LIPID

Aim: Introduction and Definition
Lipid are compounds that are soluble in organic solvents, such as ether and relatively insoluble in water or aqueous media e.g. human body fluid; blood,.... The principal unit of different forms of lipid is fatty acid with general formula $\text{RCOOH}$; $R$ is alphatic carbon chain
structure: $\text{CH}_3(\text{CH}_2)^n\text{CH}_2$; $n$ is the number of carbon. In nature, fatty acid may be:

1. Saturated; $\text{CH}_3\text{CH}_2$........, the common one in human body is Palmitic acid(C16)
2. Monounsaturated CH\(3CH2CH=CH\ldots\) (one double bond), and 3. Polyunsaturated (2 or more double bonds). The EFAs are those fatty acids that are required in human body but cannot be synthesized in it, so must be supplied in the diet to support the growth and include:
Linoleic acid C18, 2 double bonds
Linolenic acid C18, 3 double bonds
Arachidonic acid C20, 4 double bonds. These EFAs are important components of phospholipids of cell membrane and mitochondrial membrane and their deficiencies result in defect in growth and development.
Even the incidence of EFAs deficiencies is rare, it can lead to scaly dermatitis, visual and neurologic defects. The absolute EFAs are the linoleic acid, the precursor of arachidonic acid that is a substrate for Prostaglandins synthesis and the Linolenic acid, the precursor for other $\omega$-3 fatty acids.
formula important for growth and
development and used
antihypertriglyceridemic drug.
Fatty acids also may be:
Short : C2-C4
Medium: C6-C10
Long: C12 and more.
The saturated fatty acids are naturally found in Zigzag form, while the unsaturated ones are in kink form. The degree of unsaturation (number of double bonds) and the carbon chain length are important in determining of
melting point of fatty acids and so of biological membrane fluidity (permeability to lipid soluble substances).
The important structures of lipid materials are:
1. Triglycerides; Simple lipid
2. Phospholipids; Complex lipid
3. Sphingolipids and Glycolipids; Complex lipid.
4. Cholesterol (Cyclolipid)

5. Lipoproteins, Male and Female Sex Hs, Adrenal Cortical Hs (cortisol and aldosterone), Vitamin D, and other.

Definitions: Triglyceride; TG. It is fatty acid ester of glycerol.

(Triacylglycerol): \text{CH}_2\text{OCOR}_1\text{glycerol CHOCOR}_2\text{fatty CH}_2\text{OCOR}_3\text{acids}
R1, R2, R3 are different fatty acids. TG is considered as nonpolar structure and so not implied in CM formation.

Glycerol + R1 = Monoglycerol
Glycerol + R1 + R2 = Diacylglycerol
Glycerol + |R1 + R2 + R3 = Triacylglycerol
TG represents its function the principal storage form of energy in adipose tissues that needed physiologically in prolonged fasting and starvation and pathologically, for example in uncontrolled diabetes mellitus. It is also the preferred form of nutrient that is used by muscle in producing of chemical energy ATP under
Physiolog. and pathologic conditions. TG forms about 95% of dietary fat.

**Phospholipids; PL (Phosphoglycerolipids):**

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\text{CH}_2\text{O}\text{COR}_1 \\
\text{CHOCOR}_2 \\
\text{CH}_2\text{OPO}_3\text{-b} \\
b: is Nitrogen base
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Base
Choline
Ethanol amine
Serine
Inositol

PL
Lecithin
Cephalin
Phosphatidylserine
Phosphatidyl inositol triphosphate
And Cardiolipin phospholipid;
Diphosphatidyl glycerol.
PLs are considered amphipathic compounds because of their formation from polar (PO4 and nitrogen base) and nonpolar (fatty acids) structures.
Lecithin PL is:
1. the predominant type of PL in CM
2. the source of choline component of the neurotransmitter, the Acetylcholine
3. the principal lipid component of Lung surfactant (90% lipid and 10% protein), its deficiency in preterm infants is
is associated with inadequate production or secretion of surfactant causes Respiratory Distress Syndrome (RDS), the significant cause of death. Lecithin is made and secreted by pneumocytes to act as surfactant, decrease the surface tension of fluid lining the alveoli so reducing the pressure needed to reinflate
alveoli, thereby preventing alveolar collapse (atelectasis).

4. involved in emulsification of fat diet in small Intestine along with Bile salt. **Cardiolipin PL is the principal type of PL that involved in inner mitochondrial membrane structure** (important for maintenance of certain respiratory complexes).
Anti-cardiolipin ACL is used in investigation of abortion or dead infant delivery, because this PL cardiolipin is recognized by antibodies that raised against Treponema Pallidum the bacterium that causes Syphilis. Phosphatidyl inositol triphosphate in CM act as a second messenger (internal messenger) for protein hormones action.
action. Platelet activating factor PAF and Plasmalogens are compounds that belong to PL structure but differ in containing ether linkage ROR instead of ester linkage ROCOR at C1 of PL. PAF is synthesized and released by a variety of cell types, binds to
surface receptors with triggering potent thrombotic and acute inflammatory processes. It causes platelets to aggregate and degranulate, and neutrophiles and macrophages to produce superoxide radicals, the killing substance of infected bacterium.
Sphingolipids (Phosphosphingolipids: Sphingomyelin):
These are also PL but differ from phosphoglycerolipids (previous types) in their structure: They are composed of Sphingosine alcohol instead of Glycerol. Sphingosine is C18 monoalcoholamine:
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\text{CH}_3(\text{CH}_2)_{12}\text{CH} = \text{CHCHOHCHNH}_2\text{CH}_2\text{OH}
\]
Sphingosine + fatty acid = Ceramide
Ceramide + Nitrogen base = sphingolipid. Of the most significant type of these PL in humans is sphingomyelin in which the base is choline. It is an important component
of myelin sheath of nerve fibers, insulates and protects neuronal fibers of the central nervous system (preventing the short circulation of nerve electrical pulse transmission).
Glycolipids:
These are another type of lipid. Their structures are relatively similar to sphingolipid; Ceramide + carbohydrate moiety (or moieties) = Glycolipids. Of which: the simple forms are glucosylsphingolipid and galactosylsphingolipid (only one unit of
CHO). The complex forms are Globoside and Ganglioside (2-9 units of CHO). They are found in outer leaflet of plasma membrane and contribute to cell surface
In summary
1. Lipids are water insoluble substances (insoluble in systemic circulation). 2. TG is the major dietary lipid and functions as stored metabolic energy, the major component that act as source of energy is fatty acids, particularly the saturated one.
3. EFAs; are polyunsaturated fatty acids; particularly Linoleic acid and Linolenic acid which are precursors of $\omega$-drug (antihypertriglyceridemia). EFAs are essential for growth and development.

4. Phospholipids are amphipathic and so involved in CM and mitochondrial membrane
Structure. The most important one is lecithin. RDS, ACL and APL. Sphingomyelin is also PL, but contains sphingomyelin instead of glycerol alcohol. It is an important CM component of CNS and myelin sheath.