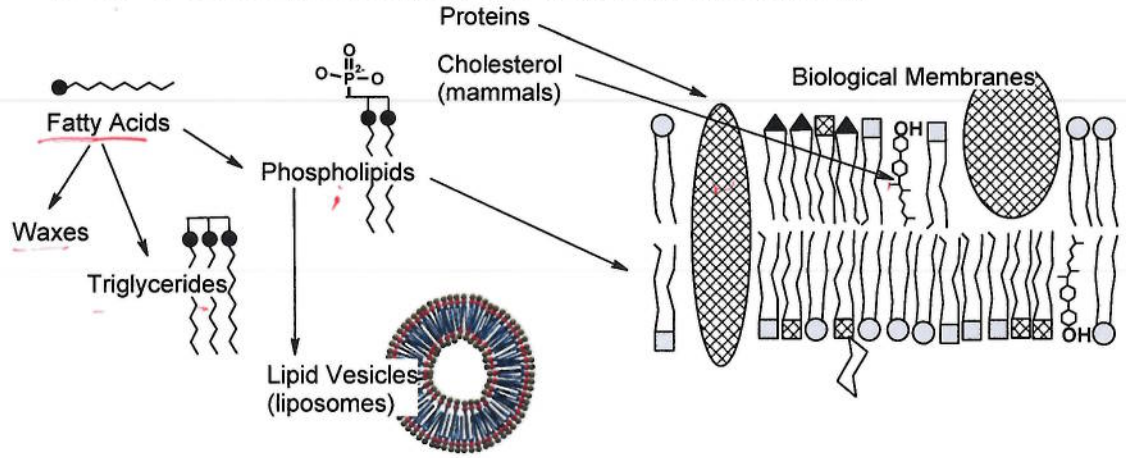
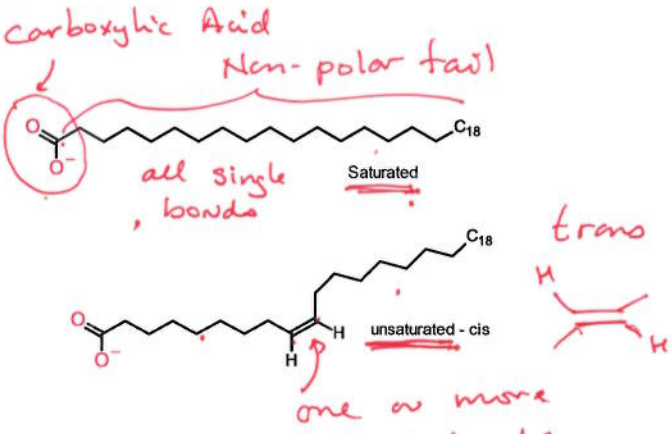
Lecture 25: Lipids and Membranes

Expectations:

- Be able to recognize and differentiate between fatty acids, waxes, triglycerides, phospholipids, and sterols (cholesterol).
- Be able to discuss the effect of cholesterol on the properties of the membrane.
- Be able to discuss the permeability properties of the membrane.
- Be able to discuss the overall structure of a biological membrane.



Lipids: A collection of different molecules that have three common characteristics:
i) generally quite insoluble in water,
ii) predominately hydrocarbon (-CH_2-),
iii) a small polar functional group.



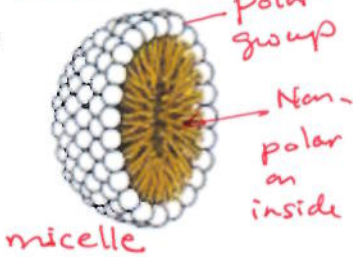
A. Fatty Acids:

A1. Structure:

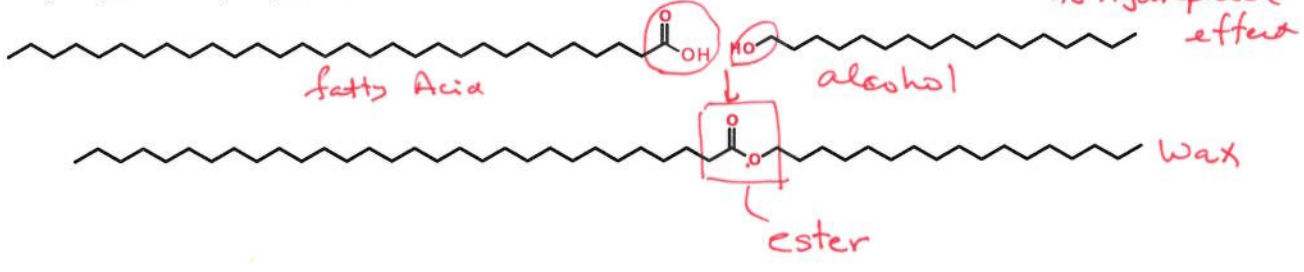
- Carboxylic acid, polar headgroup
- Non-polar hydrocarbon chain
- Saturated – no double bonds
- Unsaturated – one or more cis double bonds.

Interaction with water

1. Fatty acids form **micelles**, aggregates of fatty acids with a polar (charged) surface and a hydrophobic, waterless, interior. The assembly of micelles is spontaneous.
2. The non-polar interior can dissolve hydrophobic compounds (oily 'dirt'), therefore, fatty acids and modified fatty acids (*e.g.* SDS) are the principal components of soaps.



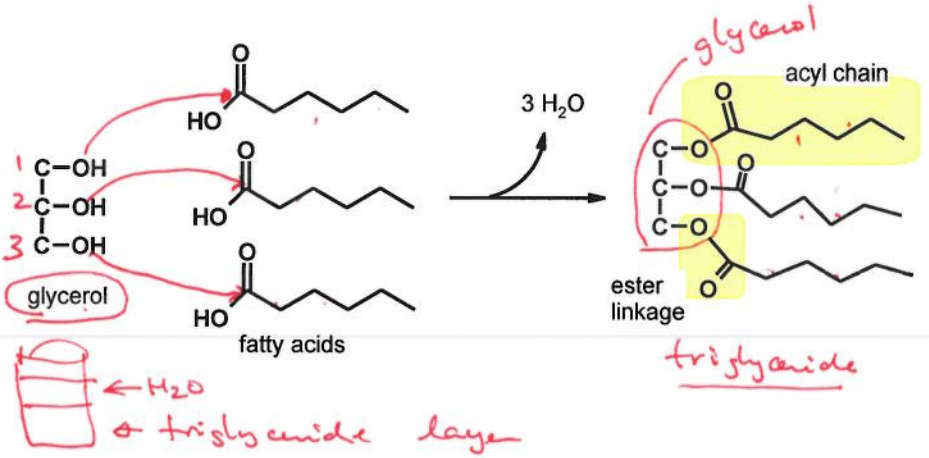
B. Waxes: Ester of a fatty acids and an alcohols, e.g. beeswax:
$CH_3(CH_2)_{29}O\text{-}CO\text{-}(CH_2)_{14}CH_3$



Triglycerides:

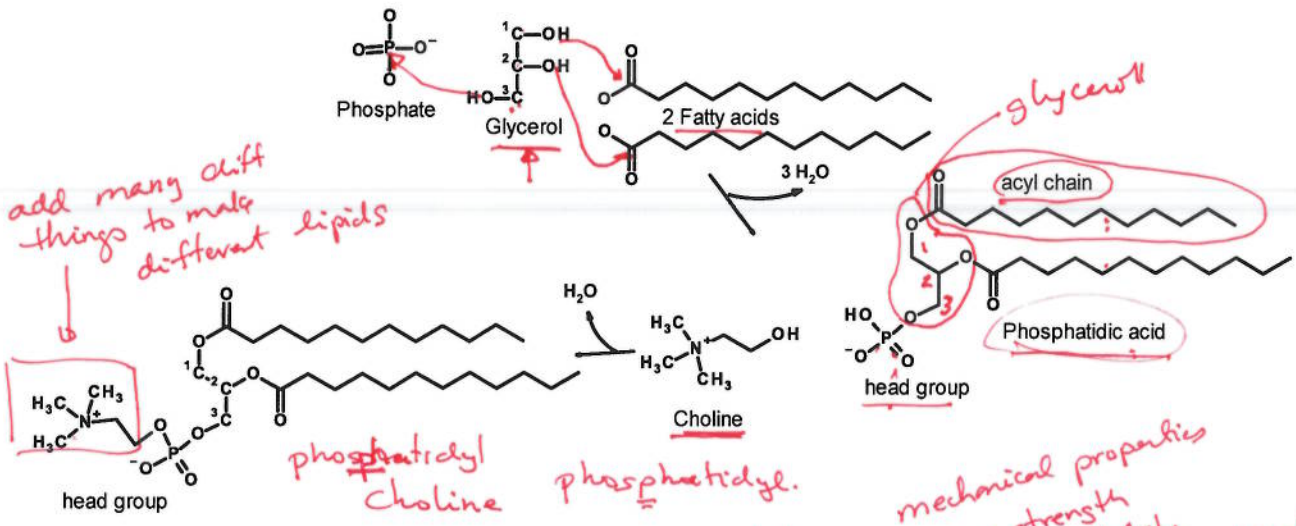
These are how fatty acids are stored in organisms for future use as an energy reserve (e.g. vegetable oils)

These do not mix with water, forming two separate layers.



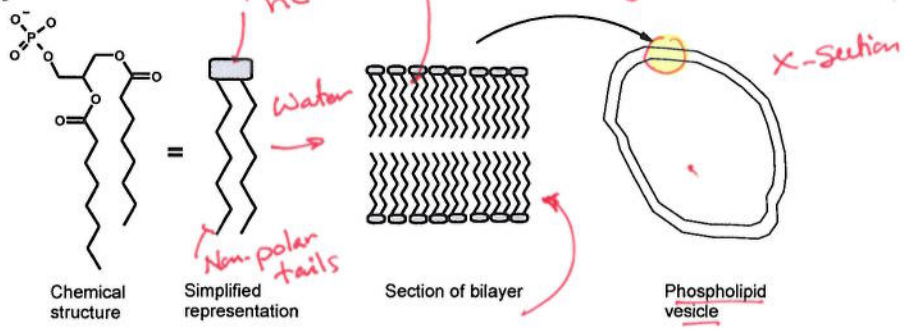
C. Phospholipids:

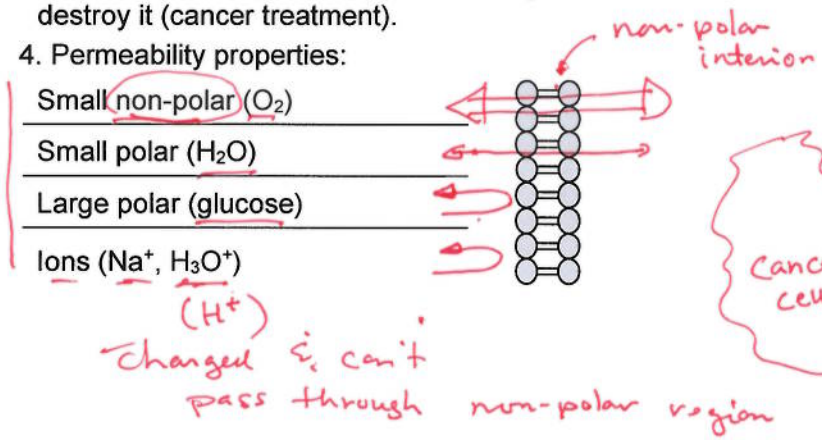
1. Phosphate + glycerol + two fatty acids (**acyl chains**) of *various* types form a phospholipid.
2. Various **head groups** are attached to the phosphate, giving a diverse set of lipids.



Physical Properties of Pure Lipid Bilayers:

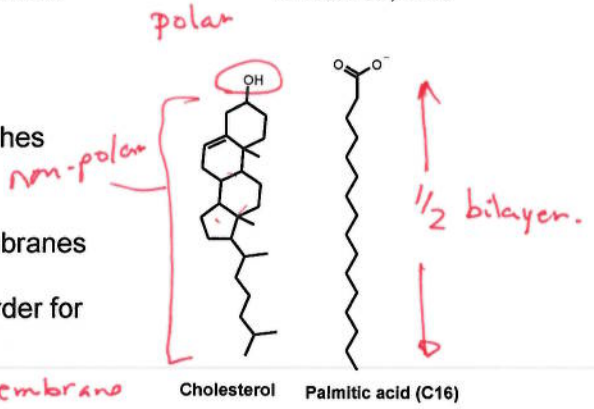
1. Phospholipids self-assemble in water to form **bilayers** (two opposing layers of phospholipids). The non-polar tails are buried due to the hydrophobic effect and the polar heads remain exposed to the water.
2. The bilayers form closed, water filled, vesicles with a 40-50 Å thick wall. These are called liposomes.
3. Liposomes can be used to encapsulate drugs and with antibodies on their surface can carry the drugs to a target cell to destroy it (cancer treatment).
4. Permeability properties:





D. Sterols - Cholesterol:

1. Is a natural sterol, you produce about 1 g/day!
2. About the same length as C_{16} fatty acid; therefore it reaches across half of the bilayer.
3. *Essential* component of most mammalian membranes.
4. Often referred to as a membrane *plasticizer*, so that membranes are fluid.
5. Reduces the permeability of the membrane, making it harder for things, such as water, to go through.



* maintain membrane fluidity.

E. Biological Membranes – *Fluid mosaic model.*

The membrane is fluid, allowing the diffusion of molecules within the plane of the membrane.
It is a mosaic, composed of:

- Phospholipids (many different types)
  - cis fatty acids increase the fluidity
- Glycolipids (lipid + carbohydrate)
- Cholesterol, also increasing the fluidity.
- Integral membrane proteins and glycoproteins. These are imbedded in the membrane and present a non-polar surface to the lipid bilayer, stabilized by the hydrophobic effect.

Function of Integral Membrane Proteins:

1. Transport (*e.g.* of protons, metabolites, electrons)
   a. Passive transport (no energy required, molecules spontaneously go from high concentration to low)
   b. Active transport (energy required, molecules are pushed from low to high concentration.)
2. Signal transduction receptors.
3. Receptors for endocytosis.
4. Enzymes.