



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ  
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الذي كنا لنهتدي لولا أن هدانا الله

الحمد لله الذي هدانا لهذا  
الذي كنا لنهتدي لولا أن هدانا الله

# **LIPID METABOLISM**

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**Dept of Biochemistry KGMC**

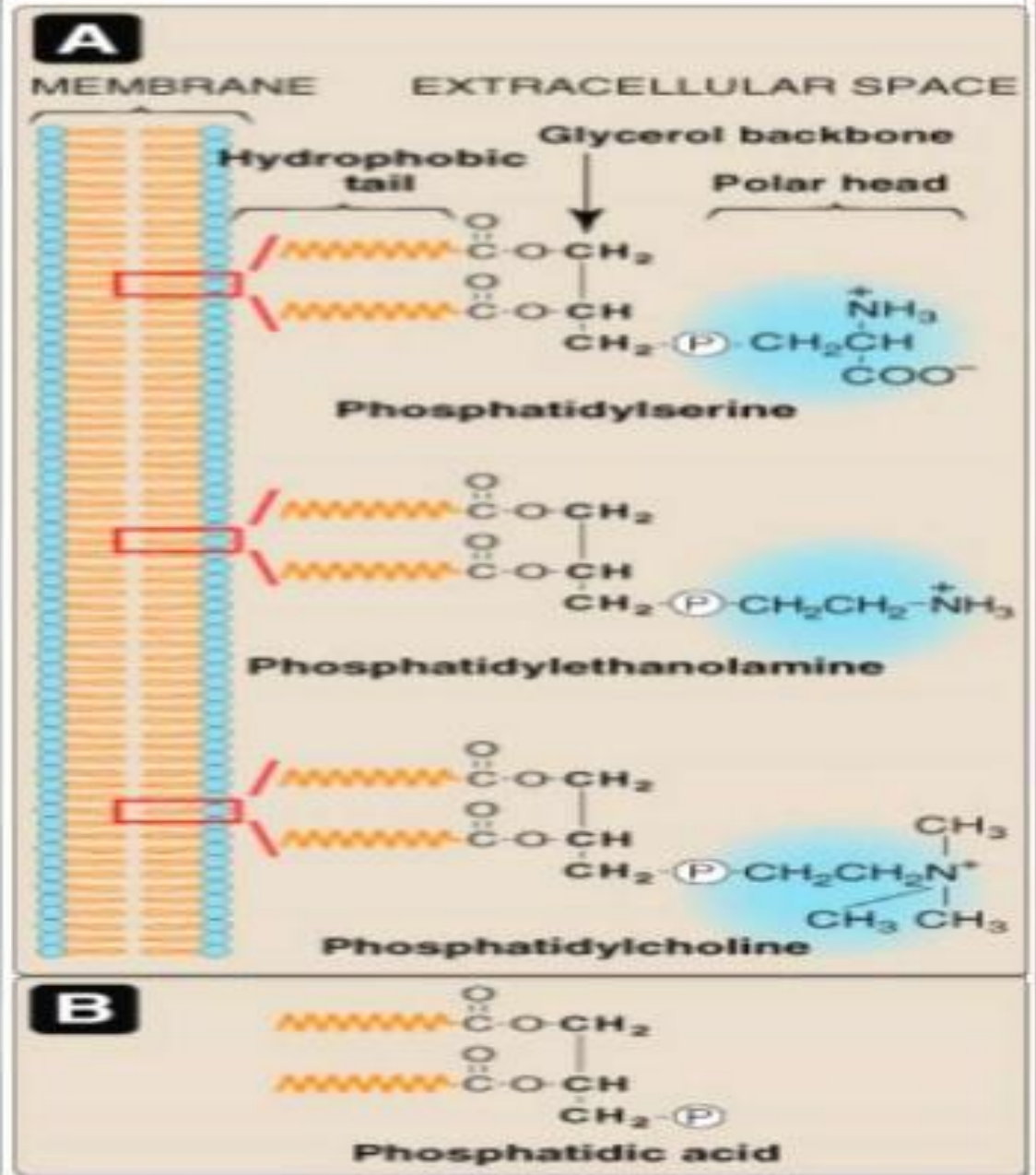


BY THE END OF THIS LESSON THE  
STUDENT WILL BE ABLE TO....

# Know

- Phospholipids synthesis (compound lipids)
- Phospholipids degradation

# Phospholipids



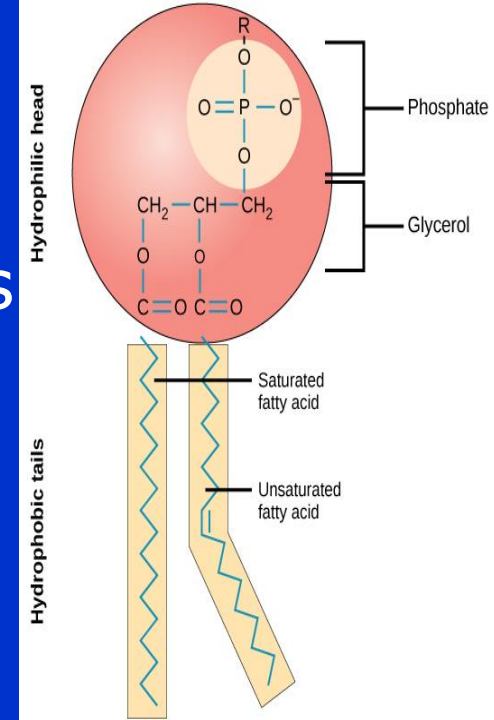


- Define phospholipids
- Function of phospholipids
- Classify phospholipids

# PHOSPHOLIPIDS

■ PHOSPHOLIPIDS are polar, ionic compounds composed of an alcohol that is attached by a phosphodiester bridge to either diacylglycerol or sphingosine.

- PHOSPHOLIPIDS are amphipathic in nature that is, each has a hydrophilic head and hydrophobic tail.
- The hydrophobic portion of the molecules are associated with other non polar constituents of membranes, including glycolipids, protein, and cholesterol.



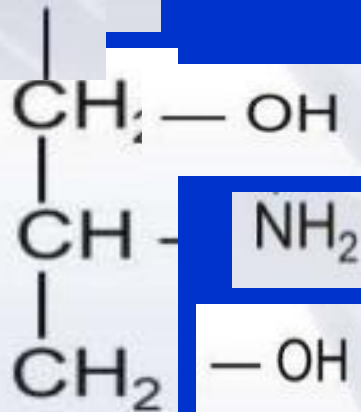
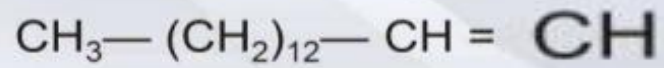


# PHOSPHOLIPIDS

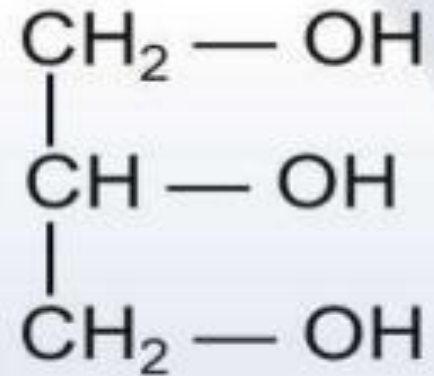
- PHOSPHOLIPIDS are specialized group of lipids performing a variety of functions.
- These include the membrane structure and functions, involve in blood clotting and supply of arachidonic acid for the synthesis of prostaglandins.

# CLASSES OF PHOSPHOLIPIDS

- There are two classes of phospholipids:
- 1. Those that have glycerol as a backbone  
glycerophospholipids.
  - Phosphatidylcholine (lecithin)
  - Phosphatidylethanolamine (cephalin)
  - Phosphatidylserine
  - Phosphatidylinositol
  - Diphosphatidyl glycerol (cardiolipin)
  - Plasmalogen
- 2. Those have sphingosine sphingophospholipids.
  - Sphingomyelin



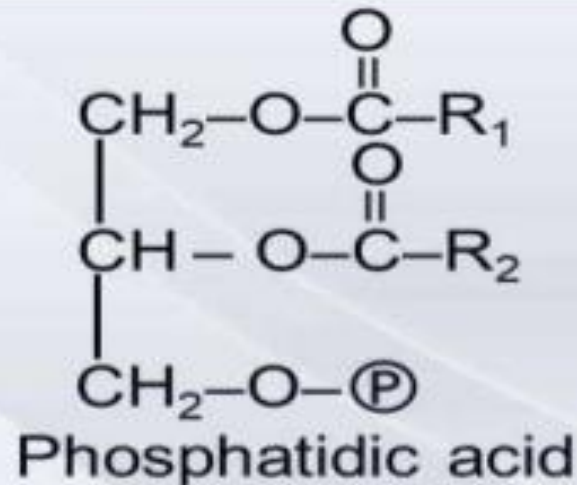
**SPHINGOSINE**



Glycerol

## (i) Glycerophospholipid

Glycerophospholipids may be considered to be derivatives of phosphatidic acid

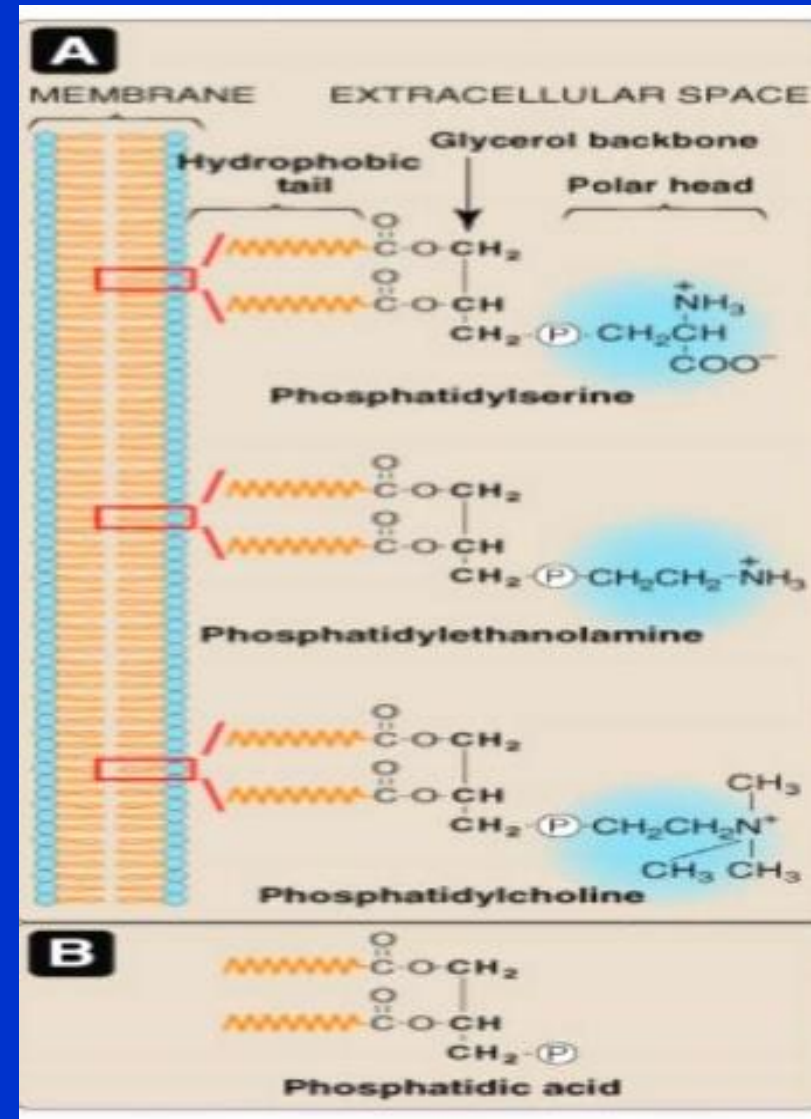


Phosphatidic acid is 1,2-Diacylglycerol-3-phosphate

- All PL are derivatives of phosphatidic acid (PA), which is diacylglycerol (DAG) with a phosphate group on carbon 3.

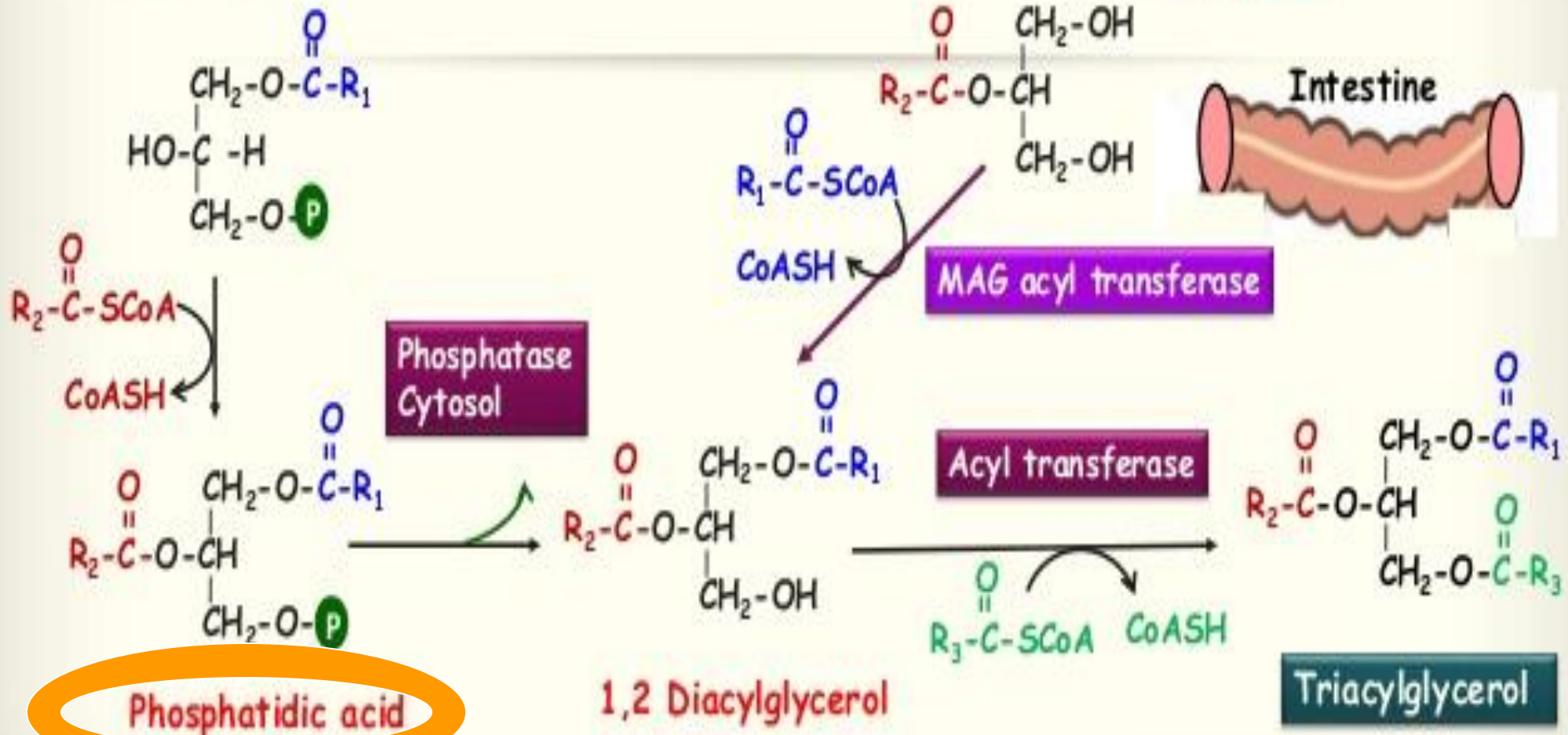
- PA is the simplest phosphoglyceride and is the precursor of the other members of this group.

- All cells except mature erythrocytes can synthesize phospholipids.



# Lysophosphatidic acid

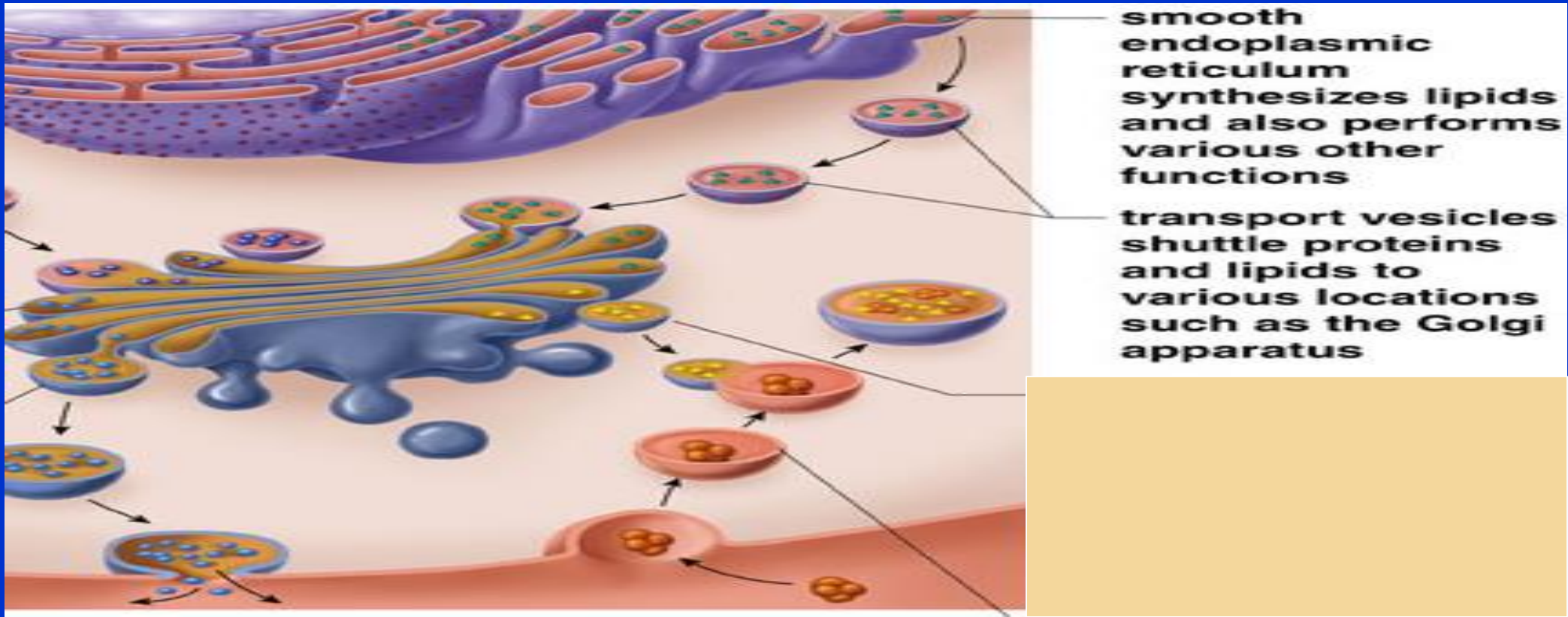
# Monoacylglycerol



# **SYNTHESIS OF PHOSPHOLIPIDS**

# SYNTHESIS OF PHOSPHOLIPIDS

- Mostly phospholipids are synthesized in the smooth endoplasmic reticulum (ER). From there, they are transported to the Golgi apparatus and then to membranes of organelles or the plasma membrane and secreted from the cell by exocytosis.



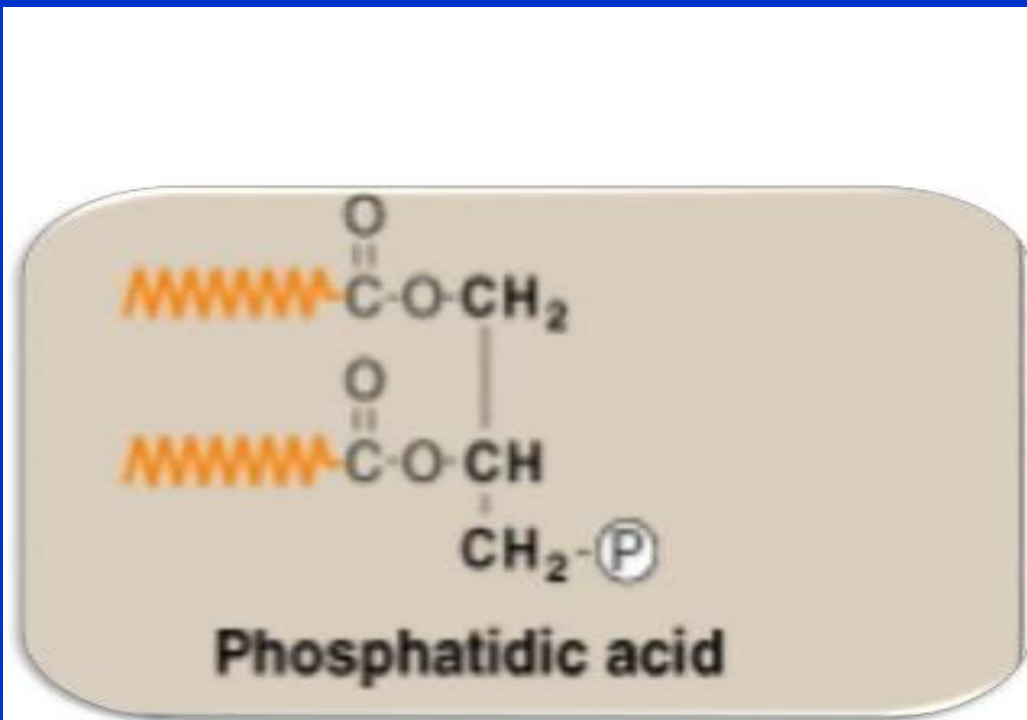


## **Synthesis of phospholipids**

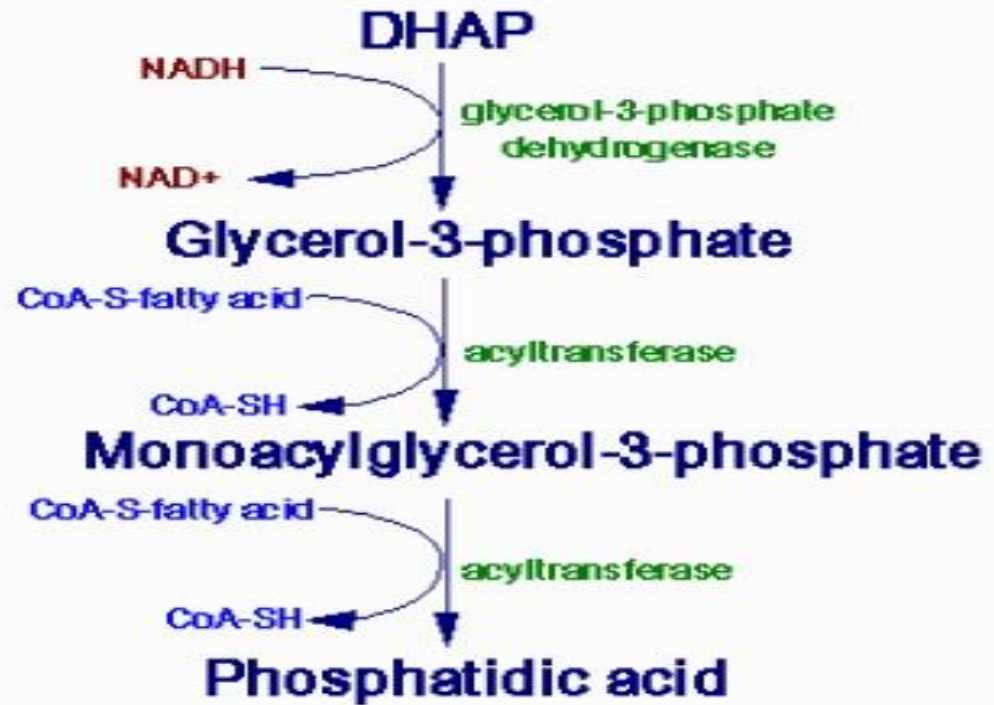
- **Phospholipids are synthesized from phosphatidic acid & 1,2-diacylglycerol, intermediates in the production of triacylglycerols.**
- **Phospholipids synthesis occurs in the smooth endoplasmic reticulum.**

# SYNTHESIS OF PHOSPHOLIPIDS

- Phosphatidic acid is an important intermediate in the synthesis of PL & TGs.
- The phosphatidic acid itself may be formed from glycerol-3-phosphate or DHAP.

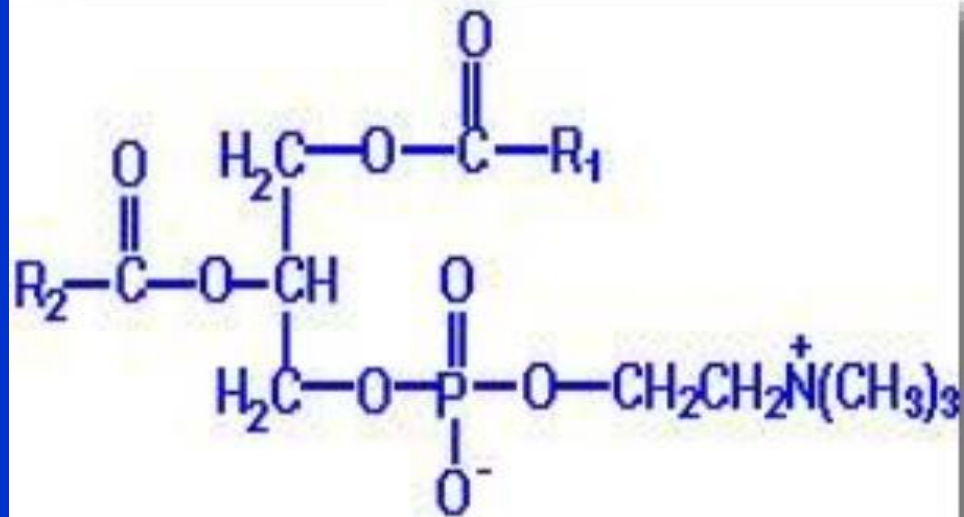


## Phosphatidic Acid Synthesis

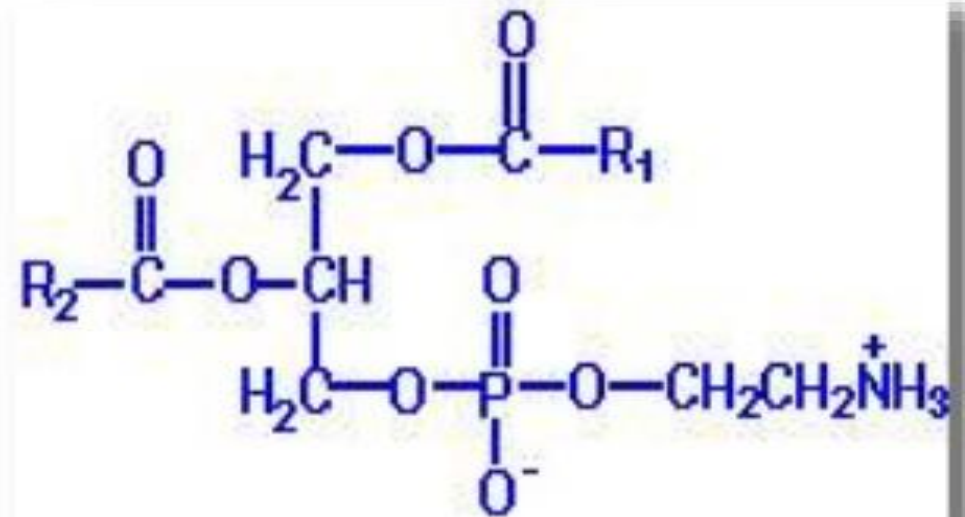


# SYNTHESIS OF LECITHIN AND CEPHALIN

**Phosphatidylcholine**



**Phosphatidylethanolamine**



# **SYNTHESIS OF Phosphatidyl choline (LECITHIN) and Phosphatidyl Ethanolamine (CEPHALIN)**

- Phosphatidyl choline and phosphatidyl ethanolamine are the most abundant phospholipids in most of the cells, choline and ethanolamine, obtained either from the diet or from the turnover of the body's phospholipids and use in the synthesis.

# Synthesis OF Phosphatidyl choline (Lecithin) and Phosphatidyl Ethanolamine (Cephalin)

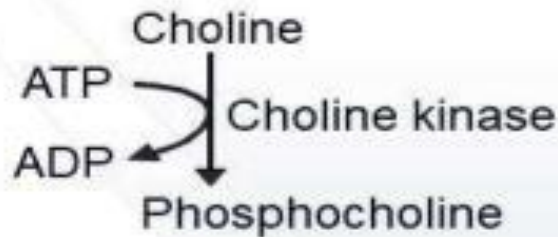
- Substrate:
  - Choline or Ethanolamine
  - 1,2-Diacyl glycerol

## Formation of lecithin & cephalin

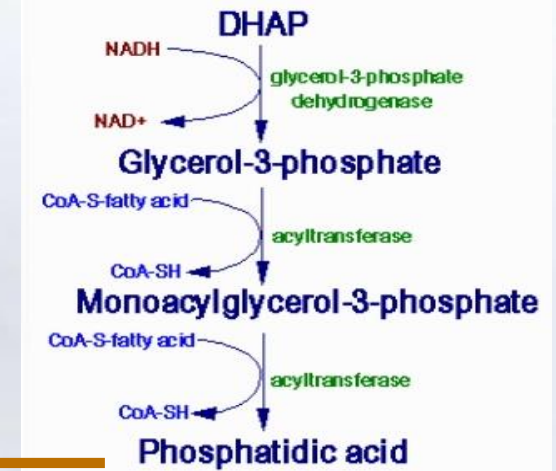
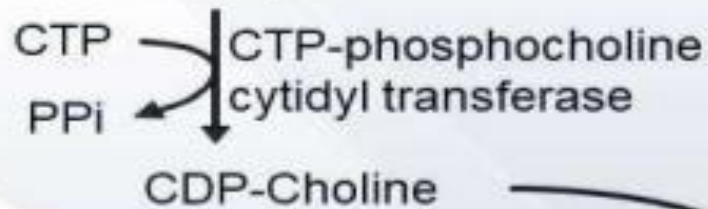
- It occurs mainly in liver & brain.
- Choline & ethanolamine first get phosphorylated & then combine with CTP to form, CDP-choline & CDP-ethanolamine.
- **Phosphatidylcholine (lecithin)** is synthesized when CDP-choline combines with 1,2-diacylglycerol.

# Lecithin synthesis

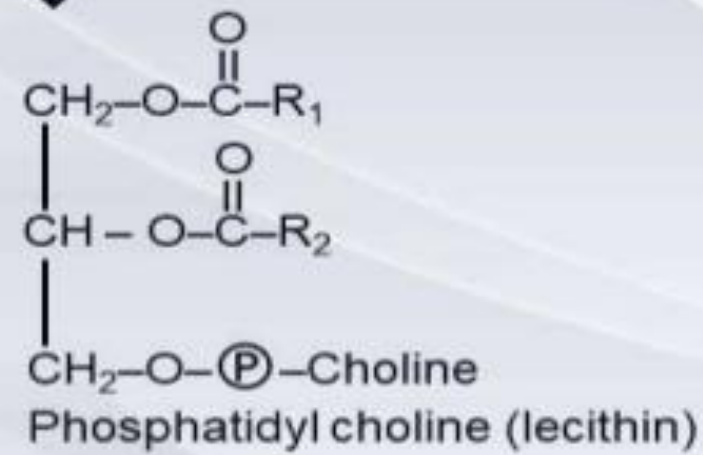
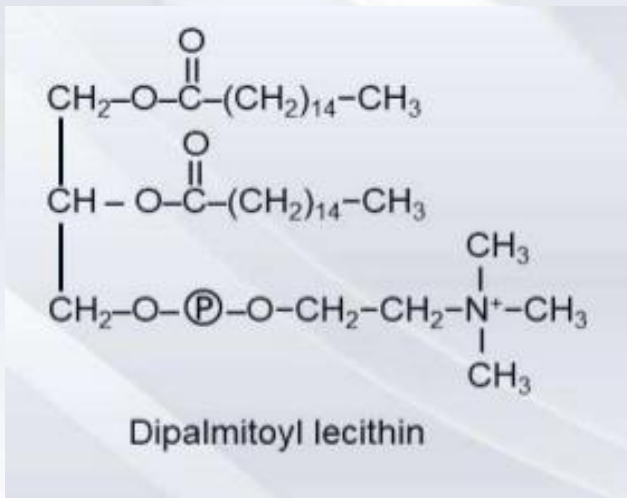
1



2



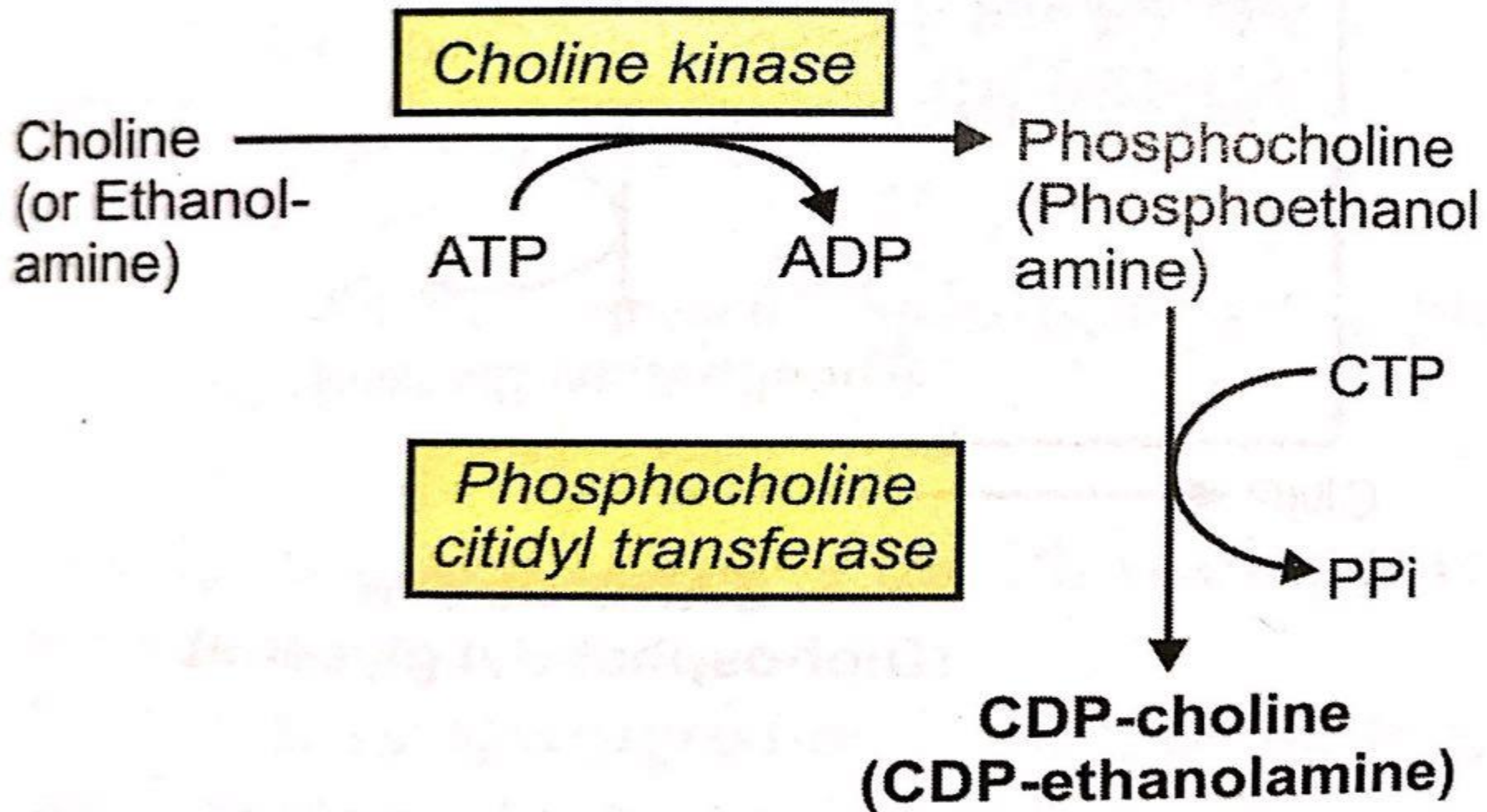
3



Synthesis of phosphatidyl choline

# SYNTHESIS OF LECITHIN AND CEPHALIN

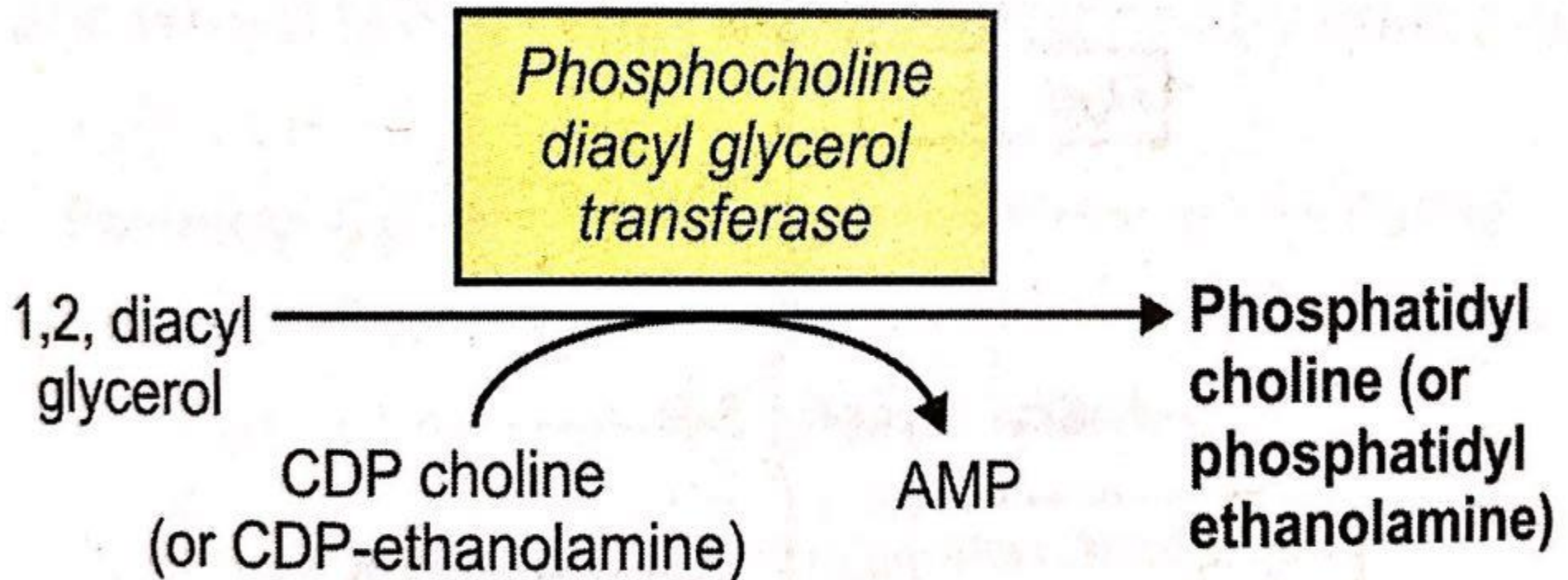
- Step-1 (activation of choline and ethanolamine)





# SYNTHESIS OF LECITHIN AND CEPHALIN

- Step-2 (formation of Phosphatidyl choline and Phosphatidyl ethanolamine)



Dipalmitoyl lecithin has palmitate at both position 1 and position 2

Dipalmitoyl lecithin is a component of lung surfactant

Lung surfactant lowers surface tension at the air/liquid interface in the alveoli

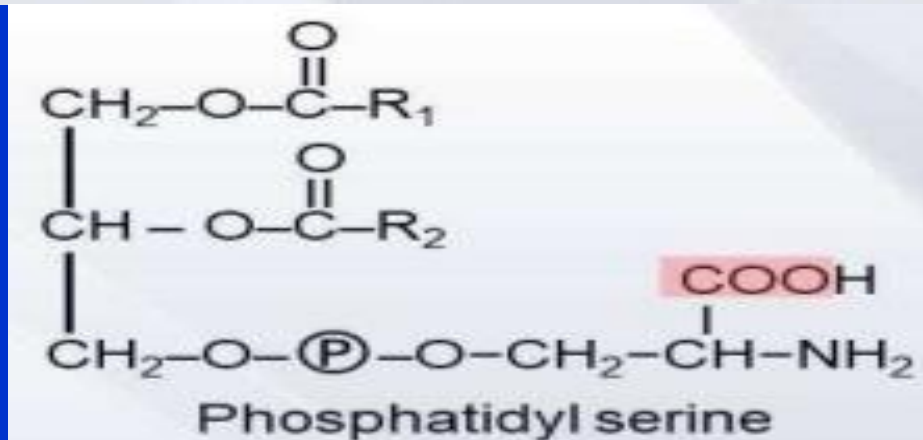
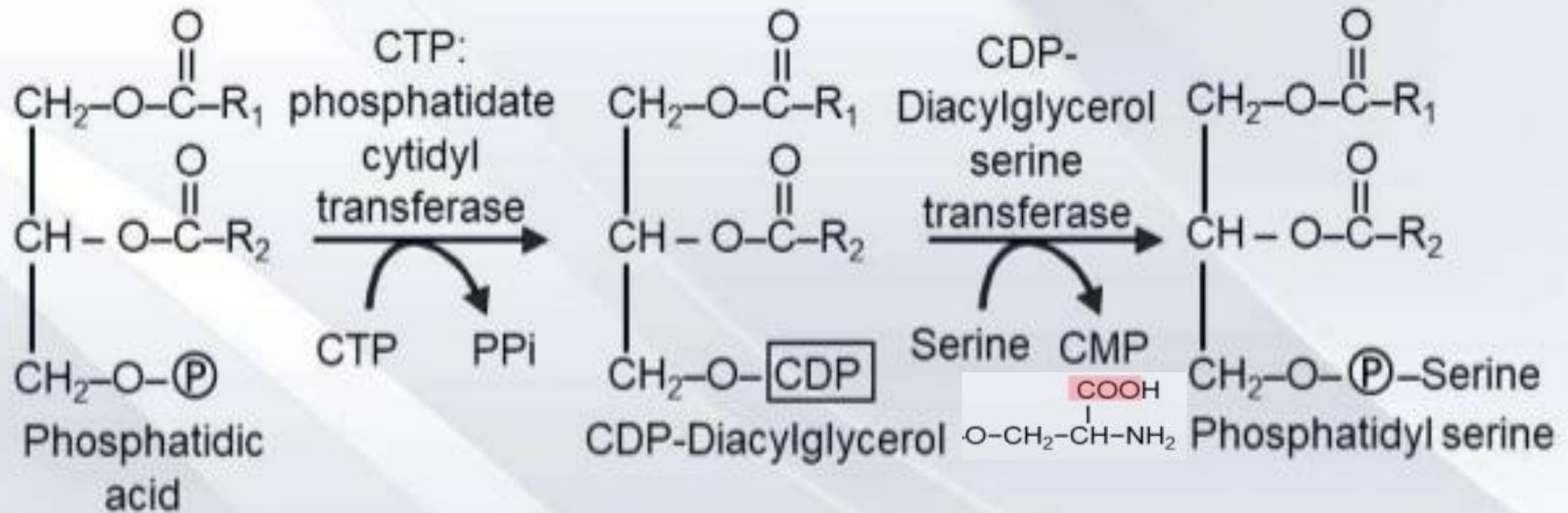
## **Role of phosphatidylcholine in lung surfactant:**

- This phospholipid is a major lipid component of lung surfactant, which is the extracellular fluid layer lining the alveoli.
- Surfactant serves to decrease the surface tension of this fluid layer, thereby preventing alveolar collapse.
- Respiratory distress syndrome (RDS) in preterm infants is associated with insufficient surfactant production and/or secretion and is a significant cause of neonatal deaths.

# Formation of cephalin

- 1. Ethanolamine  $\xrightarrow[\text{ATP} \rightarrow \text{ADP}]{\text{phosphorylated}}$  phosphoethalonamine
- 2. Phosphoethalonamine  $\xrightarrow[\text{CTP} \rightarrow \text{Ppi}]{\text{transferase}}$  CDP-ethalonamine
- CDP-ethalonamine + 1,2diacylglycerol  $\xrightarrow{\text{transferase}}$
- cephalin (phosphatidyl ethanolamine)




# Synthesis of Phosphatidyl Serine



## **Synthesis of phosphatidylserine**

- **Phosphatidyl ethanolamine can exchange its ethanolamine group with free serine to produce phosphatidylserine.**
- **On decarboxylation, gives phosphatidyl ethanolamine.**

# Synthesis of phosphatidylserine

1. phosphatidyl ethanolamine + serine   
phosphatidylserine + ethanolamine
2. Phosphatidylserine  phosphatidyl ethanolamine  
  
CO<sub>2</sub>

Phosphatidylserine synthesis in mammalian tissues is provided by the base exchange reaction, in which the ethanolamine of phosphatidyl ethanolamine is exchanged for free serine. This reaction, although reversible, is used primarily to produce the Phosphatidylserine required for membrane synthesis.

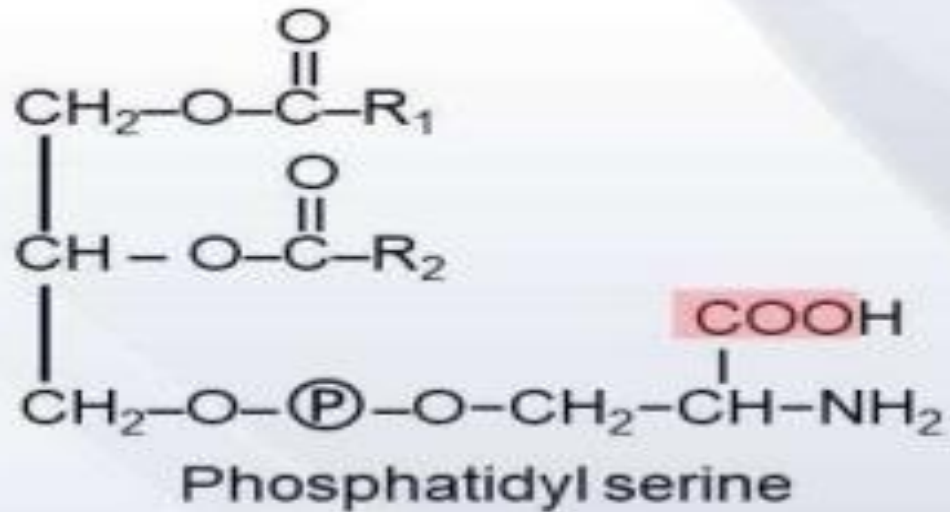
Glycerophospholipids can undergo inter-conversion

Serine residue of phosphatidyl serine can be decarboxylated to ethanolamine

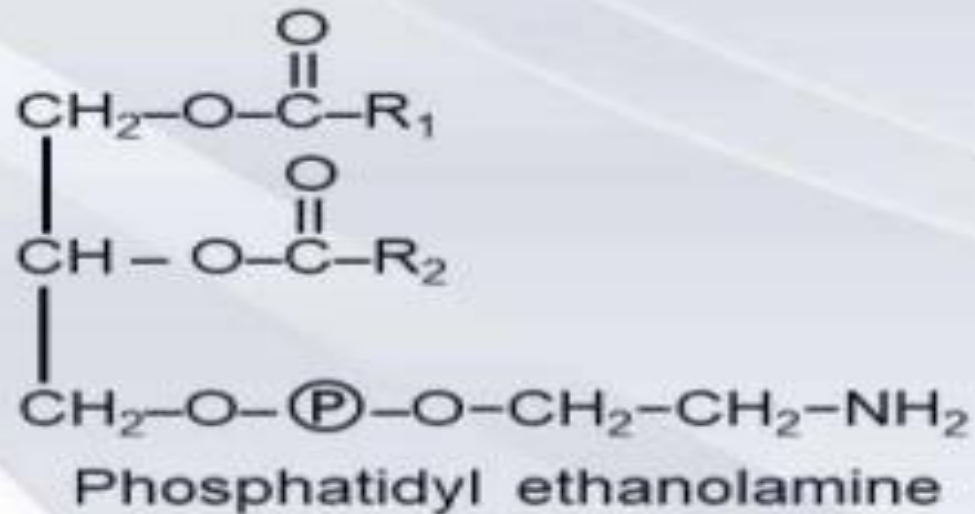
This converts phosphatidyl serine into phosphatidyl ethanolamine



# Phosphatidyl Ethanolamine synthesis



$\text{CO}_2$



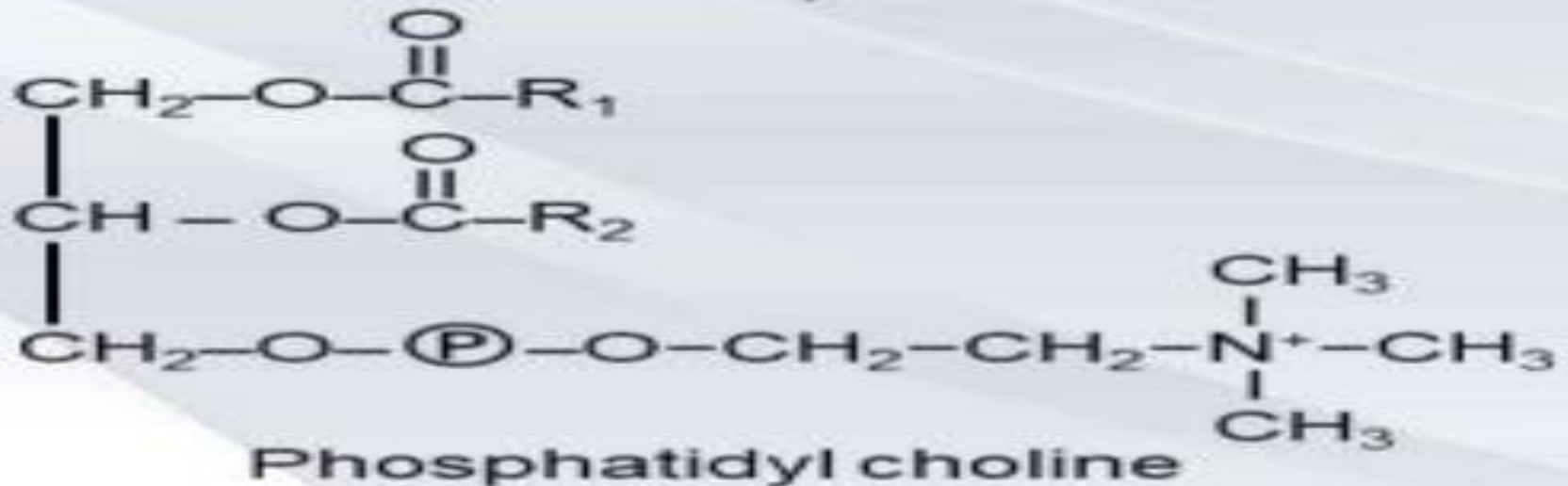
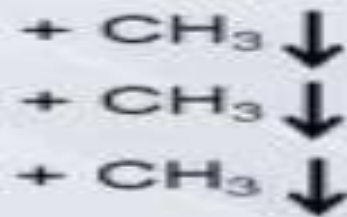
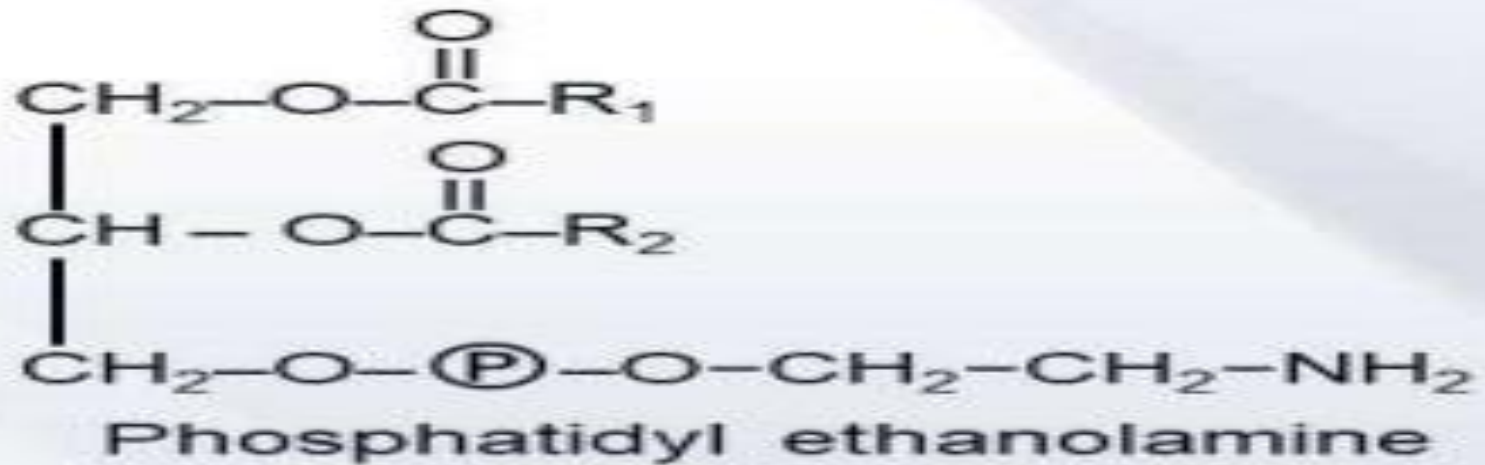
# Conversion of phosphatidyl ethanolamine into choline

Ethanolamine residue of phosphatidyl ethanolamine can be methylated

Addition of three methyl groups converts ethanolamine into choline

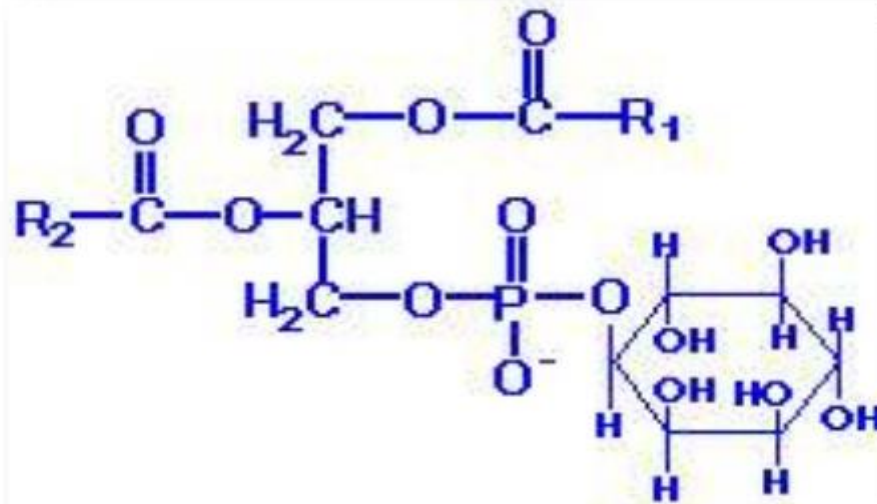
Thus, phosphatidyl choline can be formed from phosphatidyl ethanolamine

# Conversion of phosphatidyl ethanolamine into choline



# SYNTHESIS OF PHOSPHATIDYL INOSITOL

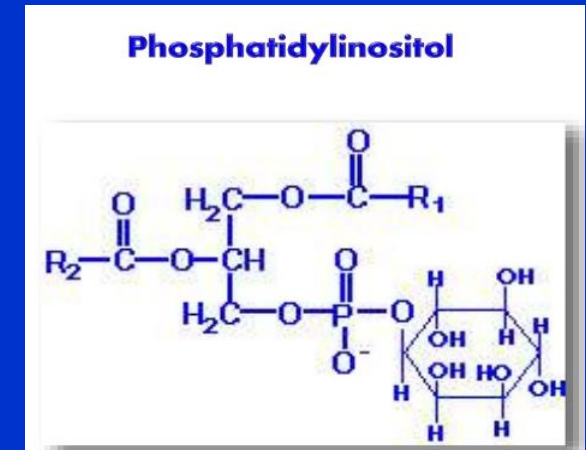
## Phosphatidylinositol



# PHOSPHATIDYL INOSITOL

- It is an unusual phospholipids frequently contains stearic acid

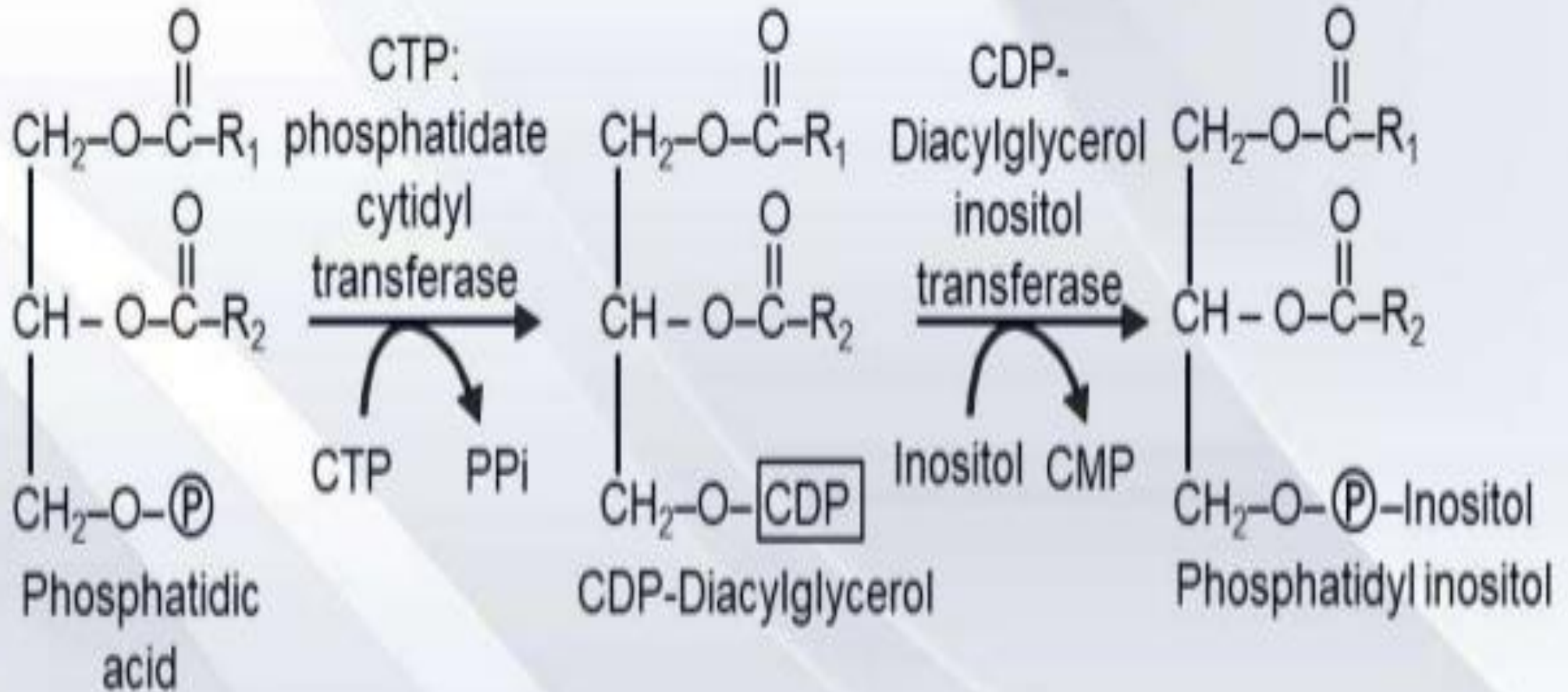
on carbon 1 and arachidonic acid on carbon 2 of the glycerol. PI, therefore, serves as a reservoir of arachidonic acid in membranes and, thus, provides the substrate for prostaglandin synthesis when required.



## Formation of phosphatidylinositol

- **CDP-diacylglycerol** produced from phosphatidic acid combines with inositol to form phosphatidyl inositol (PI).
- **Phosphatidyl inositol** contains arachidonic acid on carbon 2 of glycerol which serves as, a substrate for prostaglandin synthesis.
- **PI is important** for signal transmission across membranes.

# Synthesis of phosphatidyl inositol



# Phospholipis

- 1Phosphatidyl Inositol
- 2Phosphatidyl Inositol
- 3Phosphatidyl Serine
- 4 Phosphatidyl Inositol



**ANY QUESTION**



- **CHATTERJEA BIOCHEMISTRY**
- **LIPPINCOTT BIOCHEMISTRY**
- **HARPERS BIOCHEMISTRY**
- **SATYANARAYANA BIOCHEMISTRY**
- **INTERNET**



**Thank you**

