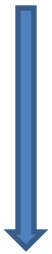
LIPIDS….

Introduction

- in 1943, term proposed by Bloor.
- Greek word “lipos” meaning fat.
- Organic compounds insoluble in water.
- Soluble in non-polar solvents.
- Composed of carbon, hydrogen and oxygen.
- Found in both plants and animals.
- Present in fruits, nuts and oils.

Constituents

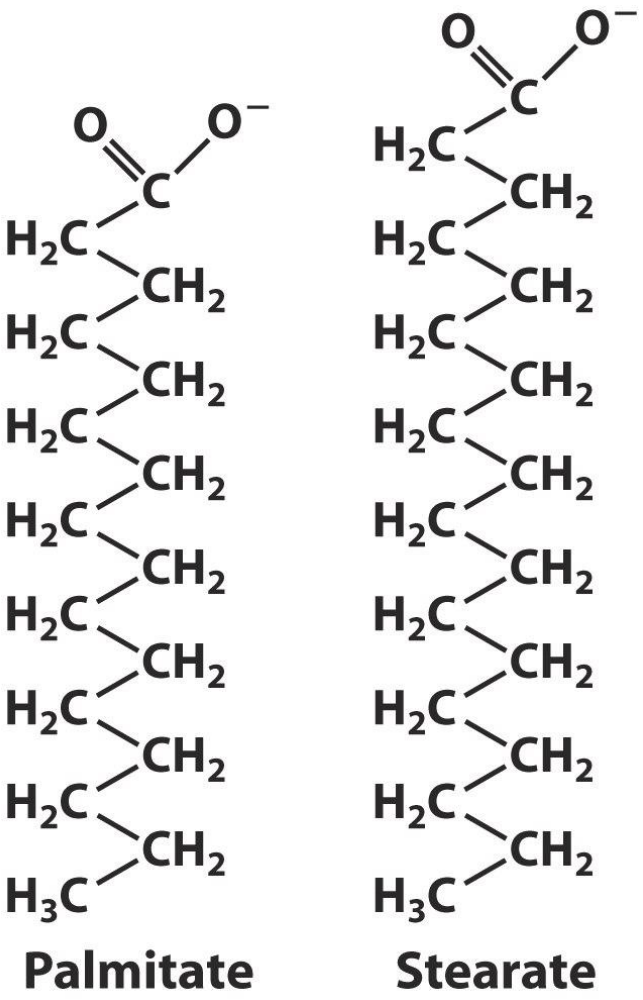
- Fatty acids and alcohol



Saturated fatty acids

- Single bonds.
- Solids at room temperature.
- High melting and boiling points.

Saturated Fatty acids



Unsaturated fatty acids

- Single and double bonds.
- Liquids at room temperature.
- Low boiling point.

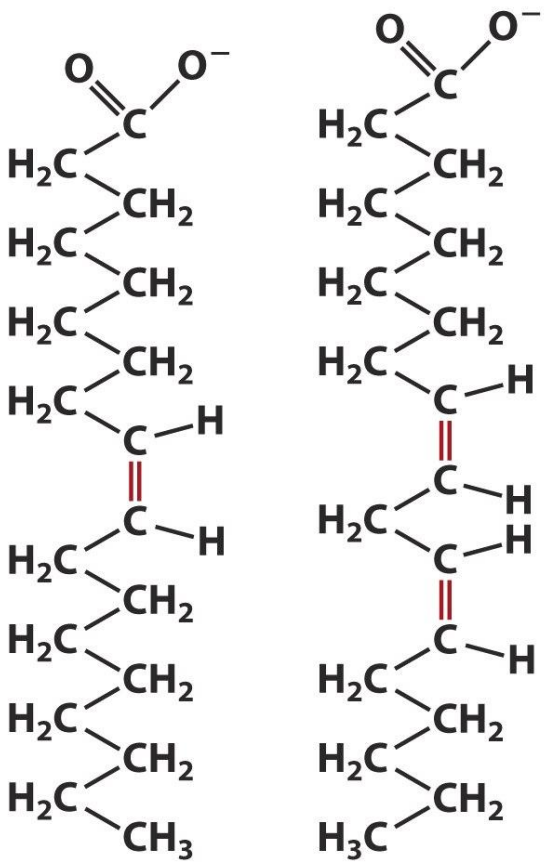
Monounsaturated fatty acids

containing one double bond

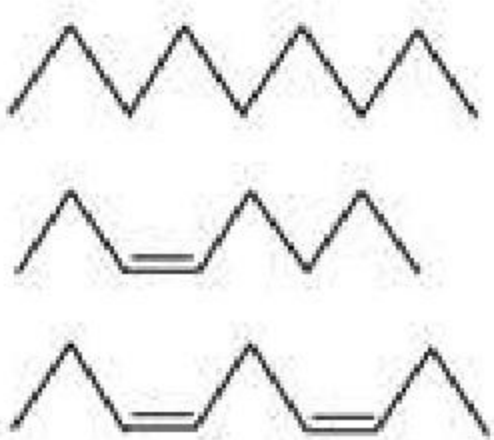
Polyunsaturataed fatty acids

- containing two or more double bonds.
- Double bonds are separated by atleast by one methylene group.

Unsaturated Fatty acids



TYPES OF FATTY ACIDS
(according to the number of double bonds)



Saturated (No bond)

Monounsaturated (1 bond)

Polyunsaturated (>1 bond)

Properties of lipids

- ✓ Concentrated source of energy.
- ✓ Serves as a cushion for vital organs.
- ✓ Structural elements of biomembranes.
- ✓ Reserviors of fat soluble vitamins.
- ✓ Serves as binding agents in food preprations.
- ✓ Serves as thermal insultors around certain organs.
- ✓ Provide shape and contour to the body.
- ✓ Act as metabolic regulators.
- ✓ Helps in cell cell interaction and signal transduction.
- ✓ Colouration of flowers.

Classification of lipids

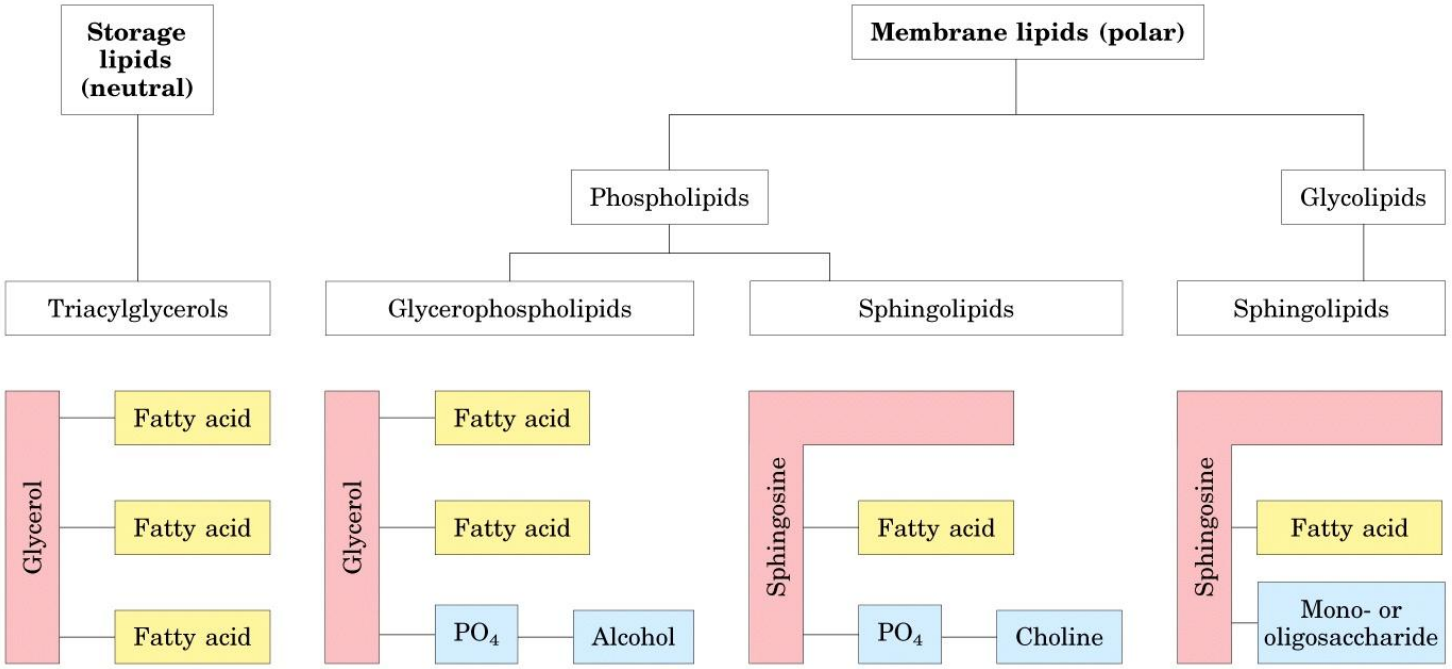
Simple lipids;

- Esters of fatty acids and alcohol.
- Esterification of fatty acids with the alcohol results in the formation of ester bond.

complex lipids;

esters of fatty acids containing groups in addition to an alcohol and a fatty acid.

Types of lipids



Storage lipids

Triacylglycerol;

- basic foundation molecule – trihydroxyl compound-**Glycerol**
- Each hydroxyl group is linked to a fatty acid by esterification.

Simple triacylglycerol

- If all the OH groups are esterified to same fatty acids.

Mixed triacylglycerol

- if different fatty acids are esterified.

Properties of triacylglycerol

- Colourless, odourless and tasteless
- Specific gravity is less than 1.0
- Have two primary biological roles-
  - energy metabolism (adipocytes in animals and cytoplasm in plants) and
  - temperature insulation.
- Act as electrical insulators allowing rapid propagation of depolarized waves along myelinated nerves.

Membrane lipids

- Amphiphillic in nature
- Found exclusively in membranes.

Two types

Glycerophospholipids and sphingolipids

Gylcerophospholipids ;

- Foundation molecule is phosphatidic acid or 1,2 diacylglycerol 3- phosphate.
- Both saturated and unsaturated fatty acids are present.
- 3rd hydroxyl group of glycerol is esterified by phospheric acid.
- Another alcohol can be esterified with the phosphate group.

- Four major types of glycerophospholipids are;

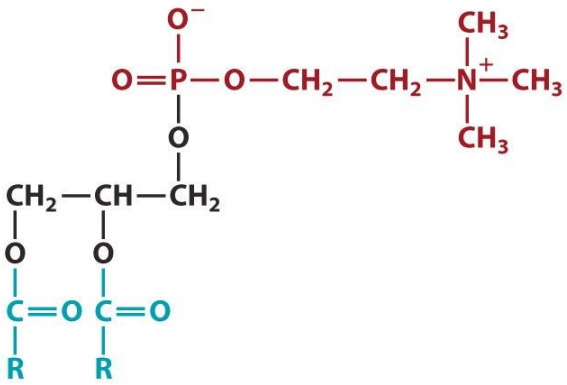
✓ Phosphatidylethanolamines

✓ Phosphatidylcholines

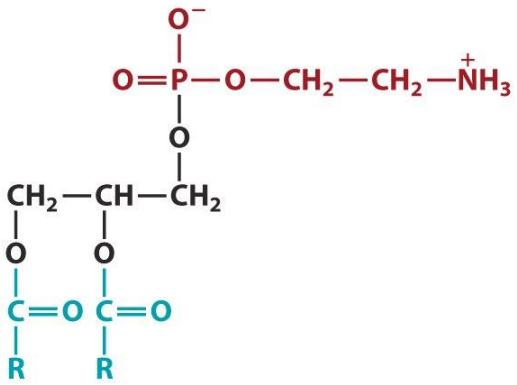
✓ Phosphatidylserines

✓ Phosphatidylinositols

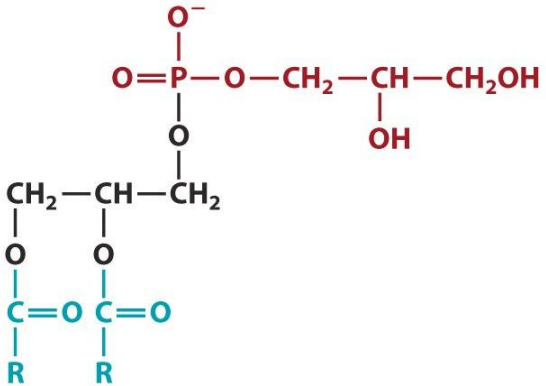
Glycerophospholipids



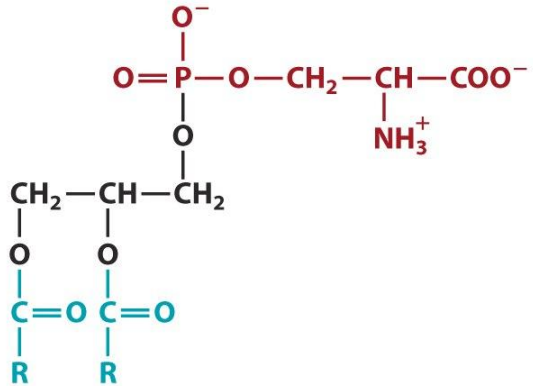
Phosphatidylcholine



Phosphatidylethanolamine



Phosphatidylglycerol



Phosphatidylserine

Sphingolipids

- Foundation molecule is sphingosine
- Sphinogosine has two functional groups (amino and hydroxyl) that can be chemically modified to make sphingolipids.
- Four major types are sphingolipids are;

➢ Ceramides

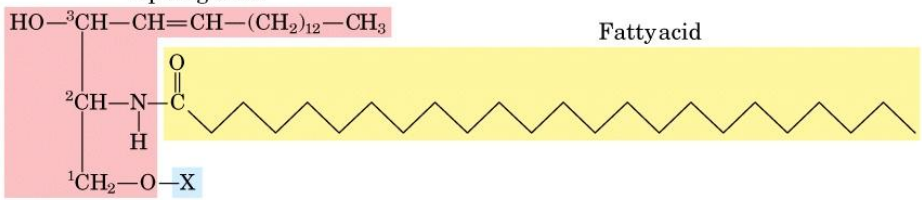
➢ Sphingomyelins

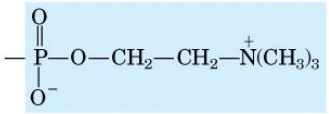
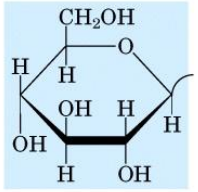
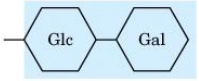
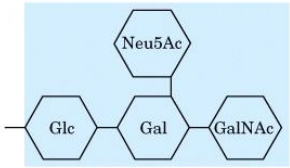
➢ Cerebosides

➢ Ganglioside

Sphingosine

Sphingolipid (general structure)



Name of sphingolipid	Name of X	Formula of X
Ceramide	—	—H
Sphingomyelin	Phosphocholine	
Neutral glycolipids Glucosylcerebroside	Glucose	
Lactosylceramide (a globoside)	Di-, tri-, or tetrasaccharide	
Ganglioside GM2	Complex oligosaccharide	

Polar lipids and membranes

- unable to assemble into micelles.
- They form bilayers composed of two monolayers or sheets of polar lipids.
- Non polar side of each sheet combines by hydrophobic interactions to exclude water in the central region of the bilayer.

Steriods

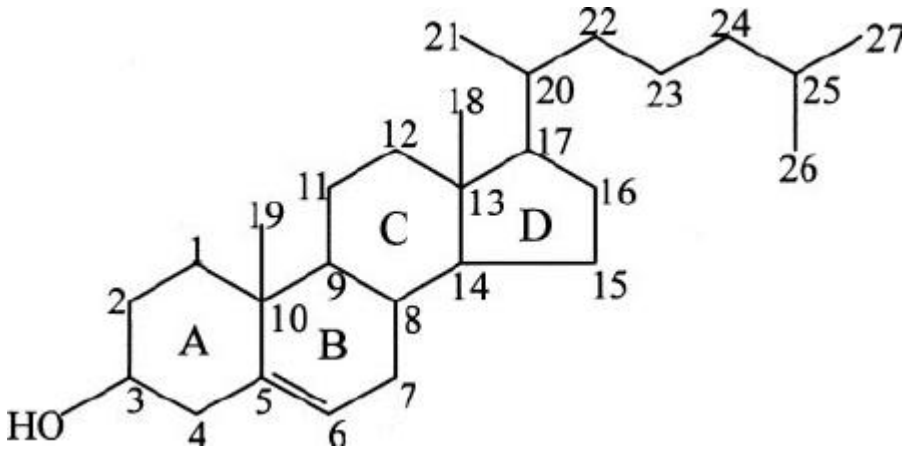
- Have the characteristic fused ring system of three six membered rings labeled as A,B and C and one five membered ring called the D ring.
- Steroids containing one or more OH groups are known as sterols.

Cholesterol

- ✓ has a hydroxyl group on the A ring, a double bond in ring B, and hydrcarbon chains attached at several locations.
- ✓ amphiphilic in nature having a polar head and an extensive non polar region.
- ✓ Chemically reactive portion of cholestrol is the hydroxyl group.
- ✓ Derived from 5 carbon compound-isoperene.

- ✓ Has 27 carbon atoms, an 0H group, a double bond, two methyl groups at C10 and C13 and a side chain at C17.
- ✓ Precursor of various compounds such as vitamin D3, bile acids and adrenocortical and sex hormones.
- ✓ Distributed widely in all cells of the body but mainly in nervous tissue.
- ✓ Poor conductor of heat and hence acts as insulator.
- ✓ Excess is harmful to body.
- ✓ Enzyme catalysed oxidation reactions on the cholesterol fused ring system leads to production of bile acids.

Structure of cholesterol



Phytosterols

- Also derived from isoperenes.
- Essential constituents in plant membrane structure.
- three major phytosterols are
  - ✓ Stigmasterol,
  - ✓ B- sitosterol and
  - ✓ campesterol.
- Differs from cholestrol in the placement of methyl groups and unsaturation of side chains.

Terpenes

- also synthesised from isoperenes.
- Important terpenes are

✓ Limonene – responsible for distant odour in citrus fruits.

✓ B-carotene – the source of orange colour in carrot

✓ Gibberellic acid – plant growth hormone

✓ Squalene- acts as a precursor for synthesis of all plant and animal sterols

✓ Lycopene – the source of red pigment in tomatoes.

Eicosanoids

- act in the local environment.
- Initiate inflammatory response, pain and fever assocaited with injury and diseases.
- Promote blood clotting and regulate blood pressure.
- Control some of the reproductive functions.
- Regulate temperature and sleep wake cycle in animals.
- Promote smooth muscle contraction.
- Three major subclasses are

✓ prostaglandins

✓ thromoboxanes

- ✓ leukotrienes

Prostaglandins

- First isolated from prostate gland in animals.
- contain a five membered ring substituted with two side chains and functional groups including a carobxylic acid and hydroxyl groups, ketones and double bonds.

Thromboxanes

- Isolated from thrombocytes
- chacterized by six membered ring containing oxygen.
- participate in the formation of blood clots.

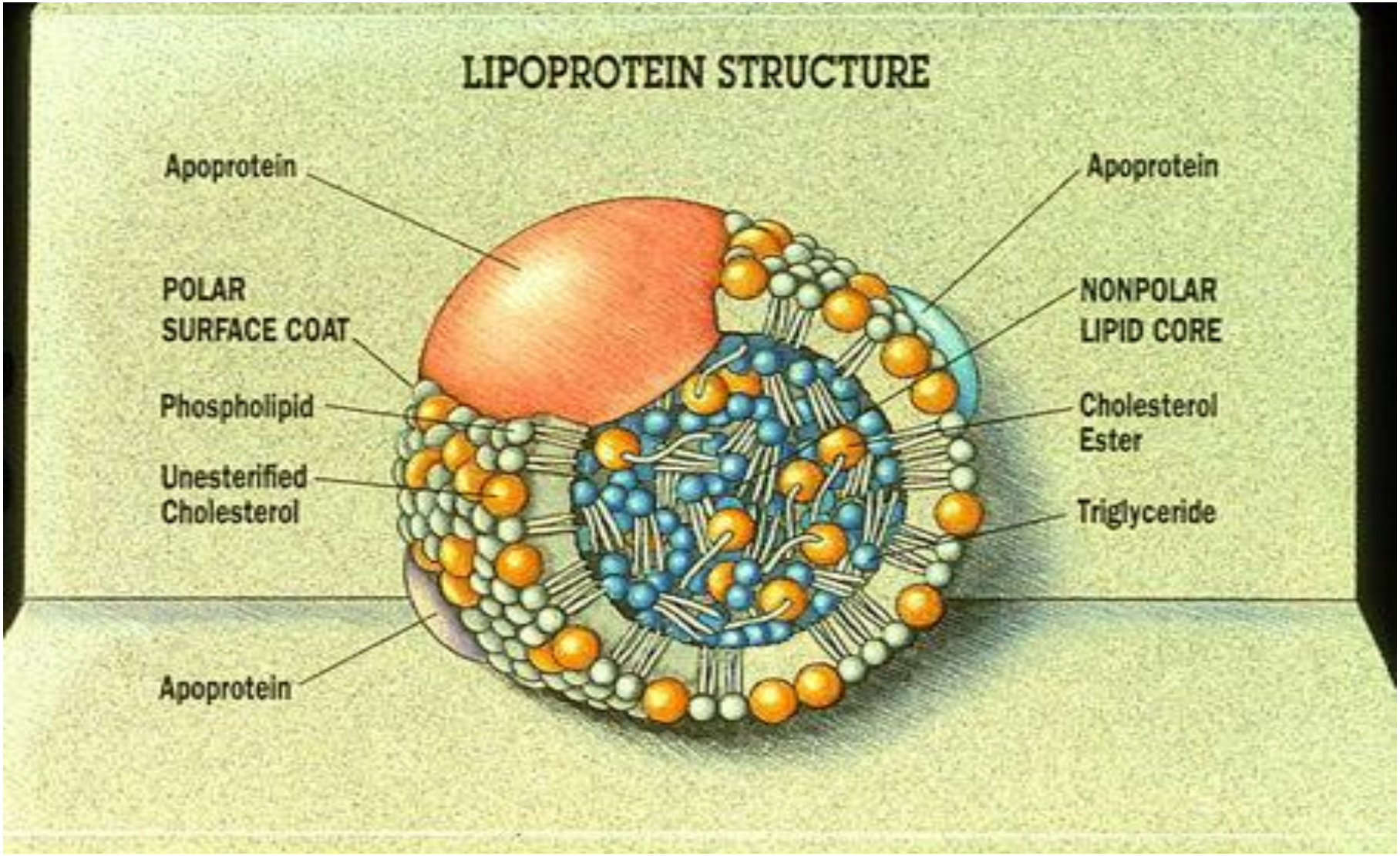
Leukotrienes

- Isolated from leukocytes.
- Linear chain and the presence of three conjugated double bonds.
- Cause the contraction of smooth muscles.

Lipoproteins

- serum particles consisting of specific proteins known as apolipoproteins and diverse combination of lipids.
- combination of lipids and proteins leads to the formation of water soluble complexes known as lipoproteins.
- Has a central core neutral, non polar lipid surrounded by a shell of phospholipids and proteins

Lipoprotein Structure



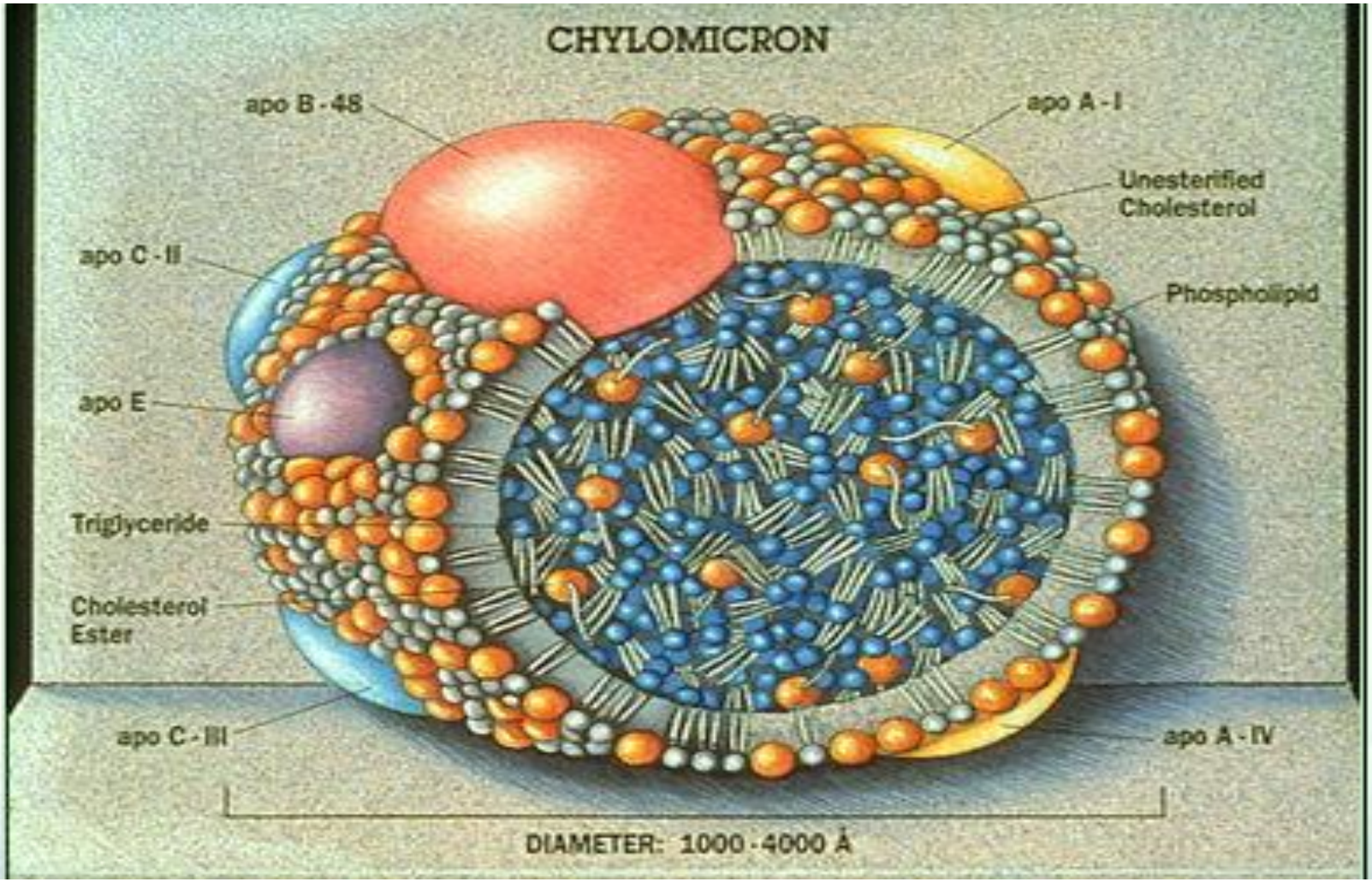
Comparative chart of Lipoproteins

Lipoprotein class	Density (g/mL)	Diameter (nm)	Protein % of dry wt	Phospholipid %	Triacylglycerol % of dry wt
HDL	1.063-1.21	5 – 15	33	29	8
LDL	1.019 – 1.063	18 – 28	25	21	4
IDL	1.006-1.019	25 - 50	18	22	31
VLDL	0.95 – 1.006	30 - 80	10	18	50
chylomicrons	< 0.95	100 - 500	1 - 2	7	84

Chylomicrons

- Has the least density.
- Consists of 98% to 99% of lipids cotent.
- Lipid content is primarilay dietery triacylglycerides.
- They get assembled in the intestines and absorbed into the bloodstream, where from they are transported to peripheral tissues.
- The enzyme lipoprotein lipase releases the free fatty acids from triacylglycerides.
- The lipoprotein after loss of various triacylglycerols becomes remnant with very high amount of cholestrol.

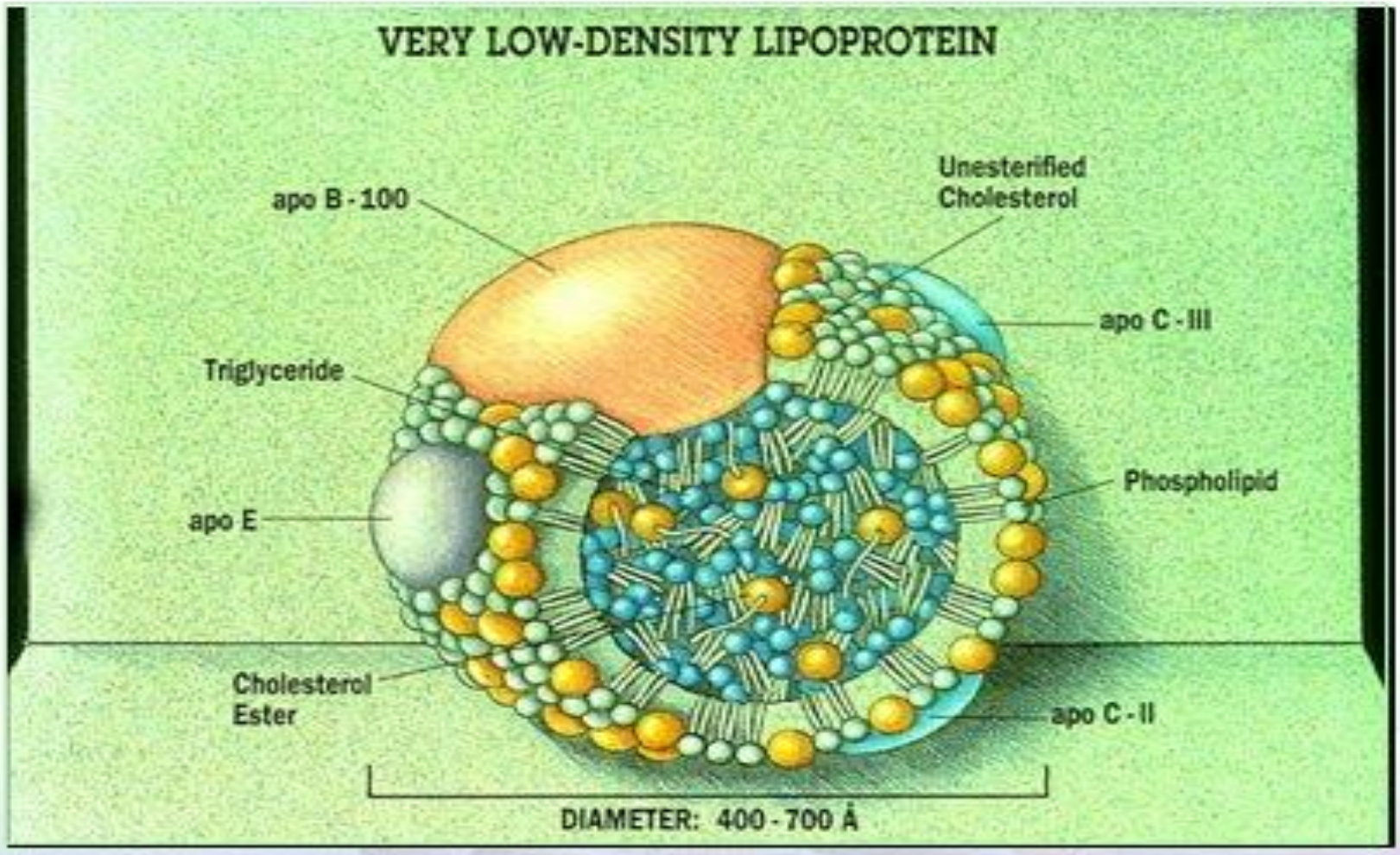
Chylomicron structure



Very low density lipoproteins (VLDL)

- ✓ Found in liver.
- ✓ Their function is to deliver synthesised lipids to the adipose and other peripheral tissues.
- ✓ Fatty acids are released in the same manner as in cylomicrons.

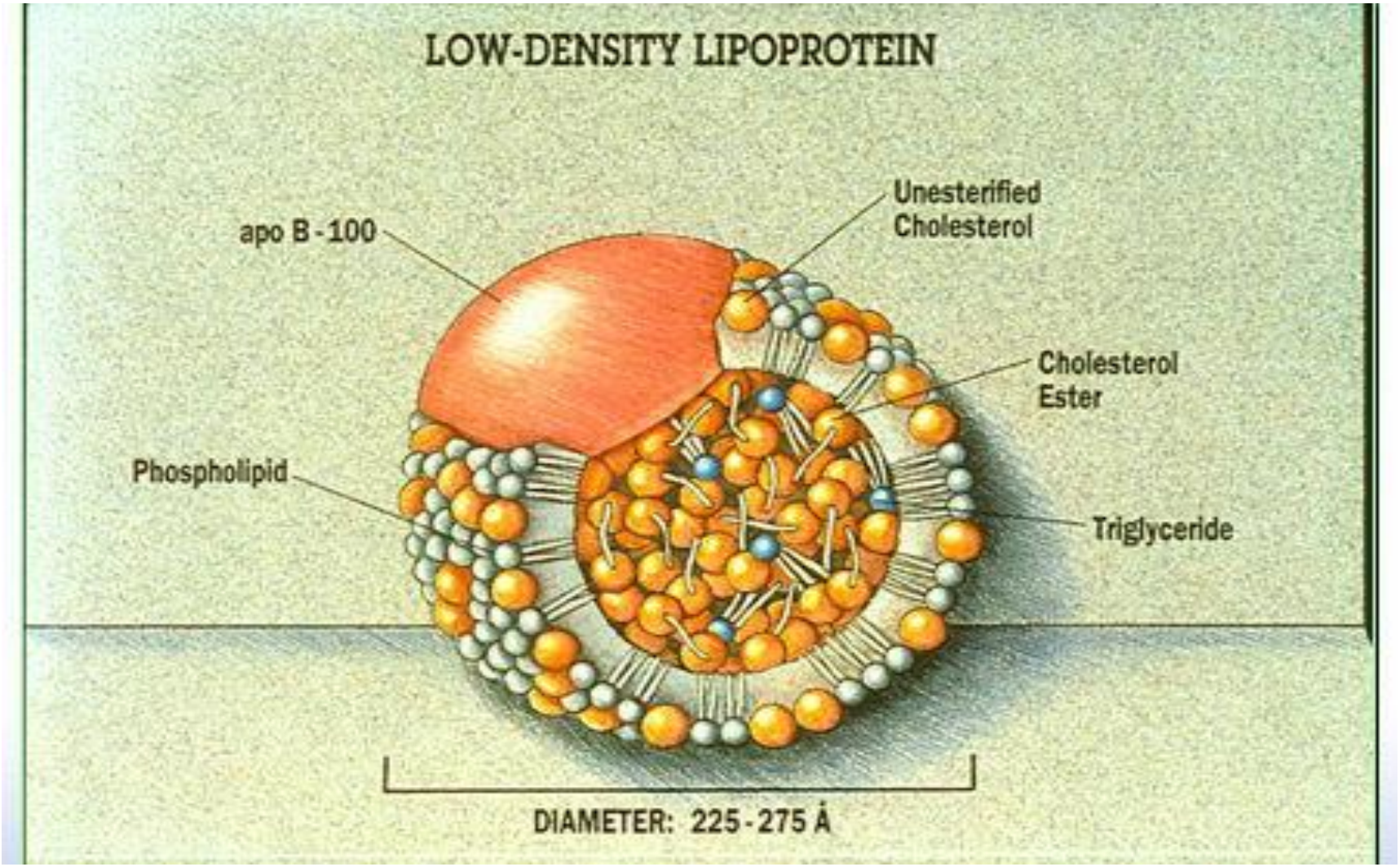
Very low density lipoproteins (VLDL)



Low density lipoproteins (LDL)

- ✓ Major carriers of cholesterol in the blood.
- ✓ Carry the cholesterol and cholesteryl esters from the liver to the adipose and other peripheral tissues.
- ✓ main lipids are cholesteryl esters containing polyunsaturated fatty acid linoleate.

Low density lipoproteins (LDL)



High density lipoproteins (HDL)

- Have higher content of proteins and are therefore more dense.
- Transport the cholestrol from peripheral tissues to liver.
- This transport is known as reverse cholesterol transport.

High density lipoproteins (HDL)