BIO 311C
Spring 2010

Exam 2:
Next Friday, Mar. 12, in this classroom

Textbook Reading Assignments for Exam 2:
As assigned for Feb. 15 – Mar. 10 on the Course Schedule

Lecture and Presentation slides to be covered on Exam 2:
All topics presented after PowerPoint #10 of Lecture 9.

Exam 2 covers biological molecules (including water and inorganic ions) and biological membranes.

Note there is some overlap between the topics that were covered in Exam 1 and those to be covered on Exam 2.

Lecture 18 – Friday 5 Mar.

Information Molecules of Cells

Information is stored in cells in the form of DNA.

Information is transferred to various locations in cells in the form of RNA.

Information is expressed in cells in the form of proteins.

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Conjugated biological molecules contain more than one class of biological molecule chemically bonded together.

Examples:

Glycolipid	**Lipopolysaccharide**
Lipoprotein	**Glycoprotein**
Nucleoprotein	**Sugar Nucleotide**

The name of a conjugated molecule indicates the classes of molecules from which it is constructed.

The largest component of a conjugated molecule is indicated as the last part of the name of the molecule.

The prefix "glyco" indicates that a portion of the molecule is carbohydrate.

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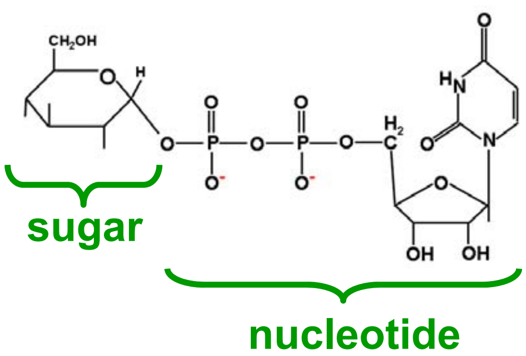
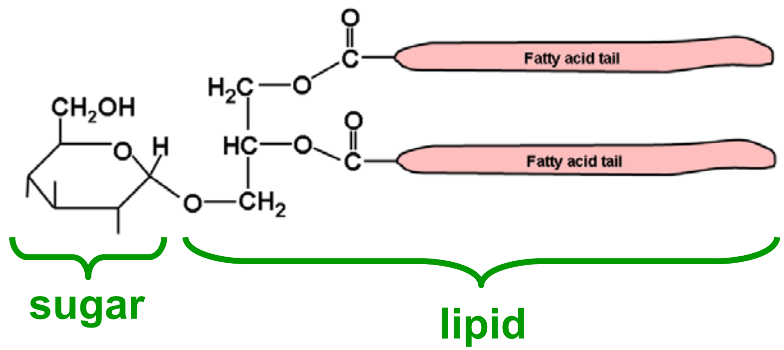
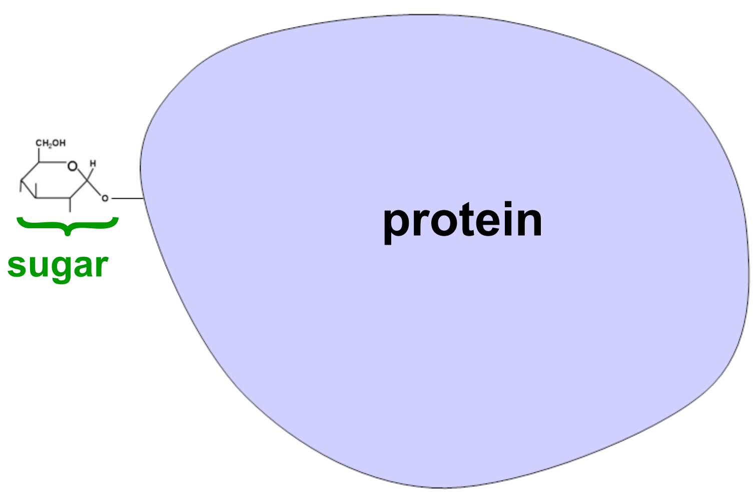
Example of Conjugated Molecules Containing a Simple Sugar



A sugar nucleotide



A glycolipid



A glycoprotein

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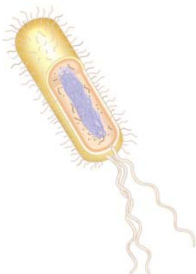
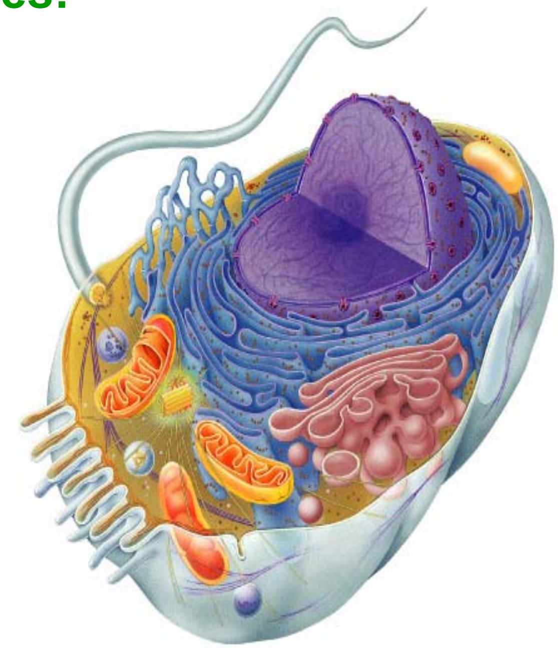
Biological membranes are essential components of all living cells.

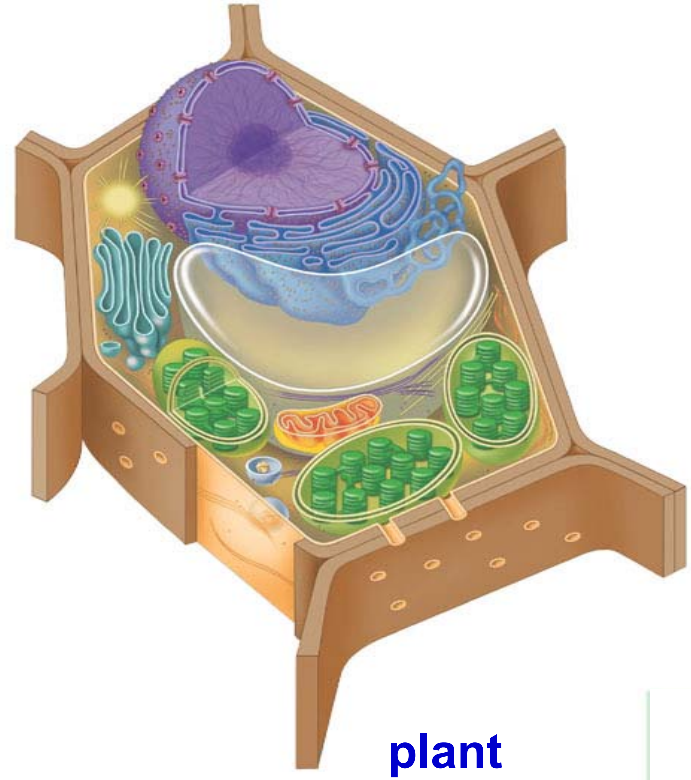
Illustrative examples:



prokaryotic cell



animal cell



plant cell

Two of their most important characteristics are their ability to:

1. physically and chemically separate aqueous spaces from each other, and
2. facilitate the transport of specific kinds of substances from the aqueous space on one side of the membrane to the aqueous space on the other side.

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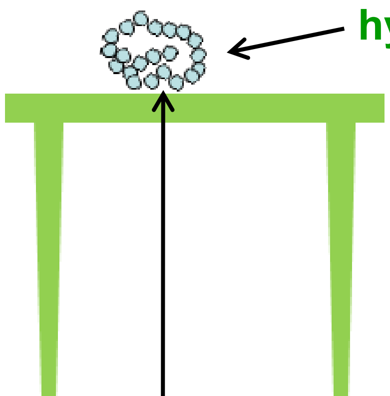
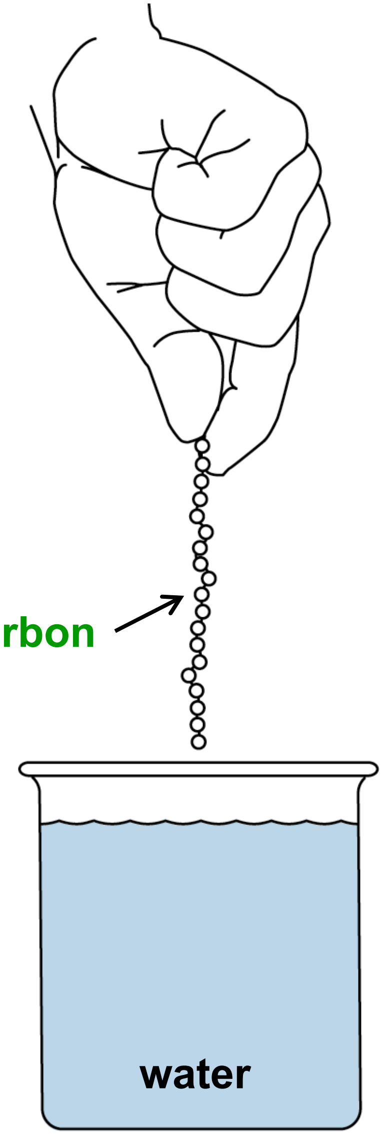
Hydrophobic bonding occurs when a nonpolar molecule or a nonpolar part of a molecule is forced into contact with water.

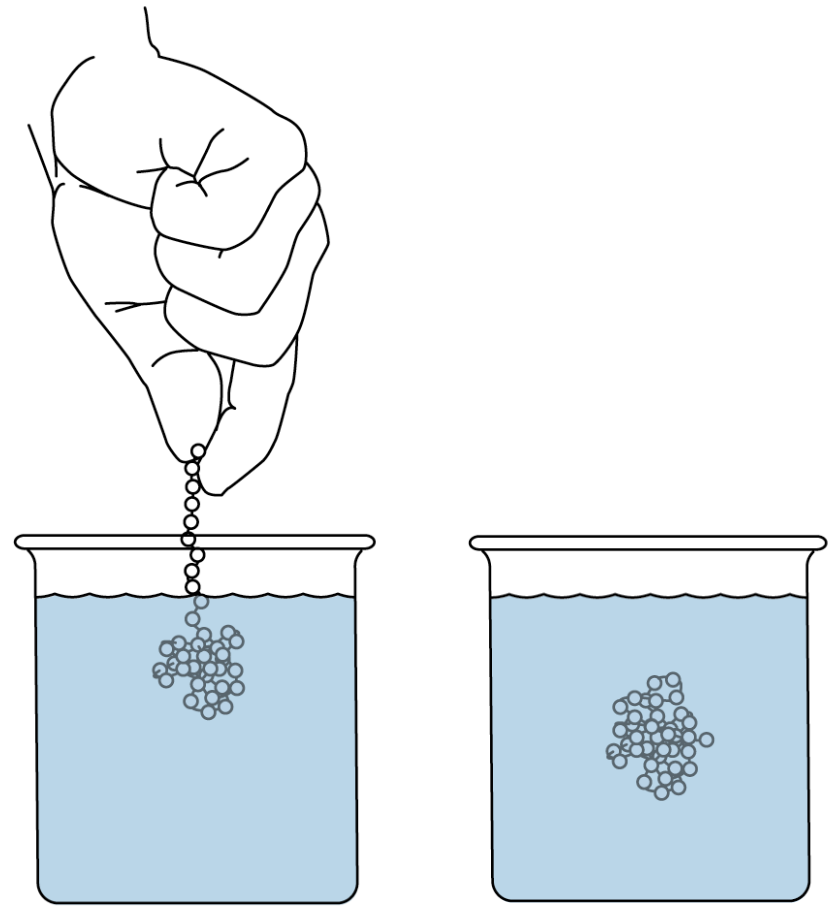
Van der Waals forces are weak interactions that occur between adjacent atoms, even atoms of nonpolar molecules



hydrocarbon

van der waals Interactions cause the molecule to fold around into a compact shape





hydrophobic bonding

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Hydrophobic bonding:

The conformation of a hydrophobic molecule or a hydrophobic portion of a molecule that comes into contact with an aqueous solution.

Consider a hydrophobic molecule and the water that surrounds it as a system. Then the lowest energy state of the system is a state that maximizes bonding among the water molecules. This especially includes hydrogen bonds among water molecules.

Maximum bonding among polar molecules occurs when hydrophobic portions of molecules are forced into compact conformations that minimize their surface exposure to water.

Note: hydrophobic bonding is not a kind of interaction between specific atoms in the hydrophobic part of a molecule. Rather, the hydrophobic part of the molecule conforms to the conformation imposed by the water molecules surrounding it.

Hydrophobic bonding can be a stronger a force in stabilizing a conformation of a hydrophobic molecule than a covalent bond.

The definition of hydrophobic bonding presented in your textbook is too superficial.

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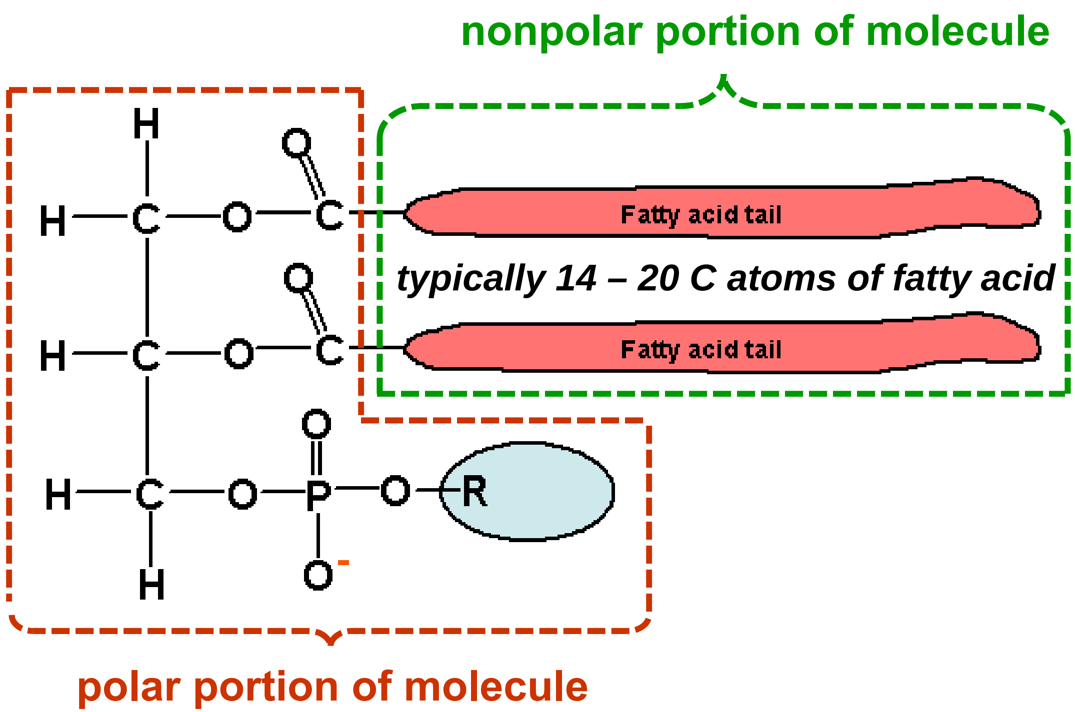
Structure of a Phospholipid



R is always very polar. It typically is non-charged or is positively charged.

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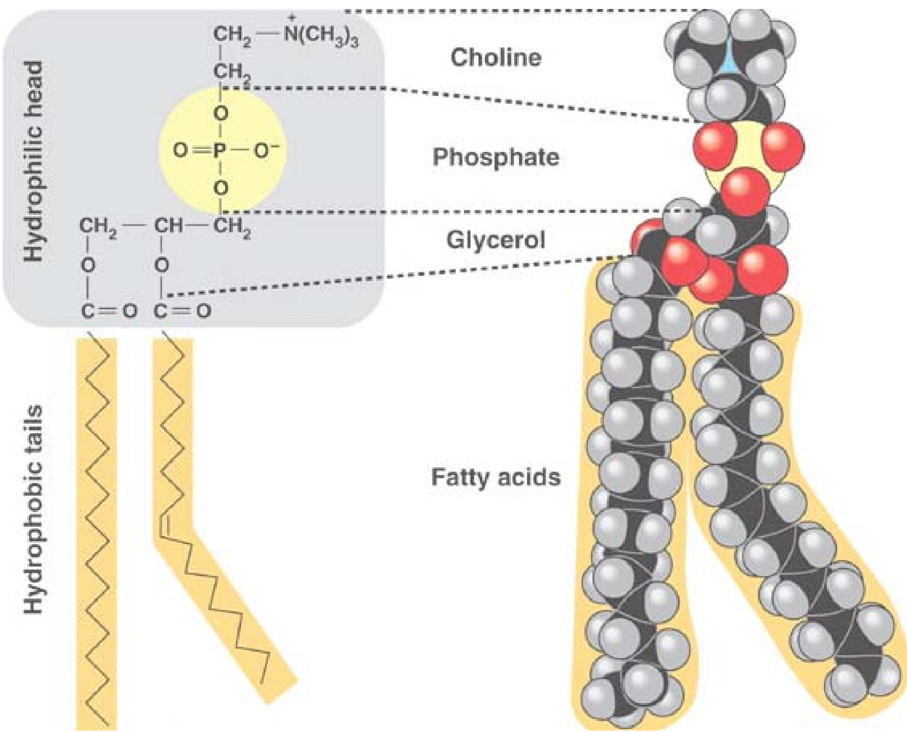
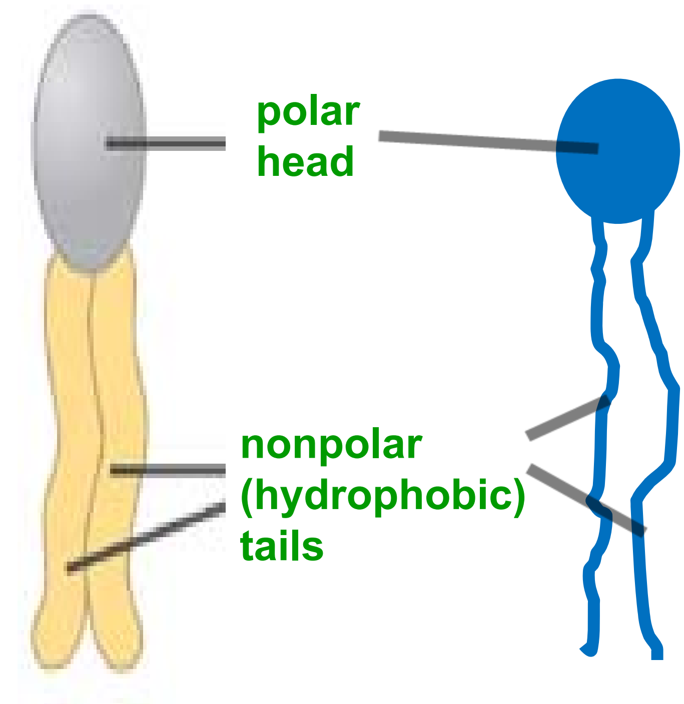
Structure of a phospholipid

From textbook Figure 5.13, p. 76



structural formula

space-filling formula



illustrations

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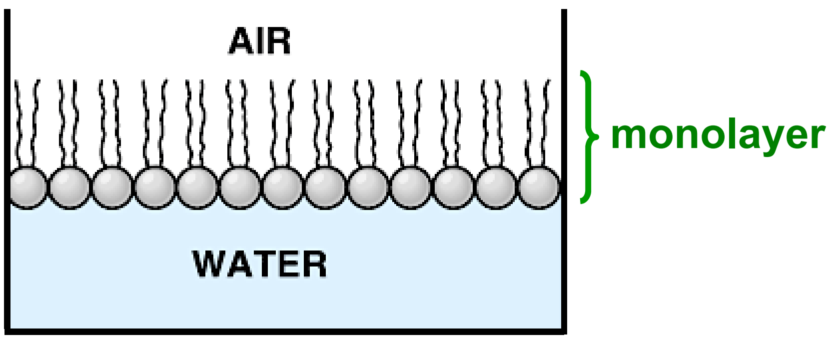
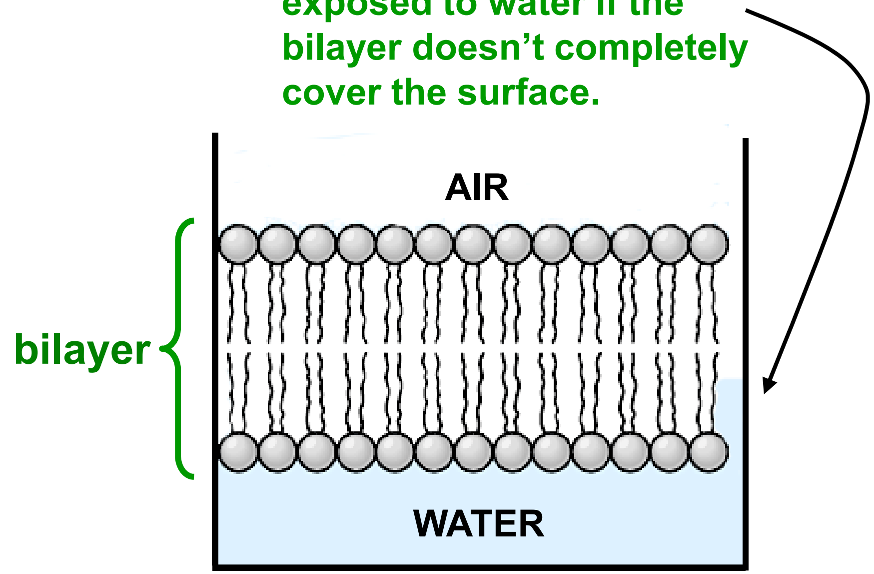
Organization of phospholipids in an aqueous solution

See textbook Fig 7.2, p. 126



monolayer of phospholipids floating on top of an aqueous solution. Their hydrophobic heads project above the solution.

Note: a hydrophobic area is exposed to water if the bilayer doesn't completely cover the surface.



bilayer of phospholipids
On the surface of an aqueous solution.

Most lipids are less dense that water.

Polar lipids form a monolayer on the surface when placed in an aqueous solution. They may form a floating bilayer when more polar lipids are added after the surface is completely covered with the monolayer.

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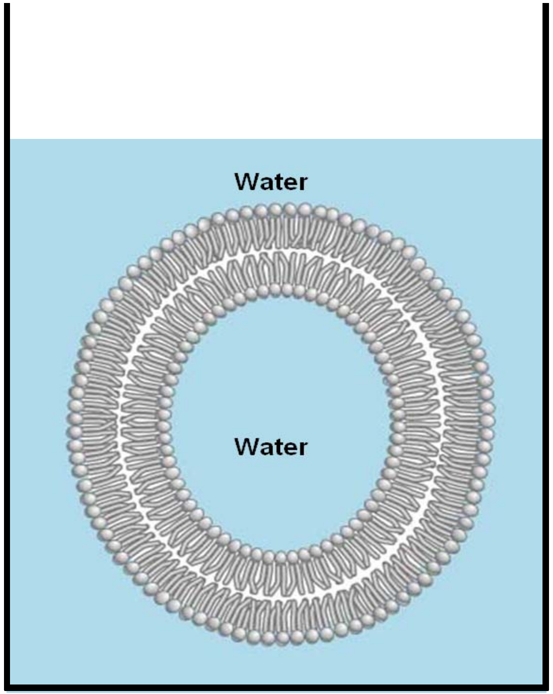
When immersed completely in an aqueous solution, a phospholipid bilayor may take the form of a hollow ball.



Cross-section of a hollow sphere made up exclusively of phospholipid molecules..

Note: No hydrophobic surface is exposed to water.

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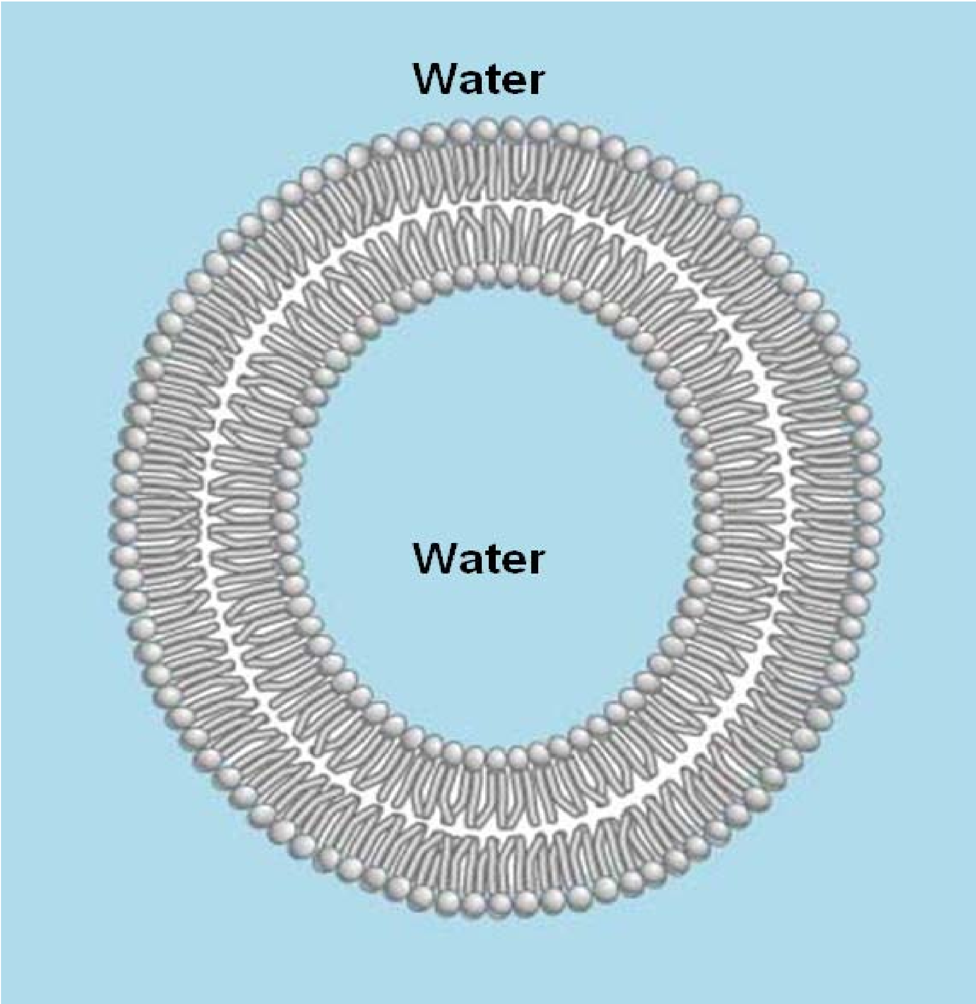
Illustration of a Cross-section of a Liposome, an Artificial Membrane-bounded Organelle

From: Freeman, Biological Science, Prentice Hall, Pub., 2002



A liposome is a hollow sphere constructed of a phospholipid bilayer. Liposomes vary greatly in diameter, but a typical diameter is 0.5 µm.

In aqueous solution, water completely surrounds the inner and outer surfaces of the liposome, but water molecules do not easily pass through the bilayer.

The chain lengths and extent of unsaturation of the hydrophobic tails of phospholipids used to construct a liposome may vary. Also the size, shape and electrical charge of the phospholipid head groups may vary. Properties of liposomes are greatly influenced by the nature of the fatty acid tails and polar head groups of their phospholipids.

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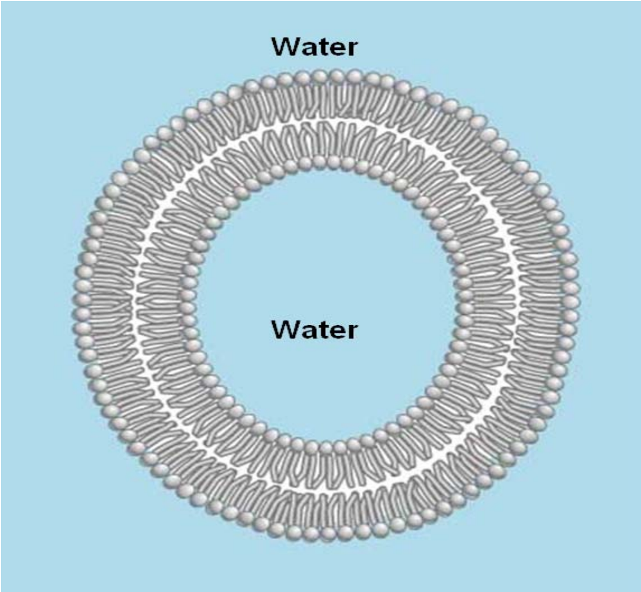
The basic building units of biological membranes are phospholipids that are built into a bilayer structure as in liposomes.



More than half of the molecules in typical biological membranes are phospholipids.

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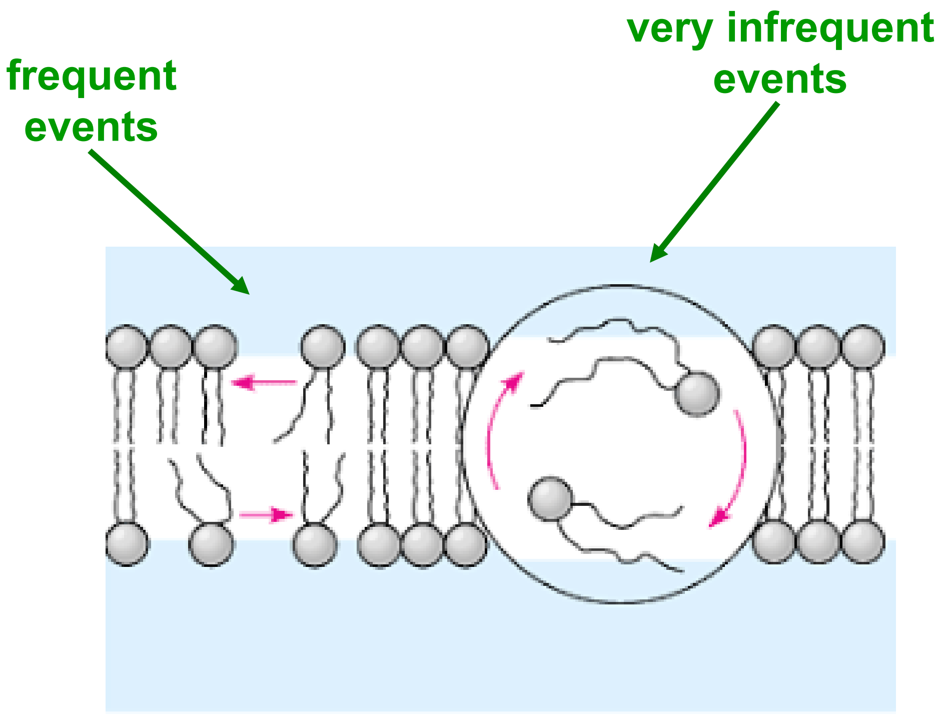
Pairs of Individual phospholipids may freely change places within a monolayer of a lipid bilayer, but phospholipids almost never flip from one layer to the other layer of a bilayer membrane.



Note: The specific phospholipids on the two sides of the bilayer may be very different since the phospholipids do not flip-flop randomly across bilayer.

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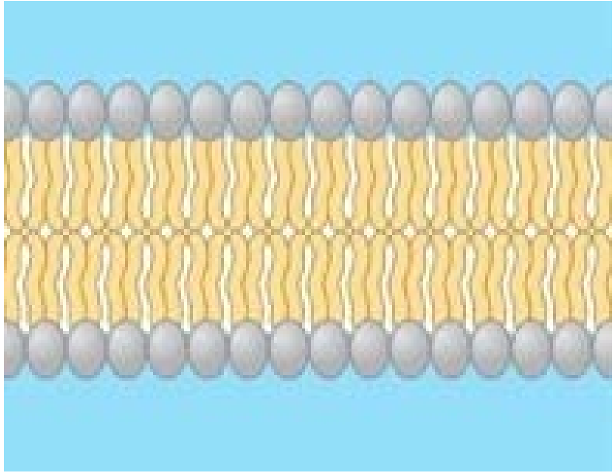
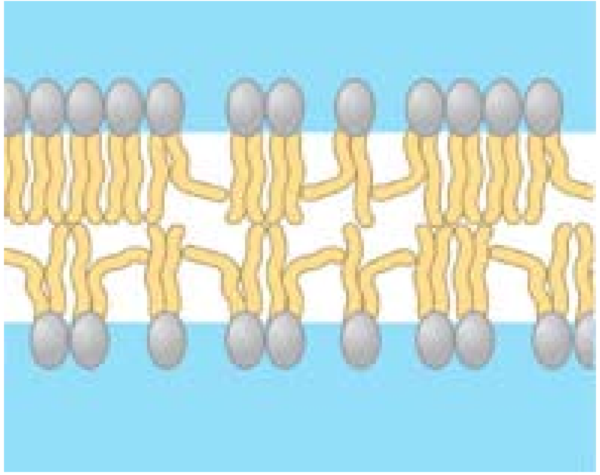
Bilayer membranes may be somewhat solidified (in a gel state) or somewhat liquid-like (in a fluid state) within the bilayer. The nature of the phospholipids that make up the bilayer greatly influence the fluidity of the membrane.



Phospholipids with longer-chain fatty acids and with saturated fatty acids make the membrane more gel-like.



Phospholipids with shorter-chain fatty acids and with unsaturated fatty acids make the membrane more fluid.

Recall that unsaturated fatty acids contain one of more carbon-carbon double bond.

For a bilayer membrane of any given phospholipid composition, raising the temperature makes the membrane more fluid, while lowering the temperature makes the membrane less fluid.

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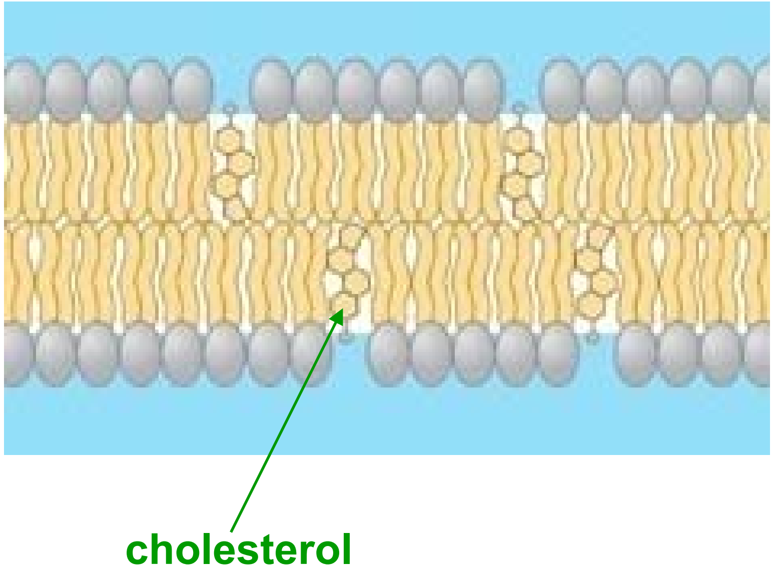
Other lipids besides phospholipids, such as cholesterol, may be inserted into the interior of a bilayer membrane. They influence the fluidity and other properties of the membrane.



Cholesterol, a steroid found in animal cellular membranes, moderates the effects of temperature on membranes by reducing fluidity at higher temperatures while retarding formation of the gel state at lower temperatures.

(For explanation see textbook Fig. 7.5).

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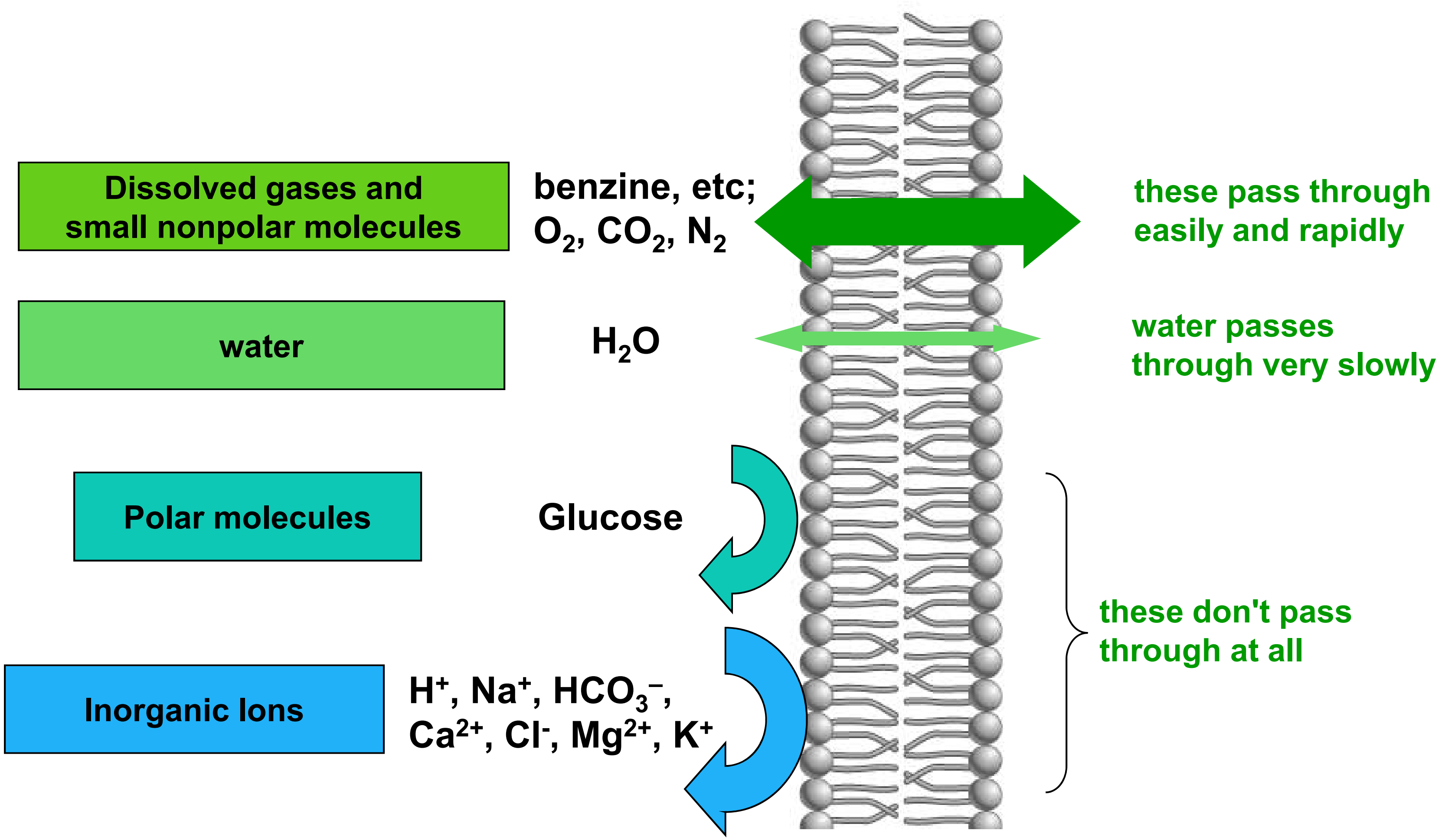
Some kinds of chemical substances pass through lipid bilayer membranes very effectively while other kinds hardly pass through at all.



Modified from: Freeman, Biological Science, Prentice Hall, Pub. 2002

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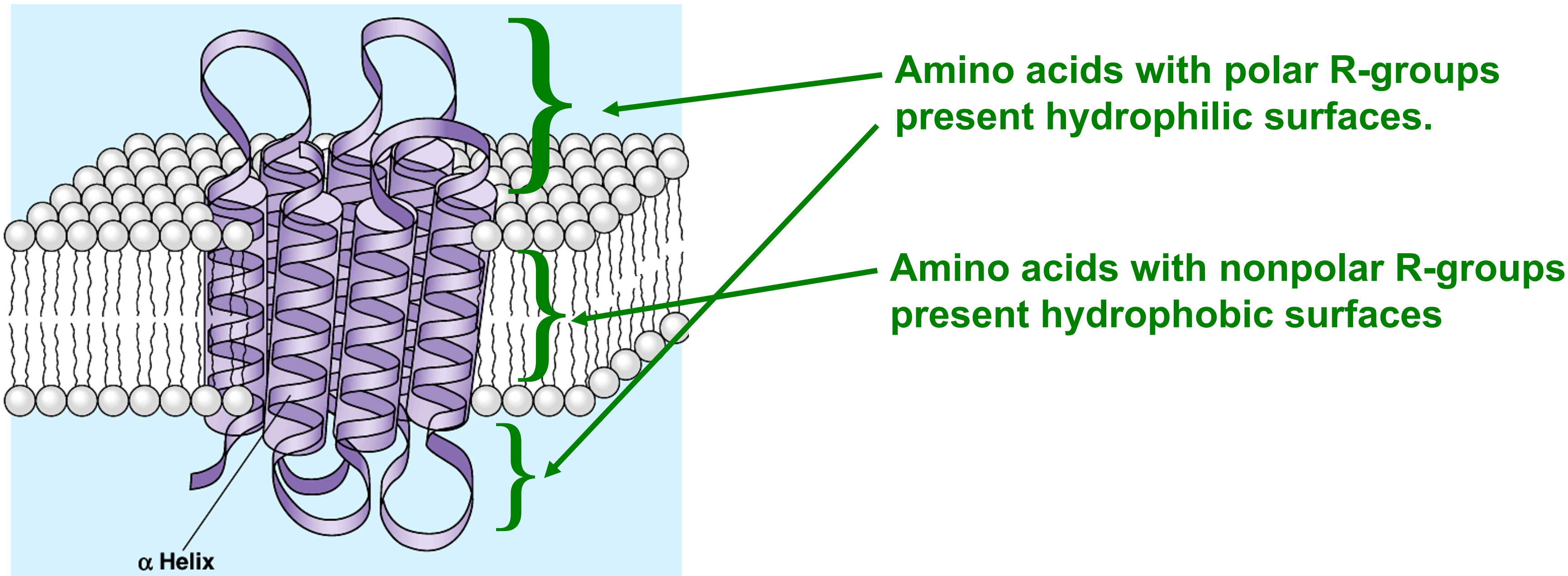
The structure of a transmembrane (integral) protein shown as a ribbon diagram

From textbook Fig. 7.8, p. 129



Transmembrane proteins pass through the hydrophobic interior of a membrane as α-helices. Their primary structure includes stretches of nonpolar amino acids whose R-groups associate with the tails of bilayer phospholipid molecules by hydrophobic bonding. Most transmembrane proteins have several stretches of transmembrane alpha helices that cluster together.

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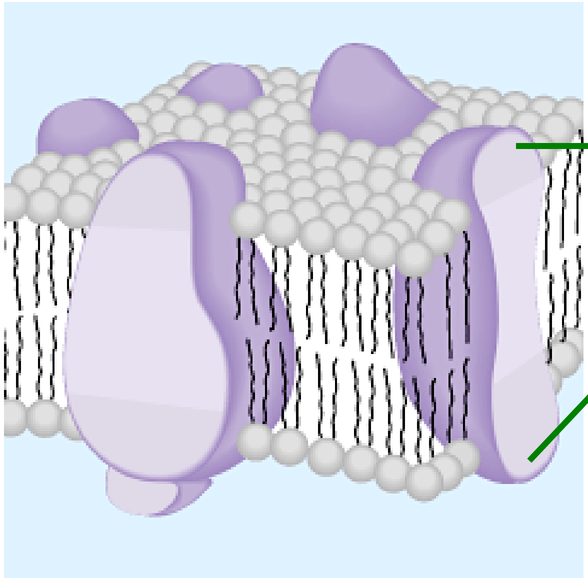
Illustration of Transmembrane Proteins of a Biological Membrane



The projections of transmembrane proteins from the surfaces of a membrane gives the membrane a mosaic appearance when looking down onto a surface.

Phospholipids and transmembrane proteins constitute the core structure of biological membranes. The core of typical biological membranes contains approximately 70% lipid and 30% transmembrane protein.

Because biological membranes are fluid at normal temperatures and have a pattern of transmembrane proteins projecting from the membrane surfaces, biological membranes are often called fluid mosaic structures.

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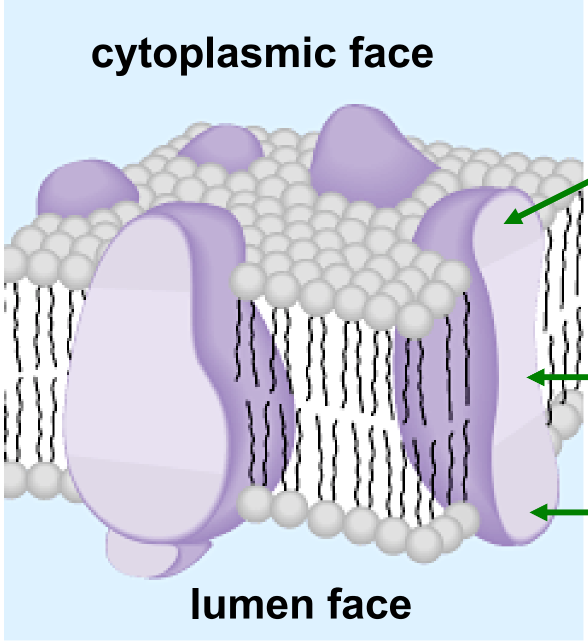
Consider the two faces of the plasma membrane or a membrane that surrounds an organelle.



This hydrophilic end of the protein may include a catalytic domain, thereby serving as an enzyme.

Hydrophobic interior of the protein

This hydrophilic end of the protein may include a binding domain for another protein, thereby anchoring the second protein to the surface of the membrane.

Each different kind of membrane in a cell contains its own unique kinds of transmembrane proteins.

Each kind of transmembrane protein is always oriented in only one direction.

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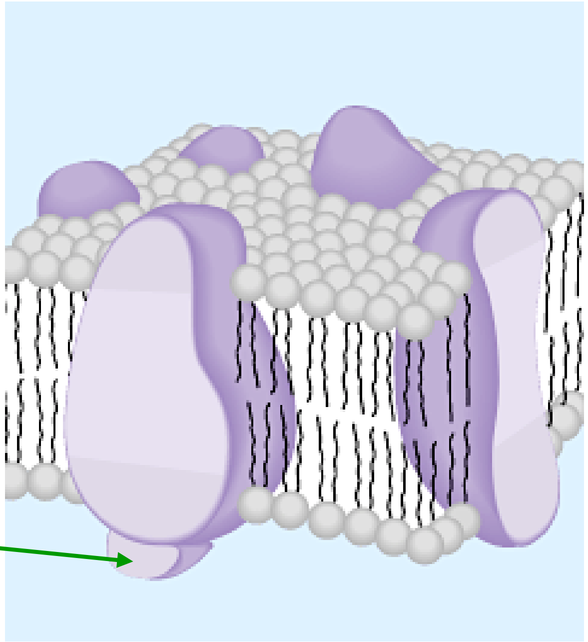
Proteins that do not pass through a biological membrane, but that are bound tightly to a surface of the membrane, are considered as components of the membrane. They have various domains that serve a variety functions, extending the range of functions of the membrane.

Different kinds of proteins are held together by the same kinds bonds that are used to maintain the tert6iary and quaternary structures of individual proteins.



peripheral membrane protein

Peripheral membrane proteins may be bound to a projecting surface of a transmembrane protein or to phospholipid head groups.

In general, transmembrane proteins are not water soluble (are hydrophobic), while peripheral membrane proteins are water soluble (are hydrophilic).

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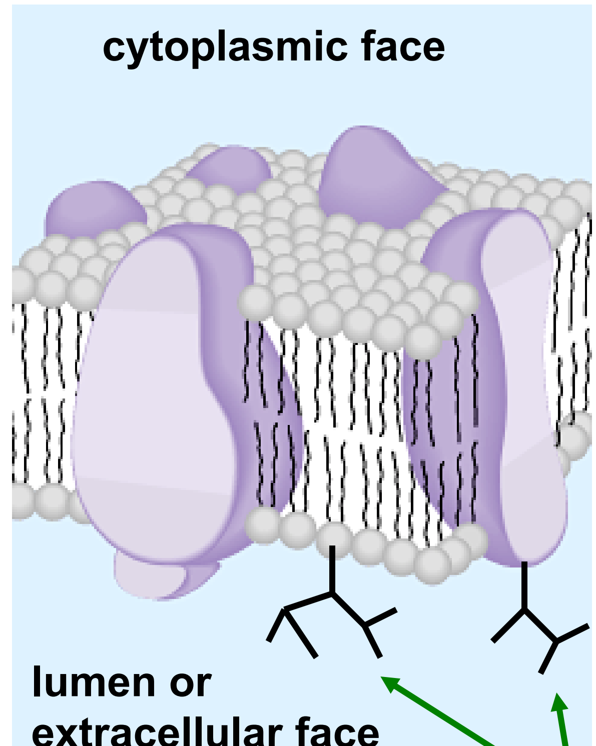
Oligosaccharides are components of most eukaryotic cellular membranes.

Oligosaccharides are attached to lumen face of membrane-bounded organelles and to the extracellular face of the plasma membrane of eukaryotic cells, but not to the cytoplasmic face.

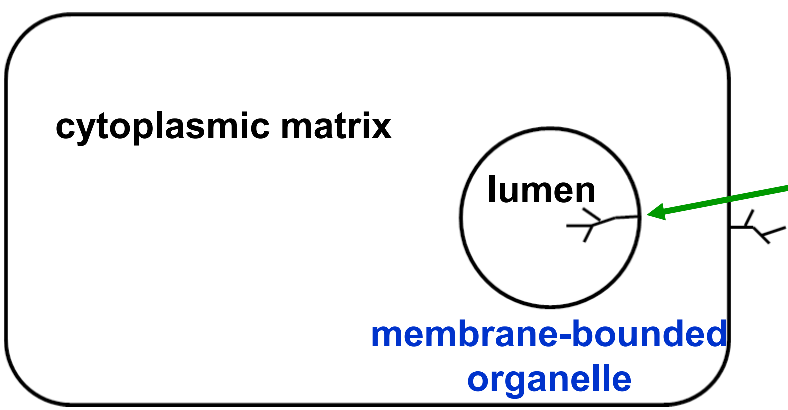
Oligosaccharides are covalently bonded to transmembrane proteins and to the polar head-groups of phospholipids.

Each different kind of membrane has its own unique complement of attached oligosaccharides.

biological membrane



oligosaccharides



eukaryotic cell

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