



Lipid Chemistry-2

Complex lipids

By lecturer:

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M.sc in Biochemistry and Molecular Biology

Objectives:

► **By the end of this lecture, the student should be able to:**

- 1. Classifies complex lipids according to their different characteristics.**
- 2. Identify the function of each complex lipid**
- 3. Describes the important functions of Dipalmitoyl lecithin in lungs.**
- 4. Free radicals and Lipid Peroxidation**

Complex lipids

```
graph TD; A[Complex lipids] --> B[Phospholipids]; A --> C[Glycolipids]; A --> D[Sulfolipids]; B --> E[Glycero-phospholipids]; B --> F[Sphingo-phospholipids]; C --> G[Gangliosides]; C --> H[Cerebrosides];
```

Phospholipids

Sulfolipids

Glycolipids

**Sphingo-
phospholipids**

Cerebrosides

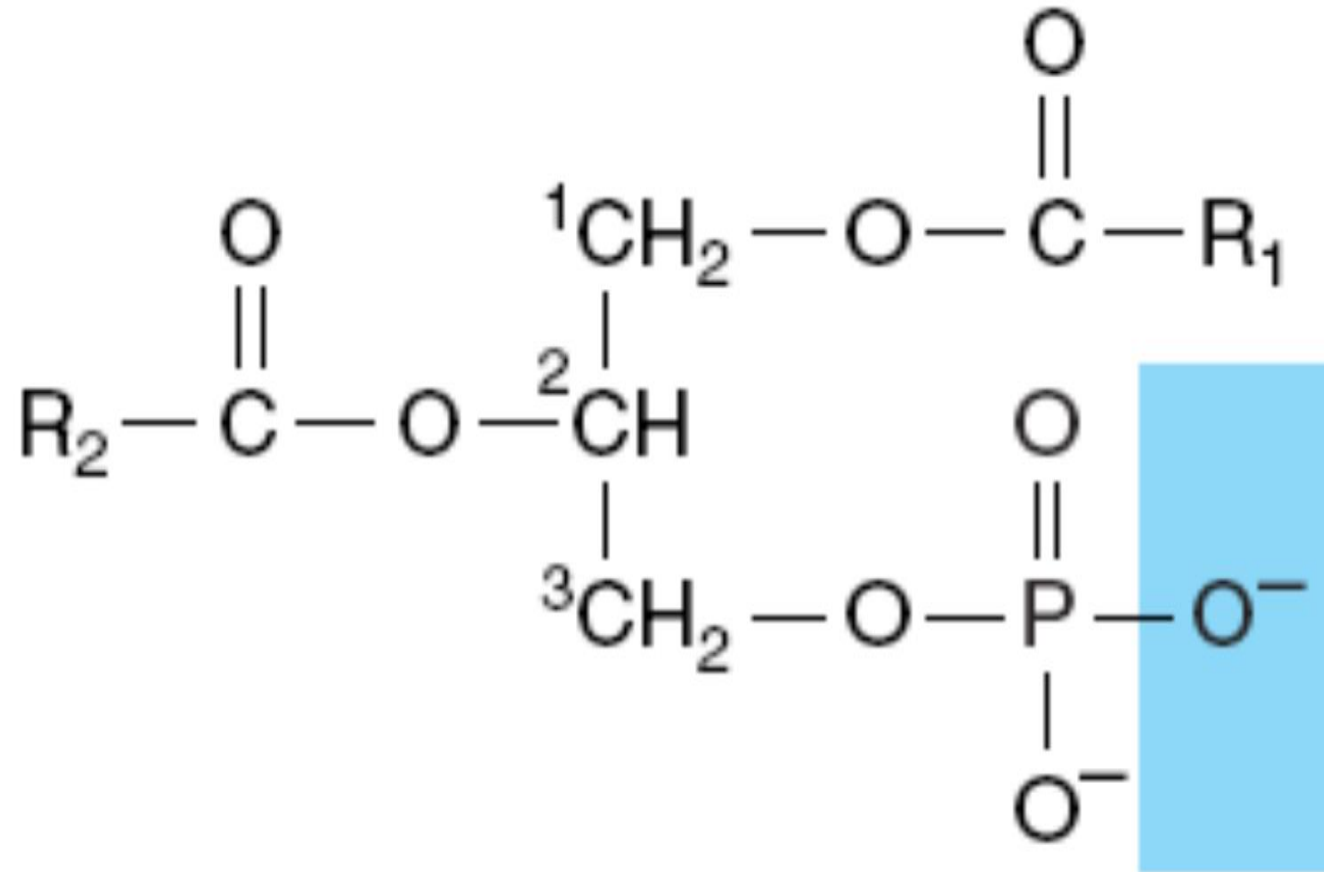
Gangliosides

**Glycero-
phospholipids**

Phospholipids

- **Glycerophospholipids (phosphoglycerides)**
- **Structure:** Glycerol + fatty acid C1 & C2 position + **phosphoric acid** at **C 3**
- **Function:** synthesis of triacylglycerols and phospholipids (**cellular membranes**).

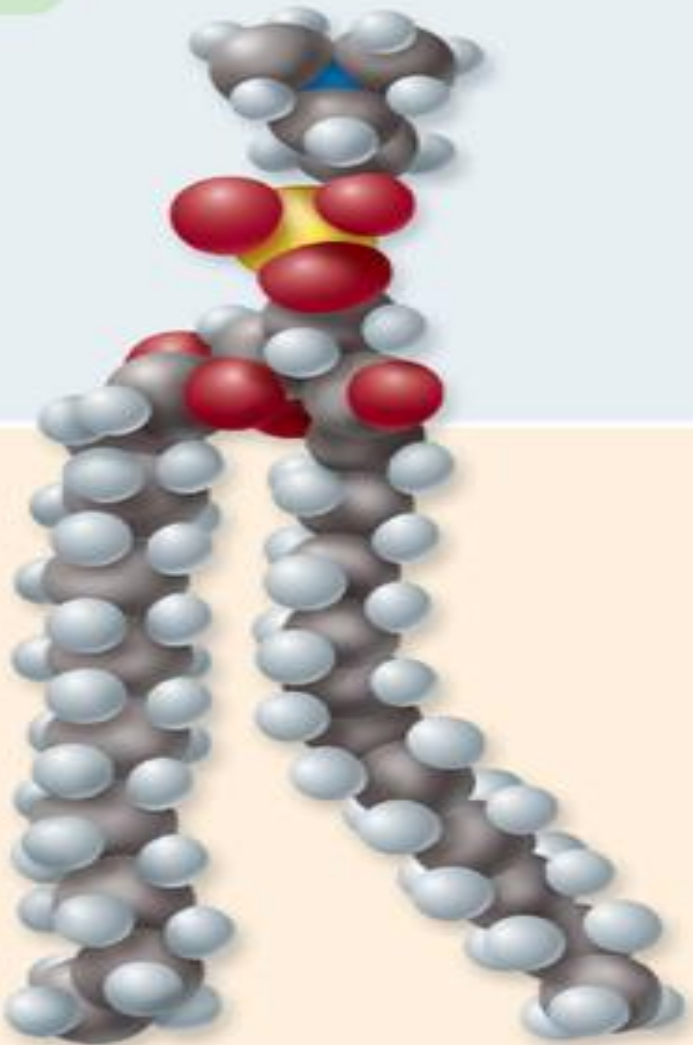
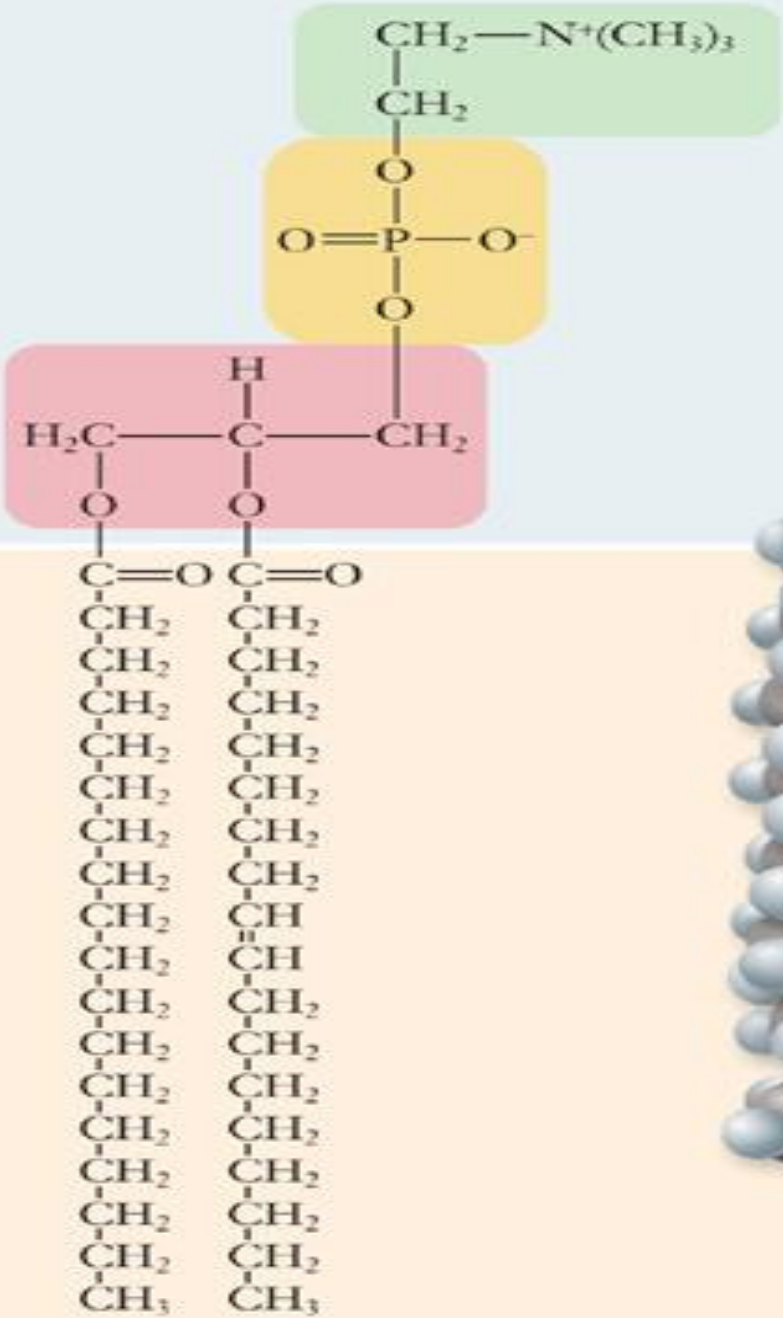
Phosphatidic acid structure



Phosphatidic acid

Polar Hydrophilic Heads

Nonpolar Hydrophobic Tails



Amphipathic lipids

- ❖ In general, lipids are **insoluble in water** since they contain a predominance of **nonpolar** (hydrocarbon) groups.
- ❖ However, *fatty acids, phospholipids, sphingolipids, bile salts*, and, to a lesser extent, *cholesterol* contain polar groups.
- ❖ Therefore, part of the molecule is **hydrophobic**, or water-insoluble; and part is **hydrophilic**, or water-soluble.
- ❖ Such molecules are described as **amphipathic**.

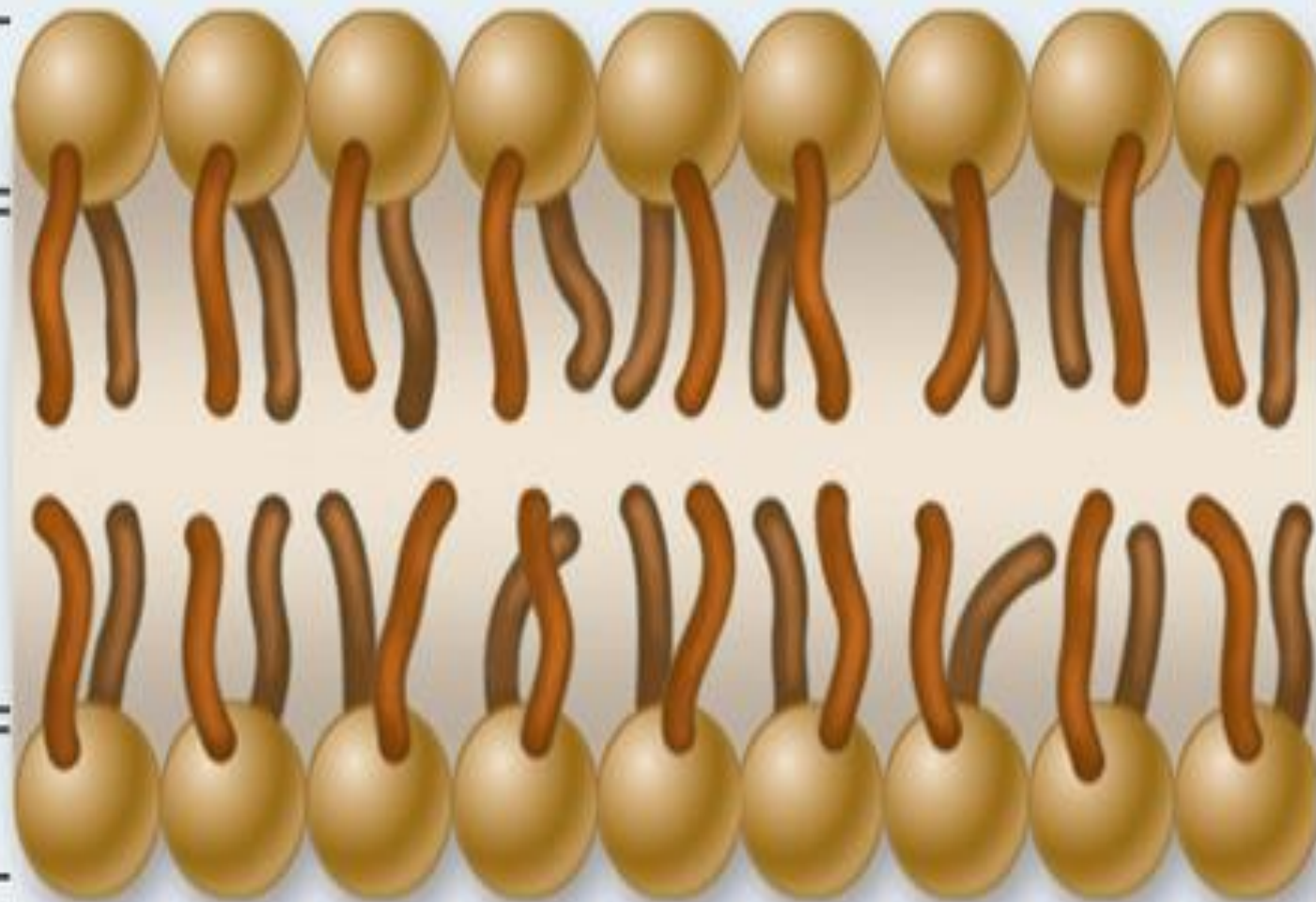
Extracellular fluid

Polar hydrophilic heads

Nonpolar
hydrophobic tails

Polar hydrophilic heads

Intracellular fluid (cytosol)



1. Glycerophospholipids compounds

Phosphoglycerides

- In most **glycerophospholipids** :

P_i is in turn **esterified** to **OH** of a **polar head group (X)**: e.g.,

➤ **Choline**  **phosphatidylcholine**

➤ **Serine**  **phosphatidylserine**

➤ **Ethanolamine**  **phosphatidylethanolamine**

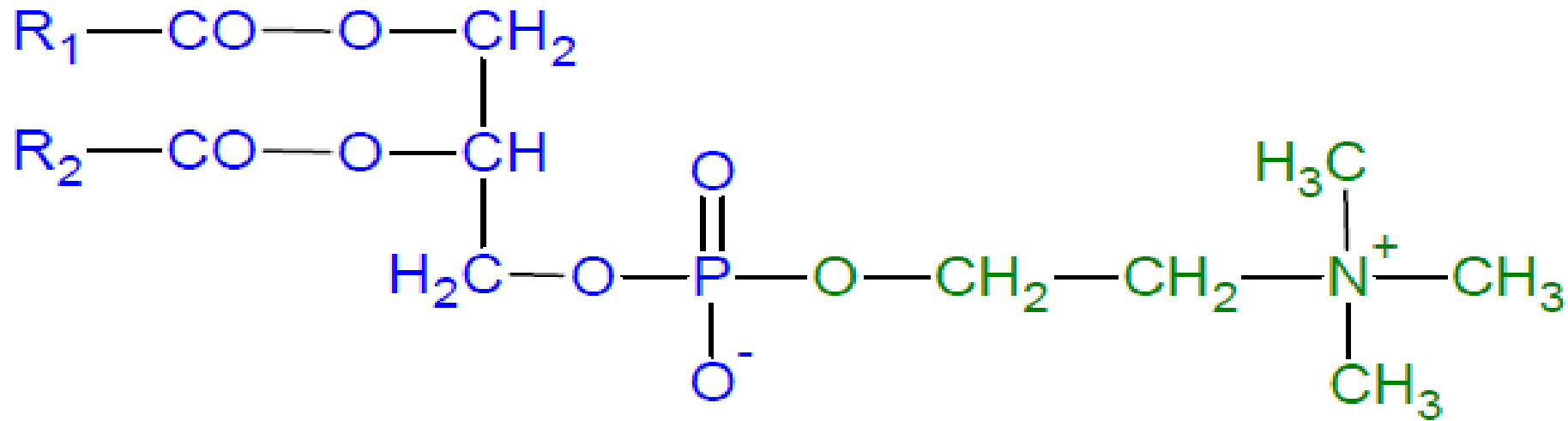
➤ **Inositol**  **phosphatidylinositol**

} *Cephalin*

1. Glycerophospholipids compounds

Phosphatidylcholine (lecithin) PC

- Is a glycerophospholipid with choline as polar head group
- It is a common membrane lipid.
- Dipalmitoyl lecithin is major constituent of the **surfactant**.



Phosphatidylcholine

1. Glycerophospholipids compounds

Phosphatidylcholine (lecithin) PC

Structure:

- 1. Glycerol**
- 2. Saturated fatty acid attached to 1 (α) position.**
- 3. Unsaturated fatty acid attached to 2 (β) position.**
- 4. Phosphoric acid attached to 3 (γ) position.**
- 5. Choline base (attached to phosphoric acid).**

Functions of Phosphatidylcholine (lecithin) PC

- 1. Enters In the structure of cell membrane. It is the most abundant phospholipid in cell membrane.**
- 2. Acts as lipotropic factor; prevent accumulation of fat in liver (fatty liver).**

Functions of Phosphatidylcholine (lecithin) PC

**3. Forms cholesterol esters which prevents atherosclerosis
(transport cholesterol to the liver and excreted with bile).**

4. Prevents gall stones: lecithin in bile solubilizes

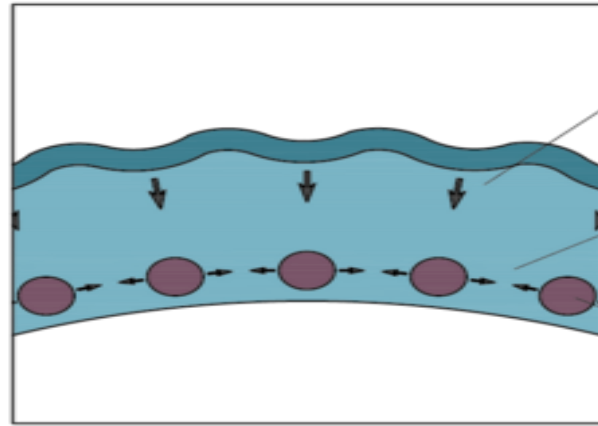
cholesterol → prevent cholesterol stones in gall bladder

Dipalmitoyl lecithin function as surfactant

- **Dipalmitoyl lecithin** is continuously secreted by the lung cells
- Acts as a surfactant in the lung **reduces surface tension**.
- During expiration: preventing adherence, due to surface tension of **the lungs**.
- During Inspiration: makes the lung easier to expand (**↑** compliance)
- **Respiratory distress syndrome (hyaline membrane disease)**

In premature babies, lungs do not secrete enough surfactant **————→** lung collapse and death from respiratory failure.

**Without Surfactant
(detail)**

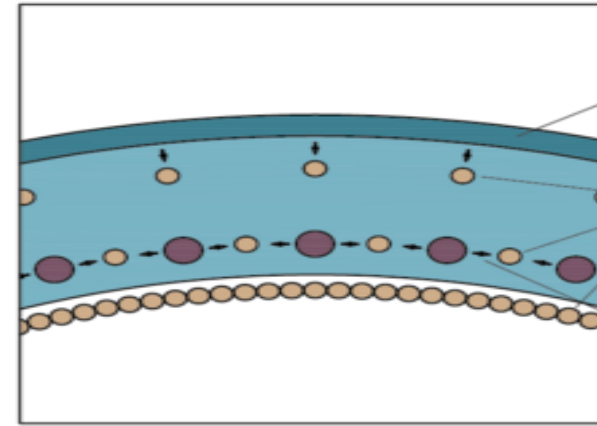


Forces that
tend to collapse
the alveolar wall

Cohesive
force

Fluid
molecule

**With Surfactant
(detail)**

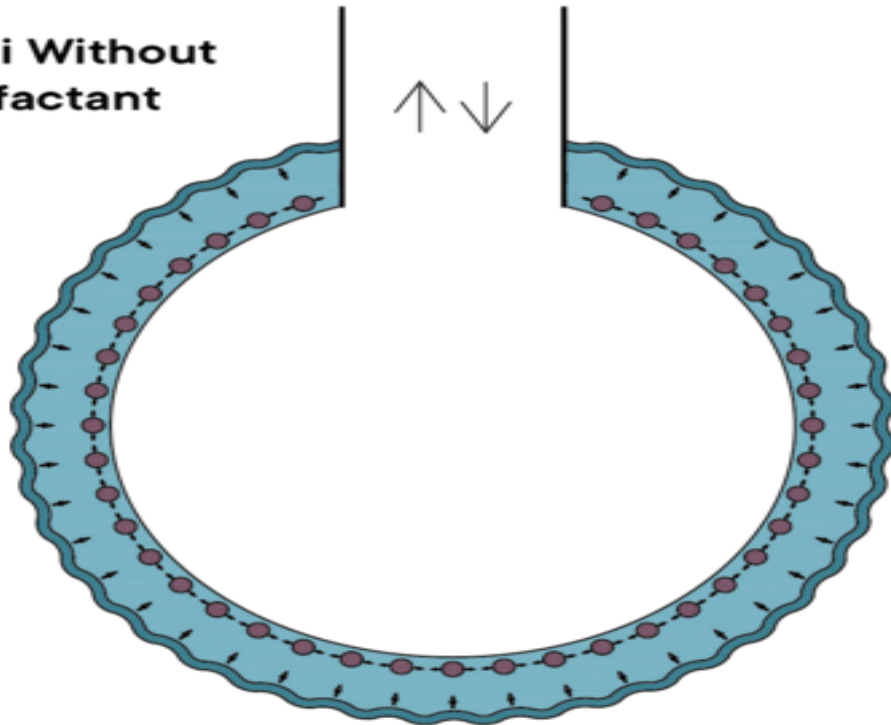


Stable alveolar
wall

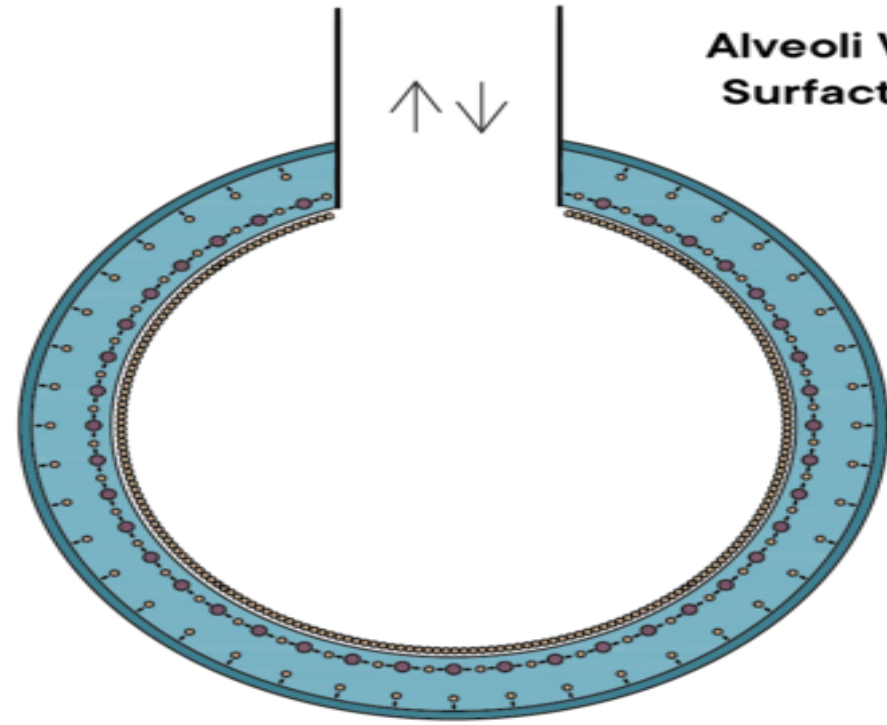
Surfactant
molecules

Reduced forces
between fluid
molecules

**Alveoli Without
Surfactant**



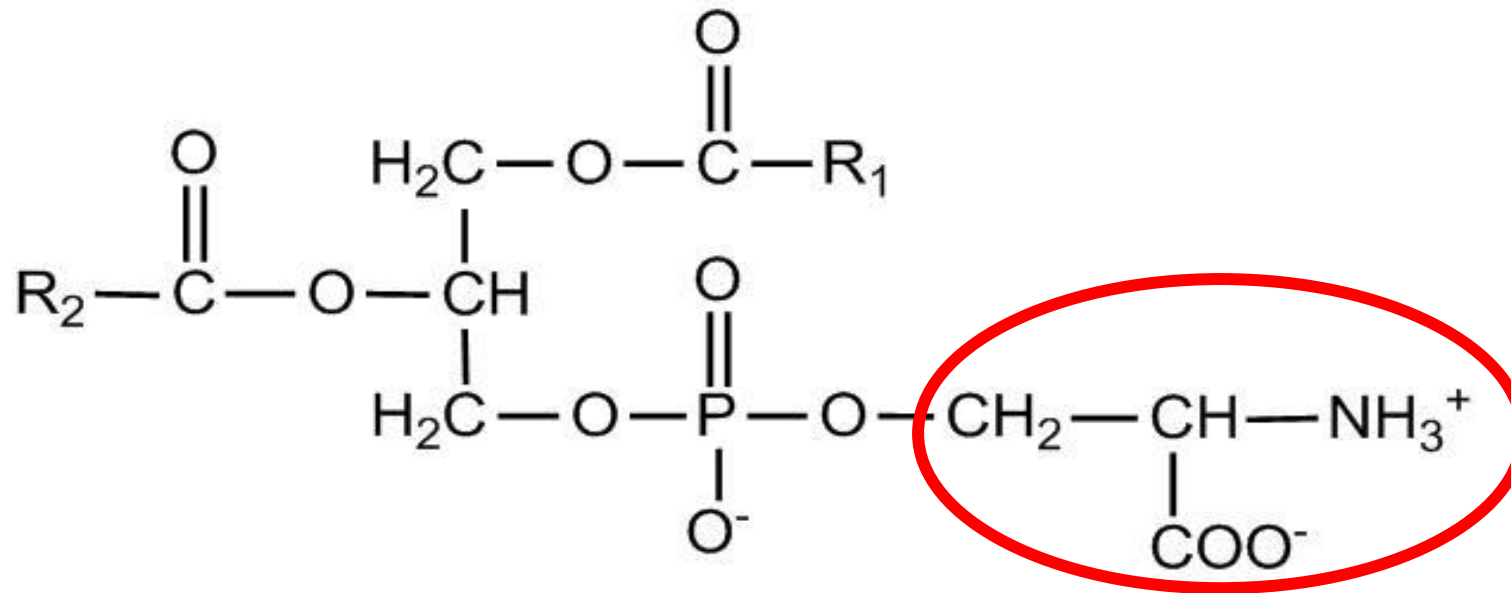
**Alveoli With
Surfactant**



1. Glycerophospholipids compounds

Cephalins / Phosphatidylserine

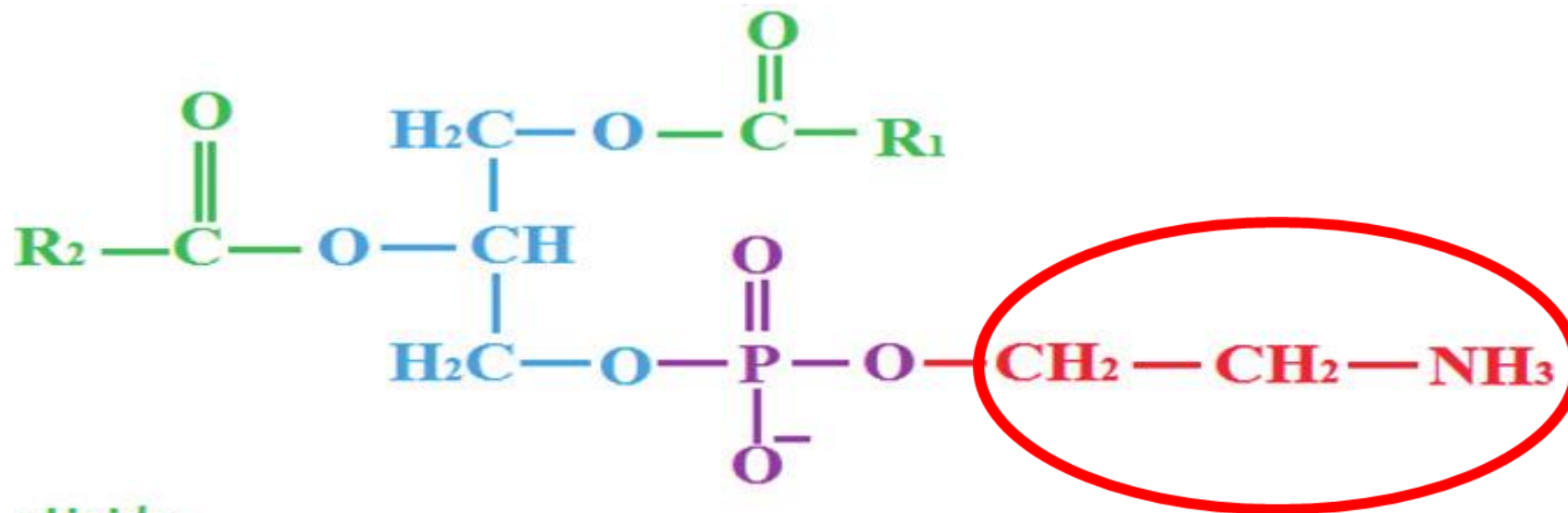
Structure: phosphoglycerides + serine



Cephalins

Phosphatidylethanolamine

Structure: phosphoglycerides + ethanolamine

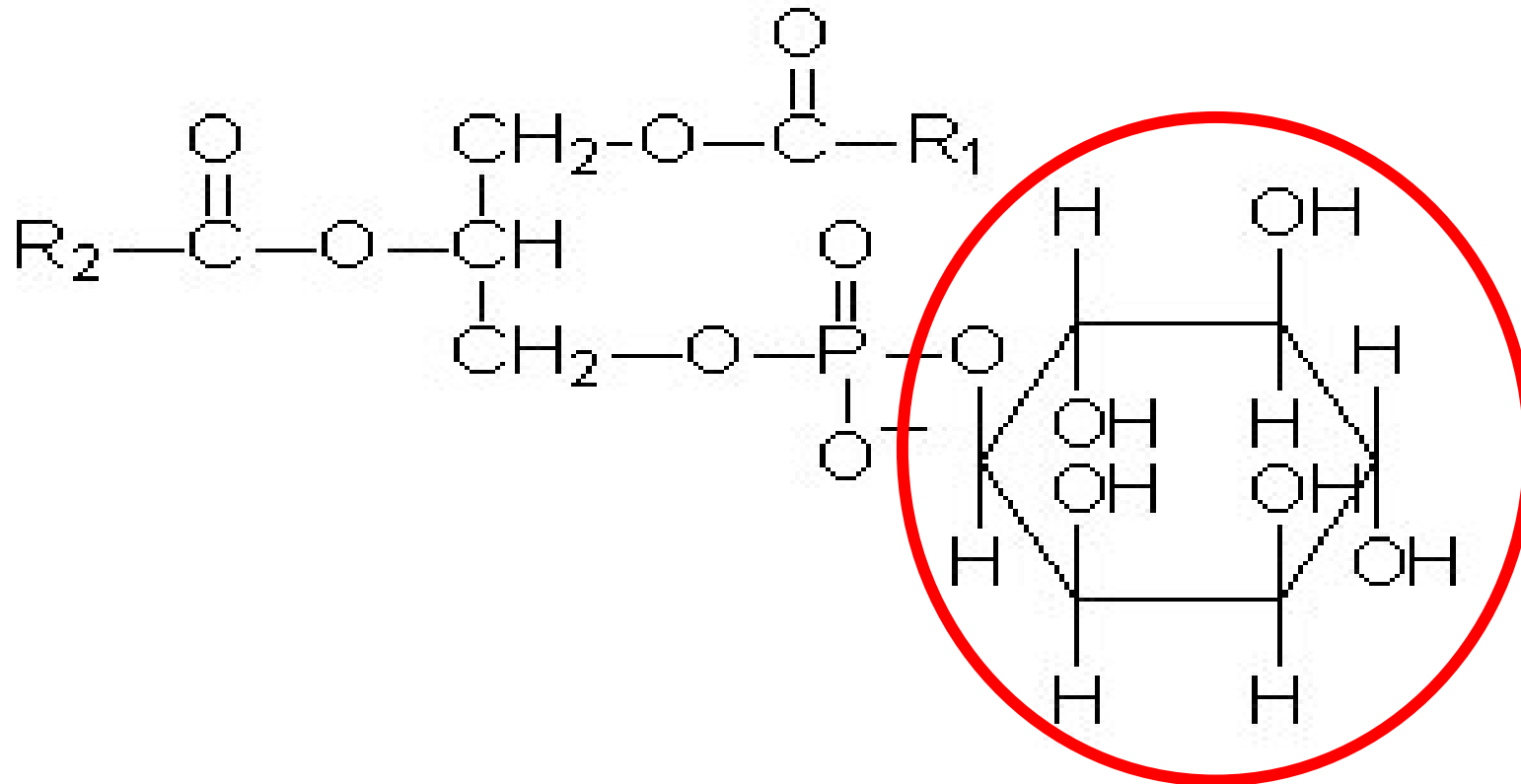


- Lipids
- Glycerol
- Phosphate
- Ethanolamine

1. Glycerophospholipids compounds

Phosphatidylinositol (PI)

- **Glycerophospholipids** with inositol as polar head group.
- In addition to being a membrane lipids, **PI** has roles in cell signaling.

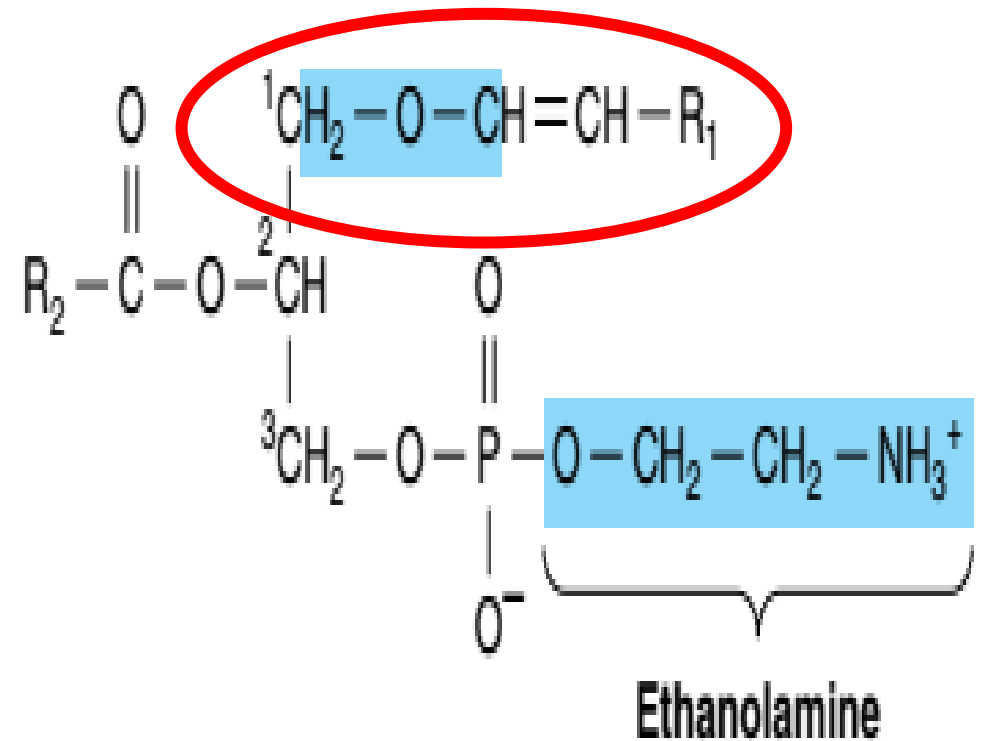


1. Glycerophospholipids compounds

Plasmalogens

Structure: is a glycerophospholipid with choline or ethanolamine as polar head group; **but one of the fatty acids replaced by unsaturated ether.**

- They are found in brain and muscle
- PAF (platelet activating factor) – causes platelet aggregation.



1. Glycerophospholipids compounds

Lysophospholipids (lysolecithin and Lysocephalin)

Structure: Like lecithin and cephalin, but contains only one fatty acid in position 1

Functions:

- **Metabolism of phospholipids**
- **Strong surface-active substance.**
- **Used in manufacturing most types of chocolates.**

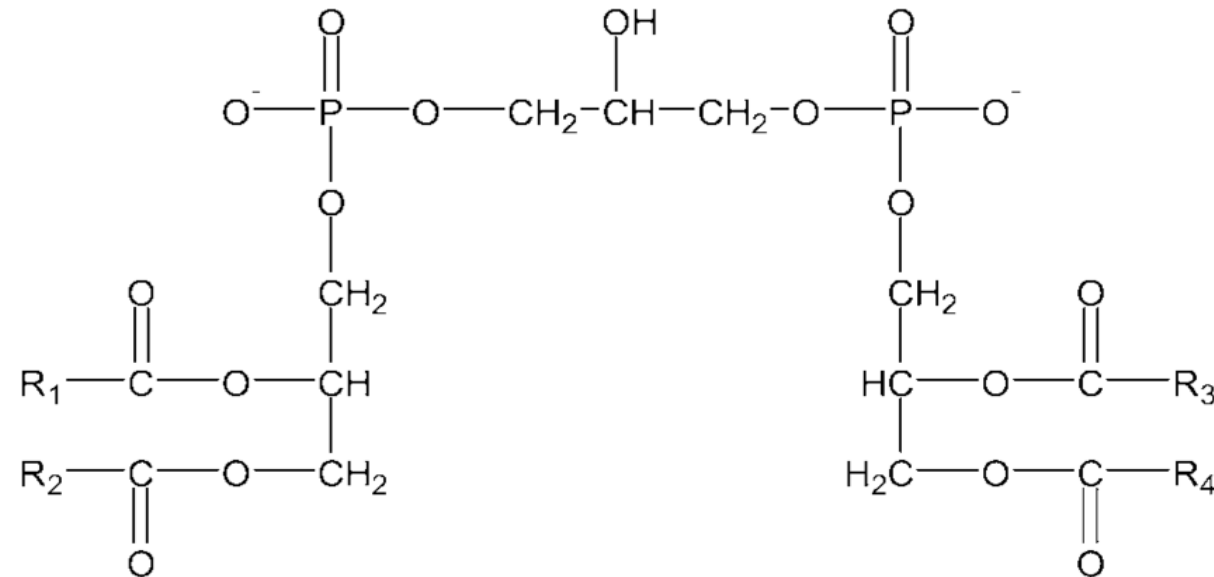
1. Glycerophospholipids compounds

Cardiolipin (diphosphatidylglycerol)

Structure: It is formed of two phosphatidic acids linked together by glycerol.

Functions:

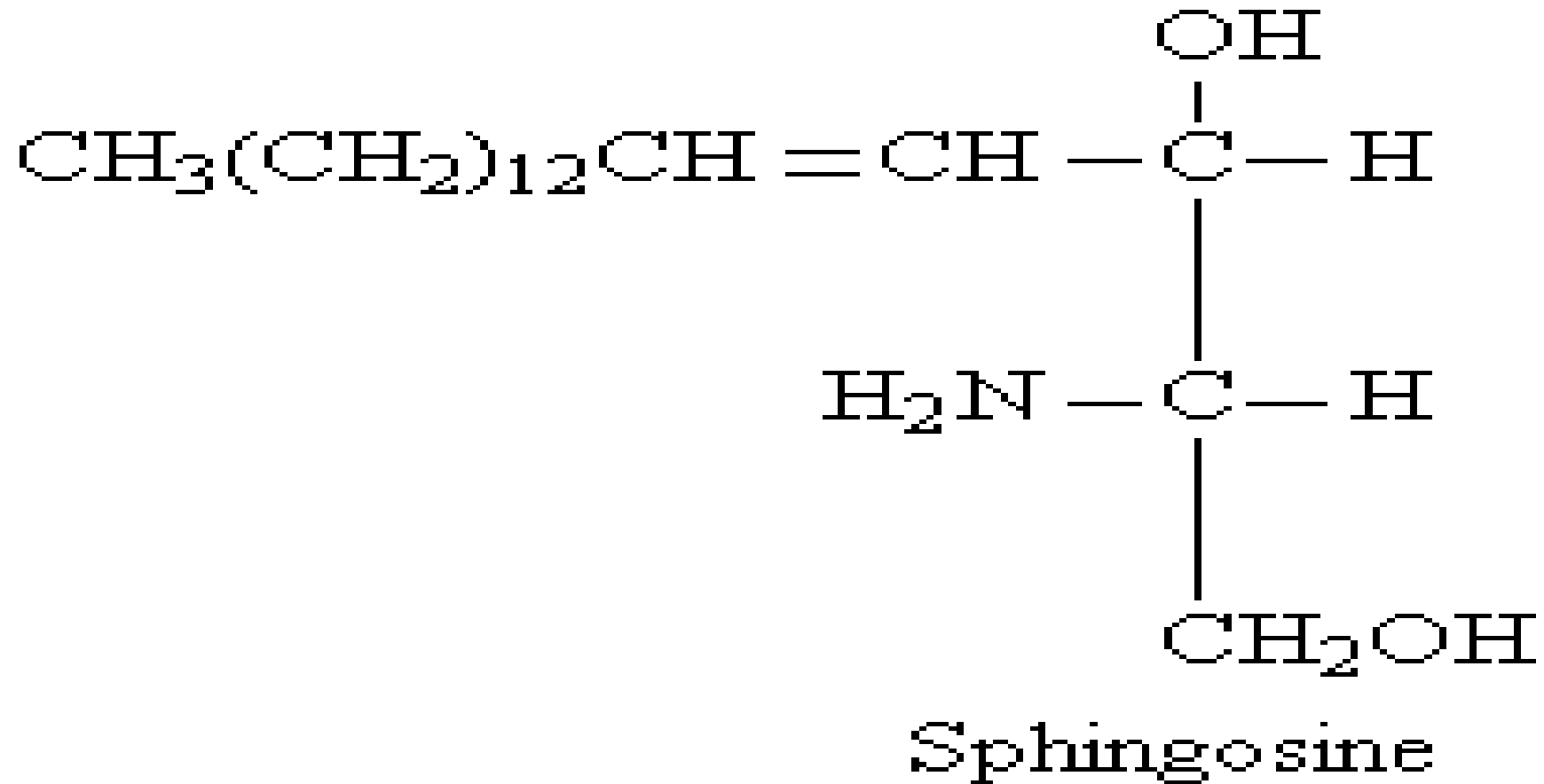
- Cardiolipin is the major lipid in **inner** mitochondrial membrane.
- Stimulates antibody formation



2. Sphingolipids

Phosphosphingosides

Sphingolipids are derivatives of the **amino alcohol sphingosine**, which has a long hydrocarbon tail.



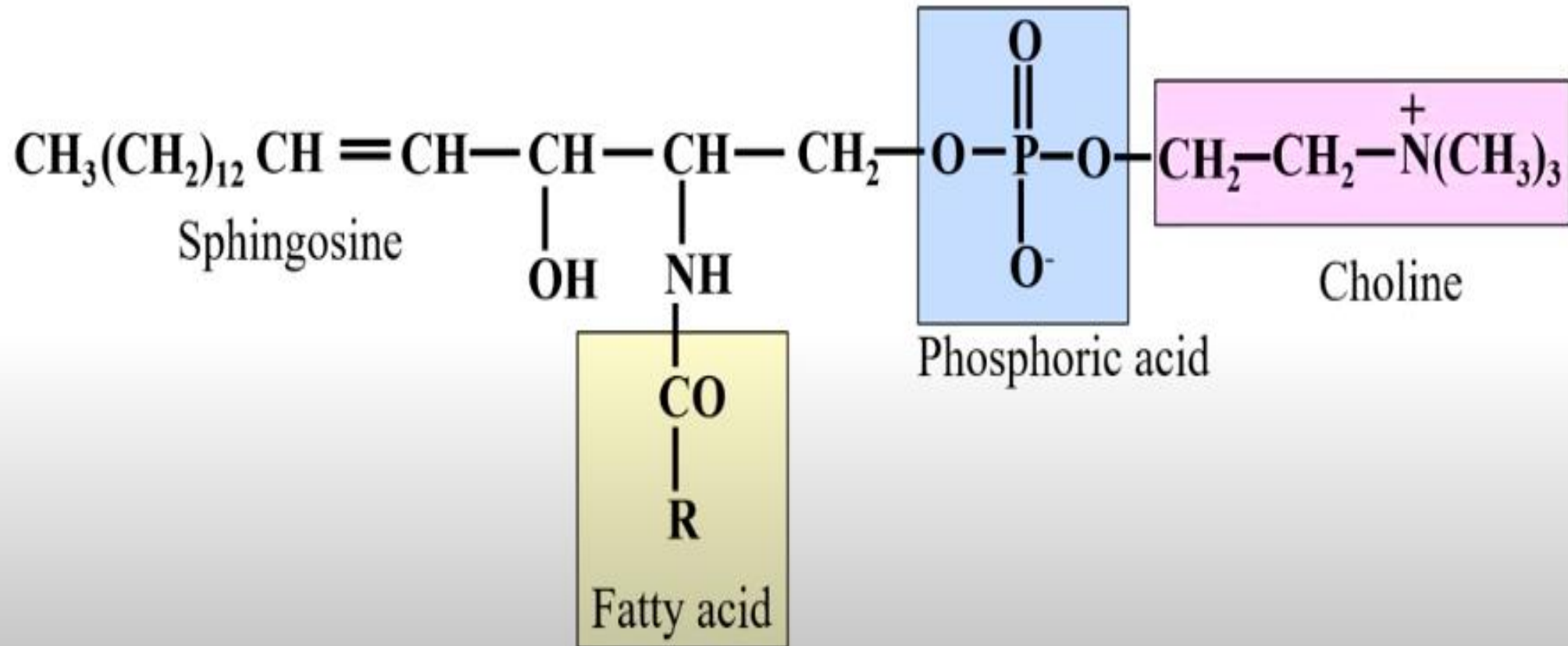
2. Sphingolipids

Sphingomyelin

Structure:

- 1. Sphingosine**
- 2. Fatty acid (attached to amino group).**
- 3. Phosphoric acid residue**
- 4. Choline base (attached to phosphoric acid).**

Sphingomyelin



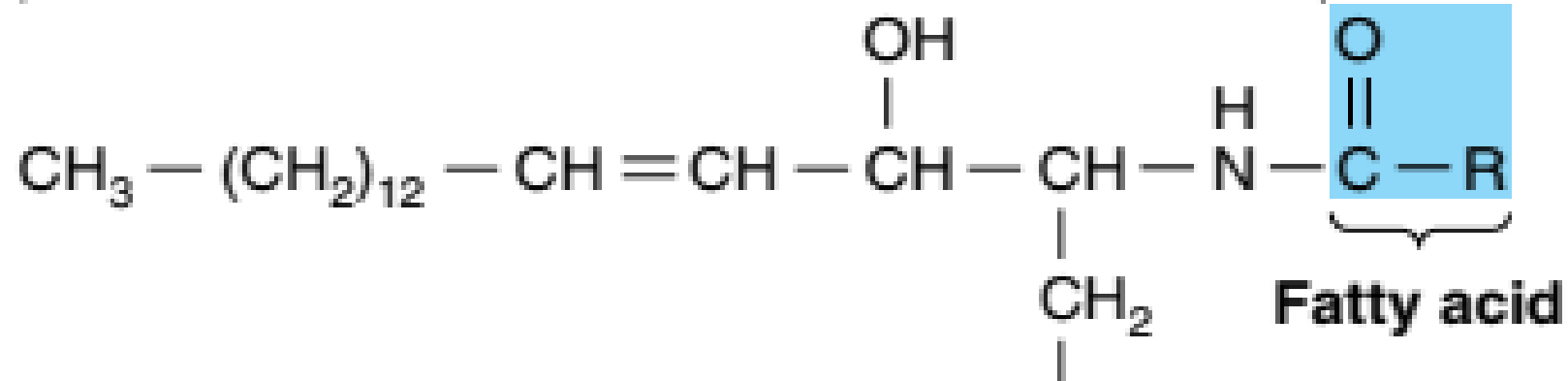
Sphingomyelin

➤ **Function:** is a common constituent of plasma membranes,
found in **brain and nerve tissue.**

Ceramide

Structure: They contain sphingosine base + fatty acid

Function: intracellular messengers, key components of skin-care products to repair and restore the skin barrier.



Glycolipids

- Are complex lipids containing carbohydrate and sphingosine
- Widely distributed in every tissue of the body (**cell surface carbohydrates**), particularly in nervous tissue such as brain.

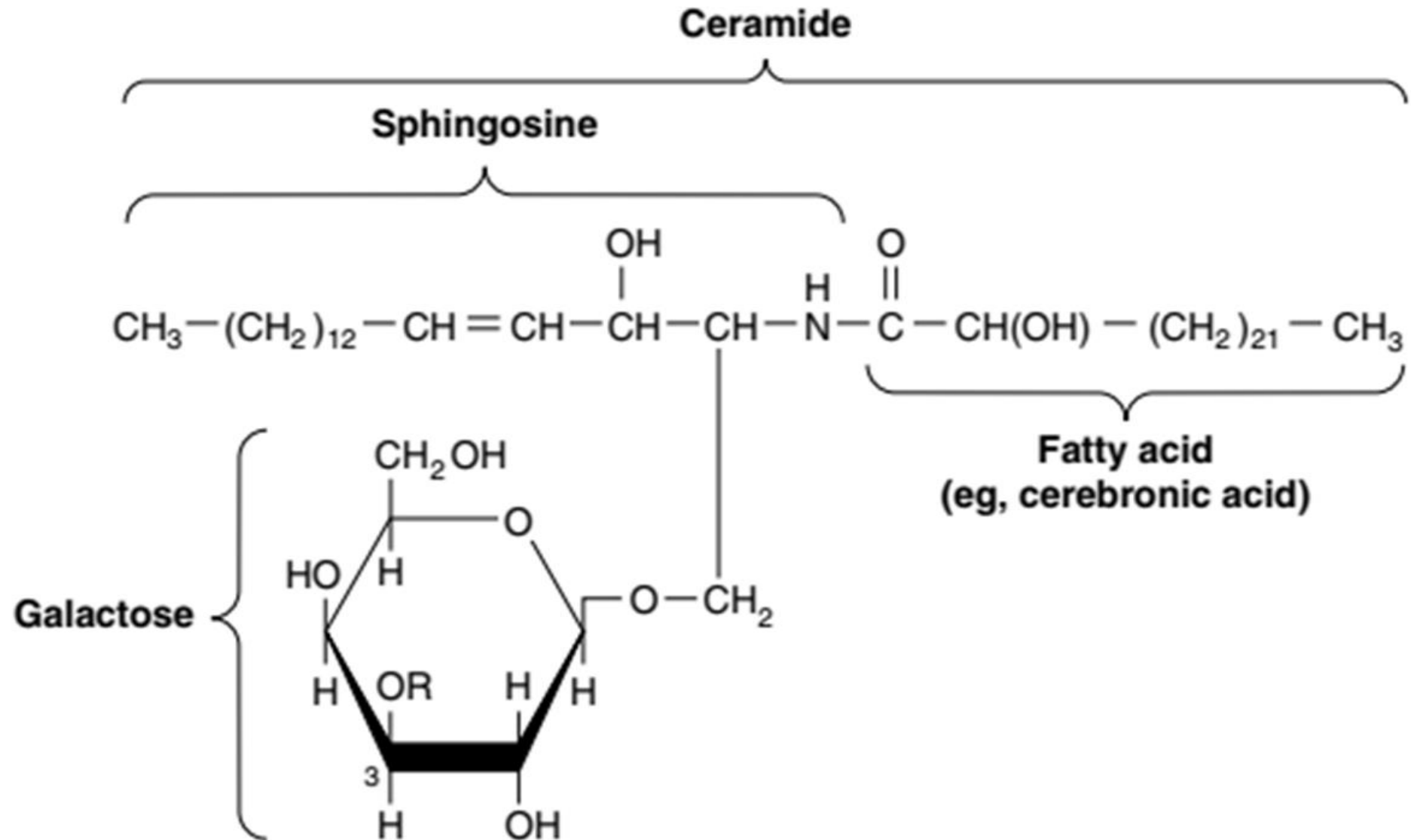
Glycosphingolipids

- **Glycosphingolipids** : are the major glycolipids found in animal tissues

Structure: ceramide and one or more sugars.

- **Galactosylceramide**: is a major glycosphingolipid of brain and other nervous tissue .

Glycosphingolipids



Glycosphingolipids (Cerebrosides)

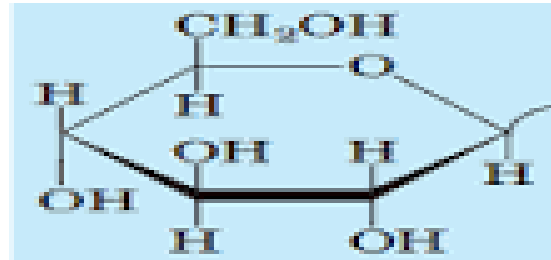
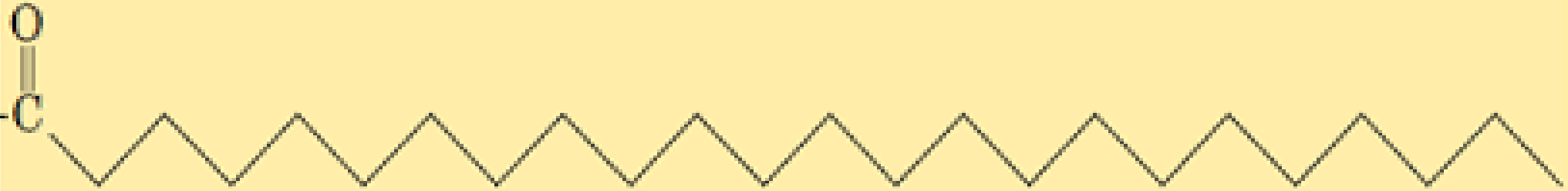
- **Structure:** Sphingolipids that contain monosaccharides.
- Can be a cerebroside with galactose.
- **Function:**
- Present in brain and nerve fibers
- Act as insulator of nerve impulse

Glycosphingolipids (Gangliosides)

- **Structure:** ceramide + oligosaccharide + sialic acid
- **Function:**
- **Present in high concentration in brain (neurons).**
- **Cell recognition, signaling & interaction between cells.**



Fatty acid



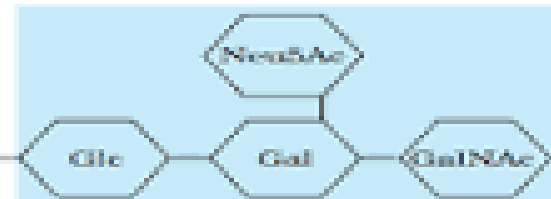
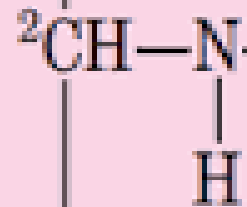
Glucose

Cerebroside

Sphingosine

Ganglioside

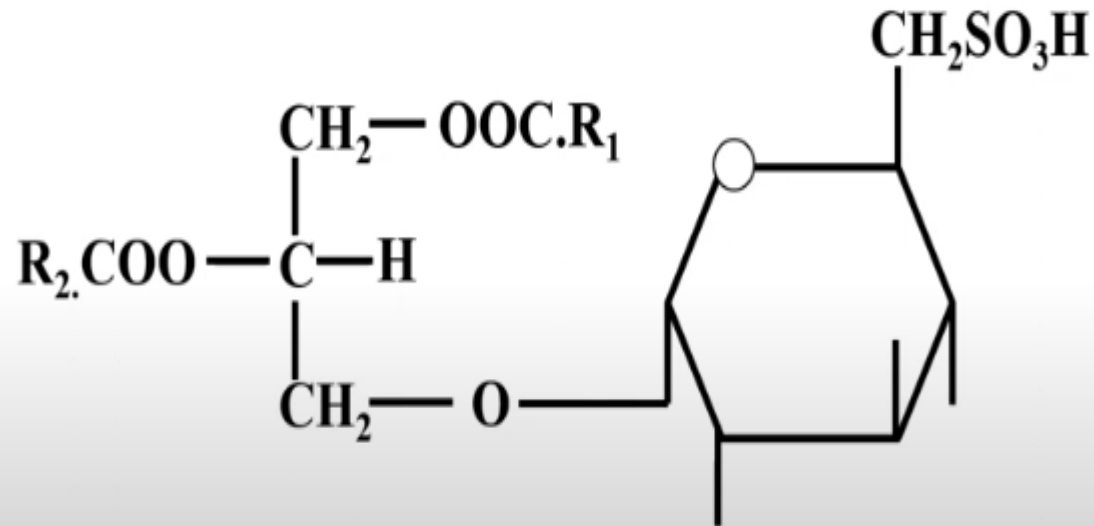
Fatty acid



Complex oligosaccharides

Sulpholipids (sulphatides)

- Glycerol + 2 F.A+ sugar + sulphate group



Sulfolipid

Lipid Peroxidation is a source of free radicals

- **Peroxidation (auto-oxidation)** of lipids exposed to oxygen is responsible not only for **rancidity of foods** but also for damage to tissues in vivo.
- Where it may be a **cause of cancer, inflammatory diseases, atherosclerosis.**
- The deleterious effects are considered to be **caused by free radicals.**





Thanks!