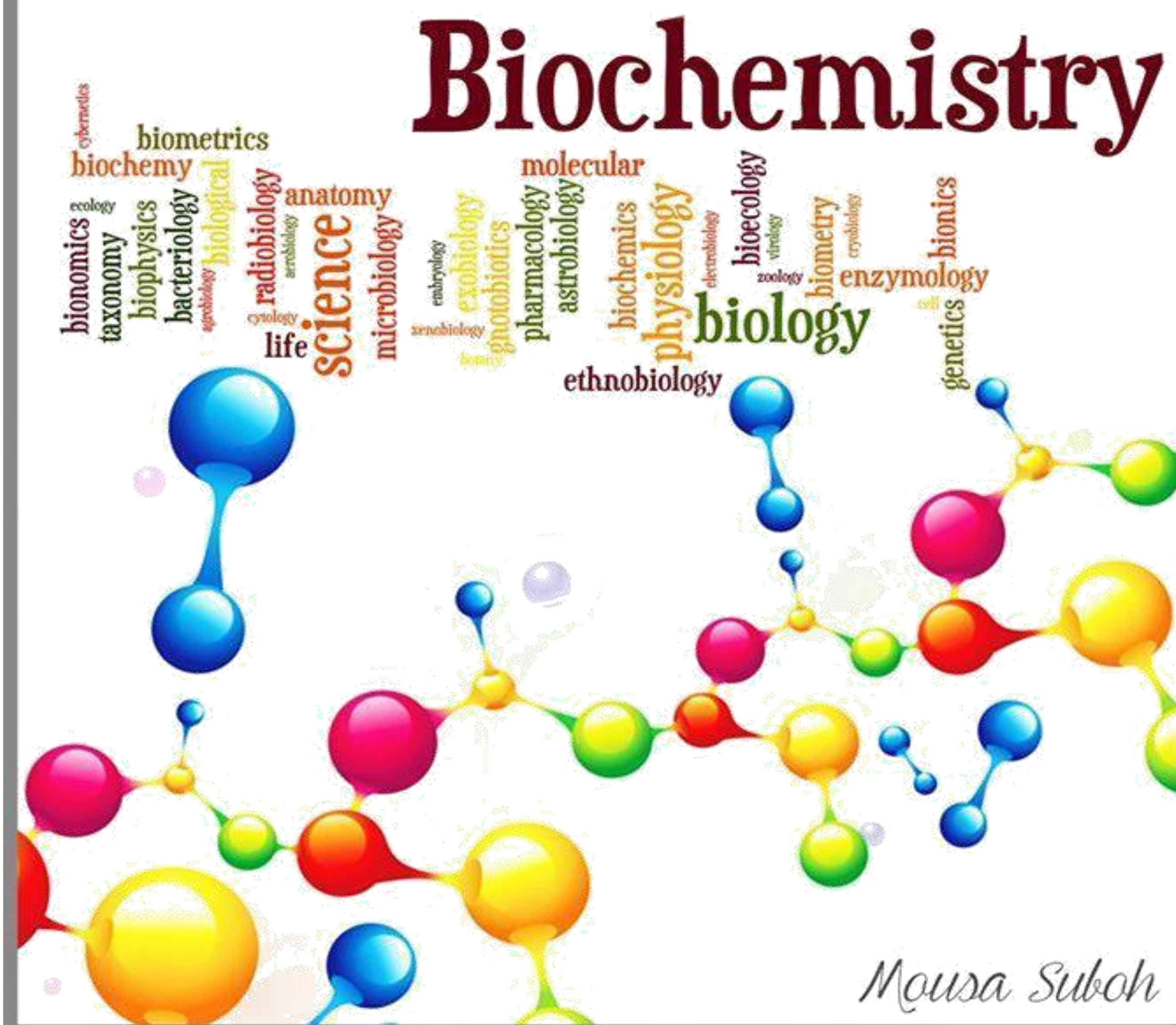
Lecture : 13

Dr. Name : Dr. Nafez

Done By : Aseil Khatib

☐ Slide ■ Sheet

Medical Committee
The University of Jordan



Lipids

In order for us to say we have a lipid; a fatty acid and a fatty alcohol must be present and linked to each other.

We classify lipids into:

I) Simple Lipids

II) Compound (conjugated/complex) lipids

III) Derived Lipids e.g. glycerol and fatty acids and alcohols

IV) Lipid-associated substances e.g. lipid soluble vitamins

V) Cyclic lipids e.g. steroids

Simple Lipids

We will start with "*Simple Lipids*"

- What are they?

Triacylglycerides :(1 glycerol as the fatty alcohol and 3 fatty acids esterified together, just like in fats and oils.

- They are uncharged due to the absence of ionizable groups
- Are the most abundant.

The most commonly found fatty acids which are connected to glycerol are:

1) Palmitic acid

2) Stearic acid

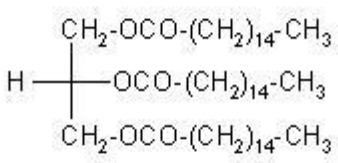
3) Oleic acid

Palmitic and stearic acids are saturated fatty acids while *oleic acid* is a mono-unsaturated fatty acid

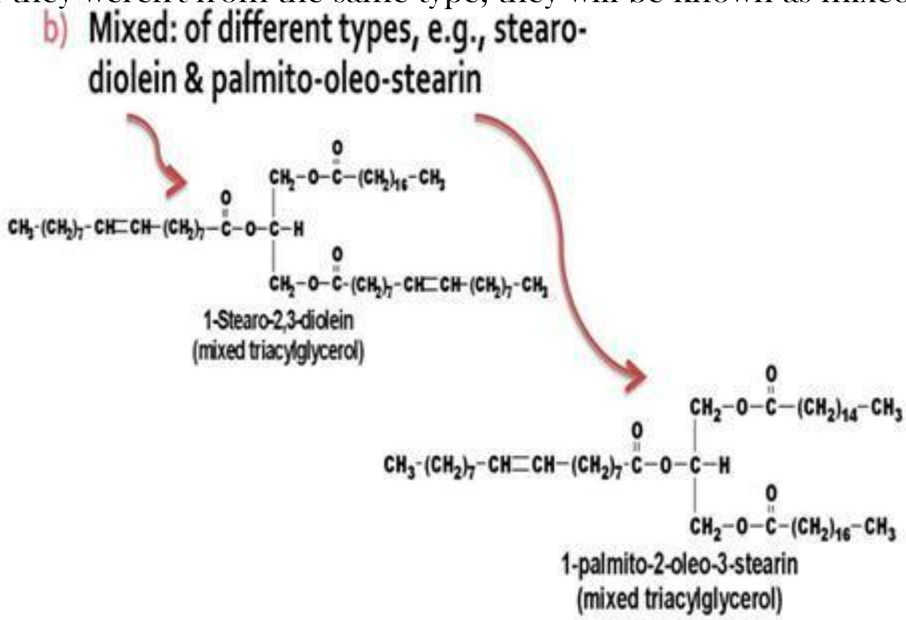
A glycerol molecule can be linked to 3 fatty acids in order to form a lipid.

**These linked fatty acids may be from the same type or different types.

- ✓ If they were from the same type, the lipid will be called a simple triglyceride. E.g tripalmitin (3 palmitic acids esterified to a glycerol molecule)



- ✓ If they weren't from the same type, they will be known as mixed:



*Physical properties of Fats and oils:

- They are colorless, odorless and tasteless when freshly prepared

- Then why do they appear yellow?

- Due to the presence of carotene pigments which are derived from carotin (a substance synthesized by plants, however it passed on to humans as we consume vegetables and plant products)

  **Carotin is present in carrots that's how it got its name

- Fats have a specific gravity less than 1
- Fats are insoluble in water, that is why when you try to mix oil and water the oil will form a layer above the water.

At room temperature, oils are found in their liquid form while fats are found in their solid form, why?

- Fats are saturated with a very high melting point, while oils are unsaturated with a low melting point as a result from the loose packing due to kinks within the structure.

*Chemical reactions:

- How were triglycerioids formed?

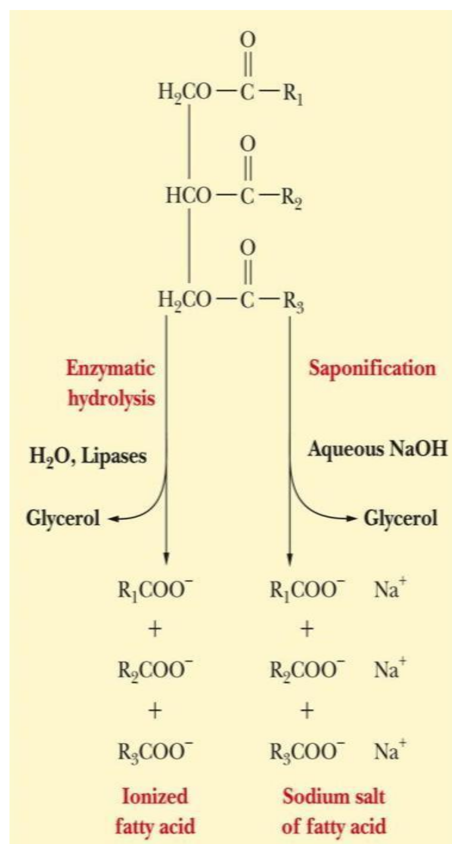
- The *opposite* of hydrolysis is condensation, which is the process by which water is removed, we bring 3 fatty acids and add alcohol to them, each carbon would form an ester bond.

- If we wanted to break down the lipid, which process is used?

- Hydrolysis, which can be achieved by 2 mechanisms

1) Passing the substance through *steam, an acid, or an enzyme* (e.g. lipase of pancreas)

2) Alkaline hydrolysis where the fatty acids are split from glycerol and added to sodium. This is also known as saponification.

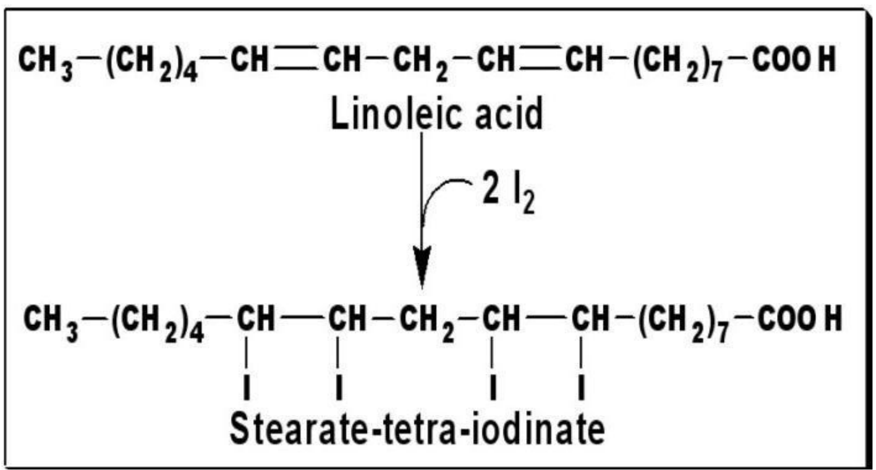


- Soaps are made of a hydrophobic region where the fatty acids lie, and a hydrophilic region where sodium ions are attached. They have the ability to emulsify ; decreasing the size of the fat droplet through splitting it into small droplets, increasing surface area needed to work on and exposing the contents within the droplet in order for various reactions to take place.

Emulsification takes place in our digestive system

3) Halogenation : adding halogens to the unsaturated fatty acids, since every molecule will be linked to a halogen, this reaction is used to determine the degree of unsaturation of the fatty acid, hence determining its biological value.

- ✓ For example if <u>2 molecules, 4 atoms of iodine</u>, were used up in the reaction below, then we would know that there were <u>2 double bonds</u> previously present.



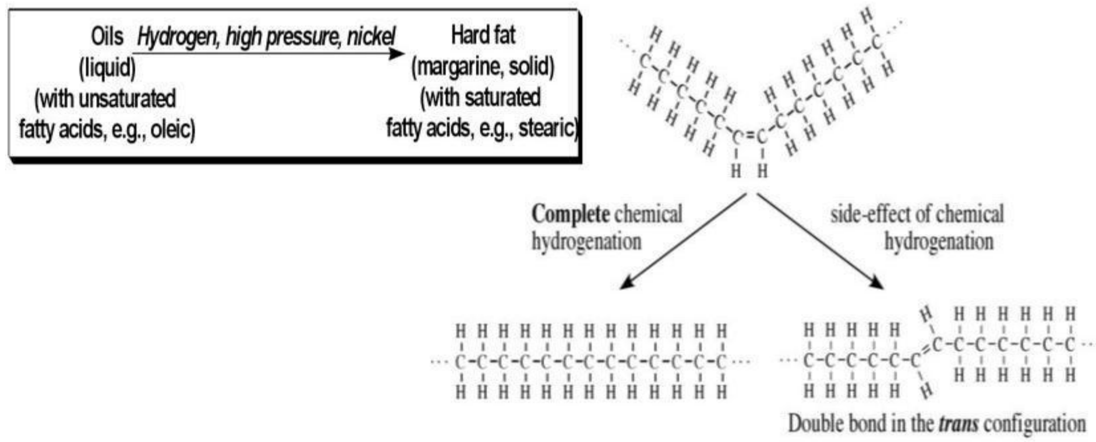
4) Hydrogenation: adding *hydrogens to double bonds* in order to turn them to single bonds.

- How is it accomplished?

- Under very high pressure of hydrogen

By this mechanism we convert oils to fats : unsaturated ⟶ saturated

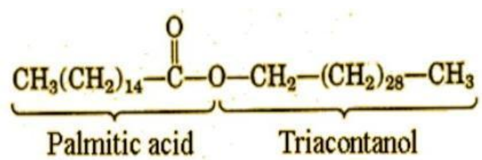
- Why do we turn oils to fats?



❖ Since it makes our food taste better, however saturated fatty acids are the worst for our health.

Trans-fat : partial hydrogenation, results in the loss of fat-soluble vitamins, occurs when we convert some *cis-bonds* to *trans-double* bonds (trans double bonds are bad for health).

The other type of simple lipids : Waxes



- Waxes are found in their *solid* form.
- They contain a *monohydric alcohol* (with a higher molecular weight than glycerol) esterified to long-chained fatty acids.
- They are insoluble in water and give a negative result when tested by acrolein
- They do not react with anything.
- They aren't easily hydrolyzed and are indigestible (pass through the GI unchanged "without any treatment"), have a zero nutritional value
- Coat vegetables, fruits and leaves in order to prevent water loss

Examples :

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

* * *The differences between neutral lipids and waxes:

Property	Waxes	Neutral lipids
1.Digestibility	Indigestible (not hydrolyzed by lipase)	Digestible (hydrolyzed by lipase)
2-Type of alcohol	Long-chain monohydric alcohol + one fatty acid	Glycerol (trihydric) + 3 F.A
3-Type of F.A	Mainly palmitic or stearic acid	Long & short chain F.A
4-Acrolein test	Negative	Positive
5-Nature at room temperature	Hard solid	Soft solid or liquid
6-Saponification	Nonsaponifiable	Saponifiable
7-Nutritive value	No nutritive value	Nutritive
8-Example:	Bees wax	Butter & vegetable oils

II) Compound Lipids

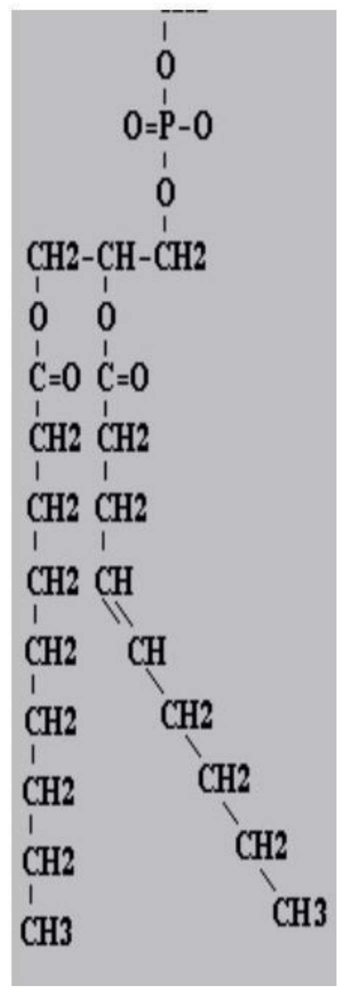
- Lipids with another group attached to them

There are many types of compound lipids, we will start discussing phospholipids:

- What are phospholipids made of?

- Fatty alcohol + fatty acid + phosphate group

The fatty alcohol present may be either glycerol or sphingosine



- When the fatty alcohol is glycerol, it is linked to 2 fatty acids, in the picture below one is saturated and one is unsaturated, *the third carbon is connected to the phosphate group.*

- There is another molecule linked to the phosphate group, and according to the nature of this molecule we will sub-classify these lipids, for instance:

Phosphatidic acid; a hydrogen is linked to the phosphate

Lecithins; choline is linked to the phosphate

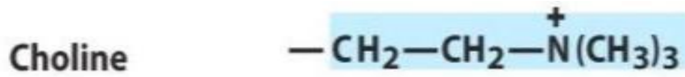
* For each phospholipid there are always isomers, we either name it "alpha" or "beta"

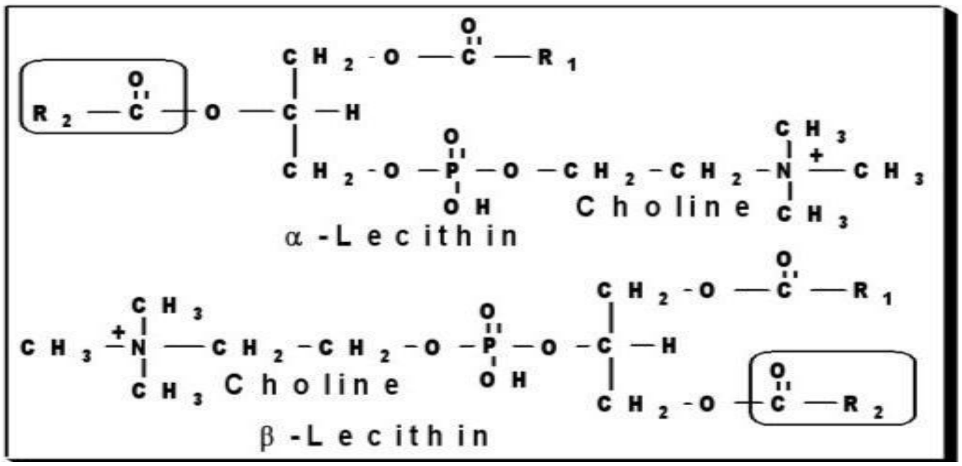
* Glycerol has 2 peripheral carbons and 1 middle carbon, *the middle carbon is called beta* while the *peripheral ones are called alpha.*

- If the phosphate is linked to a peripheral carbon then it is an "alpha-phospholipid" while if the phosphate is linked to the middle carbon then it is a "beta-phospholipid"

* If we removed the hydrogen linked to the phosphate and replaced it with choline (a nitrogenous base) then these phospholipids are now called lecithins, those are important components of the cell membrane, and are hydrolyzed by snake venom.

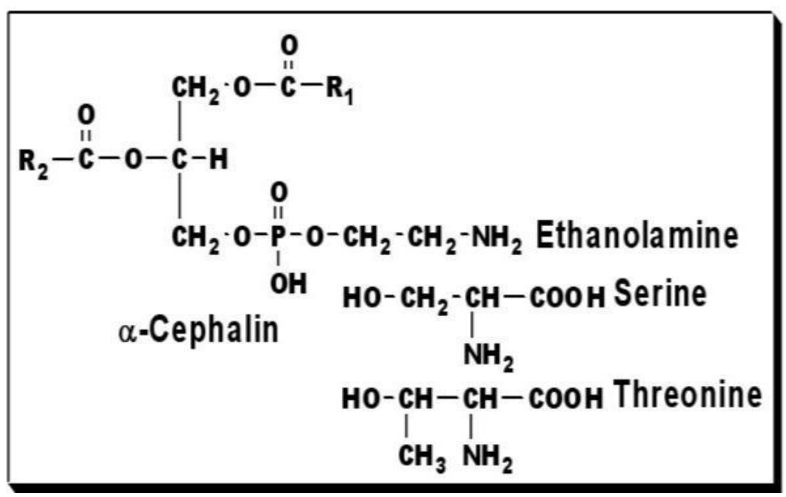
*Lecithin would be converted to lysolecithin by lecithinase present in snake venom, this causes the hemolysis of RBCs which can result in death if not treated immediately.





Cephalins or Kephalins:

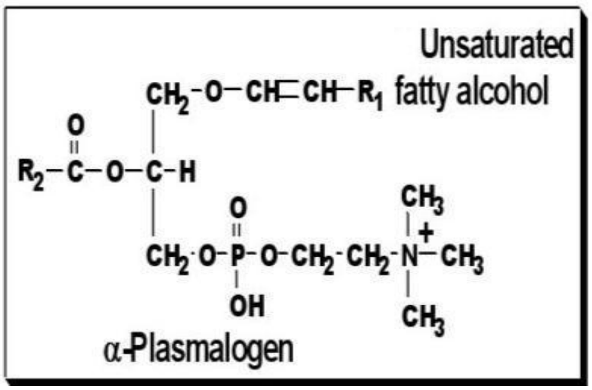
- They are named this way as they are isolated from the brain. (cephal means head)
- Their structure differs from other phospholipids since they have ethanolamine, serine or threonine linked to the phosphate group.

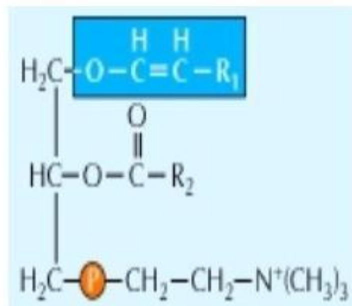


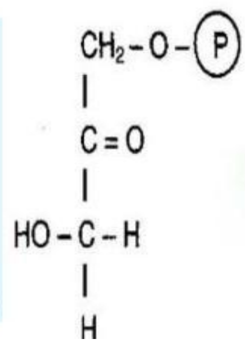
Plasmalogens:

It has a nitrogenous base linked to its phosphate group, the nitrogenous base may be choline, ethanolamine or serine.

- If the nitrogenous base connected was choline, how would plasmalogens differ from lecithins by structure ?







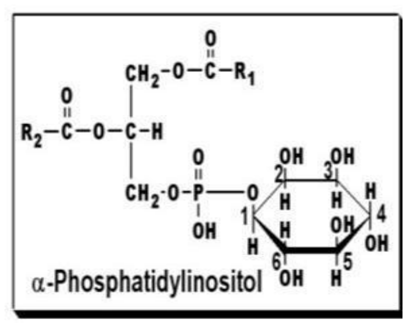
❖ Plasmalogens have an ETHER bond while lecithins have an ESTER bond (Ester bond is formed when we add carboxylic acid to a alcohol, while Ether bond is formed when we add alcohol to alcohol)

✓ Ethanolamine plasmalogens are found in the nervous tissues

✓ Choline plasmalogens are found in cardiac tissue

✓ Serine plasmalogens are found in the retina

Inositides:



Polyhydroxy six-membered ring, each carbon has a hydroxyl group, this molecule is called <u>inositol</u>.

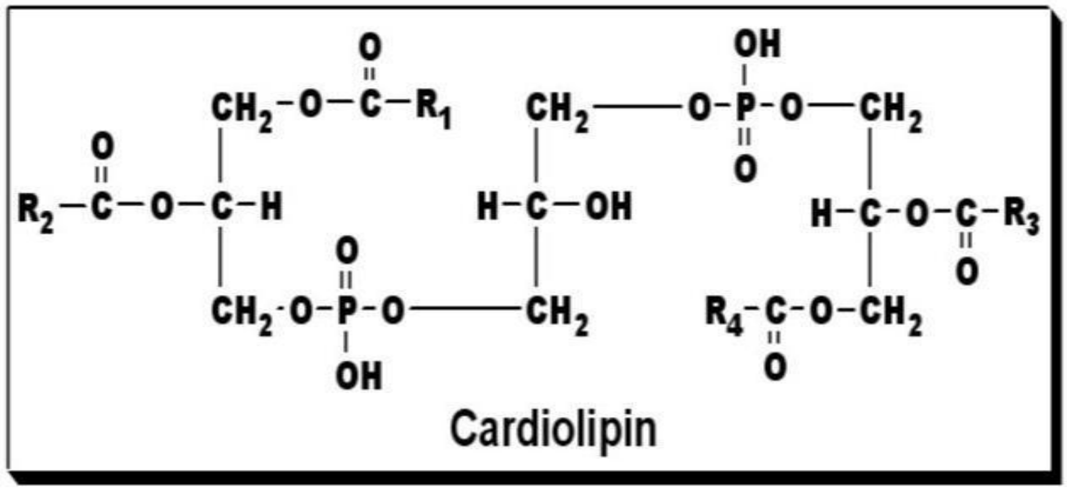
➢ Inositol can be connected to the phosphate in the phospholipid forming <u>Inositides</u>

- Where are they found?

❖ In the cell plasma membrane; as a signaling molecule approaches the cell membrane, phospholipase C-enzyme breaks down inositides into inositol triphosphate (IP3), leaving behind diacyl-glycerol (DAG). Both of these molecules (IP3 & DAG) act as second messengers for activation or inhibition of enzymatic activities.

Cardiolipins:

- 3 glycerol molecules connected to each other by phosphate groups.
- So each molecule has <u>3 glyerols, 2 phosphate groups, and 4 fatty acids</u>
- They are extracted from *cardiac tissue* that is how they got the name



Good luck