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LIPID METABOLISM

By

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LIPID METABOLISM

Introduction:

LIPIDS:

The lipid is one of the three major constituents of the diet (Lipids, Carbohydrates & proteins). It is primarily composed of C, H, & O in a ratio, which differ than in carbohydrates and in proteins. They contain in their structure the fatty acids, which are organic acids of high molecular weight. They have the common property of being insoluble in water and soluble in non-polar solvents e.g. chloroform, benzene, ether, etc.

Lipids are important dietary constituent due to their high-energy value (1 g =9.1 kcal) and due to the presence of fat-soluble vitamins (Vit. A, D, E & K) and essential fatty acids in the natural food.

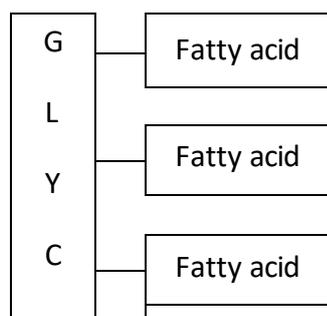
The main biological functions of lipids include storing energy (Triacylglycerols), signaling (steroid hormones), and acting as structural components of cell membranes (phospholipid, cholesterol).

Classification of Lipids:

I. Simple lipids:

They are esters of fatty acids and one of the various alcohols. They are divided into:

a. Fats and Oils: Esters of Fatty acids and glycerol .

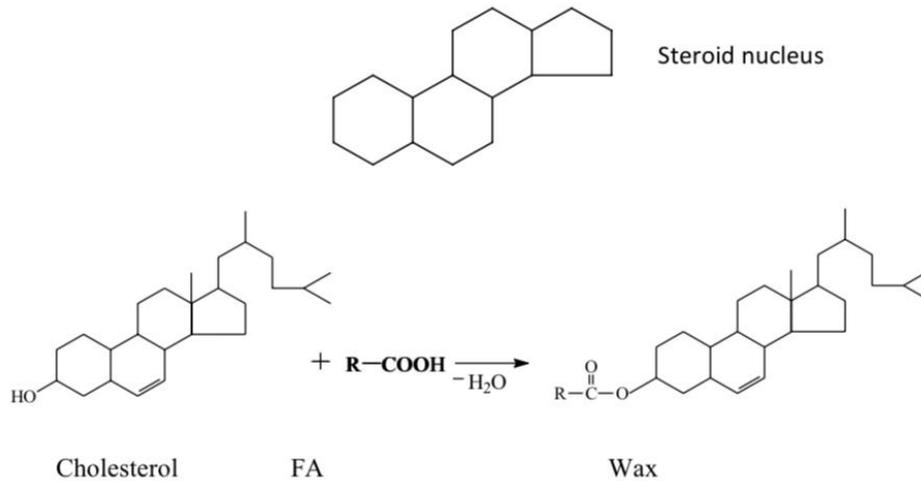




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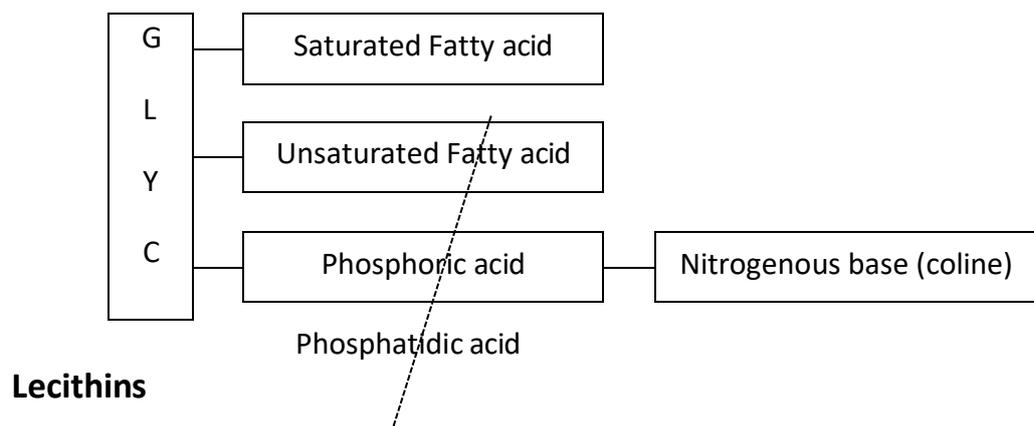


- a. Waxes: Esters of fatty acids with alcohol higher than glycerol e.g. steroids



II. Compound Lipids: It contains fatty acid + Alcohol + Other groups and according to the other groups, they are divided into:

1. Phospholipids (Phosphatides): They are compounds composed of fatty acids + Alcohol + Phosphoric Acid + Nitrogenous base.



e.g. Lecithin, Cephalins, Cardiolipins, Plasmalogens, & Sphingomylin.

2. Glycolipids (Cerbrosides): Contain simple sugar (usually Galactose) in addition to fatty acids and basic amino alcohol.





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3. Lipoproteins: Lipids combined with proteins.

4. Sulfolipids: Sulfur combined with lipids.

III. Derived lipids:

These include substances derived from the above groups by hydrolysis. This includes fatty acids (Saturated and unsaturated), Glycerol, steroids, alcohol in addition to fatty aldehydes & ketone bodies.

Review of certain points in chemistry of lipids:

1. Saturated and unsaturated fatty acids:

Saturated fatty acids have the general

formula $C_nH_{2n+1}COOH$. They

contain **no double bonds** in their

structure e.g.

Butyric acid----- C_3H_7COOH

Palmitic acid----- $C_{15}H_{31}COOH$

While the unsaturated fatty acids are characterized by the presence of one or more double bonds in their structure. They have the general formula $C_nH_{2n-1}COOH$ (If one double bond) e.g.

Palmitoleic acid $C_{15}H_{29}COOH$.

If two double bonds $C_nH_{2n-3}COOH$.

If three double bonds $C_nH_{2n-5}COOH$. And so on.



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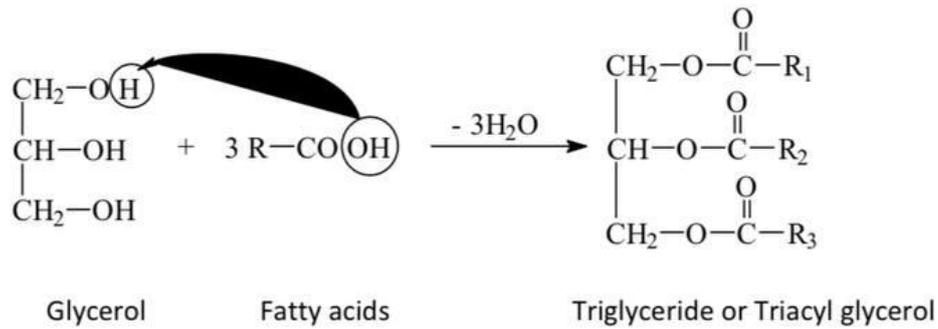


2. Fats and Oils:

Fats are solid at room temperature, while oils are liquid at room temperature. This is because fats contain saturated fatty acids while oils contain unsaturated (one or more double bonds) fatty acids. They are stored in the adipose tissues & serve as energy stores in addition they form an isolating layer in the subcutaneous tissues also surrounding certain vital organs to protect them from damage.



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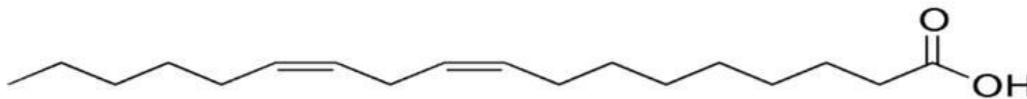
3. Essential Fatty acids:

They are:

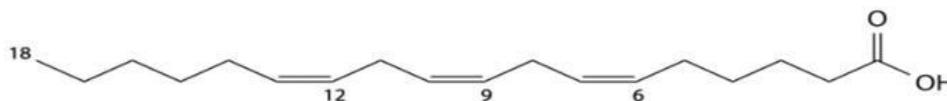
Linoleic acid (18:2)

Linolenic acid (18:3)

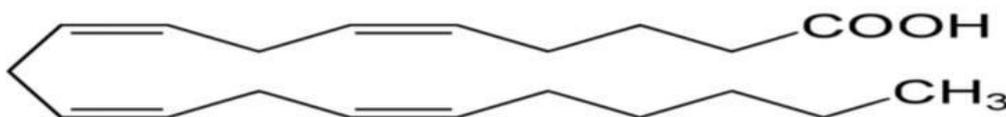
Arachidonic acid (20:4)



Linoleic acid (18:2)



Linolenic acid (18:3)



Arachidonic acid (20:4)

Linoleic acid (LA), a carboxylic acid, is a polyunsaturated omega-6 fatty acid, an 18-carbon chain with two double bonds in cis configuration. Found mostly in plant oils. It is used in the biosynthesis of prostaglandins and cell membranes.



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Linolenic acid, is a polyunsaturated omega-3 fatty acid, an 18-carbon chain with three double bonds in cis configuration.

Arachidonic acid is a polyunsaturated fatty acid present in the phospholipids of membranes of the body's cells, is a carboxylic acid with a 20-carbon chain and four cis-double bonds.

Three fatty acids are called essential as the body can not synthesis them and are required to be taken with food. They are characterized by the presence of two or more double bonds in their structure; they are also called Vitamin F. The essential fatty acids are necessary for the following reasons:

1. They are parts of the structural lipids (Phospholipids). These phospholipids contain one of the essential fatty acids and maintaining the structural property of the membrane
2. Necessary for mobilization of lipids inside the body .
3. They are involved in cholesterol metabolism as it increases its molecular weight allowing going to the intestine. Also, stimulate oxidation of cholesterol to bile acids.
4. Occur in high concentration in the reproductive organs. EFAs are required for sperm formation, the female cycle, and pregnancy.
- 5- **Cardiovascular Health.** Omega-3 fatty acids can modulate many cardiovascular disease (CVD) risk factors, including arrhythmia, high triglycerides, blood pressure.
- 6- **Weight Management.** EFAs help modulate fat production in the body. They also modulate fat burning and heat production in the body

3. Lipoproteins:

They are chemical combinations between lipids and proteins in order to convert the fatty acids and cholesterol, which are insoluble in aqueous medium to soluble one due to the presence of hydrophilic groups in the protein. Lipoproteins are important cellular constituents of the cell membrane and intracellular membrane e.g. nucleus and mitochondria.



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