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Batch : 47

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Assignment: General Science and Ability

Assignment No: 2

Topic: Carbohydrates, Proteins, Fats and their Classification.

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Carbohydrates

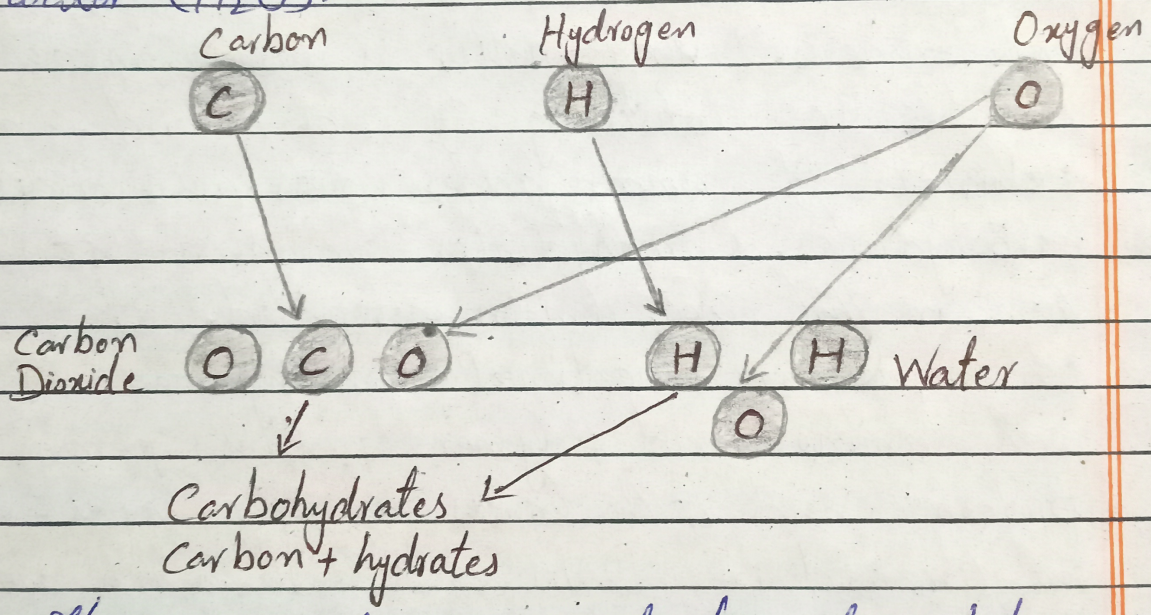
Introduction:

Carbohydrates are the most abundant biomolecules belonging to class of organic compounds found in living organisms on earth. Each year, more than 100 billion metric tons of Co_2 and H_2O are converted into cellulose and other plant products due to photosynthesis. Living matter is largely made of biomolecules consisting of water and complex polymers of amino acids, lipids, nucleotides and carbohydrates. Carbohydrates are most special of them in that they remain associated with the three other polymers mentioned. Carbohydrates are linked with amino acid polymers (proteins) forming glyco-proteins and with lipids as glycolipids. Carbohydrate are presented in DNA and RNA, which are essentially polymers of D-ribose-phosphate and 2-deoxy-D-ribose phosphate to which purines and Pyrimidines bases are attached at the C-1 reducing position. Carbohydrates are a widely diverse group of compounds that are ubiquitous in nature. More than 75% of the dry weight of the plant world is carbohydrate in nature-particularly cellulose, hemicellulose and lignin.

Definition:

Carbohydrates are polyhydroxylated aldehydes or ketones and their derivatives. The word "carbohydrate" includes polymers and other compounds synthesized from polyhydroxylated aldehydes and ketones. They can be synthesized in the laboratory or in living cells. Simple carbohydrates or the entire carbohydrate family may also be called saccharides. In general carbohydrates have the

empirical formula $(CH_2O)_n$. The term generated from carbon and hydrate; though some also contain nitrogen, phosphorus, or sulfur. Chemically, carbohydrates are molecules that are composed of carbon, along with hydrogen and oxygen usually in the same ratio as that found in water (H_2O).



They originate as products of photosynthesis, an endothermic reductive condensation of carbon dioxide requiring light energy and the pigment chlorophyll.

$$nCO_2 + nH_2O + \text{energy} \longrightarrow C_nH_{2n}O_n + nO_2$$

Typical carbohydrates are composed of strings or chains of monosaccharides - that is, chains of individual sugars.

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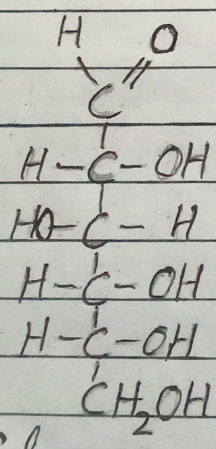
Classification of Carbohydrates / Types of Carbohydrates:

Carbohydrates are classified generally according to their degree of complexity. Hence, the free sugars such as glucose and fructose are termed monosaccharides; and the starches and celluloses, polysaccharides.

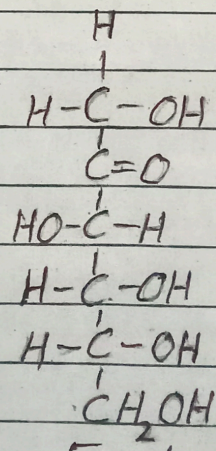
(1) Monosaccharides:

They simplest group of carbohydrates and often called simple sugars since they cannot be further hydrolyzed. Monosaccharides are colourless, crystalline solids that are soluble in water and insoluble in a non-polar solvent. Monosaccharides are either aldehydes or ketones, with one or more groups. The general formula is $C_n(H2O)_n$ or $C_nH_{2n}O_n$. Simple monosaccharides with four, five, six and seven carbon atoms are called tetroses, pentoses, hexoses and heptoses.

Examples: Glucose, Fructose, Erythrulose and Ribulose.



Glucose
an aldohexose



Fructose
a Ketohexose

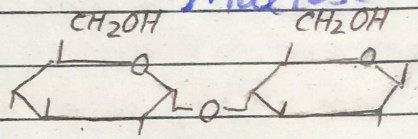
(2) **Disaccharides:**

Disaccharides consist of two sugars that are linked by a glycosidic linkage. This glycosidic linkage is formed by a condensation reaction that takes place between the two sugars units, resulting in the loss of a hydrogen atom from one monosaccharide and a hyroxyl group from the other. Disaccharides are broken down into two monosaccharide, in the small intestine during the process of digestion.

Examples:

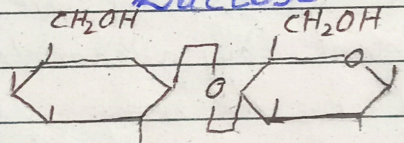
Maltose, Lactose and Sucrose.

Maltose



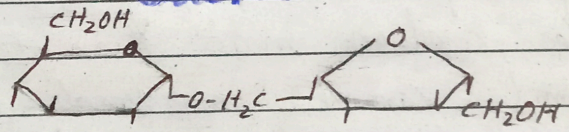
α-1,4 linkage

Lactose



β-1,4 linkage

Sucrose



(3) **Oligosaccharides:**

Oligosaccharides are compounds sugars that yield two to ten molecules of the same or different monosaccharides on hydrolysis. They are less sweet in taste. They are less soluble in water. The monosaccharide units are joined by glycosidic linkage. Based on

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the number of monosaccharide units. It is further classified as a disaccharide, trisaccharide, tetrasaccharide etc. Oligosacchrides yielding two molecules of monosaccharides on hydrolysis is known as a disaccharide and the ones yeilding three monosaccharides are known as trisaccharides and the once yeilding four monosaccharides are known as tetrasaccharides respectively, and so on. The general formula of disaccharides is $C_n(H_2O)_{n-1}$ and that of trisaccharides is $C_n(H_2O)_{n-2}$ and so on.

Examples:

Disaccharides include sucrose, lactose, maltose etc.
Trisaccharides are Raffinose and Rabinose

Polysaccharides:

They are also called "glycans". They are least soluble in water. They are most complex and most abundant. Polysaccharides cannot be directly utilized by the body. They must first be broken down into monosaccharides, the only sugar form the body can use. Polysaccharides contain more than 10 monosaccharide units and can be hundreds of sugar units in length. Polysaccharides differ from each other in the identity of their recurring monosaccharides units, in the length of their chains, in the types of bond linking units and in the degree of branching. They are primarily concerned with two important functions i.e. Structural functions and the storage of energy.

They are further classified depending on the type of molecules produced as a result of hydrolysis. They may be homopolysaccharides, containing monosaccharides of the same type or heteropolysaccharides, containing monosaccharides of different types.

Examples:

Homopolysaccharides are starch, glycogen, cellulose and pectin etc.
Heteropolysaccharides are Hyaluronic acid and chondroitin etc.

Proteins

Introduction:

Proteins are linear polymers consisting of L-amino acids. The amino acids in proteins are united through an acid-amide type of bond called a peptide linkage. Hydrolysis of proteins involves hydrolysis of peptide linkages, since a protein molecule may contain hundreds of amino acid groups.

The unique catalytic and structural properties of proteins arise in part from the cloud of side chains anchored to the polymer peptide. The structures of proteins enable them to act as the catalysts (enzymes) which control the rates of all biological reactions. They can act as regulators (hormones) of physiological relationships. Protein makes body parts such as muscles, tendons, hairs, nails, hoof etc. Protein is also an essential component of cell membrane, cytoplasm and organelles.

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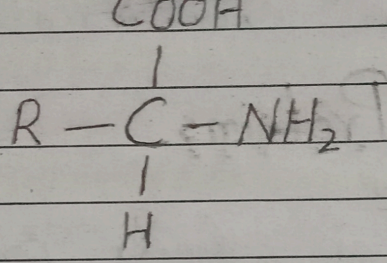
Definition:-

The word protein is derived from a Greek word "proteios" meaning "of prime importance". Proteins are biopolymers of amino acids. Proteins are highly complex nitrogenous substances that are made up of amino acids present in all living organisms. Proteins consist of carbon, hydrogen, oxygen, nitrogen and some time consists of sulphur. The human body contains thousands of different proteins.

Formula:



=> COOH is called carboxyl group.
=> H_2N is called Amino group
=> R is Alkyl group.

Properties of Proteins:

Pure proteins are generally tasteless, though the predominant taste of protein hydrolyses is bitter. Pure proteins are odourless. When heated, they turn brown and char and give off the odour of burning feathers or hair. As the protein molecules are exceedingly complex in structure and are very large so they have high molecular weights ranging from 10,000 to 100,000.

Sources of proteins:

Plant Source: Beans, Pulses, Cereals and dry fruits.
Animals Source: Cheese, milk, poultry and fish.

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Classification of Proteins

Protein Classification based on Chemical Composition

On the basis of their chemical composition, proteins may be divided into two classes: simple and conjugated proteins.

(1) Simple Proteins

Simple proteins are also known as homoproteins. They are made up of only amino acids.

Examples:

Fibrous Proteins:

These are animal proteins which are highly resistant to digestion by proteolytic enzymes. They ar water soluble.

(a) Collagens:

It contains high proportion of hydroxy proline and hydroxylysine. It is a major protein of connective tissues. On boiling with water it form gelatin.

(b) Elastins:

It is present in tendons and arteries.

(C) Keratins:

It contains large amount of sulphur as cystine. It is present in hair, wool, nails etc.

(2) Conjugated Proteins

They are proteins which contain non-protein group (also called prosthetic group) attached to the protein part. On hydrolysis, they give non-protein component and amino acid mixture.

Examples:

Glycoproteins, chromoproteins, phosphoproteins, Nucleoproteins and lipoproteins.

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Protein classification based on shape:

On the basis of their shape, proteins may be divided into two classes: fibrous and globular.

(1) Fibrous Proteins:

They have primarily machnical and structural functions, providing support to the cells as well as the whole organism. These proteins are insoluble in water as they contain, both internally and on their surface, many hydrophobic amino acids. The presence on their surface of hydrophobic amino acids facilitates their packaging into very complex supermolecular structures.

Examples:

Fibroin, Collagen, α-Keratins and Elastin.

(2) Globular Proteins:

Most of the proteins belong to this class. They have a compact and more or less spherical structure, more complex than fibrous proteins. They are generally soluble in water but can also be found inserted into biological membranes (transmembrane proteins), thus in a hydrophobic environment.

Examples:

Myoglobin, haemoglobin and cytochrome.

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Fats

Fat is also known as fatty acid and it is made up of three important elements: carbon, hydrogen and oxygen, but the amount of carbon is in maximum quantity. It is an important part of the diet for all animals and humans. Body stores fat for protection, warmth and energy. Different types of fats, which are, saturated and unsaturated, keep our body healthy in different ways.

Classification of Fats:

Fats can be classified into saturated and unsaturated fats.

(1) Saturated Fats:

A saturated fat is a type of fat in which the fatty acid chains have all or predominantly single bonds. Saturated fatty acids, especially palmitic and stearic acids are found in animal products such as cream, cheese, butter, other whole milk dairy products and fatty meats which also contain dietary cholesterol. Certain vegetable products have high saturated fat content, such as coconut oil and palm kernel oil. Many prepared foods are high in saturated fat content, such as pizza, dairy desserts and sausage.

(2) Unsaturated Fats:

Unsaturated fats contain a single or multiple double or triple bonds in the fatty acid chain. Unsaturated fats are liquid at ambient temprature in

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the form of oil. Unsaturated fats can be found in nuts, seeds, olive oil, peanut oil and avocados. They can be further broken down into mono-unsaturated and polyunsaturated fats.