

Biochemistry 2nd stage

Dr.Lamees Majid Al-Janabi

LIPID METABOLOSIM

ILO:K2,S12,A0.

Objectives:

The students are learned to understand the following points:

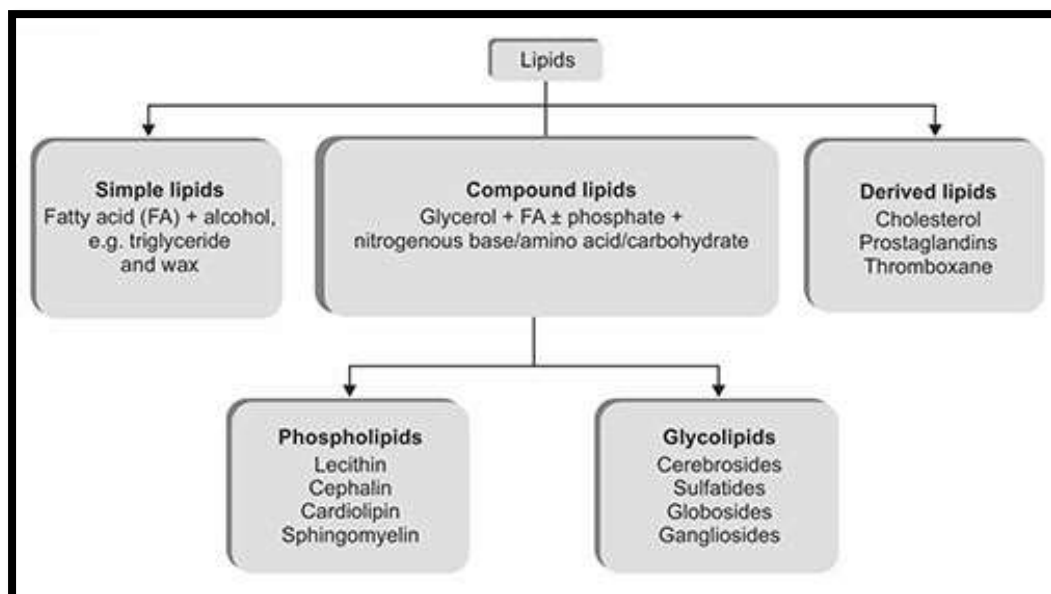
- Brief review about lipids chemistry including fatty acids, Cholesterol, Triglycerides, and Phospholipids
- Their sources, function, and plasma levels.

Brief review about lipid chemistry:

Definition: Lipids are organic substances, relatively insoluble in water and soluble in organic solvents like alcohol, ether, etc. They are mainly compounds of C, H and O, but also carry P, N and S in some cases.

Classification

Lipids are classified as following:



- a. **Simple lipids:** Esters of fatty acid with alcohol.
 - Fats or oils (triacylglycerol): Esters of fatty acids with glycerol
 - Waxes: Esters of fatty acids with long-chain aliphatic alcohols other than glycerol, e.g. acetyl alcohol. These are solid at room temperature.
- b. **Compound lipids:** Esters of fatty acids with alcohol, carrying additional groups such as phosphate and nitrogenous group or carbohydrate. Compound lipids are of two types:
 - Phospholipids: For example, glycerophospholipids, sphingophospholipids
 - Glycolipids: For example, cerebrosides, sulfatides, gangliosides, globosides.
- c. **Complex lipids:** For example, lipoproteins—very low density lipoprotein (VLDL), low density lipoprotein (LDL), high density lipoprotein (HDL) and chylomicrons.
- d. **Derived lipids:** Obtained by hydrolysis of simple or compound lipids. For example, steroids (cholesterol), prostaglandins, leukotrienes, etc.

Functions of lipids.

- ❖ Source of energy.
- ❖ Concentrated fuel reserve (adipose tissue).
- ❖ Constituent of membranes and regulate membrane permeability. For example, phospholipids, glycolipids, lipoproteins and sterols.
- ❖ As compounds of inner mitochondrial membrane, lipids participate in electron transport chain.
- ❖ Phospholipids, glycolipids and sterols are constituents of plasma lipoprotein, which transport fat.
- ❖ Source of fat-soluble vitamins and bile acids.
- ❖ Metabolic regulators—steroid hormones and prostaglandins
- ❖ Protect internal organs, serve as insulating materials.

Fatty Acids

Definition: Fatty acids are monocarboxylic acids with hydrocarbon side chain. They are simplest form of lipid

Classification

a. Depending on nature of hydrocarbon chain

- **Saturated fatty acids:** Do not contain double bonds in their hydrocarbon chain, e.g. palmitic and stearic acid
- **Unsaturated fatty acids:** Contain one (monounsaturated) or more (polyunsaturated) double bonds in their hydrocarbon chain, e.g. oleic acid, linoleic acid, linolenic acid, arachidonic acid.

b. Depending on number of carbon atoms

- **Even-chain fatty acids:** Natural lipids with even number of carbon atoms in their chain, e.g. palmitic acid (16), stearic acid (18)
- **Odd-chain fatty acids:** Propionic acid (3C) and valeric acid (5C).

c. Depending upon length of hydrocarbon chain of fatty acid

- **Short-chain fatty acids:** Chain contains six or less than six carbons, e.g. propionic acid, butyric acid, etc.
- **Medium-chain fatty acids:** Chain contains 8–14 carbons, e.g. caprylic acid, myristic acid, etc.
- **Long-chain fatty acids:** Chain contains 16–22 carbons, e.g. palmitic acid, stearic acid, etc.

d. Depending upon nutritional importance

- **Essential fatty acids:** Not synthesized in the body, therefore should be taken in the diet, e.g. linoleic acid, linolenic acid and arachidonic acid
- **Non-essential fatty acids:** These can be synthesized in the body, e.g. palmitic acid, stearic acid, etc.

Essential fatty acids.

The essential fatty acids (EFA) are those which cannot be synthesized by the body, hence they should be supplied in the diet. Chemically, they are polyunsaturated fatty acids (PUFA).

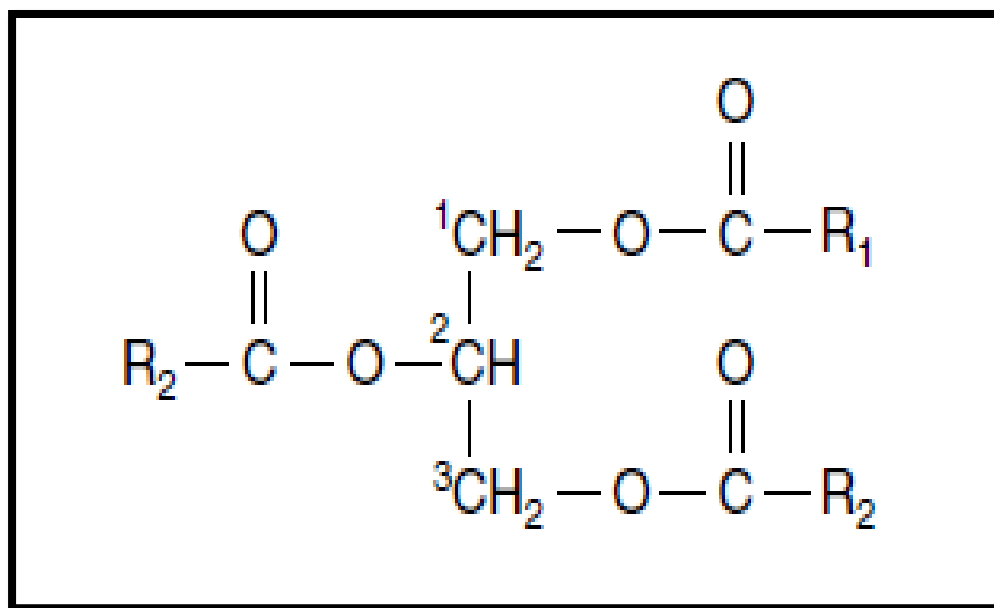
Biochemical basis for essentiality: Linoleic and linolenic acids are essential fatty acids— humans lack the enzymes that can introduce double bonds beyond carbon 9 of fatty acids.

Functions of essential fatty acids: It is required for the following:

- Membrane structure and function
- Transport of cholesterol
- Formation of lipoproteins
- Synthesis of eicosanoids—prostaglandins, thromboxane, leukotrienes
- Protective effect against fatty liver.

Deficiency of EFA: The deficiency of EFA results in phrynoderma, hair loss and poor wound healing.

Triglyceride



Sources:

1) Exogenous: main component of the diet ,daily intake is between 100-200 g, by the action of pancreatic Lipase will be hydrolyzed to monoglycerides and 2 fatty acid, these will be absorbed and the TG resynthesised in the mucosal cell and incorporated in structure called "Chylomicron" and release into intestinal lymph and reach systemic circulation through thoracic duct .

2) Endogenous: the liver is the major site for synthesis from glycerol and fatty acid which incorporated into Lipoproteins and release into the circulation to utilized by peripheral tissue as energy source or stored in adipose tissue.

phospholipids

Phospholipids are lipids containing phosphoric acid + fatty acids + alcohol ± nitrogenous base. They contain both polar and non-polar groups and are called amphipathic lipids.

Classification

- a. **Glycerophospholipids:** Contain glycerol as alcohol e.g. Lecithin , Dipalmitoyl lecithin, Cephalin , Plasmalogens , Platelet-activating factor ,Cardiolipin Phosphatidic acid , Phosphatidylinositol .
- b. **Sphingophospholipids:** Contain sphingosine as alcohol. *For example*, sphingomyelins—major component of membranes of nervous tissue

Functions of Phospholipids

- Constituent of cell membrane, myelin sheath
- Constituent of surfactant (dipalmitoyl lecithin) in lungs
- Second messenger (phosphatidylinositol)
- Source of arachidonic acid—for prostaglandin synthesis
- Components of lipoproteins (transport of lipids)
- Absorption of fat from the intestine (micelles and chylomicrons)
- Acts as lipotropic factor and prevents fatty liver
- Responsible for maintaining the conformation of electron transport chain in mitochondria.

Glycolipids

Definition: Glycolipids are carbohydrates—lipid complexes having amphipathic nature.

They are the important components of cell membrane and nervous tissue.

Composition: Ceramide (sphingosine + fatty acid) + carbohydrate. Do not have phosphoric acid.

Classification: Depending on the nature of attached carbohydrate chain.

- *Cerebrosides:* Galactocerebroside (ceramide + galactose).
- *Sulfatides:* Ceramide + galactose + sulfate.
- *Globosides:* Ceramide + more than one hexose or hexosamine.

- *Gangliosides*: Ceramide + oligosaccharides + NANA (N acetylneuraminic acid).

Prostaglandins

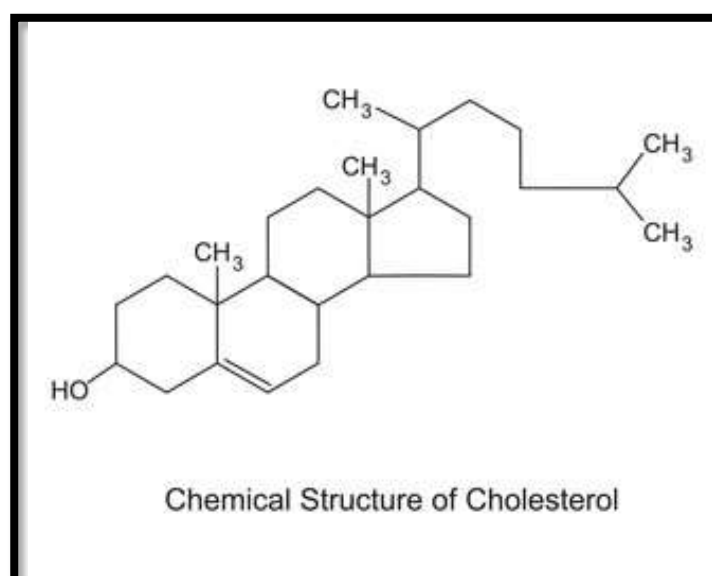
Definition: Unsaturated hydroxyl and ketosubstituted C20 fatty acids.

Synthesis: Formed from arachidonic acid by cyclooxygenase pathway.

Significance: Act as local hormones and mediators of inflammation.

Non-steroidal antiinflammatory drugs (NSAIDs) like aspirin, are the inhibitors of cyclooxygenase.

Cholesterol



We have two types of cholesterol :

- 1) Endogenous: greater of the body cholesterol is provided by synthesis of about 700 mg/day (MORE THAN HALF)
- 2) Exogenous: daily intake of the cholesterol usually less than 1g/day of which 40-70 % is absorbed.

Functions

- Constituent of cell membrane
- Formation of bile salts (liver)
- Synthesis of steroid hormones (cortisol, aldosterone, testosterone, estrogen, progesterone)
- Precursor of vitamin D.