Lipids

They are heterogeneous class of naturally occurring organic compounds. Their elementary composition is C, O and H in some ratio. They may contain P, N.

They characterized by being soluble in organic solvents including diethyl ether, chloroform, methylene chloride, and acetone but not in water (hydrophobic).

Sources:

Plants: commonly in seeds (cotton seed oil, line seed oil, sunflower oil).

Animal: tissue fat & depot fat (subcutaneous fat, around kidney, abdominal fat).

Biological Importance of Lipids:

1-They are more palatable and storable to unlimited amount compared to carbohydrates.

2-They have a high-energy value (25% of body needs) and they provide more energy per gram than carbohydrates and proteins but carbohydrates are the preferable source of energy.

3- Supply the essential fatty acids that cannot be synthesized by the body.

4- Supply the body with fat-soluble vitamins (A, D, E and K).

5- They are important constituents of the nervous system. Electronic insulators allow rapid propagation of nerve waves along myelinated nerves.

6- Tissue fat is an essential constituent of cell membrane & organelles.

7- Heat insulator (subcutaneous fat).

8- Protection of internal organs (kidney)

9- Metabolic regulators (hormones, bile acids).

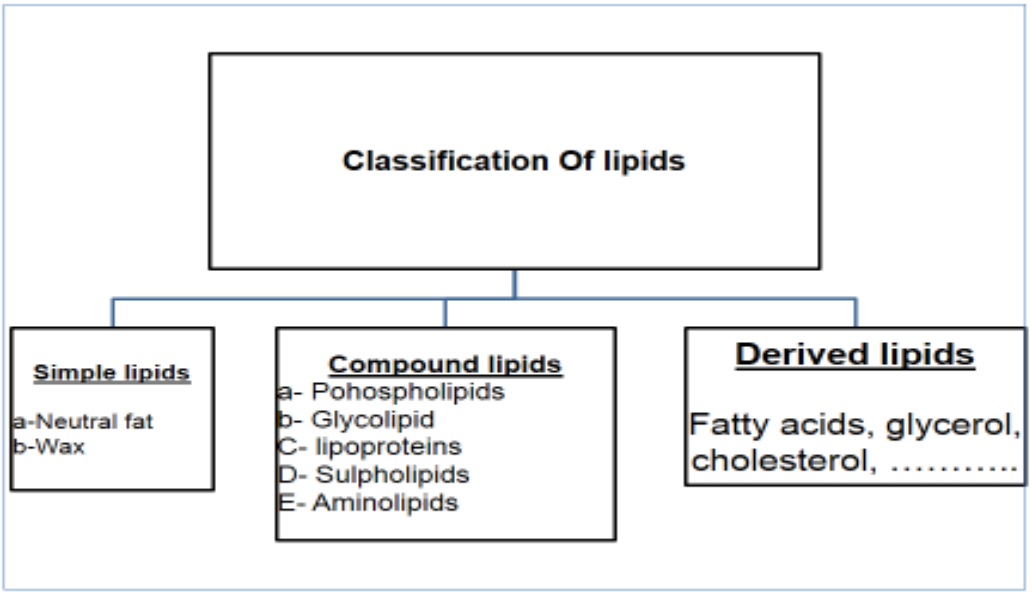
Classification of Lipids

A) ***Based on the Biological functions, Lipids can be classified into:***

- **Storage Lipids—**The principle stored form of energy (lipids in adipose tissue).
- **Structural Lipids–** The major structural elements of Biological Membranes.

***B) Based on their chemical composition:*.**

1. Simple lipids (Fats & Waxes)
2. Compound or conjugated lipids
3. Derived Lipids



Fatty acids

Fatty acids are aliphatic mono-carboxylic acids that are mostly obtained from the hydrolysis of natural fats and oils. The general formula is R-(CH2) n-COOH and mostly have straight chain (a few exceptions have branched and heterocyclic chains). "n" is mostly an even number of carbon atoms (2-34) with a few exceptions that have an odd number.

Nomenclature of fatty acids

A)-Trivial Names (common).

Palmitic acid is found in palm oil

Oleic acid is a major constituent of olive oil (oleum)

Stearic (from the Greek word meaning solid) acid is solid at room temp.

Arachnids (spiders contain arachidonic acid).

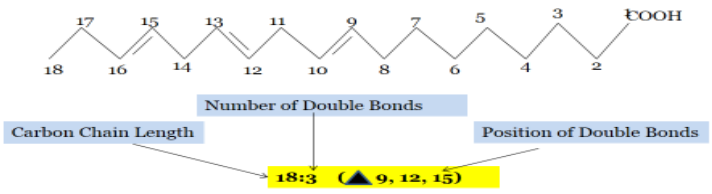
B)-IUPAC system (systemic).

IUPAC names follow the nomenclature conventions of the International Union of Pure and Applied Chemistry. These names describe the structures in detail. Counting begins from the carboxylic end. Double bounds are labeled with cis-/ trans.

C)-Two Abbreviation Systems

- **The carboxyl-reference system:** indicates the number of carbons, the number of double bonds, and the positions of the double bonds, counting from the carboxyl carbon (which is numbered 1, as in the IUPAC system).

  It differs from the IUPAC system in that it uses a number (*e.g.*, 16) to denote chain length instead of a name derived from Greek (*e.g.*, hexadecanoic acid).
- **The omega (n)-reference system**: indicates the number of carbons, the number of double bonds and the position of the double bond closest to the omega carbon, counting from the omega carbon (which is numbered 1 for this purpose). Ex: omega - 3 and omega - 6 fatty acids



Classification of fatty acids

Saturated Fatty acids	Unsaturated fatty acids

1-Volatile short-chain fatty acids(2-6 **C)** They are liquid in nature. Water-soluble and volatile at room temp. Acetic F.A. (2C) CH3-COOH. Butyric F.A. (4C) CH3-(CH2)2-COOH.	**1-Monounsaturated fatty acid** Contain only one double bond. Oleic acid $18:1\Delta^{9}$
2-Non-volatile short-chain fatty acids(7-10 C) They are solids, water-soluble and non-volatile at room temperature. Caprylic (8 C) CH3-(CH2)6-COOH. Capric (10 C) CH3-(CH2)8-COOH.	**2-Polyunsaturated fatty acids** Contain more than one double bond. Linoleic(ω-6)$18:2\ \Delta^{9,12}$
3-Long-chain fatty acids(more than 10 C) They are non-volatile and water-insoluble palmitic(16C) CH3-(CH2)14-COOH stearic (18 C) CH3-(CH2)16-COOH lignoceric (24C) CH3-(CH2)22-COOH	

Fatty acid derivatives

A-Hydroxy fatty acids

Ex. Ricinolic acid (12-hydroxy 9-Cis-octadecenoic acid).

Naturally occurs in Castor oil. It has analgesic and anti-inflammatory effects.

B- Cyclic fatty acids.

Ex. Chaulmoogric acid. Naturally occurs in chaulmoogric plant. It is used in treatment of leprosy.

C- Prostanoids.

It includes prostaglandins, prostacyclins and thrombxanes. Arachidonic acid is an intermediate in prostaglandins synthesis which produced by almost all nucleated cells. Prostanoids play an important role in regulation of inflammation, contraction and relaxation of smooth muscles and blood vessels.

Essential fatty acids

They are essential fatty acids that cannot be synthesized in the human body and must be taken in adequate amounts in the diet. They are required for normal growth and metabolism. They are present in vegetable oils such as corn oil, linseed oil, peanut oil, olive oil and also in cod liver oil and animal fats.

Linoleic(ω-6)18:2 $\Delta^{9,12}$

linolenic (ω-3)18:3 $\Delta^{9,12,15}$

Arachidonic acids 20:4 $\Delta^{5,8,11,14}$

I)-Simple lipids

They are esters of fatty acids with various alcohols. It includes neutral fat (triglycerides) & wax.

Triglycerides (fats & oils): glycerol + 3 fatty acids.

Waxes: fatty acid + a long-chain alcohol (other than glycerol).

A)-Waxes

Waxes are solid simple lipids containing a monohydric alcohol (with a higher molecular weight than glycerol) esterified to long-chain fatty acids. Waxes are widely distributed in nature.

The most commonly known wax is the bees wax which secreted by honeybees. A major component of beeswax is the (mericyl palmitate), which is an ester of palmitic acid with myricyl alcohol and is used in constructing of their honeycombs.

Lanolin (wool fat) is prepared from the wool-associated skin glands and is secreted by sebaceous glands of the skin.

Differences between neutral lipids and waxes:

	Waxes	**Neutral lipids**
Digestibility	Indigestible (not hydrolyzed by lipase).	Digestible (hydrolyzed by lipase).
Type of alcohol	Long-chain monohydric alcohol + one fatty acid.	Glycerol + 3 fatty acids
Type of fatty acids	Fatty acid mainly palmitic or stearic acid.	Long and short chain fatty acids.
Acrolein test	Negative.	Positive.
Rancid ability	Never get rancid.	Rancidible.
Nature at room temperature.	Hard solid.	Soft solid or liquid.
Saponification	Non saponifiable.	Saponifiable.
Nutritive value:	No nutritive value.	Nutritive.
Example	Bee waxe.	Butter and vegetable oils.

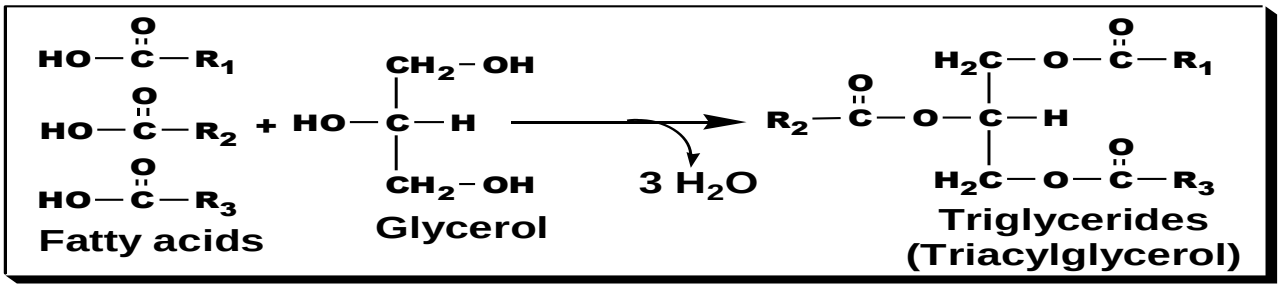
B-Neutral Fats and oils (Triglycerides)

They are called neutral because they are uncharged due to absence of ionizable groups in it.

The neutral fats are the most abundant lipids in nature. They constitute about 98% of the lipids of adipose tissue, 30% of plasma or liver lipids, less than 10% of erythrocyte lipids.

They are esters of glycerol with various fatty acids. Esterification of glycerol with one molecule of fatty acid gives **monoglyceride**, and that with 2 molecules gives

diglyceride. Since the 3 hydroxyl groups of glycerol are esterified, the neutral fats are also called "**Triglycerides**".



Types of triglycerides

1-Simple triglycerides: If the three fatty acids connected to glycerol are of the same type the triglyceride is called simple triglyceride.

2-Mixed triglycerides: If they are of different types, it is called mixed triglycerides.

Natural fats are mixtures of mixed triglycerides with a small amount of simple triglycerides.

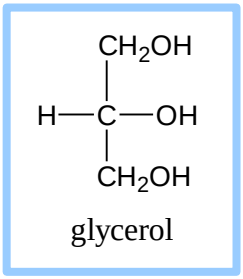
Fatty alcohol (glycerol)

It has three hydroxyl groups that are responsible for its solubility in water and its hygroscopic nature.

It is a colorless, odorless and viscous liquid. Glycerol is sweet-tasting and of low toxicity.

Oxidation of glycerol gives glyceric acid. Several phosphate derivatives of glyceric acid, including 2-phosphoglceric acid, are important biochemical intermediates in glycolysis.

Dehydrogenation of glycerol gives glyceraldehyde or dihdroxyacetone, both are the link between carbohydrate and lipid metabolism.



glycerol

Uses of Glycerol

Glycerol enters in pharmaceutical and cosmetic preparations.

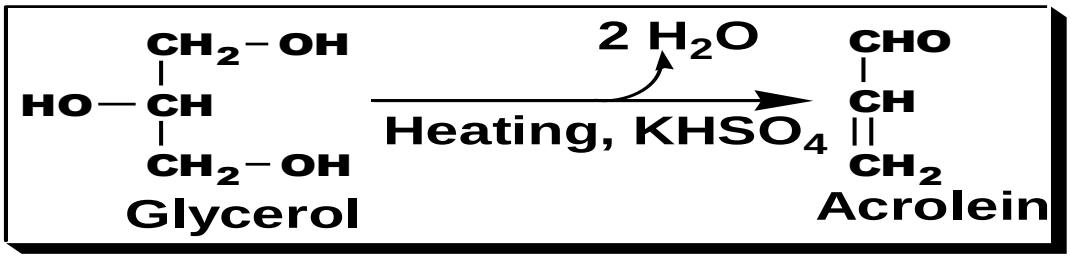
Nitroglycerin (NG): also known as trinitroglycerin (nitric acid & glycerol) is a heavy, colorless, oily, explosive liquid. It is also used as a vasodilator to treat chronic heart failure and angina.

Acroline test

The Acrolein test is used for determination of free glycerol or any compound containing glycerol.

Whe fat is heated strongly in the presence of a dehydrating agent such as potassium bisulfate or con. sulphuric acid the glycerol portion of the molecule is dehydrated to form the unsaturated aldehyde, acrolein (CH2=CH–CHO). Acroline has the odor peculiar to burnt cooking grease.

The pungent, irritable odor of acroline is toxic and strongly irritant for the skin, eyes, and nasal passages.



General characters of fatty acids& fat

A-Physical properties of fat and oils

1-Color: Freshly prepared fats and oils are colorless, odorless and tasteless. Any color, or taste is due to association with other foreign substances, e.g., the yellow color of body fat or milk fat is due to carotene pigments (cow milk).

2-Solubility: Short chain fatty acids (less than 6 carbons) & medium chain fatty acids (6-10 C) are water soluble and insoluble in fat solvents. Long chain fatty acids (more 10 C) are only soluble in fat solvents

3-Specific gravity: fats sp.gr is less than one and, therefore, they float on water.

4-Melting points: of fats depending on chain length & degree of saturation.

Increase of chain length leads to increase of melting point.

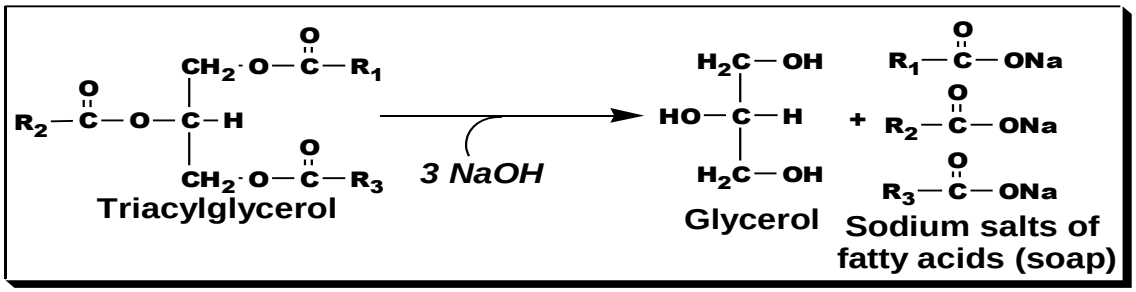
Increase number of double bonds leads to decrease of melting points.

B-Chemical reactions of lipid.

1) - Saponification (salt formation)

Alkaline hydrolysis produces glycerol and salts of fatty acids (soaps).

Soaps cause emulsification of oily material this help easy washing of the fatty materials. Salts of Na+ & k + are water soluble, while Ca + + & Mg + + are insoluble in water.



2)-Ester formation

Fatty acids react with alcohol to form esters (3 fatty acids +glycerol).

3)-Hydrogenation or hardening of oils

It is a type of addition reactions accepting hydrogen at the double bonds of unsaturated fatty acids to form the corresponding saturated fatty acid.

It is the base of hardening of oils (margarine manufacturing), e.g., change of oleic acid of fats (liquid) into stearic acid (solid). This hydrogenation occurred under high pressure of hydrogen and is catalyzed by finely divided nickel or copper and heat

Advantages for hydrogenated oil or fat are as follows:

1. It is more pleasant as cooking fat.

2. It is digestible and utilizable as normal animal fats and oils.
3. It is less liable to cause gastric or intestinal irritation.
4. It is easily stored and transported and less liable to rancidity.

Disadvantages of hydrogenated Fats

It lacks fat-soluble vitamins (A, D, E and K) and essential fatty acids.

4)-Halogenations

Neutral fats containing unsaturated fatty acids have the ability of adding halogens (e.g., iodine or bromine) at the double bonds. It is a very important property to determine the degree of unsaturation of the fat or oil that determines its biological value.

5-Rancidity (spoilage) of fat

It is a physico-chemical change in the natural properties of the fat leading to the development of unpleasant odor or taste or abnormal color particularly on aging.

Causes:

Exposure to atmospheric oxygen, light, moisture and heat

Bacterial or Fungal contamination.

Saturated fats resist rancidity more than unsaturated fats that have unsaturated double bonds.

Types

1-Hydrolytic rancidity

2-Oxidative rancidity

3-Ketonic rancidity

4-Lipooxidative rancidity

1-Hydrolytic rancidity

It results from slight hydrolysis of the fat by lipase enzyme or certain lipolytic bacteria leading to the liberation of free fatty acids and glycerol at high temperature and moisture. Volatile short-chain fatty acids have unpleasant odor.

Inactivation of enzyme through heating and then kept fat away from moisture and heat prevent this type of rancidity.

2-Ketonic Rancidity

It is due to the contamination with certain dry mould (fungi) such as Asperigillus Niger on fats such as coconut oil. Its enzymes oxidize certain low M.W saturate fatty acids as caprylic, capric and lauric acids which give Ketones, fatty aldehydes, short chain fatty acids and fatty alcohols are formed.

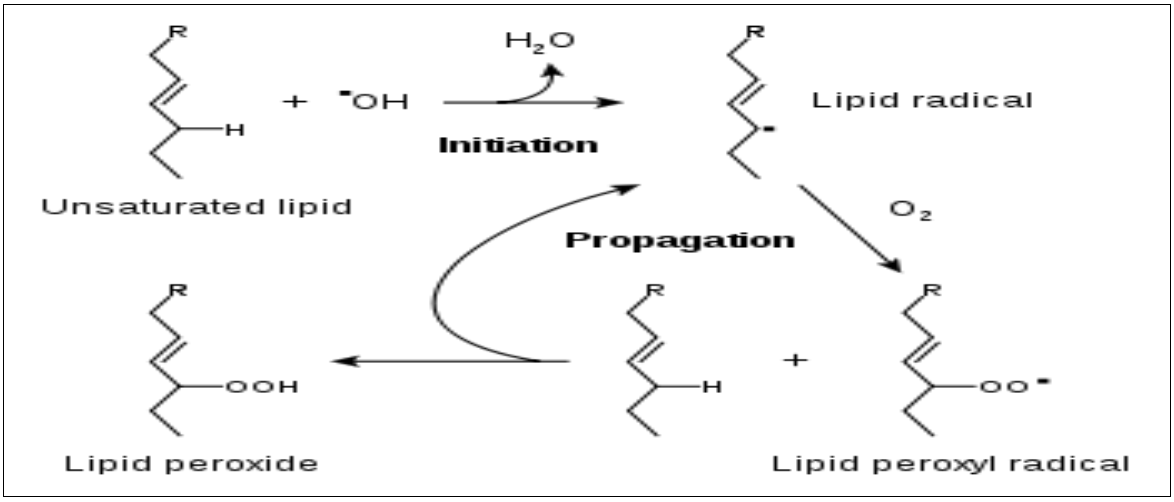
Moisture accelerates ketonic rancidity. Sterilization of fat to destroy mold spores prevents this type of rancidity.

3-Lipooxidative Rancidity

Occur in both animal and plant fat. It caused by certain type of enzymes which liberate free radicals which produce peroxides. It is active even at low Temp. causing spoilage of frozen food.

4-Oxidative Rancidity

It is oxidation of fat or oil catalyzed by exposure to oxygen, light and/or heat producing peroxide derivatives which on decomposition give substances, e.g., peroxides, aldehydes, ketones and dicarboxylic acids that are toxic and have bad odor. This occurs due to oxidative addition of oxygen at the unsaturated double bond of unsaturated fatty acid of oils.



Hazard effects of Rancid Fats

- The products of rancidity are toxic, (causes food poisoning and cancer).
- Rancidity destroys the fat-soluble vitamins (vitamins A, D, K and E).
- Rancidity destroys the polyunsaturated essential fatty acids.
- Rancidity causes economical loss because rancid fat is inedible.

Prevention of rancidity

- Avoidance of the causes (exposure to light, oxygen, moisture, high temperature and bacteria or fungal contamination).
- Keeping of fats or oils in well-closed containers in cold, dark and dry place (i.e., good storage conditions).
- Removal of catalysts such as lead and copper that catalyze rancidity.
- Addition of anti-oxidants to prevent peroxidation in fat.

An antioxidant: is a molecule that inhibits the oxidation of other molecules. Oxidation reactions can produce free radicals. In turn, these radicals can start chain reaction which can cause damage or death to the cell. Antioxidants terminate these chain reactions by removing free radical intermediates, and inhibit other oxidation

reactions. They do this by being oxidized themselves, so antioxidants are often reducing agents.

Natural antioxidants: ascorbic acid (vit.C), tochopherols (vit. E) and flavonoids.
Synthetic antioxidants: butylated hydroxyanosiol (BHA) and butylated hydroxytoluene (BHT).

Analysis and Identification of fats and oils (Fat Constants)

Numbers of tests used for checking the purity of fat for detection of adulteration. Identification of the biological value and natural characters of fat.
Detection of fat rancidity and presence of toxic hydroxy fatty acids.

1-Iodine number

It is the number of grams of iodine absorbed by 100 grams of fat or oil.
It is a measure for the degree of unsaturation of the fat.
Unsaturated fatty acids absorb iodine at their double bonds, therefore, as the degree of unsaturation increases iodine number and hence biological value of the fat increase.
It is used for identification of the type of fat, detection of adulteration and determining the biological value of fat.

2-Saponification number

It is the number of milligrams of KOH required to completely saponify one gram of fat.

Fats containing short-chain acids will have more carboxyl groups per gram than long chain fatty acids and consume more alkali.

Butter has higher saponification number. (216-233)

Coconut oil (250-269).

3-Acids Number

It is the number of milligrams of KOH required to neutralize the free fatty acids present in one gram of fat. It is used for detection of hydrolytic rancidity because it measures the amount of free fatty acids present.

4-Reichert- Meissl Number

It is the number of milliliters of 0.1 N KOH required to neutralize the water-soluble fatty acids obtained by saponification of 5 grams of fat. Short-chain fatty acid (less than 10 carbons) is distillated by steam.

Uses: for detection of fat adulteration.

Butter that has high percentage of short-chain fatty acids has highest Reichert-Meissl number compared to margarine.

5-polenski value

It is the number of milliliters of 0.1 N KOH required to neutralize the volatile water-insoluble fatty acids distilled from 5 grams of fat.

Coconut oil has high polenski value.

2-Compound Lipids (Conjugated)

They are lipids that contain additional substances, e.g., sulfur, phosphorus, amino group, carbohydrate, or proteins beside fatty acid and alcohol.

Compound lipids are classified into the following types:

I- Phospholipids

Phospholipids or phosphatides are compound lipids, which contain phosphoric acid.

The membranes bounding cells and subcellular organelles are composed mainly of phospholipids. Myelin sheath of nerves is rich with phospholipids.

Phospholipids are composed of:

Fatty alcohols (glycerol, inositol or sphingosine)

Fatty acids (a saturated and an unsaturated fatty acid).

Phosphoric acid.

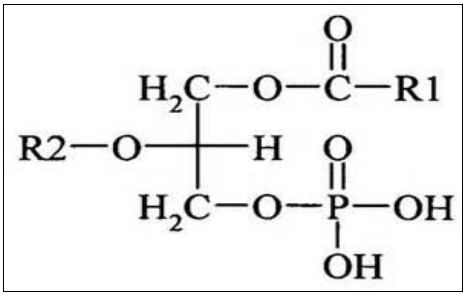
Nitrogenous base (choline, serine, threonine or ethanolamine).

Classification of phospholipids according to alcohol presents in it

Glycerophospholipids	**Sphingophospholipids**
1. Phosphatidic acid 2. Lecithins 3. Cephalins 4. Plasmalogens 5. Phosphatidyl serine 6. Inositides 7. Cardiolipin	They contain sphingosine as an alcohol and are named Sphingomyelins.

1. **Phosphatidic acid**

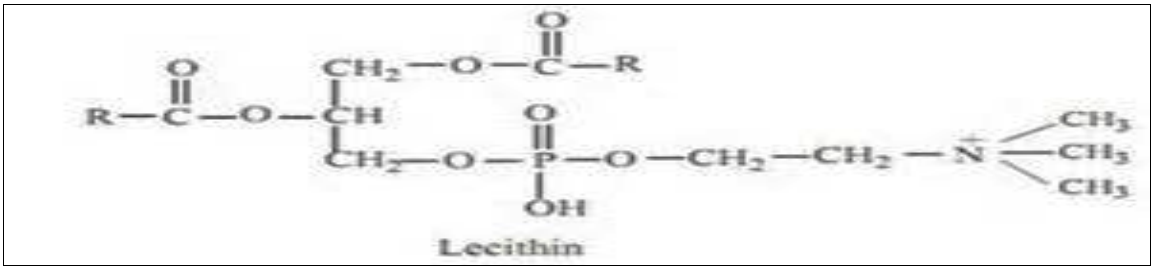
It is composed from glycerol, two molecules of fatty acids and phosphoric acid. It is a metabolic intermediate in synthesis of triglycerides and glycerophospholipids.



(Phosphatidic acid)

2. **Lecithins (phosphatidylcholine)**

Lecithins are glycerophospholipids that contain choline as a base beside phosphatidic acid.



Glycerol is connected at C2 with a polyunsaturated fatty acid and at C1 with a saturated fatty acid. Many different lecithins are present in nature due to the wide variety of fatty acids. Lecithins are a constituent of cell membrane, nervous tissue, brain and egg yolk.

Lysolecithin: Snake venom contains lecithinase A enzyme, which hydrolyzes only the polyunsaturated fatty acid attached to C2 converting lecithin into lysolecithin which causes hemolysis of RBCs. Lysolecithins are also intermediates in metabolism of phospholipids.

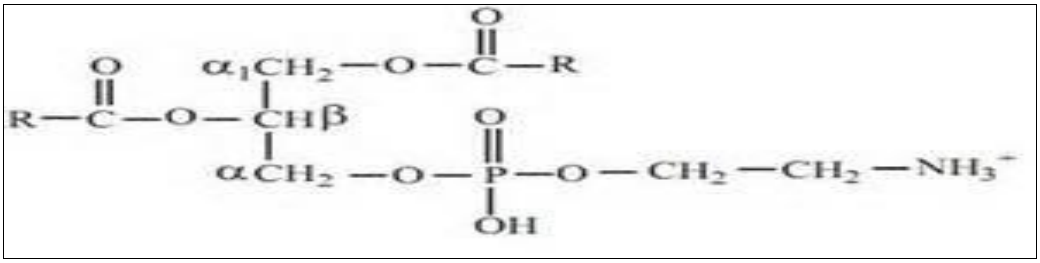
dipalmitoyl-lecithin (Lung surfactant): It is produced by alveolar cells. It lowers alveolar surface tension and improves gas exchange besides activating macrophages to kill pathogens.

Lecithins consider as a store for choline which acting as a lipotropic factor.

3. Cephalins (phosphatidyl ethanolamine)

Cephalins resemble lecithins in structure except that choline is replaced by ethanolamine. It occurs in association with lecithins in tissues and are isolated from the brain so it also called Kephalins (Kephale = head).

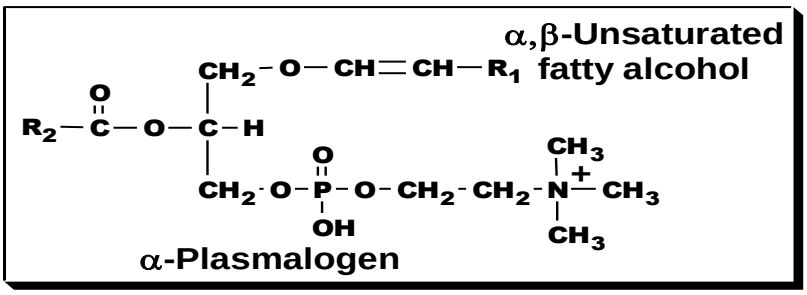
Certain cephalins are constituents of thromboplastin which accelerates the clotting of blood by activation of prothrombin to thrombin in presence of calcium ions.



4. Plasmalogens

Plasmalogens resemble lecithins and cephalins in structure but differ in the presence of α,β-unsaturated fatty alcohol rather than a fatty acid at C1 of the glycerol connected by ether bond.

Plasmalogens are found in the cell membrane phospholipids fraction of liver, semen and eggs. It constitutes about 10% of brain and muscle phospholipids.



5. phosphatidyl serine

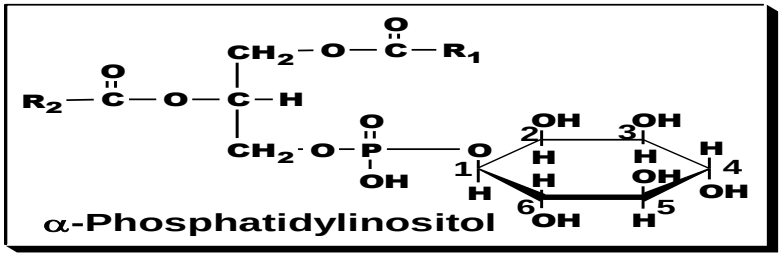
Phosphatidyl serine resembles lecithins in structure except that choline is replaced by amino acid serine**.**

6. Inositides (Phosphatidyl inositol)

They are formed of glycerol, one saturated fatty acid, one unsaturated fatty acid, phosphoric acid and cyclic sugar alcohol (inositol) instead of the nitrogenous base.

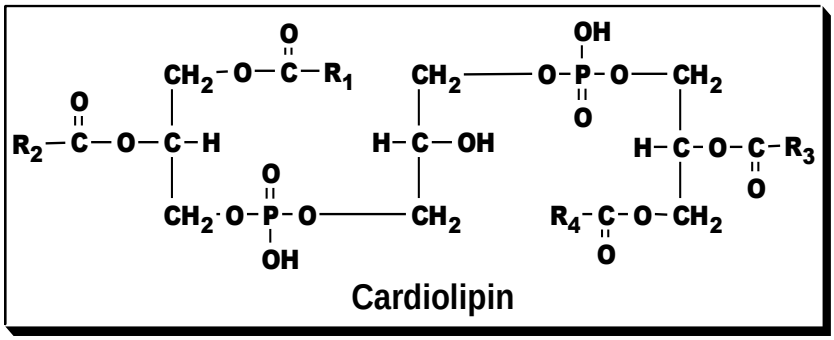
Phosphatidyl inositol is a major component of cell membrane phospholipids of different tissue.

They play a major role as second messengers during signal transduction for certain hormone. On hydrolysis by phospholipase C enzyme phosphatidyl-inositol-4,5-diphosphate produces diacyl-glycerol and inositol-triphosphate both act to liberate calcium from its intracellular stores to mediate the hormone effects.



7-Cardiolipins

They are diphosphatidyl-glycerol. They are found in the inner membrane of mitochondria initially isolated from heart muscle (cardio). It is formed of 3 molecules of glycerol, 4 fatty acids and 2 phosphate groups. It is used in serological diagnosis of autoimmunity diseases.

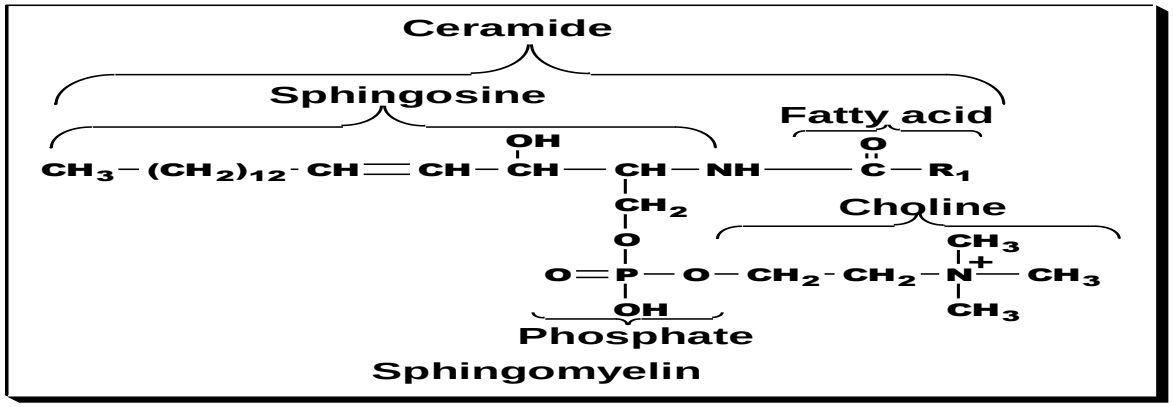


Sphingophospholipids

Sphingomyelins

Sphingomyelins contain sphingosine as the amino alcohol instead of glycerol, they contain two nitrogenous bases: sphingosine itself and choline.

Sphingomyelins structure is sphingosine, one long-chain fatty acid, choline and phosphoric acid. The fatty acid is attached by an amide linkage to the amino group of sphingosine. The part of sphingomyelin in which the amino group of sphingosine is attached to the fatty acid by an amide linkage is called Ceramide



II-Glycolipids

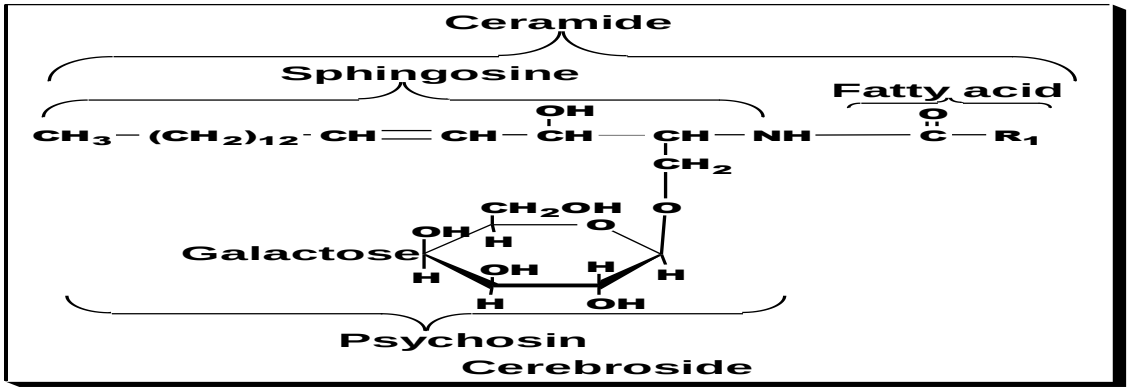
They are lipids that contain carbohydrate residues with sphingosine as the alcohol and a very long-chain fatty acid. They are present in cerebral tissue, therefore are called cerebrosides.

They are classified according to the number and nature of the carbohydrate residue(s) present in the glycolipids into cerebrosides (galactosides) and gangliosides.

A-Cerebrosides (galactosides)

They occur in myelin sheath of nerves and white matter of the brain tissues and cellular membranes. They are important for nerve conductance.

They contain sugar, usually β-galactose and may be glucose or lactose, sphingosine and fatty acid, but **no phosphoric acid**.



Types of cerebrosides:

According to the type of fatty acid and carbohydrate present, there are 4 different types of cerebrosides isolated from the white matter of cerebrum and in myelin sheaths of nerves.

- **Kerasin** contains lignoceric acid (24 carbons) and galactose.

- **Cerebron** (Phrenosin) contains cerebronic acid (2-hydroxylignoceric acid) and galactose.

- **Nervon** contains nervonic acid (unsaturated lignoceric acid at C15) and galactose.

- **Oxynervon** contains oxynervonic acid (2-hydroxynervonic acid) and galactose.

- **Sulfatides:**

They are sulfate esters of kerasin or phrenosin in which the sulfate group is usually attached to the –OH group of C3 or C6 of galactose. Sulfatides are usually present in the brain, liver, muscles and testes.

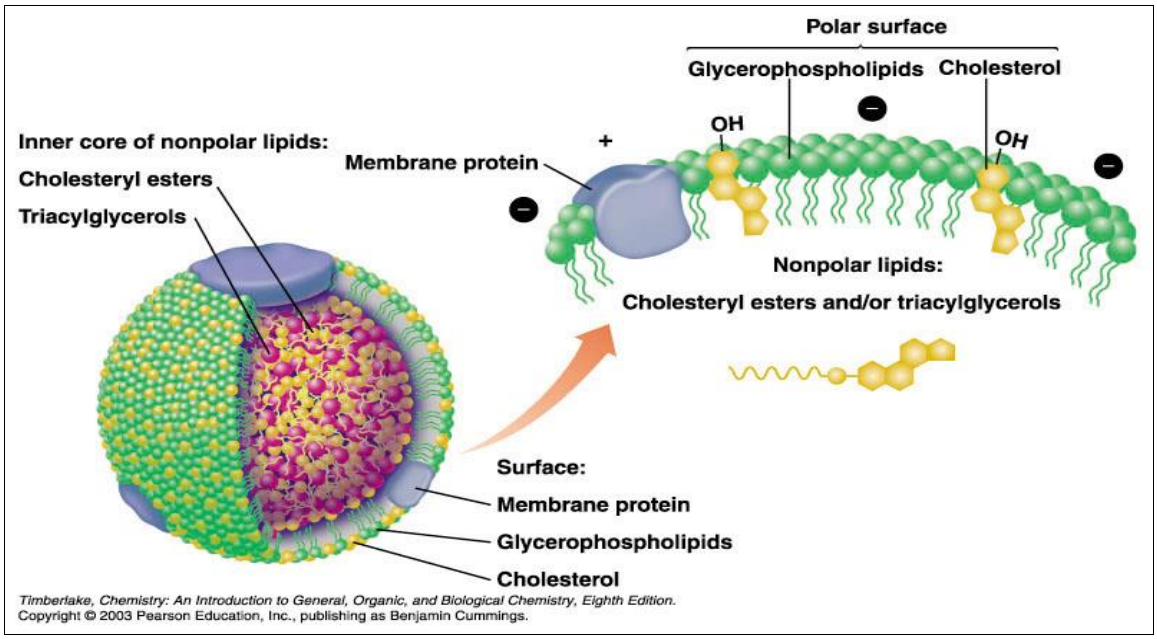
B-Gangliosides

They are more complex glycolipids that occur in the gray matter of the brain, ganglion cells, and RBCs. They transfer biogenic amines across the cell membrane and act as a cell membrane receptor.

Gangliosides contain sialic acid (N-acetylneuraminic acid), ceramide (sphingosine + fatty acid of 18-24 carbon atom length), 3 molecules of hexoses (1glucose + 2 galactose) and hexosamine.

III-Lipoproteins

Lipoproteins are lipids combined with proteins in the tissues. The lipid component is phospholipid, cholesterol or triglycerides. They are widely distributed in tissues being present in cellular and subcellular membranes (structural lipoproteins). Lipoproteins present and transported in blood plasma called (transport lipoproteins).



Plasma lipoproteins

They are composed of a protein called apolipoprotein and different types of lipids (Cholesterol, cholesterol esters, phospholipids and triglycerides). As the lipid content increases, the density of plasma lipoproteins decreases.

Classification of plasma lipoproteins according to method of separation:

Ultra-centrifugation	**Electrophoresis**
Using the rate of floatation in sodium chloride solution • **Chylomicrons** • **VLDL (very low density lipoproteins)**	According to migration in an electric field • **Chylomicrons** • **pre-β-lipoproteins** • **β-lipoproteins**

• **LDL (low density lipoproteins)** • **HDL (high density lipoproteins**) • **albumin-free fatty acids complex**	• **α-lipoproteins** • **albumin-free fatty acids complex**

a) Chylomicrons: They have the largest diameter and the least density. They contain 1-2% protein only and 98-99% fat. The main lipid fraction is triglycerides absorbed from the intestine and they contain small amounts of the absorbed cholesterol and phospholipids.

b)Very low-density lipoproteins (VLDL) or pre-β-lipoproteins: Their diameter is smaller than chylomicrons. They contain about 7-10% protein and 90-93% lipid. The lipid content is mainly triglycerides formed in the liver. They contain phospholipid and cholesterol more than chylomicrons.

c) Low-density lipoproteins (LDL) or β-lipoproteins: They contain 10-20% proteins in the form of apolipoprotein B. Their lipid content varies from 80-90%. They contain about 60% of total blood cholesterol and 40% of total blood phospholipids. As their percentage increases, the liability to atherosclerosis increases.

d) High-density lipoproteins (HDL) or α-Lipoproteins: They contain 35-55% proteins in the form of apolipoprotein A. They contain 45-65% lipids formed of cholesterol (40% of total blood content) and phospholipids (60% of total blood content). They act as cholesterol scavengers, as their percentage increases, the liability to atherosclerosis decreases. Due to their high protein content they possess the highest density.

e) Albumin-free fatty acids complex: It is a proteolipid complex with 99% protein content associated with long-chain free fatty acids for transporting them.

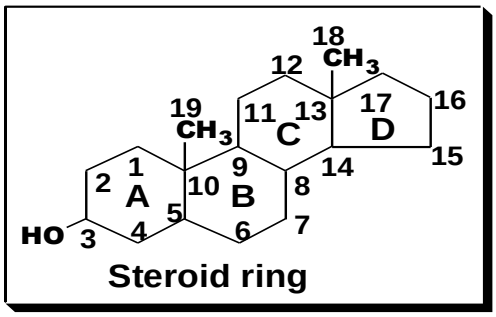
3-Derived lipids

These are substances derived from hydrolysis of simple and compound lipids including fatty acids, alcohols, steroids, pigments, fat soluble vitamins,-------.

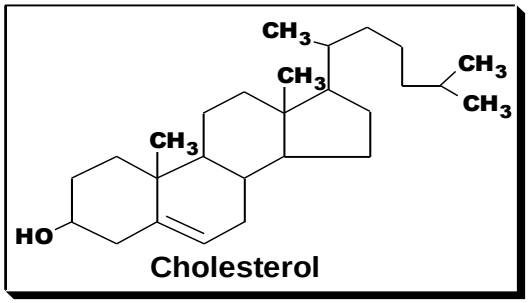
Steroids:

Steroids constitute an important class of biological compounds.

Steroids are usually found in association with fat. They can be separated from fats after saponification since they occur in the unsaponifiable residue.



Steroid ring



Cholesterol

Cholesterol

It is the most important sterol in animal tissues as free alcohol or in an esterified form (with linoleic, oleic, palmitic acids or other fatty acids).

Cholesterol is a very hydrophobic compound consists of four fused hydrocarbon rings A, B, C, and D, called the "steroid nucleus" or cyclo pentane perhydro phenanthrane ring.

It has a hydroxyl group on C3, a double bond between C5 and C6, 8 asymmetric carbon atoms and a side chain of 8 carbon atoms.

Tissues contain different amounts of it that serve a structural and metabolic role, e.g., adrenal cortex content and brain.

It is synthesized in the body from acetyl-CoA. Cholesterol does not exist in plants and is also taken in the diet as in butter, milk, egg yolk, brain, meat and animal fat.

In the blood (the total cholesterol amounts about 200 mg/dL of which 2/3 is esterified, chiefly to unsaturated fatty acids while the remainder occurs as the free cholesterol.

Cholesterol derivatives:

1. Adrenal cortical hormones.
2. Male and female sex hormones.
3. Vitamin D
4. Bile acids.

Cholesterol is oxidized into 7-Dehydrocholesterol (a second double bond between C7 and C8). When the skin is irradiated with ultraviolet light 7-dehydrocholesterol is converted to vitamin D3. This explains the value of sun light in preventing rickets.

Cholesterol oxidized in the liver and producing cholic and chenodeoxycholic acids that are conjugated with glycine or taurine to produce glycocholic, glycochenodeoxycholic, taurocholic and taurochenodeoxycholic acids. They react with sodium or potassium to produce sodium or potassium bile salts. Bile acids emulsify lipid during digestion.

Ergosterol

It was first isolated from ergot, a fungus then from yeast. It differs from 7-dehydrocholesterol in the side chain as it has a third double bond between C22&C23. Ergosterol is converted to vitamin D2 by irradiation with UV. Ergosterol and 7-dehydrocholesterol are called Pro-vitamins D or precursors of vitamin D.

Trans Fatty Acids

Exist in very small amounts in natural foods. Trans fatty acids lowers HDL level and raises total blood cholesterol

They also raise plasma conc. of LDL-lipoprotein – athrogenic lipoprotein.

Trans fatty acids are formed when vegetable oils are hydrogenated during the formation of margarine etc.

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