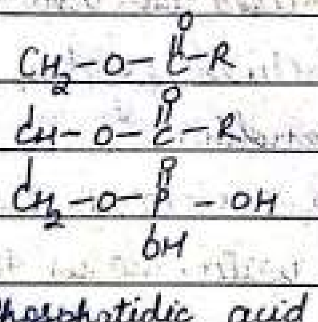
Complex Lipids or Conjugated lipids

Complex lipids or conjugated lipids are esters of fatty acids and alcohol but also have a phosphate carbohydrate or protein group. They are of following types

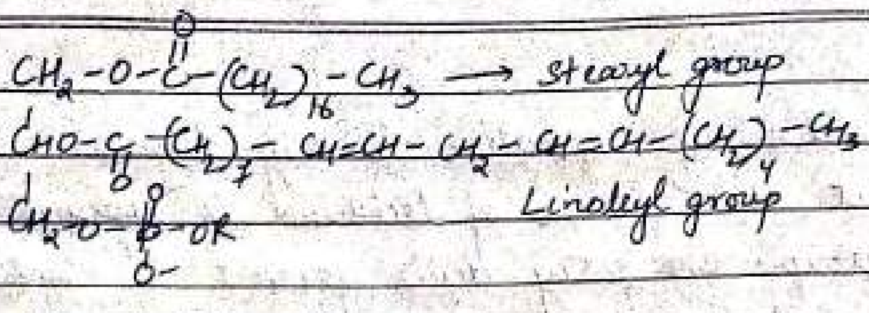
① Phosphoacylglycerols (Phospholipids)

If one of the alcoholic groups of glycerol is esterified by a phosphoric acid molecule and two fatty acids are esterified to the glycerol molecule, the resulting compound is called a phosphatidic acid.



Phosphatidic acid
(diacyl glycerol)

One molecule of phosphoric acid can form ester bonds both to glycerol and some other alcohol creating a phosphatidyl ester. Phosphatidyl esters are classed as phosphoacylglycerols or phospholipids. Fatty acids present may be widely different.



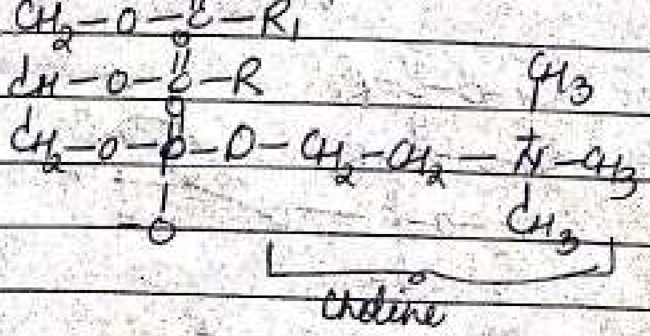
Phosphatidly ester

Phospholipids are most important lipids. They are important components of biological membranes and are essential for their proper functioning. They regulate cell permeability, control transport and metabolism of synthesized dietary fat and participate in blood coagulation.

Phospholipids include the following types depending upon the nature of the second alcohol group esterified to phosphoric acid.

① Lecithins :-

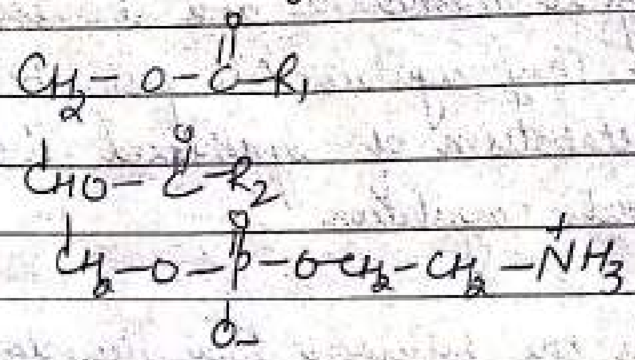
Lecithins are monoamino-monophospholipids. An example is that of phosphatidyl choline. They usually occur along with cholesterol in the nervous tissue and in egg yolk. The fatty acids most commonly found in Lecithins are palmetic acid, stearic acid, oleic acid, linoleic and linolenic acid. But only two of these are present at a time in one molecule of Lecithin. Lecithins play an important role in permeability, osmotic tension and surface conditions of cells.



Phosphatidly Choline, a Lecithin

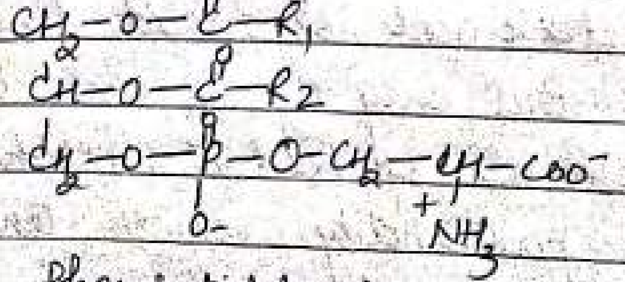
Cephaline:-

The composition of cephaline is very similar to Lecithens but the Choline of lecithin is replaced by aminoethanol group. The fatty acids present in Cephaline are also different. Cephaline form components of certain lipoproteins and form an important factor behind blood Coagulation.

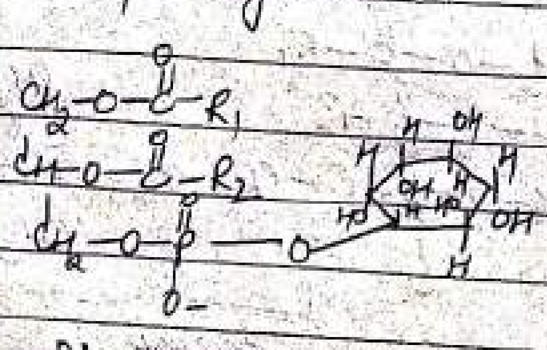


Phosphatidyl ethanolamine

Other important phospholipids are phosphatidylserine and phosphatidyl inositol. Phosphatidylinositol and phosphatidic acid are either precursors of or are themselves, membrane derived second messengers.



Phosphatidylserine



Phosphatidylinositol

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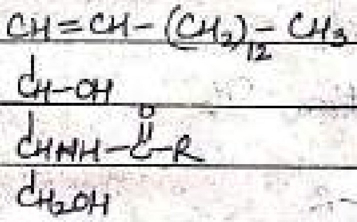
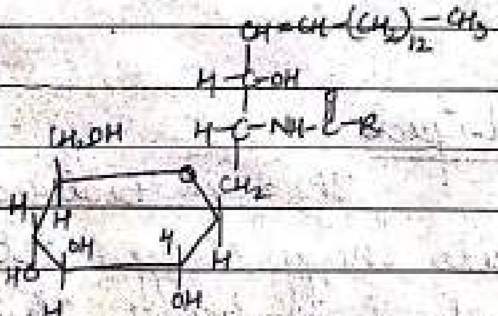
Glycolipids:-

If a Carbohydrate is bound to an alcohol group of a lipid by a glycosidic linkage the resulting Compound is a glycolipid.
Ceramides are the parent Compounds for glycolipids and the glycosidic bond is formed between the primary alcohol group of the ceramide and a sugar residue. The resulting compound is called a cerebroside. In most cases, the sugar is glucose or galactose. For example, glucocerebroside contains glucose.



Ceramide



Glucocerebroside

Cerebroside are found in nerve and brain cells, primarily in Cell membranes.

Sphingolipids:-

Sphingolipids do not contain glycerol, but they do contain the long chain amino alcohol Sphingosine. Sphingolipids are found in both plants and animals. they are particularly abundant in nervous System. The simplest Compounds of this Class are the Ceramides which consists of one fatty acid linked to the amino group of Sphingosine by an amide bond

$CH=CH-(CH_2)_{14}-CH_3$
$|$
$CH-OH$
$|$
$CHNH_2$
$|$
CH_2OH

Sphingosine

In sphingomyeline the primary alcohol group of sphingosine is esterified to phosphoric acid, which in turn, is esterified to another amino alcohol, choline, Sphingomyeline occur in cell membranes in the nervous system.

$CH=CH-(CH_2)_{12}-CH_3$
$|$
$CHOH$
$|$
$CHNH-\overset{O}{\overset{\|}{C}}-R$
$|$
$CH_2-O-\overset{O}{\overset{\|}{P}}-O-CH_2-CH_2-\overset{+}{N}(CH_3)_3$
$|$
O^-

Biological Functions of Lipids

The main biological functions of lipids include energy storage, acting as structural component of cell membranes. They play an important role in metabolism, nutrition and health.

1. Energy storage and Rich Source of Energy:-

Triglycerides are a major form of energy storage in animals because of their high calorific value (9.4 Kcal/g). Fats are stored in the adipose tissue and act as reserve food material. Animals use triglycerides for energy storage whereas plants, which do not require energy for movement, can afford to store food for energy in the form of starch.

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2. Structural Constituents:-
Phospholipids and glycolipids are the structural Components of all the membrane systems of the cell. The glycerophospholipids are the main structural components of biological membrane, such as the cellular plasma membrane and the intracellular membranes of organelles. In animal cells the plasma membrane physically separates the intracellular components from the extracellular enviroment.

3. Solvents and Fat Transport:-
Lipids act as Solvent for fat-Soluble vitamins A, D, E & K. The fat-Soluble vitamins, which are isoprene-based lipids are essential nutrients stored in the liver and fatty tissues. Phospholipids play an important role in the transport and metabolism of fatty acid.

4. Heat Insulators and Shock Absorbers:-
Fat deposited in the Subcutaneous tissues act as insulators conserving body heat. The fat deposited around visceral organs and underneath the skin act as Cushion and absorb mechanical Shocks. Lipids form a protective waxy covering on the parts of plants to check loss of water by evaporation.

5. Metabolism:-
Lipids play an important role in the metabolism. Triglycerides and phospholipids are broken down into free fatty acids in the form of acyl-CoA molecules are broken down to generate acetyl-CoA. The

acetyl-CoA is then ultimately converted into ATP, CO_2 and H_2O using citric acid cycle.

6. Nutretion and Health

Lipids play diverse and important role in nutrition and health. Many lipids are absolutely essential for life. Adrenocorticoids, sex hormones and vitamin D are synthesized from Cholesterol. However, there is also considerable awareness that abnormal levels of Cholesterol and trans fatty acids are risk factors for heart disease amongst others.

Humans have requirement for essential fatty acids such as linoleic acid and alpha linolenic acid in the diet because they cannot be synthesized from simple precursors in the diet.

Most vegetable oils are rich in linoleic acid (safflower, sunflower and corn oils). Alpha-linolenic acid is found in the green leaves of plants and in selected seeds, nuts and legumes. Most of the lipids found in food is in the form of triacylglycerol, cholesterol and phospholipids.

Phospolipids and Cell membranes

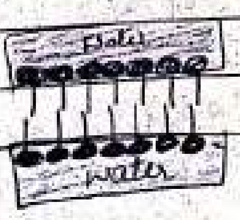
The fats are found, we said, in storage fat cells of plants and animals. Their function rests on their chemical properties: through oxidation, they are consumed to help provide energy for the life processes.

The phospholipids, on the other hand are found in the membranes of cells—all cells—and are basic structural elements of living organism. This vital function depends, in a fascinating way, on their physical properties.

Phosphoglycerides molecules are amphipathic, and in this respect differ from fats - but resembles Soaps & detergents. The lipophilic part is, again, the long fatty acid chains. The hydrophilic part is the dipolar ionic end: the substituted phosphate group with its positive and negative charge. In certain situations, however - at an aperture between two aqueous solutions for example - they tend to form bilayers: two rows of molecules are lined up, back to back, with their polar end projecting into water on the two surfaces of bilayer. Although the polar groups are needed to hold molecules in position, the bulk of bilayer is made up of fatty acid chains. Non-polar molecules can therefore dissolve in this mostly hydrocarbon wall and pass through it, but it is an effective barrier to polar molecules and ions.

It is in the form of bilayers that phosphoglycerides are believed to exist in cell membranes. They constitute walls that not only enclose the cell but also very selectively control the passage, in and out, of the various substances - nutrients, waste products, hormones etc - even from a solution of low concentration to high concentration.

Now many of these substances that enter and leave the cells are highly polar molecules like carbohydrate and amino acids, or ions like sodium and potassium. How can these molecules pass through cell membranes when they cannot pass through simple bilayers? And how can permeability be so highly selective



A phospholipid bilayer. The lipophilic fatty acid chains are held together by van der Waals forces. The hydrophilic ends dissolve in water.

The answers to both questions seems to involve the proteins that are also found in cell membranes: embedded in the bilayer and even extending clear through it. Protiens are very long-chain amides. Protiens chains can be looped and coiled in a variety of ways; the conformation that is favoured for a particular protein molecule depends on the exact sequence of aminoacids along its chain!

It has been suggested that transport through membranes happens in the following way. A protien molecule, coiled up to turn its lipophilic parts outwards, is dissolved in the bilayer, forming a part of the cell wall. A molecule approaches a potassium ion say. If the particular protien is the one designed to handle potassium ion, it recieves the ion into its polar interior. Hidden in this lipophilic wrapping, the ion is smuggled through bilayer and released on the other side.

Now, if the transport protein is to do its job, it must be free to move with in the membrane. The molecules of bilayer, while necessarily aligned, must not be locked into a rigid crystalline lattice - as they would be if all the fatty acid chains were saturated. Acutally, some of the chains in the membrane phospholipids are unsaturated and these, with their cis stereochemistry and the accompanying bend, disrupt the alignment enough to make enough the membrane semiliquid at physiological temperature.