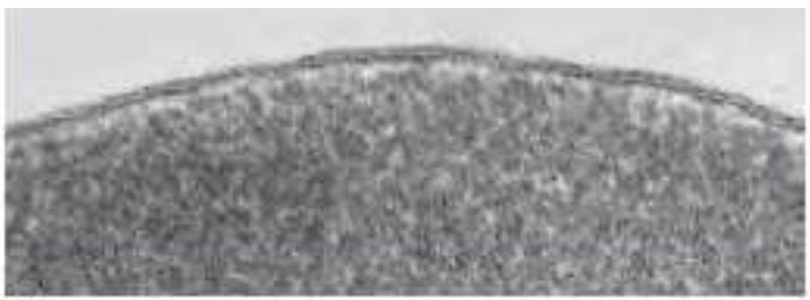
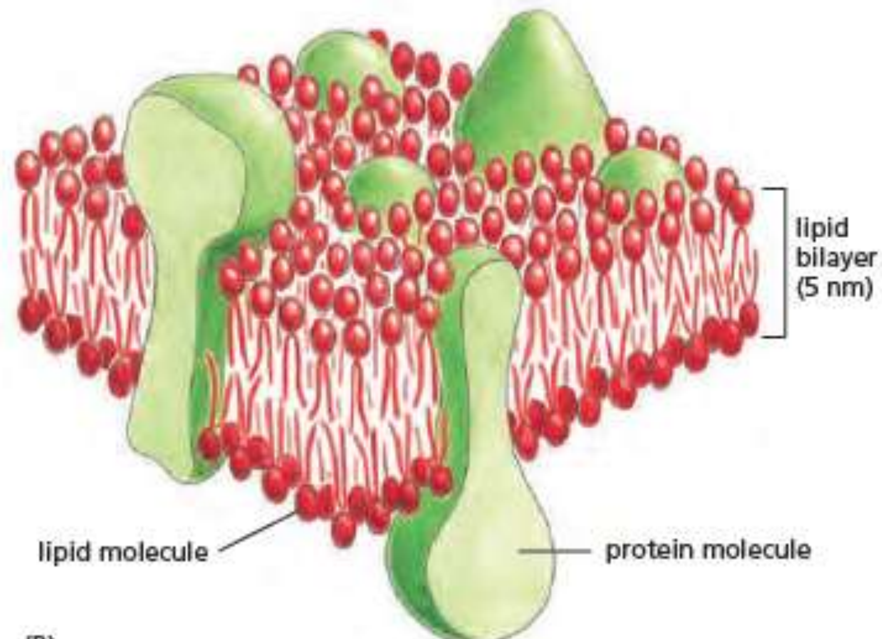
Membrana celular

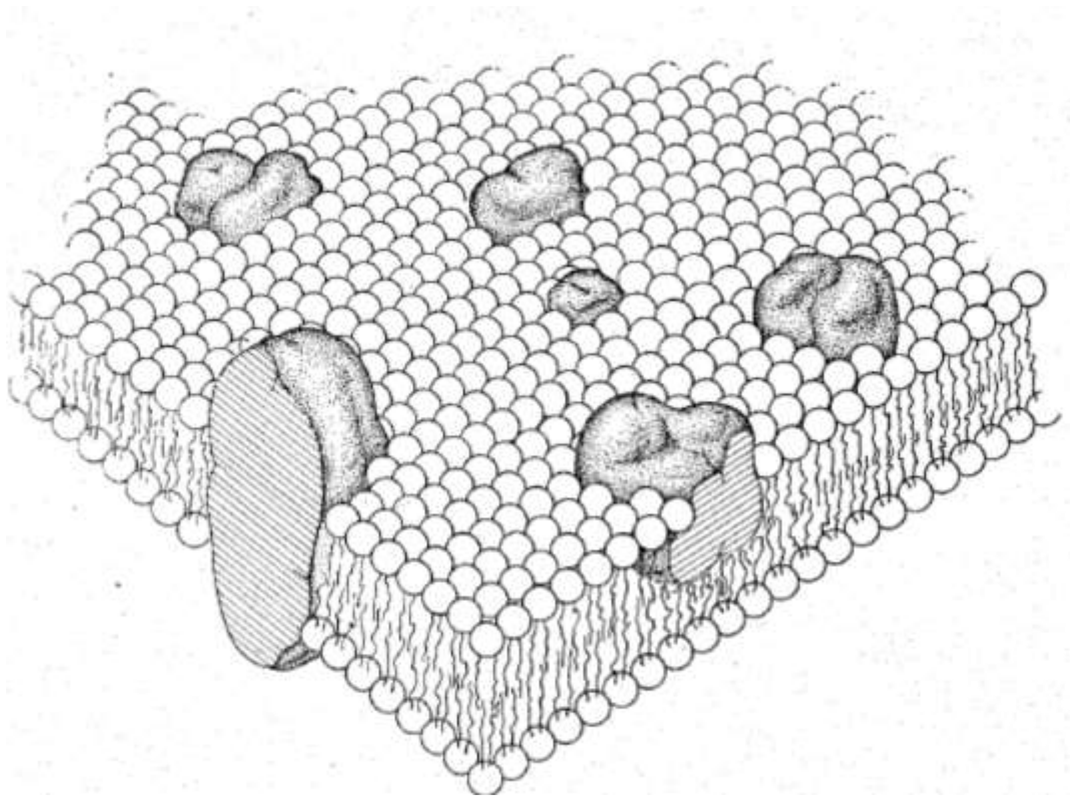
Membrane Structure


(A)

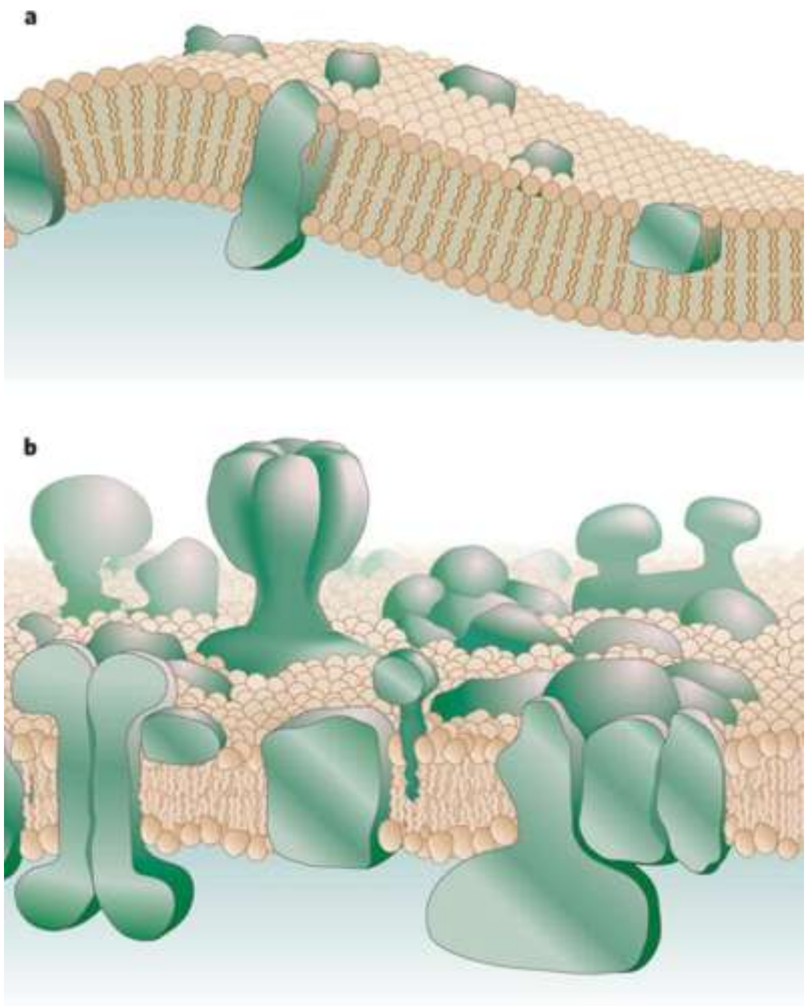


(B)

Two views of a cell membrane. (A) An electron micrograph of a segment of the plasma membrane of a human red blood cell seen in cross section, showing its bilayer structure. (B) A three-dimensional schematic view of a cell membrane and the general disposition of its lipid and protein constituents. (A, courtesy of Daniel S. Friend.)



The lipid-globular protein mosaic model with a lipid matrix (the fluid mosaic model); schematic three-dimensional and cross-sectional views. Figure 3 from Singer, S. J., & Garth Nicholson. The fluid mosaic model of cell membranes. Science **175** (4023): 720-731, February 18, 1972.

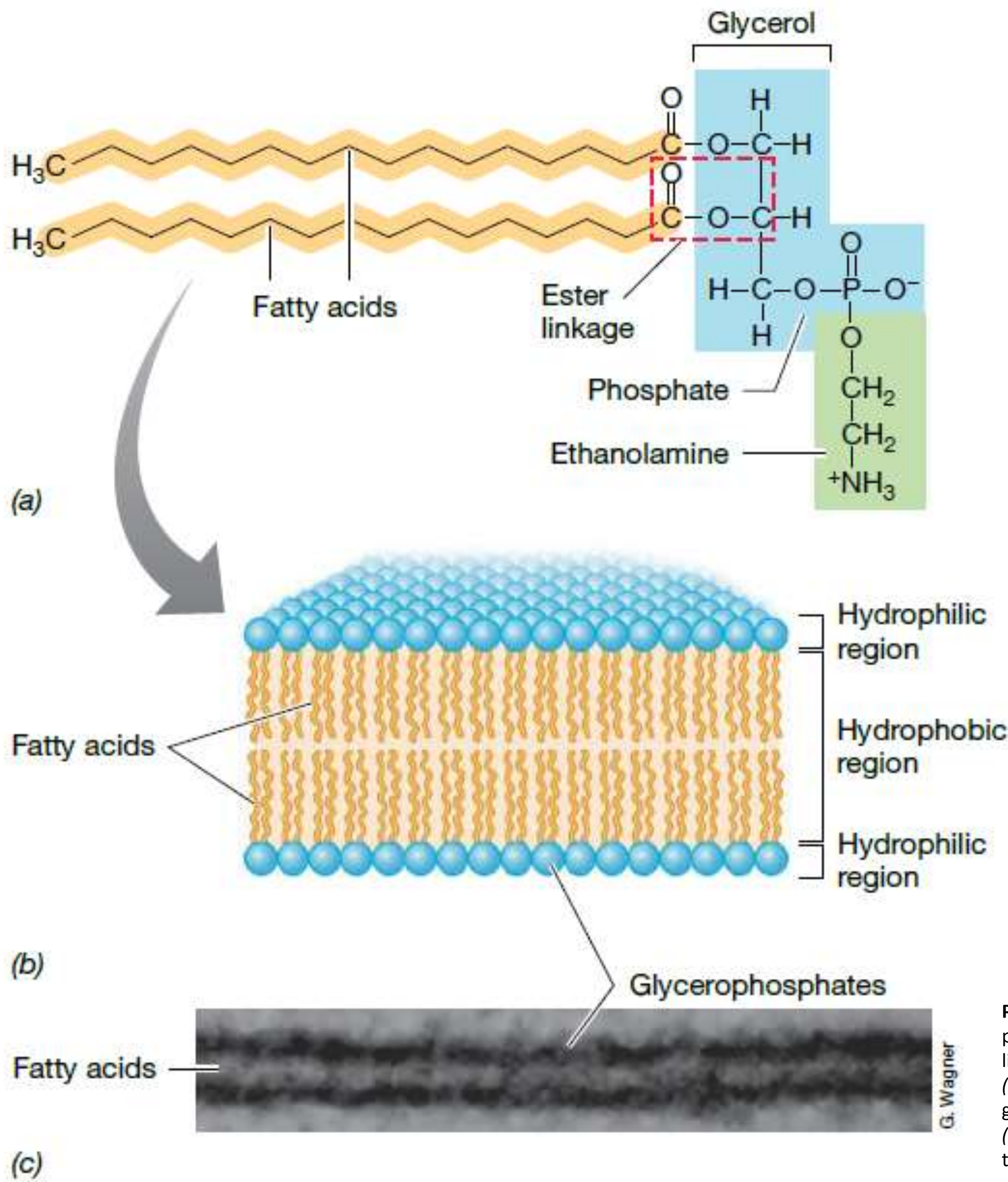


The Singer–Nicolson model. (A) The originally proposed model. (B) An amended and updated version, according to Engelman.

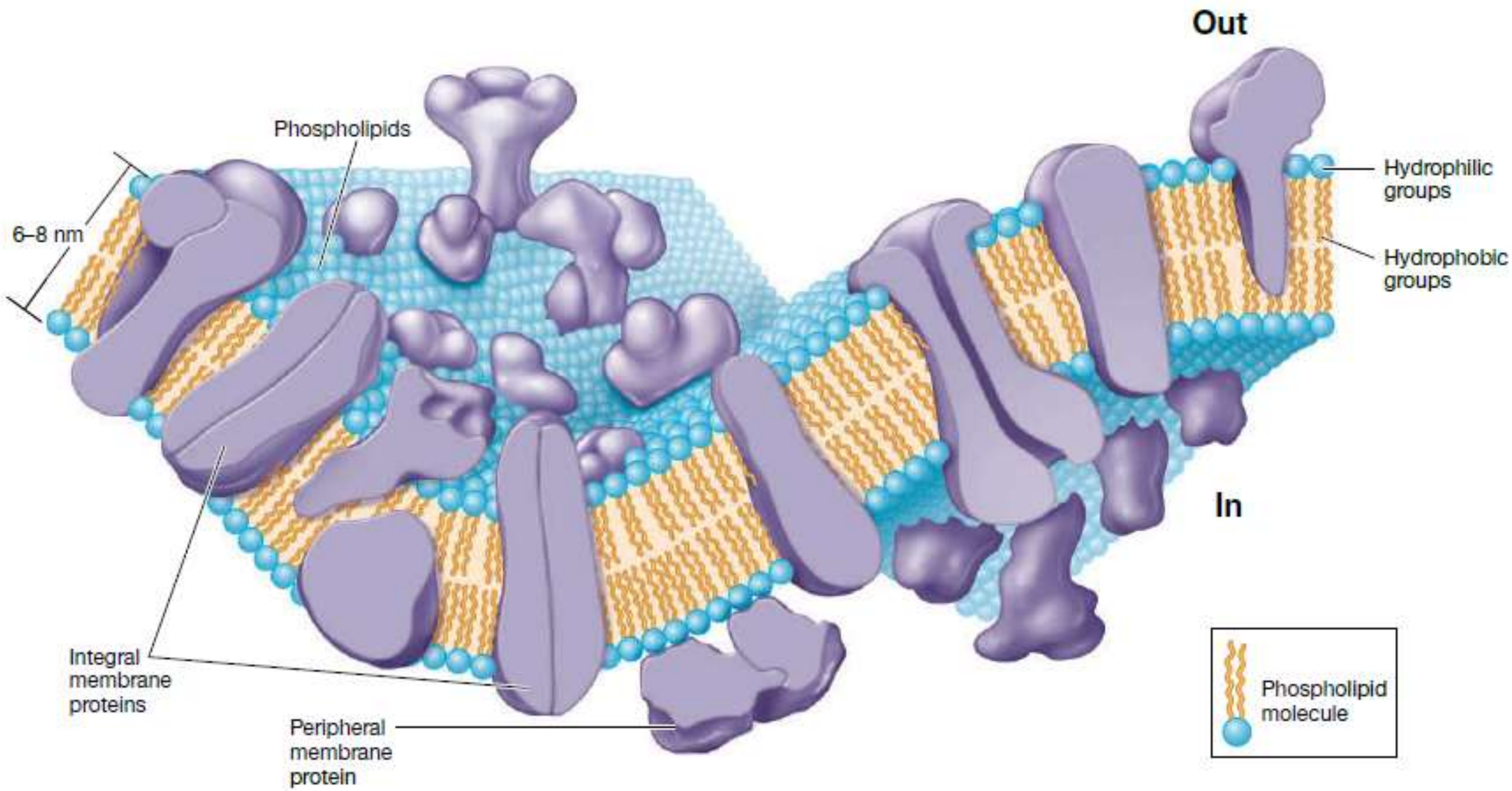
- Membrana plasmática, delgada capa (8 – 10 nm) que envuelve completamente a la célula y es de vital importancia para el mantenimiento de su integridad.
- Barrera altamente selectiva que capacita a la célula para concentrar metabolitos específicos y excretar materiales de desecho → permeabilidad selectiva

Composición de la membrana

- La estructura general de la membrana citoplasmática es una bicapa fosfolipídica
- Los fosfolípidos están formados por componentes hidrofóbicos e hidrofílicos
- Los fosfolípidos en solución acuosa, tienden a formar bicapas de manera natural.



Phospholipid bilayer membrane. *(a)* Structure of the phospholipid phosphatidylethanolamine. The side chains are fatty acids and the ester linkage (characteristic of the lipids of *Bacteria* and *Eukarya* but not *Archaea*). *(b)* General architecture of a bilayer membrane; the blue spheres depict glycerol with phosphate and/or other hydrophilic groups. *(c)* Transmission electron micrograph of a membrane. The light inner area is the hydrophobic region of the model membrane shown in *b.*



Structure of the cytoplasmic membrane. The inner surface (**In**) faces the cytoplasm and the outer surface (**Out**) faces the environment. Phospholipids compose the matrix of the cytoplasmic membrane with proteins embedded (integral) or surface associated (peripheral). The general design of the cytoplasmic membrane is similar in both prokaryotic and eukaryotic cells, although there are chemical differences between different species.

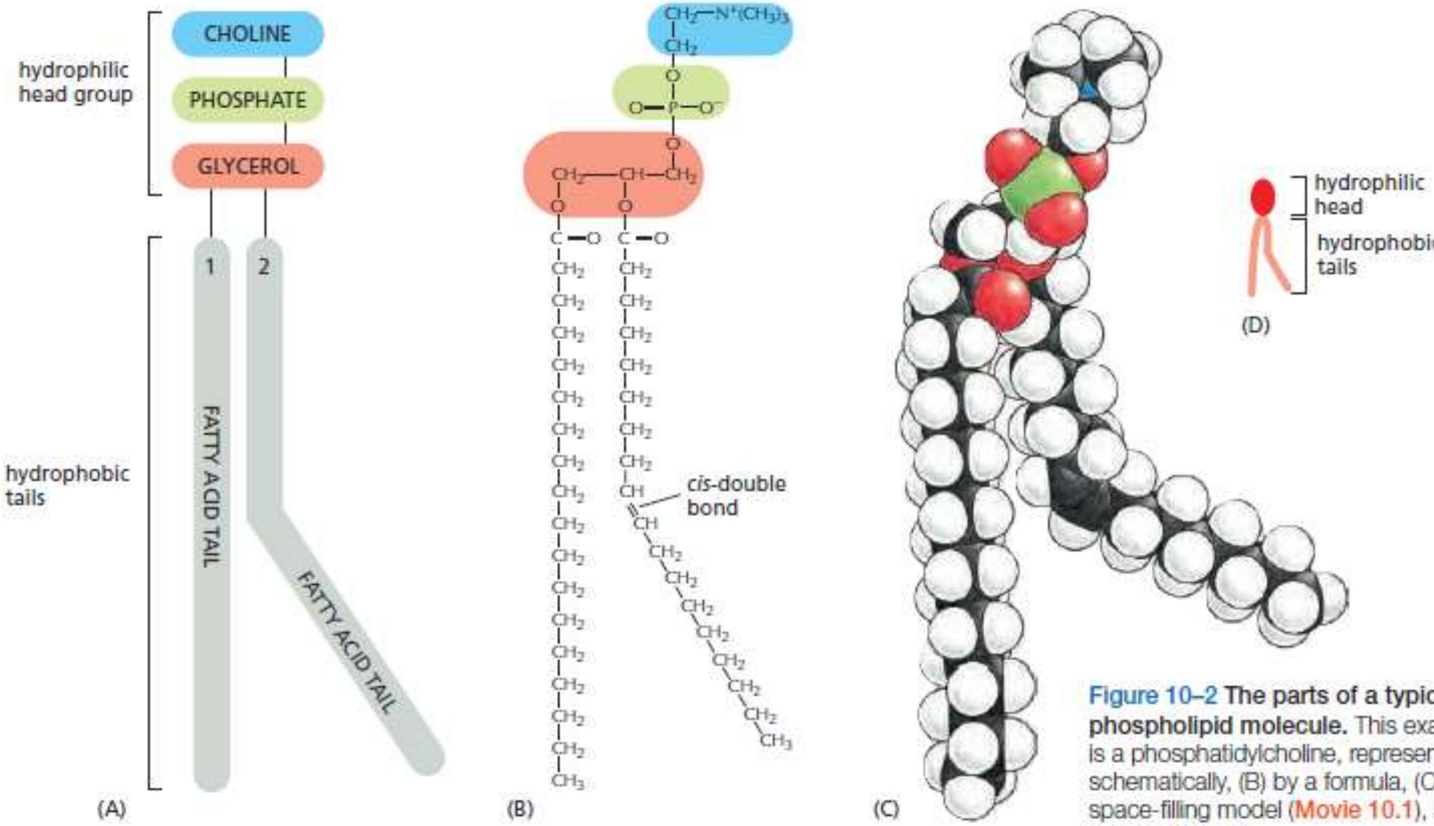
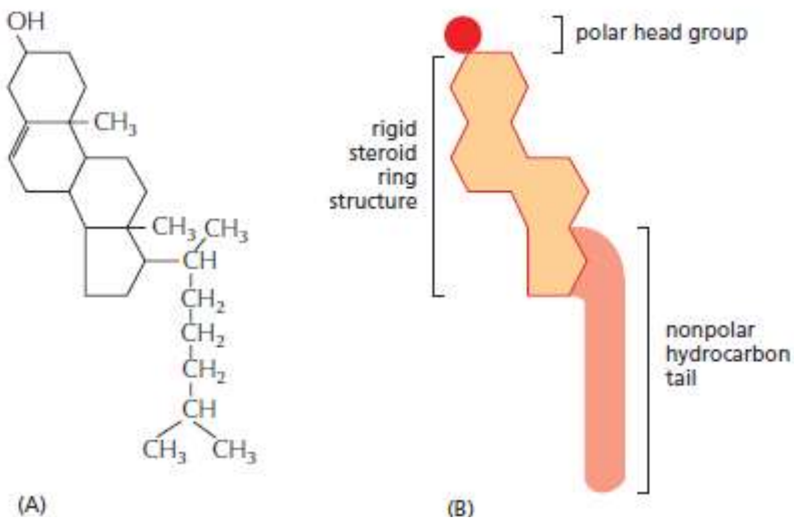
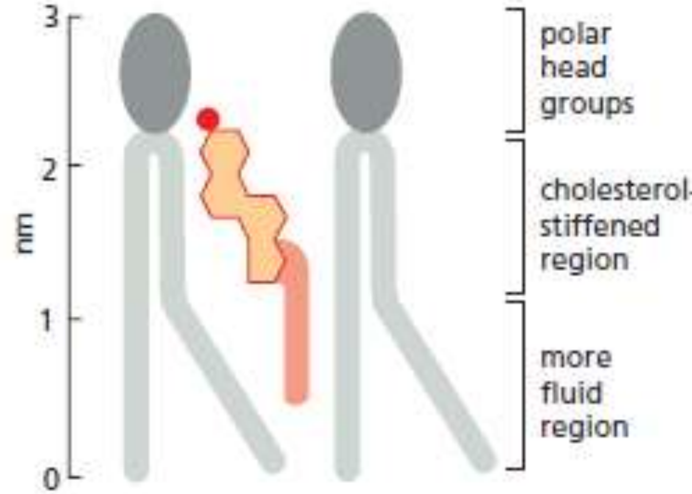


Figure 10–2 The parts of a typical phospholipid molecule. This example is a phosphatidylcholine, represented (A) schematically, (B) by a formula, (C) as a space-filling model (Movie 10.1), and (D) as a symbol.



The structure of cholesterol. Cholesterol is represented (A) by a formula, (B) by a schematic drawing.



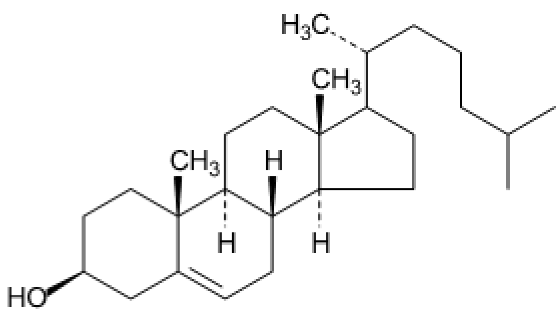
Cholesterol in a lipid bilayer. Schematic drawing (to scale) of a cholesterol molecule interacting with two phospholipid molecules in one monolayer of a lipid bilayer.

TABLE 10–1 Approximate Lipid Compositions of Different Cell Membranes						
	Percentage of total lipid by weight					
Lipid	Liver cell plasma membrane	Red blood cell plasma membrane	Myelin	Mitochondrion (inner and outer membranes)	Endoplasmic reticulum	*E. coli* bacterium
Cholesterol	17	23	22	3	6	0
Phosphatidylethanolamine	7	18	15	28	17	70
Phosphatidylserine	4	7	9	2	5	trace
Phosphatidylcholine	24	17	10	44	40	0
Sphingomyelin	19	18	8	0	5	0
Glycolipids	7	3	28	trace	trace	0
Others	22	14	8	23	27	30

Compares the lipid compositions of several biological membranes. Note that bacterial plasma membranes are often composed of one main type of phospholipid and contain no cholesterol. In archaea, lipids usually contain 20–25-carbon-long prenyl chains instead of fatty acids; prenyl and fatty acid chains are similarly hydrophobic and flexible; in thermophilic archaea, the longest lipid chains span both leaflets, making the membrane particularly stable to heat. Thus, lipid bilayers can be built from molecules with similar features but different molecular designs. The plasma membranes of most eukaryotic cells are more varied than those of prokaryotes and archaea, not only in containing large amounts of cholesterol but also in containing a mixture of different phospholipids.

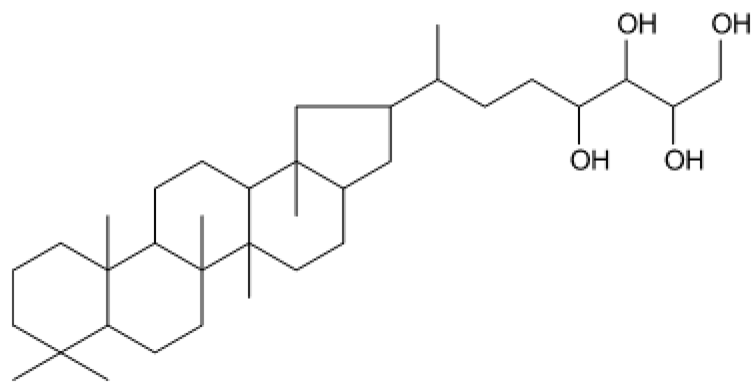
Agentes reforzantes de membrana: Esteroles y hopanoides

In Domain Eukarya



Cholesterol

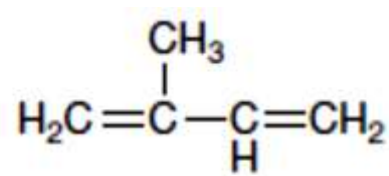
In Domain Bacteria

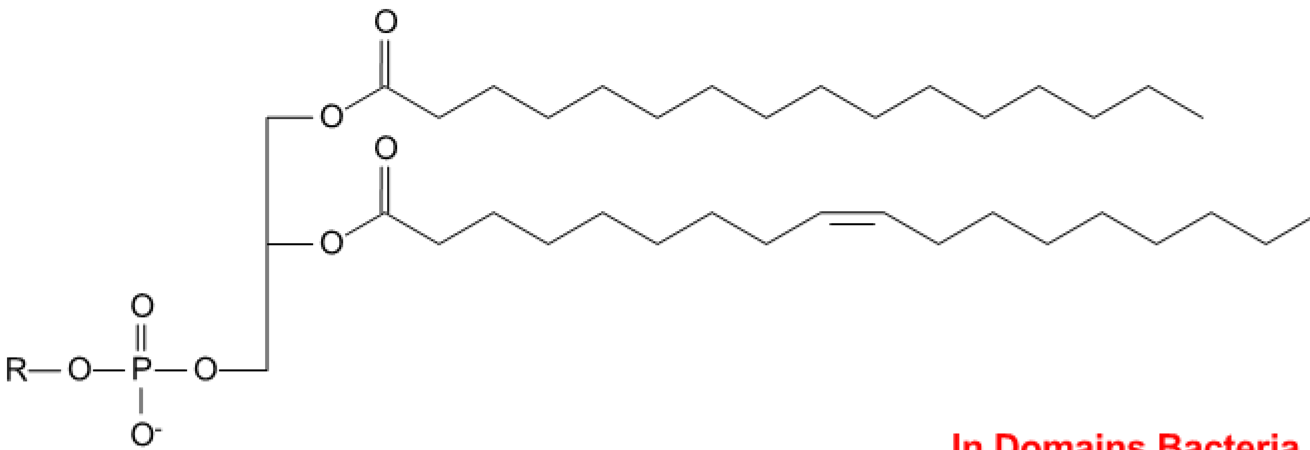


2,3,4-Tetrahydroxypentane-29-hopane

Membrana de Archaea

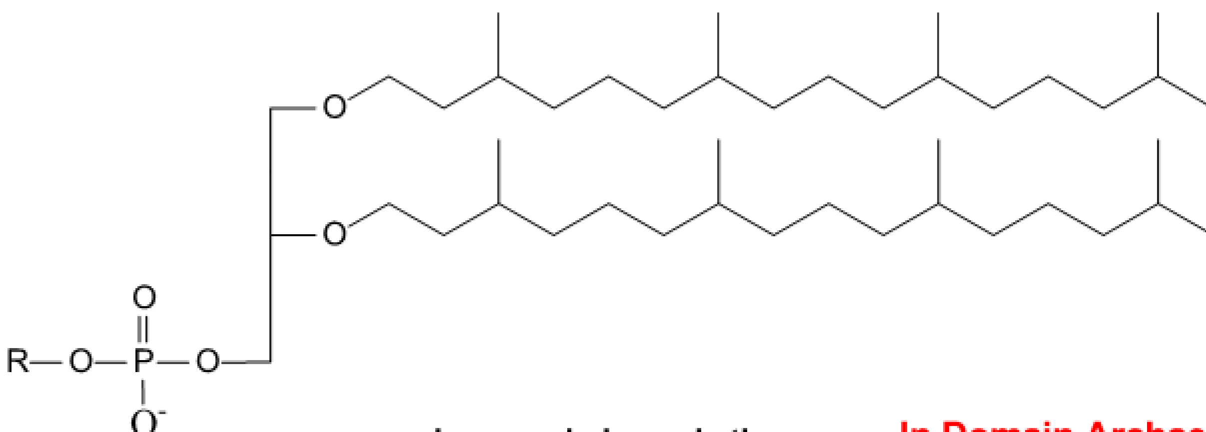
- Bacteria y Eukarya; el enlace éster son los responsables de la unión entre el glicerol y los ácidos grasos,
- Los lípidos de las Archaea poseen enlaces éter responsable de la unión entre el glicerol y las cadenas laterales hidrofóbicas. Además carecen de ácidos grasos y en su lugar tienen cadenas laterales formadas por unidades repetidas del isopreno (5C):





Phospholipid

In Domains Bacteria and Eukarya



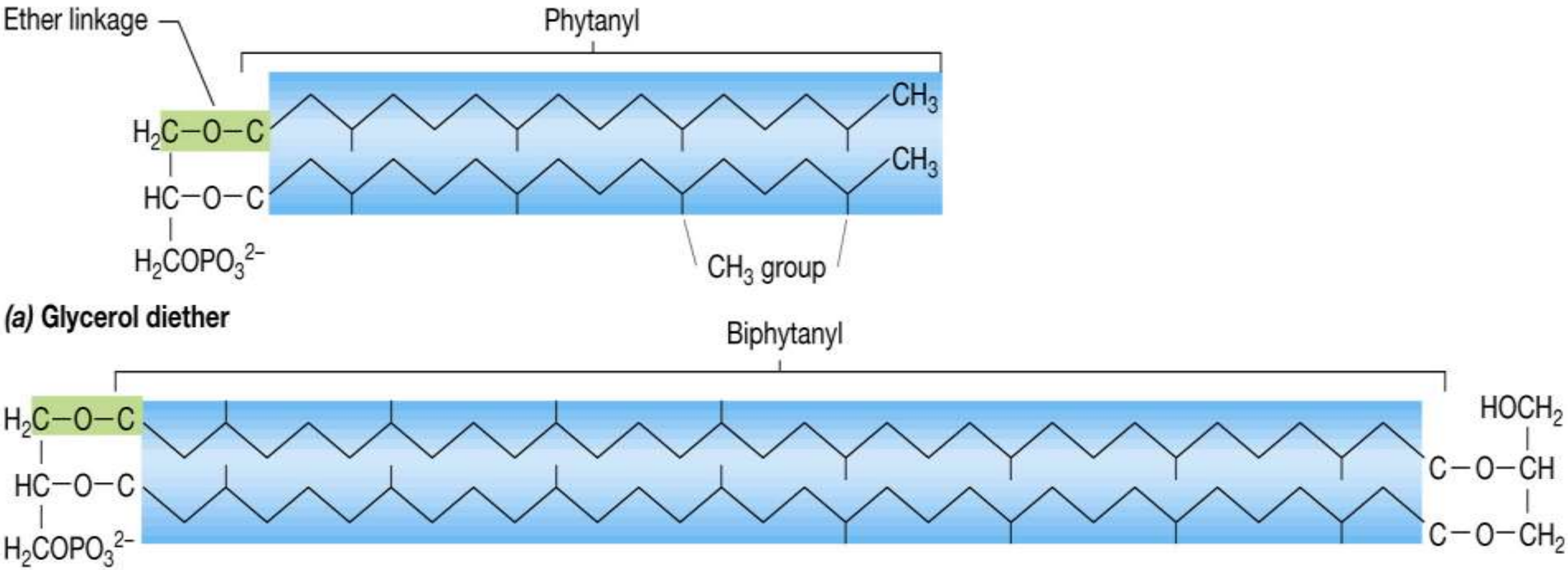
Isoprenyl glycerol ether

In Domain Archaea

Diéteres y tetraéteres de glicerol

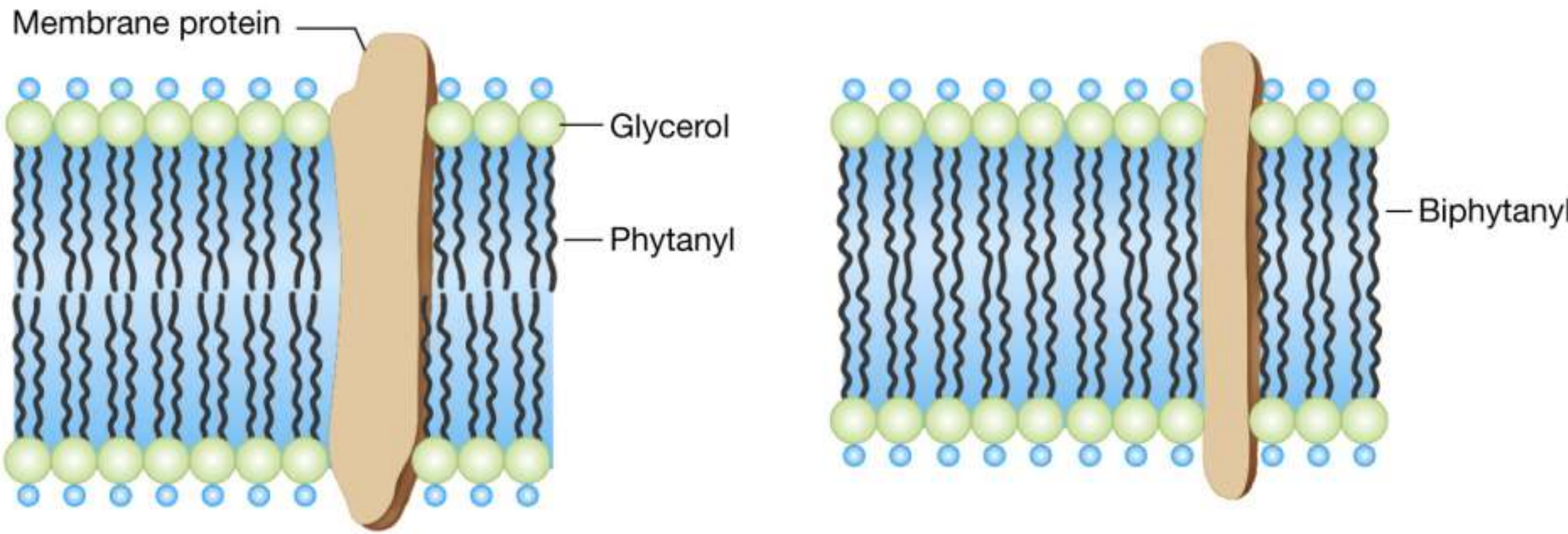
- Dos tipos de lípidos presentes en Archaea: diéteres y tetraéteres
- Principales tipos de lípidos presentes en Archaea
- Tetraéter, las cadenas laterales de fitanilo de cada molécula de glicerol se unen covalentemente entre sí → monocapa (Bifitanilo)
- Monocapas lipídicas son más estables y resistentes a la disgregación: hipertermofílicas

Diéteres y tetraéteres



(a) **Glycerol diether**

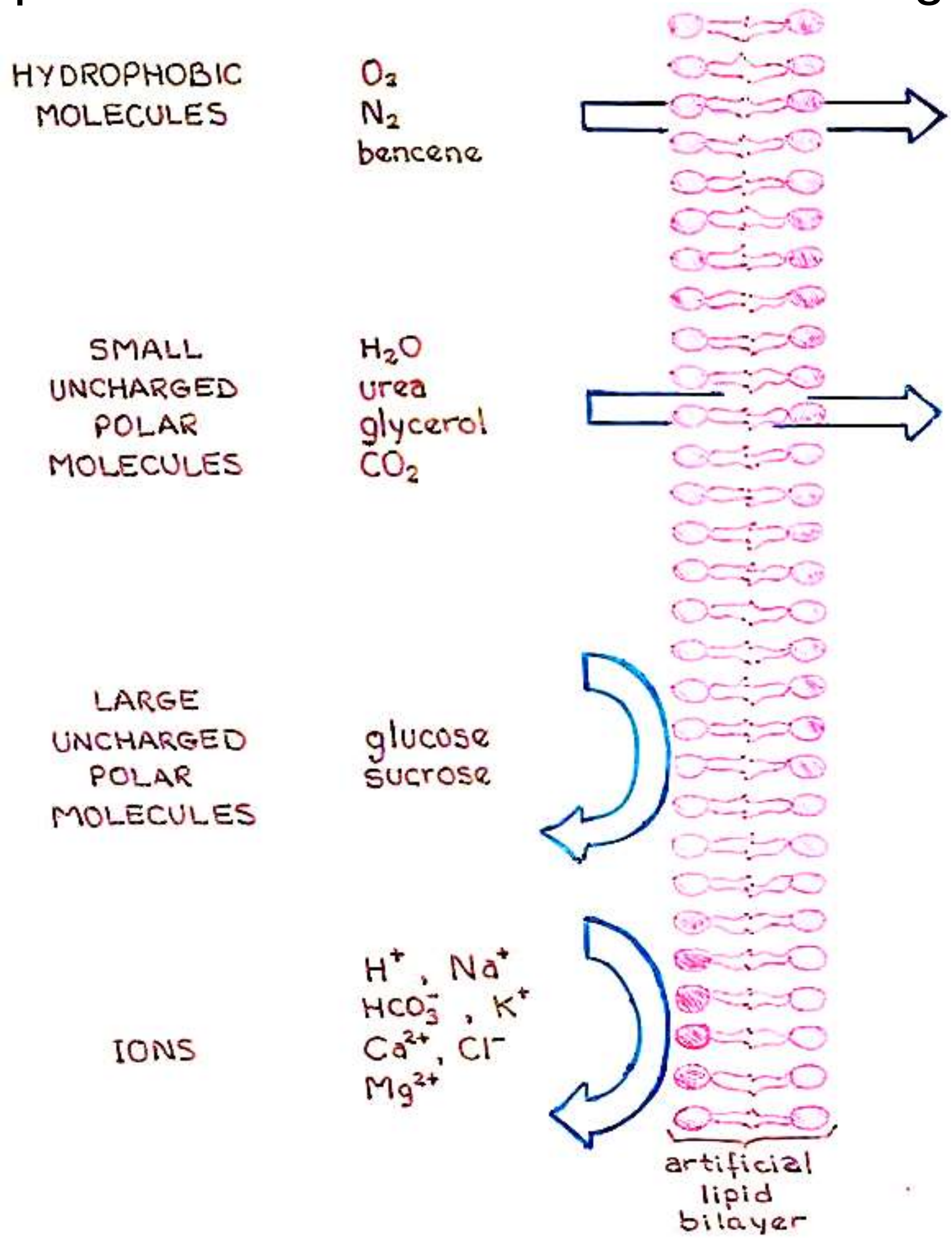
(b) **Diglycerol tetraether**



(c) **Lipid bilayer**

(d) **Lipid monolayer**

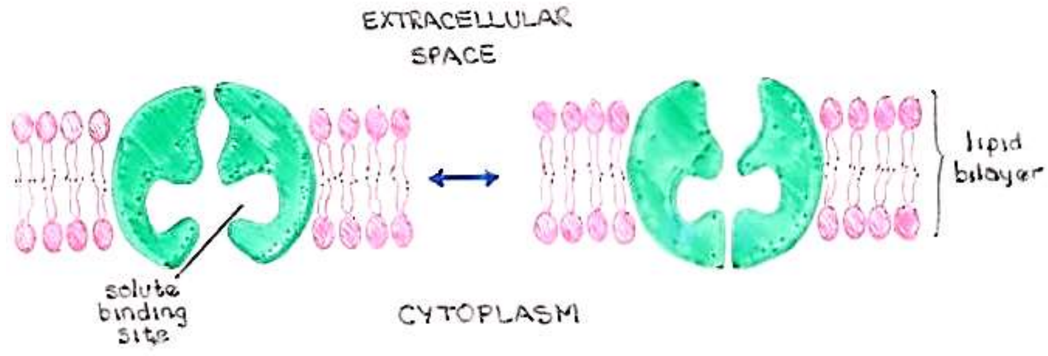
Transporte a través de membranas biológicas



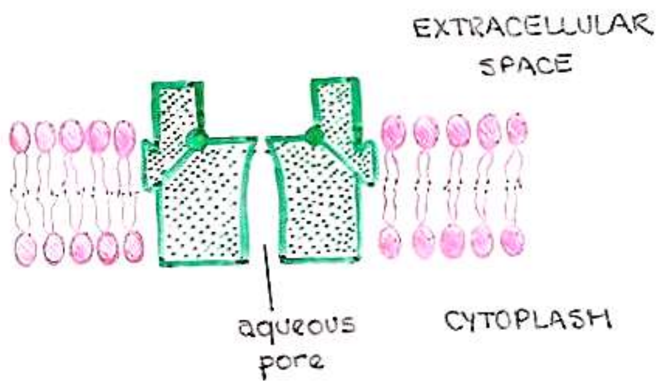
THE RELATIVE PERMEABILITY OF A SYNTHETIC LIPID BILAYER TO DIFFERENT CLASSES OF MOLECULES.

Dos clases de proteínas en transporte de membrana

- Proteínas carrier, se unen a un soluto específico a ser transportado y sufren un cambio conformacional para transferir el soluto a través de membrana
- Proteínas canal, forman poros llenos de agua que permiten al soluto específico (usualmente iones inorgánicos de tamaño y carga apropiada) pasar a través de ello



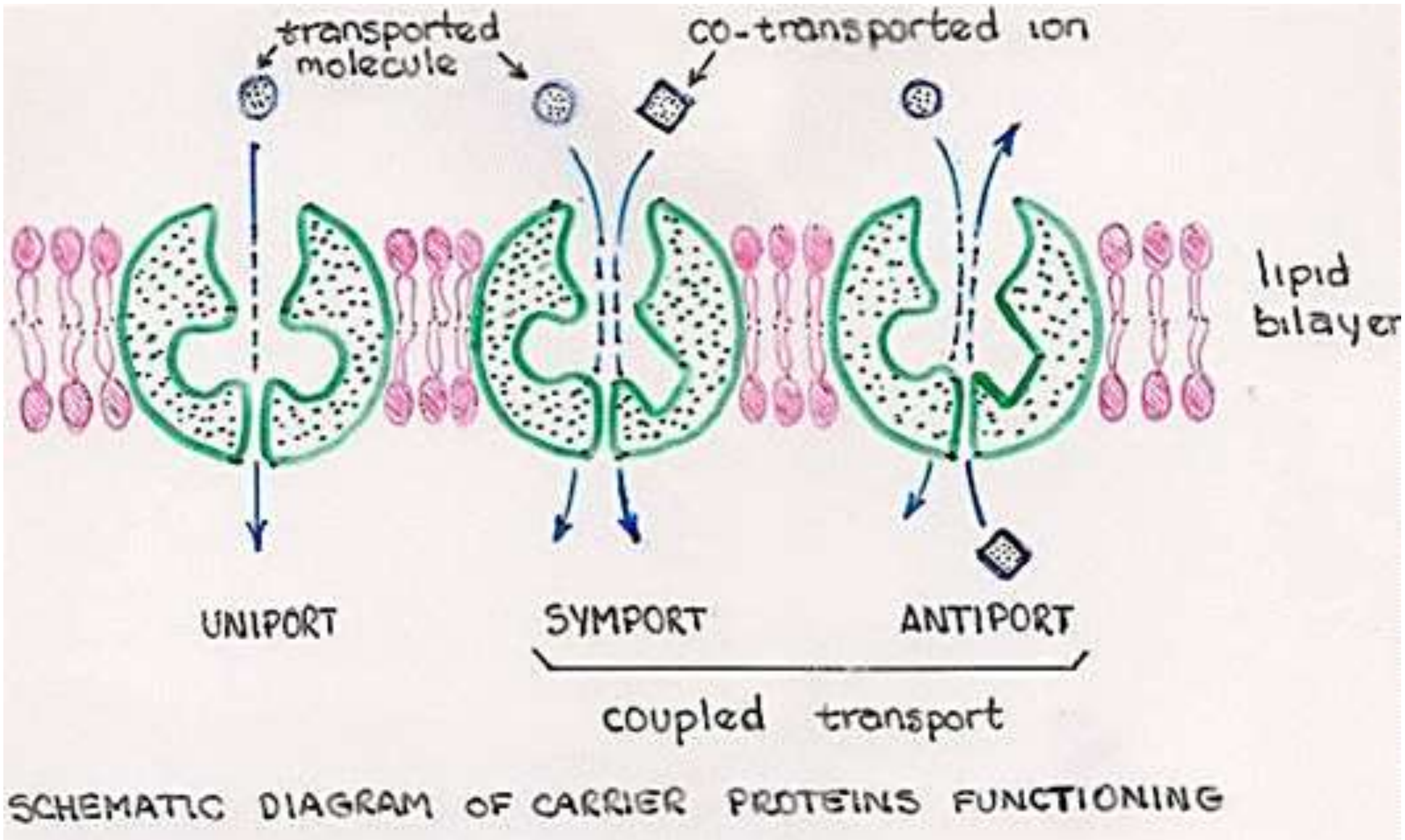
(A) CARRIER PROTEIN

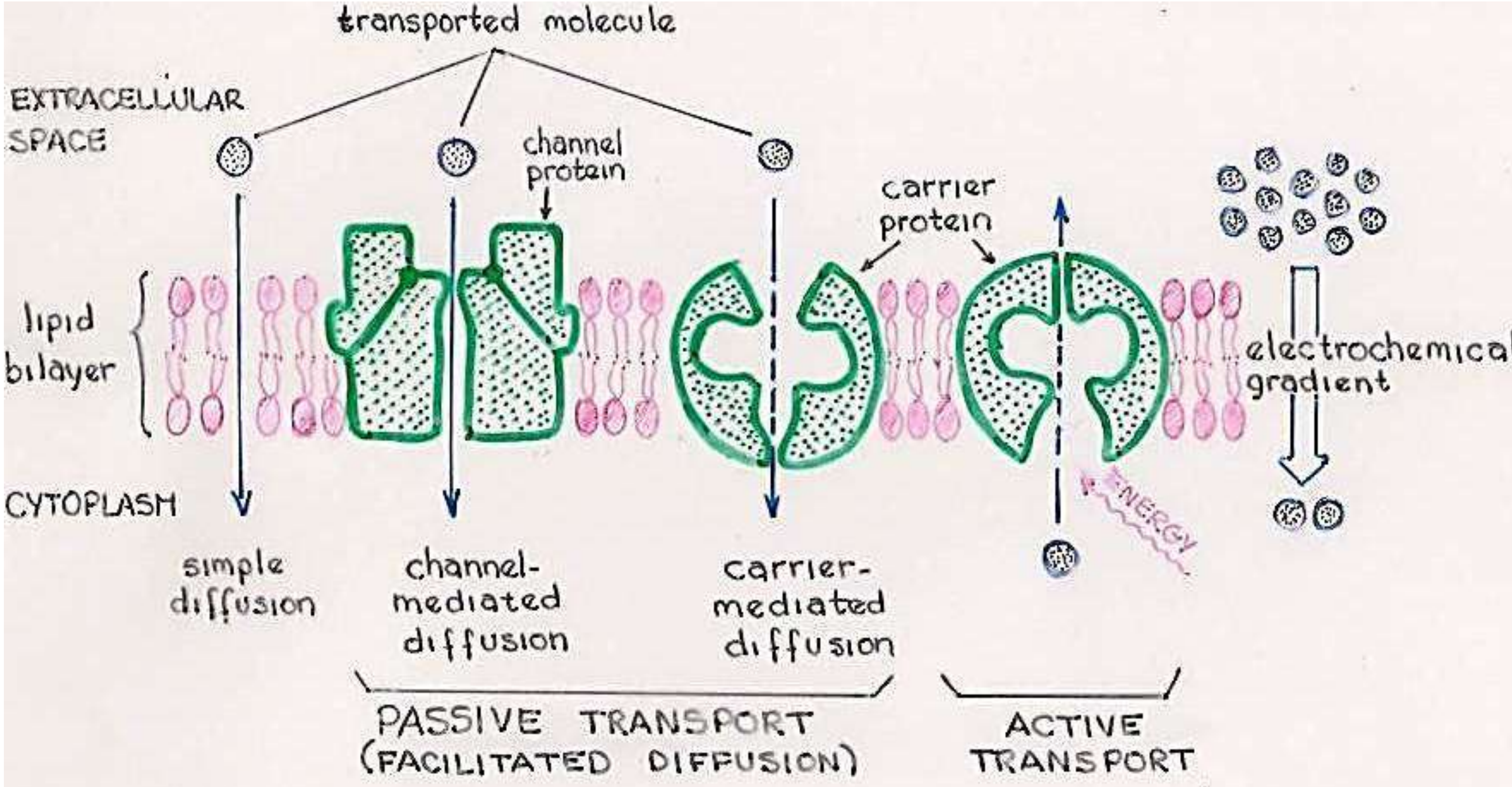


(B) CHANNEL PROTEIN

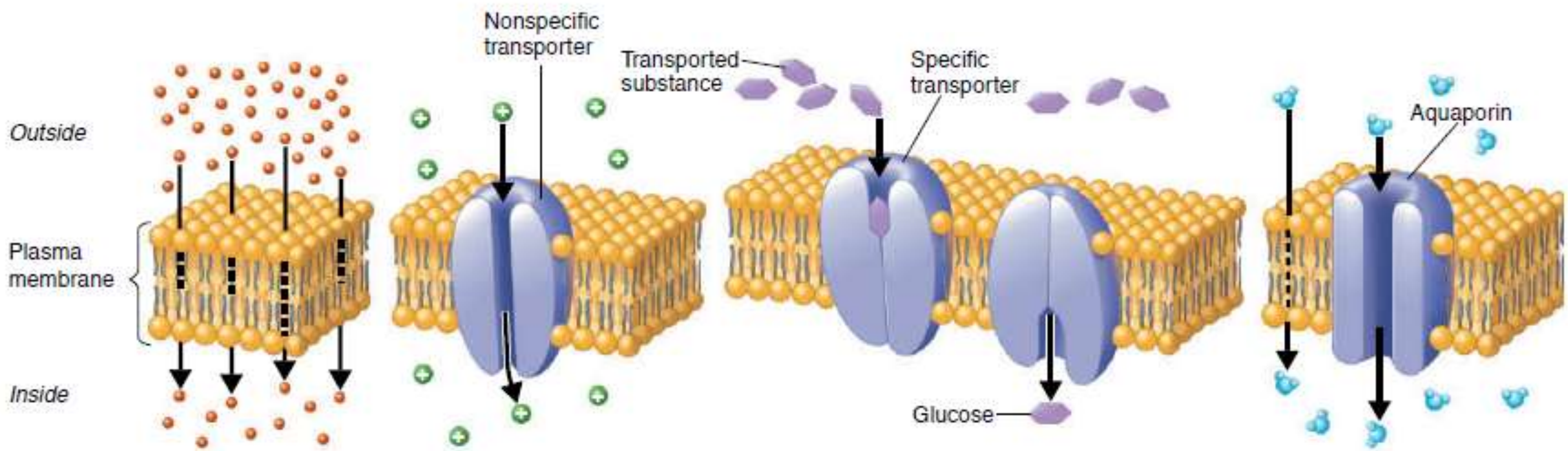
6.2 A SIMPLIFIED SCHEMATIC VIEW OF THE TWO CLASSES OF MEMBRANE TRANSPORT PROTEINS.

Tres tipos de transportadores de membrana:





IG3 SCHEMATIC DIAGRAM OF PASSIVE TRANSPORT DOWN AN ELECTROCHEMICAL GRADIENT AND ACTIVE TRANSPORT AGAINST AN ELECTROCHEMICAL – GRADIENT.

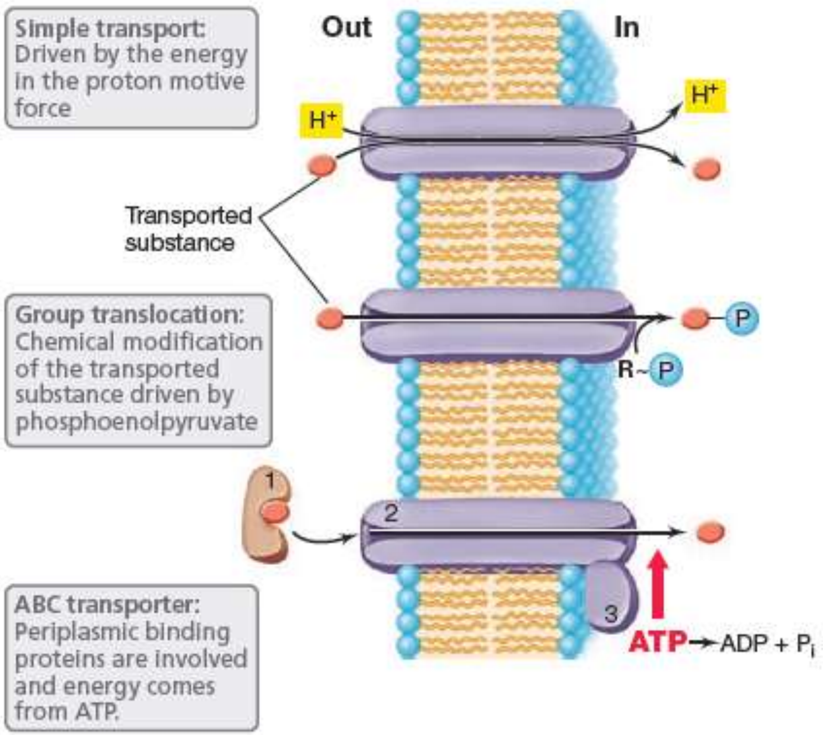


(a) Simple diffusion through the lipid bilayer **(b)** Facilitated diffusion through a nonspecific transporter **(c)** Facilitated diffusion through a specific transporter **(d)** Osmosis through the lipid bilayer (left) and an aquaporin (right)

Passive processes

Transporte de nutrientes

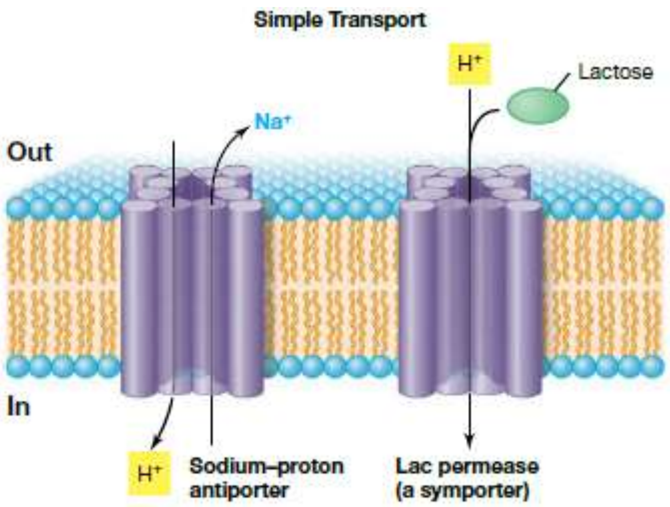
- Tres mecanismos de transporte en procariotas: transporte simple, translocación de grupos y los sistemas de transporte ABC



The three classes of transport systems. Note how simple transporters and the ABC system transport substances without chemically modifying them, whereas group translocation results in chemical modification (in this case phosphorylation) of the transported substance. The three proteins of the ABC system are labeled 1, 2, and 3.

1.- Transporte simple

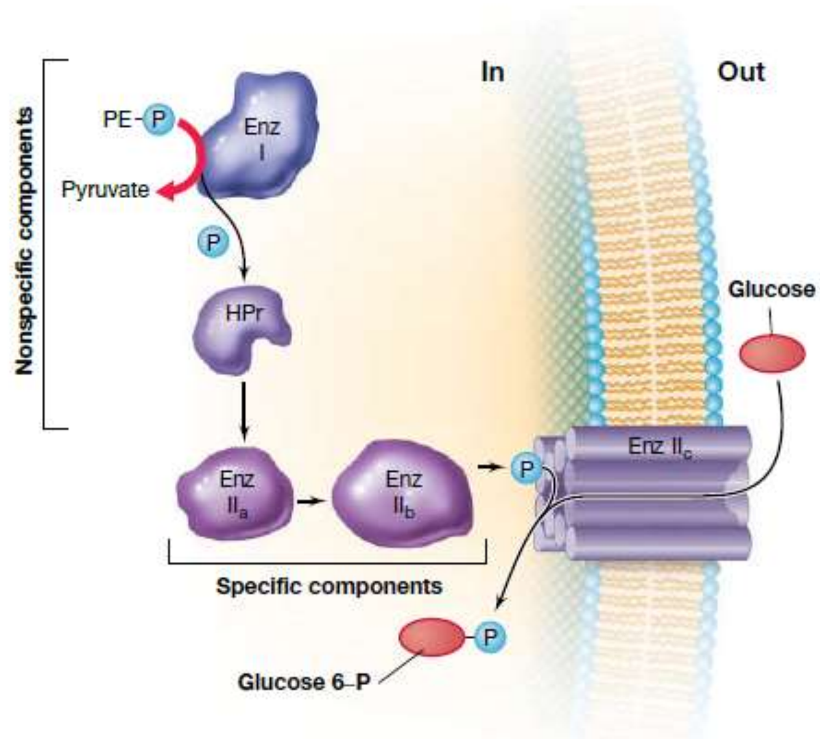
- Transporte simple participa una proteína de transporte transmembranal
- *E.coli*: lac permeasa, proteína transportadora simple, un tipo de simportadora
- Resultado neto: acumulación de lactosa contra el gradiente de concentración



Structure of membrane-spanning transporters and symport and antiport events. Transmembrane transporters are composed of a polypeptide that forms 12 α-helices (each shown as a cylinder) that aggregate to form a channel through the membrane. Note how transport is linked to dissipation of the proton motive force.

2.- Translocación de grupos

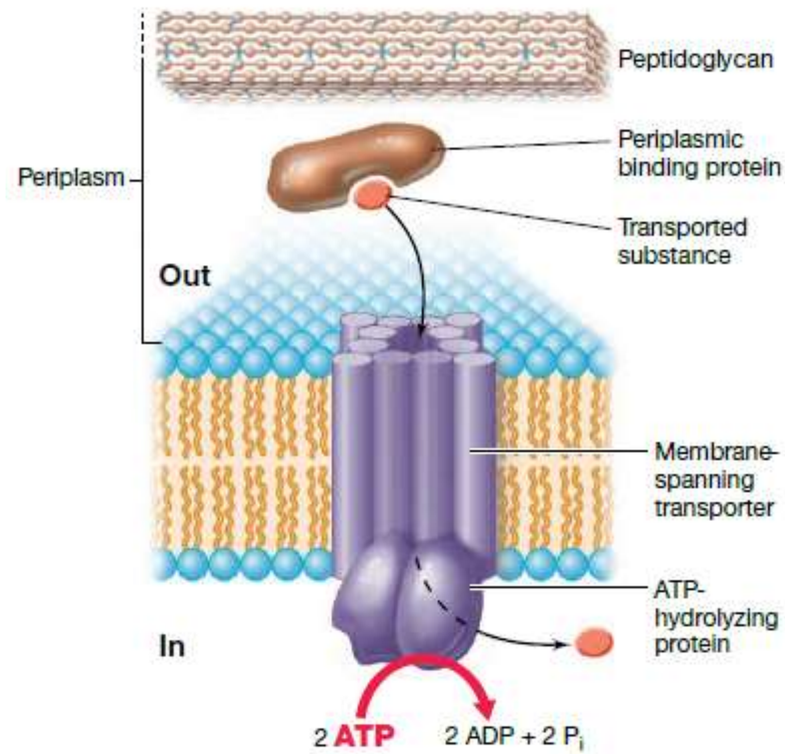
- 1) la sustancia transportada se modifica químicamente durante el proceso de transporte, 2) un compuesto orgánico rico en energía (más que pfm) impulsa el transporte
- El sistema de traslocación de grupos más estudiado es el que transporta glucosa, manosa y fructosa en *E. coli*
- Durante el transporte de estos compuestos son fosforilados por el sistema fosfotransferasa



Mechanism of the phosphotransferase system of *Escherichia coli.* For glucose transport, the system consists of five proteins: Enzyme (Enz) I, Enzymes IIa, IIb, and IIc, and HPr. A phosphate cascade occurs from phosphoenolpyruvate (PE-P) to Enz IIc and the latter actually transports and phosphorylates the sugar. Proteins HPr and Enz I are nonspecific and participate in the transport of any sugar. By contrast, the three components of Enz II are specific for a particular sugar

3.- Proteínas periplasmáticas de unión y sistema ABC (ATP-binding cassette)

- Los sistemas de transporte que utilizan proteínas periplásmicas de unión junto con un transportador de membrana y proteínas que hidrolizan ATP se llaman sistemas de transporte ABC (ATP-binding cassette)
- Se han identificado más de 200 sistemas ABC de transporte diferentes. Captan compuestos orgánicos como azúcares y aminoácidos, nutrientes inorgánicos como sulfato y fosfato y algunos metales.



Mechanism of an ABC transporter. The periplasmic binding protein has high affinity for substrate, the membrane-spanning proteins form the transport channel, and the cytoplasmic ATP-hydrolyzing proteins supply the energy for the transport event.