

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# **Lipid Compounds of Physiological Significance**

**By**

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# Objectives

By the end of this lecture, students are expected to:

- recognize various functions of lipid compounds
- relate lipid metabolism to specific clinical problems
- identify examples of lipid compounds of physiological importance
- recognize examples of complex lipids, such as:
  - Phospholipids
  - Glycolipids
  - Lipoproteins

# Functions of lipid compounds

- Major energy source for the body
- Structural component of cell membranes
- Important regulatory molecules; examples:
  - Fat-soluble vitamins
  - Steroid hormones
  - Prostaglandins
  - Signaling molecules; e.g. Inositol triphosphate (IP3)

# Lipids and Related Clinical Problems

- **Obesity**
- **Atherosclerosis**
- **Hypertension**
- **Coronary heart diseases**

# Lipid Compounds

- **Heterogeneous group**
- **Relatively water-insoluble (Ketone bodies are the exception)**
- **Soluble in non-polar solvents**

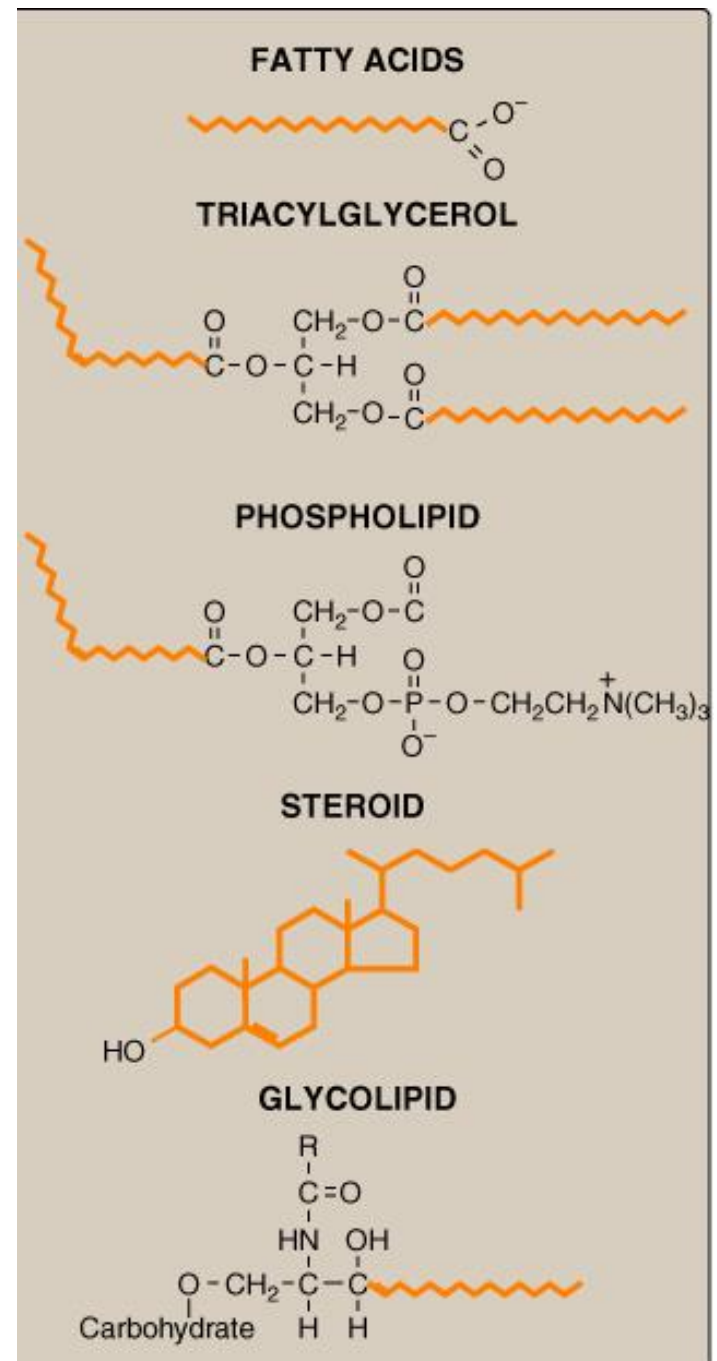
# 1. Simple Lipids:

1. Fatty acids
2. Ketone bodies
3. Triacylglycerol
4. Cholesterol

# 2. Complex Lipids:

1. Phospholipids
2. Lipoproteins
3. Glycolipids

**Lipid Compounds:  
Heterogeneous Group**



# Fatty Acids

$\text{CH}_3(\text{CH}_2)_n$	$\text{COO}^-$
Hydrophobic hydrocarbon chain	Hydrophilic carboxyl group (ionized at pH 7)

**Amphipathic: Both hydrophobic & hydrophilic parts**



# Fatty Acids

- **Chain length:**
  - **Short-chain & Medium-Chain** e.g. **Fatty acids in milk**
  - **Long-Chain** e.g. **Palmitic acid 16:0**
  - **Very long-chain** e.g. **Nervonic acid 24:1**
- **Degree of saturation:**
  - **Saturated: No double bonds**
  - **Unsaturated:**
    - **Mono- or poly-unsaturated**
    - **Cis- or trans-form of double bond**
- **Essential fatty acids**

# Fatty Acids

Fatty acids with chain lengths of four to ten carbons are found in significant quantities in milk.

Structural lipids and triacylglycerols contain primarily fatty acids of at least sixteen carbons.

COMMON NAME	STRUCTURE
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Formic acid	1
Acetic acid	2:0
Propionic acid	3:0
Butyric acid	4:0
Capric acid	10:0
Palmitic acid	16:0
Palmitoleic acid	16:1(9)
Stearic acid	18:0
Oleic acid	18:1(9)
Linoleic acid	18:2(9,12)
Linolenic acid	18:3(9,12,15)
Arachidonic acid	20:4(5, 8,11,14)
Lignoceric acid	24:0
Nervonic acid	24:1(15)

Precursor of prostaglandins

Essential fatty acids

# Essential Fatty Acids

1. **Linoleic acid, 18:2** (the precursor of arachidonic acid)
2. **Linolenic acid, 18:3**
3. The precursor of prostaglandins, **Arachidonic acid 20:4**, is also considered **essential fatty acid** if linoleic acid is deficient from diet

# Plasma Fatty Acids

**Esterified form (~90%):**

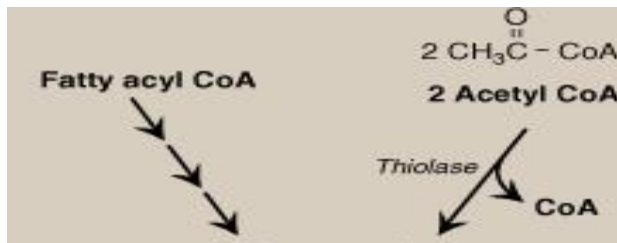
**In triacylglycerol, cholesterol ester,  
phospholipids (as part of lipoproteins)**

**Free-form (unesterified) = Free Fatty Acids  
(FFA):**

**Transported in association with albumin**

# **Triacylglycerols (TG)**

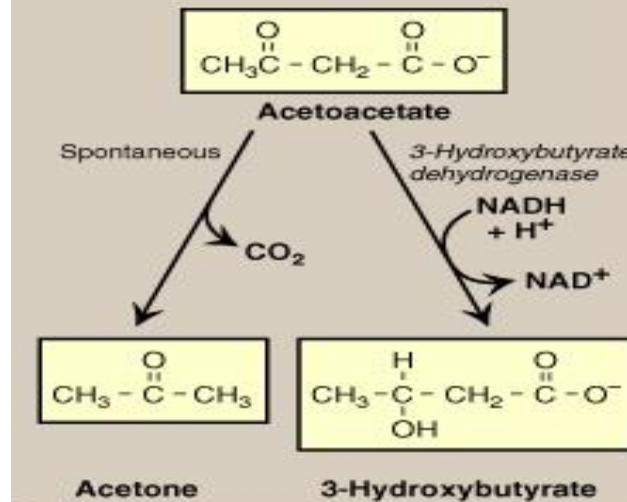
- **Storage form of lipids in adipose tissue**
- **Constitute ~ 90% of dietary lipids**
- **Composed of glycerol plus 3 fatty acids**
- **Transported in blood: in chylomicrons & in very low density lipoprotein (VLDL)**



# Ketone Bodies

1. Acetone
2. Acetoacetate
3.  $\beta$ -Hydroxybutyrate

1. Water-soluble lipids
2. Increase in Diabetic Ketoacidosis (DKA)



# Phospholipids

## A. Glycerophospholipids

### Glycerol-containing phospholipids

1. Phosphatidylcholine (Lecithin)  
e.g., Surfactant (Dipalmitoylecithin)
2. Phosphatidyl inositol (signaling molecule)

## B. Sphingo-phospholipids:

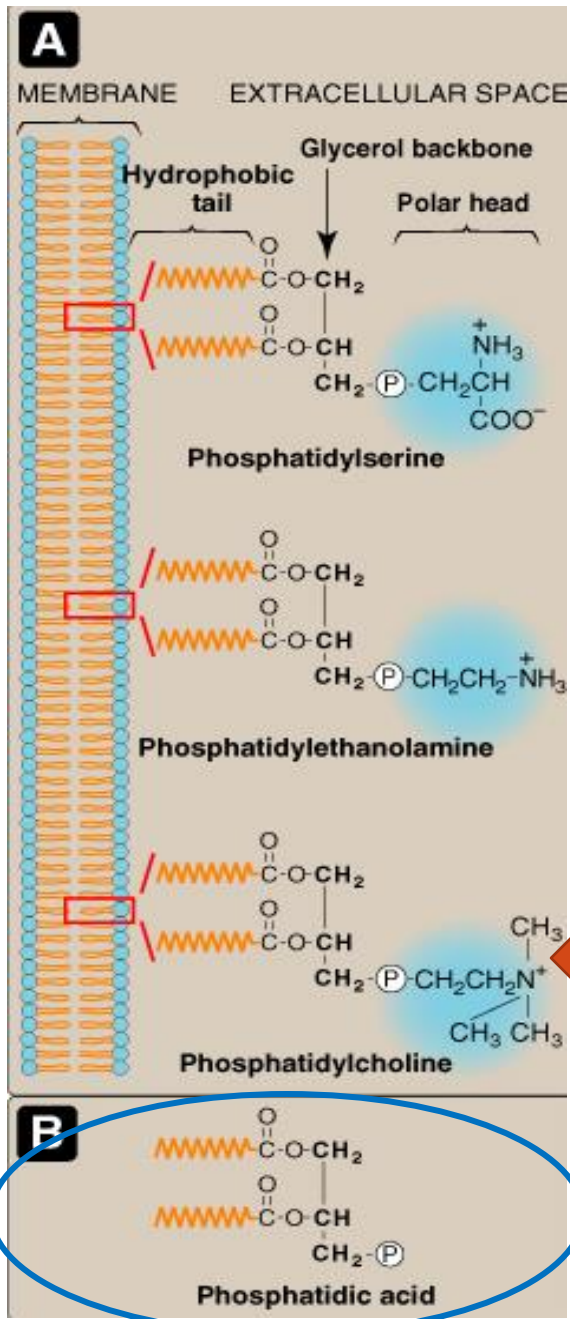
### Sphingosine-containing phospholipids:

e.g., sphingomyelin (Myelin sheath)

*(To be discussed with CNS Block)*

# Phospholipids:

## A. Glycerophospholipids

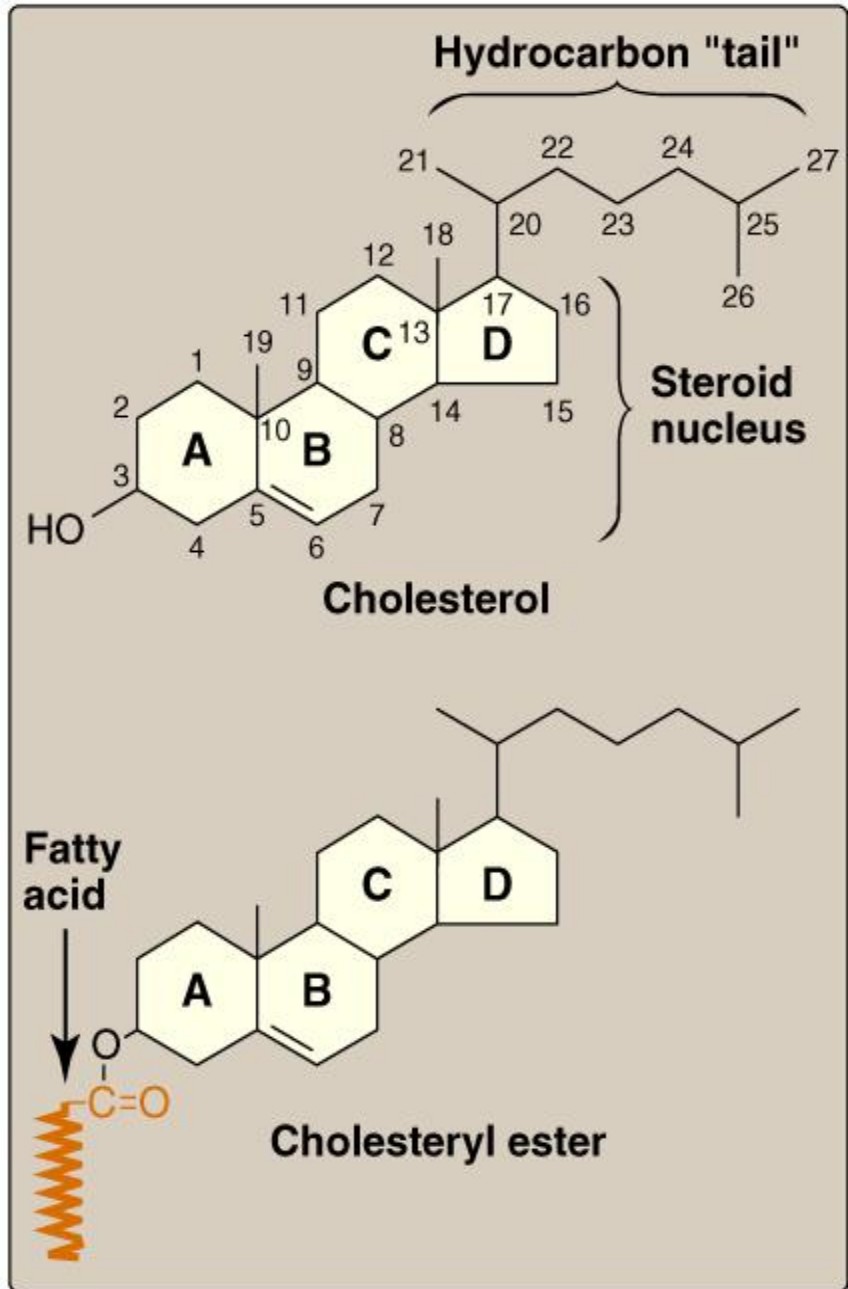


- e.g. of members:
- 1. Phosphatidylcholine (Lecithin)
- e.g., Surfactant (Dipalmitoyl lecithin)

Parent Compound Phosphatidic acid



# Cholesterol: Structure



# Overview and Functions of Cholesterol

- **Major Sterol of animal tissues**
- **Component of cell membranes**
- **Precursor for:**
  - Bile acids & salts**
  - Vitamin D**
  - Steroid hormones:**
    - Mineralocorticoids**      e.g., **Aldosterone**
    - Glucocorticoids**      e.g., **Cortisol**
    - Sex hormones**      e.g., **Testosterone**  
**Estrogen & progesterone**
- **Abnormally high level in blood (Hypercholesterolemia):**
  - Associated with Atherosclerosis & Coronary Artery Disease (CAD)**

# **Lipoprotein Structure**

**Protein part: Apoproteins or apolipoproteins**

**Abbreviations: Apo-A, B, C**

**Functions:**

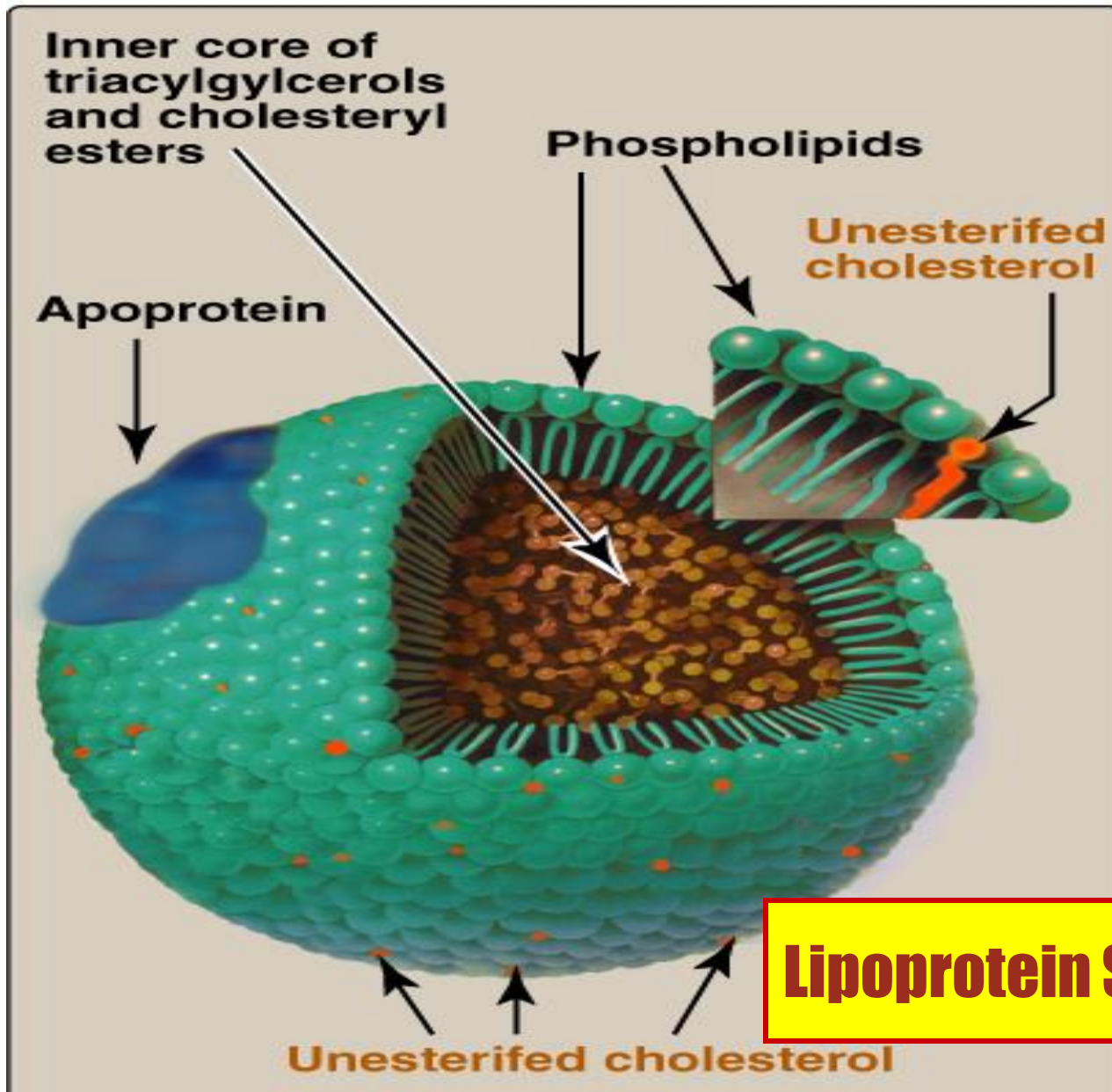
**Structural and transport function**

**Enzymatic function**

**Ligands for receptors**

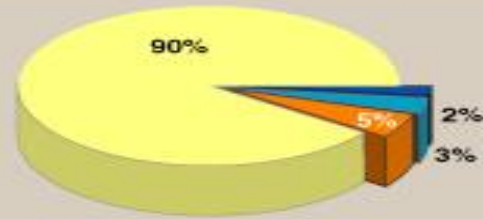
**Lipid part:**

- **According to the type of lipoproteins**
- **Different lipid components in various combinations**



**Lipoprotein Structure**

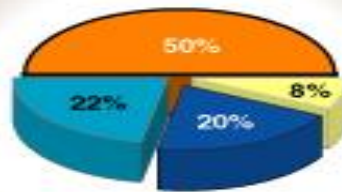
# Composition of Lipoproteins



Chylomicron



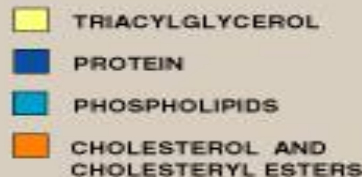
Very-Low-Density Lipoprotein (VLDL)



Low-Density Lipoprotein (LDL)



High-Density Lipoprotein (HDL)

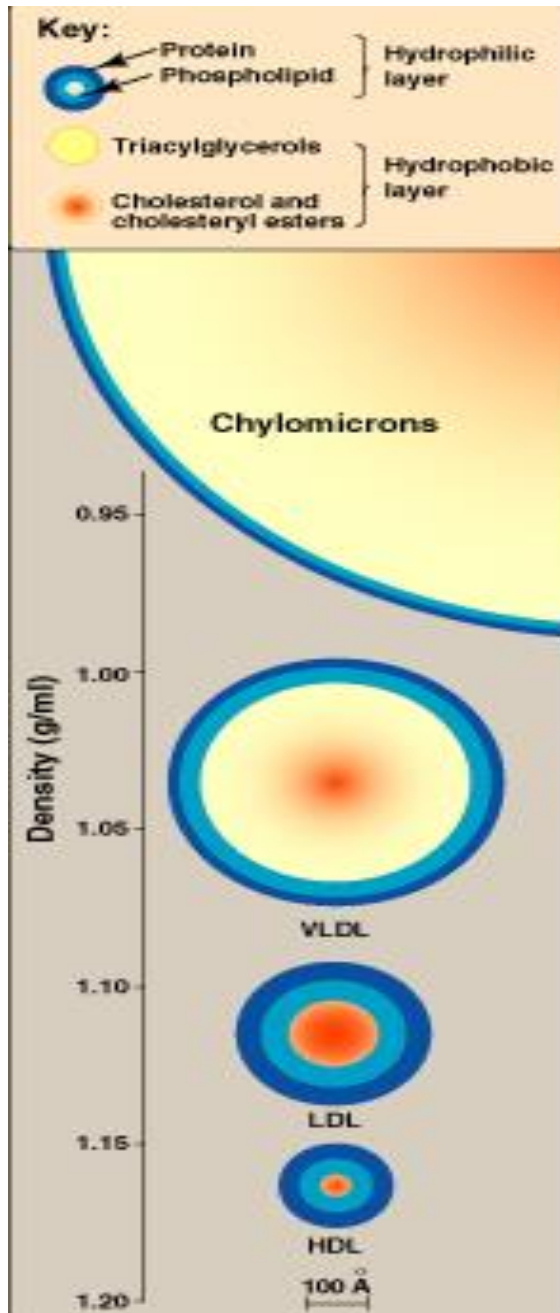


**Chylomicrons**

**Very low density Lipoprotein (VLDL)**

**Low density Lipoprotein (LDL)**

**High density Lipoprotein (HDL)**



# Ultracentrifugation of Lipoproteins

# Plasma Lipoproteins

## Transport of Triacylglycerol (TG):

**Chylomicrons:** TG of dietary origin

**VLDL:** TG of endogenous synthesis

## Transport of Cholesterol :

**LDL:** Mainly free cholesterol

**HDL:** Mainly esterified cholesterol

# Take Home Message

- **Lipids are heterogeneous group of compounds**
- **Lipids are relatively water-insoluble**
- **Simple lipids:**
  - Fatty Acid, TG, Ketone bodies, Cholesterol**
- **Complex lipids:**
  - e.g., Phospholipids, Lipoproteins**
- **Lipids have important physiological functions**
- **Lipid disorders are the basis for common human diseases, namely obesity and atherosclerosis**