Lipids

Heterogeneous group of macromolecules share the dominance of non-polar (water-insoluble)

They are mostly amphipathic

Functions: 1) Storage (highest energy value) 2) structural component of membranes 3) Precursor of hormones and Vitamins (D, E, K, A) 4) shock absorbance 5) Thermal insulator

Derived lipids

Fatty acids COOH

☆ Mono-carboxyl + hydrocarbon chain

☆ They are amphipathic

→ Saturated: all bonds are single

→ Unsaturated: one or more double bonds

Mono — Poly

→ Cis ⇝ H atoms have the same orientation ⇝ introduce kinks to reduce strain (Cis more predominant)

→ Trans ⇝ opposite orientation, No kinks

Short FA	long FA
Liquid, Volatile	Solid, Non-Volatile
↓ melting point	↑ melting point
Water soluble	Water insoluble
Acetic, butyric, Capric	Palmitic, stearic

↑ Saturated ⇝ more compacted ⇝ ↑ M.P

Eicosanoids

20 carbon — derived from arachidonic acid

1) Leukotrienes (20:4) ⇝ linear with 3 conjugated ⊜
   → Constriction respiratory smooth muscles (asthma)
2) Thromboxane (20:2) ⇝ Cyclic with 2 Ether
   → Induce platelet aggregation (↑ clotting)
   → Vasoconstriction
3) Prostacyclin (20:2) ⇝ Cyclic, 2 Rings
   → Inhibit platelet aggregation (↓ clotting)
   → Vasodilation
4) Prostaglandin (20:3) ⇝ Cyclic
   → Inhibit platelet aggregation (↓ clotting)
   → Induce inflammation and fever

Aspirin inhibits COX 1 & 2 ⇝ Side effect: bleeding + affect GI and Renal

↓ COX 1 → ↓ thromboxane → ↓ clotting

↓ COX2 → ↓ PG → ↓ inflammation and fever

Celebrex inhibits COX 2 only

Omega 3

→ ALA → EPA → DHA

→ Reduce inflammation
   → ↓ Eicosanoids
   → ↑ anti-inflammatory

→ Fish oil ⇝ EPA and DHA ⇝ Enhance memory

Omega 6

→ Linoleic → Arachidonic

→ Induce inflammation

Linoleic is the precursor of
1) Arachidonic acid
2) Essential neuronal FAs
3) Acyl glucosylceramide
   → Prevent water loss from skin

Omega 9

→ Oleic

→ Reduce cholesterol

Dietary deficiency of FAs causes Red scaly dermatitis

Simple lipids

Waxes

Monohydric alcohol + Fatty acid

↳ Ester bond

☆ Water insoluble

☆ No nutritional value

☆ Very resistant for rancidity

Fats and oils

Animal → Saturated → solid → fat

Vegetable → Unsaturated → liquid → oil

Hydrogenation: add H atoms convert Unsaturated Cis into saturated or unsaturated trans

CHD risk: Trans > Saturated > Cis

Complex lipids

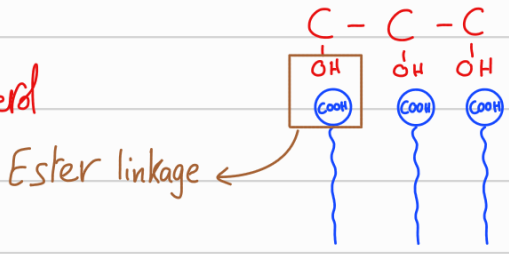
Storage lipids:

Tri acyl glycerol (TAGs) ⇝ 3FA + Glycerol

3 FA

↳ simple TAG ⇝ all FA are similar

↳ Mixed TAG ⇝ FAs are different



Ester linkage

Hydrolysis: break TAG producing Glycerol + 3FA ionized

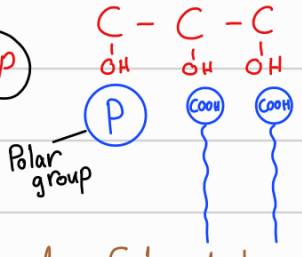
Saponification: using a base ⇝ Glycerol + 3 FA salt

Membrane lipids

1) Glycero phospholipids ⇝ Glycerol + 2 FA + Phosphate + polar group

Hydrophobic tails

hydrophilic head



The bond: Ester linkage

↳ Phosphatidyl choline (Lecithins)

↳ the most abundant type

↳ Targeted by snake venom causing RBC hemolysis

↳ Phosphatidyl ethanolamine , phosphatidyl serine

↳ Cephalins → abundant in the brain

↳ Phosphatidyl inositol → Nitrogenous base having a cyclic sugar alcohol

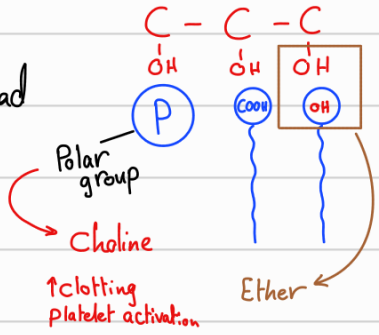
↳ membrane component , second messenger

↳ Cardiolipin (Diphosphatidyl-glycerol)

↳ abundant in the inner membrane of mitochondria

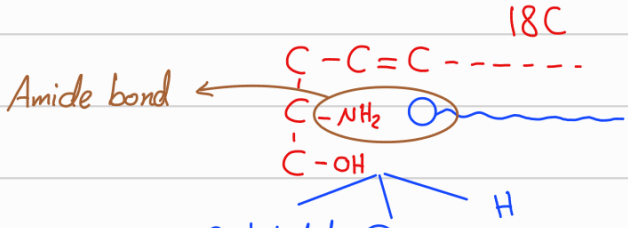
↳ 3 Glycerol , 4 FA , 2 (P)

Plasmalogens ⇝ Glycerol + 1 fatty alcohol + 1 Fatty acid + polar head
- derived from Dihydroxyacetone
- Protect against reactive oxygen species



Note: Amphipathic lipid form micelle by emulsification process
- cell membrane, Vesicle, liposome ⇝ lipid bilayer / Micelle ⇝ single layer

2) Sphingo lipids
- Sphingosine + FA + polar group



Ceramide ⇝ sphingsine + FA + H

Sphingomyelin ⇝ sphingosine + FA + phosphocholine
- in myelin sheath (coating around nerve fibers)

Glycolipids ⇝ Sphingosine + FA + Carbohydrate
- Blood types are determined by the terminal sugar on glycolipids
  - Galactose ⇝ B
  - N-acetyl galactose amine ⇝ A

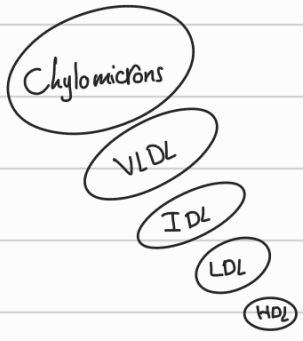
Carbohydrate + Ⓟ + choline
- Glycolipid
  - Cerebroside → 1 sugar
  - Globoside → 2 or more sugar
  - Ganglioside → 2 or more sugar
    - Sialic acid
- Sphingomyelin

Sulfatides:
- Galactocerebroside with sulfate on C3

Lipoproteins
- Transport lipid through the plasma of the blood

HDL ⇝ smallest ⇝ ↓ lipid ⇝ ↑ protein

Chylo microns ⇝ largest ⇝ ↑ lipid ⇝ ↓ protein



3) Steroids ⇝ Nucleus (4 fused rings) + Side chain
- derived from isoprene
- Cholesterol is the most common, which amphipathic (Polar is OH on C3)
  - only animals
  - used to produce Sex hormones, Vitamin D and Bile acids

Cholesterol ester ⇝ Cholesterol + FA
- Transport larger amount of lipids

Atherosclerosis is the accumulation of lipids (LDL) on the walls of blood vessels

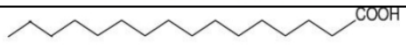
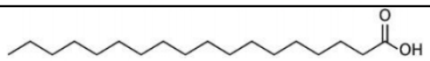
☆ lipid bilayer ⇝ outer ⇝ phosphotidyl choline, sphingomyelin, glycoproteins
↳ inner ⇝ Phosphotidyl serine, Phosphotidyl ethanolamine, Phosphotidyl inositol

Membrane fluidity: ↑ temperature = ↑ fluid, ↑ unsaturated = ↑ fluid, Cholesterol = Intermediate fluidity

Membrane proteins:

1) Integral ⇝ Penetrate, bypass, anchored
↳ transmembrane domain ⇝ α-helix in humans, β-sheets in Bacteria

2) Peripheral ⇝ Non-covalent
3) lipid anchored ⇝ Covalent
↳ on the surface (don't penetrate)

Structure & Formula	Systematic Name / Omega	Common Name	C : Double
 $CH_3(CH2)_{12}COOH$	n-Tetradecanoic Acid	Myristic Acid	14 : 0
 $CH_3(CH_2)_{14}COOH$	n-Hexadecanoic Acid	Palmitic Acid	16 : 0
 $CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$	Δ^9 -Hexadecenoic acid ω 7	Palmitoleic Acid	16 : 1
 $CH_3(CH_2)_{16}COOH$	n-Octadecanoic Acid	Stearic Acid	18 : 0
 $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$	Δ^9 -Octadecenoic acid ω 9	Oleic Acid	18 : 1
 $CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_5COOH$	$\Delta^{9,12}$ -Octadecadienoic acid ω 6	Linoleic Acid	18 : 2
 $CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$	$\Delta^{9,12,15}$ -Octadecatrienoic acid ω 3	Alpha-Linolenic Acid (ALA)	18 : 3
 $CH_3(CH_2)_4(CH{=}CHCH_2)_4(CH_2)_2COOH$	$\Delta^{5,8,11,14}$ -Eicosatetraenoic acid ω 6	Arachidonic Acid	20 : 4
 $CH_3CH_2(CH{=}CHCH_2)_5(CH_2)_2COOH$	$\Delta^{5,8,11,14,17}$ -Eicosapentaenoic acid ω 3	Eicosapentaenoic Acid (EPA)	20 : 5
 $CH_3CH_2(CH{=}CHCH_2)_6CH_2COOH$	$\Delta^{4,7,10,13,16,19}$ -Docosahexaenoic Acid ω 3	Docosahexaenoic Acid (DHA)	22 : 6