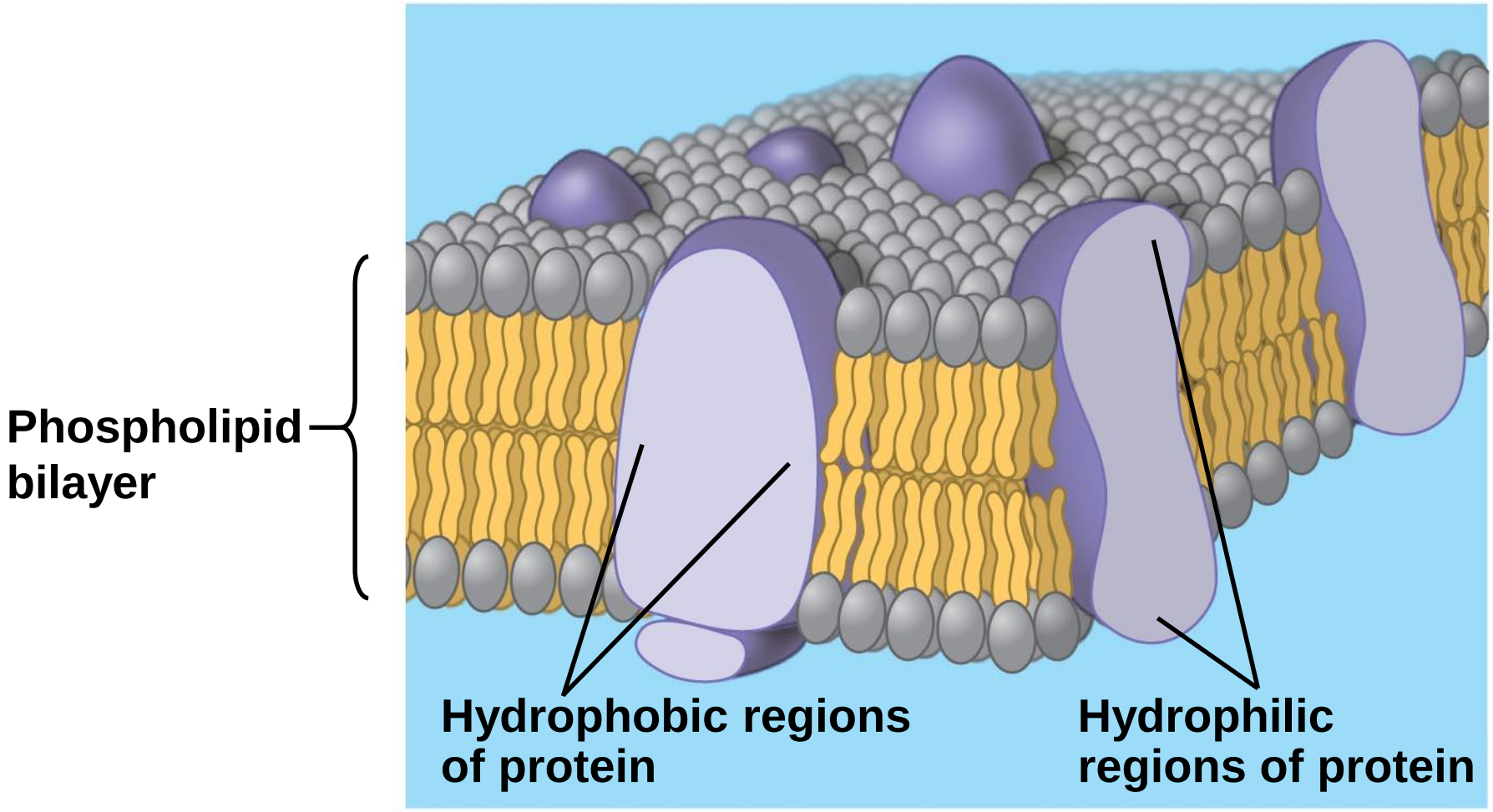
Membrane Structure and Function

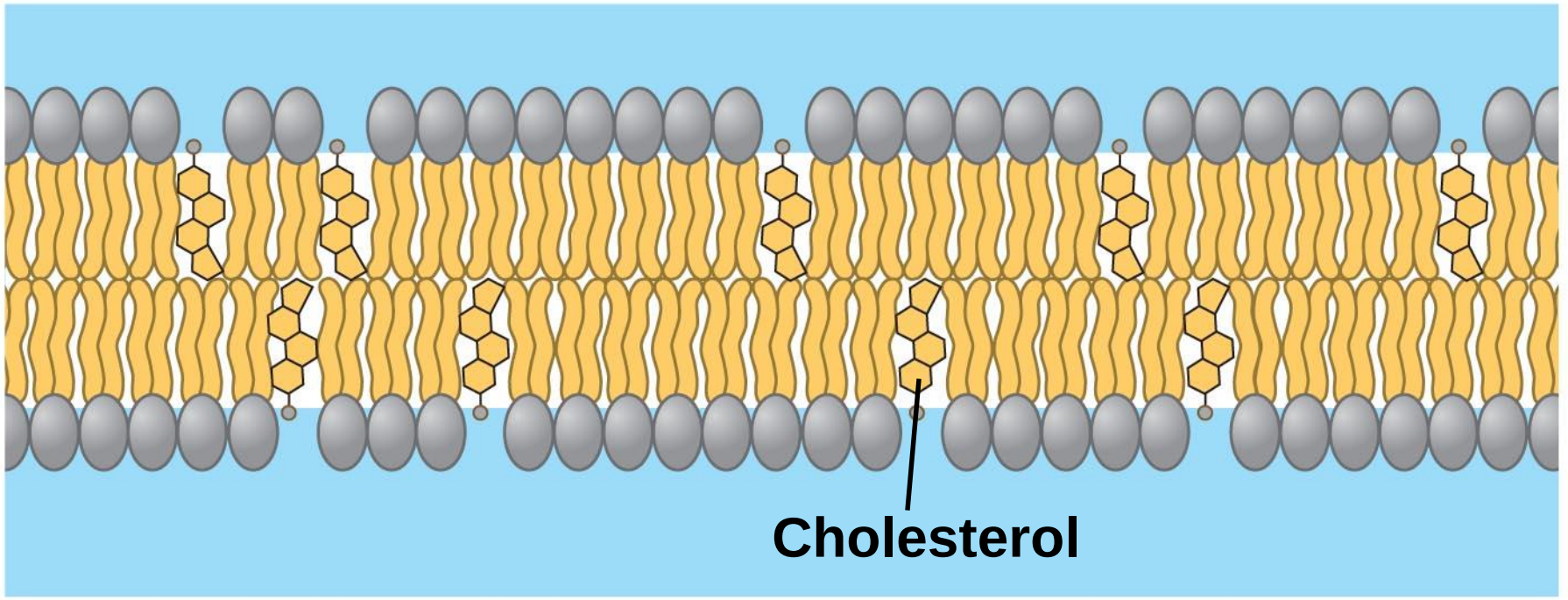
Fig. 7-3



Negative Feedback in a cell membrane

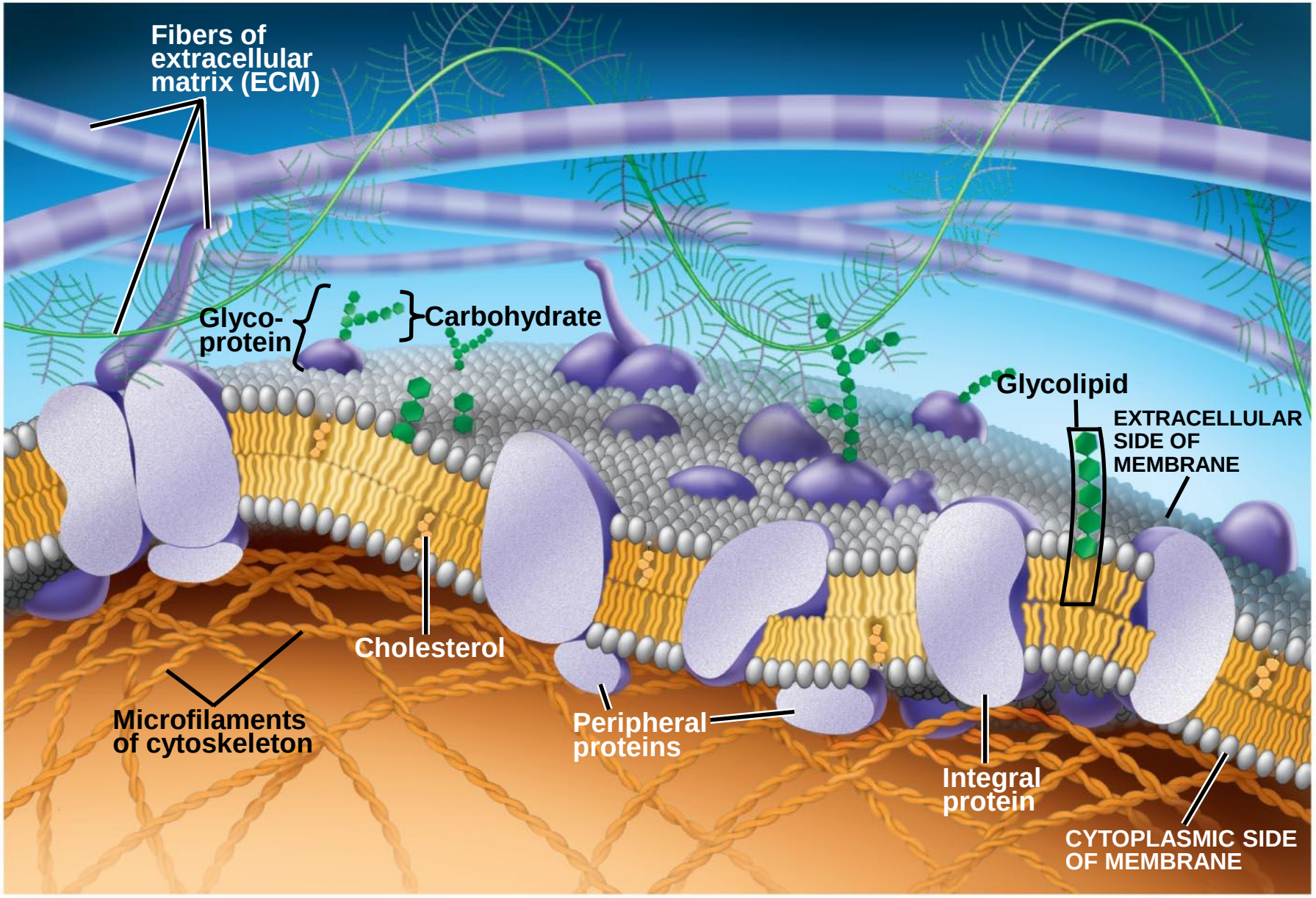
- The steroid cholesterol has different effects on membrane fluidity at different temperatures
- At warm temperatures (such as 37°C), cholesterol restrains movement of phospholipids
- At cool temperatures, it maintains fluidity by preventing tight packing

Fig. 7-5c



(c) Cholesterol within the animal cell membrane

Structure of Cell Membrane



Membrane Proteins and Their Functions

- **Peripheral proteins** are bound to the surface of the membrane
- **Integral proteins** penetrate the hydrophobic core

Selective permeability of cell membrane

- A cell must exchange materials with its surroundings, a process controlled by the plasma membrane
- Plasma membranes are selectively permeable, regulating the cell's molecular traffic

The Permeability of the Lipid Bilayer

- **Hydrophobic (nonpolar) molecules**, such as hydrocarbons, can dissolve in the lipid bilayer and pass through the membrane rapidly
- **Polar molecules**, such as sugars and water, do not cross the membrane on their own

Transport Proteins

- **Transport proteins** allow passage of hydrophilic substances across the membrane
- Some transport proteins, called channel proteins, have a hydrophilic channel that certain molecules or ions can use as a tunnel
- Channel proteins called **aquaporins** facilitate the passage of water

- Other transport proteins, called ***carrier proteins***, bind to molecules and change shape to shuttle them across the membrane

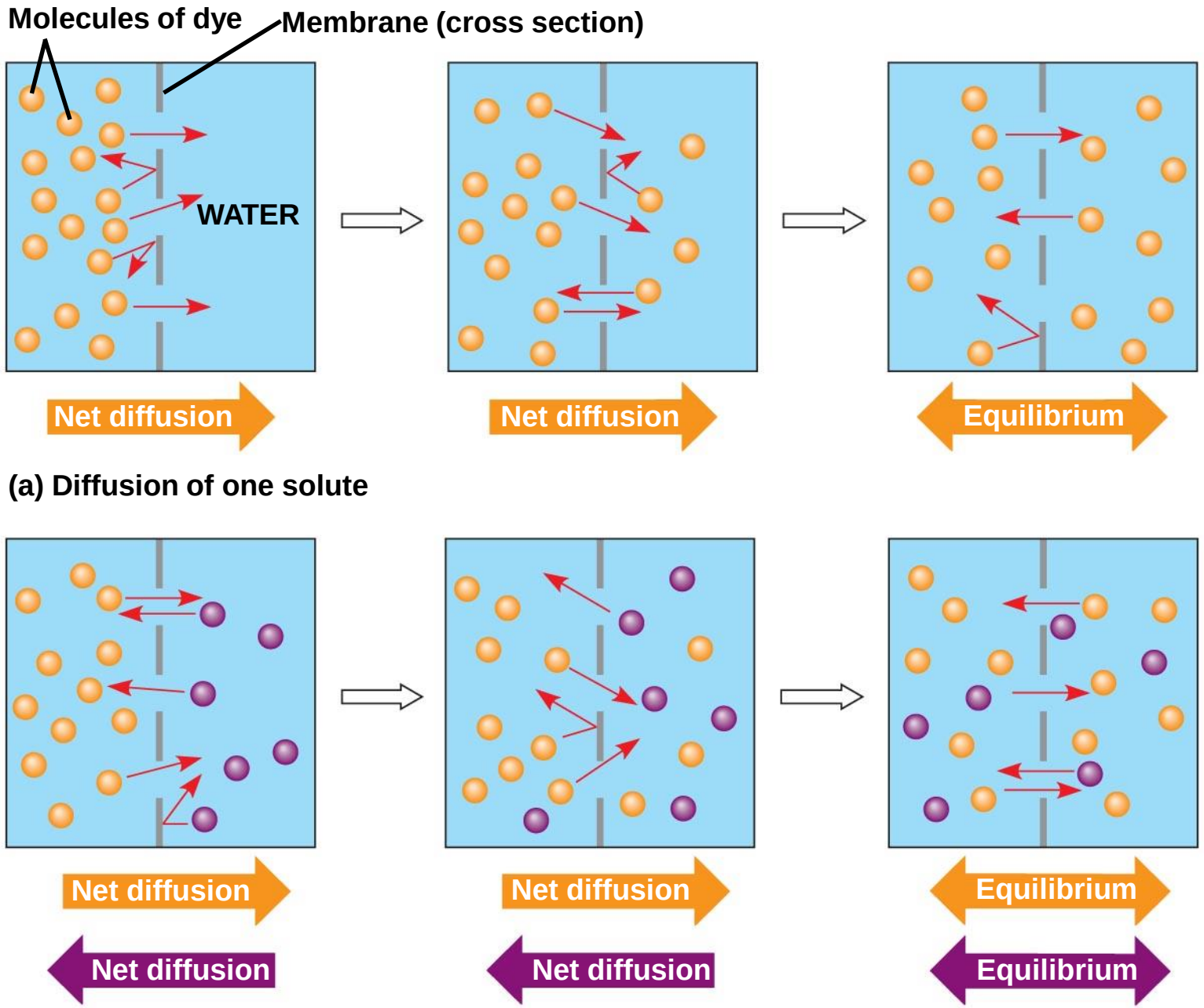
- **A transport protein is specific for the substance it moves**

Passive transport is diffusion of a substance across a membrane with no energy investment

- **Diffusion** is the tendency for molecules to spread out evenly into the available space

- The diffusion of a substance across a biological membrane is **passive transport** because it requires no energy from the cell to make it happen

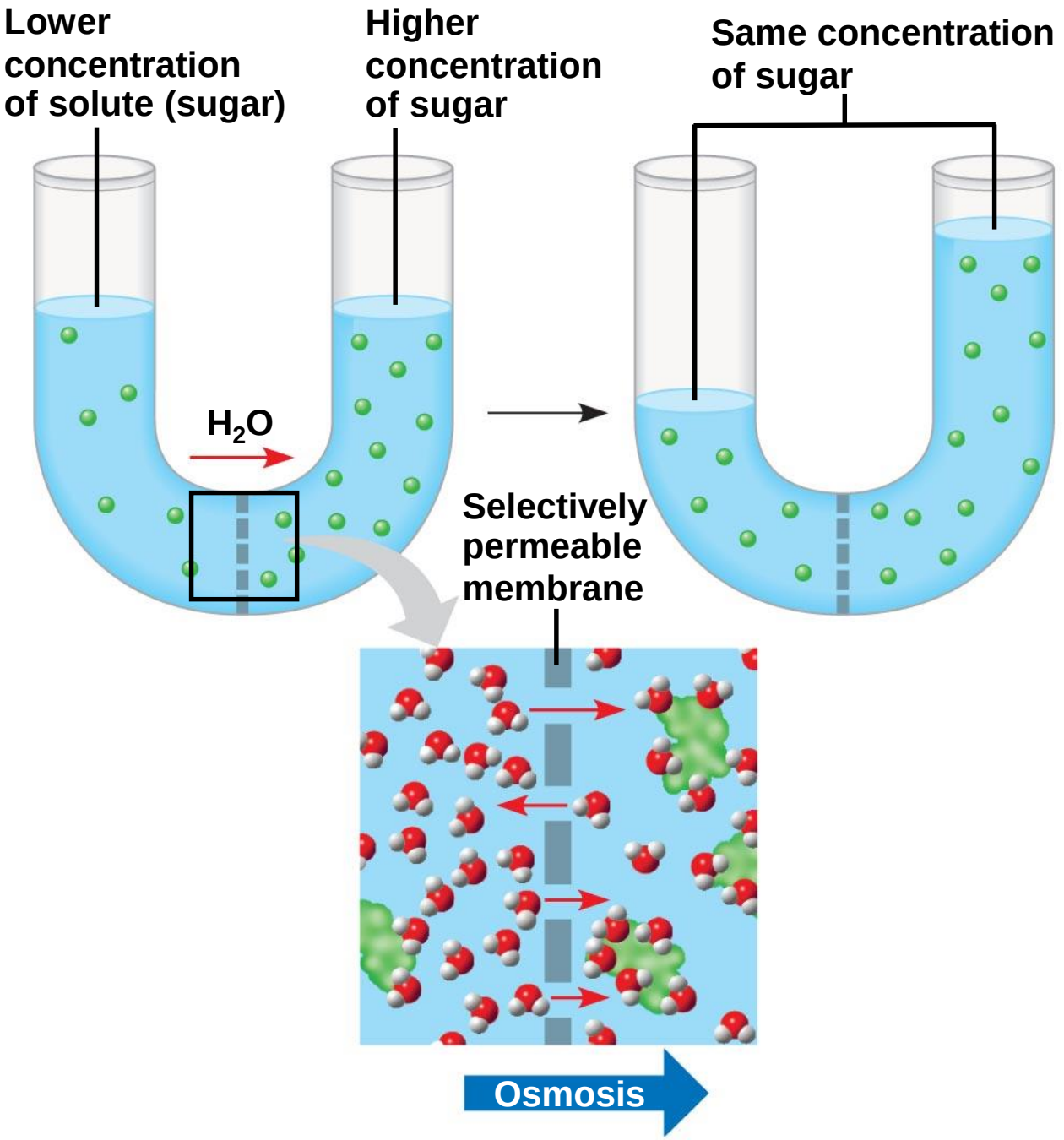
Fig. 7-11



Effects of Osmosis on Water Balance

- **Osmosis** is the diffusion of water across a selectively permeable membrane
- Water diffuses across a membrane from the region of lower solute concentration to the region of higher solute concentration
- Ex. Kidney function

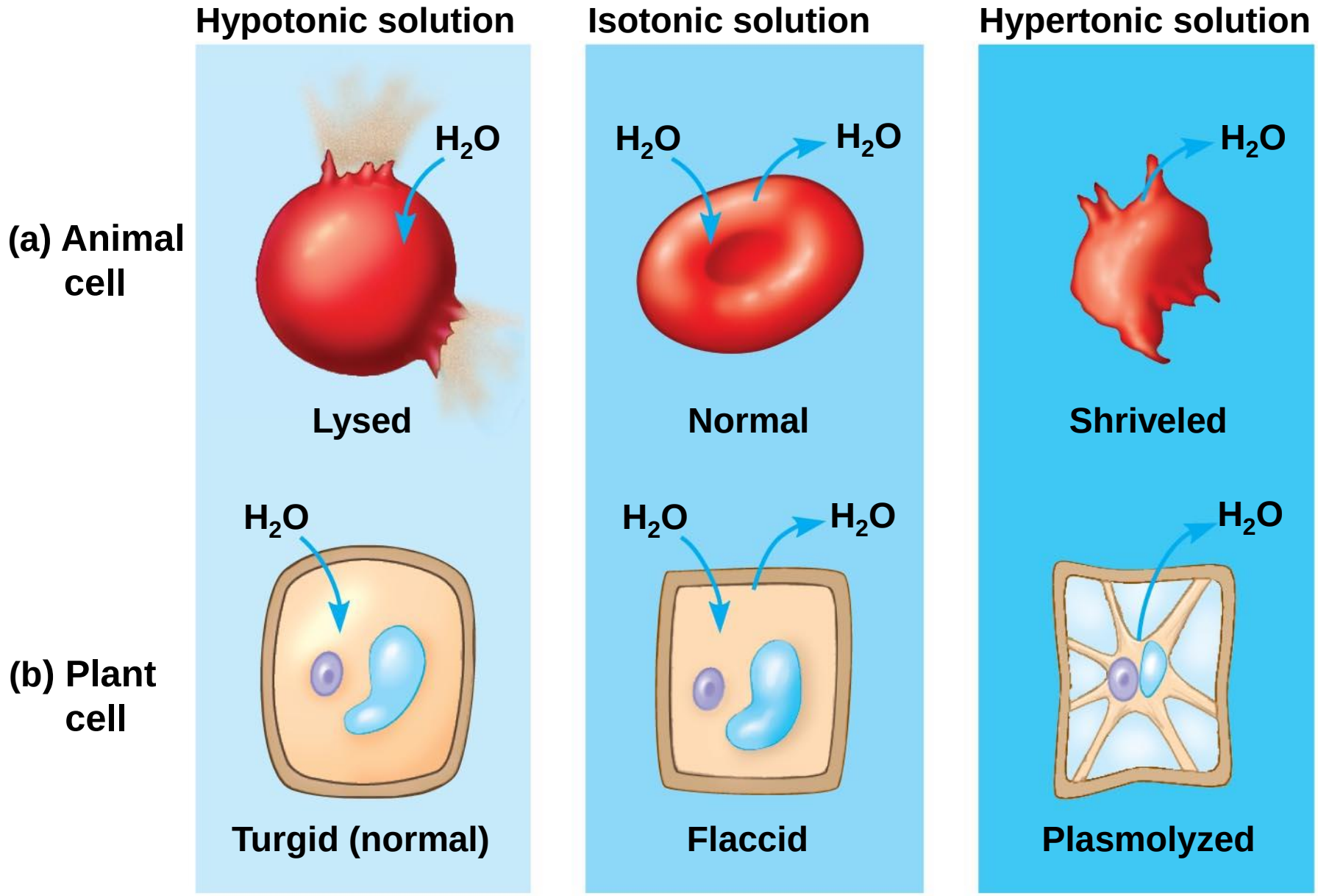
Fig. 7-12



Water Balance of Cells Without Walls

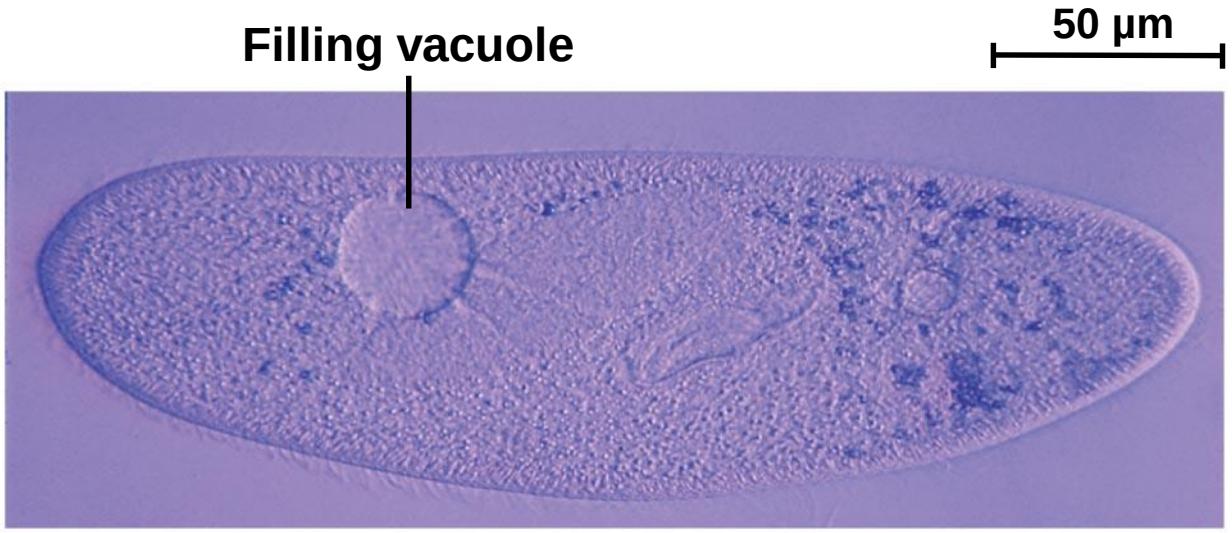
- **Tonicity** is the ability of a solution to cause a cell to gain or lose water
- **Isotonic** solution: Solute concentration is the same as that inside the cell; no net water movement across the plasma membrane
- **Hypertonic** solution: Solute concentration is greater than that inside the cell; cell loses water
- **Hypotonic** solution: Solute concentration is less than that inside the cell; cell gains water

Fig. 7-13

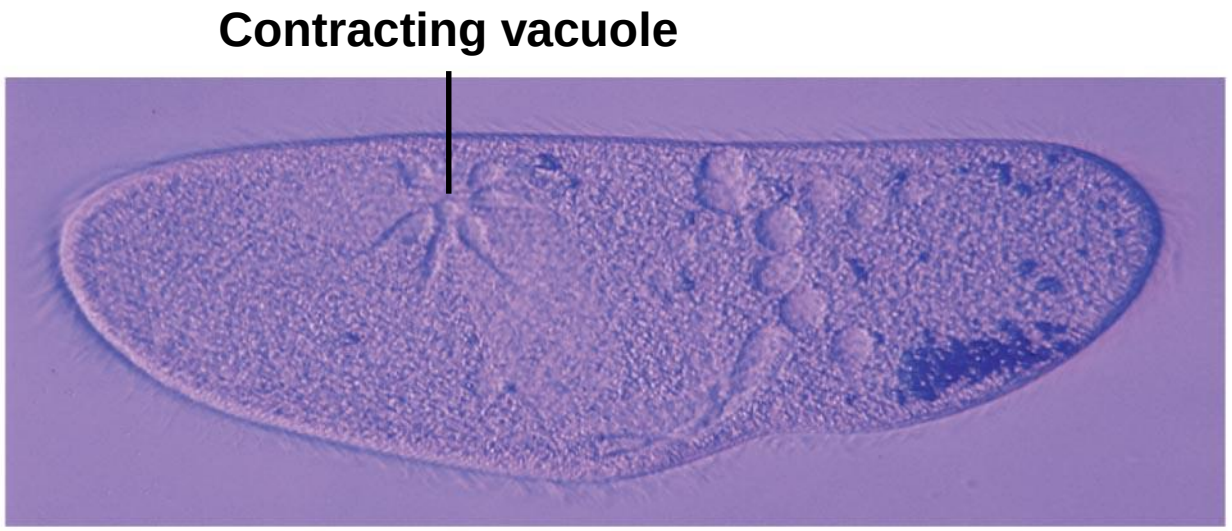


- Hypertonic or hypotonic environments create osmotic problems for organisms
- **Osmoregulation**, the control of water balance, is a necessary adaptation for life in such environments
- The protist *Paramecium,* which is hypertonic to its pond water environment, has a contractile vacuole that acts as a pump

Fig. 7-14



(a) A contractile vacuole fills with fluid that enters from a system of canals radiating throughout the cytoplasm.

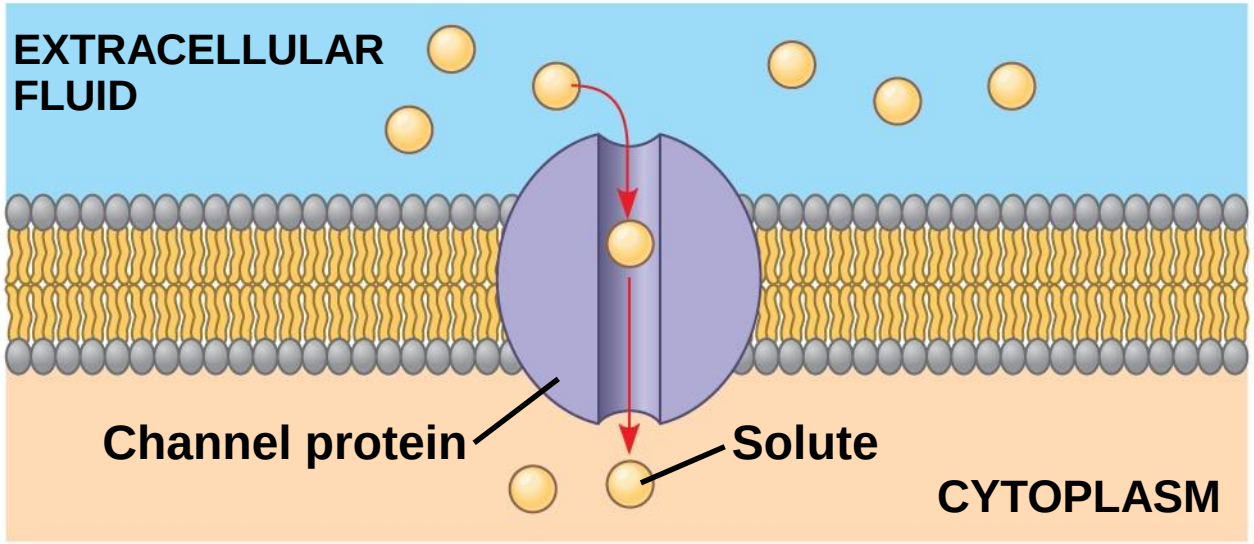


(b) When full, the vacuole and canals contract, expelling fluid from the cell.

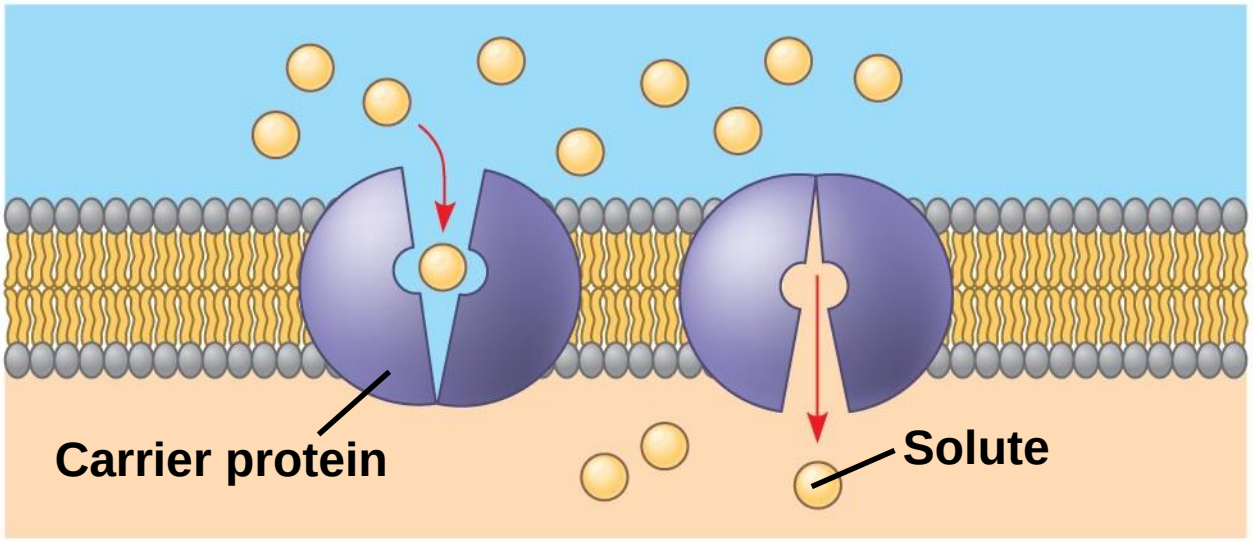
Facilitated Diffusion: Passive Transport Aided by Proteins

- In **facilitated diffusion**, transport proteins speed the passive movement of molecules across the plasma membrane
- Channel proteins provide corridors that allow a specific molecule or ion to cross the membrane
- Channel proteins include
  - Aquaporins, for facilitated diffusion of water
  - **Ion channels** that open or close in response to a stimulus (**gated channels**)

Fig. 7-15



(a) A channel protein



(b) A carrier protein

- Some diseases are caused by malfunctions in specific transport systems, for example the kidney disease cystinuria

Active transport uses energy to move solutes against their gradients

- Facilitated diffusion is still passive because the solute moves down its concentration gradient
- Some transport proteins, however, can move solutes against their concentration gradients

The Need for Energy in Active Transport

- **Active transport** moves substances against their concentration gradient
- Active transport requires energy, usually in the form of ATP
- Active transport is performed by specific proteins embedded in the membranes

- Active transport allows cells to maintain concentration gradients that differ from their surroundings
- The **sodium-potassium pump** is one type of active transport system

Fig. 7-16-7

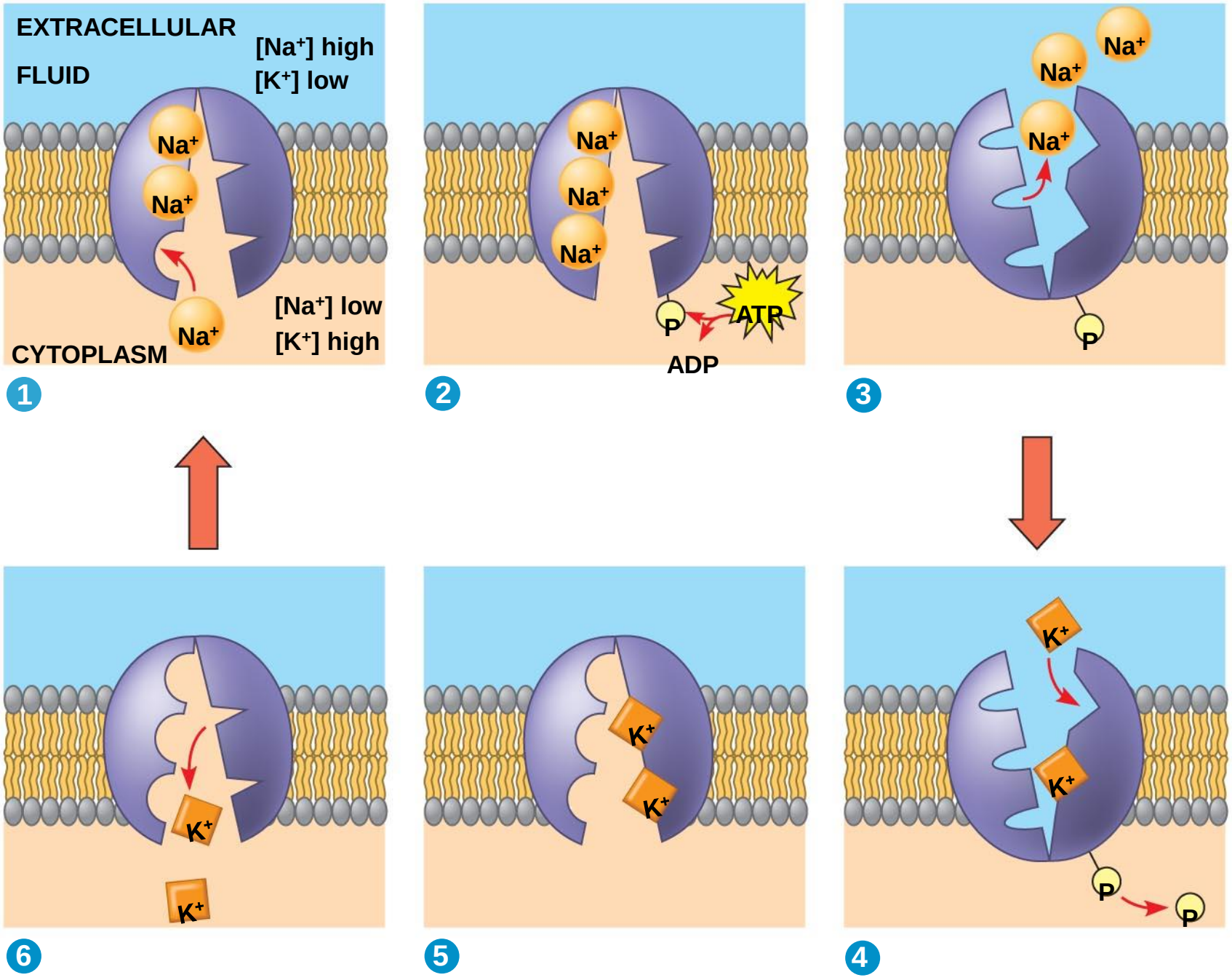
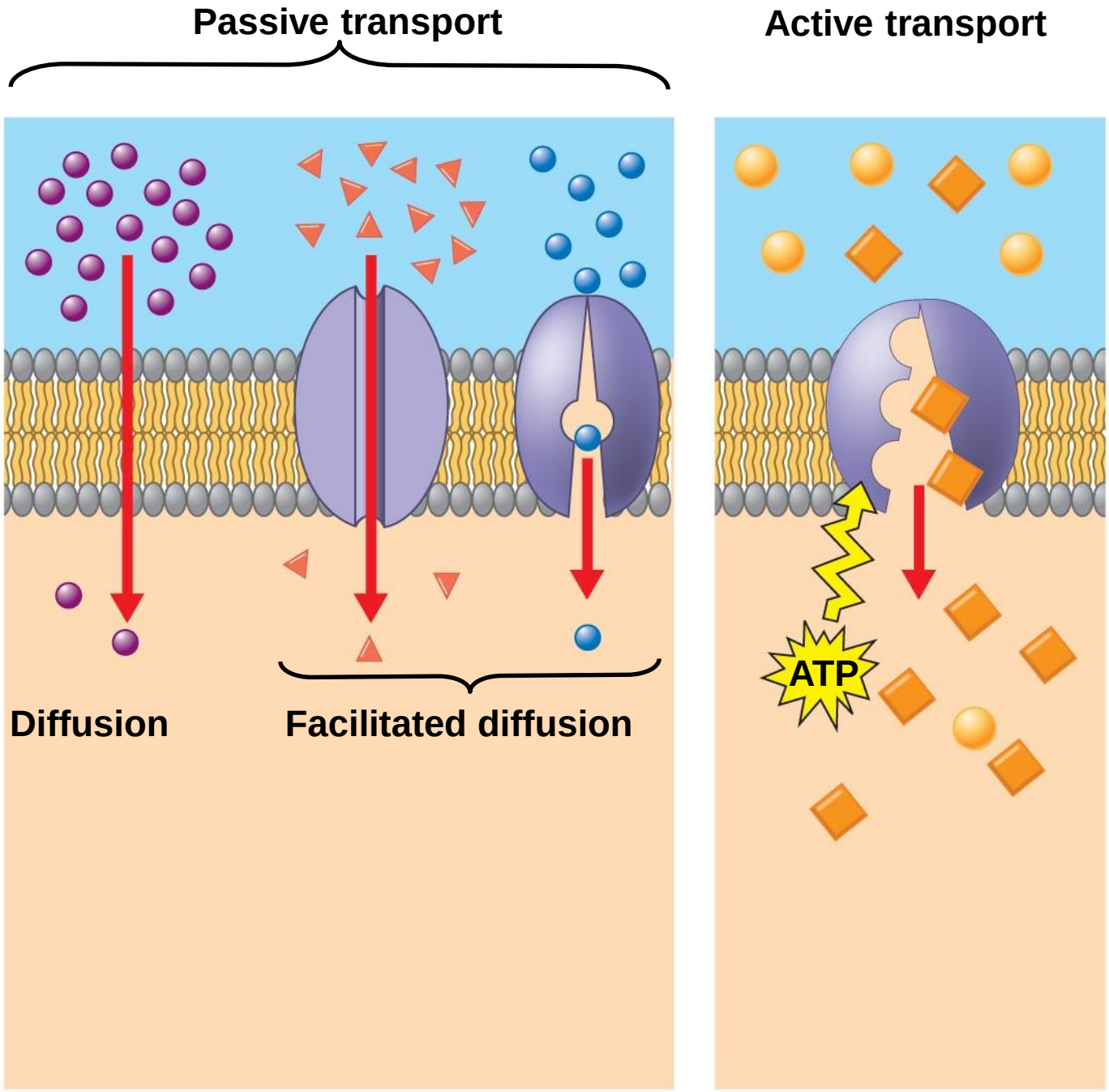


Fig. 7-17



How Ion Pumps Maintain Membrane Potential

- **Membrane potential** is the voltage difference across a membrane
- Voltage is created by differences in the distribution of positive and negative ions
- Ex. Nerve signal transmission

Bulk transport across the plasma membrane occurs by exocytosis and endocytosis

- Small molecules and water enter or leave the cell through the lipid bilayer or by transport proteins
- Large molecules, such as polysaccharides and proteins, cross the membrane in bulk via vesicles
- **Bulk transport requires energy**

Exocytosis

- In **exocytosis**, transport vesicles migrate to the membrane, fuse with it, and release their contents
- Many secretory cells use exocytosis to export their products

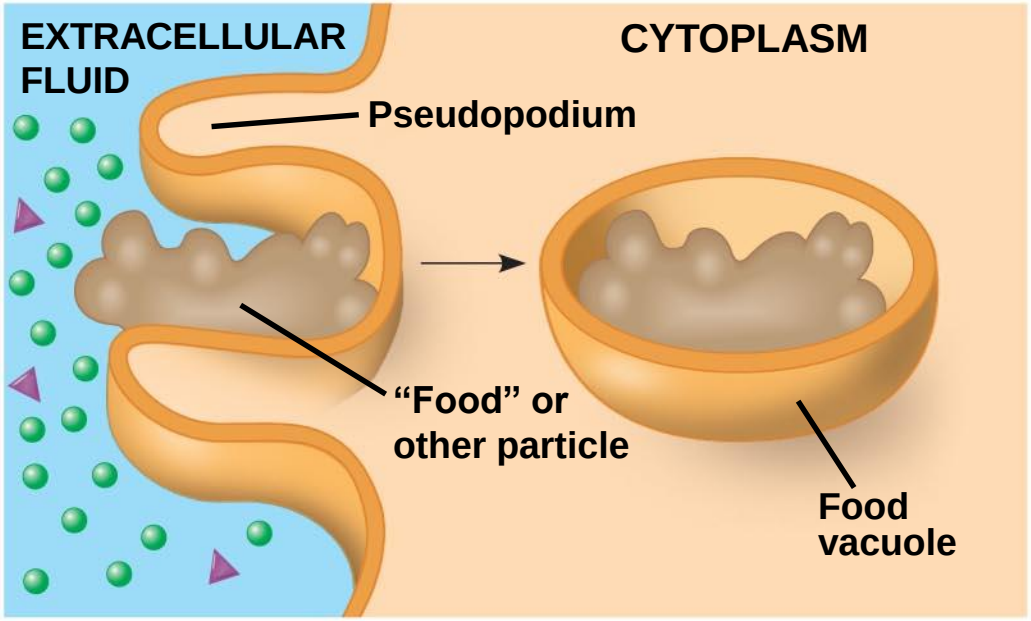
Endocytosis

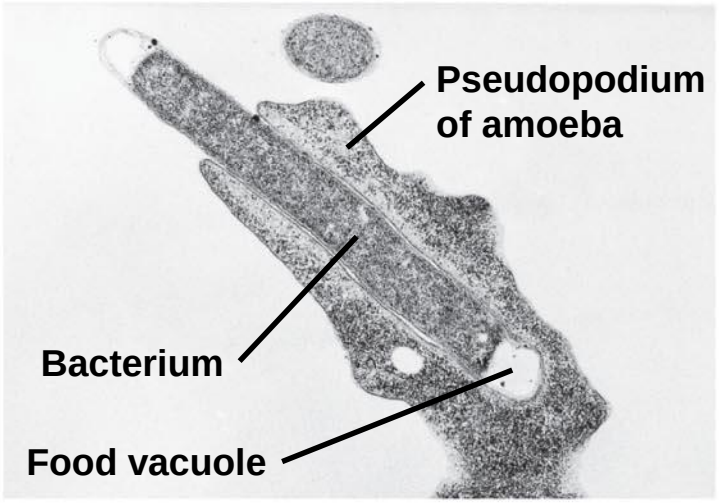
- In **endocytosis**, the cell takes in macromolecules by forming vesicles from the plasma membrane
- There are three types of endocytosis:
  - Phagocytosis (“cellular eating”)
  - Pinocytosis (“cellular drinking”)
  - Receptor-mediated endocytosis

- In **phagocytosis** a cell engulfs a particle in a vacuole
- The vacuole fuses with a lysosome to digest the particle
- In **pinocytosis**, molecules are taken up when extracellular fluid is “gulped” into tiny vesicles

Fig. 7-20a

PHAGOCYTOSIS

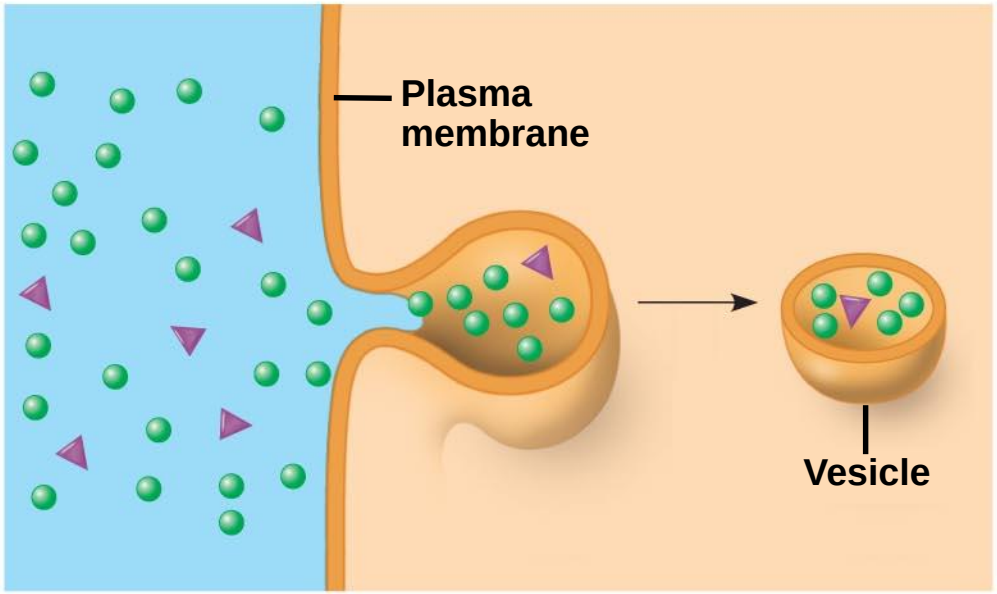


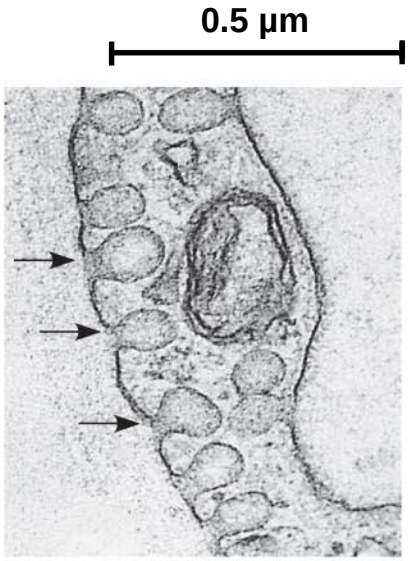


An amoeba engulfing a bacterium via phagocytosis (TEM)

Fig. 7-20b

PINOCYTOSIS



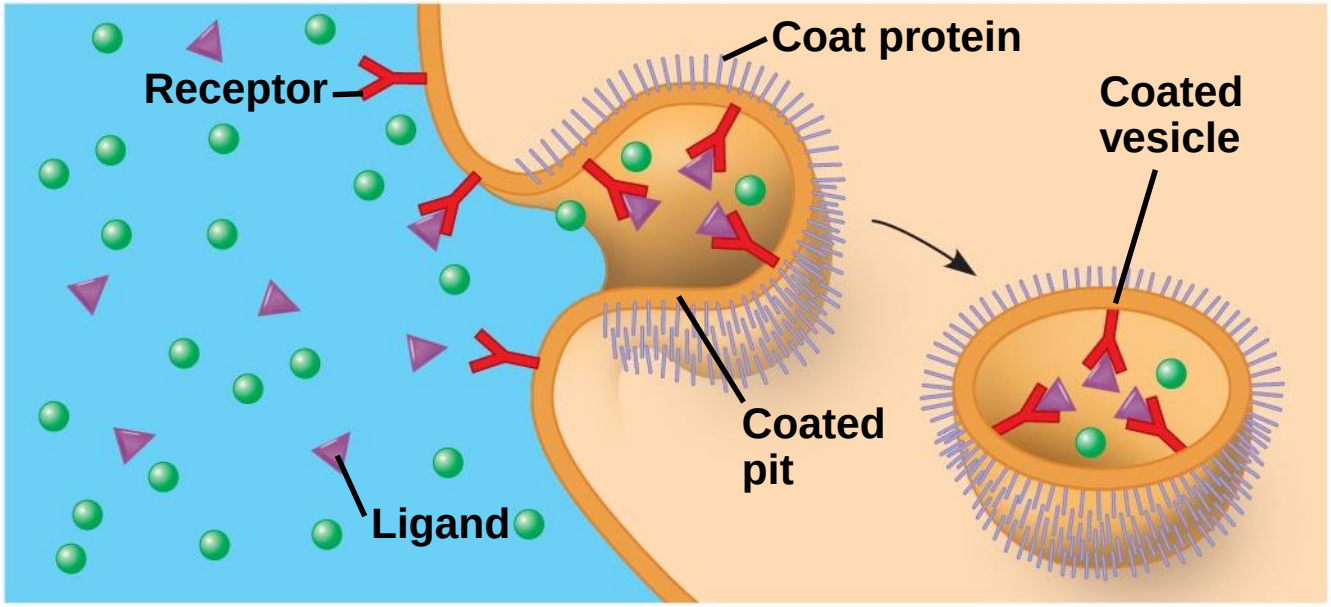


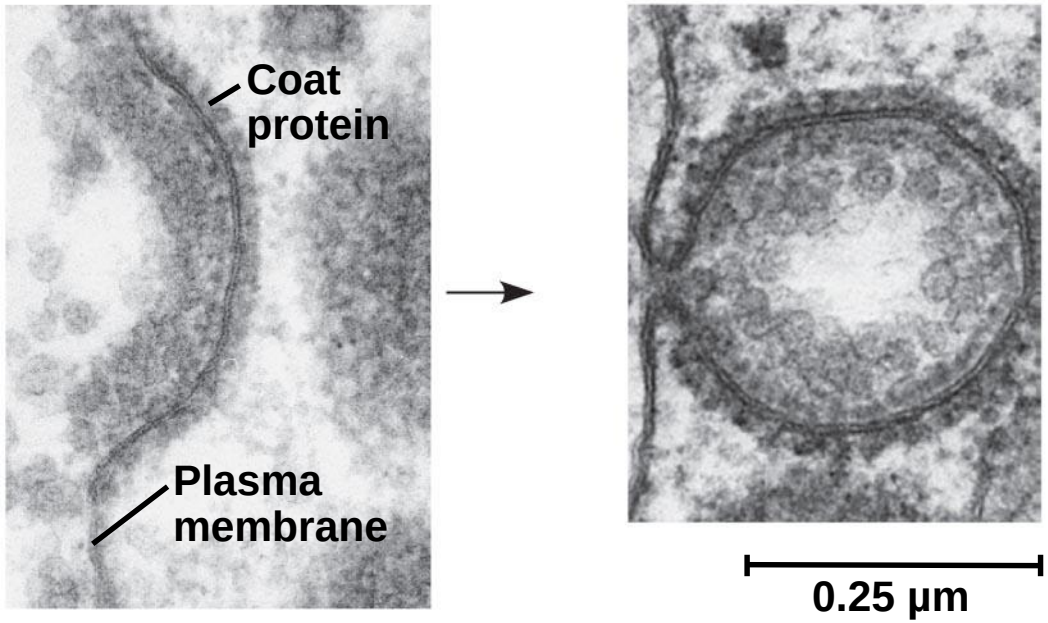
Pinocytosis vesicles forming (arrows) in a cell lining a small blood vessel (TEM)

- In **receptor-mediated endocytosis**, binding of ligands to receptors triggers vesicle formation
- A **ligand** is any molecule that binds specifically to a receptor site of another molecule
- Ex: familial hypercholesterolmia

Fig. 7-20c

RECEPTOR-MEDIATED ENDOCYTOSIS





A coated pit and a coated vesicle formed during receptor-mediated endocytosis (TEMs)

Fig. 7-UN3