



Lipid

Lipids are a broad group of fatty, wax-like molecules found in the human body and other organisms. Lipids are organic compounds that are insoluble in water but soluble in organic solvents like chloroform, ether, benzene.

Monomers of the lipid

Fatty acids are the building blocks of all lipid types. Fatty acid consists of a straight chain of carbon atoms, with hydrogen atoms along the length of the chain and at one end of the chain and a carboxyl group (-COOH) at the other end. It is that carboxyl group that makes it an acid (carboxylic acid). Fatty acids classification based on the **number of double bond**:

Saturated fatty acids have Zero double bond like Stearic acid. This fatty acid is very stable, solid at room temperature. The tissues of animals contain large amounts of long-chain saturated fatty acids. Saturated fatty acid are ideal for cooking because of their natural ability to withstand heat without being damaged such as butter.

1. **Monounsaturated fatty acids** have one double bond like Oleic acid. This fatty acid is liquid at room temperature, solidify in the refrigerator, less stable than a saturated fatty acid molecule. These are good for cooking, but only at very low temperatures such as olive oil, oil in almonds, hazelnuts, and avocados.
2. **Polyunsaturated fatty acids** have two or more double bonds like Linoleic acid. This type are liquid both at room temperature and in the refrigerator, and they should never be used for cooking such as vegetable oils, soybean oil, flax seed oil, and sunflower oil.
3. **Cis and trans unsaturated fatty acids** : Cis fats are the typical form of

unsaturated fatty acids found in nature. In industrial products, the unsaturated fatty acid can be converted into saturated fatty acid by hydrogenation for economic advantages, but at high temperatures, during hydrogenation, the product still contains double bonds with hydrogen atom on incorrect position, these products called trans fats that raise the LDL (bad cholesterol)

Lipid classification based on the structure

1. Simple lipids (Esters of fatty acids with certain molecule)
 - ❖ Fats and Oils: which contain (fatty acids + glycerol) such as triglycerides, diglycerides and monoglyceride. A fat is solid at ordinary room temperature, but oil is liquid.
 - ❖ Waxes: which contain an ester of a long-chain of fatty acid + alcohol like some fruits, leaves, beeswax, protective coat in animals.
2. Compound lipids (Esters of fatty acids + Alcohol + other groups like phosphate, Nitrogenous base, carbohydrate, Protein):
 - ❖ Phospholipids (diglycerides): which contain two fatty acids + glycerol + phosphoric acid, found in the cellular membranes. Based on the type of alcohol:
 - ✓ Glycerphospholipids: Contain Glycerol as alcohol such as lecithin & cephalin
 - ✓ Sphingophospholipids: Contain sphingosine as alcohol such as sphingomyelin
 - ❖ Lipoprotein: lipid + protein complex. Based on the density, the types of lipoproteins are :
 - ✓ Chylomicron: is the largest lipoprotein molecule act to transport the triglycerides, cholesterol, phospholipid and protein into different tissues for storage.
 - ✓ Very low-density lipoprotein (VLDL) transport the synthesized triglycerides from the liver to the adipose tissues for storage.
 - ✓ Intermediate low-density lipoprotein (LDL)

- ✓ Low -density lipoprotein (LDL) called **bad cholesterol** because it transport the cholesterol and other lipid molecules around the body tissues.
 - ✓ High -density lipoprotein (HDL): called **good cholesterol** because it transport the cholesterol and other lipid molecules into the liver to be broken down.
 - ❖ Glycolipids: which contain fatty acids + carbohydrates ,their role is to maintain the stability of the cell membrane and during immune response facilitate cellular recognition.
 - ❖ Other compound lipids: Sulpholipids (brain and nervous tissues), Aminolipids and other Lipopolysaccharides
3. Derived lipids are the substances derived from simple and compound lipids by hydrolysis:
 - ✓ Ketone bodies
 - ✓ Eicosanoid
 - ✓ Steroids
 - ✓ Alcohol
 - ✓ Fatty acids
 4. Miscellaneous lipids: vitamin E & K, carotenoids, squalene, hydrocarbons like pentacosone and Terpenes .

Function

1. Cell membrane molecules as receptors, antigens and membrane anchors for proteins
2. Steroid hormone synthesis like estrogens, androgens and cortisol
3. Bile production
4. Energy storage and utilization

Lipid metabolism

Exogenous lipid metabolism

Gastrointestinal lipolysis

1. In mouth: digestion of exogenous lipid begin in the mouth through chemical digestion by **lingual lipase** (secreted from **Ebner's glands**).
2. In stomach: lipids continue to the stomach where chemical digestion continues by **gastric lipase** (secreted from gastric chief cells in the fundic mucosa in the stomach) and mechanical peristalsis digestion.
3. In small intestine:
 - ✓ **Bile acids** will emulsify lipid by broken down a large lipid molecules into small lipid aggregates.

- ✓ the hormone cholecystokinin (CCK) stimulate pancreas to secrete **Pancreatic lipase** that act to hydrolysis of the triglycerides into free fatty acids and glycerol units to be absorbed into the small intestinal epithelial cells. Ingested cholesterol is not broken down by the lipases and stays intact until it enters the epithelium cells of small intestine.
- 4. Once the triglycerides are broken down into **free fatty acids and glycerol with cholesterol, and other molecules** will aggregate into structures called **micelles**. The micelles bump its contents to enter the brush border enterocytes by simple diffusion while the cholesterol enter to the enterocytes by special channels.
- 5. Inside the epithelial cell cytosol, free fatty acids and glycerol are recombined back into triglycerides, then **triglycerides with cholesterol**, phospholipid and proteins are packaged into bigger particles called **chylomicrons**.
- 6. Chylomicrons are leave the enterocytes via exocytosis into the space outside the cells. Chylomicrons are transport through lacteals into lymph, thoracic duct, and ultimately into the bloodstream then attach the cells.
- 7. Lipoprotein lipase in the luminal surface of capillary-endothelial cells hydrolyze the triglycerides of the chylomicron to release free fatty acid and glycerol across the cell membrane for direct use as energy source or recombined to form triglycerides for storage. After that the chylomicron remnant go to the liver for dissociation its remnant contents.