LIPOPROTEINS

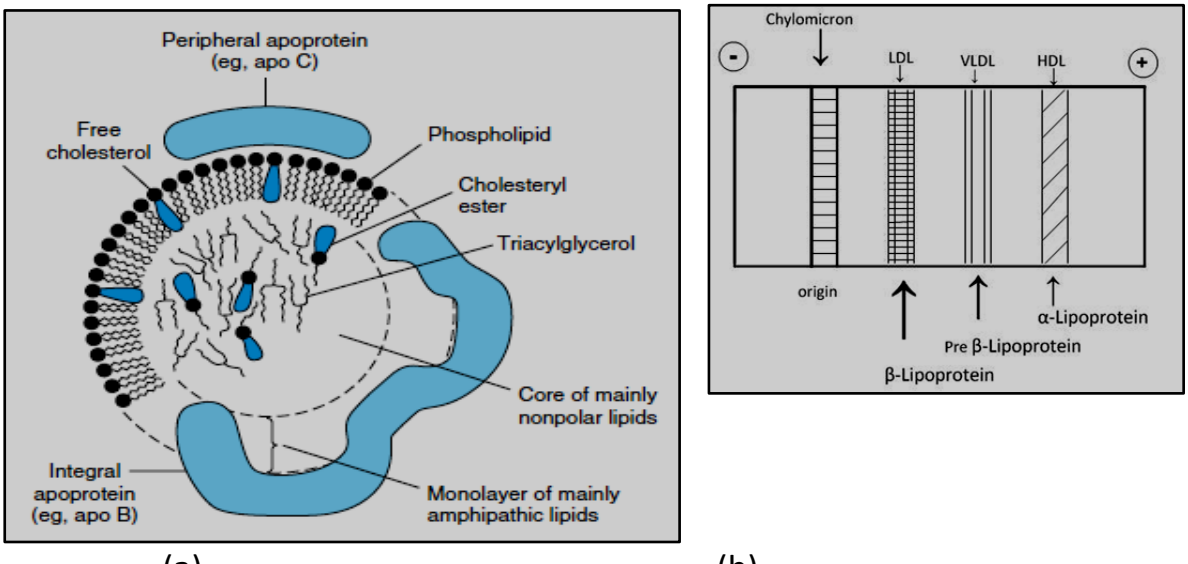
They are lipids protein complexes found in plasma. They are non-covalent assemblies. The protein part of lipoprotein is called as *apolipoprotein* or *apoprotein*. Non-covalent forces hold the apoprotein and lipids together.

Structure

Lipoprotein structure consists of non-polar lipid core surrounded by apoproteins and more polar lipids. The outer apoprotein and polar lipid coat of lipoprotein solubilizes these lipid rich particles in aqueous plasma.

Classification of lipoproteins

1. Based on their **density**, the lipoproteins of blood plasma are classified into four classes. The four of lipoproteins can be separated by ultra-centrifugation. Density of lipoproteins is inversely related to the lipid content. The greater the lipid content, lower is the density. Different classes of lipoproteins based on the density are 1. **chylomicrons**, 2. **Very low-density lipoproteins**, 3. **Low-density lipoproteins** and 4. **High-density lipoproteins**.
2. Different classes of plasma lipoprotein can be separated by electrophoresis. Based on **differences in electrophoretic mobilities** the plasma lipoproteins are classified into four classes. They are: 1. **α-lipoproteins**, 2**. Pre-β-lipoproteins**, 3. **β-lipoproteins** and 4. **Chylomicrons**.



(a) (b)

Figure 3.5. (a) Plasma lipoprotein general structure.
(b) Electrophoresis lipoproteins

The similarities with the structure of the plasma membrane are to be noted. Small amounts of cholesteryl ester and triacylglycerol are to be found in the surface layer and a little free cholesterol in the core.

Composition of Lipoproteins

Lipids of lipoproteins

The lipid constituents of lipoproteins are mostly triglycerides, free and esterified cholesterol and phospholipids. The non-polar triglyceride and cholesterol ester are usually present in the core of lipoproteins whereas polar phospholipids along with apoprotein forms outer coat. However, the proportion of triglycerides, cholesterol and phospholipids differs in various lipoproteins. (Table 3.5).

Table 3.5 Composition of the lipoproteins in plasma of humans

Lipoprotein	Source	Diameter (nm)	Density (g/mL)	Composition		Main Lipid Components	Apolipoproteins
				Protein (%)	Lipid (%)		
Chylomicrons	Intestine	90–1000	< 0.95	1–2	98–99	Triacylglycerol	A-I, A-II, A-IV,[1] B-48, C-I, C-II, C-III, E
Chylomicron remnants	Chylomicrons	45–150	< 1.006	6–8	92–94	Triacylglycerol, phospholipids, cholesterol	B-48, E
VLDL	Liver (intestine)	30–90	0.95–1.006	7–10	90–93	Triacylglycerol	B-100, C-I, C-II, C-III
IDL	VLDL	25–35	1.006–1.019	11	89	Triacylglycerol, cholesterol	B-100, E
LDL	VLDL	20–25	1.019–1.063	21	79	Cholesterol	B-100
HDL	Liver, intestine, VLDL, chylomicrons					Phospholipids, cholesterol	A-I, A-II, A-IV, C-I, C-II, C-III, D,[2] E
HDL_1		20–25	1.019–1.063	32	68		
HDL_2		10–20	1.063–1.125	33	67		
HDL_3		5–10	1.125–1.210	57	43		
Preβ-HDL[3]		< 5	> 1.210				A-I
Albumin/free fatty acids	Adipose tissue		> 1.281	99	1	Free fatty acids	

Abbreviations: HDL, high-density lipoproteins; IDL, intermediate-density lipoproteins; LDL, low-density lipoproteins; VLDL, very low density lipoproteins.
[1]Secreted with chylomicrons but transfers to HDL.
[2]Associated with HDL_2 and HDL_3 subfractions.
[3]Part of a minor fraction known as very high density lipoproteins (VHDL).

Apoprotein of lipoprotein

The proportion of protein part differs in various lipoproteins (Table 3.5). Further, the composition part also differs among various lipoproteins. There are five types of apoproteins. They are apoprotein A, apo B, apo C, apo D and apo E. some of the apoproteins have subtypes also. Subtypes of apo A, apo B, apo C are A-I, II; B-48, B-100 and C-I, II, III respectively. Apo-B is the largest of all apoproteins. It is glycoprotein contains Sialic acid, mannose, glucose, Galactose and fucose. The composition of various lipoproteins is shown in Table 3.5. other little known apoprotein are apo F, apo G and apo H.

Function of lipoproteins

Lipoprotein are involved in the transportation of lipids in the body.

1. **Chylomicrons** they transport dietary or exogenous triglycerides from intestine to liver.
2. **Very low density lipoproteins (VLDL)** they are involved in the transport of endogenous triglycerides from liver to extra hepatic tissues.
3. **Low density lipoproteins** (**LDL)** LDL is the major vehicle for the transport of cholesterol from liver to extra hepatic tissues.
4. **High density lipoprotein (HDL)** HDL is the major vehicle for the transport of cholesterol from extra hepatic tissues to liver.

Other noteworthy function of lipoproteins

In addition to their structural function, apolipoproteins have other function also. They are:

1. Important for synthesis and degradation of lipoproteins.
2. Activators/inhibitors of some enzymes associated with lipid metabolism.

LIPID LAYERS, MICELLES AND LIPOPROTEINS

Lipids like triglycerides are insoluble in water because they contain non-polar hydrophobic hydrocarbon chain. Similarly, cholesterol is also insoluble in water because of hydrophobic steroid nucleus.

Amphipathic molecules

Lipids like cholesterol, phospholipids and bile salts contain both water soluble polar head group and water insoluble non-polar tail. Since they have two very different kinds of groups these molecules are called as ' amphipathic molecules' (Fig. 3.6).

Lipid monolayer

When amphipathic molecules like phospholipids are present in water, their polar head groups orient towards water phase and hydrophobic tails towards air. As a result, a unimolecular lipid layer is formed at water air interphase. Figure 3.6.

Micelles

When amphipathic lipids are present beyond a critical concentration in aqueous medium, they aggregate into spheres. The sphere aggregates of the amphipathic lipids are known as micelles. (Figure 3.6). In the sphere shaped micelles polar head groups of amphipathic lipids are on the exterior whereas the non-polar tails are in the interior. Bile salts can form micelles.

Lipid Bilayer

Structure

When phospholipids are present in water oil mixture, their polar head group orient towards water and non-polar tails towards oil. As a result, lipid Bilayer is formed (Figure 3.6). Lipid bilayer is formed even in the absence of oil phase because of hydrophobic attraction.

Function

Lipid bilayer is the basic structure of cell membrane.

Mixed micelles

Structure

They are also micelles but they may be composed of various types of amphipathic lipids. They are formed when micelles of particular lipid combine with other lipids. During the digestion and absorption of lipids, micelles of bile salts combines with products of lipid digestion and forms mixed micelles. (Figure 3.6).

Function

Formation of mixed micelles is very important for digestion and absorption of lipids. Mixed micelles are also formed during cleaning action of soap and detergents.

Liposomes

Structure

When lipid bilayer closes on itself a spherical vesicle called as 'liposome' is formed (Figure 3.6).

Functions

1. Liposomes are used as carrier of cettain drugs to specific site of body where they act. They can deliver drugs directly into cell because they easily fuses with cell membranes
2. They are used in cancer therapy to deliver drugs only to cancer cells.
3. In gene therapy also they are used as vehicles for genes.

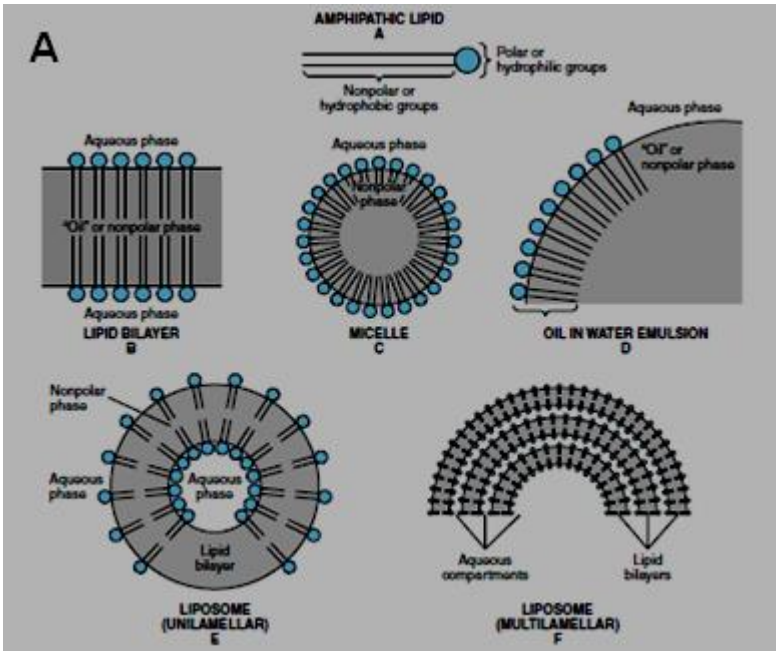
Lipoprotein X (LpX).

Structure

1. It is a variant of LDL. It contains apo C as well as albumin.
2. It is a bilammallar vesicle with an aqueous lumen. It contains equal amounts of phospholipids and cholesterol. Triglycerides and cholesterol esters are present in only small amounts (2 to 3%).

Medical importance

1. It appears in the plasma of cholestatic patient. It may be formed in bile and enters plasma due to regurgitation that occurs in cholestatic individuals.
2. It interacts with other lipoproteins present in plasma.



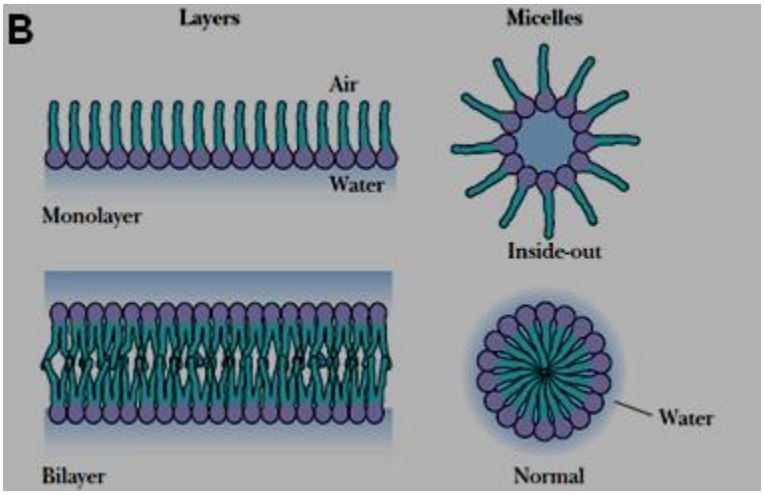


Figure 3.6 A & B Several spontaneously formed lipid structures