Omega fatty acids

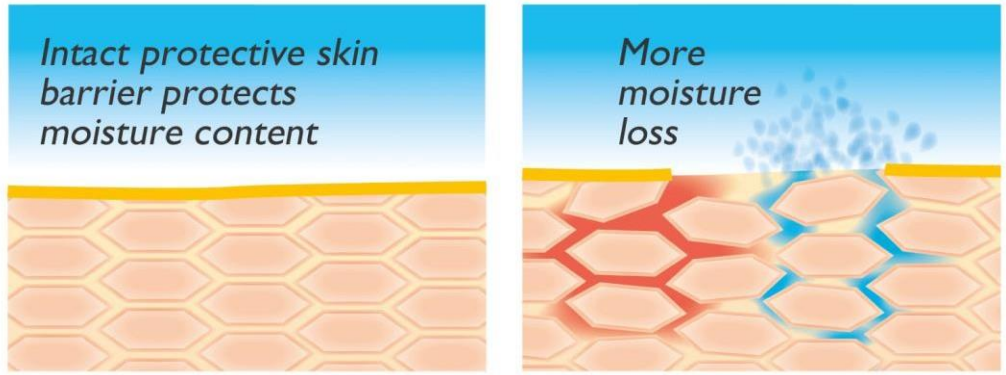
- Omega-3 fatty acids
  - α-linolenic acid → eicosapentaenoic acid (EPA) → docosahexaenoic acid (DHA)
    - They reduce inflammatory reactions by:
      - Reducing conversion of arachidonic acid into eicosanoids
      - Promoting the synthesis of anti-inflammatory molecules
- Omega-6 fatty acids
  - Arachidonic acid **Increase inflammation**
    - stimulates platelet and leukocyte activation,
    - signals pain,
    - Induces bronchoconstriction,
    - regulates gastric secretion
- Omega-9 fatty acids
  - Oleic acid
    - Reduces cholesterol in the circulation

The importance of Omega-3 fatty acids Reduce inflammation 1by reducing synthesis eicosanoids from arachodinic acid 2increase the synthesis of anti-inflammatory molecules

Why is linoleic acid essential?

1. It serves as a precursor of arachidonic acid. It is abundantly present in Lard
2. It covalently binds another fatty acid attached to cerebrosides (to be discussed) in the skin, forming an unusual lipid (acylglucosylceramide) that helps to make the skin impermeable to water.
   This function of linoleic acid may help to explain the red, scaly dermatitis and other skin problems associated with a dietary deficiency of essential fatty acids.
3. It is the precursor of important neuronal fatty acids.

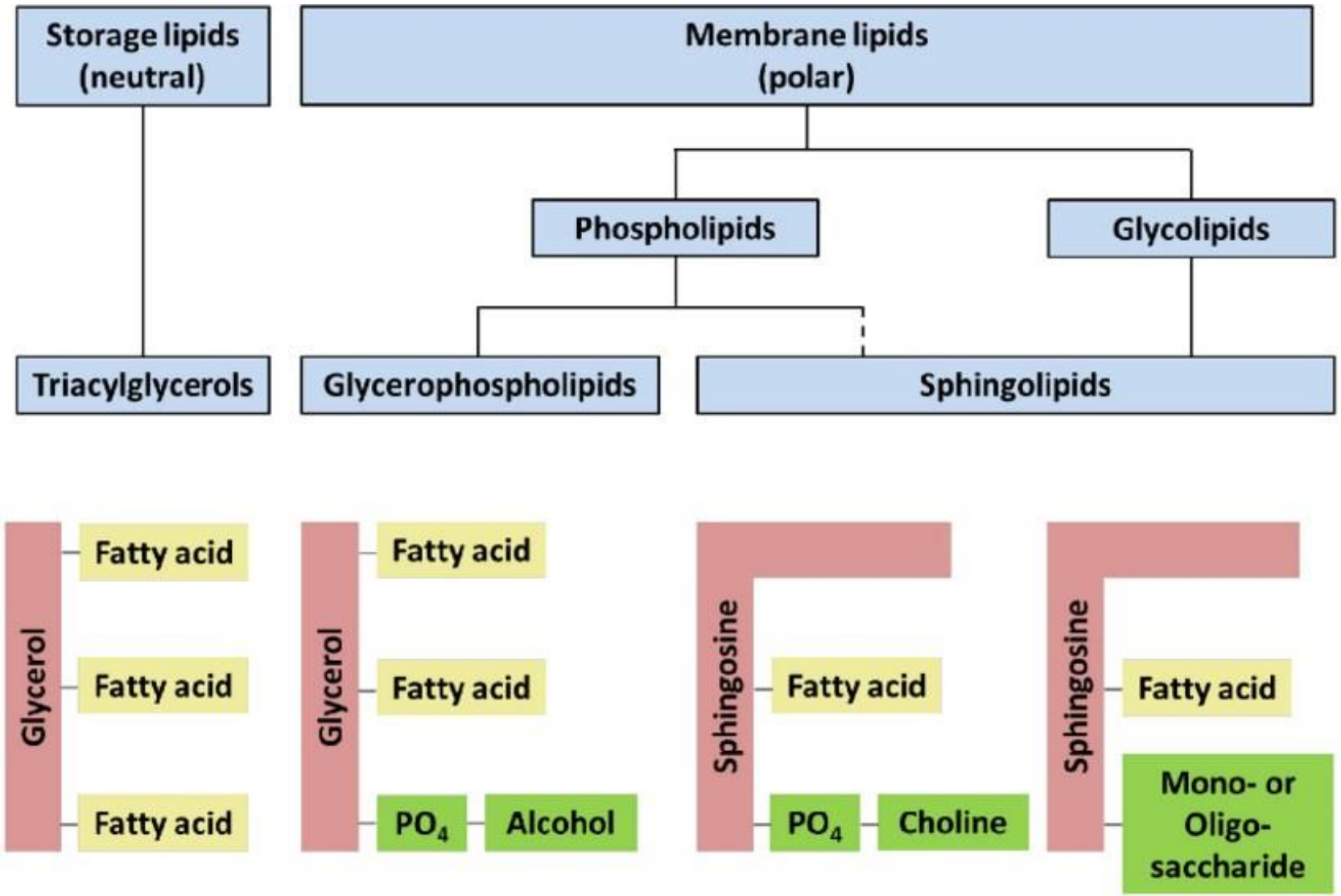
The linoleic acid acts as a barrier on the skin by bonding with cerebroside and forming a compound acylglucosylceramide It moisturizes the skin and helps it function as a barrier



Intact protective skin barrier with linoleic acid rich lipids

Loss of lipids results in break-down in skin barrier function. The skin loses a large amount of water and dries out.

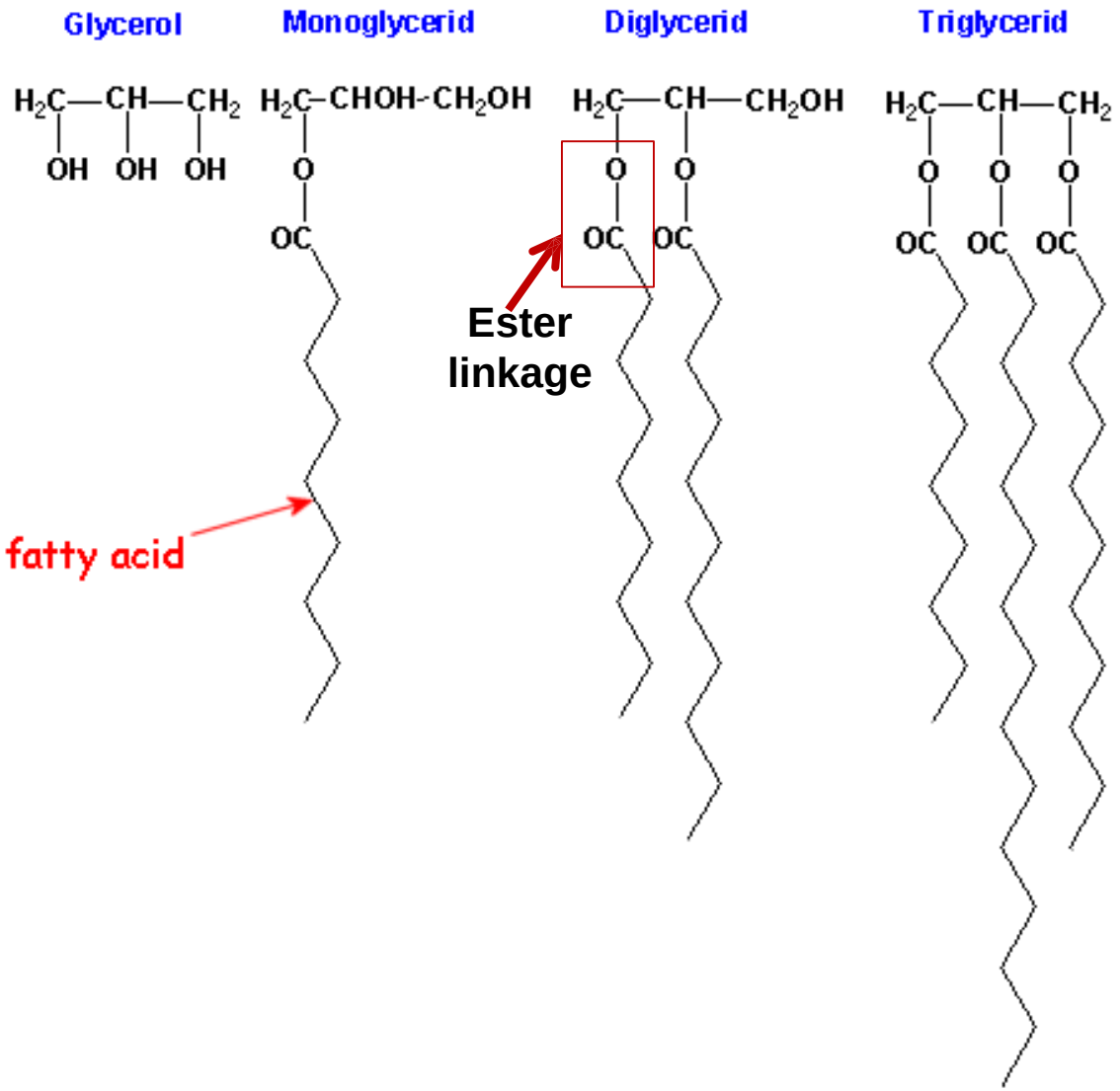
Complex lipids


Storage lipids (neutral)
Membrane lipids (polar)
Phospholipids
Glycolipids
Triacylglycerols
Glycerophospholipids
Sphingolipids
Glycerol
Fatty acid
Fatty acid
Fatty acid
Glycerol
Fatty acid
Fatty acid
PO4
Alcohol
Sphingosine
Fatty acid
PO4
Choline
Sphingosine
Fatty acid
Mono- or Oligo-saccharide

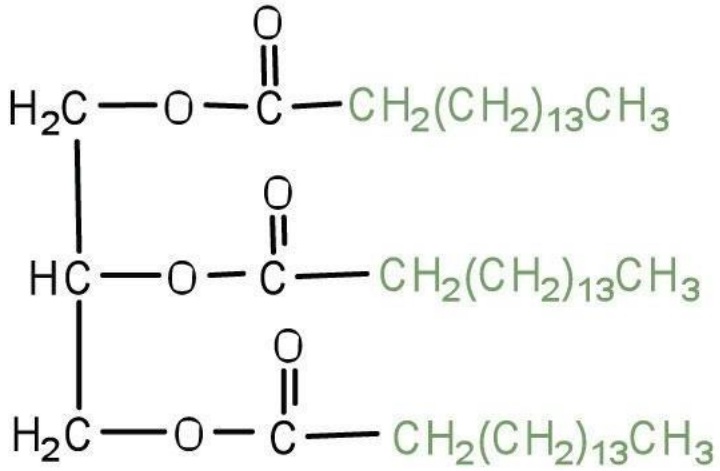
Triglycerides

Triglycerides:
3 fatty acid attached to glycerol by ester linkage, they release a water molecule by dehydration reaction

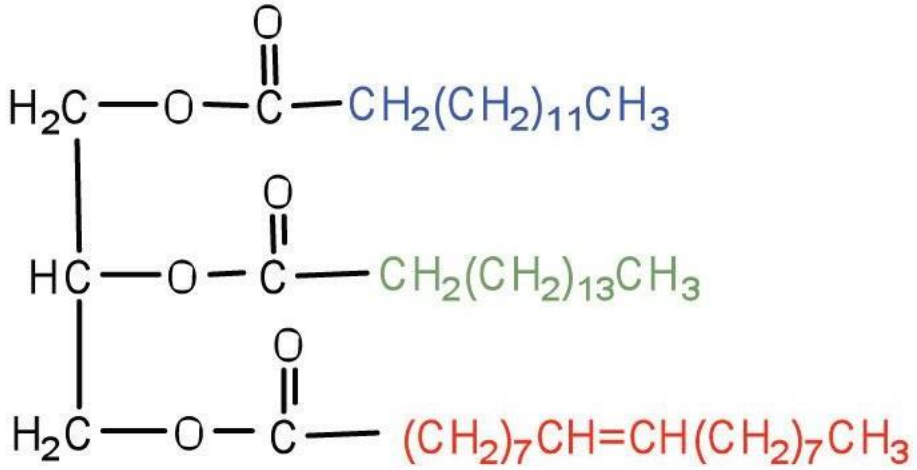
We get triacylglycerol by synthesised it inside the body or by eating, as each oil or fat is a mixture of different types of triacylglycerol



Types of glycerides



Tristearin
a simple triglyceride



a mixed triglyceride

Edited by Dr.Mamoun : This compound contains 16 C , so it's palmatic acid

They are all of the same type as Fatty acid

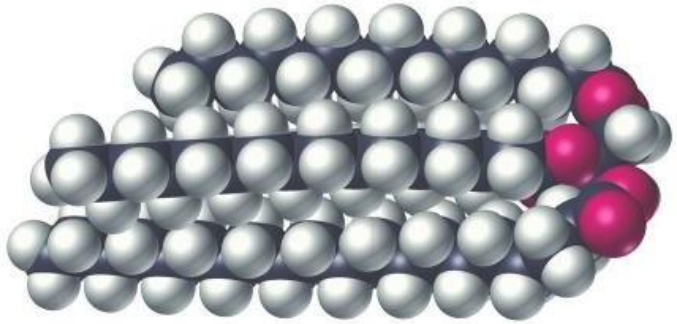
How soluble will a triglyceride be if fatty acids are unsaturated?

more than one type of fatty acid

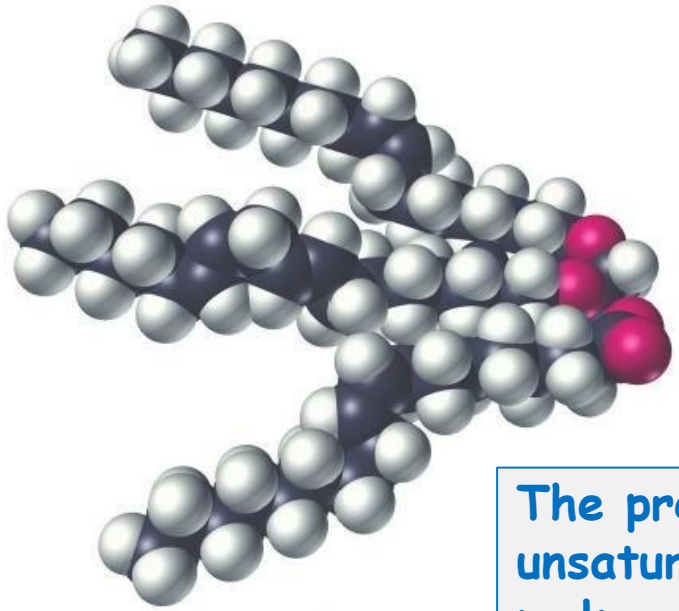
Solid vs. liquid fats

- Vegetable oils consist almost entirely of unsaturated fatty acids, whereas animal fats contain a much larger percentage of saturated fatty acids.
  - This is the primary reason for the different melting points of fats and oils.

#The unsaturated fatty acid is a low melting point
The saturated fatty acid is a high melting point



A fat



An oil

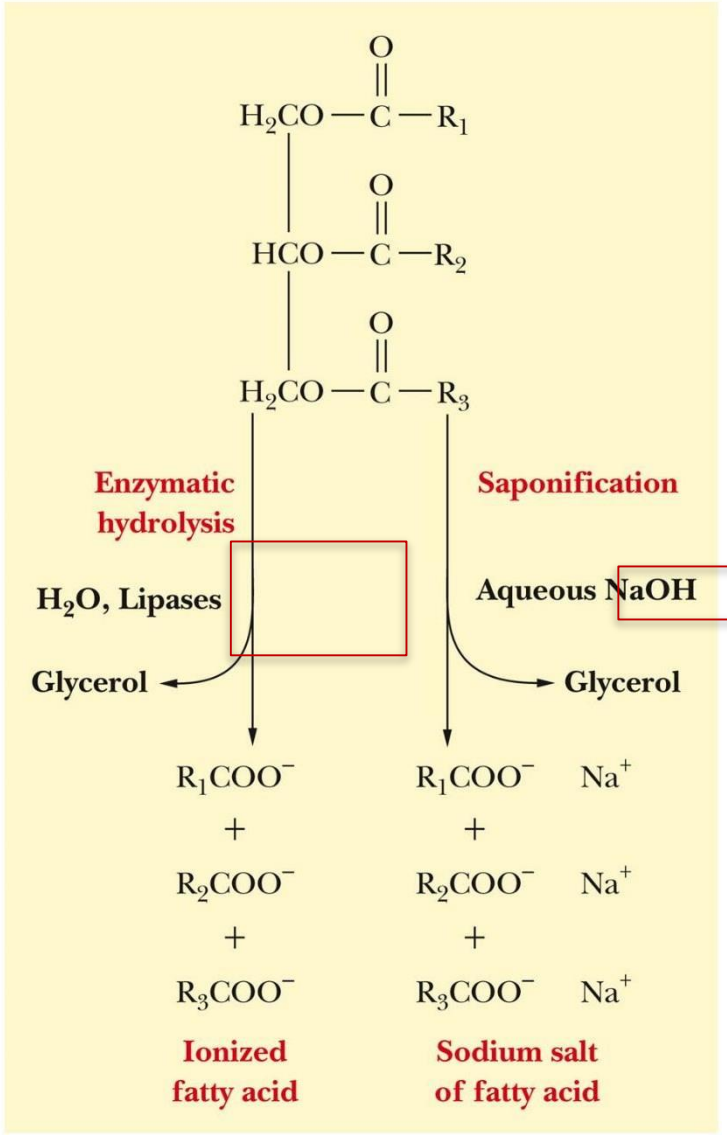
The presence of unsaturated fatty acid makes kinks

Saponification

- Hydrolysis: steam, acid, enzyme (e.g., lipase of pancreas)

- Saponification: Alkaline hydrolysis produces salts of fatty acids (soaps). Soaps cause emulsification of oily material.

Triacylglycerol interacts with strong base (NaOH) in the presence of water , the acid reacts with the base and produces salt and H2O



hydrolysis reaction takes place inside in the cells by lipase enzyme which synthesized and secreted by pancreas released into the intestinal tract to hydrolyze triacylglycerol

How does soap work?

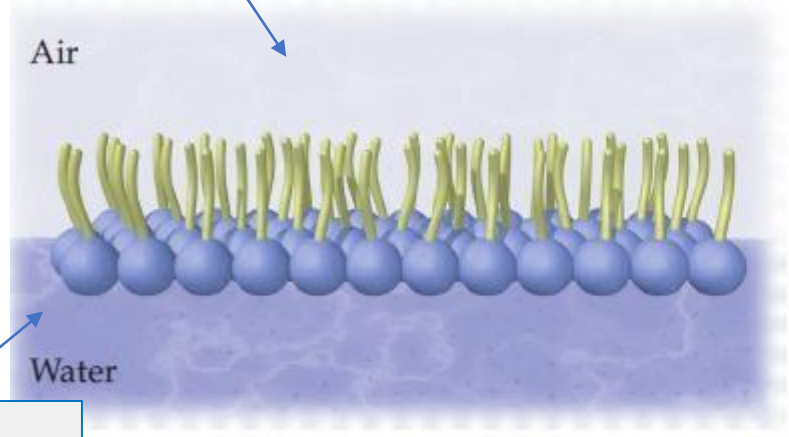
- When mixed with water, the hydrophobic hydrocarbon tails cluster together to create a nonpolar microenvironment and the hydrophilic ionic heads interact with water.
- The resulting spherical clusters are called micelles.
- Grease and dirt are trapped inside micelles and the complex can be rinsed away.

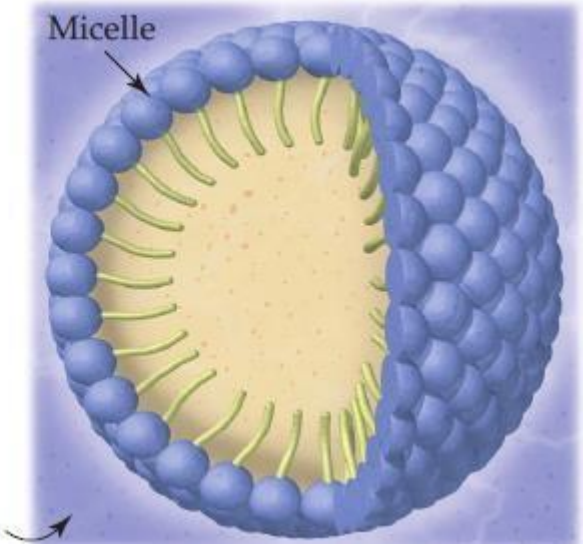
Soap is amphipathic molecules

Micelle forms when grease(hydrophobic part) is inside and water (hydrophobic part) is outside

Hydrophobic (non polar)

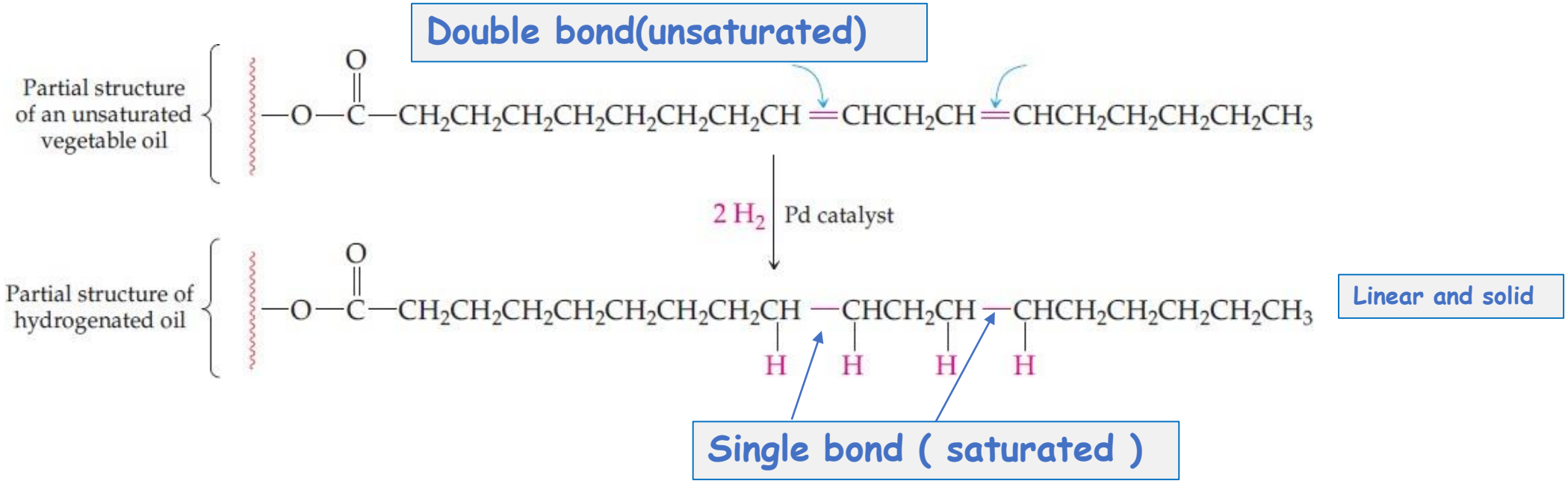
Hydrophilic (polar)





Hydrogenation : Addition of hydrogen to unsaturated fatty acids to convert it to saturated fatty acids

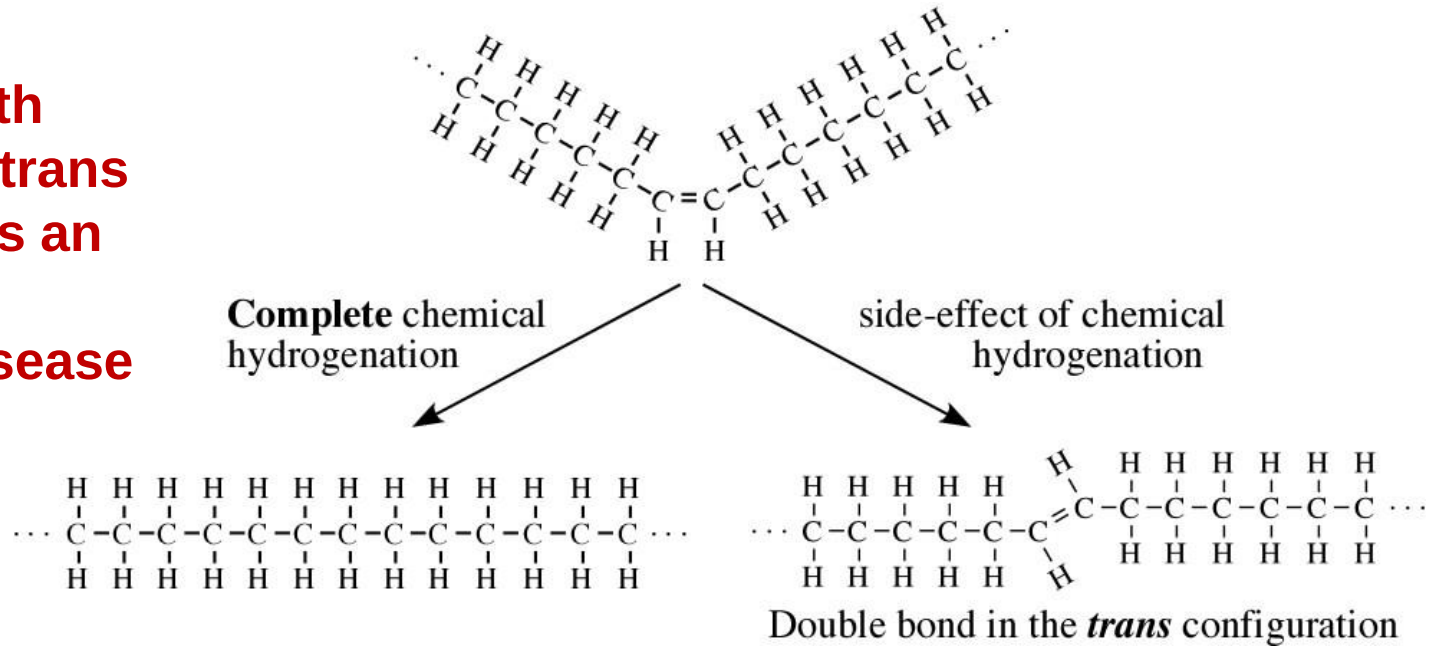
- The carbon-carbon double bonds in vegetable oils can be hydrogenated to yield saturated fats in the same way that any alkene can react with hydrogen to yield an alkane.



Trans fat (Don't have kinks) , that is why they are associated with coronary heart disease .

- Although the animal fat is unhealthy, it has better cooking properties and better taste.
- Therefore, chemists invented a method of converting unsaturated oil into solid form by partially hydrogenating it.
- Partial hydrogenation converts some, but not all, double bonds into single bonds generating (trans fats).

The primary health risk identified for trans fat consumption is an elevated risk of coronary heart disease (CHD).



Example: margarine

- In margarine, only about two-thirds of the double bonds present in the starting vegetable oil are hydrogenated, so that the margarine remains soft in the refrigerator and melts on warm toast.

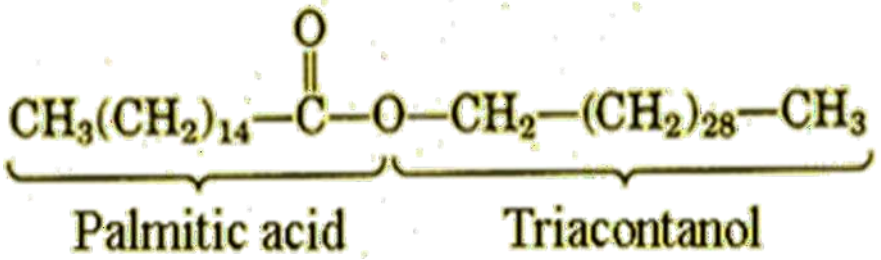
Nutrition Facts

Serving Size 1 Tbsp (14g)
Servings Per Container 32

Amount Per Serving	
Calories 100	Calories from Fat 100
	% Daily Value*
Total Fat 11g	17%
Saturated Fat 2g ←	10%
Trans Fat 3g ←	
Cholesterol 0mg	→ 0%

Trans fats (plants sources)
Unhealthy and cheap

Waxes



- Solid simple lipids containing a monohydric alcohol (C16 ~ C30, higher molecular weight than glycerol) esterified to long-chain fatty acids (C14 ~ C36). Examples: palmitoyl alcohol
- Insoluble in water
- Are not easily hydrolyzed (fats) & are indigestible by lipase s
- Are very resistant to rancidity
- Are of no nutritional value
- Coatings that prevent loss of water by leaves of plants

Type	Structural Formula	Source	Uses
Beeswax	$CH_3(CH_2)_{14}-C(=O)-O-(CH_2)_{29}CH_3$	Honeycomb	Candles, shoe polish, wax paper
Carnauba wax	$CH_3(CH_2)_{24}-C(=O)-O-(CH_2)_{29}CH_3$	Brazilian palm tree	Waxes for furniture, cars, floors, shoes
Jojoba wax	$CH_3(CH_2)_{18}-C(=O)-O-(CH_2)_{19}CH_3$	Jojoba	Candles, soaps, cosmetics

Study the uses

Made of ester between fatty acid and long hydrocarbon chain

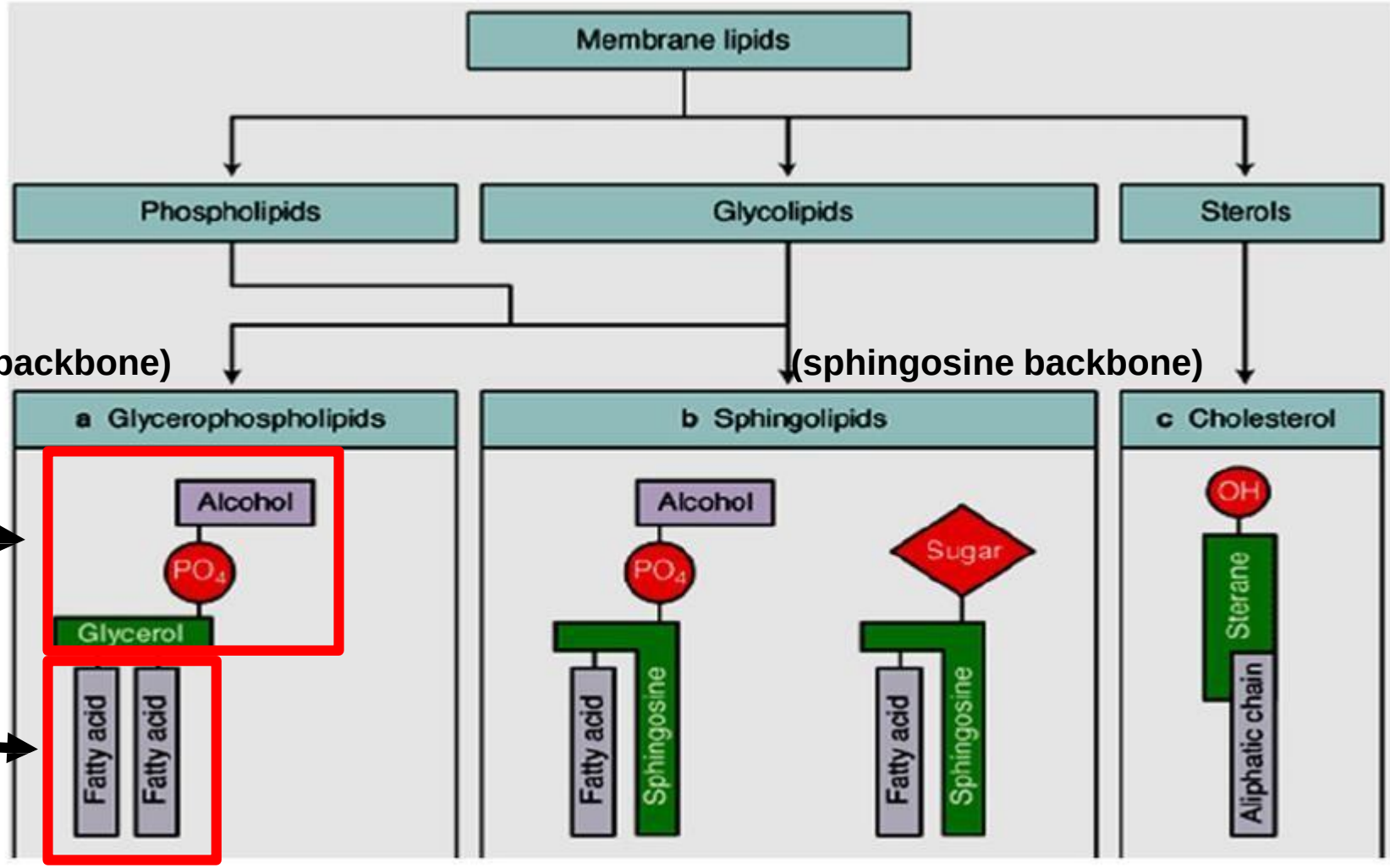
- coats the feathers of ducks allowing them to swim and float

- present on the surface of leaves to prevent water loss/ dehydration

- Present on the surface of imported apples to give the shiny appearance and prevent bugs from reaching the apple

Membrane lipids

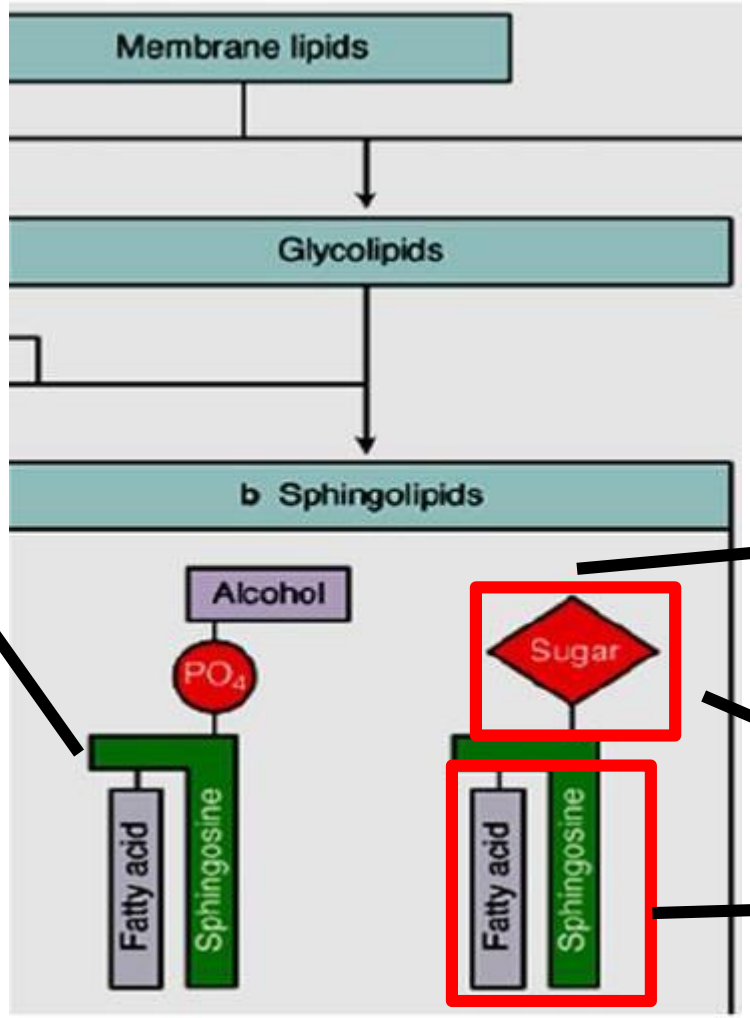
The most prevalent class of lipids in membranes is the glycerophospholipids



Hydrophilic head

Hydrophobic tails

Sphingomylein
(it is inbetween,it is a phospholipid as it has a phosphate group,however it is also a sphingolipid as it has sphingosine)



Note that there is only one fatty acid tail,however a portion of the sphingosine that is a long hydrocarbon chain also acts as the second tail

Glycolipids (major type of sphingolipids)

Polar head

Hydrophobic tail

Phospholipids (phosphoacylglycerols)

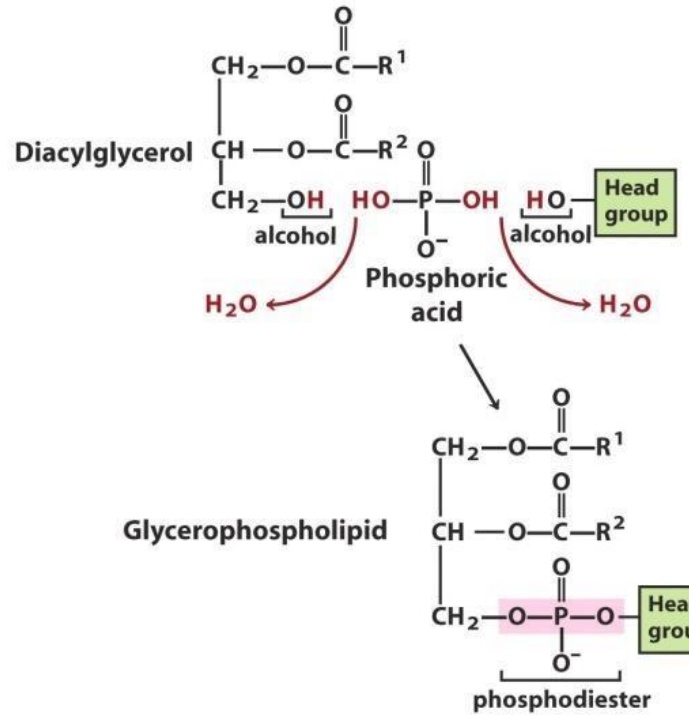
- Phosphatidic acids

(Most basic type, just 2 fatty acid + glycerol + phosphate)

- Phosphatidylcholine (lecithin)
  - Most abundant membrane lipid

Has choline group attached to phosphate

- Cephalins
  - Phosphatidylethanolamine
  - Phosphatidylserine
    - abundant in brain
- Phosphatidylinositol
  - sends messages across cell membranes
- Cardiolipin
- Plasmalogens



Phosphatidic acid	—	—H
Phosphatidylethanolamine	Ethanolamine	$-CH_2-CH_2-\overset{+}{N}H_3$
Phosphatidylcholine	Choline	$-CH_2-CH_2-\overset{+}{N}(CH_3)_3$
Phosphatidylserine	Serine	$-CH_2-\underset{COO^-}{CH}-\overset{+}{N}H_3$

Amine + carboxyl group, it is highly charged so very polar

Glycerophospholipids - Lecithins

- Snake venom contain lecithinase, which hydrolyzes polyunsaturated fatty acids and converting lecithin into lysolecithin
  - hemolysis of RBCs

Phosphatidylcholine **Choline** $-CH_2-CH_2-\overset{+}{N}(CH_3)_3$

Lecithinase removes phosphatidylcholine from the cell membrane of RBC's, causing the cell to pop

Also present in food,to emulsify food,as it is amphipathic,one part of it polar and the other is nonpolar, allowing it to mix fats into the food with polar substances

Emulsification

- Because of their amphipathic nature, they act as emulsifying agents, that is substances that can surround nonpolar molecules and keep them in suspension in water.