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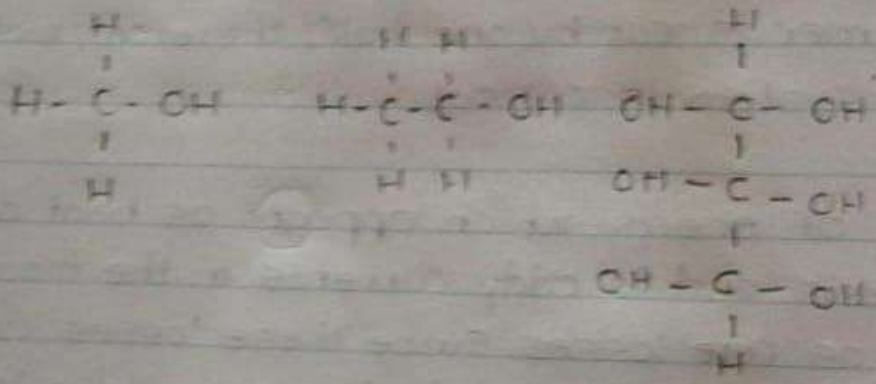
Bio Chemistry

Hydrocarbons

Organic Compounds formed by forming bonds between Carbon atoms and remaining bonds with hydrogen atoms are called hydrocarbons

eg:- Methane, propane, butane

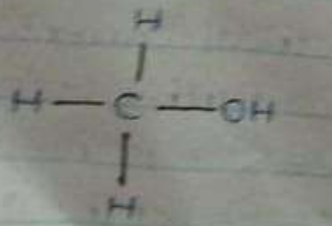
Methane is the main compound of bio gas produced by the decomposition of organic matter. Domestic gas Cylinders contain propane and butane.



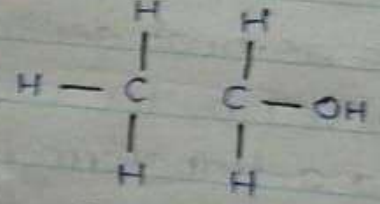
Functional groups contained in bio molecules

- Depending on the functional groups, the chemical and physical properties of bio-molecules are decided.
- The following shows different functional groups bonding with hydrocarbon structure.

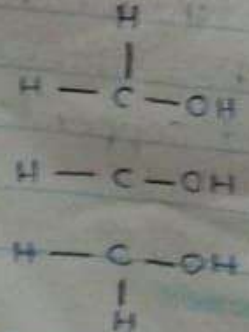
1) R-OH (R indicates CH_3)
(Alcohol)



Methanol

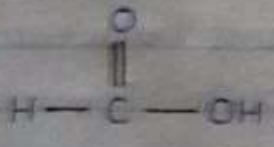


Ethanol

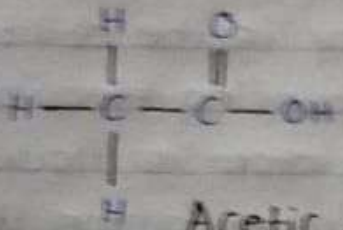


Glycerol

2) R - COOH (Carboxylic acid)

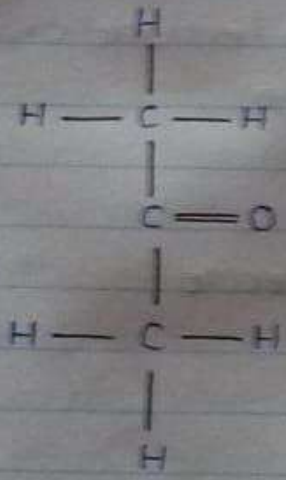


Phomic acid



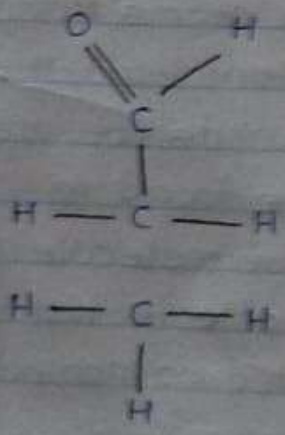
Acetic acid

3) R - Co - R (ketone)



Dihydroxyacetone

4) R - CHO (Aldehyde)

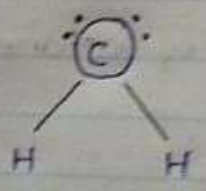


Glyceraldehyde

Physical and chemical properties of organic compou

01) Electronegativity

Electronegativity is the ability of a bond between ato to attract the bonding electron to an atom. The most electronegative atom is flourine. When a bond formed between 2 hydrogen atoms, there is no attraction of the bonding electrons towards either atoms because of atoms are identical. such atoms show no electroneg- tivity. Electronegativity affect the polarity of the molecule. In a water molecule, the bonding electrons are pulled more towards the oxygen because oxygen is more electronegative than hydrogen

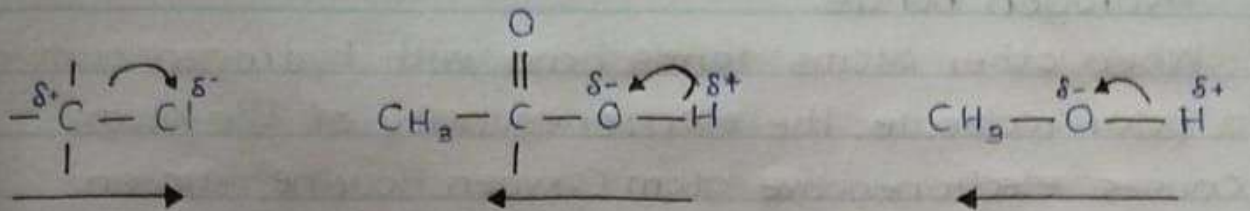


Water molecule

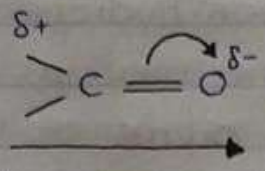
02) Polarization

When 2 equal atoms forming the covalent bond, their electronegativity is also the same as there is no attraction of electrons towards either atoms. But when the different atoms forming the covalent bond, the bonding electron pair is attracted towards the atom with more electronegativity. That is the bond is polarizable. If the bond is polarized, the molecule can become a polar molecule. If the molecule is not polarized, then such molecules are called as non-polar molecules.

eg:- Methane is a non polar molecule while water is a polar molecule. In addition to electronegativity, the polarization of molecule is also affected by electron repulsion of atoms that are close to the bonding atoms.



Chlorine group Carboxylic group Hydroxyl group



ketone group

The melting point and boiling point of water are relatively high. Water is a more polar molecule than ethyl alcohol. Ethyl Alcohol also has a higher molecular weight than water. But under standard conditions, the boiling point of water is 100°c while the ethyl alcohol has 78°C. Since the molecules of polarized solvent (Here, water molecule) are tightly bound together by intermolecular attraction forces, more heat must be supplied for evaporation.

3) Acidic, Basic, Neutral

A molecule or group is acidic if it can release hydrogen (H^+) ion to the medium.

If hydrogen ion can be obtained from the medium, it is regarded as basic molecule.

The molecules or group that don't have those properties are considered as neutral molecules.

Among the above mentioned groups, carboxyl acid shows the acidity as the highest. A hydroxyl group contains alcohol doesn't show such acidity because the electrons from the carbon attach to the oxygen are repelled towards oxygen. The most basic is the amino group.

Hydrogen bonds

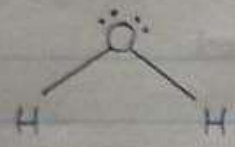
When other atoms forms bond with hydrogen atom in a polar molecule, the electronegativity of the atoms causes electronegative atom (oxygen, Flourine, nitrogen) resulting in a small negative charge on the more electronegative atom and a small positive charge on the less electronegative ~~atom~~ hydrogen atom. When sub molecules are in the same medium, an attractive positively charged hydrogen atoms of two hydrogen atoms. The bonds formed due to these attractive forces are called hydrogen bonds.

Solubility OF Organic Compounds

Polar molecules dissolve in polar solvents and non polar molecules in non polar solvents.
Most polar bio molecules dissolve in water (Ex- alcohol, glucose, etc), as they exist as ion.

Lipids do not dissolve in water because lipid molecule has non polar components

Shapes of molecules



O : C : O

Conical shape linear shape

Two factors determine the shape of the molecule

1) No. of bonds around the central atom
2) No. of unshared electrons in the valence shell

For example, Co_2 is a linear molecule but water is an angular molecule. This is because the oxygen atom in a water molecule has an unbounded electron pair. As the size of molecule increases, the complexity of the shape of the molecule is all increased.

Characteristics of Functional group

A molecule's properties also vary depending on the Functional group it contained

eg:- Acidity, Basicity, Polarity, etc

Carbohydrates, lipids, proteins, etc, that we eat everyday are also organic compounds.
Below are some categories of natural and synthetic organic materials that we use on a daily basis.

- Food - Carbohydrate, lipids, protein, vitamins, amino acids
- Medicine - Antibiotic, painkillers
- Synthetic materials - plastic, polythene, regiform

- Industrial products - alcohol, organic acids, paints, rubber products, texiles, fuel

- ReFrigerant gases

- Wood products

- Fossil Fuel - lubricant; petrol, diesel

Bio molecules

Bio chemistry is the study of matter, matter and energy changes important to biological processes. Various chemical reactions occur in living organisms. They are named as bio chemical reactions and each reaction there is a transformation of matter and energy.

During the photosynthesis in plants, light energy is converted into chemical energy and stored as organic compounds. Organic compound act as various food, providing energy for the biological activities for all living organisms. Some of these compounds also contributes to the building of living organisms.

The types of molecules contained in all living things are called bio-molecules. There are several types of bio-molecules involved in biological process

1) Carbohydrates
2) Proteins
3) Lipids
4) Nucleic acids
5) Vitamins

Carbohydrates

This is the most common organic compound group. Starch and cellulose are it's main forms. Carbohydrates are the organic compounds that are aldehydes, ketones rich in hydroxyl groups. Carbon, hydrogen and oxygen are the constituent elements. It's ratio of hydrogen : oxygen is 2:1. Carbohydrates in general perform the following functions for living organisms.

Functions

1. Act as structural molecules
   eg:- Cellulose in cell wall

2. For energy storage and energy production
   eg:- Glucose

3. As reserved food
   eg:- Starch in plants

Types of carbohydrates

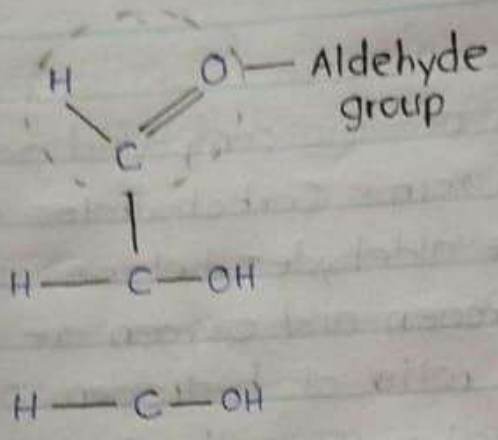
~~Monosaccharides~~

Carbohydrates are divided into 3 groups,

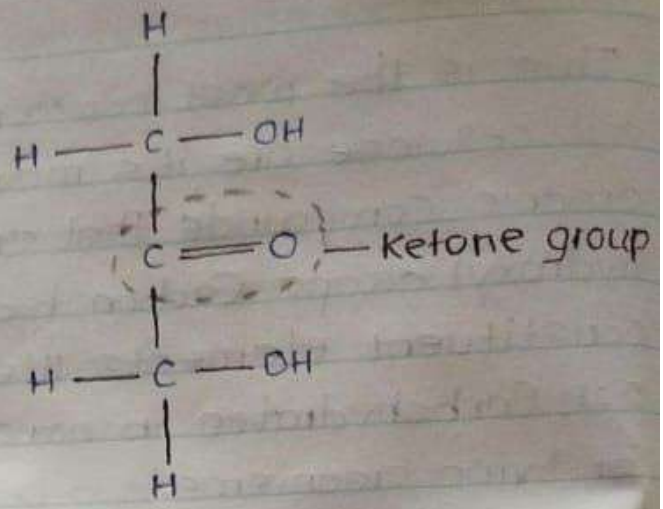
1) Monosaccharides
2) Disaccharides
3) Polysaccharides

Monosaccharides

Monosaccharides is the simplest form of carbohydrate. They are the compounds having 3-7 carbon atoms and having 2 or more hydroxyl groups. The example for the simplest monosaccharides are, glyceraldehyde and dihydroxyacetone.

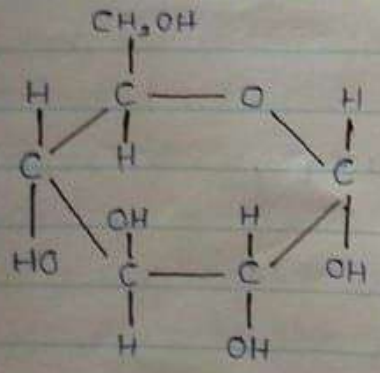


Glyceraldehyde

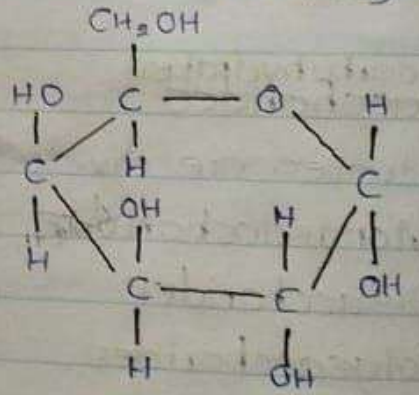


dihydroxyacetone

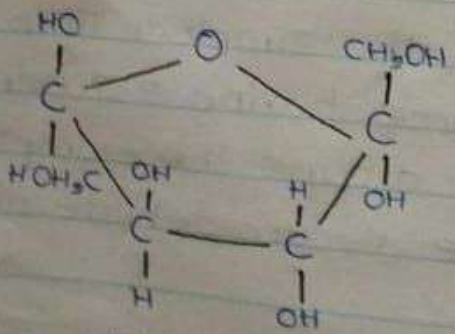
Monosaccharides with an Aldehyde group are called Aldoses and monosaccharides with a ketone group are called ketoses, monosaccharides cannot be hydrolized (dilute with water) by reaction with water. But, cells use monosaccharide as fuel to produce energy. The general molecular Formulae for monosaccharide is $(CH_2O)_n$, monosaccharides are soluble in water. It is sweet. Some of the most common momosacharides are; i) glucose



Glucose



Galactose



Fructose

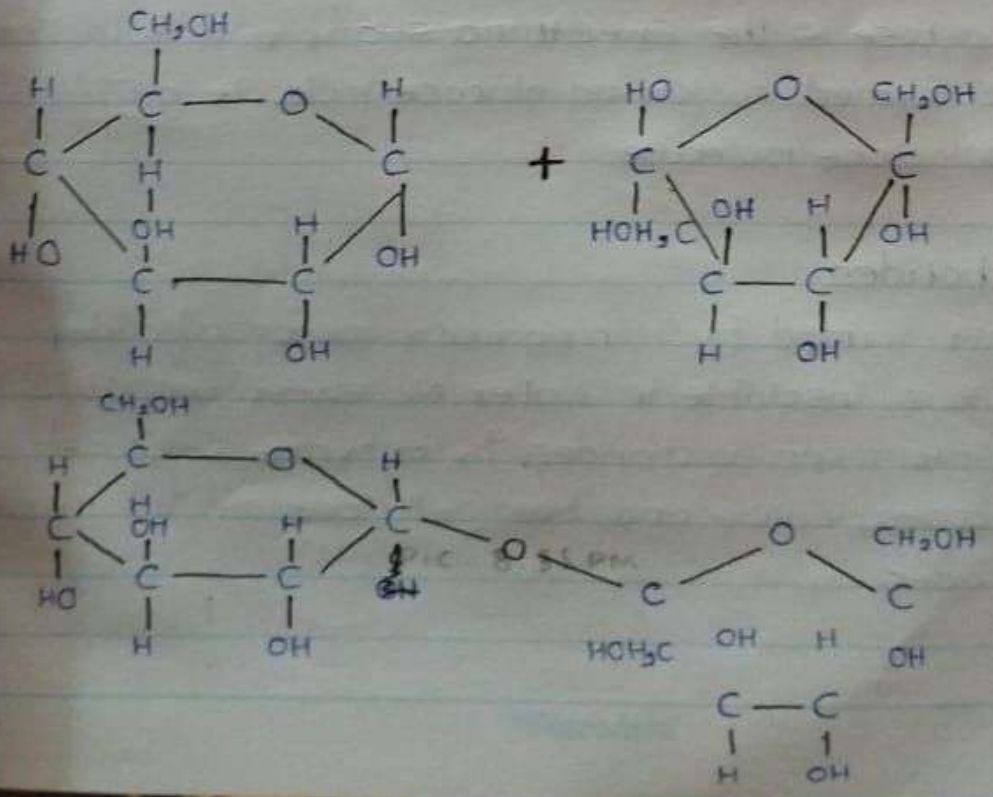
1) Glucose - It is an aldose and commonly used as fuel for cells. One of the main monosaccharides produced by the plant during photosynthesis is glucose. Then it is converted into starch and stored. Glucose is the building block of glycogen and cellulose. Glucose can be converted into ketones and proteins.

2) Fructose - Fructose is a ketose. It is too sweet and contain in Fruits and honey

3) Galactose - Galactose is an Aldose. It is present in milk.

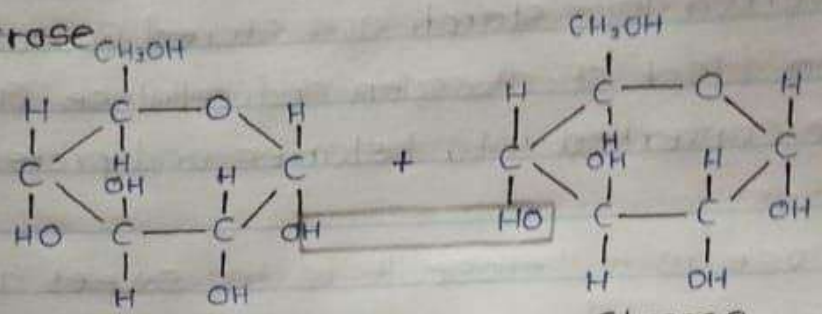
Disacharides

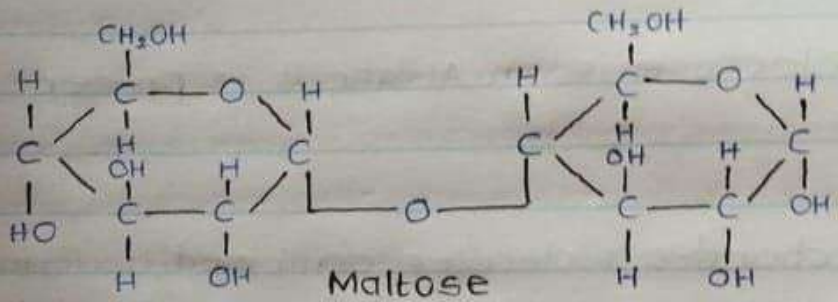
Two monosaccharides molecules combined to form disaccharide molecule by releasing a water molecule. The bond between 2 monosaccharides molecules for the formation of disaccharide molecule is called glycozidic bond. Disaccharides can be broken down into monosaccharides by enzymatic hydrolisis with water. And all disacharides are soluble in water. It is 'sweat' in water.



1) Maltose - The disaccharide obtain during the hydrolysis of starch, formed by joining 2 glucose molecules.

2) Sucrose





3) Sucrose - This is contained in beetroot, sugarcane etc. It is formed by joining a glucose molecule and Fructose molecule.

3) Lactose - Lactose is the sweetning sugar in milk. Lactose is formed by joining glucose molecule and galactose molecule.

Polysaccharides

A polymer, formed by joining many monosaccharide molecules. It is insoluble in water. No sweetness. Can be hydrolized into mono saccharides by enzymes. Cellulose, Starch, glycogen, inuline and hemicellulose are the major polysaccharides.

1) Cellulose - It is the main component of plant cell wall. The largest percentage of dry wood weight is cellulose. Humans cannot digest cellulose. But some herbivores are able to digest cellulose, Because some of the microbes are live there elimentary track.

2) Starch - The main reserve food that stores as energy in plants. Starch is widely stored in vegetable, Fruits seed and etc. It is a polysaccharide formed by many monosaccharides. molecules by the agitation of glucose molecule.

3) Glycogen - This is the organic food of animals stored as glycogen. It is also a polymer compound of glycogen molecules and made reserve food in human liver.

Chemical identification of Carbohydrate

A liquid benedict solution or ~~peling~~ Fehling solution and an aquasous solution of simple sugar subjected to heat. Then a brick red colour precipitate can be obtained

Benedict colour - Blue

IF there is no sugar no colour change appeared in blue colour benedict or Fehling solution. When a little bit of simple sugar available then the solution appeared as yellowish or green in colour. By this test, monosaccharides and disaccharides can be indentified but sucrose cannot be identified as it is not an oxidising sugar.

Uses of Carbohydrates

Carbohydrates are the most spreaded group of organic compounds in the living world.
Starch contained in plants, cellulose in woods, glycogen contained as reserved food in the bodies of animals are the main forms of carbohydrates. The list given in below are the ways of in which carbohydrates are important for living systems and human use.

- Energy supply
  Carbohydrate provides energy, avoiding the use of proter to produce energy. Carbohydrates are alao the source of energy for brain cells therefore it is important for nerve tissues.

- As reserve food
  eg: Starch in plants, glycogen in animals, sucrose in sugarcane.

- Formation of structural components
  eg: Cellulose in plant cell. (cellulose is the main component of dry wood)
  Chitin in the cell wall of fungi

- Use of monosaccharides for bio synthetic activities
  eg:- Formation of glyco lipids (combination of lipids and carbohydrates)

- As a necessary component of carbohydrates for proper fat metabolism or fat oxidation

- The cellulose contain in fibre found in some carbohydrate food prevents constipation in the human digestive tract. It also reduces the risk of diabates, cancer and heart disease. Therefore, fibre is an essential component of the human diet. Constipation is the condition caused by persistant suppression of the drug action for fibre stimulate contraction in digestive tract, reducing the risk of constipation.

- Some carbohydrates stimulate the growth of bacteria which are important for digestion. Carbohydrates are important for the fertilization of organisms, immune system function and blood clotting.

- Industrial application
- For industrial alcohol production, maize, potato, etc are used as raw materials. Ethanol is produced by fermenting them. Some countries in the world use ethanol as fuel for vehicles. These are called bio fuels as they are produced using living organisms.

- Cellulose is used as raw material to produce paper, cardboard, linen, cotton, etc. Cellulose is also converted into the protective sheets such as transparent cellopane, and synthetic fibres such as rayon and fabrics.

- Carbohydrates are used as outercoating (chitosan) of some pharmaceutical tablets and capsules or to form pharmaceutic -al tablets into specific shapes.

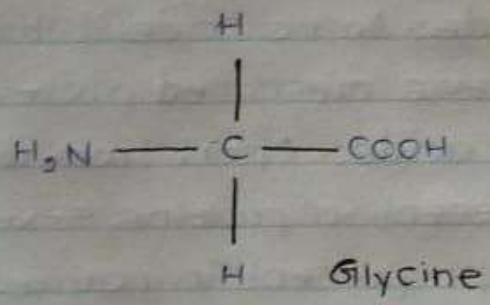
- Caramalized sucrose is used to produce jams, jellys etc made from fruits.

- Sugars like mannitol and sobitol are used as artificial sweatners.
- Cellulose produces sponges that facilitates water absorption.
- Manufactures of water soluble gums using cellulose.
- Cellulose is used as a based material in the production of celluloid Films used in film and photography.
- Cellulose is used to make cellulose nitrate or nitrate Cellulose, a type of Smokeless gun powder, ~~Starch, a renewable material~~
- Starch ~~a renewable mate~~ is used to produce renewable material which is like bio degradable plastics, packaging materials and molds.
- Starch is used as a raw material to produce textiles, cosmetics, ~~meteel~~ medicine, paints.
- Carbohydrates chitin is used to produce tough and flexible threads that decomposes and is used to suture wounds as the sutures dissolve after the surgery There is no need to cut the sutures and remove them.

Proteins

Proteins are made up of amino acids.
Amino acids - In amino acids, there are two functional groups: an amino group and a carboxylic group. Both these groups are attached to the α carbon atom only. Amino acids are alpha (α) amino carboxylic acids. The carbon atom is tetrahedral in shape. The various groups attached to it are placed in different positions. Since the valence of the carbon atom is four, four groups can be attached to the carbon atom. Based on the groups attached to the carbon atom it may be of 2 types.

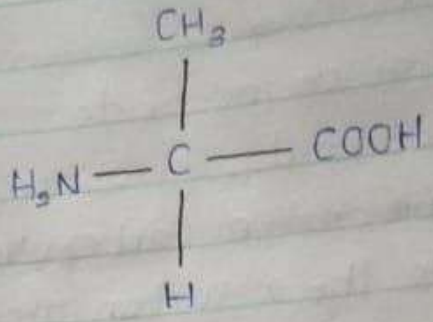
1. Symetric carbon atom :- When the valence of the carbon is satisfied by more than one similar atoms/groups then the particular carbon atom is called as Symmetric Carbon atom.
Eg:- Glycine



Glycine

Compounds containing Symmetric carbon atoms are optically inactive since they cannot rotate the plane of polarized light.

2. Asymmetric Carbon atom :- When the valence of the carbon is satisfied by 4 different groups, then that particular carbon atom is called an asymmetric carbon atom.
Eg:- Alanine



Alanine

Classification of amino acids

Amino acids can be classified in various ways.

01. Based on side chains:- Based on the structure of the R or groups, all the amino acids are classified as alphatic, aromatic and heterocyclic amino acids.

02. Based on their presence or absence of proteins:- Amino acids are classified as protein amino acids and non protein amino acids.

a) Protein amino acids:- Amino acids that are used for synthesis of proteins are called protein amino acids.

b) Non protein amino acids:- Apart from the 20 amino acids that are present in proteins, several non protein amino acids are also present in nature. These are obtained by the slight modification of 20 protein amino acids.

Eg:- beta alanine, hydroxy proline, N-acetyl glutamic acid

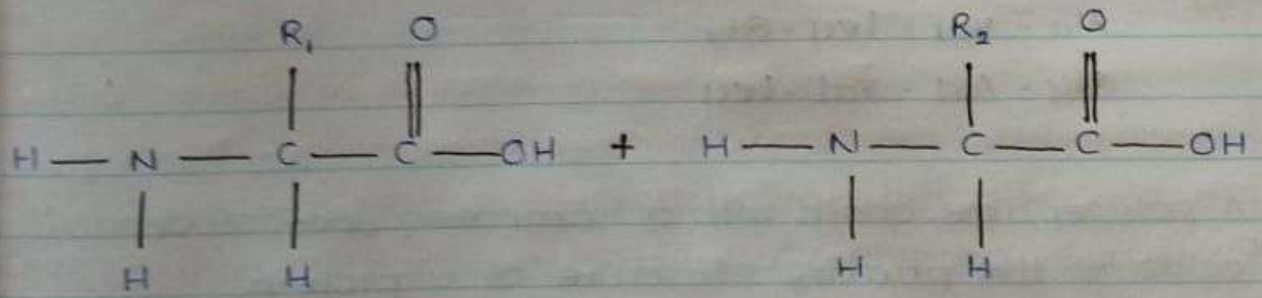
03. Based on requirement to the body as essential and non-essential:- Animals cannot synthesise all the 20 amino acids that are present in nature proteins. Some have to be provided to the body through external diet. The amino acids which cannot be synthesized by the body, which have to be supplied through diet are called essential amino acids. On the other hand, some amino acids can be synthesized

by the body, they are called as non-essential amino acids.

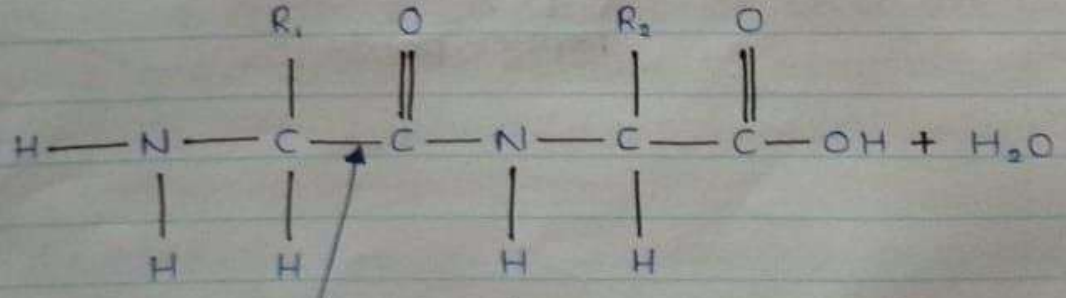
Essential amino acids	Non-essential amino acids
Methoinine	Alanine
Arginine Histidine	Asparatic acid
Threonine	Glutamic acid
Tryptophan	Cysteine
Valine	Glycine
Isoleucine	Proline
Leucine	Serine
phenylalanine	Tyrosine
Lysine	

- Meat eggs and cheese are the dietary suppliments including all essential amino acids

- Amino acids, one another are linked together by peptide bonds.



Amino acid Amino acid



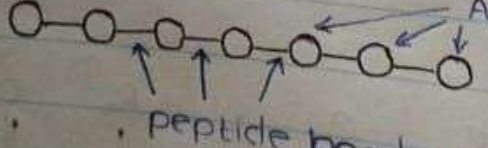
Dipeptide

- Many amino acids are polymerized to form polypeptide chains.
- Different amino acids join together in different sequences form polypeptide chains with different properties
- If no. of polypeptide bonds exceed 100, those are called proteins.
- The order in which the different amino acid to molecules are linked in a polypeptide chain or protein is unique to other proteins.

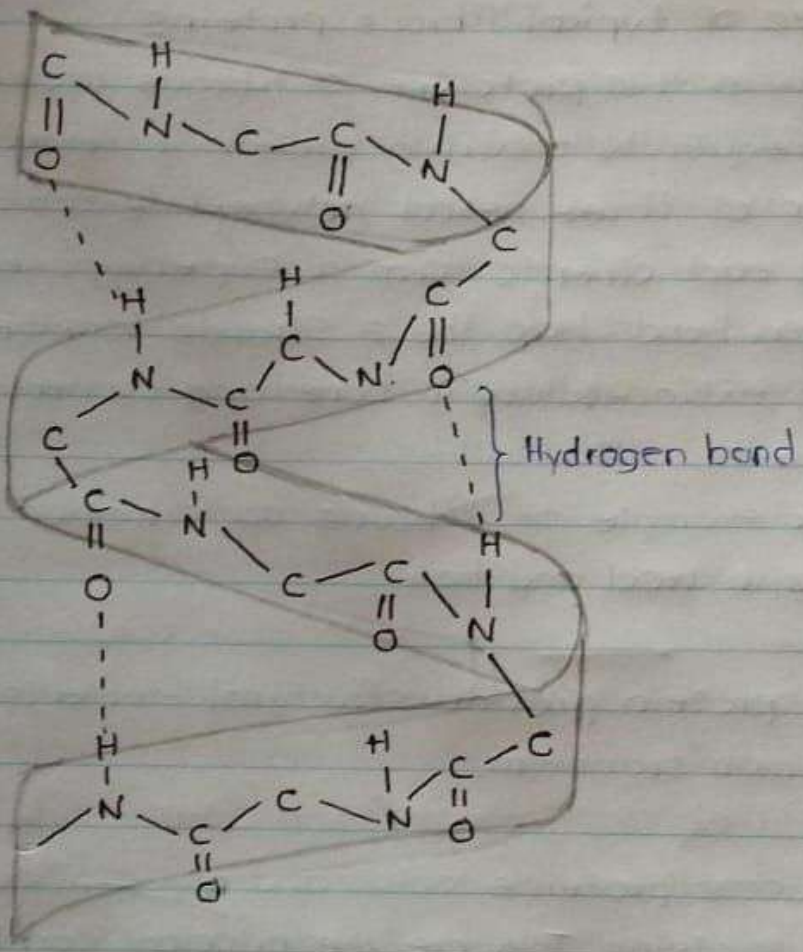
  eg:- Glycine (Gly), Alanin (Ala), Valine (Val), Leucine (Leu) are Five Forms of polypeptide chains resulting from the joining of only 4 amino acids in different sequences.

  eg:- Gly - Ala - Val - Leu
  Leu - Gly - Ala - Val
  Val - Leu - Gly - Ala
  Ala - Val - Leu - Gly
  Gly - Ala - Val - Leu

- A polypeptide chain with a linear sequence of amino acids is the primary structure of a protein.



- The hellical or coiled structure formed by hydrogen bonds between adjacent amino acids in a polypeptide chain is called the secondary structure of the proteins



- The folding and coiling of the polypeptide chain of a protein results in a characteristic three dimensional structure. It is the tertiary structure of protein.

- Different positions of the same polypeptide chain are connected by side chains and cross links. Forming 3D structure of protein.

- The three dimensional structure of proteins is arranged is 2 ways as fibrous and globular.

Fibrous proteins.

The overall shape of fibrous protein is a long rod Fibrous proteins are non soluble in water.

Examples of typical fibrous proteins

- Collagen, is the prototype of fibrous proteins and the most frequently occuring protein in vertebrates. Collagen consists of three helical polypeptide chains wrapped around each other to form a superimposed triple helix. Hydrogen bonds hold the 3 strands together. Collagen is located extracellulary in bone and connective tissue.

- Another example of fibrous conformation in protein is keratin in wool and hair.

- Fibrous protein provide structural elements to the animal and human organism.

- The muscle proteins, actin and myosin, are also mainly fibrous proteins. They are the principal constituents of muscle fibers, but do also occur in other kinds of cell. These proteins are structural proteins in the resting state as well as functional proteins when in action. Muscle fibre Fibrous protein provide structural elements to the animal and human organism.

Globular proteins

Globular proteins are compact functional proteins. The overall shape of a globular protein is spherical, as the name indicates. Their tertiary and quaternary structure are complex. Globular proteins are water-soluble.

Globular protein are located at the cell membrane and act as enzymes or cells. The examples for globular proteins are hemoglobin and myoglobin and cytochrome.

Hemaglobin protein helps to transport oxygen and carbondioxide during blood circulation, but myoglobin protein helps to transport oxygen and carbondioxide in muscles. The cytochrome protein helps to transport electrons.

The conjugate protein makes with the conjunction of molecules and proteins, these are called as complex hybrid protein and essential for normal functions of human body. Ex:- Glycoprotein made with a conjuction of carbohydrate with protein, Nuclear protein made with the conjunction of amincacid with protein. lipo protein made with the conjunction of lipid molecules and protein.

Glycoproteins

Glycoproteins play a role as antibodies in immune recognition and as antigenic determinants in human cell membranes. The use of glycoproteins for the typing and matching of blood groups and grafts is examplary of the specificity of proteins in organisms.

Different test for identification of proteins

01. Biuerate test
When protein added to the biuerate solution the colour change to indigo colour/purple colour.
bluish violet

02. Millon test
When Million reagent added to the protein the white colour precipitate is Formed and turns to brick red when boiling.

03. Xanthoproteic test
IF there is Formation of yellow prercipitate the the precense of protein is confirmed.

04. Ninhydrin test
IF there is the precense of blue colouration then the presence of protein is confirmed.

Industrial application of protein

- Gluten helps to produce bread and other wheat flour applications.
- Albumin contain in eggs and helps to produce bakery products
- Cassane and whey protein present in milk and helps to produce milk related products like curd, yoghurt, cheese and icecream.
- Gelelatin which is used to produce jelly and toffee made with collagen protein. In addition to that several types of proteins used as enzymes in industrial applications.

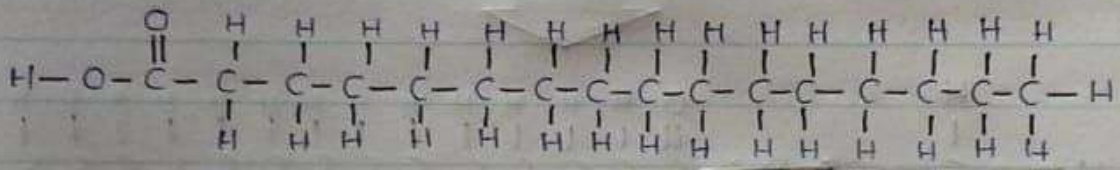
Lipids

The main constituent elements of lipids are carbon, hydrogen and oxgen. It is insoluble in water but soluble in non-polar organic solvents like chloroFoam and carbon tetrachloride. The building blocks of simple lipids are glyceral and Fatty acids. Fatty acids are carboxylic acids that may contain 16 to 18 carbon atoms. Some Fatty acids have only single bonds betwe Carbon atoms and named as saturated Fatty acids.

eg:- Lauric acid - $CH_3(CH_2)_{10}COOH$

Mystric acid - $CH_3(CH_2)_{12}COOH$;

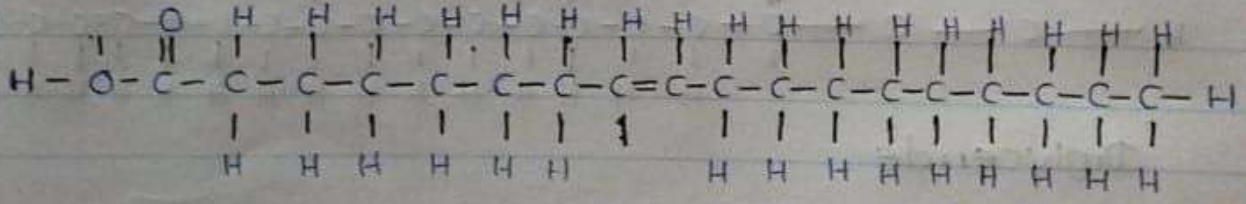
Palmetic acid - $CH_3(CH_2)_{14}COOH$



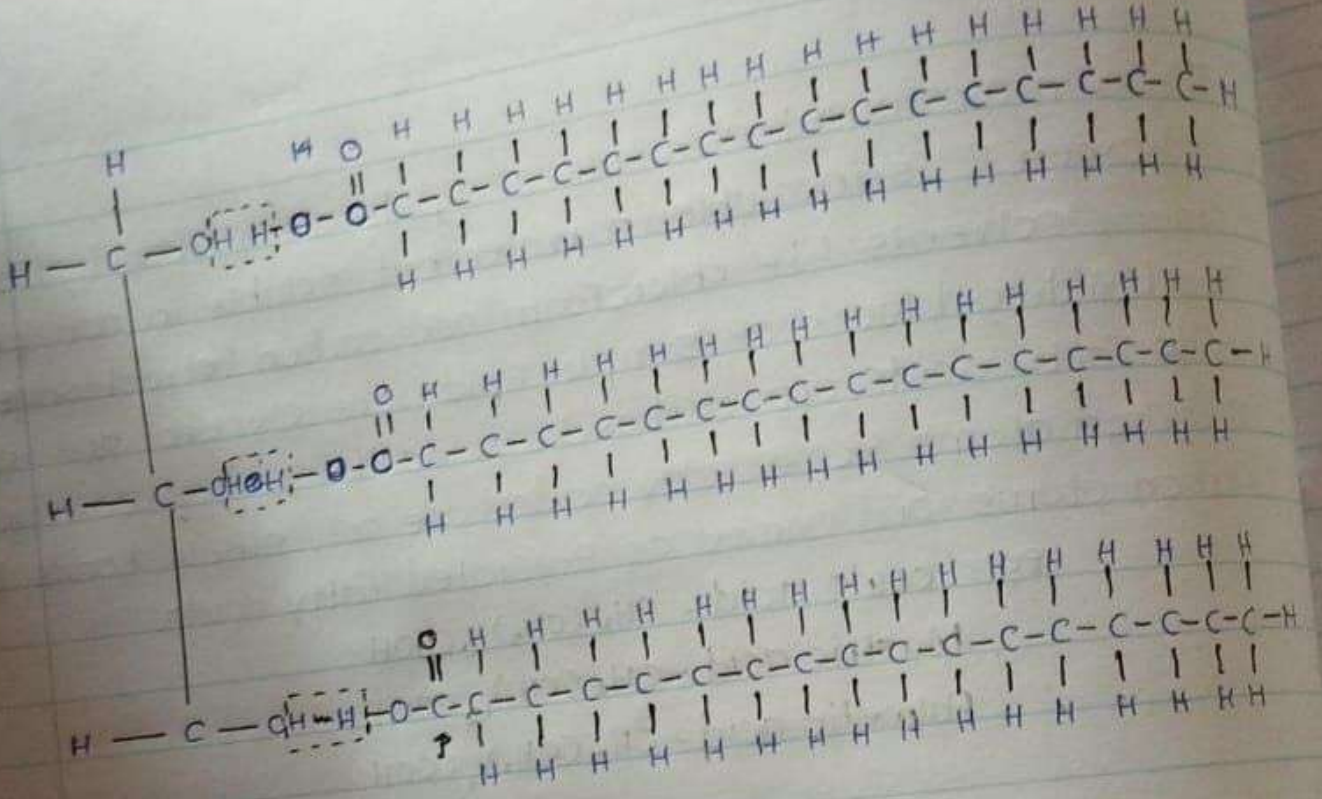
▲ Palmetic acid (saturated Fatty acids)

Some Fatty acids have double bonds in addition to the single bonds between carbon atoms, so they are called unsatturated Fatty acids.

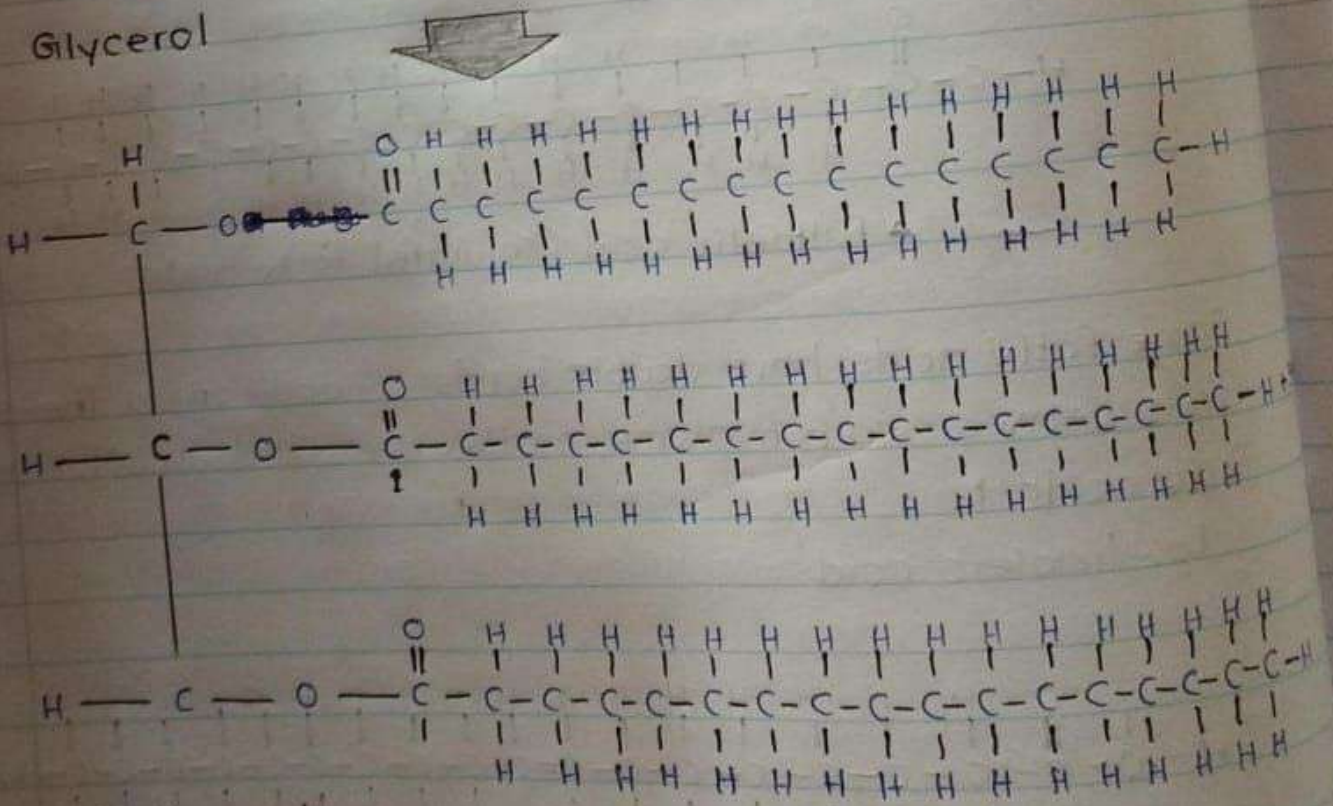
Eg:- linoleic acid



One glyceral molecule combined with 3 Fatty acid molecule to form lipid molecule. These are called as triglycal or triglyceride



Glyceral



Diglyceride

- The bonds formed between Glycerol and Fatty acid molecules are called ester bonds.

- Lipids store as energy in longterm in living organisms.

- Lipids are present as oil and fats in foods and in biological tissues.

- Lipid act as hormone and vitamin.
  Ex:- estrogen, hormone and vitamin D

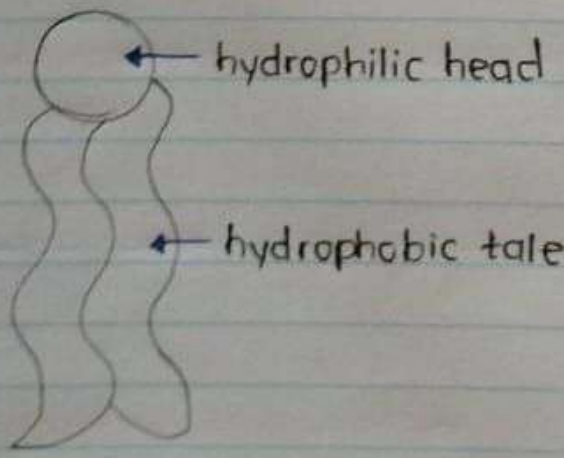
- Lipids are available as liquids at room temperature are called oil. Similary lipids available in solid forms in room temperatu are called Fats.

- Triglycerids which forms animal fats are available as solid form. Lipids

- Lipids stored in specialized tissues of animal body act as insulaters and protect against cold weather.

- A lipid called phospholipids forms with the phosphate group in triglycerid instead of one fatty acid.

- In a phospholipid molecule, the end with phosphate group named as hydrophilic head and opposite end named as hydrophobic tale end.



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