



Lec5 Lipids

Lipids

A lipid is a fatty, oily, or waxy compound that is insoluble in water (hydrophobic). It is a combination of alcohol (glycerol) and fatty acids.

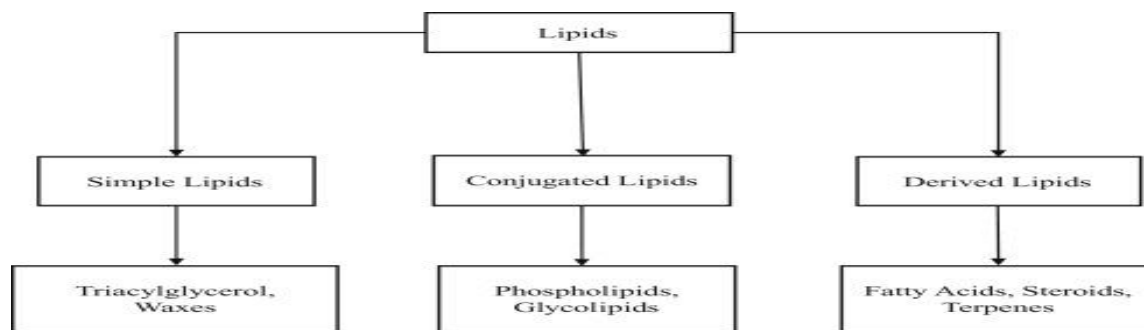
Lipids are an important component Together with carbohydrates and proteins, and they are considered as one of the main constituents of living tissues and food

The importance of Lipids

- 1-Fats are stored in the tissues as energy storage, which is used after the stored sugars run out.
- 2-Fats are basic structural components of cell structure such as cell membrane.
- 3-Fats and proteins combine to form lipoproteins, this type transport fats through the blood
- 4- involved in synthesis of steroid hormones as cortisol and testosterone .
- 5-The presence of fats in the food gives a feeling of satiety, due to the slow digestion and absorption of fats
- 6-There are unsaturated fatty acids of great importance, such as omega fatty acid, which decrease LDL and increase HDL and thus reduces heart disease.

Classification of lipids

- 1- Simple lipids: contain Neutral lipids, waxes
- 2- Conjugated lipids: contain phospholipids, Glycolipids, Lipoproteins, Chlorolipids.
- 3-Derived lipids: contain Steroids, Sterols, Terpenes

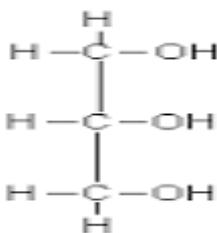


Neutral lipids:

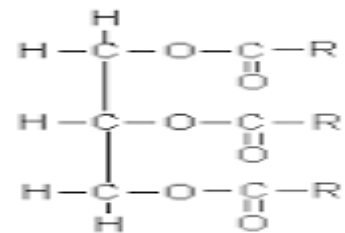
Triglyceride: They are the esters of three fatty acids with (glycerol) and its main storage form of lipid in our body.



Fatty acid



Glycerol



Triacylglycerol

Waxes: They are the esters of fatty acids with alcohols of high molecular weight. It is the main component of beeswax.

Conjugated lipids

Phospholipids: A phospholipid is a type of lipid molecule that is the main component of the cell membrane. A phospholipid is made up of two fatty acids and glycerol with the addition of a phosphate group.

For examples: Lecithin (phosphatidyl choline), plasmalogen, phosphatidic acid, sphingomyelin.

Phosphatidyl choline (lecithin)

These are most abundant phospholipids of the cell membrane having both structural and metabolic functions.

lecithin is found in lungs, secreted by pulmonary type II epithelial cell. It acts as a lung surfactant and is necessary for normal lung function. It reduces surface tension in the alveoli, thereby prevents alveolar collapse

In its absence, the lungs tend to collapse and this condition is known as **respiratory distress syndrome**.

Glycolipids: They are compounds that contain sugars and fatty acids and do not contain phosphoric acid such as cerebrosides they are founds in Liver, Nervous tissue, Brain.

Lipoproteins: are formed by combination of lipid with protein, e.g. serum lipoproteins like:

- Chylomicrons
- Very low-density lipoprotein (VLDL)
- Low density lipoprotein (LDL)
- High density lipoprotein (HDL).

Derived lipids

Includes saturated and unsaturated fatty acids, steroids, Terpenes

1-fatty acids:

Saturated fatty acids: there is **no double bond** in these fatty acids such as Palmitic acid is found naturally in palm and butter, cheese, milk and meat.

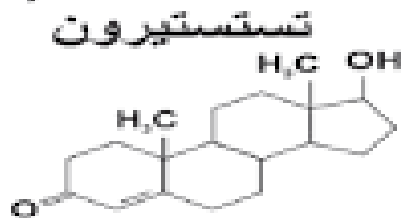
such as palmitic acid.

***Unsaturated fatty acids:** which **have double bonds**

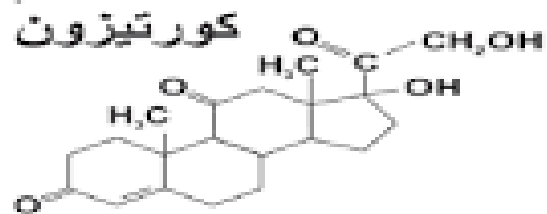
such as oleic acid that is an omega-9 monounsaturated fatty acid found in various animal and vegetable sources.

2-steroides: It is a group of hydrocarbon rings that combined with some fatty acids and for example of steroids: cholesterol, vitamin D and hormones as : testosterone, estrogen and cortisol

(a) Testosterone



(b) Cortisone



(c) Vitamin D



(d) Cholesterol



Lec.6 Lipoproteins

LIPOPROTEINS

- Lipoproteins are large water-soluble complexes formed by a combination of lipid and protein that transport insoluble lipids through the blood between different organs and tissues.
- Lipoproteins consist of a lipid core containing nonpolar triacylglycerol and cholesterol ester surrounded by layer of phospholipid
- **Triacylglycerol** is the predominant lipid in chylomicrons and VLDL. **Cholesterol** is the predominant lipid in LDL.
- **HDL** containing 50 percent of protein and 50 percent of lipid so **it has the highest density**.

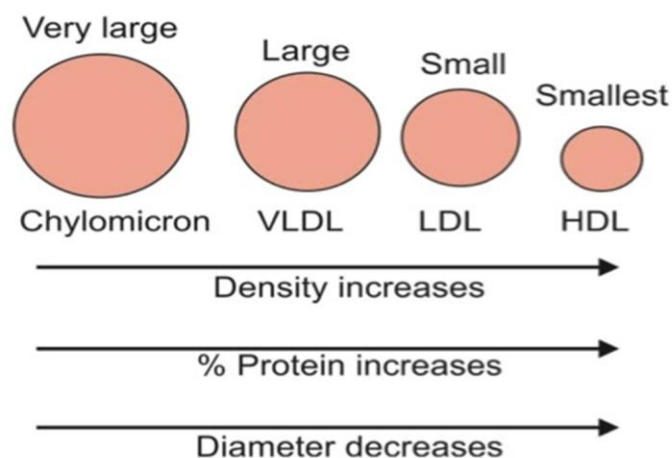
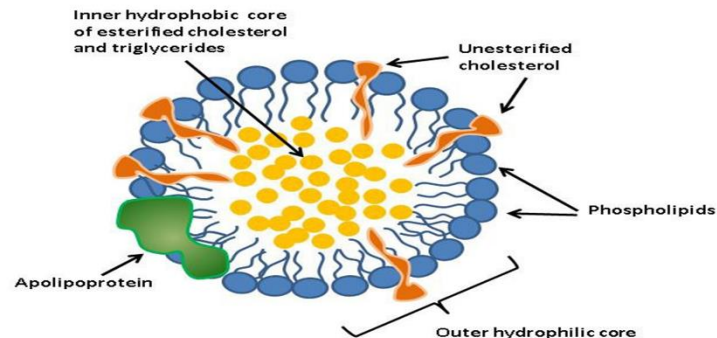


Figure 3.14: Diagrammatic representation of lipoprotein with increasing densities

Metabolism of Chylomicrons

Cholesterol and fatty acids released from dietary fats after absorption they are re-esterified to form cholesterol esters and triacylglycerols. These together with phospholipids and **apo B-48** form chylomicrons.

- **Chylomicrons are composed of:**
- Triacylglycerols (85 – 90%)
- Cholesterol and cholesterol ester(5%)
- Phospholipids
- Protein (apolipoprotein B-48).



- After a fatty meal, the plasma is milky in appearance (**lipemia**) due to the presence of **chylomicrons**.
- Normally the lipemia clears within a few hours by the uptake of chylomicrons by tissues

In the peripheral tissues there is **Lipoprotein lipase enzyme** that work on chylomicron hydrolyzes triacylglycerol to fatty acid and glycerol. The fatty acids are taken up by adipose cells (**for storage as triglyceride**) and muscle cells as an energy source.

As the chylomicrons loses triacylglycerol, called **chylomicron remnants** which are taken up by the liver receptors.

Metabolism of VLDL

- The **hepatic triacylglycerol** and cholesterol are transported in the form of VLDL.
- This triacylglycerol rich particle contains **apo B-100**
- Like chylomicrons VLDL-triacylglycerol is hydrolyzed by lipoprotein lipase in the peripheral tissues
 - triacylglycerol removal by lipoprotein lipase results with formation of cholesterol rich LDL.

Metabolism of LDL

- LDL is formed from VLDL metabolism as discussed above. LDL is a small cholesterol rich lipoprotein containing only apo B-100.
- LDL is removed from the circulation by the binding of LDL to specific LDL receptor present on the cell of liver and other peripheral tissue.

Metabolism of HDL

- HDLs are synthesized and secreted from liver as disk shaped nascent HDL particles that consist primarily of phospholipids, **cholesterol** and **apo A-1** as the main apolipoproteins

HDL picks up cholesterol from other lipoproteins and peripheral tissue then HDL enter the liver where cholesterol removed from HDL and used in other functions

- **Reverse cholesterol transport prevents deposition of cholesterol in the tissues and is thought to be antiatherogenic. An elevated HDL cholesterol (good cholesterol) level decreases the risk of coronary heart disease.**

Table 3.3: The four main lipoproteins and their site of synthesis and function

<i>Lipoprotein</i>	<i>Site of synthesis</i>	<i>Function</i>
Chylomicrons	Intestine	Transport of dietary lipids from intestine to peripheral tissues
VLDL	Liver	Transport of triacylglycerol from liver to peripheral tissues
LDL	Plasma VLDL	Transport of cholesterol from liver to peripheral tissues
HDL	Liver and intestine	Transport of free cholesterol from peripheral tissues to the liver (Reverse cholesterol transport)

Cholesterol functions

- The cells may use this cholesterol to **maintain their cell membranes**.
- In specific tissue such as adrenal cortex, or gonads this cholesterol is utilized in **steroid hormone synthesis**.
- Liver uses this cholesterol for **synthesis of bile acids**.

ATHEROSCLEROSIS

High level of serum cholesterol results in atherosclerosis. The atherosclerosis is characterized by hardening and narrowing of the arteries due to deposition of cholesterol and other lipids in the inner arterial wall which leads to formation of plaque (sticky deposit) and results in the endothelial damage and narrowing of the arterial lumen that's end with coronary heart disease (CHD).

