PROTOPLASM

- Fluid along with all the structures of cell bounded within the limits of cell membrane, is known as protoplasm. So protoplasm includes plasma membrane, cytoplasm and Nucleus. Protoplasm of a single cell is called **Protoplast** (wall less cell)
- Origin of the word protoplasm has taken from a greek word (Protos = first, Plasma = organisation).
- Protoplasm was first observed by **Corti, 1772.**
- **Felix Dujardin,** 1835 observed jelly like substance in animal cells (protozoa) and gave the name **'Sarcode'.**
- **J.E. Purkinje,** 1840 observed similar substance in plant cells and coined the term **'Protoplasm'.**
- **Hugo Van Mohl,** 1846 studied the nature of protoplasm present in the embryonic cell of plants and explained the importance of protoplasm in the cell division.
- **Max schultze,** 1861 established similarity between sarcode and protoplasm. Schultze proposed protoplasm theory (name given by **O. Hertwig).** Max shultze firstly told that protoplasm is physical basis of life.
- **J.S. Huxley,** 1868 wrote a book "Protoplasm is physical basis of life"
- **Rinke and Roderwald,** 1881 first of all performed the chemical analysis of protoplasm.

PHYSICAL NTURE OF PROTOPLASM

Several theories are proposed to explain physical nature of protoplasm.

(1) **Alveolar theory -** "Butschali" (1982). Protoplasm is a foamy emulsion consist of bubbles of high density fluid.

(2) **Granular theory -** "Altman (1893. Fine granules are homogenously distributed into the homogenous medium of Protoplasm". Granules were termed as "Bioplast of Cytoplst"

(3) **Fibrillar theory :** "Flemmig," (1894). Microscopic filaments (Micelles or mitomes) like strutures are dispaersed in a liquid matrix (Paramitome or Hyaloplasm).

(4) **Reticlular theory -** "Hanstein, Klein and Carnomy" (1898) Protoplasm" is a mesh work of microscopic filaments.

(5) **Colliadal theory -** "Fisher 1894, Hardey" 1899 and "Wilson" 1925.

This is most acceptable theory for protoplasm . According to this theory, the protoplasm is a **Polyphasis Colloidal System.**

PHYSICAL PROPERTIES OF PROTOPLASM

(1) Protoplasm is a translucent, odourless and polyphasic fluid.

(2) Protoplasm is a crystallo-colloid type of solution.

Protoplasm is a mixture of such chemical substances among which some form crystalloid i.e. true solution (Sugar, Salts, Acids, Bases etc.) and other which form colloidal solution (Proteins, lipids etc.)

(3) Size of colloidal particles (0.001 to 0.1 μm) is between true solution and suspension.

(4) Colloidal system composed of two stages. (i) Dispersion phase or continuous form or intermicellus and (ii) Dispersed phase or discontinuous phase or Micellus

On the basis of dispersion and dispersed phase there are four types of colloids -

(A) **Sol =** Dispersion phase is liquid and dispersed phase is solid. In sol stage, protoplasm is less viscous. Protoplasm is sol stage occurs in majority of living cells.

(B) **Gel =** Dispersion phase is solid and dispersed phase id liquid. Protoplasm is more viscouse e.g. Skin Cells.

(C) **Emulsion -** Both stage are liquid i.e. fluid colloidal particles are dispersed in a liquid matrix e.g. blood plasma composed of both sol and emulsion.

(D) **Aerosol -** solid particles remains suspended in gas e.g. smoke. Aerosol does not occur in living system.

(5) Protoplasm mainly composed of either sol or gel.

(6) Sol stage provides cylosis, Brownian movements and high reactivity protoplasm.

(7) Gelation of protoplasm provides elasticity, contractibility, rigidity and viscosity.

(8) Colloid particles have electric charge these remain in a continuous random motion, called Brownain movement.

(9) Environmental conditions like temperature, pressure and pH cause changes in the properties of protoplasm. This change brings endocellular movement o protoplasm called cyclosis.

(10) Brownian movement and cyclosis are more, significant in sol stage of protoplasm.

(11) Being a liquid mixture, the protoplasm has surface tension. Solutes (Proteins and lipids) having less surface tension, form a delimiting membrane t surface. This membrane is called **Interface membrane** (Plasma membrane).

Interface membrane has power of rapid regeneration.

(12) Being colloid, protoplasm exhibits **"Tyndal effect"** i.e.

Scattering of incident light rays. If colloidal particles are large, then white and if they are small then blue light is observed.

(13) Sol and gel stages of protoplasm are intercovertible s the protoplasm is a reversible colloidal system. Non living colloids are irreversible.

(14) Ageing-with age, charges of colloid particles diminished, Brownian movements stops so ultimately it becomes non reactive (death of protoplasm).

(15) Viscosity of protoplasm = 2-20 centipoises

(16) pH = 6-8

(17) Refractive index = 1.4

BIOLOGICAL PROPERTIES OF PROTOPLASM

Protoplasm is a living substance so it posses biological properties also.

(1) Protoplasm has motion because of cylosis, amoeboid and Brownian movement. These movements deped on age of cells, amount of water, genetic factors and chemical composition of protoplasm.

(2) Protoplasm exhibits irritability when provided stimuli.

Sensitivity of protoplasm to external stimuli is called irritability. Transmission of stimuli from one place to another is called conductivity.

Besides irritability, conductivity also occurs in protoplasm of many cells e.g. Nerve cells, muscle cells etc.

(3) Different chemical reactions take place in protoplasm. Constructive reactions are called **Anabolic process** like synthesis of different types of biomolecules. Destructive reaction like oxidation of food called catabolic process. **Anabolic** and **Catabolic Process** collectively called metabolism.

(4) Protoplasm has the capacity to take external material and resynthesize them in a new form **(assimilation).**

(5) Respiration and excretion.

CHEMICAL NATURE OF PROTOPLASM

Approximately 34 elements participate in the composition of protoplasm but only 13 elements are main or universal element in protoplasm i.e. C, H, O, N, Cl, Ca, P, Na, K, S, Mg, I, Fe.

Carbon, Hydrogen Oxygen and Nitrogen form the 96% part of protoplasm

S.No.	Elements	% Amount
1.	Oxygen	62
2.	Carbon	20
3.	Hydrogen	10
4.	Nitrogen	3
5.	Calcium	2.5
6.	Phosphorus	1.14
7.	Chlorine	0.16
8.	Sulphur	0.14
9.	Potassium	0.11
10.	Sodium	0.10
11.	Magnesium	0.07
12.	Iodine	0.014
13.	Iron	0.010

Rest of the elements of protoplasm occur in very small quantity (0.756%). These are, therefore called **Trace elements.** These includes Copper, Cobalt, Manganese, Zinc, Boron, Vanadium, Chromium, Tin, Silicon. Fluorine, Molybdenum, Nickel, Selenium Argenic.

Element	% weight of	
	Earth's crust	Human body
Hydrogen	0.14	0.5
Carbon	0.03	18.5
Oxygen	46.6	65.0
Nitrogen	Very little	3.3
Sulphur	0.03	0.3
Sodium	2.8	0.2
Calcium	3.6	1.2
Magnesium	2.1	0.1
Silicon	27.7	negligible

COMPOUNDS OF PROTOPLASM

Although some elements occur in protoplasm as free ions but mostly two or more elements are variously combined to form different kinds of compounds.

Inorganic compounds :

1. Water = 70-90%
2. Salts, acids, bases, gases = 1-3%

Organic Compounds :

1. Proteins = 7-14%
2. Lipids = 1-3%
3. Carbohydrates = 1-2%
4. Nucleic acids, enzymes and other = 1.3%

WATER

(1) It is a best solvent in nature, it forms the fluid matrix of protoplasm. All other constituents of protoplasm are its solutes.

(2) Being an ideal dispersion medium, it causes Brownian movement of colloid particles, resulting into their collision and mutual bombardment. This facilitates reactivity between the various compounds necessary for maintaining protoplasm in live state.

(3) It causes streaming or cyclosis in protoplasm facilitating its chemical exchange with the environment, and transportation of solutes from one part to the others

(4) It itself participates in certain types of chemical reactions, particularly in the hydrolytic breakdown of complex compounds.

(5) Having a high specific heat, it minimises temperature variation and thus protects protoplasm against ill effects of sudden rise or fall of temperature in the environment.

(6) Of total water, 95% water is free water and 5% water occurs as bound water.

(7) Water - Human body - 65-70% of total body weight.

(8) Human body = 40 litre :

55% (22 litre) - intracellular fluid

45% (18 litre) - extracellular fluid

(9) Animal kingdom - Hardest material : Enamel

(10) Plant kingdom - Hardest material : Sporopollenin

SALTS :

(1) Salts in protoplasm occur in ionised form. These ions re responsible for electric conductivity, rendering protoplasm irritable and response to environmental changes.

(2) These provides linkage or chemical bonds in many chemical reactions. Such type of linkage called “Salt link age”.

(3) Some metallic and other ions such as Mg, Fe, Zn, Mo, Mn etc. act as cofactors in enzymatic activities.

(4) These regulate the osmotic pressure and chemical exchange of protoplasm from its environment.

(5) Some ions also act as co-factor :

ZN^{+2} - carbonic anhydrase Fe^{+2} - Aconitase, catalase

Cu^{+2} - Tyrosinase [CBSE 2004] Mo - Nitrogens

Mg^{+2} - Co-factor of many respiratory enzymes like Kinase, Enolase, Dehydrogenase

Ni - Urease enzyme

(6) Some other factions of ions :

Na^{+} , K^{+} ions - Nerve induction

Ca^{+2},Mg^{+2} ions - Muscle contraction, Reduce more excitability of nerves and muscle.

Ca^{+2} ion - Blood clotting, Bone formation

- Most abundant mineral element in animal body

Na^{+}, K^{+} ions - Main component of ringer solution.

K^{+} - Helpful in seismonastic movement, stomatal opening and closing.

ACIDS AND BASES :

These prevent pH variations by forming a buffer system in protoplasm, for e.g. carbonic acid - Bicarbonate buffer system.

ORGANIC COMPOUNDS OF PROTOPLASM :

(1) Carbohydrates -

→ Main source of energy.

→ First respiratory substrate - carbohydrate

→ $R.Q. = \left[R.Q. = \frac{CO_2}{O_2} \right]$

→ Compounds of carbon, Hydrogen and Oxygen with ratio of H and O is 2:1, so they are also called as **hydrates of carbon.**

→ Generalised formular of carbohdrates is C_x (H_2O) y.

→ Simple carbohydrates which are soluble in water and sweet in taste are called **"Sugar'.**

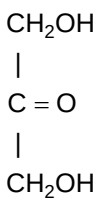
→ Carbohydrates are main source of energy in body. In a normal man 55-65% of energy in available to him in the form of carbohydrates present in his diet.

CLASSIFICATION OF CARBOHYDRATES :

On the basis of numbers of saccharides in hydrolysis, Carbohydrates are classified as Monosaccharides, oligo saccharides and Polysaccharides.

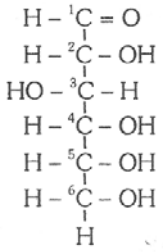
A. Monosaccharides :

1. They are simples sugars which can not be further hydrolysed.
2. In their generalised formula x in always equal to y i.e. number of Carbon and Oxygen atoms same.
3. First step of oxidation - Phosporylation
4. All monosaccharides occur in d and 1 form, except the DHAP.

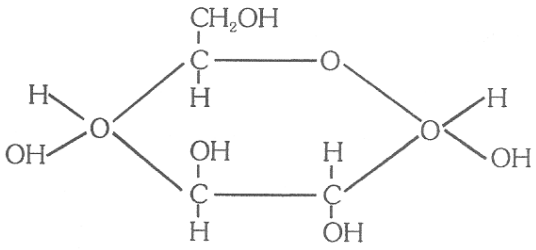


Dihydroxy acetone

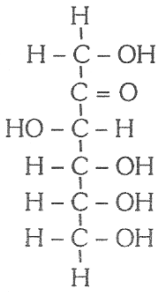
5. The structure of saccharides in either ring or straight chain.
6. A six membered ring is known as **pyranose** and five membered ring is **furanose.**
   Phyranose and furanose names were given by **"Haworth".**
7. **Anomer -** In aqueous solution, Glucose occurs in cyclic structure. In anomers, position of - H and -OH groups are changed on C_1 carbon atom.



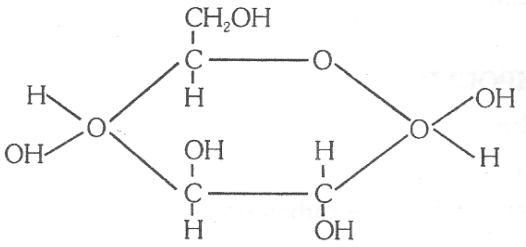
Glucose (Straight chain)



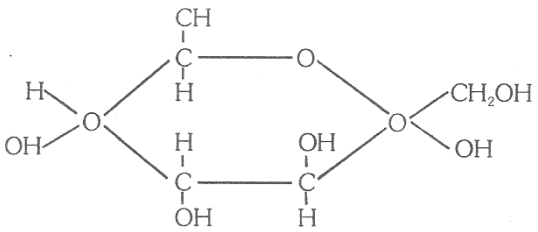
α-Glucose (Pyranose structure)



Fructose (Straight chain)



β-Glucose



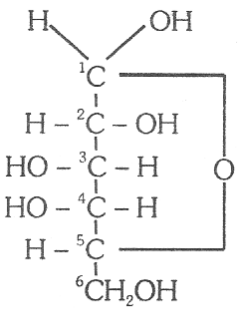
Fructose (Pyranose structure)

Epimer : Isomer formed as a result of interchange of the -OH and -H groups on carbon atom 2,3 ad 4 of glucose, are known as epimer.

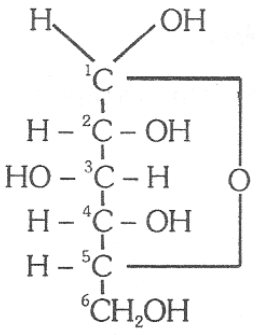
Epimer of Glucose :

Mannose (Difference on C_2 carbon)

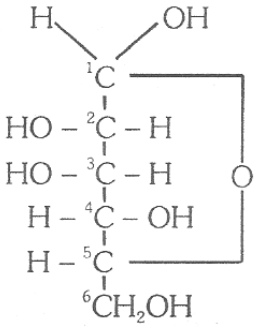
Galactose (Difference on C_4 carbon)



Galactose



Glucose



Mannose

On the basis of number of carbon atoms monosaccharides are classified in following groups.

(i) **Trioses -** $C_3H_6O_3$ e.g. Glyeraldehyde and Dihydroxy acetone. PGAL and DDAP are precursors of all other carbohydrates.

(ii) **Tetroses -** $C_4H_8O_4$ e.g. Erythrose, Erythrulose

(iii) **Pentasoses –** $C_5H_{10}O_5$ e.g. Ribose, Ribulose, Xylulose, Arabinos, Deoxyribose ($C_5H_{10}O_4$)

(iv) **Hexoses –** $C_6H_{12}O_6$ e.g. Glucose, Fructose, Galactose, Mannose, Rhamnose ($C_6H_{12}O_5$)

(v) **Heptose** – $C_7H_{14}O_7$ e.g. Sedoheptulose

- Chemically all carbohydrates are polyphydroxy aldehyde or kenotones.
- Monosaccharised with free aldehyde group are turned as ***Aldoses*** (PGAL, Erythrose, Ribose, Arabinose, Dexxyribose, Glucose, Galactose, Mannose).
- While monosaccharides with free ketone group are called ***ketoses*** (DHAP, Erythruolose, Ribulose, Xylulose, Fructose, Sedoheptulose).

  All monosaccharides are **"reducing sugars"** as their free dldehyde or ketone groups are capable of reducing Cu^{++} to Cu^{+}.

  This property is the basis of Benedict's test or fehlig's test used to detect the presence of glucose in urine
- Beside RNA ribose sugar is an important component of ATP, NAD, NADP and FAD
- In deoxyribose the second carbon is devoid of oxygen atom.
- Arabinose occurs in **"Gum arabic".**
- Glucose is dextrorotory so it is called **"dextrose"**
- Glucose is found in grapes in abundant quantity so it is also known as **"grape sugar"**
- Glucose in the main repiratory substrate in the body. Other types of hexose are converted into glucose by liver.
- Fructose is Laevoratory so it is called **"Laevulose".**
- Fructose is found in honey and sweet fruits so it is called as **"Fruit Sugar".**
- Fructose is the sweetest sugar.
- Galactose is not found in free stage.
- In mammalian body, galactose occurs as a part of milk sugar lactose.
- Galactose is also found as a component of glycolipids (for e.g. **cerebrosides**) and pectin Hemi cellulose etc.
- Mannose not found in free state.
- Mannose occurs in albumin of egg and in wood as component of hemicellulose.
- Glucose in also known as **blood sugar.**
- **Aspartame** is not commonly used artificial sweetener.
- Most sweetest chemical substance is **Thaumatine**, Obtained from a bacteria ***Thaumatoccus donielli.***
- Galactose is known as **brain - sugar**

DERIVATIVES OF MONOSACCHARIDES

(1) **Amino sugers -** Formed by the displacement of hydroxyl group from second carbon atom by amino group e.g. Glucosamine, Galactosamine.

(2) **Sugar alsohol -** Aldehyde group (-CHO) of the sugar is changed to primary alcohol (-CH_2OH). Sorbitol and Mannitol are respectively formed from glucose and mannose.

(3) **Sugar acids** - They are formed by the oxidation of terminal -CHO or -CH_2OH group of sugar to produce carboxyl group -COOH e.g. Glucoronic acid, Galacturonic acid.

(4) **Glycoside -** They are compound formed by condenstioin reaction between a sugar (eg. glucose) and hydroxyl group of another substance which may be a sugar, a sterole, methanol in presence of dry HCI. They are acetel which can be hydrolysed by strong reagents like HCN, NH_2OH, $C_6H_5NHNH_2$. They cannot be hydrolysed in acidic condition. Streptomycin is a glycoside.

B. Oligo - Saccharides

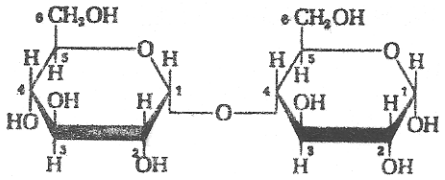
Oligo - Saccharides are those carbohydrates which on hydrolysis yield 2 to 10 monosaccharide units (monomers). In oligosaccharides, monosccharides are linked together by glyosidic bonds. Aldehyde or ketone group of one monosaccharide reacts with alcoholic group of another monosaccharide to form glycosidic bond. One molecule of H_2O elimintes during glycosidic bond formation (dehydraton synthesis). Direction of glycol sidic bond is 1' - 4".

When another monosaccharide unit is fructose then the direction of linkage is 1'-2". (Non reducing sugars). For e.g. Sucrose

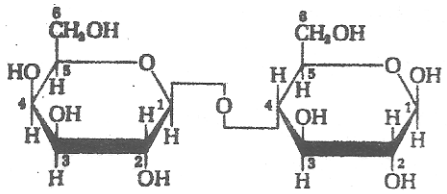
Types or Oligosaccharides :

(i) **Disaccharides -** composed of two monosaccharide units i.g. Maltose, Surcrose, Lactose, Trehalose.

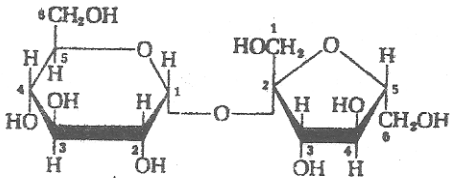
- All disaccharides are water soluble and sweet in taste, so they are known as **sugar.**



Maltose



Lactose



Sucrose

- Maltose is commonly called **malt sugar.** It is intermediate compound in starch digestion. Maltose has 1'-4" glycosidic linkage between α-D glucose and α-D glucose
- Lactose is milk sugar with β-1'-4" glycosidic linkage between glucose and galactose
- Lactose is least sweets sugar.
- Maximum % of lactose = Human milk = 7%
- In plant transport of sugar is present in form of sucrose.
- Sucrose is also known as **invert sugar.**
- Sucrose is called Cane Sugar or Table Sugar or Commercial Sugar. Sucrose composed of α-D Glucose and fructose.
- Trehalose is present in haemolymph of insects. It has glycosidic linkage between two anomeric carbon (α glucose and β-Glucose).

(ii) **Trisaccharides**- ***e.g.*** Raffinose (Galactose + Glucose + Fructose)

(ii) **Tetrasccharides** - ***e.g.*** Stachyose (Gal. + Gal. + Glu. + Fructose)

(iv) **Pentasaccharides** - ***e.g.*** Barbascose (Gal. + Gal. + Glu. + Glu+ Fructose)

Raffinose and stachyose occur in phloem and may be emplyed for translocation of carbohydrates.

C. Polysaccarides :

- Poly saccharides composed of large number of monosaccharide units.
- Suffix '---an' is added in their names and they are known as **glycans.**
- Pentose polyaccharides are called **pentosans** for e.g.
  araban (from L - rabinose), xylan (from D-xylose), all these found in cell wall.
- Hexose polysacchrides are called **"hexans".** for e.g. mannam (from mannose) cellulseo, starch etc.
- Polysaccharides are insoluble in water and do not taste sweet.
- All polysaccharide are nor - reducing
- According to function, they are classified as nutritive and structural.
  On structural basis polysaccharides are of two types.

(i) **Homopolysaccharides :**

Commposed of same monomers. Biologically important homopolysaccharides are as follows :

(a) **Cellulose :** Linear polymer of β-D-glucose units (6000 to 10,000). It ha s β 1'-4" linkage. Partial digestion yields a collebiose units (Desaccharide).

Cellulose in main component of plant cell wall. In wood, cellules is 50% and in cotton, it is 90%

- Most abundant organic molecule on earth.
- In urochortes animals their occur cellulose like material and it is called **"Tunicine"** it is also called **Animal cellulose.**
- It is also used to form **Rayon fibre** (Artificial silk).

(b) **Starch -** It is main stored food in plants. Starch is polymer of α-D-glucose units. Starch consists of two types of chain.

(i) **Amylose :** 250-300 glucose units are arranged in an unbranched chan by α 1'-4" linkage.

(ii) **Amylopectin :** A branched chain molecule. Approximately 30 glucose units are linked by α 1'-4" and α-1'-6" linkage.

- Amyloe gives blue colour with iodine.
- Amylopectin gives red colour with iodine.
- Starch present in potato contains 20% amylose and 805 amylopectin.

(c) **Glycogen :** Storage form of carbohydrate in animals, storage region of glycogen is live and muscles. Storage of glycogen liver > muscle. Glycogen is also called as **animal starch.** Glycogen is highly branched polymer of α-D-glucose.

- Glycogen is formed by the 1' 4" bond linkage at long chain and 1',6" bond linkage at branching point.
- Glycogen gives red colour with iodine.
- Glycogen is store food of fungi.

(d) **Chitin :** Linear polymer of N-acetyl - D-glucosamine with β-1' - 4" - linkage.

- N-acetly D-glucosamine is an amino acyl (-NH-CO-CH_3) derivative of β-D-glucose.
- Chitin is a important component of exoskeleton of Arthropods and cell walls of fungi.
- Second most abundant organic molecule on earth.
- It is also called **Fungal cellulose.**

(e) **Inulin :** Linear polymer of fructose units linked with β-1' 2" bonds. Insulin is found in roots of **Dahalia and Artichoke.** It is water soluble polysaccharide and it is used to know the glomerular filtration rate.

- It is smallest storage polysaccharide.

(f) **Dextrin -** Dextrin is an intermediate substance in the digestion of glycogen of glycogen and starch. By hydrolysis of dextrin, glucose and maltose are formed. It also occurs as stored food in yeast and bacteria.

(II) **Heteropolysaccharide :**

Composed of different monosaccharide units.

(a) **Hyaluronic acid -** Found in vitreous humour, umbilical cord, joints and connective tissue in the form of lubricating agent. It also occurs in animal cell coat as binding material **(Animal cement).**

- Hyaluronic acid is made up of D-glucuronic acid and N-acetyl - D-glucosamine arranged in alternate order. These different monosaccharides have β-1',3" bonds and such disaccharides have β 1'-4'. bonds.

(b) **Chondriotin -** D-glucuronic acid + N-acetyl galactosamin.

- Chondriotin ocucurs in connective tissue.
- Sulphate ester of chondriotin is main structural component of cartilage, tendons and bones.

(c) **Heparin -** It is anticoagulant of blood. Heparin is made up of D-glucuronic acid and N-sulphate glucosmine arranged in alternate order

(d) **Pectins -** Methylated galacturonic acid + gaglactose + arabinose.

- Pecting found in cell wall where is bind cellulose fibrils in bundles.
- Stals of pectin i.e. Ca and Mg- pectates from middle lamella in plants.
- It is also called **Plant cement.**

(e) **Hemicellulose -** Mannose + Galactose+ Arabinose + Xylullose.

- Store material - Phytalophus (**Ivory palm)**. Hemicellulose which is obtained from this plant is white. hard and shiny and it is used to form billiard ball and artificial ivory.

MUCOPOLYSACCHARIDES

Slimy polysaccarides with capacity to bind proteins and water are called mucopolysaccarides. In plants, mulcilage is a common mucopolysaccaride formed of galactose and monnose units.

Hyaluronic acid, chondirotin, heparin are other examples.

Especial Points :

1. **Peptidoglycan -** Present in cell wall of bacteria.
   - Composed of N -acetly Glucosamine + N - acetyl muramic acid + peptide chain of 4-5 amino acids.
2. **Agar - Agar -** It is a mucopolysaccaride which is obtaiend form some red algae -Gracilaria, Gelidiu, Chondrus. It is composed of D-galactose and L-galactose unit and after every 10th unit a sulphate group is present it is used for preparing culture medium (1, 3 linkage).

LIPIDS

- Fat and its derivatives and combinaly known as lipid.
- Lipd term coined by Bloor.
- Compounds of C, H, O but the ratio of Hydrogen and Oxygen is not 2:1. The amount of oxygen is considerably very less.
- Lipipds are insoluble in water and soluble in organic solbents like acetones, chloroform, benezene, hot alcohol, ether etc.
- Lipids occur in protoplasm as minute globules.
- Lipids do not form polymer.

- Lipids provide more than double energy as compare to carbohydrate.
- In animals, fat present in subcutaneous layer and working as food reservior and stock absorber.
- Lipid required less space for storage as compare to carbohyddrate because lipid molecule is hydrophobic and condense.
- Animls store maximum amount of food in the form of lipid.
- Lipid provides maximum amount of metabolid water as compare to carbohydrate and protein on oxidation.
- Lipds are not strictly macromolecules.

(A) Simple Lipid or Neutral Fats :

- These are esters of long chain fatty acids and alcohol. In majority of simple lipids, the alcohol is a trihydroxy sugar alcohol i.e. glycerol.
- Three moledules of fatter acid linked with one molecule of glycoerol. The linkage is called “ester bond”. such type of lipids called Triglycerides. Three molecules of water are released during formation of triglycerides (dehydration synthesis)
- Similar or different fatty acid participate in the composition of a fat molecule. Simple lipids contain two types of ftty acids.

(i) **Saturated fatty acids :** are those in which all the carbon atoms of hydro-cabron chain are saturated with hydrogen atoms

e.g. Palmitic acid - $CH_3(CH_2)_{14}$ - COOH

Stearic acid - $CH_3(CH_2)_{16}$ - COOH

(ii) **Unsaturated fatty acids :** acids are those in which some carbon atom are not fully occupied by hydrogen atoms

e.g. Oleic acid-$CH_3(CH_2)_7$ CH = CH$(CH_2)_7$ COOH

Linoleic acid - $CH_3(CH_2)_4$- (CH = CH-$CH_2)_6$ - COOH

Liolenic acid - CH_3 - CH_2 - (CH = CH-$CH_2)_3$ - $(CH_2)_6$ - COOH

Polyunsaturated = fatty acids with more than one double bonds in their structure e.g. Linoleic acid, Linolenic acid, Arachidonic acid, Prostagladins (derived form arachidonic acid)

- Unasturated fatty acid also called as essential fatty acids because no animal is able to synthesize them.
- Simple lipids with saturated fatty acid remain solid at normal room temperature e.g. fats
- Simple lipids with unsatured fatty acids remain liquid at room temperature e.g. oils.
- Saturted fatty acids are less reactive so they tend to store in body and cause obesity.
- Unsaturated fatty acids are more reactive so they tend o metabolise in body and provide energy.
- Oils with poly unsaturated are recommended by physicians for persons who suffer from high blood cholesterol or cardio-vascular diseases. This is because increasing the proportion of poly unsaturated fatty acids to saturated fatty acids, without raising the fats in the diet tend to lower the cholesterol level in blood.

Waxes - Are monoglycerides with only one molecule of fatty acid attached to a long chain monohydroxy alcohol. Waxes are more resistant to hydrolysis s compared to triglycerides. Waxes have an important role in pretetion. They from water insoluble coating on hair and skin in animals and stem, leaves and fruits of plants.

e.g.

Bees Wax (Hexacosyl palmitate)

Carnuaba (Myricyl cerotate) which occurs on leaves, stem and fruits.

Spermaceti In skull of whale and Dolphin.

Cerumen or ear was - occurs in external auditory meatus

Lanoline or **cholesterol este -** occurs in blood, sebum and gonadial ducts as lubricating agent.

It is also obtained from wool of sheep.

(B) Conjugated or Compound Lipids :

(1) **Phospholipids or phosphatide or phopholipins :**

2 Molecules of fatty acdi + Glycerol + H_3PO_4 + Nitrogenous compound. Phospholipids are most abundant type of lipids in protoplasm.

Phospholipids have both hydrophilic polar end (H_3PO_4 and nitrogenous compound) and hydrophobic non polar end (farry acids). Such molecules are called amphipathic. Due to this property, phospholipids form biomolecular layer in cell membrane.

Some biologically important phospholipids are as following :

(a) **Lecithin or Phosphatidyl choline**

- Nitrogenous compound in lecithin is **choline**
- Lecithin occurs in egg yolk, oil seeds and blood.
- In blood lecithin functions as carrier molecule. It helps in transportation of other lipid.

(b) **Cephalin -** Similar to lecithin but the nitrogenous compound is **ethanolamine,** cephalin occurs in nervous tissue, egg yolk and blood platelets.

(c) **Sphingolipids** or **sphingomylins** similar to lecithin but in place of glycerol it contains an amino alchohol **sphingosine.**

Sphingollipids occur in **myelin - sheath** of nerves, other examples of phospholipid are phosphatidly serine, phosphtidyl inositol, plasmologens.

(2) **Glycolipd :** 2 fatty acid + sphingosine + galactose

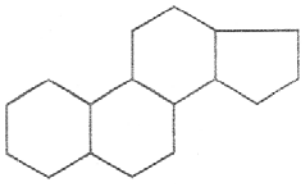
eg. Cerebroiside which occurs in white matter of brain –

Gangliosides- These occur in nerve ganglia and spleen. These also contain **N-acetyl neurominic acid** and glucose beside other compounds.

(3) **Derived Lipids :** Lipid derived from simple or conjugated lipid. Derived lipids re complex in structure. They are insoluble in water and soluble in organic solvents.

(1) **Steroids :** Steroids exhibit tetracyclic structure called "Cyclo pentano perhydrophenanthrene nucleus "

On the basis of functional group, steroids are of two types –



(a) **Sterols :** Alcoholic steroids e.g. **cholesterol -** Cholesterol abundantly occurs in brain, nervous tissue, Adrenal gland and skin. Cholesterol is parent steriod. Several other biologically important steroids re derived from cholesterol. 7 - dehydro cholesterol which occurs in skin in a provitamin. On exposure to ultraviolet radiation, it transforms in cholecalciferol i.e. vitamin D

- Cholesterol is also called **"most decorated micromolecle in biology".**

Ergosterol : It occurs in oil seed, fungi like ergot and yeast. Ergosterol is precursor of another form of Vitamin D-Ergocalciferol.

Coprosterol : Occurs in faucal matter. It forms by decomposition of cholesterol by colon bacteria.