Plasma/Serum Lipids and Lipoproteins

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I will cover this topic in three lectures

1. Definition and description the form of lipids in blood stream

2. Disorder of lipid metabolism

3. Case study

Lipids play a critical role in almost all aspects of biological life

- They are structural components in cells
- Are involved in metabolic and hormonal pathways.

Lipids are defined as organic compounds that are poorly soluble in water but miscible in organic solvents.

PLASMA LIPIDS

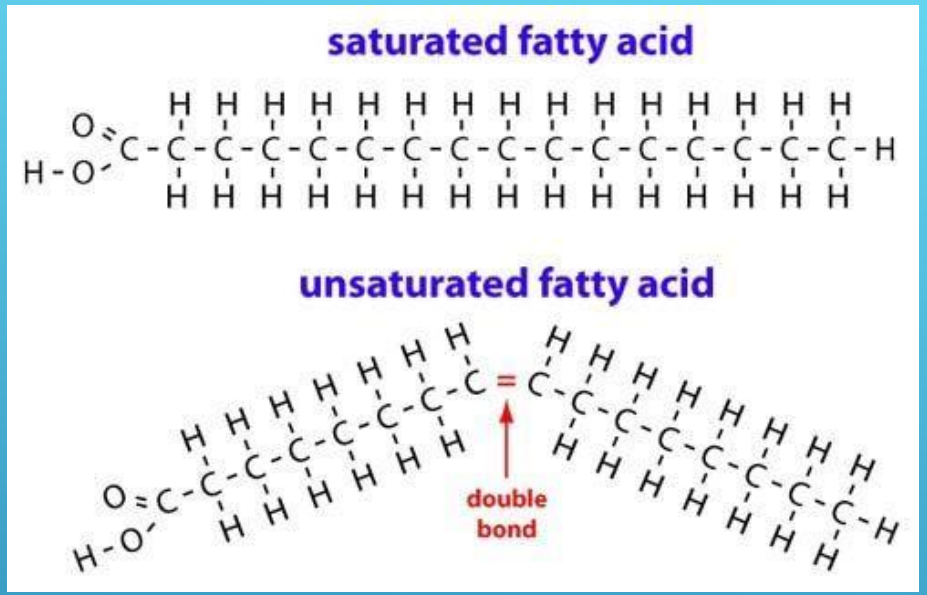
1. Fatty acid

These are straight-chain carbon compounds of varying lengths. They may be saturated, containing no double bonds, monounsaturated, with one double bond, or polyunsaturated, with more than one double bond.
Fatty acids can esterify with glycerol to form triglycerides or be non-esterified (NEFAs) or free. Plasma NEFAs liberated from adipose tissue by lipase activity are transported to the liver and muscle mainly bound to albumin. The NEFAs provide a significant proportion of the energy requirements of the body.

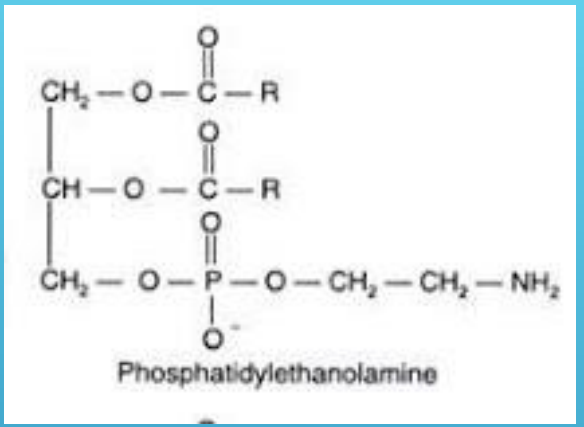
2. Triglyceride

Triglyceride is formed by esterified NEFAs and Glycerol. Triglycerides are transported from the intestine to various tissues, including the liver and adipose tissue, as lipoproteins. Following hydrolysis, fatty acids are taken up, re-esterified and stored as triglycerides. Plasma triglyceride concentrations rise after a meal, unlike that of plasma cholesterol.

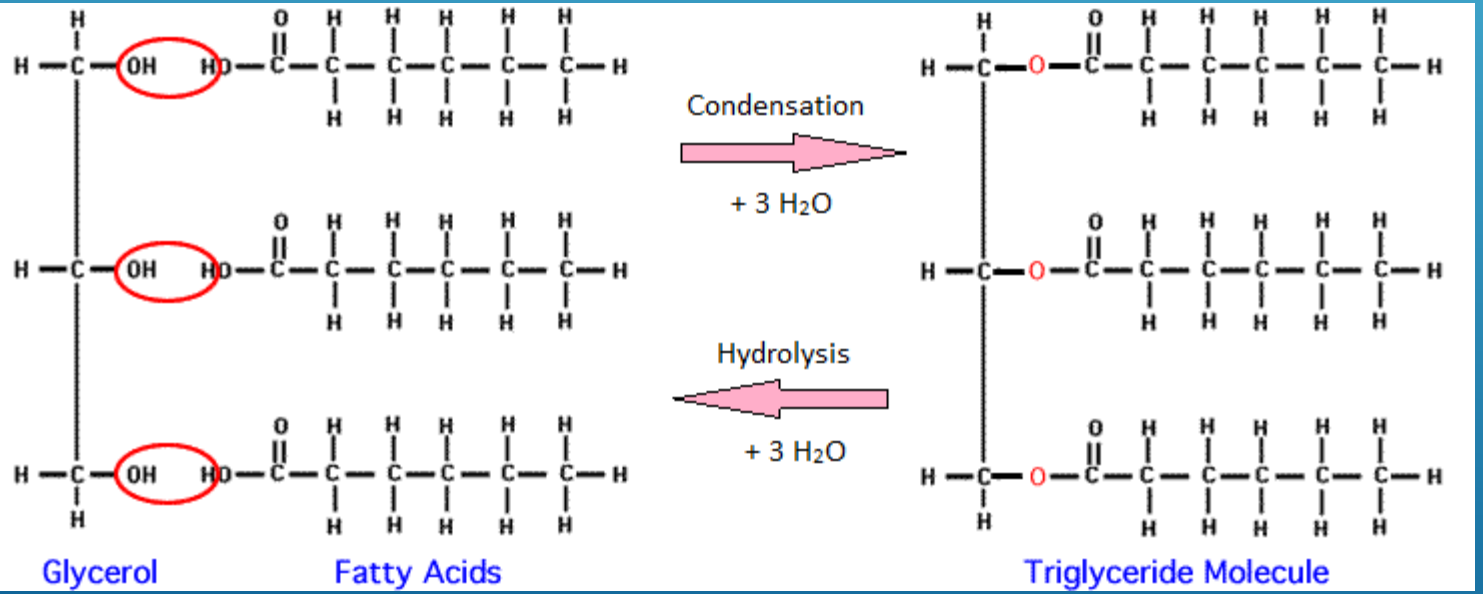
A


saturated fatty acid
unsaturated fatty acid
double bond

C


Phosphatidylethanolamine

B

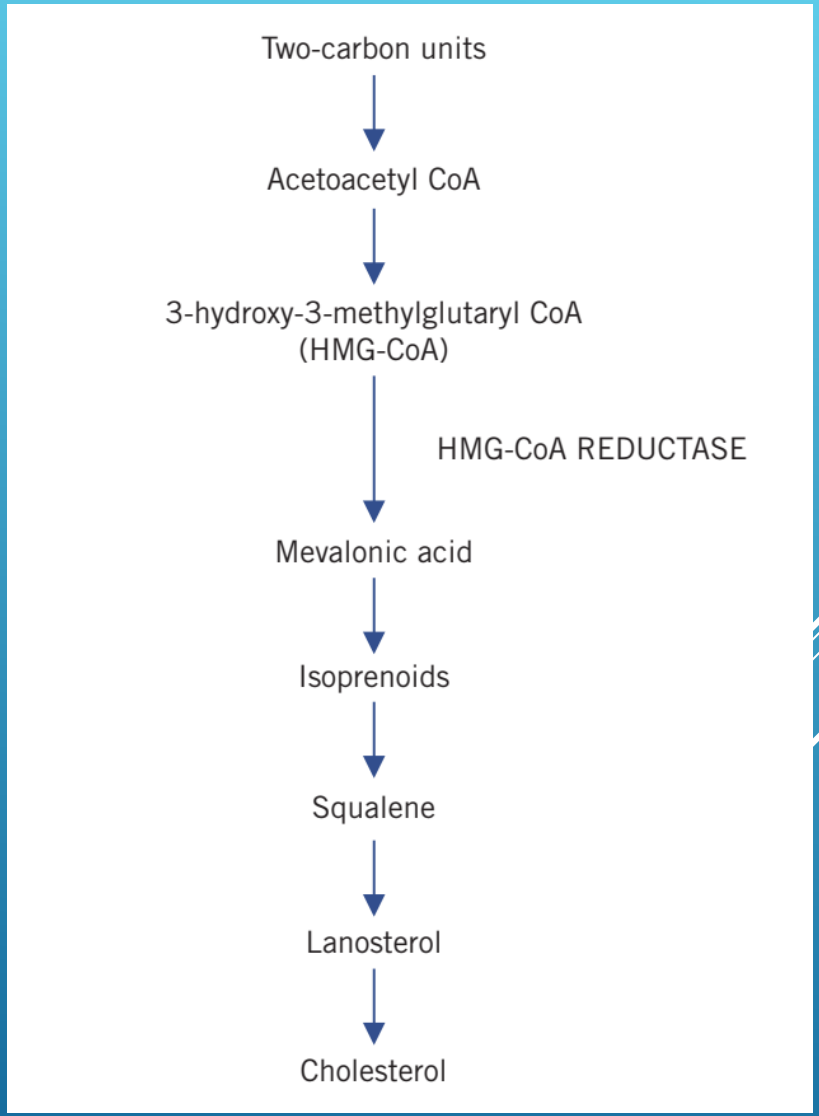

Condensation
+ 3 H2O
Hydrolysis
+ 3 H2O
Glycerol
Fatty Acids
Triglyceride Molecule

3. **Phospholipids**

are complex lipids, similar in structure to triglycerides but containing phosphate and a nitrogenous base in place of one of the fatty acids. They fulfil an important structural role in cell membranes, and the phosphate group confers solubility on nonpolar lipids and cholesterol in lipoproteins.

4. **CHOLESTEROL**

Cholesterol, is a steroid alcohol found exclusively in animals and present in virtually all cells and body fluids. It is a precursor of numerous physiologically important steroids, including bile acids, steroid hormones and Vitamin D. A summary of the cholesterol synthetic pathways is shown in Figure. The rate-limiting enzyme is 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMG-CoA reductase), which is controlled by negative feedback by the intracellular concentration. About two-thirds of the plasma cholesterol is esterified with fatty acids to form cholesterol esters.

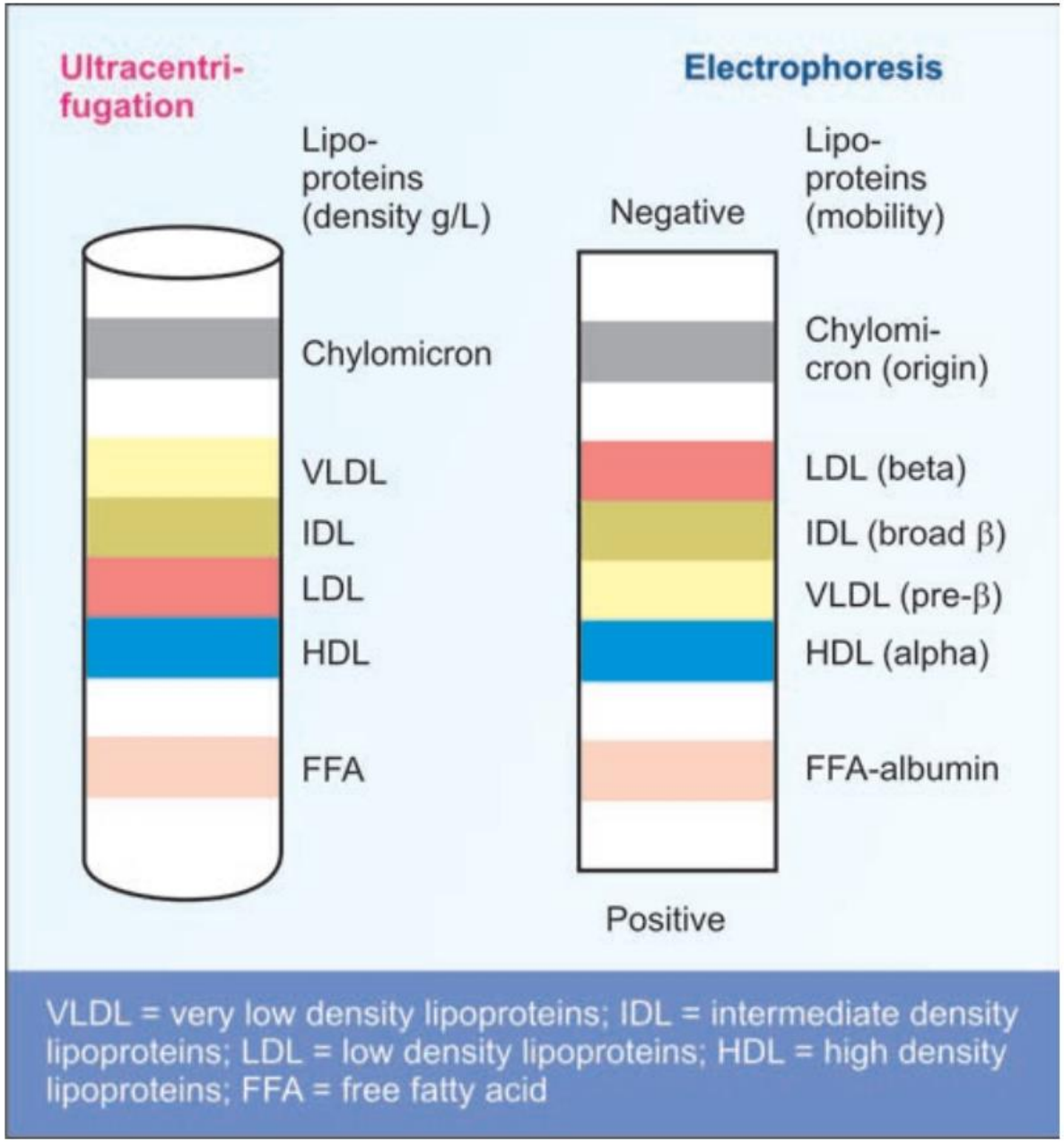


LIPOPROTEINS

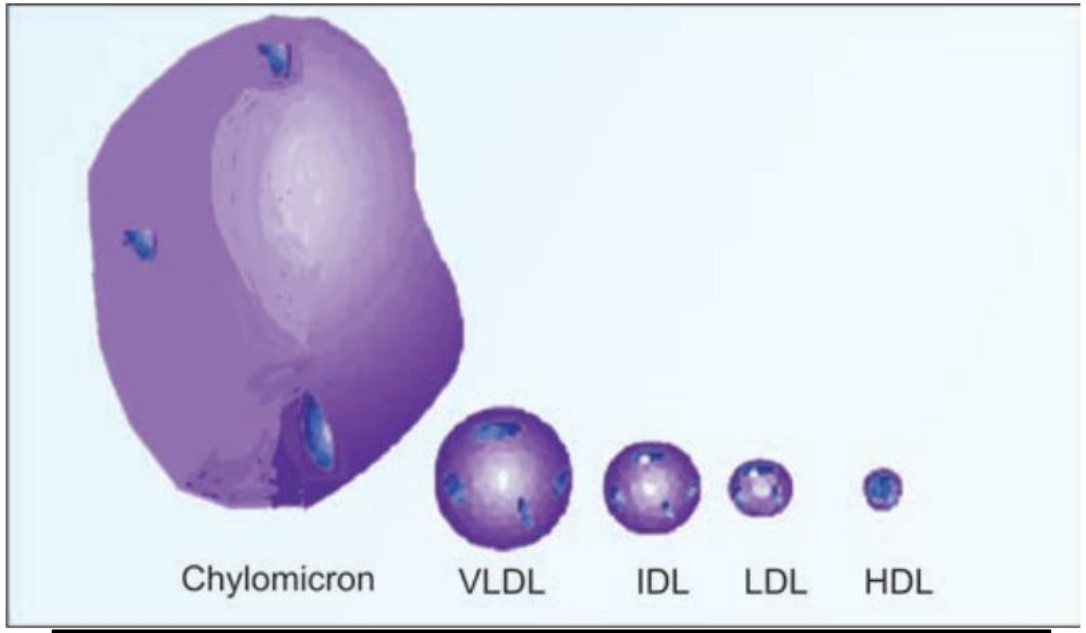
Because lipids are relatively insoluble in aqueous media, they are transported in body fluids as, often spherical, soluble protein complexes called lipoproteins. Lipids can be derived from food (exogenous) or synthesized in the body (endogenous). The water-soluble (polar) groups of proteins, phospholipids and free cholesterol face outwards and surround an inner insoluble (nonpolar) core of triglyceride and cholesterol esters.

Lipoproteins are classified by their buoyant density, which inversely reflects their size. The greater the lipid to protein ratio, the larger their size and the lower the density. Lipoproteins can be classified into five main groups. The first three are triglyceride rich and, because of their large size, they scatter light, which can give plasma a turbid appearance (lipaemic) if present in high concentrations:

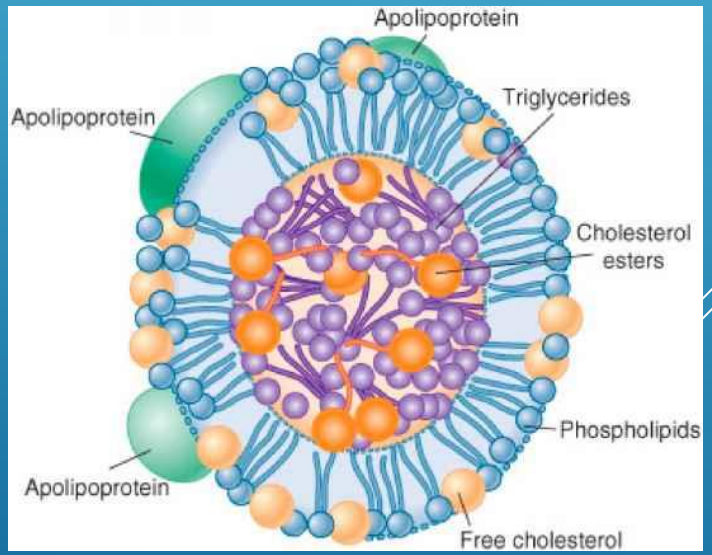
- **Chylomicrons** are the largest and least dense lipoproteins and transport exogenous lipid from the intestine to all cells.
- **Very low-density lipoproteins (VLDLs)** transport endogenous lipid from the liver to cells.
- **Intermediate-density lipoproteins (IDLs),** which are transient and formed during the conversion of VLDL to low-density lipoprotein (LDL), are not normally present in plasma. The other two lipoprotein classes contain mainly cholesterol and are smaller in size:
- **Low-density lipoproteins (LDL)** are formed from VLDLs and carry cholesterol to cells.
- **High-density lipoproteins (HDLs)** are the most dense lipoproteins and are involved in the transport of cholesterol from cells back to the liver (reverse cholesterol transport). These lipoproteins can be further divided by density into HDL2 and HDL3.



Comparison of electrophoretic and ultracetrifuge patterns of lipoproteins



Comparison of sizes of lipoproteins



Structure of lipoprotein

General Characteristics of Lipoproteins

Their salient characteristics and compositions are given in Table.

[redacted] Characteristics of different classes of lipoproteins

	Chylomicron	VLDL	IDL	LDL	HDL	FFA (*)
Density g/ml	<0.95	0.95-1.006	1.006-1.019	1.019-1.063	1.063-1.121	1.28-1.3
Diameter (nm)	500	70	30	25	15	-
Electrophoretic mobility	origin	pre-beta	broad beta	beta	alpha	albumin
% composition						
Protein	2	10	20	20	30-60	99
TAG	80	50	30	10	10	0
Phospholipids	10	20	20	20	20-30	0
Cholesterol	8	20	30	50	10-30	0
FFA	0	0	0	0	0	1
Apoproteins	A,B-48,C-II,E	B-100, C-II,E	B-100, E	B-100	A-I, C, E	Albumin
Transport function	TAG from gut to muscle and adipose	TAG from liver to muscle		Cholesterol from liver to peripheral tissues	Cholesterol from peripheral tissues to liver	FFA from fat depot to muscle and liver

The lipoprotein molecules have a polar periphery made of proteins, polar heads of phospholipids and cholesterol. The inner core consists of the hydrophobic TAGs and tails of phospholipids. The apoproteins also increase the solubility of lipids.

Thank you for your attention