

INTRODUCTION

- The word lipid is derived from a Greek word “**lipos**” which means Fat. Biological lipids are a chemically diverse group of organic compounds which are insoluble in water.
- They are soluble in non-polar solvents such as- ether, chloroform, or benzene. Lipids are hydrophobic in nature due to the predominance of hydrocarbon chains.(-CH₂- CH₂-CH₂-) in their structures.
- lipids are are the chief storage form of energy, they provide 6-fold as much energy as an equivalent mass of glycogen.Fat and oils are the principle stored forms of energy in many organism. Lipids participate in oxidative phosphorylation.
- Neutral lipids upon hydrolysis yield glycerol and fatty acids . Many lipid molecules are amphipathic.
- In aqueous environment lipid molecules associate by non-covalent interactions to form supramolecular structures such as monolayers, micelles, bilayers and vesicles.

DEFINITION-

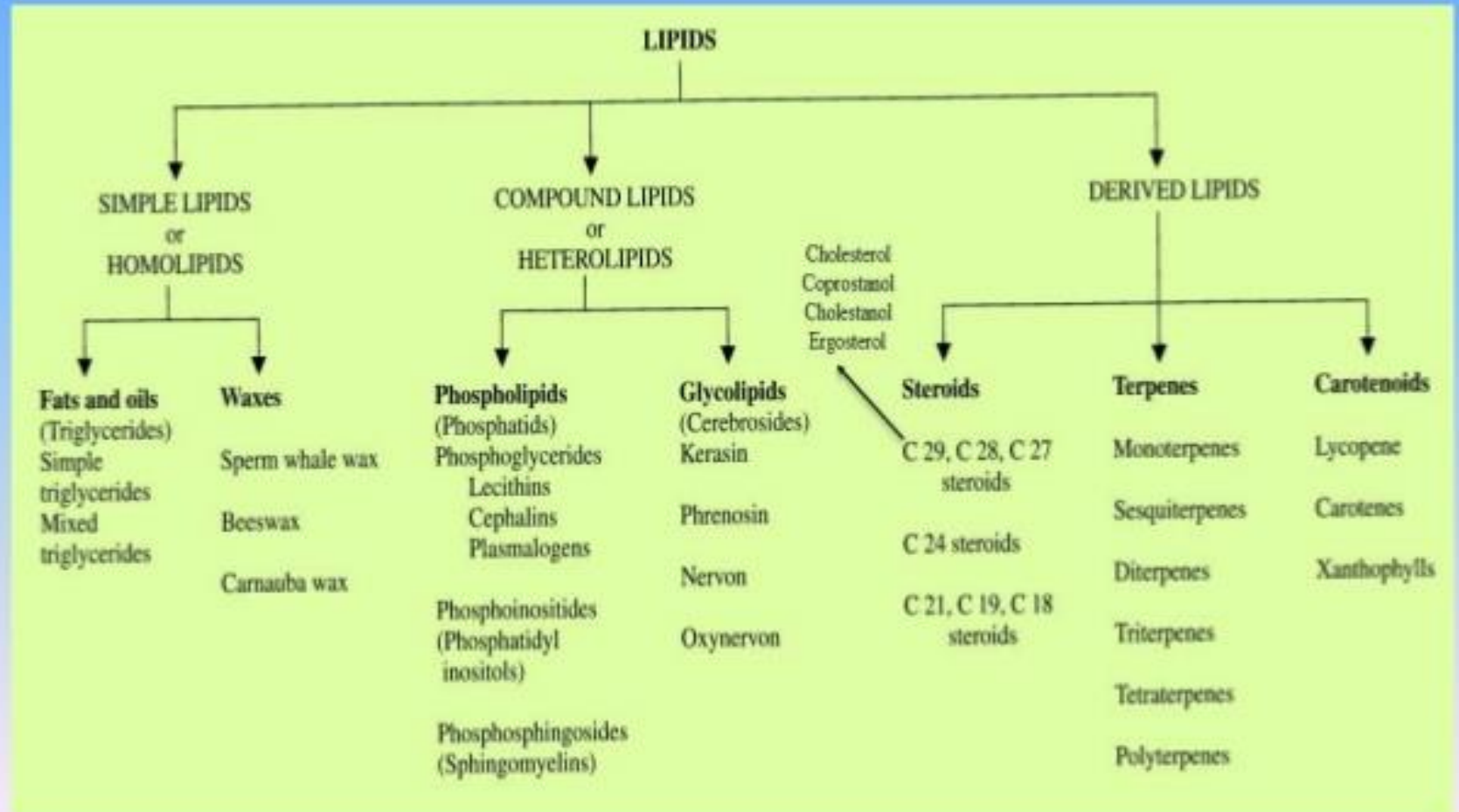
Lipids may be regarded as organic substances relatively insoluble in water, soluble in organic solvents, potentially related to fatty acids and utilized by the living cells.

ROLE-

- They serve as a storage form of metabolic fuel. (fatty acid, Triacylglycerol) and serve as a transport form of metabolic fuel.(free fatty acid, triglyceride and cholesterol ester)
- They provide the structural components of membranes(phospholipids, glycolipids, galactolipids, sphingolipids)
- They have protective functions in bacteria, plants, insects, and vertebrates, serving as a part of the outer coating between the body of the organism and the environment.
- It serve as pigment(carotene), hormones(vitamin A & D), signaling molecules(eicosanoids, phosphatidylinositol, steroid hormone) cofactors(vitamin E, K and lipid quinones) detergent(bile salt).

- Important dietary components because of their high energy value and also because of the fat-soluble vitamins and the essential fatty acids contained in the fat of natural foods.
- Structural components of biomembranes
- Serve as thermal insulators in the subcutaneous tissues and around certain organs
- Nonpolar lipids act as electrical insulators, allowing rapid propagation of depolarization waves along myelinated nerves
- Provide shape and contour to the body
- Act as metabolic regulators
- Combinations of lipid and protein (lipoproteins) are important cellular constituents, occurring both in the cell membrane and in the mitochondria, and serving also as the means of transporting lipids in the blood.

Classification Of Lipids



1. Simple lipids

Esters of fatty acids with various alcohols

a. Fats and oils (triglycerides) • These esters of fatty acid have glycerol, a trihydroxy alcohol. • Triglycerides are abundant and constitute about 98 percent of all dietary lipids.

b. Waxes • Waxes are long-chain saturated and unsaturated fatty acid esters with monohydroxy alcohols, which have high molecular weight. • Waxes are produced naturally by skin glands as a protection, to keep it lubricated and water-proof.

2. Complex lipids:

Esters of fatty acids containing groups in addition to an alcohol and a fatty acid.

a. Phospholipids: Lipids containing, in addition to fatty acids and an alcohol, a phosphoric acid residue. They frequently have nitrogen-containing bases and other substituents, eg, in glycerophospholipids the alcohol is glycerol and in sphingophospholipids the alcohol is sphingosine.

b. Glycolipids (glycosphingo lipids): Lipids containing a fatty acid, sphingosine, and carbohydrate.

c. Other complex lipids: Lipids such as sulfolipids and aminolipids. Lipoproteins may also be placed in this category.

3. Precursor and derived lipids:

These include-

- A. fatty acids
- B. Glycerol
- C. steroids

A. Fatty acids

- are aliphatic carboxylic acids having the general formula $R-(CH_2)_n-COOH$.
- They occur mainly as esters in natural fats and oils but do occur in the unesterified form as free fatty acids, a transport form found in the plasma.
- Fatty acids that occur in natural fats are usually straight-chain derivatives containing an even number of carbon atoms.
- The chain may be saturated (containing no double bonds) or unsaturated (containing one or more double bonds).
- Fatty acids are the building blocks of dietary fats. The human body stores such fats in the form of triglycerides.
- Fatty acids are also required for the formation of membrane lipids such as phospholipids and glycolipids.
- They are required for the esterification of cholesterol to form cholesteryl esters.
- They act as fuel molecules and are oxidized to produce energy.

B. Glycerol

- Also called Glycerin.
- Trihydric alcohol as it contains three hydroxyl groups.
- Can be obtained from diet, from lipolysis of fats in adipose tissue and from glycolysis.
- Can be utilized for the synthesis of triacylglycerols, phospholipids, glucose or can be oxidized to provide energy.
- Used as a solvent in the preparation of drugs and cosmetics
- Nitroglycerine is used as a vasodilator

C. STEROLS

- Cholesterol is widely distributed in all cells of the body but particularly in nervous tissue.
- It is a major constituent of the plasma membrane and of plasma lipoproteins.
- It is synthesized in many tissues from acetyl-Co A and is the precursor of all other steroids in the body, including corticosteroids, sex hormones, bile acids, and vitamin D.
- Cholesterol is a major constituent of gallstones.
- Its chief role in pathologic processes is as a factor in the genesis of atherosclerosis of vital arteries, causing cerebrovascular, coronary, and peripheral vascular disease.
- Normal level of serum total cholesterol ranges between 150-220 mg/dl
- Physiological variations-Low at the time of birth, increases with advancing age. The level is increased during pregnancy.
- Pathological Variations-a) Low cholesterol (Hypocholesterolemia)-Thyrotoxicosis, anemia, hemolytic jaundice, wasting diseases and malabsorption syndrome.

Qualitative Tests for lipids

(1) Solubility: Solubility of lipid in organic solvent depends on length of hydrocarbon chain of fatty acid attached to glycerol. Lipids are soluble in solvent like chloroform, ether, alcohol, hexane etc.

(2) Formation of translucent spot on paper:

Ordinary writing paper becomes semitransparent when a drop of oil is applied to paper.

(3) Formation of acrolein:

Glycerol from fat gets dehydrated with the help of solid potassium bisulphate and acrylic aldehyde or acrolein is produced.

(4) Emulsification: When oil or liquid fat is shaken with water, it is finely divided and is dispersed in the water to form what is known as emulsion. Shaken a drop of oil with water in a test tube. The oil becomes finely divided forming an emulsion.

(5) Iodine absorption test: This test is for unsaturated fatty acids for fat. A drop of iodine is added to fat (fat solution is prepared in chloroform) and shaken. The solution will decolorize if unsaturated fatty acid is present.

(6) Rancidity:

- When fat is allowed to stand for a sufficient length of time in contact with air and moisture, particularly in the presence of light, gets oxidized and it becomes rancid. It liberates free fatty acids. It is less palatable and is said to have gone rancid. Antioxidants are used to prevent rancidity of fat. Small amount of antioxidant is added to protect oxidation. Vitamin E and derivatives of phenol are used as antioxidants.

Lipid storage diseases(Sphingolipidosis)

Disease	Enzyme deficiency	Nature of lipid accumulated	Clinical Symptoms
Tay Sach's Disease	Hexosaminidase A	G _{M2} Ganglioside	Mental retardation, blindness, muscular weakness
Fabry's disease	α-Galactosidase	Globotriaosylceramide	Skin rash, kidney failure (full symptoms only in males; X-linked recessive).
Metachromatic leukodystrophy	Arylsulfatase A	Sulfogalactosylceramide	Mental retardation and Psychologic disturbances in adults; demyelination.

Lipid storage diseases(Sphingolipidosis)– contd.

Disease	Enzyme deflency	Nature of lipid accumulated	Clinical symptoms
Krabbe's disease	β -Galactosidase	Galactosylceramide	Mental retardation; myelin almost absent.
Gaucher's disease	β -Glycosidase	Glucosyl ceramide	Enlarged liver and spleen, erosion of long bones, mental retardation in infants.
Niemann–Pick disease	Sphingomyelinase	Sphigomyelin	Enlarged liver and spleen, mental retardation; fatal in early life.
Farber's disease	Ceramidase	Ceramide	Hoarseness, dermatitis, skeletal deformation, mental retardation; fatal in early life