrates are primarily produced by plants and form a large group of naturally occurring organic compounds. Some common examples are cane sugar, glucose, starch, etc. Most of them have a general formula Cx(H2O)y and were considered hydrates of carbon from where the name carbohydrates were derived.

Chemically carbohydrates can be defined as optically active polyhydroxy aldehydes or ketonesor the compounds which produce such units on hydrolysis. Some of the carbohydrates which are sweet in taste are also called sugars.

Classification of carbohydrates:

Carbohydrates can be classified on their behavior on hydrolysis. They can be broadly classified in to following 3 groups.

1. Monosaccharides:

A carbohydrate that cannot be hydrolysed further to give simpler units of polyhydroxy aldehyde or ketone is called a monosaccharide. Some common examples are glucose, fructose, ribose etc.

Monosaccharides can further be classified on the basis of no. of carbons and the type of functional group present in them. If the monosaccharide contains an aldehyde group then it is known as aldose and if it contains a keto group it is known as ketose.

Different types of monosaccharides:

- Carbon atoms
- General term

Triose

glyceraldehyde, dihydroxyacetone

Tetrose

erythrose, erythrulose

Pentose

ribose, deoxyribose

Hexose

glucose, fructose

Heptose

sedoheptulose

2. Oligosaccharides:

Carbohydrates that yield 2 to 10 monosaccharides units, on hydrolysis, are called oligosaccharides. They are further classified as disaccharides, trisaccharides, tetrasaccharides etc., depending upon the no. of monosaccharides they provide on hydrolysis. Some of the common examples are:

- Disaccharides: maltose, sucrose, lactose
- Trisaccharides: raffinose
- Tetrasaccharides: stachyose
- Pentasaccharides: barbascose

3. Polysaccharides:

Carbohydrates which yield a large no. of monosaccharide units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, gums, etc. Polysaccharides are not sweet in taste, hence they are called as non-sugars.

The carbohydrates may also be classified as reducing or non reducing sugars. All those carbohydrates which reduce Fehlings solution and Tollens reagent are reffered to as reducing sugars. All monosaccharides whether aldose or ketose are reducing sugars.

In dissacharides, if the reducing groups of monosaccharides i. e. aldehydic or ketonic groups are bonde, these are non reducing sugars eg: sucrose.

PROTEINS

The word protein is derived from greek word “ proteios” meaning primary or prime importance. All proteins are actually the polymers of amino acids.

There are approximately 300 amino acids known to exist but only 20 types of amino acids are used in the formation of proteins. Out of these 20 amino acids 10 of them are not synthesized in body of animals so they are must in biet. These are known as ESSENTIAL AMINO ACIDS. Rest 10 are synthesized in animal body so they are NON ESSENTIAL AMINO ACIDS.

ESSENTIAL AMINO ACIDS

Threonine, valine, leucine, isoleucine, lysine, methionine, phenylalanine, tryptophane, arginine, histidine

NON ESSENTIAL AMINO ACIDS

Glycine, alanine, serine, cysteine, aspartic acid, glutamic acid, asparagine, glutamine, tyrosine, proline

Essential elements in proteins are C, H, O, N. Most of the proteins contain sulphur. Few also contain iodine, iron and phosphorus. After water proteins are the most abundant compound in protoplasm.

STRUCTURE OF PROTEINS

Proteins can be classified into two types on the basis of their molecular shape.

(a) Fibrous proteins

When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre- like structure is formed. Such proteins are generally insoluble in water. Some common examples are keratin (present in hair, wool, silk) and myosin (present in muscles), etc.

(b) Globular proteins

This structure results when the chains of polypeptides coil around to give a spherical shape. These are usually soluble in water. Insulin and albumins are the common examples of globular proteins. Structure and shape of proteins can be studied at four different levels, i. e., primary, secondary, tertiary and quaternary, each level being more complex than the previous one.

(i) Primary structure of proteins:

Proteins may have one or more polypeptide chains. Each polypeptide in a protein has amino acids linked with each other in a specific sequence and it is this sequence of amino acids that is said to be the primary structure of that protein. Any change in this primary structure i. e., the sequence of amino acids creates a different protein.

(ii) Secondary structure of proteins:

The secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two different types of structures viz. Î±-helix and Î²-pleated sheet structure. These structures arise due to the regular folding of the backbone of the polypeptide

chain due to hydrogen bonding between and -NH- groups of the peptide bond. Î±-Helix is one of the most common ways in which a polypeptide chain forms all possible hydrogen bonds by

twisting into a right handed screw (helix) with the -NH group of each amino acid residue hydrogen bonded to the C O of an adjacent turn of the helix. In

Î²-structure all peptide chains are stretched out to nearly maximum extension and then laid side by side which are held together by intermolecular hydrogen bonds. The structure resembles the pleated folds of drapery and therefore is known as Î²-pleated sheet.

(iii) Tertiary structure of proteins:

The tertiary structure of proteins represents overall folding of the polypeptide chains i. e., further folding of the secondary structure. It gives rise to two major molecular shapes viz. fibrous and globular. The main forces which stabilise the 2° and 3° structures of proteins are hydrogen bonds, disulphide linkages, van der Waals and electrostatic forces of attraction.

(iv) Quaternary structure of proteins:

Some of the proteins are composed of two or more polypeptide chains referred to as sub-units. The spatial arrangement of these subunits with respect to each other is known as quaternary structure. Isoenzymes attain such type of structure.

NUCLEIC ACID

Nucleic acid is that substance which not only controls the inheritance of traits from one generation to next but is also able to express its effect through the formation and functioning of traits. Components of nucleic acid that controls characters are called genes. Genes are located over chromosomes.

Based upon its functioning and nature nucleic acid is also known as hereditary material or genetic material. There are basically 2 types of nucleic acid, namely

1. DNA (deoxyribo nucleic acid)

2. RNA (ribo nucleic acid)

1. DNA:

DNA or deoxyribonucleic acid is a helically twisted double chain polydeoxyribonucleotibe macromolecule which constitutes the genetic material of all organisms with the exception of riboviruses. In prokaryotes it occurs in nucleoid and plasmids. This dna is usually circular. In eukaryotes most of the DNA is found in chromatin of nucleus. It is linear.

DNA is a long chain of polymer of several hundred thousand of deoxy-ribonucleotides. A DNA molecule has 2 unbranched complementary strands. They are spirally coiled. The 2 spiral strands of DNA are collectively called DNA duplex.

A deoxyribonucleotide of DNA is formed by cross linking of 3 chemicals- phosphoric acid, deoxyribose sugar and a nitrogen base. 4 types of nitrogen bases occur in DNA. They belong to 2 groups, they are:

a. PURINES: adenine or A , guanine or G

b. PYRIMIDINES: cytosine or C , thymine or T

2. RNA

A polymeric constituent of all living cells and many viruses, consisting of a long, usually single-stranded chain of alternating phosphate and ribose units with the bases adenine, guanine, cytosine, and uracil bonded to the ribose. RNA molecules are involved in protein synthesis and sometimes in the transmission of genetic information.

ENZYMES

Enzymes are biological catalysts. they are positive catalysts that catalyze the biological reactions. Chemically enzymes are globular proteins. Some important enzymes and their functions are as follows:

- Î±-amylase converts starch to n-Glucose
- emulsin converts cellulose to n-Glucose
- pepsin and trypsin converts proteins to amino acids
- nucleases convert DNA or RNA to nucleotides

VITAMINS

Certain organic compounds are required in small amounts in our diet but their deficiency causes specific diseases. These compounds are called vitamins. most of the vitamins cannot be synthesised in our body but plants can synthesise almost all of them, so they are considered as essential food factors.

They are generally regarded as organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism. Vitamins are designated by alphabets

A, B, C, D, etc. some of them are further named as sub-groups e. g. B1, B2, B6, B12, etc.

Vitamins are classified into two groups depending upon their solubility in water or fat.

(i) fat soluble vitamins: vitamins which are soluble in fat and oils but insoluble in water are kept in this group. These are vitamins A, D, E and K. They are stored in liver and adipose (fat storing) tissues.

(ii) water soluble vitamins: B group vitamins and vitamin C are soluble in water so they are grouped together. Water soluble vitamins must be supplied regularly in diet because they are readily excreted in urine and cannot be stored (except vitamin B12) in our body.

HORMONES

Hormones are biomolecules which are produced in ductless(endocrine) glands and are carried to different parts of the body by the blood stream where they control various metabolic processes. These are required in minute quantities and unlike fats and carbohydrates these are not stored in body but are continuously produced.

There are basically 3 types of hormones:

1. STEROIDAL HORMONES

a. sex hormones: androgen, estrogen, gestogen

b. corticoids: cortisone, corticosterone

2. PEPTIDE HORMONES

oxytocin, vasopressin, angiotensin, insulin

3. AMINE HORMONES

Adrenaline, thyroxine

CO-ORDINATION OF DIFFERENT BIOMOLECULES IN HUMAN BODY

Carbohydrates:

The body uses carbohydrates directly from the monosaccharide glucose. Glucose is in the blood and extracellular fluids (lymph) and can be made from glycogen. Glycogen is stored in the liver and muscles and in smaller amounts in the other organs and tissues of the body. Energy is derived from glucose by the splitting of the glucose molecules into smaller compounds and oxidizing these to form water, which frees quite a large amount of energy. Some of the other functions that carbohydrates perform in human body:

1. Carbohydrates Provide Fuel for the Central Nervous System
2. Carbohydrates Provide Fuel for the Muscular System
3. Carbohydrates Supposedly Spare Proteins

Proteins:

Protein is essential for humans…that means that we can’t do without it in our food and in our bodies, in part because of the nitrogen it contains (the major source of nitrogen for the body) and in part because of the particular building blocks that make up protein. Protein is made up of twenty different building blocks, called amino acids, arranged in thousands and thousands of different ways. Every cell in the human body contains protein as part of its structure (cell membrane and other structures). It also serves to build strong stuctures in the body, as a whole (bones, muscles, tendons, and ligaments); it makes up the compounds that our body used to make the biochemical reactions occur in our body, called enzymes; it is found in our blood as parts of the red blood cells (hemoglobin) and as carriers for other materials (transport proteins); and it is part of the immune system (antibodies) that helps protect our body from foreign invaders, such as bacteria, viruses, and toxic substances.

Some proteins help keep the fluid in our body where it should be, such as the proteins in our blood. Some proteins in our blood and other tissues help keep the acid-base balance in our body in ranges that allow us to stay alive.

Nucleic acid:

The nucleic acids most prominent within the human body system are DNA and RNA. These materials are responsible for maintaining and reproducing the cells that make up the body. They are involved in a number of processes which work to provide the materials needed for cell repair and metabolism processes.

The DNA and RNA molecules within each cell are the body’s most essential nucleic acid materials. Both types of molecules are responsible for generating the materials needed to sustain cell life. Energy production, cell metabolism and cell reproduction processes are all directed by the information contained inside these nucleic acids. These materials are structured in such a way that all the information needed to carry out everyday cell functions and cell repair are contained inside these molecules.

Enzymes:

Our human body produces about 22 different digestive enzymes. A majority of the source of these enzymes are found in fruits, vegetables, meats, grains and other foods.

These enzymes are essential for healthy digestion. Enzymes are found in abundance in raw fruits and vegetables. For example, in a juicy sweet fruit, there is sucrase, the enzyme required to digest sucrose. In fibrous foods there is, packaged together, cellulase to digest them. In grains there is maltase, to digest malt, and so on.

When we consume these enzyme-deficient foods, our deprived body will have to generate its own enzymes required to digest the food. The more we depend on our internally-produced enzymes, the more stress we put on our body systems and organs. When our body enzymes are busy digesting our heavy meal that has no enzyme, their function of rebuilding and replenishing our worn-out and damaged cells are neglected.

Vitamins:

Vitamins are very important because they perform various functions in our body. Vitamins promote the normal growth by providing metabolism and ensuring protection against the viruses. For the proper growth of the children vitamins are very important. Vitamins also help in the hormones formation, blood cells and formation of chemicals in our body. Vitamins are also required for metabolism and they create metabolically active enzymes which are very essential for various functions of our body. Vitamins also assist in forming bones and tissues.

Vitamin A plays an important role in vision, bone growth, reproduction, cell division and differentiation. Vitamin B complex improves the body’s resistance to stress. Aids in digestion, promotes good muscle tone, healthy skin. Vitamin B complex reduces muscle spasms, leg cramps, hand numbness and helps regulate blood pressure. Vitamin C is responsible for helping to build and maintain our tissues and strengthening our immune system. Adequate amounts of vitamin D is necessary for preventing bone loss. Vitamin E is the most effective, fat-soluble antioxidant known to occur in the human body. The main function of vitamin E is to maintain the integrity of the body’s intracellular membrane by protecting its physical stability and providing a defense line against tissue damage caused by oxidation. Alpha-lipoic acid helps to neutralize the effects of free radicals on the body. Vitamin K plays an important role in blood clotting and bone metabolism (carboxylation of osteocalcin). Bioflavonoids have antioxidant, anti-inflammatory, antiallergenic, antiviral, and anti-carcinogenic properties.