**UNIT – 5 LIPID METABOLISM**

**LIPID**  1. Lipid are heterogenous group of compound including fats, oils, waxes and other related substances. 2. These are insoluble in water and soluble in organic solvents like ether, chloroform and benzene. So lipids are therefore called hydrophobic. 3.Lipid in combination with protein forms important constituents of cell membrane in a cell. 4. Lipids are made up of Carbon, Hydrogen and Oxygen. But in lipid the ratio of Hydrogen and Oxygen is not in the ratio of 2:1 as in sugars. 5. The number of Oxygen atoms are lesser than in Carbohydrates. 6. In some lipids the sulphur, nitrogen or phosphorus may be present.

**Lipid metabolism** 1. The Lipid metabolism is the synthesis and degradation of [lipids](https://en.wikipedia.org/wiki/Lipid) in cells. 2. In the process there is the breakdown or storage of fats for energy and the synthesis of structural and functional lipids, which are involved in the construction of [cell membranes](https://en.wikipedia.org/wiki/Cell_membrane). 3. The process of synthesizing these fats is called Lipogenesis . 4. Other types of lipids are [fatty acids](https://en.wikipedia.org/wiki/Fatty_acid) and [membrane lipids](https://en.wikipedia.org/wiki/Membrane_lipids). 5. Lipid metabolism is often considered as the [digestion](https://en.wikipedia.org/wiki/Digestion) and absorption process of dietary fat. 6. The Lipid digestion is the first step of lipid metabolism. It is the process of breaking the triglycerides down into smaller [monoglyceride](https://en.wikipedia.org/wiki/Monoglyceride) units with the help of [lipase](https://en.wikipedia.org/wiki/Lipase) enzymes. 7. The Lipid absorption is the second step in lipid metabolism is the absorption of fats. 8. Once the triglycerides are broken down into individual fatty acids and [glycerols](https://en.wikipedia.org/wiki/Glycerol), along with cholesterol, they will aggregate into structures called [micelles](https://en.wikipedia.org/wiki/Micelle). 9. The Fatty acids and monoglycerides leave the micelles and diffuse across the membrane. 10. Since lipids are [hydrophobic](https://en.wikipedia.org/wiki/Hydrophobic_effect) molecules, they need to be solubilized before their metabolism can begin.

**CLASSIFICATION OF LIPIDS** The lipids which are stored in the body and are the source of energy, and the other structural lipids which forms the cell membrane are divided into following major classes :- I. SIMPLE LIPIDS/HOMOLIPIDS II. COMPOUND LIPIDS/HETEROLIPIDS III. DERIVED LIPIDS

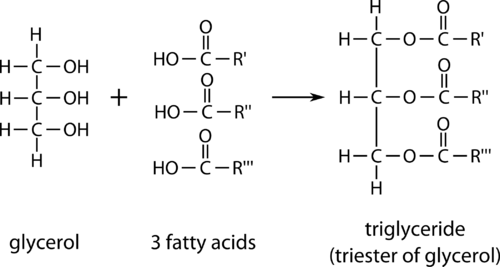
LIPID

SIMPLE LIPID COMPOUND LIPID DERIVED LIPID

FAT WAXES

**I. SIMPLE LIPIDS** These are the esters of fatty acids with various alcohols. [Esters = chemical compound derived from an acid in which at least one – OH (hydroxyl group) is replaced by – O – (alkyl group). These are derived from a R – COOH (carboxylic acid) and an alcohol] [Fatty acids = carboxylic acid with a long aliphatic chain] These are of two types :- 1. Fats and oils (Triglycerides and triacylglycerols) 2. Waxes

**1. Fats and oils (Triglycerides and triacylglycerols)** :- These are the esters of fatty acids derived from a Glycerol (C3H8O3) and three fatty acids 3(COOH – R). A fat molecule consists of a glycerol and three fatty acids. Glycerol is a small organic molecule with three hydroxyl (OH) groups, while a fatty acid consists of a long hydrocarbon chain attached to a carboxyl group. A typical fatty acid contains 12 – 18 carbons, though some may have as few as 4 or as many as 36. Fat molecules are also called triacylglycerols or triglycerides.

 Fig :- Fat molecule. The R in the three fatty acids represents a long C – C – C chain. In Triglycerides the Rs may or may not be the same.

The Triglycerides are of following types :-

**i. Simple Triglycerides** :- In simple triglycerides the three fatty acids radicles are of same type. Eg :- Tristearin (C57H110O6), Triolein (C57H104O6).

O

H2C – O – C – R1 Fatty acid1

O

HC – O – C – R1 Fatty acid1

O

H2C – O – C – R1 Fatty acid1

**ii. Mixed Triglycerides** :- In mixed triglycerides the three fatty acids radicles are different from each other. Eg :- Distearo – olein (C57H108O6), Dioleo – palmitin (C16H32O2).

O

H2C – O – C – R1 Fatty acid1

O

HC – O – C – R2 Fatty acid2

O

H2C – O – C – R3 Fatty acid3

**2. Waxes** :- These are the esters of fatty acids with high molecular weight monohydroxyl alcohols. Eg :- Beeswax (C15H31CO2C30H61) etc.

O

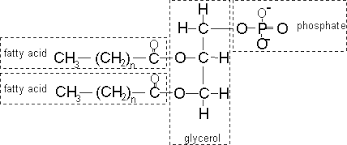
C

R OR

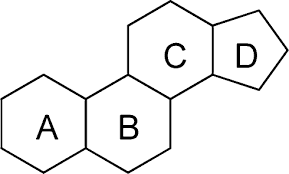
Long chain of C’s Waxes are another important category of lipids. Wax covers the leaf surfaces of some plants, where its hydrophobic properties prevent water from sticking to into the surface. Structurally waxes typically contain long fatty acid chains connected to alcohols by ester linkages, although waxes produced by plants often have plain hydrocarbons mixed.

**II. COMPOUND LIPIDS** These are the esters of fatty acids with alcohol and possess additional groups also. This is of following types :- 1. Phospholipids/Phosphatids 2. Glycolipids 3. Sphingolipids 4. Lipoproteins

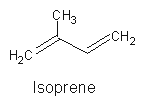
**1. Phospholipids/Phosphatids** :- Phospholipids are a class of [lipids](https://en.wikipedia.org/wiki/Lipids) that are a major component of all [cell membranes](https://en.wikipedia.org/wiki/Cell_membrane). They play an important structural and metabolic roles in living cells. They form [lipid bilayers](https://en.wikipedia.org/wiki/Lipid_bilayer) in cell membrane. These compound lipids contains fatty acids and glycerol in addition to a phosphoric acid, nitrogenous bases and other substances. They are amphipathic (hydrophobic and hydrophilic) in nature. The structure of the phospholipid molecule generally consists of two [hydrophobic](https://en.wikipedia.org/wiki/Hydrophobic) fatty acid "tails" and a [hydrophilic](https://en.wikipedia.org/wiki/Hydrophile) "head" consisting of a [phosphate](https://en.wikipedia.org/wiki/Phosphate) group. The two components are usually joined together by a [glycerol](https://en.wikipedia.org/wiki/Glycerol) molecule. These are found in the structure of plasma membrane. The phospholipids can be phosphoglycerides, phosphoinositides and phosphosphingosides.

**2. Glycolipids** :- These are in association with carbohydrates. These are found in the structure of plasma membrane. In several respects the glycolipids resemble phospholipids. The molecule is amphipathic, the polar group being a galactosyl derivative of a diglyceride, the non – polar part of the molecule being a pair of long, straight – chain fatty acids. The two most abundant glycolipids are mono – and di – galactosyl diglyceride. They are characteristic of photosynthetic tissues since they are the major lipid component of chloroplast lamellae, largely replacing the phospholipids. Eg :- Galactolase, Glucose etc. **3. Sphingolipids** :- Sphingolipids are the class of lipids in plants. They are comprise with a wide range of complex lipids. These are abundant and essential components of plasma membrane and other endomembranes of plant cells. Sphingolipid metabolites have also been linked to the regulation of cellular processes. These lipids have an amino alcohol, spingosine associated with it. (Amino alcohol :- Oxygen compound contain amine & alcohol group formed by the reaction of CH4, NH4 & H2O in a nitrogen compound) (Spingosine :- 18 – carbon amino alcohol with an unsaturated hydrogen, molecular formula C18H37NO2) **4. Lipoproteins** :- This lipid is composed of lipid and proteins. The egg yolk is rich in lipoproteins.

**III. DERIVED LIPIDS**  Derived lipids are the substances derived from simple and compound lipids. These include hydrolytic products of lipids and lipid like compounds . These includes fatty acids , alcohols , monoglycerides and diglycerides , steroids , terpenes, carotenoids . The most common derived lipids are steroids , terpenes and carotenoids. **1. Steroids/Sterols** :- Steroids are another class of lipid molecules. These are the derivatives of fused ring like system. They have no fatty acids, they cannot be hydrolyzed by heating with alkali to yield fatty acid components. They are the organic compound with four rings. Although they do not resemble the other lipids structurally, but are included in lipid category because they are also hydrophobic and insoluble in water. All steroids have four linked carbon rings and several of them, like cholesterol, also have a short tail. This system consists of 3 – cyclohexane rings (A, B and C) fused in nonlinear or phenanthrene manner and a terminal cyclopentane ring (D). Many steroids also have an – OH functional group attached at a particular site. Such steroids are also classified as alcohols, and are thus called sterols. Examples of steroids :- cholesterol etc.



**2. Terpenes** :- These derived lipid compounds are produced from isoprene, which is a hydrocarbon having 5C – atoms. In general, these hydrocarbons and their oxygenated derivatives have lesser than 40 carbon atoms. The simplest terpenes are called monoterpenes and conform to the formula C10H16, those with the formula C15H24 are called as sesquiterpenes, with C20H32 as diterpenes and with C30H48 as triterpenes. They are found in many citrus plants and the family coniferae.



**3. Carotenoids** :- These are formed in plants. The carotenoids are lipophilic secondary metabolites isoprene derivatives. The carotenoids can exert important physiological functions in plants. They are essential components of the photosynthetic machinery, and play a critical role in preventing photooxidative damage. The importance of carotenoids for plant growth and development is evident since at least two major phytohormones, strigolactones and abscisic acid, are derived from carotenoid precursors. Other carotenoid, like lycopene, a red carotenoid pigment contained in tomato and watermelon, is a potent antioxidant. They are coloured red or yellow. Eg :- Lycopene carotenoid, the pigment of Tomato. Carotene carotenoid, the pigment of Carrot.

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