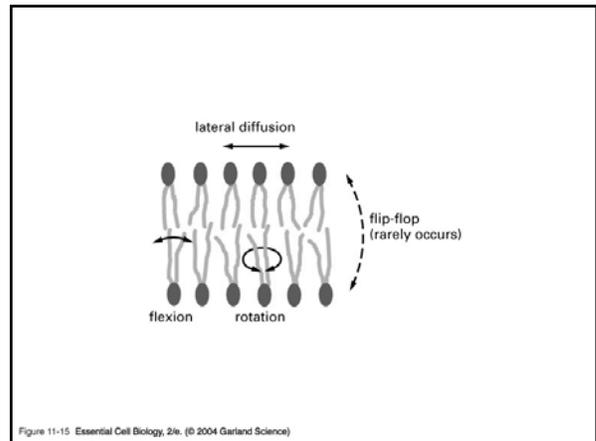


### The Lipid Bilayer Is a Two-Dimensional Fluid

The aqueous environment inside and outside a cell prevents membrane lipids from escaping from bilayer, but nothing stops these molecules from moving about and changing places with one another within the plane of bilayer. The membrane behaves as two dimensional fluids, which is crucial for membrane functions.

#### Phospholipids can move within the plane of the membrane

The drawing shows the types of movement possible for phospholipid molecules in a lipid bilayer.

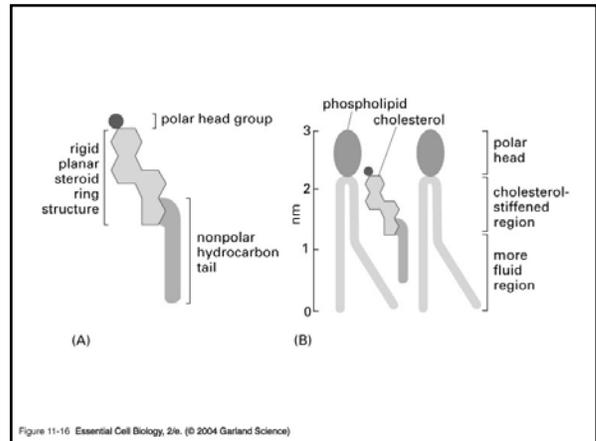


### The Fluidity of a Lipid Bilayer Depends on Its Composition

The fluidity of a cell membrane is important for membrane function and has to be maintained within certain limit. Just how fluid a lipid bilayer is at a given temperature depends on its phospholipid composition, in particular, on the nature of hydrocarbons tails. **The closer and more regular packing of the tails, the more viscous and less fluid the bilayer will be.** Two major properties of hydrocarbon tails affect how tightly they pack in bilayer.

1. The length of tails: Short tails have tendency to increase fluidity
2. Degree of unsaturation of tails: Lipid bilayer that contain a large proportion of unsaturated hydrocarbon tails are more fluid than those with lower proportions.

In animal cells, membrane fluidity is modulated by the inclusion of the sterol cholesterol. These short, rigid molecules are present in especially large amounts in the plasma membrane, where they fill space between neighboring phospholipids molecules left by kinks in their unsaturated hydrocarbon tails.

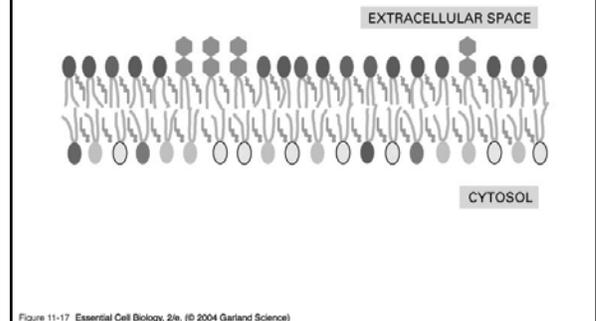


Fluidity is important for many reasons:

1. it allows membrane proteins rapidly in the plane of bilayer.
2. It permits membrane lipids and proteins to diffuse from sites where they are inserted into bilayer after their synthesis.
3. It enables membranes to fuse with one another and mix their molecules.
4. It ensures that membrane molecules are distributed evenly between daughter cell when a cell divides.

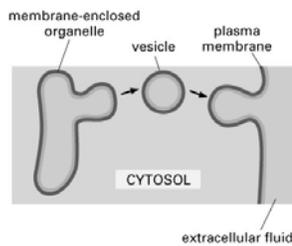
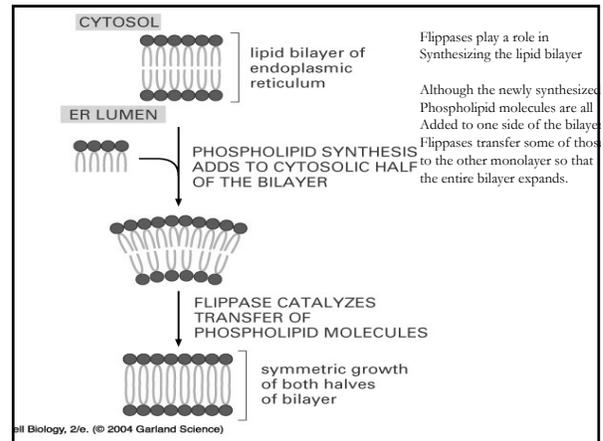
### The Lipid Bilayer Is asymmetrical

Cell membranes are generally asymmetrical: they present a very different face to the interior of the cell or organelle than they show to the exterior. The two halves of the bilayer often include strikingly different selections of phospholipids and glycolipids.



### Synthesis of Lipid Bilayer in Eukaryotic cell

New phospholipids molecules are synthesized by enzymes that are bound the part of ER membrane that faces the cytosol; these enzymes use as substrates fatty acids available in the cytosolic half of the bilayer and they release the newly made phospholipids into same monolayer



Membrane vesicles are generated by budding and fusing

Figure 11-19 Essential Cell Biology, 2/e. (© 2004 Garland Science)

### Membrane Proteins

Membrane proteins not only transport particular nutrients, metabolites, and ions across the lipid bilayer: they serve many other functions.

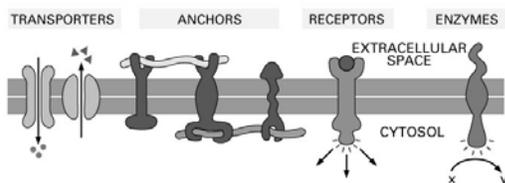


Figure 11-20 Essential Cell Biology, 2/e. (© 2004 Garland Science)

### Some Examples of Plasma Membrane Proteins and Their Functions

Functional Class	Protein Example	Specific Function
Transporters	Na <sup>+</sup> pump	actively pumps Na <sup>+</sup> out of cells and K <sup>+</sup> in
Linkers	integrins	link intracellular actin filaments to extracellular matrix proteins
Receptors	platelet-derived growth factor (PDGF) receptor	binds extracellular PDGF and, as a consequence, generates intracellular signals that cause the cell to grow and divide
Enzymes	adenylate cyclase	catalyzes the production of intracellular cyclic AMP in response to extracellular signals

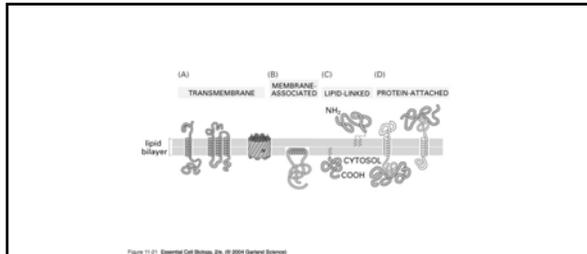
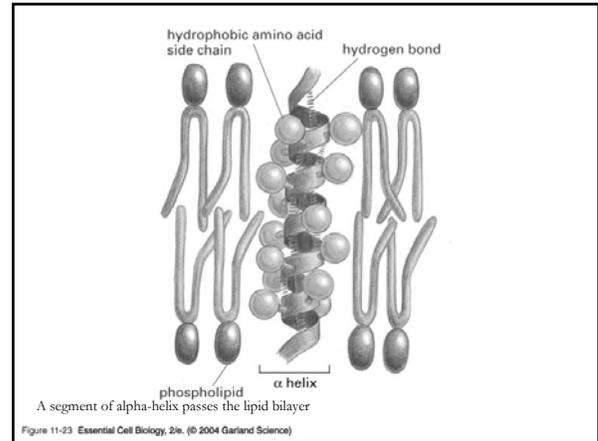


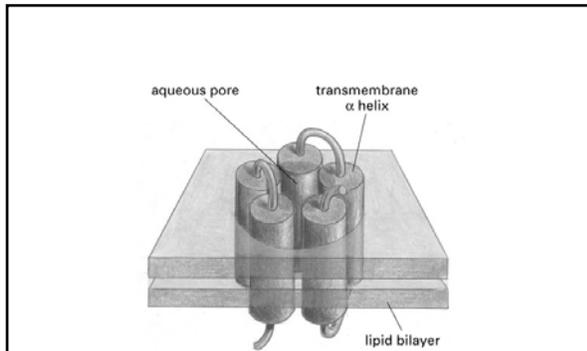
Figure 11-21 Essential Cell Biology, 2/e. (© 2004 Garland Science)

Membrane proteins can associate with the lipid bilayer in several different ways. (A) Transmembrane proteins can extend across the bilayer as a single  $\alpha$ -helix, or as multiple  $\alpha$  helices, or as a rolled-up  $\beta$  sheet (called a  $\beta$  barrel). (B) Some membrane proteins are anchored to the cytosolic surface of the bilayer by an amphipathic  $\alpha$  helix. (C) Others are attached to either side of the bilayer solely by a covalent attachment to a lipid molecule (red zigzag lines). (D) Finally, many proteins are attached to the membrane only by relatively weak, noncovalent interactions with other membrane proteins.



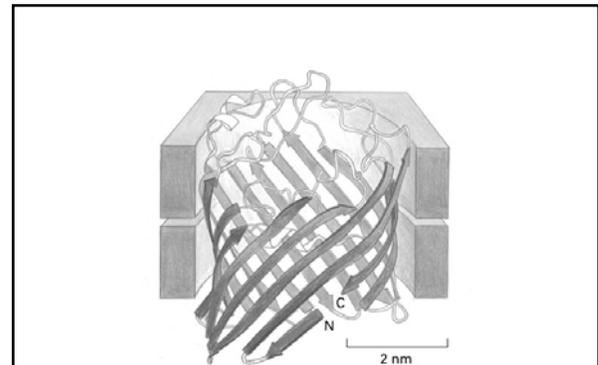
A segment of alpha-helix passes the lipid bilayer

Figure 11-23 Essential Cell Biology, 2/e. (© 2004 Garland Science)



A transmembrane hydrophilic pore can be formed by multiple alpha-helices

Figure 11-24 Essential Cell Biology, 2/e. (© 2004 Garland Science)



Porin molecules form water-filled channels in the outer membrane of the bacterium.

Figure 11-25 Essential Cell Biology, 2/e. (© 2004 Garland Science)

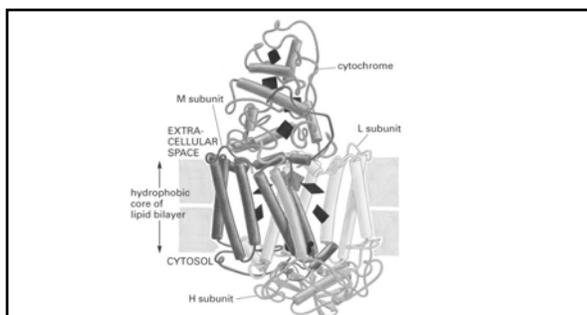


Figure 11-29 Essential Cell Biology, 2/e. (© 2004 Garland Science)

The photosynthetic reaction center of the bacterium *Rhodospseudomonas viridis* captures energy from sunlight

### The Plasma Membrane Is Reinforced by the Cell Cortex

A cell membrane by itself is extremely thin and fragile. In particular, the shape of the cell and mechanical properties of plasma membrane are determined by a meshwork of fibrous proteins, called cell cortex. It is attached to the cytosolic surface of the membrane.

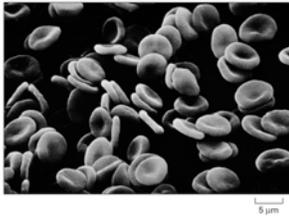


Figure 11-30 Essential Cell Biology, 6th (© 2004 Garland Science)

Red blood cells have a distinctive flattened shape, and they lack nucleus and other organelles

**The spectrin-based cell cortex of human red blood cells.**

Spectrin molecules (together with a smaller number of actin molecules) form a meshwork that is linked to the plasma membrane by the binding of at least two types of attachment proteins (shown in *blue* and *yellow*) to two kinds of transmembrane proteins (shown in *brown* and *green*). The electron micrograph in (B) shows the spectrin meshwork on the cytoplasmic side of a red blood cell membrane. The meshwork has been stretched out to show the details

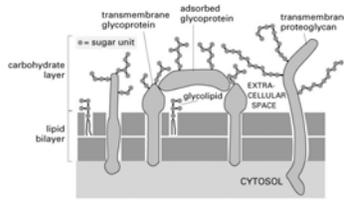
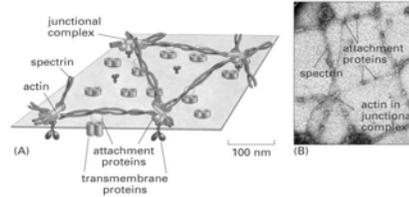


Figure 11-32 Essential Cell Biology, 6th (© 2004 Garland Science)

**The Cell Surface Is Coated with Carbohydrate**

In eukaryotic cells many of the lipids in the outer layer of the plasma membrane have sugars covalently attached to them. The same is true for most of the proteins in the plasma membrane. The great majority of these proteins have short chains of sugars, called oligosaccharide. Proteins are linked to these oligosaccharide called glycoproteins. Some membrane proteins are linked to long oligosaccharide called proteoglycans.

**Functions of carbohydrates on plasma membrane:**

- The carbohydrate layer helps to protect cell surface from mechanical and chemical Damage
- As carbohydrate layer adsorb water, they give slimy surface. This help cells like blood cells move squeeze in through narrow blood vessel.
- It is important for cell-cell recognition.

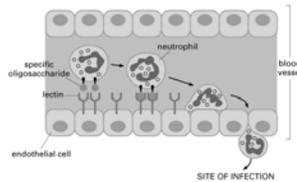


Figure 11-33 Essential Cell Biology, 6th (© 2004 Garland Science)

The recognition of the cell surface carbohydrate on the neutrophils is the first stage of their migration out of the blood at sites of infection.

**Chapter 12  
Membrane Transport (Page 389 420)**

Cells live and grow by exchanging molecules with their environment, and the plasma membrane acts as a barrier that controls the transit of molecules into and out of the cell. Because interior of the lipid bilayer is hydrophobic, the plasma membrane tends to block the passage of almost all water soluble molecules.

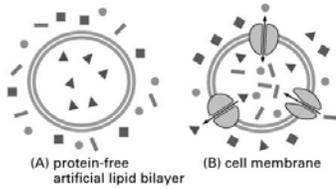


Figure 12-1 Essential Cell Biology, 2/e, (© 2004 Garland Science)

### Principles of Membrane Transport

#### The Ion Concentrations Inside a Cell Are Very Different from Those Outside

Living cells maintain an internal ion composition that is very different from the ion composition in the fluid around them. These differences are crucial for a cell's survival and functions.

Table 12-1 Comparison of Ion Concentrations Inside and Outside a Typical Mammalian Cell

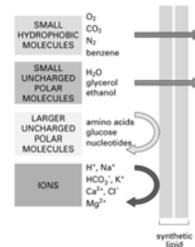
Component	Intracellular Concentration (mM)	Extracellular Concentration (mM)
<b>Cations</b>		
Na <sup>+</sup>	5-15	145
K <sup>+</sup>	140	5
Mg <sup>2+</sup> **	0.5	1-2
Ca <sup>2+</sup> **	10 <sup>-7</sup>	1-2
H <sup>+</sup>	7 x 10 <sup>-5</sup> (10 <sup>-7.2</sup> M or pH 7.2)	4 x 10 <sup>-5</sup> (10 <sup>-7.4</sup> M or pH 7.4)
<b>Anions</b>		
Cl <sup>-</sup>	5-15	110
Fixed anions**	high	0

\*The concentrations of Ca<sup>2+</sup> and Mg<sup>2+</sup> given are for the free ions in the cytosol. There is a total of about 20 mM Mg<sup>2+</sup> and 1-2 mM Ca<sup>2+</sup> in cells, but this is mostly bound to proteins and other substances and thus cannot leave the cell. Much of the total cell Ca<sup>2+</sup> is stored within various organelles.  
 \*\*The fixed anions are the negatively charged small and large organic molecules that are trapped inside the cell, being unable to cross the plasma membrane.

© 2004 GARLAND PUBLISHING

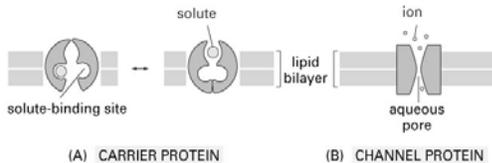
#### Lipid Bilayers Are Impermeable to Solutes and Ions

The hydrophobic interior of the lipid bilayer creates a barrier to the passage of the most hydrophilic molecules, including ions. They are as reluctant to enter a fatty acids environment as hydrophilic environment. Cell membranes allow water and small nonpolar molecules to permeate by simple diffusion. But for the cells to take up nutrients and release waste product, membranes must also allow the passage of many other molecules, such as ions, sugars, amino acids, nucleotides, and many other cell metabolites.



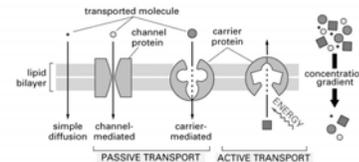
#### Membrane Transport Proteins Fall into Two Class: Carriers and Channels

Membrane transport proteins can be divided into two main classes: carriers and channels. The basic difference between carrier proteins and channel proteins is the way they discriminate between solutes, transporting some solutes but not the others. A channel protein discriminates mainly on the basis of size and electrical charge: A carrier protein allows the passage only to solute molecules that fit into binding site on the protein.



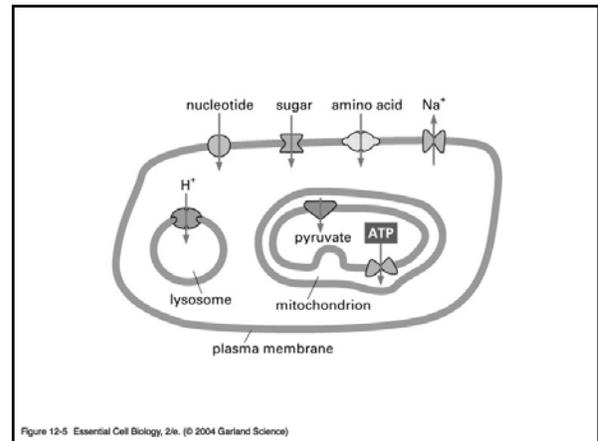
#### Solutes Cross Membranes by Passive or Active Transport

The direction of transport depends, in large part, on the relative concentrations of the solute. Molecules will flow from the region of high concentration to a region of low concentrations spontaneously. Such movements are called passive transport, because they need no other driving force. To move a solute against its concentrations gradient, however, a transport protein must do work: it has to drive the "uphill" flow by coupling it to some other process that provides energy. Transmembrane solute movement driven in this way is named as active transport. It is carried out only by special types of carrier proteins that can harness some energy source to transport process



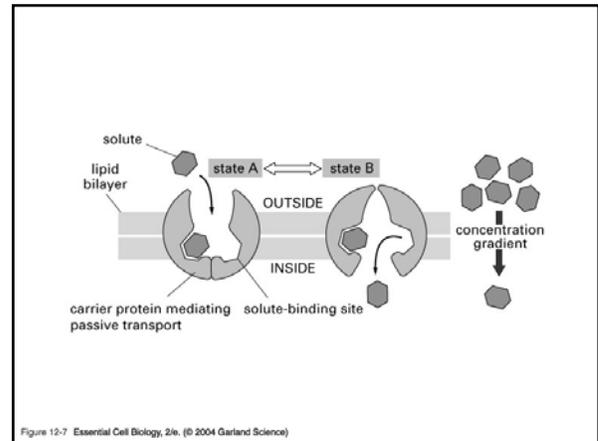
### Carrier Proteins and Their Functions

Carrier proteins are required for the transport of almost all small organic molecules across cell membrane, with the exception of fat soluble molecules. Each carrier protein is highly selective, often transporting just one type of molecule. Both Plasma membrane and organelles membranes have different sets of carrier proteins to meet their requirements.



### Concentrations Gradient and Electrical Forces Drive Passive Transport

A simple example of a carrier protein that mediates passive transport is the glucose carrier found in the plasma membrane of mammalian liver cells. When sugar is plentiful outside of the liver cell (after a meal), glucose molecules will bind to externally displayed binding site of carrier. When the protein switches conformation, it carries molecule inward and release glucose molecule in cytosol.



For electrically charged molecules, either small organic ions and inorganic ions, and additional forces come into play.

Most cell membranes have voltage across them, a difference in the electrical potential on each side of the membrane, referred as **membrane potential**.

This difference in potential exerts a force on any molecule that carries an electrical charge. The net force driving a charged molecule across the membrane is therefore a composite of two forces, one due to the concentration gradient and the other due to the voltage across the membrane. This net driving force called the **electrochemical gradient**.

