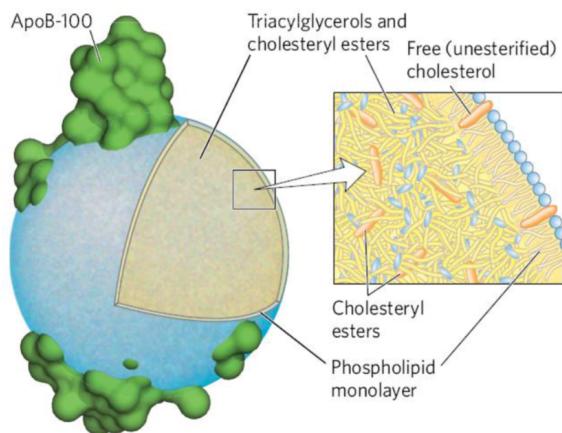
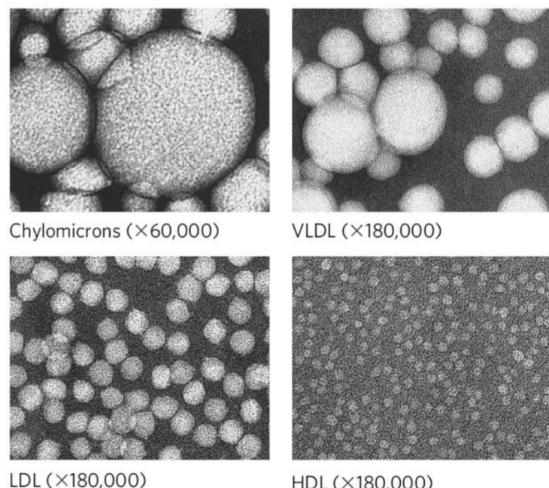


## Lipoproteins

(b) Low-density lipoprotein (LDL)

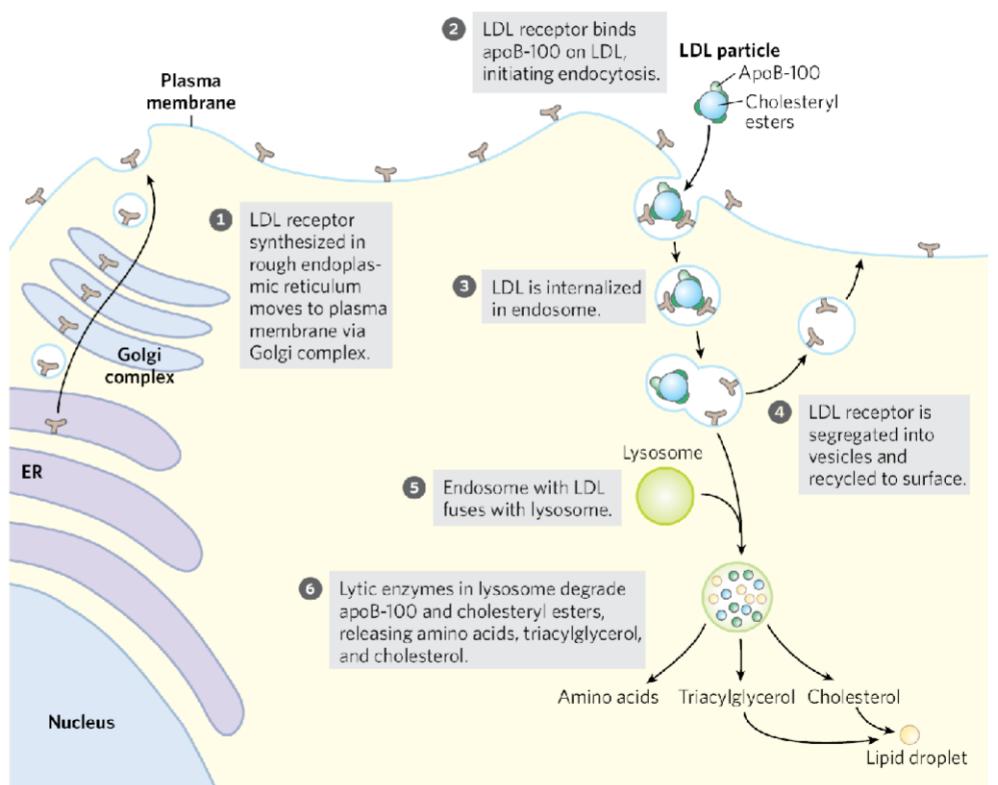


(c)



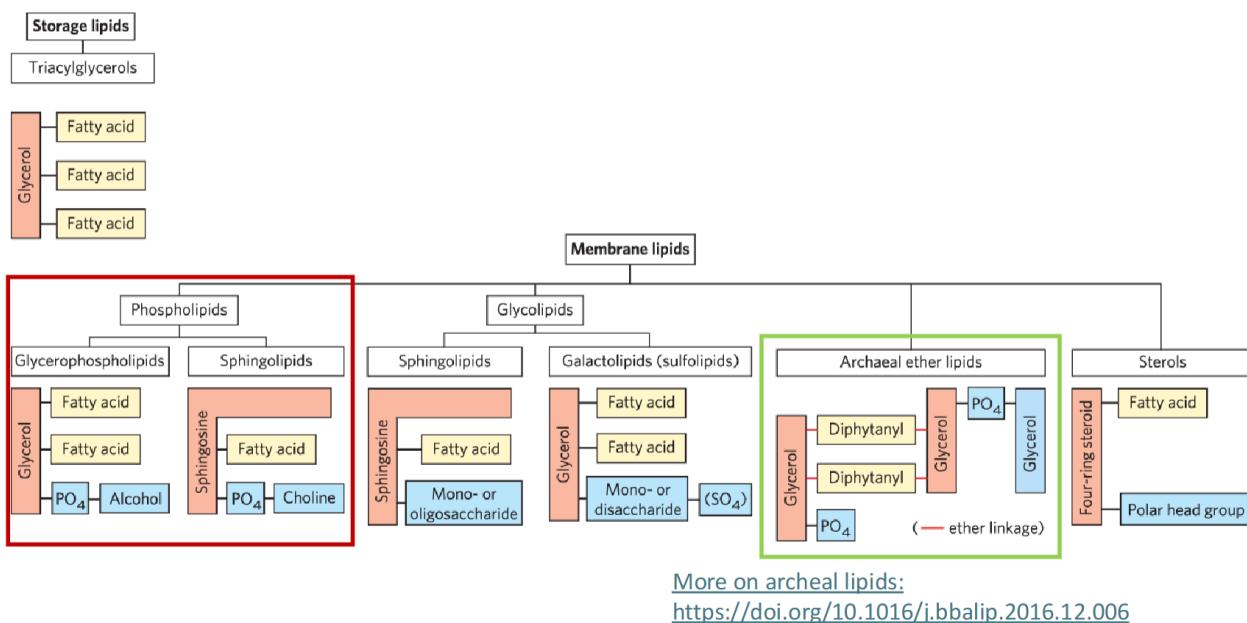
## Receptor-Mediated Endocytosis

apoB-100 of LDL is recognized by receptors in the plasma membrane.



Nelson & Cox, Lehninger Principles of Biochemistry, 8e, © 2021 W.H. Freeman and Company

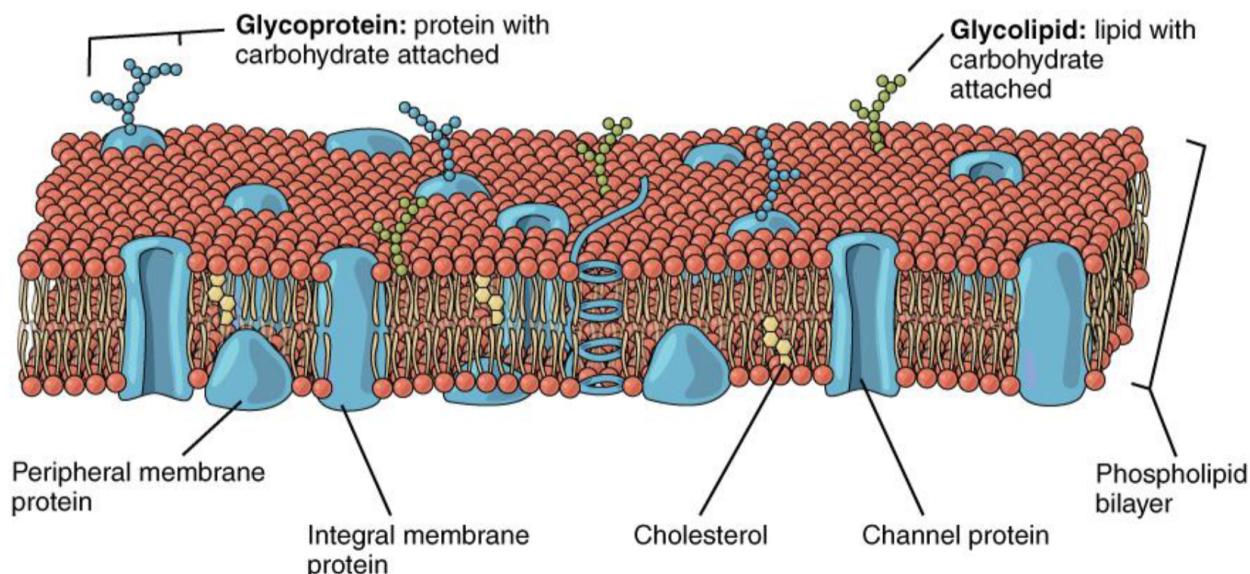
## Some Common Types of Storage and Membrane Lipids

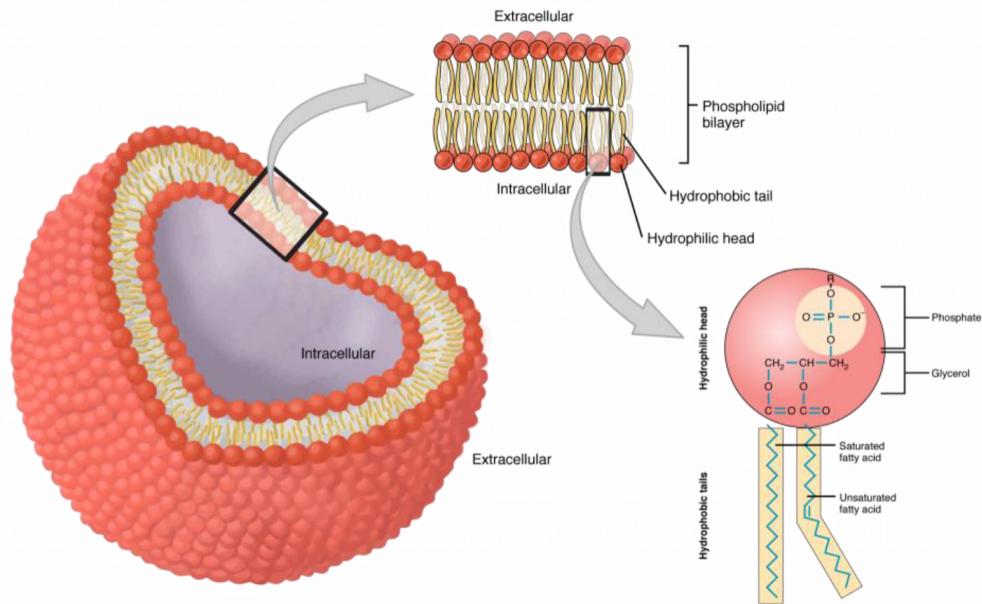


More on archeal lipids:

<https://doi.org/10.1016/j.bbaliip.2016.12.006>

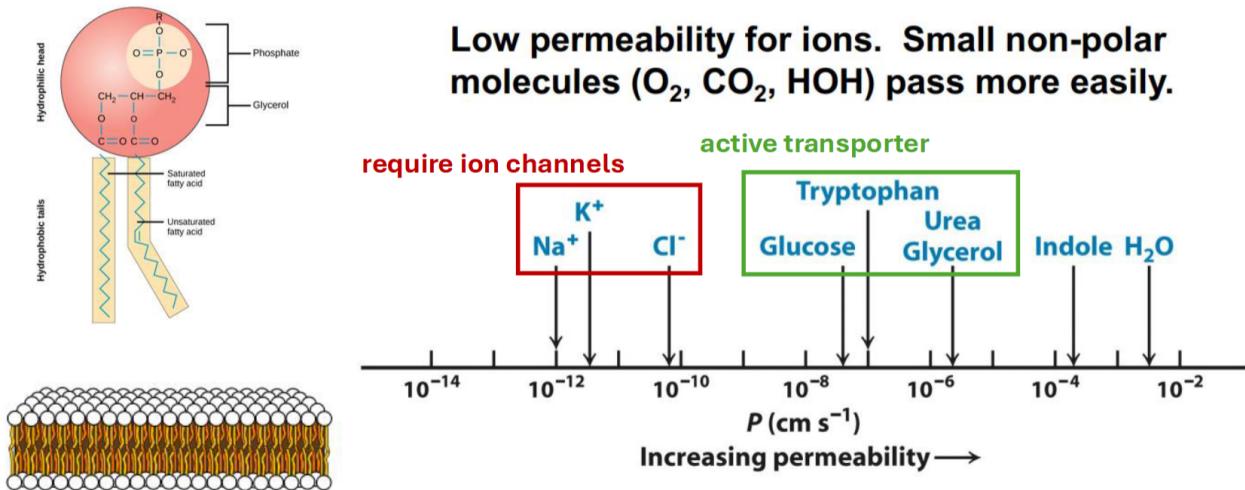
## Cell Membrane: Fluid Mosaic Model



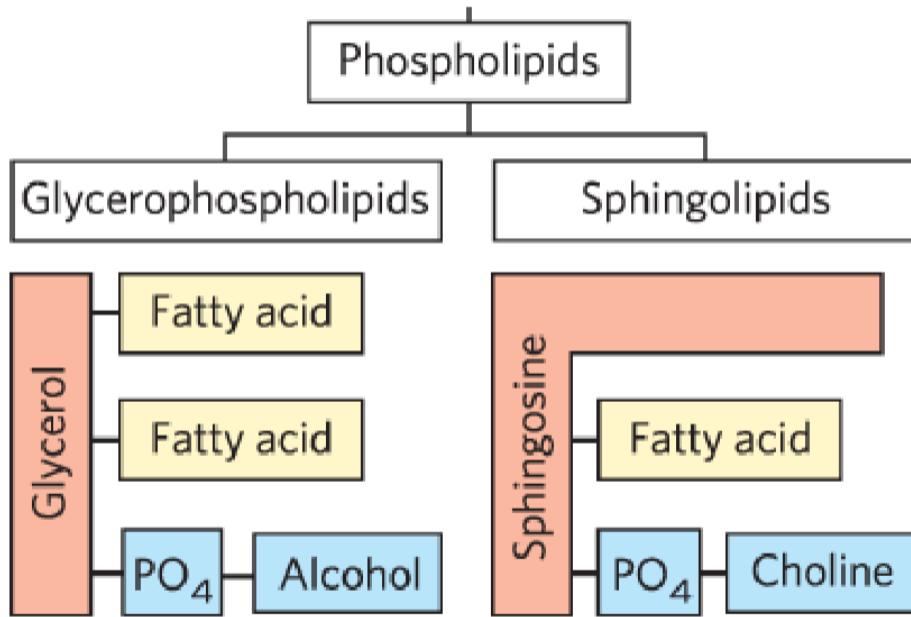


## Membrane Permeability

- Low permeability for ions.
- Small non-polar molecules ( $\text{O}_2$ ,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ ) pass more easily.



## Types of Phospholipids



### Glycerophospholipids

- Backbone: Glycerol
- Structure: Two fatty acids attached to the glycerol backbone, a phosphate group ( $\text{PO}_4$ ) linked to an alcohol (e.g., choline or ethanolamine)
- Function: In cell membranes, it has a role in structural integrity and signaling

### Sphingolipids:

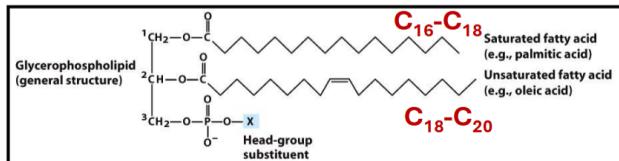
- Backbone: Sphingosine
- Structure: One fatty acid attached to the sphingosine backbone, a phosphate group ( $\text{PO}_4$ ) linked to choline or another alcohol group
- Function: In cell membranes, particularly in neural tissues, they contribute to signaling and cellular recognition

## Glycerophospholipids

**precursor to the other glycerophospholipids**

**common membrane components**

**part of several signaling pathways**



Name of glycerophospholipid	Name of X	Formula of X	Net charge (at pH 7)
Phosphatidic acid	—	—H	-1
Phosphatidylethanolamine	Ethanolamine	—CH <sub>2</sub> —CH <sub>2</sub> —NH <sub>3</sub> <sup>+</sup>	0
Phosphatidylcholine	Choline	—CH <sub>2</sub> —CH <sub>2</sub> —N(CH <sub>3</sub> ) <sub>3</sub> <sup>+</sup>	0
Phosphatidylserine	Serine	—CH <sub>2</sub> —CH—NH <sub>3</sub> <sup>+</sup> COO <sup>-</sup>	-1
Phosphatidylglycerol	Glycerol	—CH <sub>2</sub> —CH—CH <sub>2</sub> —OH OH	-1
Phosphatidylinositol 4,5-bisphosphate	myo-Inositol 4,5-bisphosphate		-4
Cardiolipin	Phosphatidyl-glycerol		-2

**Structure:** Glycerophospholipids are based on a glycerol backbone, with two fatty acids and a phosphate group attached. The phosphate group is further linked to a polar "head group" (e.g., ethanolamine, choline, serine, glycerol).

**Roles:**

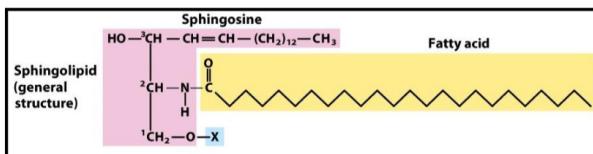
- Precursor function:** Phosphatidic acid serves as the precursor to other glycerophospholipids
- Membrane components:** Glycerophospholipids like phosphatidylethanolamine, phosphatidylcholine, and phosphatidylserine are crucial for membrane structure and function
- Signaling pathways:** Specialized glycerophospholipids (e.g., phosphatidylinositol 4, 5-bisphosphate) participate in intracellular signaling, regulating processes like calcium release and enzyme activation
- **Cardiolipin:** Vital for mitochondrial membrane integrity and function

## Sphingolipids

**precursor to the other sphingolipids**

**common membrane component**

**glycolipids**



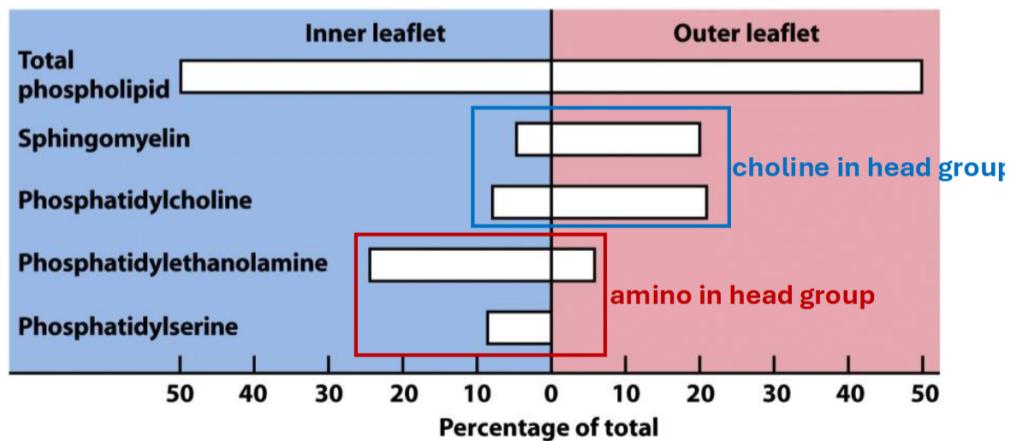
Name of sphingolipid	Name of X—O	Formula of X
Ceramide	—	—H
Sphingomyelin	Phosphocholine	
Neutral glycolipids Glucosylceramide	Glucose	
Lactosylceramide (a globoside)	Di-, tri-, or tetrasaccharide	
Ganglioside GM2	Complex oligosaccharide	

**Structure:** Sphingolipids are built on a sphingosine backbone (rather than glycerol), with a single fatty acid and a polar head group. The head groups can vary, producing different sphingolipid types

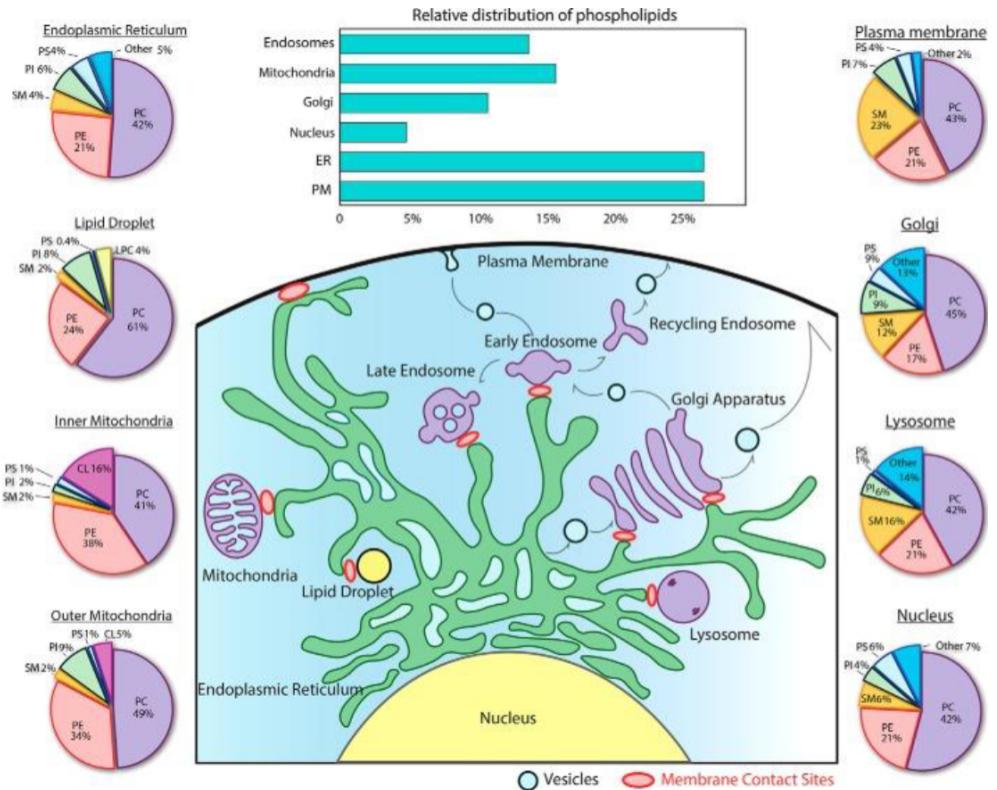
- Precursor function:** Ceramide acts as a precursor for more complex sphingolipids
- Membrane components:** Sphingomyelin is a major component of myelin sheaths in nerve cells
- Glycolipids:** These include neutral glycosphingolipids (e.g., glucosylceramide) and more complex gangliosides. These glycolipids play roles in cell recognition, signaling, and interactions.

## Phospholipid Asymmetry

- Cell membranes maintain asymmetry in phospholipid content
- Why? Likely helps maintain different electric environments and contribute to structure - also relevant for biological regulation
- If phosphatidylserine (PS) is seen on the outer membrane, it's targeted for phagocytosis
  - In platelets, this triggers aggregation



## Lipids in Organelles



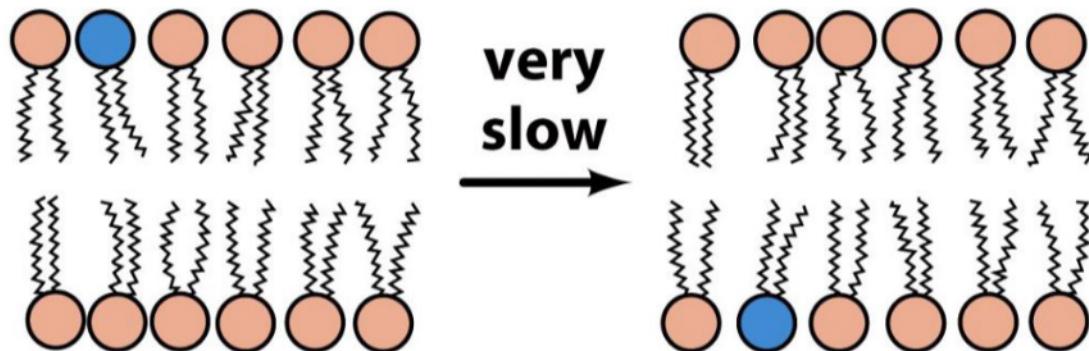
doi:10.1074/jbc.R117.000582

Abbreviations for the pie charts:

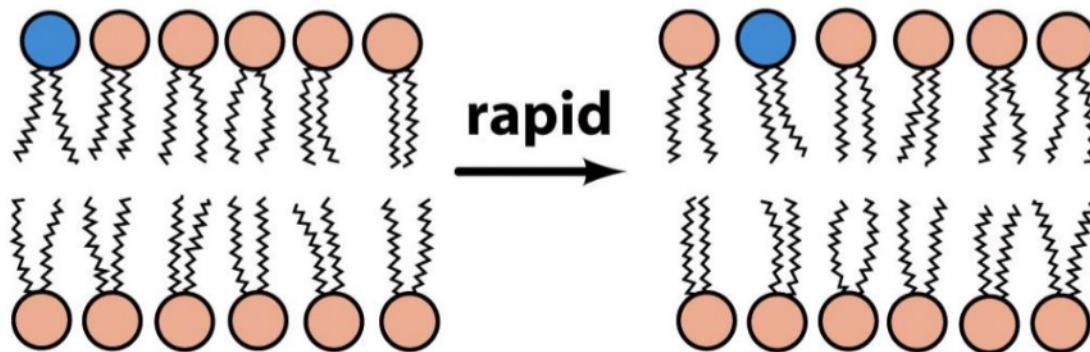
- Phosphatidylcholine (PC)
- Phosphatidylethanolamine (PE)
- Phosphatidylserine (PS)
- Phosphatidylglycerol (PG)
- Cardiolipin (CL)
- Sphingomyelin (SM)
- Other - Includes Phosphatidic Acid (PA)
- Diacylglycerol (DAG) and Lysolipids
- Lipids show distinct distributions and functions across different organelles, with specific abundances in organelles/compartments such as the **endoplasmic reticulum (ER)**, **mitochondria**, **lysosomes**, **nucleus**, **Golgi apparatus**, **plasma membrane (PM)**, **endosomes**, and **lipid droplets**.

## Phospholipid Diffusion

### Transverse diffusion



### Lateral diffusion



Changes in lipid organization can affect various cellular functions, such as membrane trafficking or signal transduction. These membrane-related effects can cause disease in living organisms due to genetic alterations, environmental factors (e.g., high dietary intake of saturated fats), or both

### Flippase, Floppase, and Scramblase

- **Flippase and Floppase** maintain asymmetry by putting phospholipids where they're "supposed" to be
- **Scramblase** indiscriminately flips phospholipids both directions - what would happen if scramblase dominated?
  - Phospholipid content would **even out** (50:50 equilibrium)
  - This would include PS
- **Scramblase** is activated by levels of  $\text{Ca}^{2+}$  signaling that trigger in case of damage - beginnings of apoptosis (conversely flippase and floppase are inhibited)

