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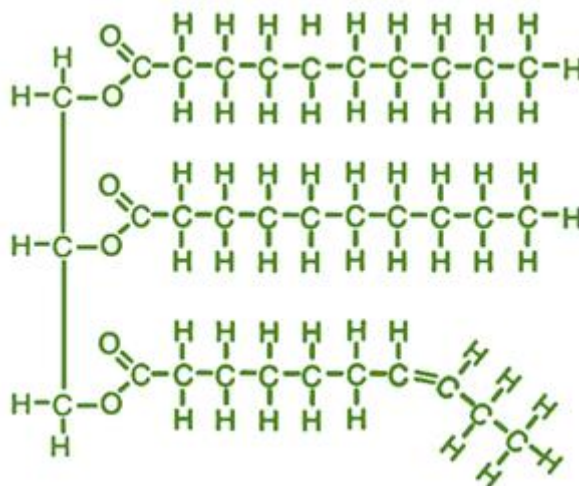
19FTB202- BIOCHEMISTRY FOR FOOD TECHNOLOGY

UNIT 2 - LIPIDS

TOPIC 2 & 3 Classification of Lipids- Simple, Compound and Derived Lipids & Introduction fatty acids and types of Fatty acids

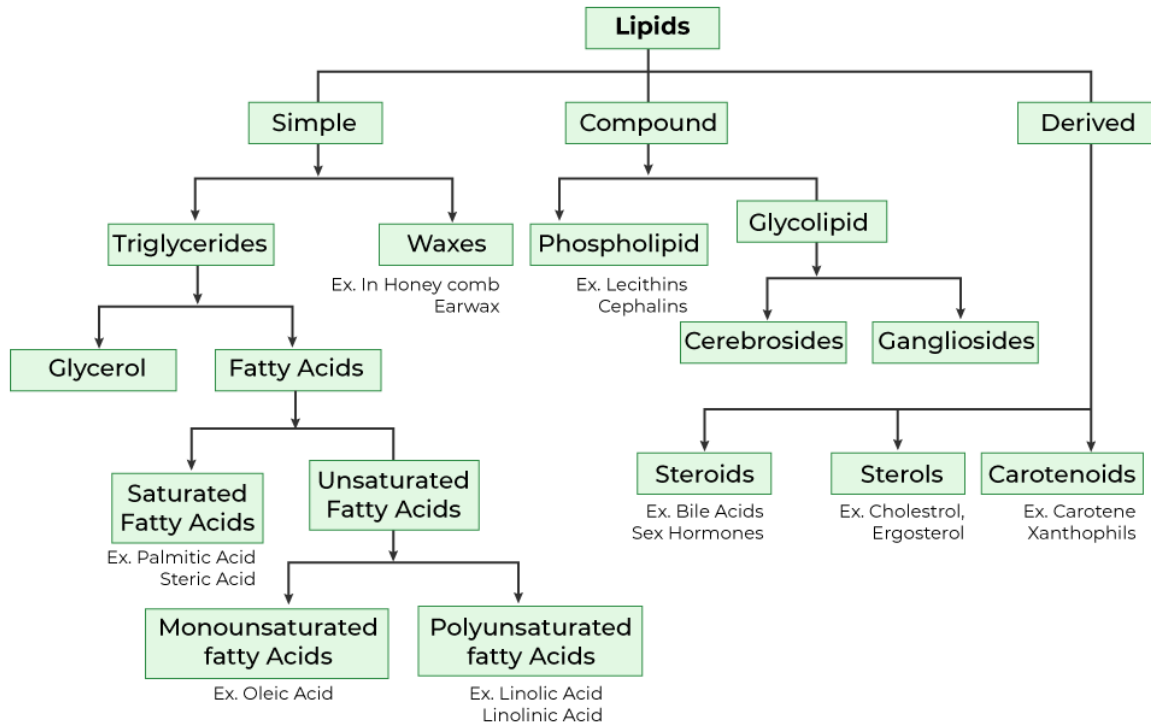
Lipid Structure

Lipids are made up of two molecules, glycerol, and fatty acids. Glycerol molecule consists of three carbon atoms with a hydroxyl group attached to them and Fatty acids are long chains of hydrocarbons with a carboxylic acid group at the end.



Function of Lipids

- They act as energy **storage**.
- Lipids play a very important role in the building up of biological **cell membranes**.
- It acts as **insulation**, a poor conductor of heat.
- Protecting the plant leaves from direct heat, and drying.
- They also act as **hormones** in the body.
- It acts as the structural component of the body and also acts as the hydrophobic barrier.
- A major source of energy in animals.
- It provides color to many fruits and vegetables with the presence of carotenoid pigment.



Types of Lipids

Lipids are mainly classified into three types. They are simple, complex, and derived lipids.

- **Simple Lipids:** Simple lipids are triglycerides, esters of fatty acids, and wax esters. The hydrolysis of these lipids gives glycerol and fatty acids.
- **Complex Lipids:** Complex or compound lipids are the esters of fatty acids with groups along with alcohol and fatty acids. Examples are Phospholipids, Glycolipids.
- **Derived lipids:** Derived lipids are the hydrolyzed compounds of simple and complex lipids. Examples are fatty acids, steroids, fatty aldehydes, ketone bodies, lipid-soluble vitamins, and hormones.

Simple Lipids

Simple lipids are triglycerides, esters of fatty acids, and wax esters. The hydrolysis of these lipids gives glycerol and fatty acids. Simple lipids are classified into Triglycerides and Waxes.

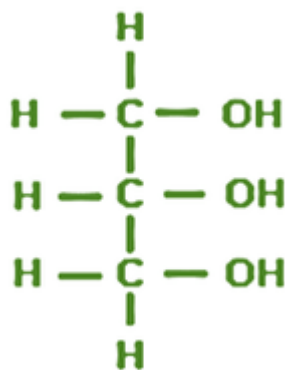
1. **Fats:** Fatty acids join with glycerol via ester bonds.
2. **Waxes:** Fatty acid join with a large molecular weight monohydric alcohol with an ester bond.

Triglycerides

Triglycerides are the lipid molecules that are esters formed from one glycerol molecule associated with three fatty acid molecules. They are the constituents of fats and oils. Lipids that are solid at room temperature are fats and lipids that are liquid at room temperature are oils.

Glycerol

It is a colorless, odorless, viscous liquid that is sweet-tasting and non-toxic. The glycerol backbone is found in those lipids known as glycerides. It is a simple polyol compound.



Complex Lipids

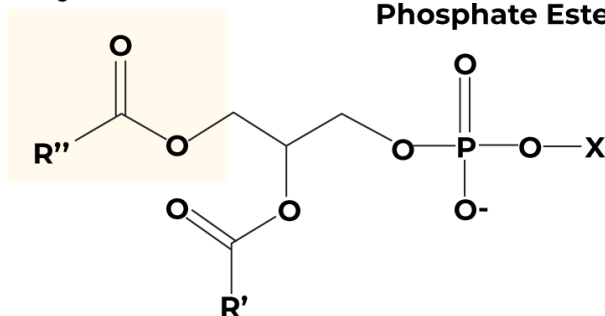
Complex or compound lipids are the esters of fatty acids with groups along with alcohol and fatty acids. Examples are Phospholipids, Glycolipids.

Phospholipids

Phospholipids are constituents of cellular membranes. An ester is formed when a hydroxyl reacts with a carboxylic acid and loses H_2O . Phospholipids also known as phosphatides are classes of lipids whose molecule has a hydrophilic head and two hydrophobic tails. A head containing a phosphate group and tails derived from fatty acids joined by a glycerol molecule. They serve as emulsifiers.

Fatty Acid Esters

Phosphate Esters



There are two types of phospholipids:

- **Glycerophospholipids:** Glycerophospholipids are the class of phospholipids containing glycerol as alcohol, two fatty acids, and phosphate. It is the most abundant lipid in the cell membrane.
- **Sphingophospholipids:** Sphingophospholipids are the class of phospholipids containing sphingosine as alcohol. It produces ceramide by an amide linkage to a fatty acid. Ceramide is an important component of skin. It acts as a second messenger to regulate **programmed cell death**.

Glycolipid

It is a structural lipid, an essential part of the cell membrane. They are lipids with a carbohydrate, attached by a glycosidic bond. They act as receptors at the surface of the red

blood cell. It helps in the determination of an individual blood group. It has an important role in maintaining of stability of the cell membrane. It kills pathogens to help the immune system of the body. Cerebrosides and Gangliosides are the two types of Glycolipids.

Precursor Lipids

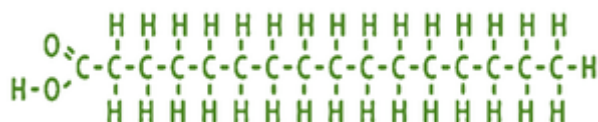
These are those lipids when simple and complex lipids are hydrolyzed and form different compounds. Some examples are- Fatty acids, Glycerol, and alcohol.

Fatty Lipids

Fatty acids are carboxylic acids; they are long chains of hydrocarbons with a carboxylic group at the end. Fatty acids are an important component of lipids, they are the building blocks of fat in the body. There are two types of fatty acids, saturated fatty acids, and unsaturated fatty acids.

Saturated Fatty Acids

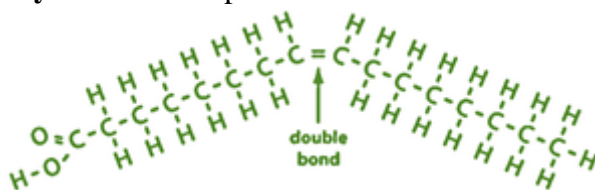
It consists of single C-C single bonds. These molecules fit closely together in a regular pattern and have strong attractions between fatty acid chains. These fatty acids have high melting points, which makes them solid at room temperature. Examples of saturated fatty acids are palmitic acid and stearic acid.



Unsaturated Fatty Acids

Unsaturated fatty acids are fatty acids that consist of one or more C=C double bonds. An unsaturated fatty acid is divided into two types.

1. **Mono polyunsaturated fatty acids:** Example: oleic acid.
2. **Polyunsaturated fatty acids:** Example: linoleic acid.



Role of Fats

Fats play an essential role in the body including:

- Fats help our body by absorbing and transporting important fat-soluble vitamins.
- They are an important source of essential fatty acids.
- They insulate and protect our vital body organs.
- Fats produce energy in the form of carbohydrates.
- Fats are the structural component of cells.
- They help the body produce and regulate hormones.
- Fats support cell growth.
- They maintain your core temperature.

- Maintains blood pressure and cholesterol under control.

Derived Lipids

Derived lipids are the hydrolyzed compounds of simple and complex lipids. Examples are fatty acids, steroids, fatty aldehydes, ketone bodies, lipid-soluble vitamins, and hormones.

Steroids

Steroids are found in the cell membrane and have fused ring structures. Many steroids have -OH functional groups, they are also hydrophobic and insoluble in water. All the steroids have 4 linked carbon rings and most of them have a short tail. Steroids also act as hormones in the body.

Sterols

Sterols are solid steroid alcohols that are widely present in plants and animals such as cholesterol and ergosterol. They are the subgroup of steroids, which naturally occur in most eukaryotes. They are found in animal products. They are used to make bile for digestion in the body. Sterols can have greater than half of the membrane lipid content in cells and they are known to alter membrane structure and fluidity.

Carotenoids

Carotenoids are lipid-soluble compounds. They are pigments that are mainly responsible for many of the yellow and red colors of plant and animal products. Carotenoids consist of carotenes and xanthophylls. A class of hydrocarbons is carotenes and its oxygenated derivatives are xanthophylls. They give color to many fruits and vegetables. They have antioxidant and anti-inflammatory properties for humans. Carotenoids are important in the health of the human eye.

Physical Properties of Lipids

- Lipids are insoluble in water.
- At room temperature, lipids either present liquid condition or non-crystalline solids condition.
- They act as energy storage molecules.
- They are soluble in organic solvents like alcohol, chloroform, benzene, etc.
- Fats consist of high proportions of saturated fatty acids.
- Fats and Oils of pure form are colorless, odorless, and tasteless.
- They even act as insulation.
- Oils consist of high proportions of unsaturated fatty acids.

Chemical Properties of Lipids

- **Halogenation:** Halogenation is the reaction in which the free or combined unsaturated fatty acids gain double bonds on reacting with halogens. This cause halogen solutions to decolorize.
- **Saponification:** It is the process of hydrolyzing triglycerides with an enzyme called lipase or hydrolysis with an alkaline form of two products.
- **Hydrogenation:** it is the process used for turning oils into fats. The hydrogenation process is used in industries to produce fat products. Butter is one example of the hydrogenation process. It involves breaking of double bonds of unsaturated fatty acids with hydrogen and turning them into hydrogenated (saturated) fatty acids.
- **Rancidity:** Rancidity is the undesirable state that occurs in oils, fats, and their products. Due to the oxidation of unsaturated fatty acids or hydrolysis of fats and oils, it produces an undesirable odor. In food industries, rancidity is one of the major concerns.
- **Hydrolysis of triglycerides:** Carboxylic acid and alcohol are produced by hydrolysis of triglycerides with water.