Plasma Membrane

Sandwich Model

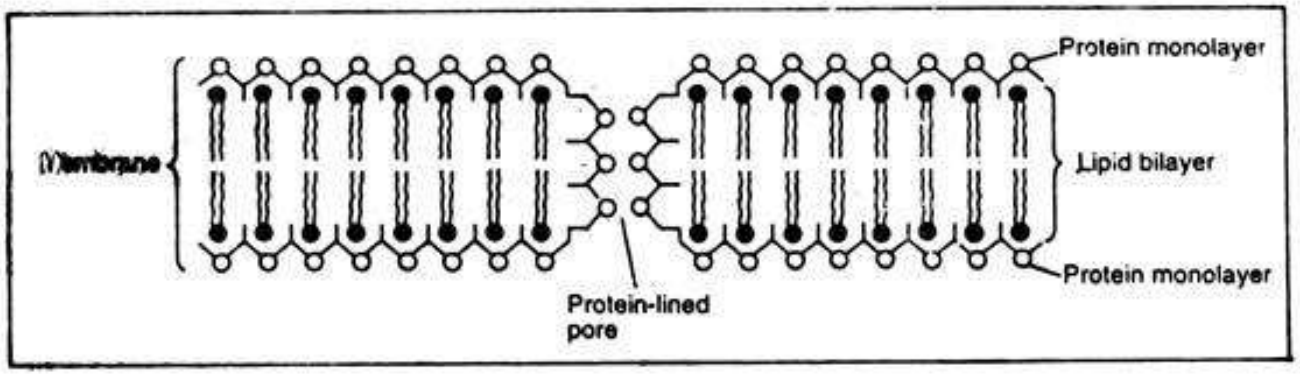


Fig. 2.3: Danielli-Davson Model.

Unit Membrane

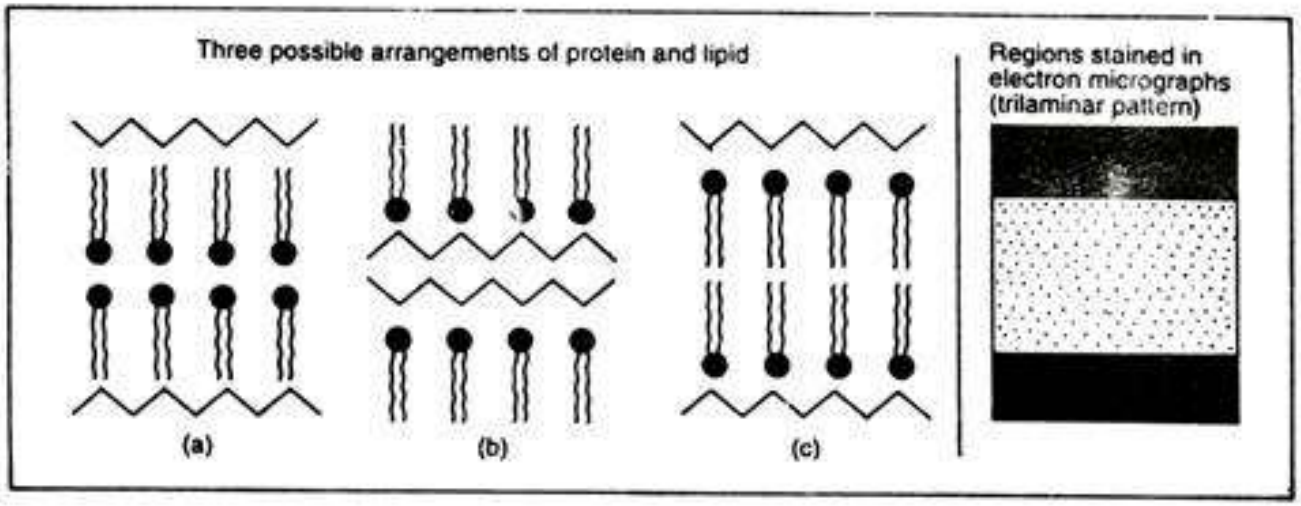


Fig. 2.4: X-ray diffraction analysis of Myelin membranes.

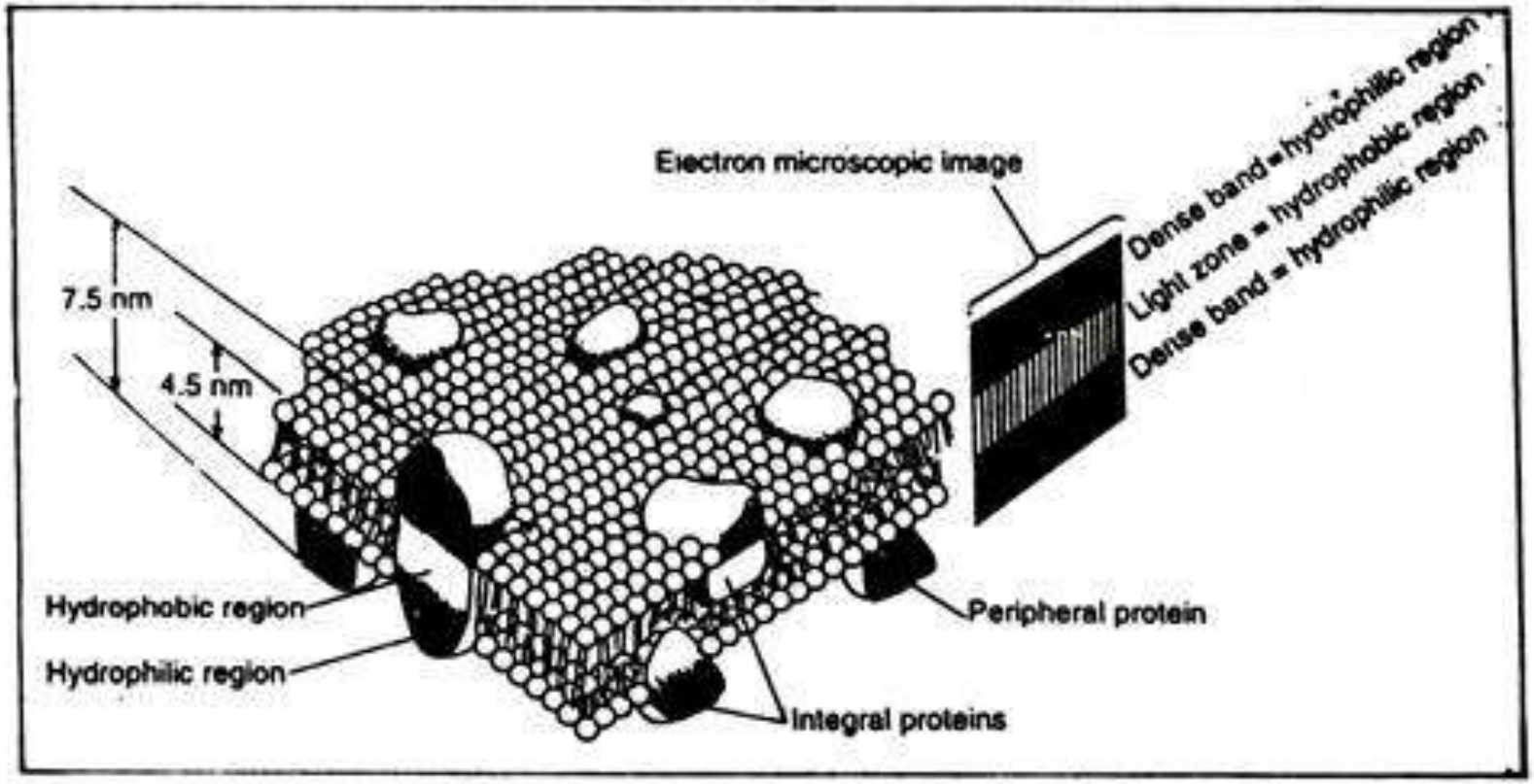
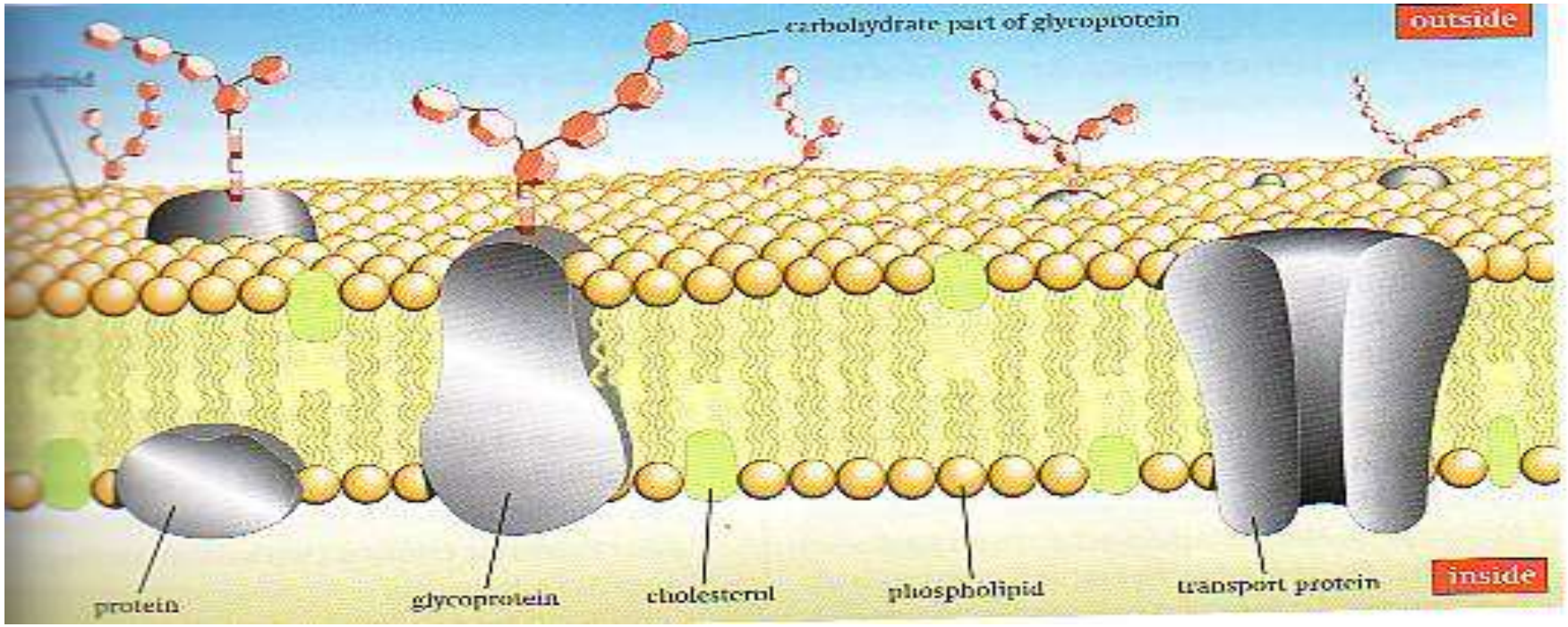


Fig. 2.6: The fluid-mosaic model of membrane organisation.

FLUID MOSAIC MODEL



FLUID- because individual phospholipids and proteins can move side-to-side within the layer, like it's a liquid.

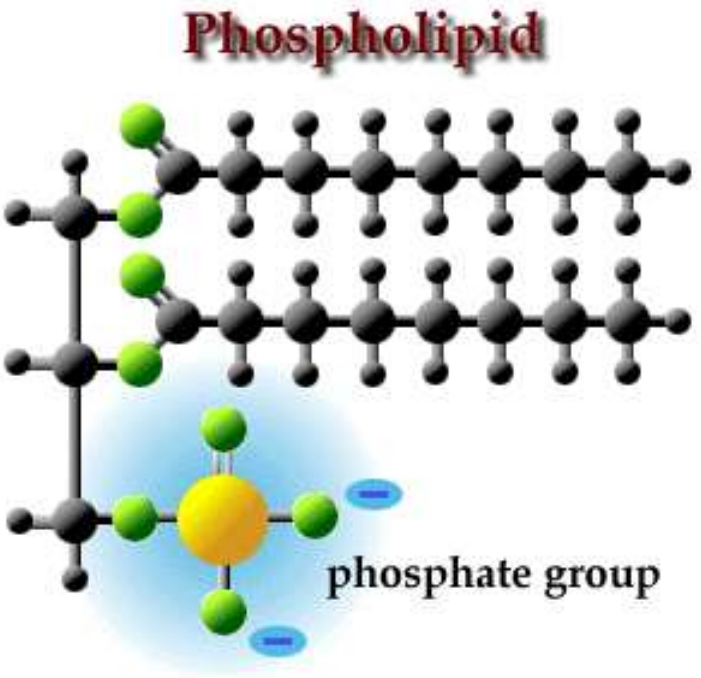
MOSAIC- because of the pattern produced by the scattered protein molecules when the membrane is viewed from above.

Functions

- **Protection and support – Maintains cell shape and size**

Solubility

- **Materials that are soluble in lipids can pass through the cell membrane easily**



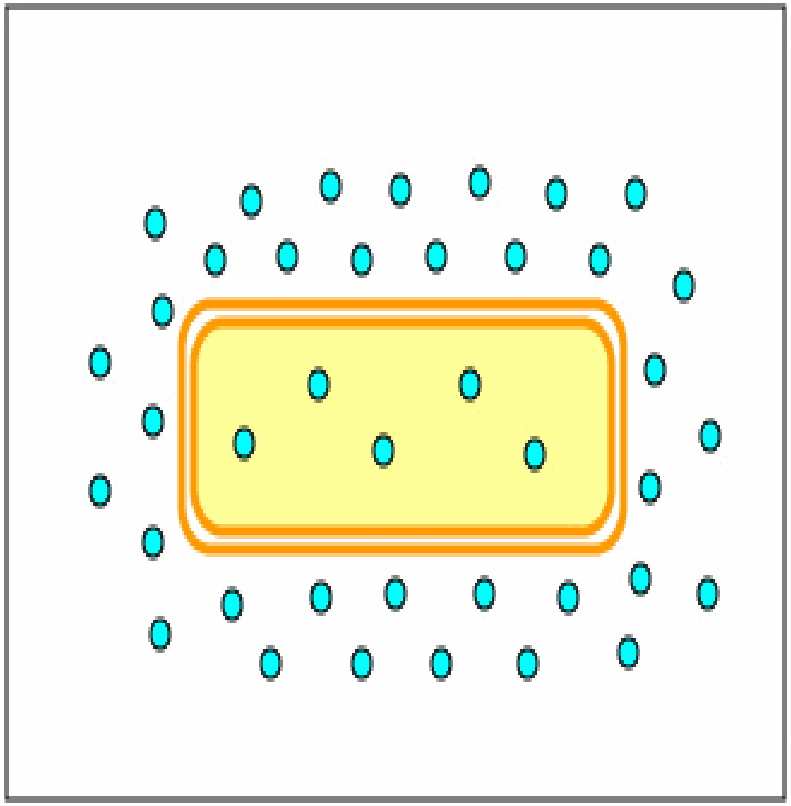
Selective Permeablility

- Small molecules and larger hydrophobic molecules move through easily.
- e.g. O_2, CO_2, H_2O

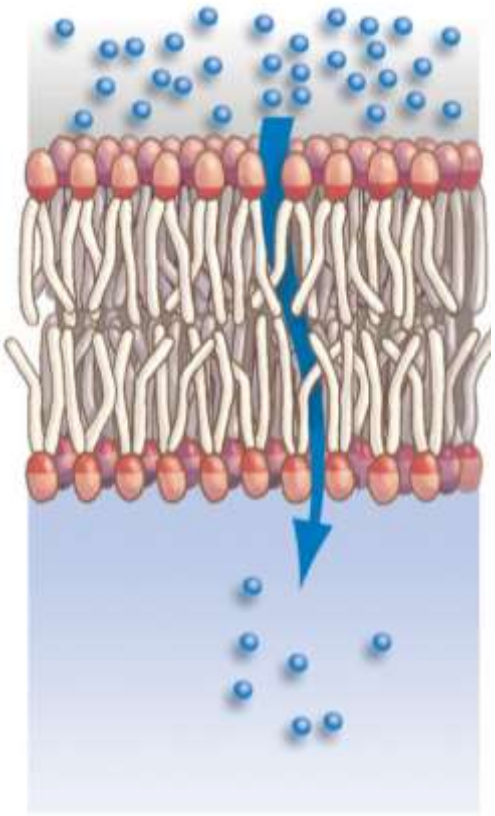
Ions, hydrophilic molecules larger than water, and large molecules such as proteins do not move through the membrane on their own.

DIFFUSION

Diffusion is a PASSIVE process which means no energy is used to make the molecules move, they have a natural KINETIC ENERGY



simple diffusion



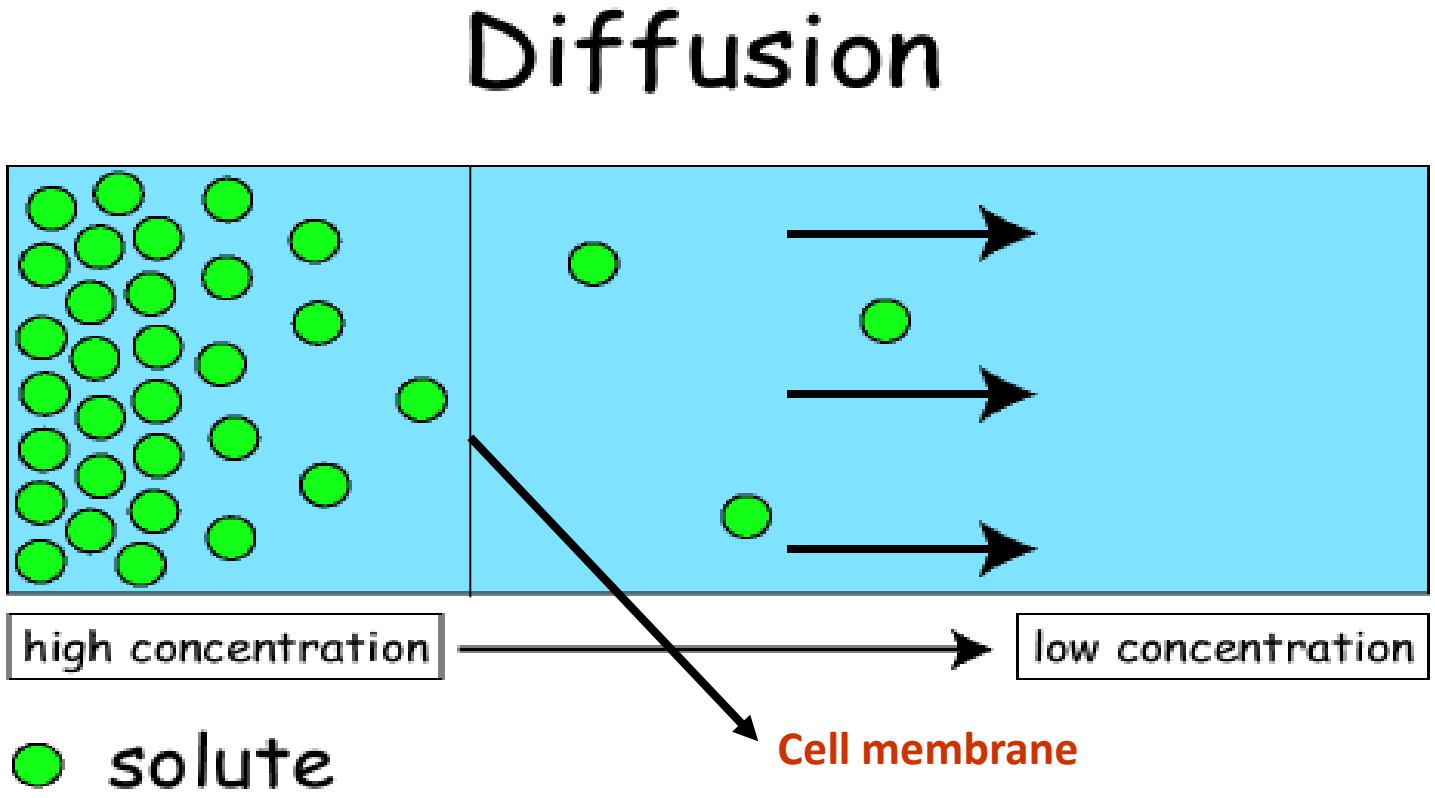
Materials move down their concentration gradient through the phospholipid bilayer.

Passive Transport

Simple Diffusion

- Doesn't require energy
- Moves high to low concentration
  - Example: Oxygen or water diffusing into a cell and carbon dioxide diffusing out.

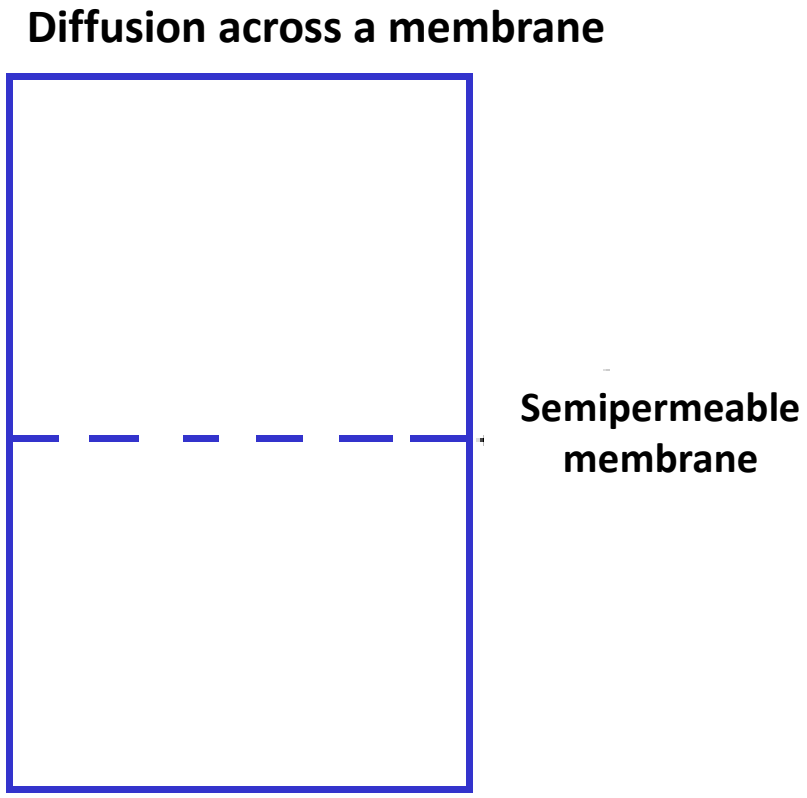
Diffusion through a Membrane



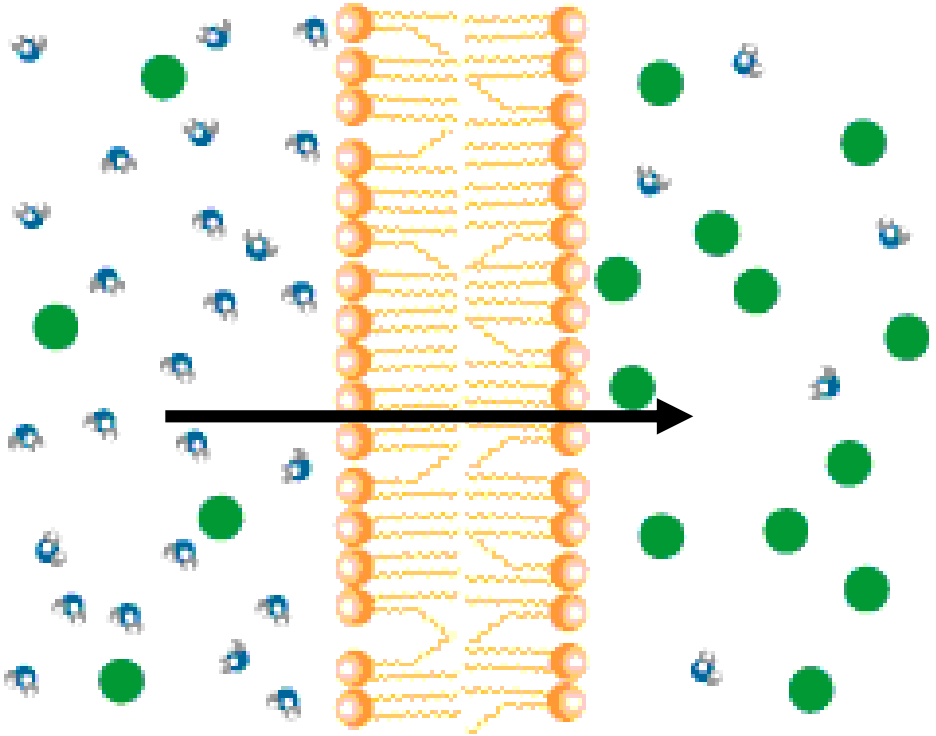
Solute moves DOWN concentration gradient (HIGH to LOW)

Osmosis

- **Diffusion of water across a membrane**
- **Moves from HIGH water potential (low solute) to LOW water potential (high solute)**

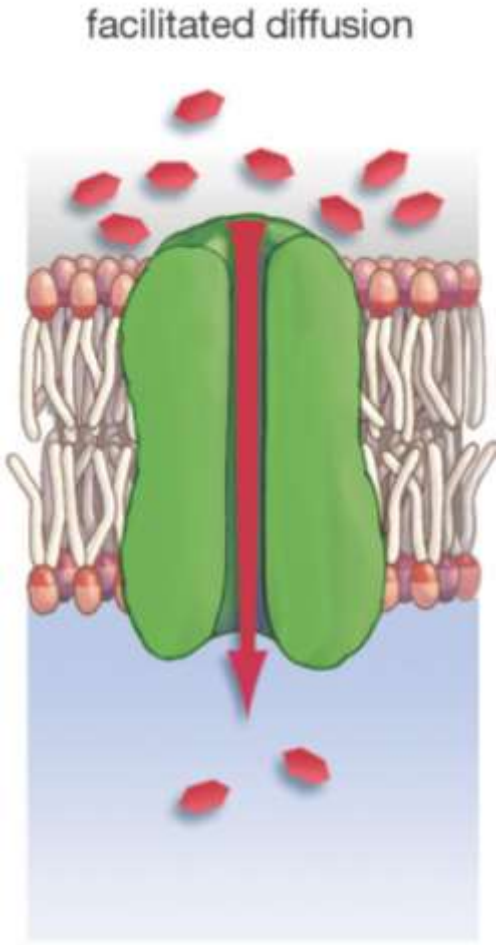


Diffusion of H_2O Across A Membrane



High H_2O potential
Low solute concentration

Low H_2O potential
High solute concentration



The passage of materials is aided both by a concentration gradient and by a transport protein.

Passive Transport

Facilitated diffusion

- Doesn't require energy
- Uses transport proteins to move high to low concentration

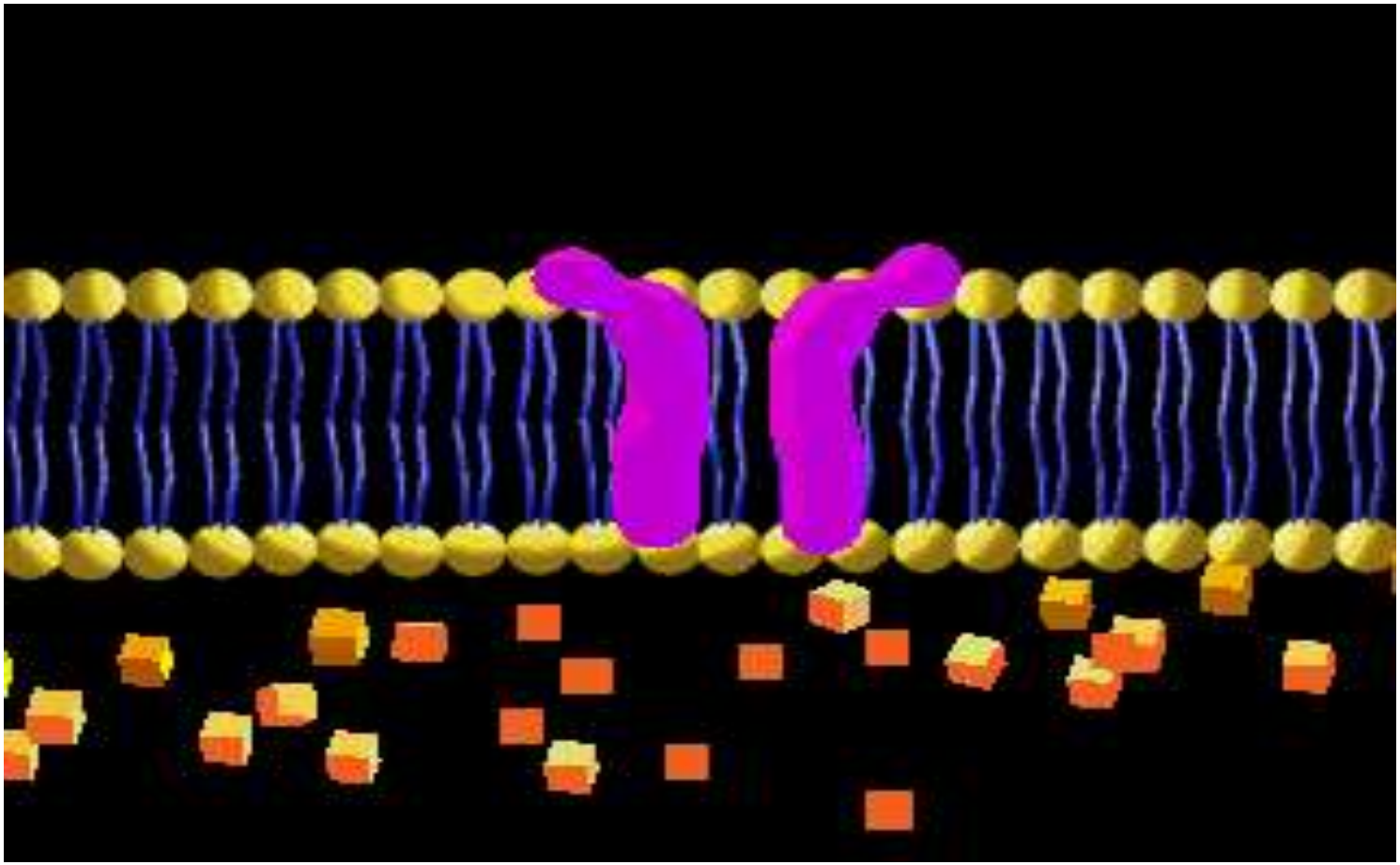
Examples: Glucose or amino acids moving from blood into a cell.

Types of Transport Proteins

- **Channel proteins are embedded in the cell membrane & have a pore for materials to cross**
- **Carrier proteins can change shape to move material from one side of the membrane to the other**

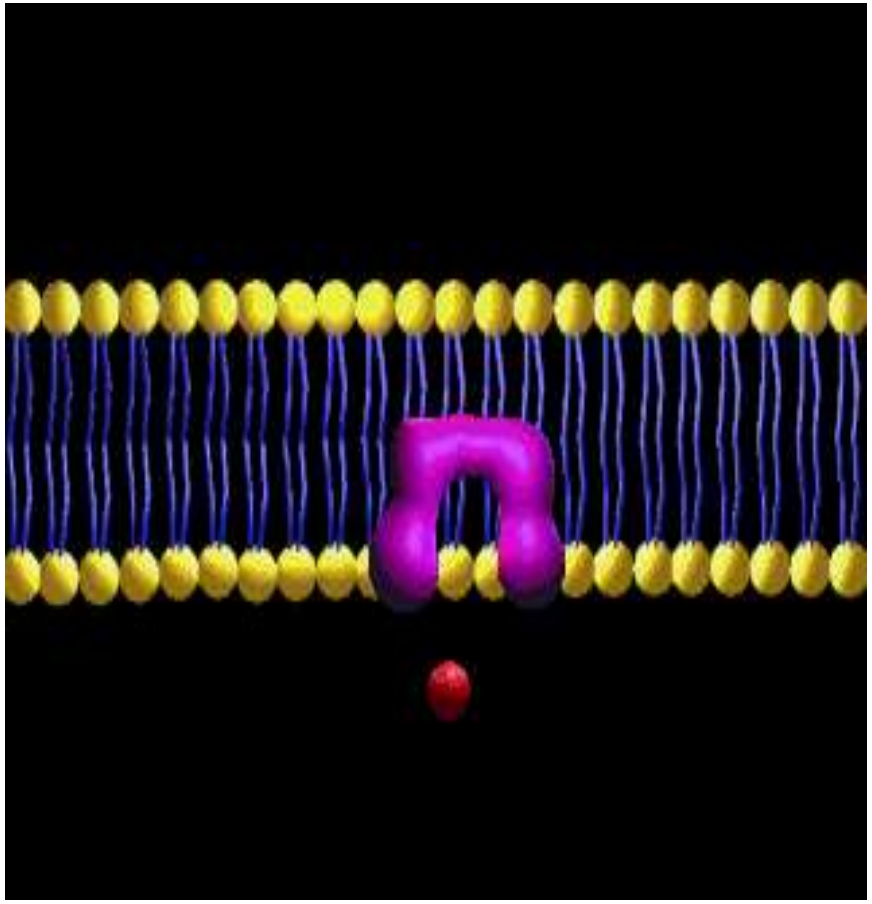
Facilitated Diffusion

Molecules will randomly move through the pores in Channel Proteins.

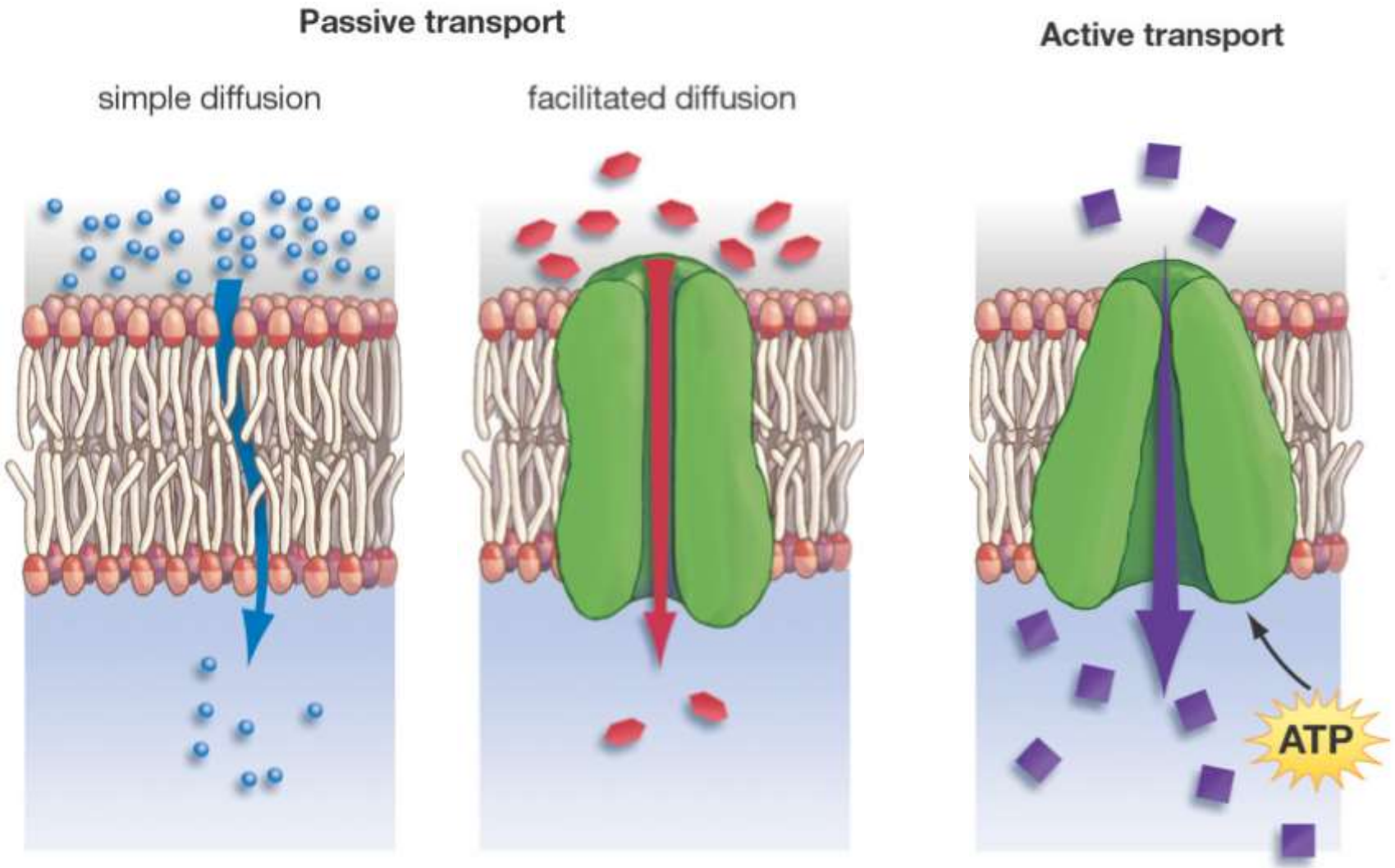


Facilitated Diffusion

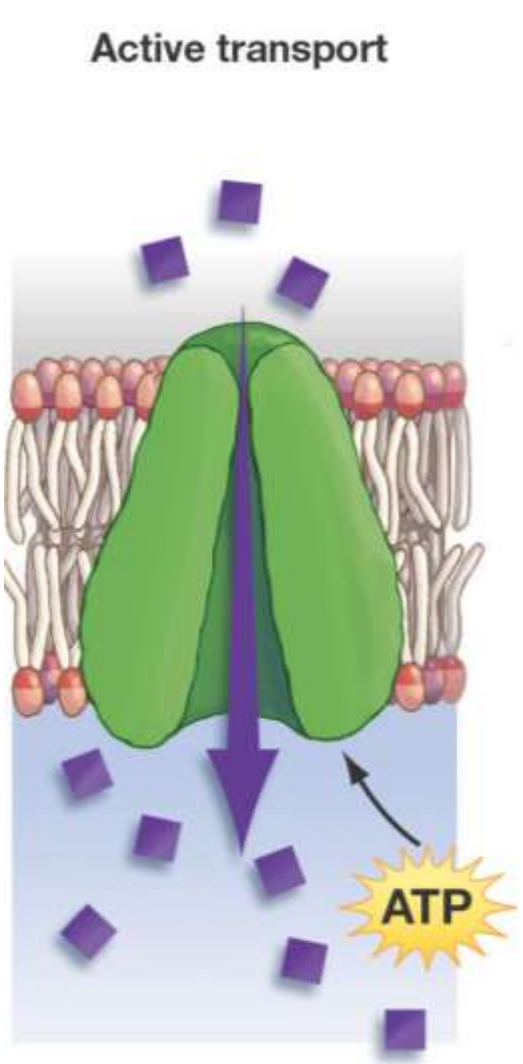
- **Some Carrier proteins do not extend through the membrane.**
- **They bond and drag molecules through the lipid bilayer and release them on the opposite side.**



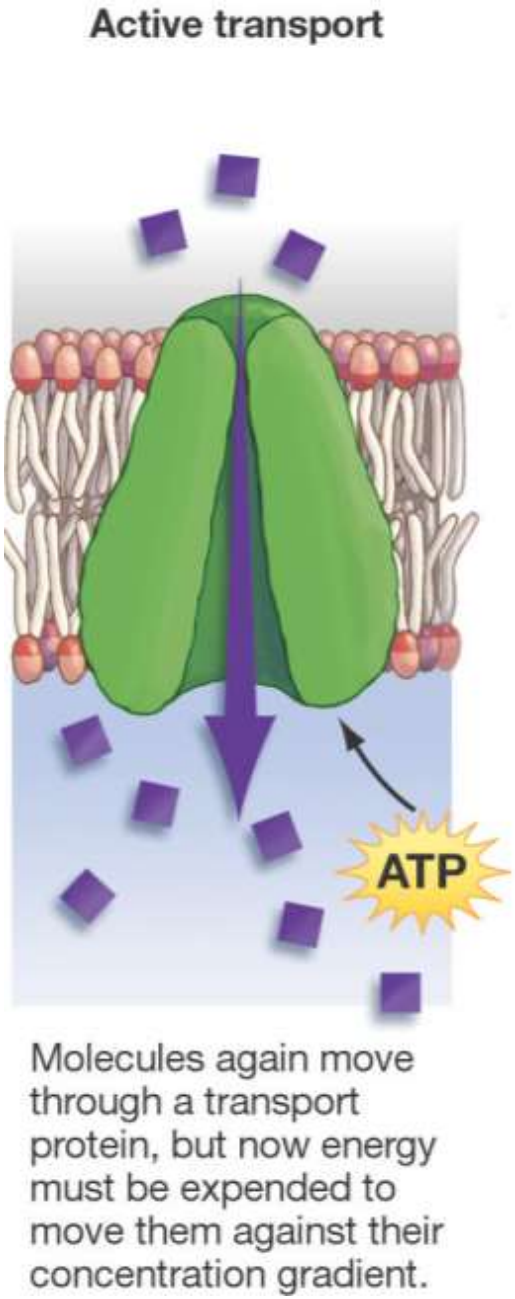
Three Forms of Transport Across the Membrane



Active Transport



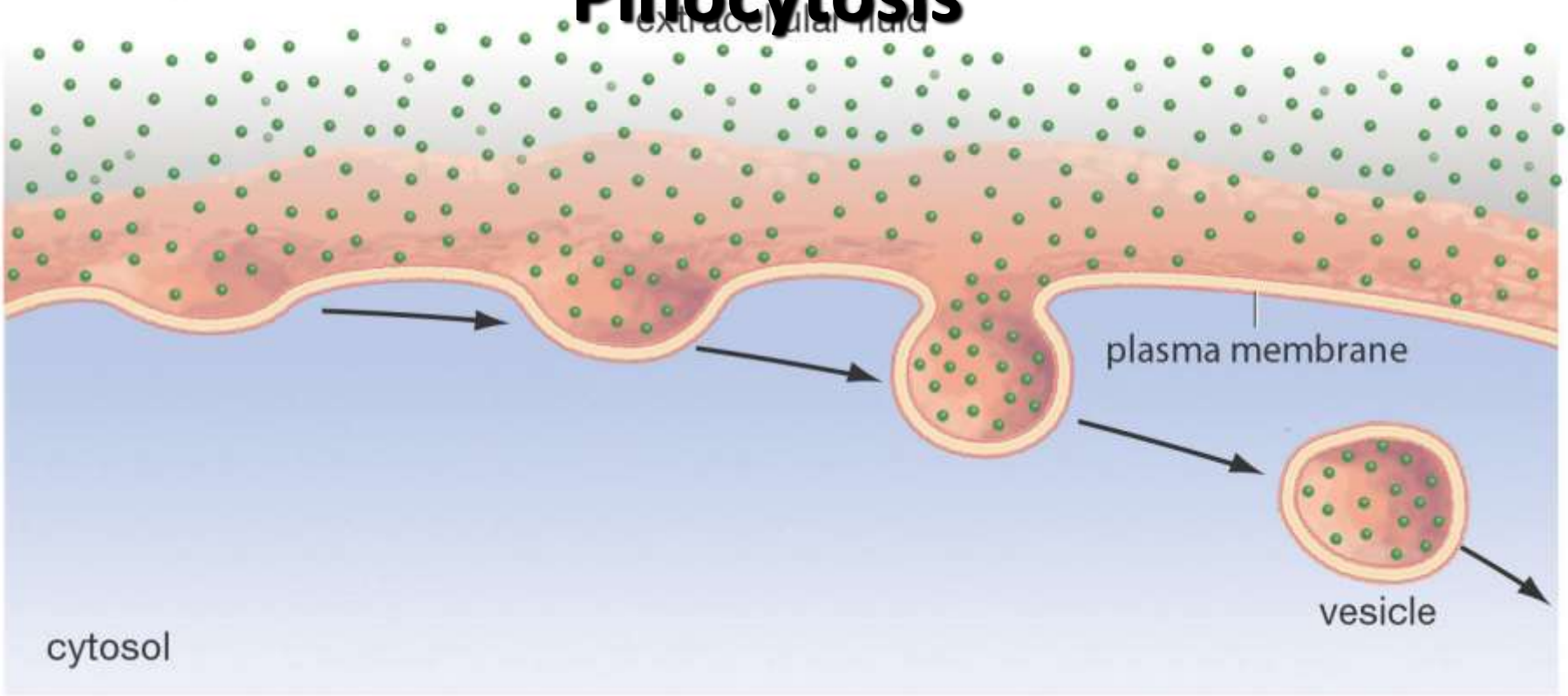
- Requires energy or ATP
- Moves materials from LOW to HIGH concentration
- AGAINST concentration gradient



Active transport

- Examples: Pumping Na^+ (sodium ions) out and K^+ (potassium ions) in against strong concentration gradients.
- Called Na+-K+ Pump

Endocytosis
Pinocytosis

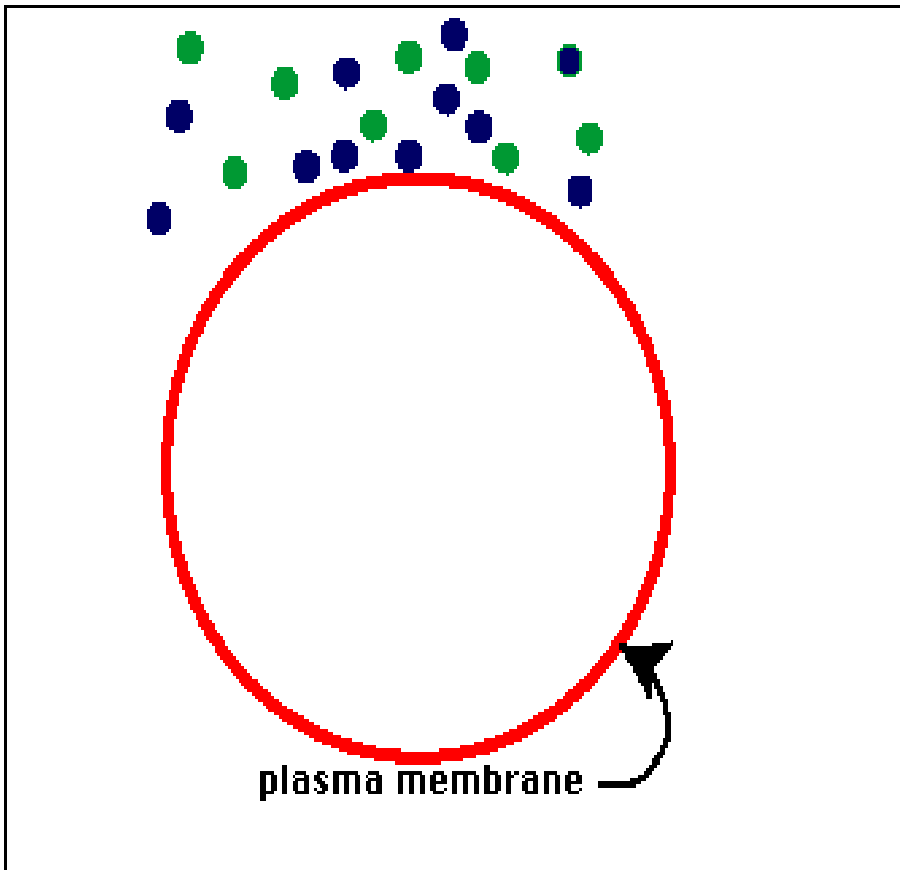


Most common form of endocytosis.

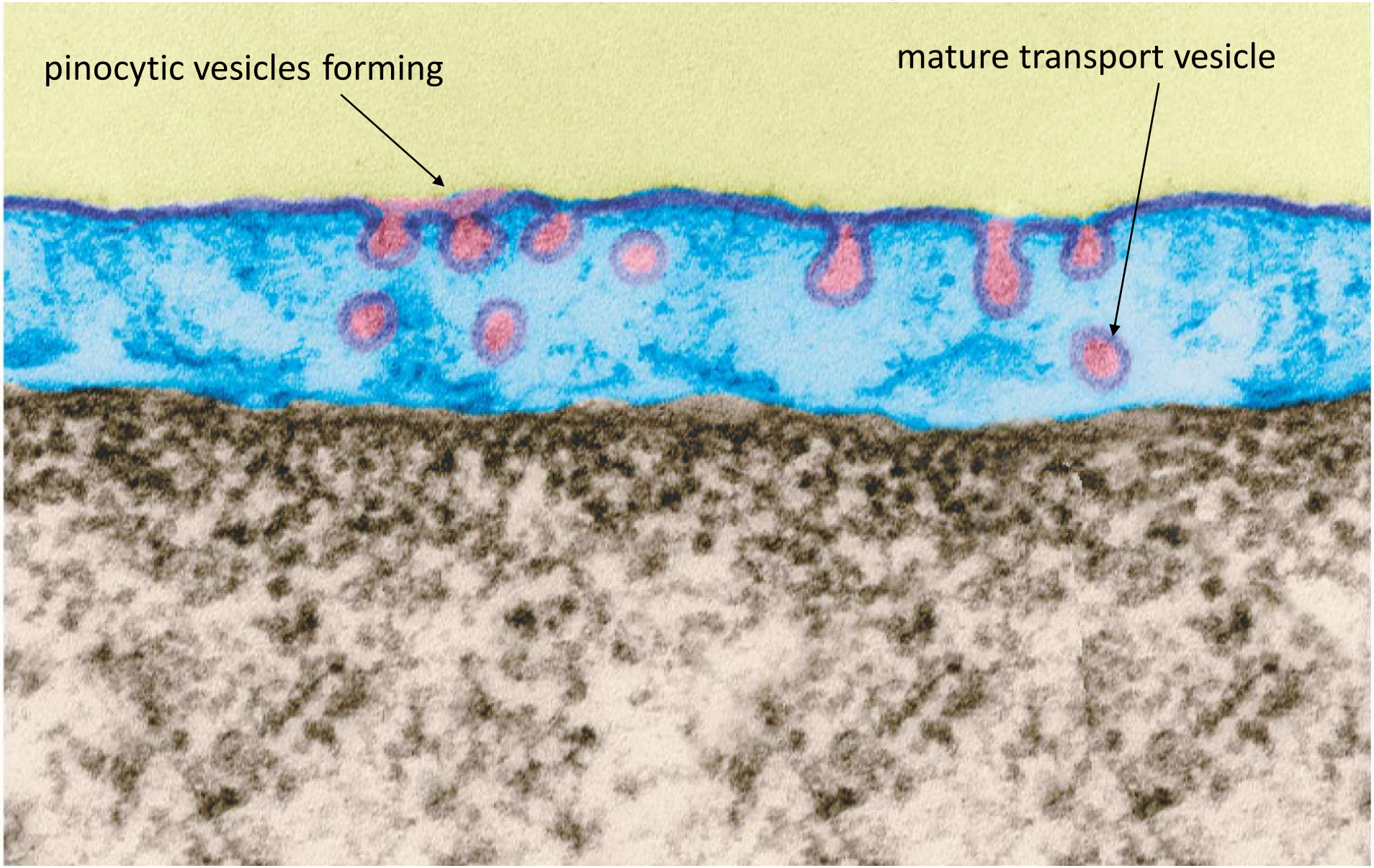
Takes in dissolved molecules as a vesicle.

Pinocytosis

- Cell forms an invagination
- Materials dissolve in water to be brought into cell
- Called “Cell Drinking”

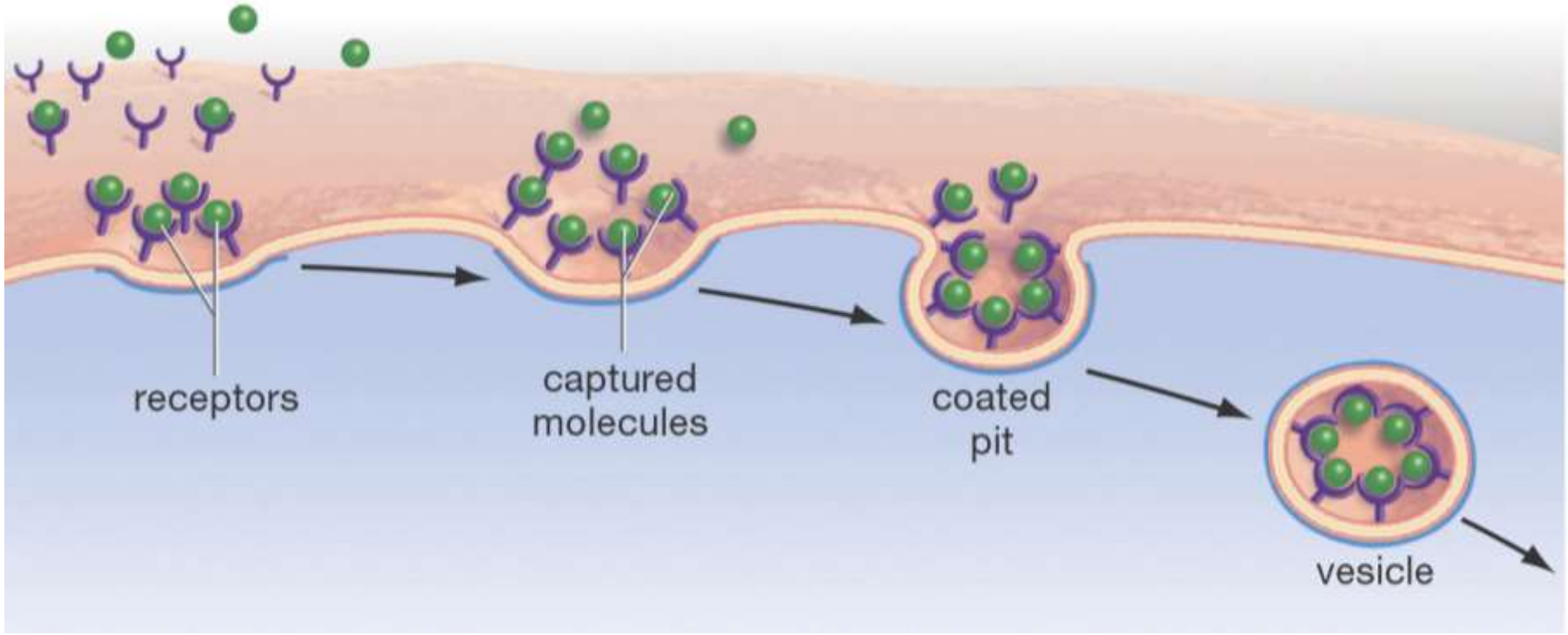


Example of Pinocytosis



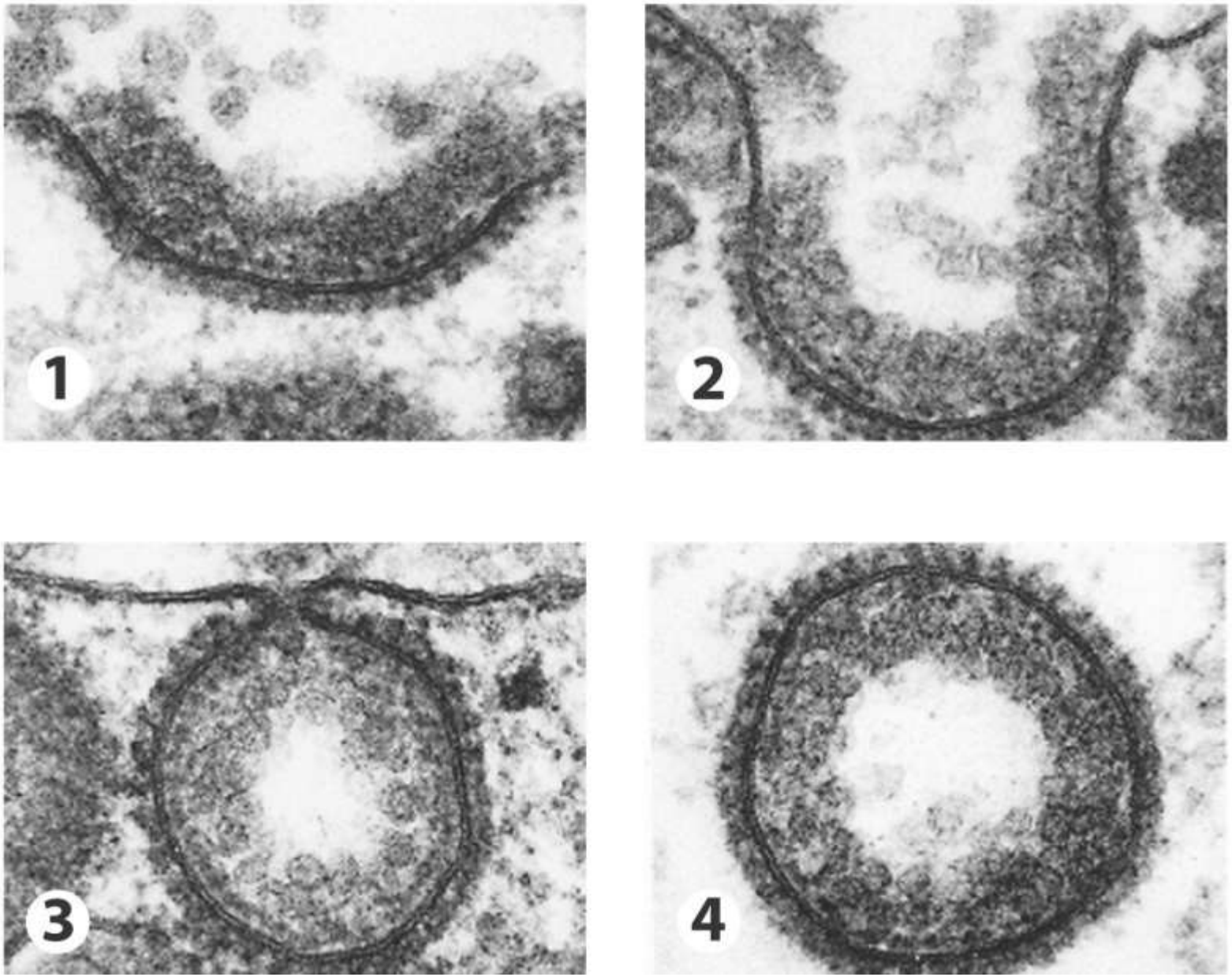
Transport across a capillary cell (blue).

Receptor-Mediated Endocytosis

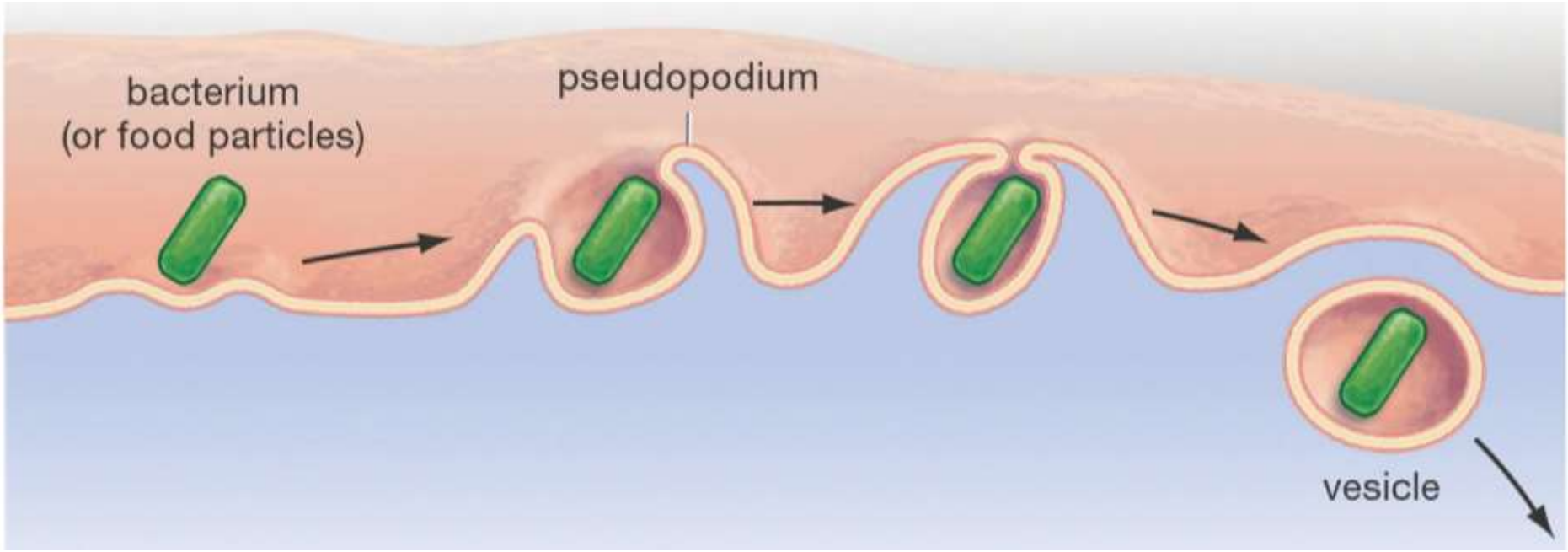


Some integral proteins have receptors on their surface to recognize & take in hormones, cholesterol, etc.

Receptor-Mediated Endocytosis



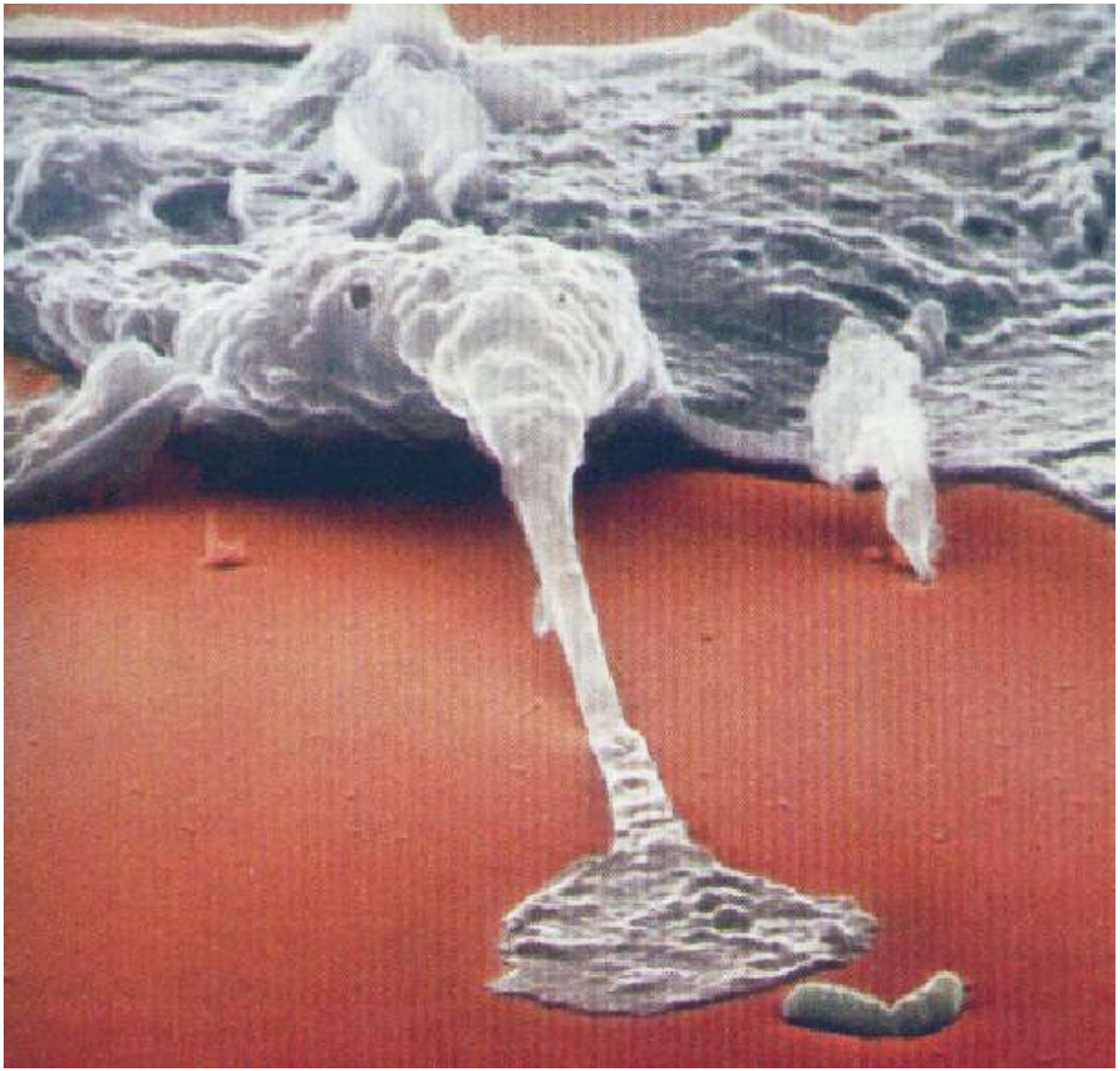
Endocytosis – Phagocytosis



Used to engulf large particles such as food, bacteria, etc. into vesicles

Called "Cell Eating"

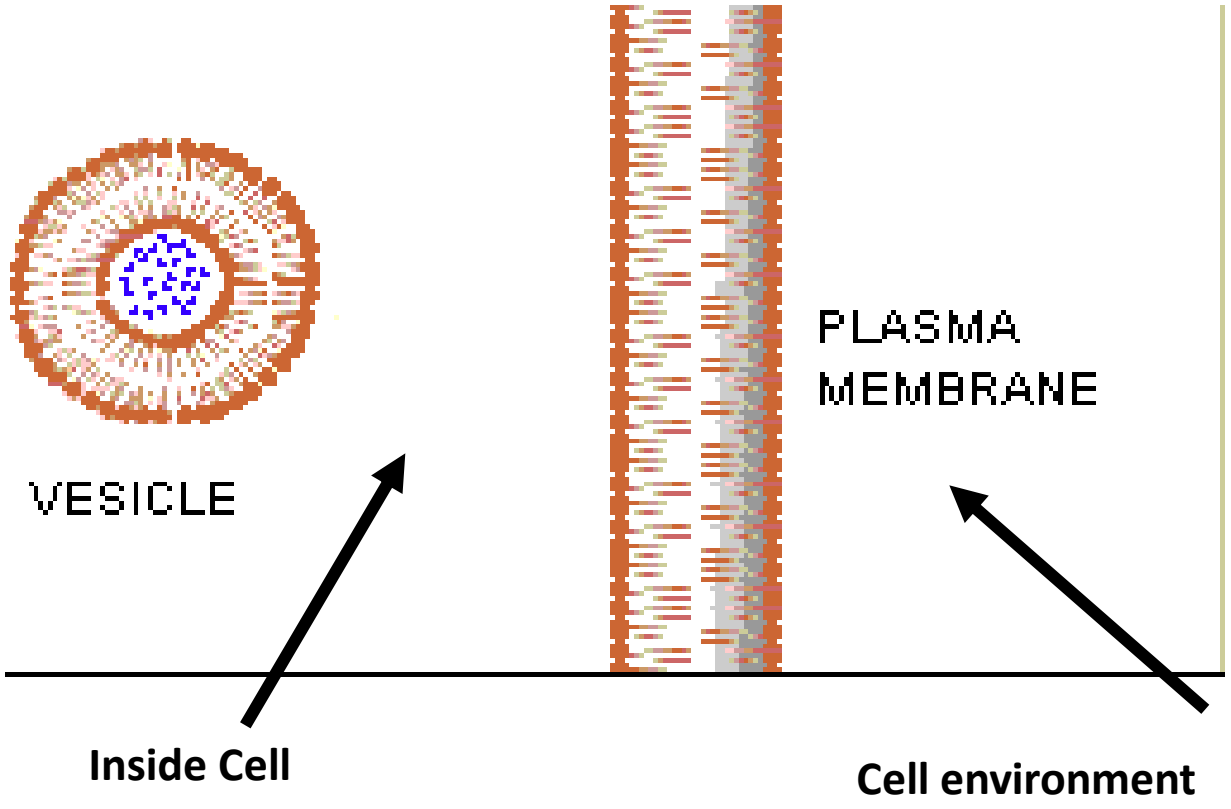
Phagocytosis About to Occur



Phagocytosis - Capture of a Yeast Cell (yellow) by Membrane Extensions of an Immune System Cell (blue)

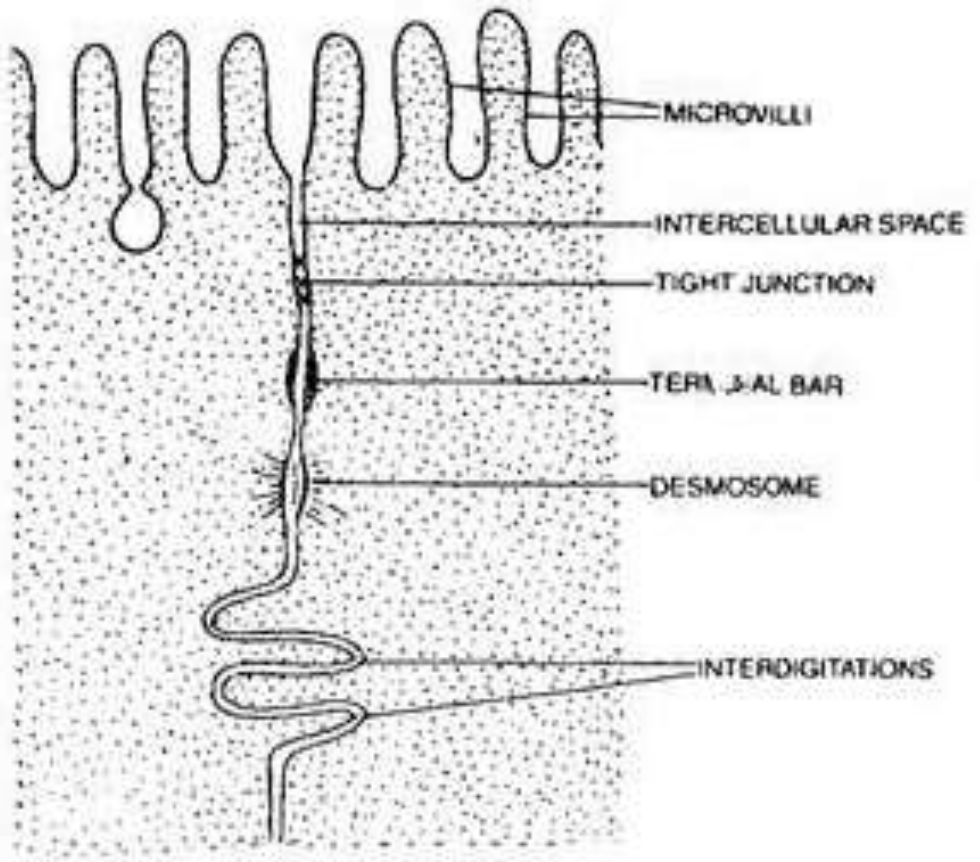
Exocytosis

The opposite of endocytosis is exocytosis. Large molecules that are manufactured in the cell are released through the cell membrane.



- **Formation of cell organelles**
- **Increasing the absorptive surface**
- **Transmission of nerve**
- **impulses**

Modifications of Cell Membrane



Various modifications of cell membrane.

Modifications of Cell Membrane

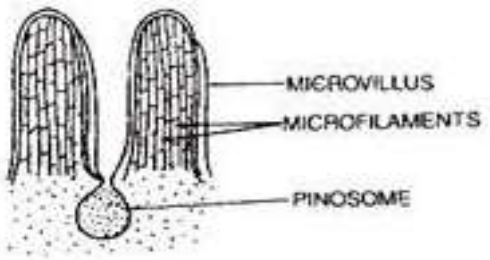
1. Microvilli:

They are finger like evaginations of 0.6—0.8 µm length and 0.1 µm diameter which are found on the free surface of cells engaged in absorption, e.g. intestinal cells, hepatic cells, mesothelial cells, uriniferous tubules. The surface having microvilli is called striated border or brush border.

Microvilli increase the surface area several times. The narrow spaces in between microvilli take part in pinocytosis.

2. Mesosomes:

They are plasmalemma infoldings found in bacteria. One type of mesosome is attached internally to the nucleoid. It is required for nucleoid replication and cell division.



Two microvilli and a pinosome developing in between.

3. Junctional Complexes:

They are contacts between adjacent cells which in case of animal cells are separated by spaces of 150-200 Å filled with tissue fluid. The important ones are:

(i) Interdigitations:

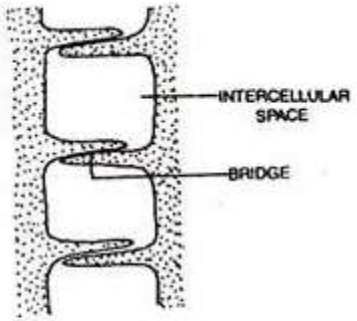
There is interlocking of finger-like membrane outgrowths between two adjacent cells. Interdigitations increase the area of the contact between two cells for exchange of materials.

(ii) Intercellular Bridges:

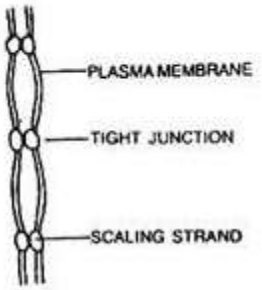
Projections from adjacent cells make contact for rapid conduction of stimuli.

(iii) Tight junctions:

(Zonulae Occludentes, singular— Zonula Occludens). Here plasma membranes of two adjacent cells are fused at a series of points with a network of ridges or sealing strands. Tight junctions occur in epithelia with high electrical resistance and where filtration is to occur through the cells, e.g., capillaries, brain cells, collecting tubules of kidneys.

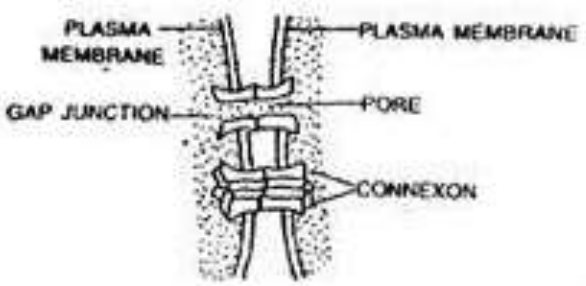


Intercellular bridges.



Tight junctions between two plasma membranes.

- **(iv) Gap Junctions:**
- The adjacent cells have protoplasmic connections through special protein cylinders called connexons. Each connexon is made of six identical protein subunits around a hydrophilic channel.



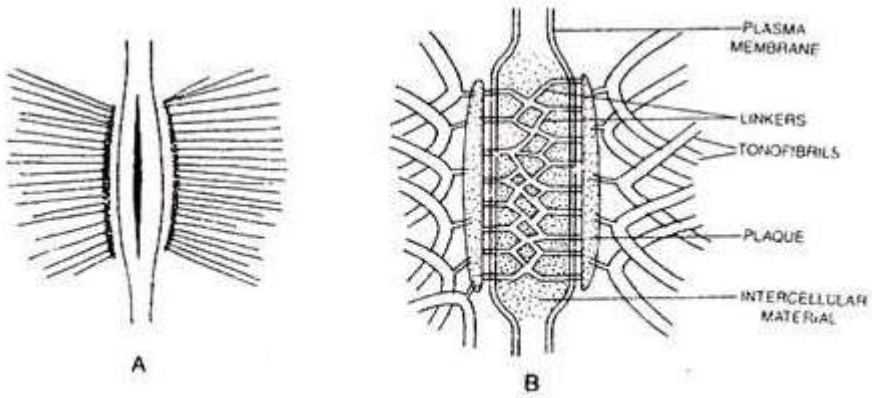
Gap junctions between two cells.

(v) Plasmodesmata:

They are protoplasmic bridges amongst plant cells which occur in the areas of cell wall pits or pores.

(vi) Desmosomes:

(Maculae Adherentes, singular—Macula Adherens). Adjacent membranes possess disc-shaped thickenings of about 0.5 (am diameter, a number of tonofibrils (= tonofilaments) and trans-membrane linkers embedded in dense intercellular material. Desmosomes function as spot welds and are hence called spot desmosomes. They occur in epithelia subjected to disruption.



Structure of desmosome. (A) in section. (B) detailed reconstruction.

(vii) Terminal Bars:

(Belt Desmosomes, Zonulae Adherentes, singular—Zonula Adherens. Intermediary Junction). Terminal bars are desmosomes without tonofibrils. Bands of thickenings occur on the inner surface of membrane. The bands contain microfilaments and intermediate filaments.

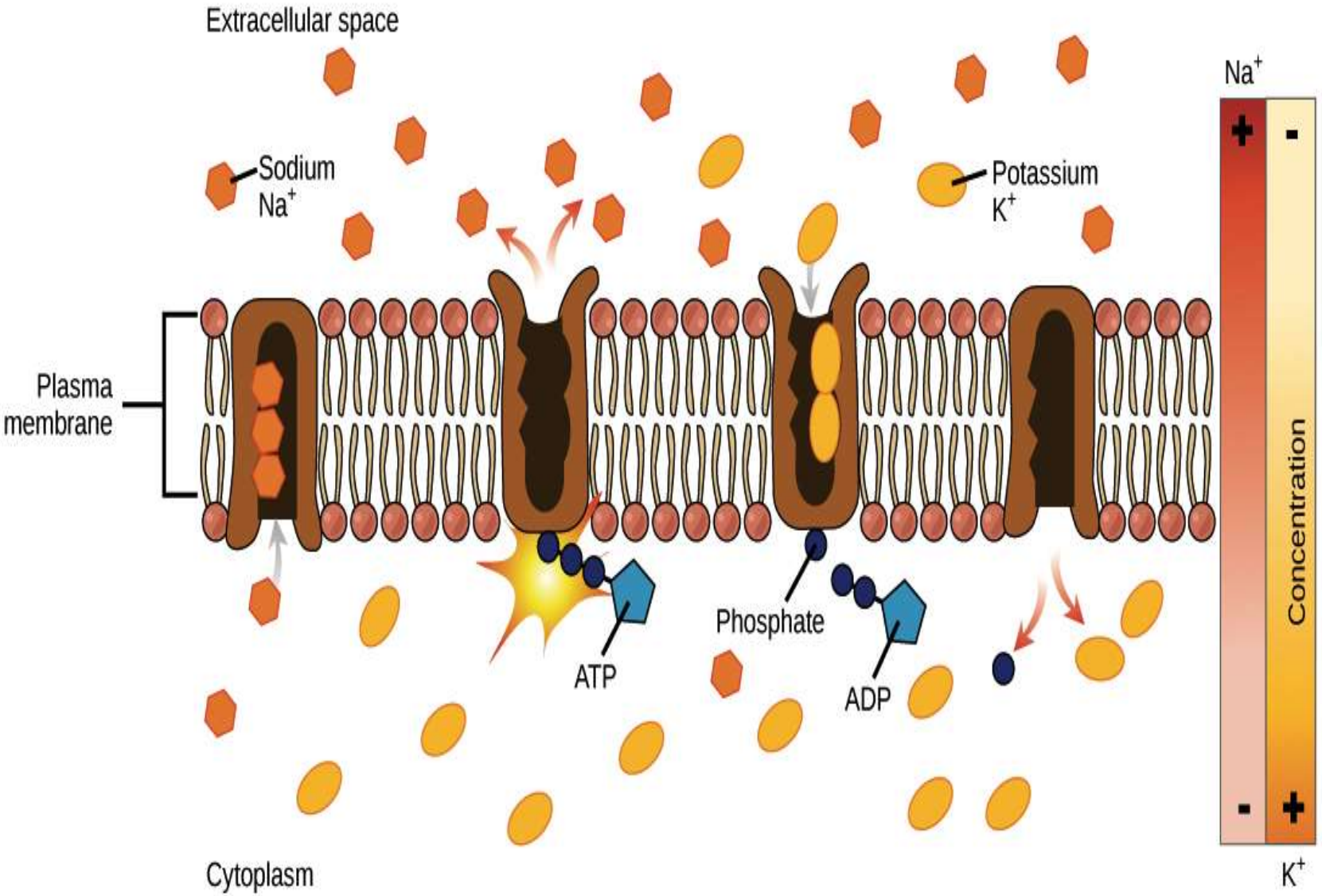
Active Transport

- To move substances against a concentration or electrochemical gradient, a cell must use energy.
- Active transport mechanisms do just this, expending energy (often in the form of ATP) to maintain the right concentrations of ions and molecules in living cells.
- In fact, cells spend much of the energy they harvest in metabolism to keep their active transport processes running.
- For instance, most of a red blood cell's energy is used to maintain internal sodium and potassium levels that differ from those of the surrounding environment.

- Active transport mechanisms can be divided into two categories.
- **Primary active transport** directly uses a source of chemical energy (e.g., ATP) to move molecules across a membrane against their gradient.
- **Secondary active transport** (**cotransport)**, on the other hand, uses an electrochemical gradient – generated by active transport – as an energy source to move molecules against their gradient, and thus does not directly require a chemical source of energy such as ATP.

Primary active transport

- One of the most important pumps in animal cells is the **sodium-potassium pump**, which moves Na^++start superscript, plus, end superscript out of cells, and K^++start superscript, plus, end superscript into them.
- Because the transport process uses ATP as an energy source, it is considered an example of primary active transport.



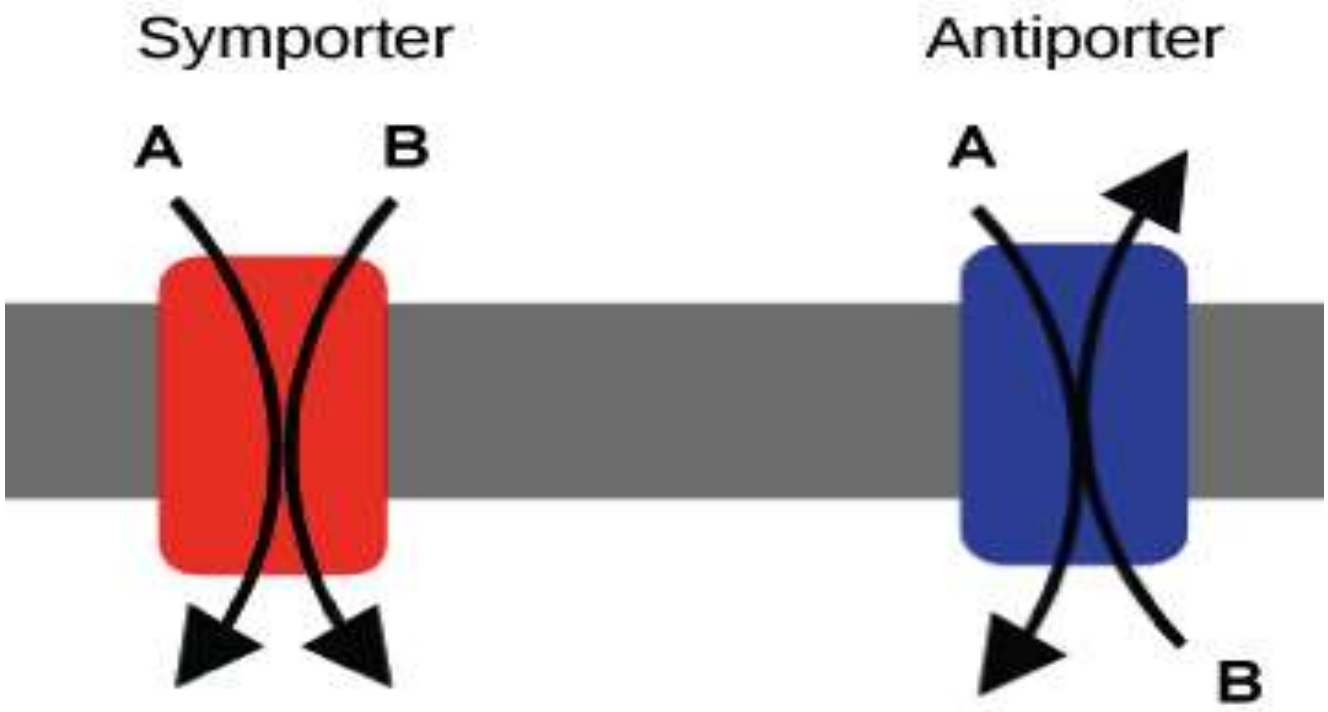
..\..\Active Transport _ Primary And Secondary - YouTube (360p).mp4

Secondary active transport

- The electrochemical gradients set up by primary active transport store energy, which can be released as the ions move back down their gradients.
- Secondary active transport uses the energy stored in these gradients to move other substances against their own gradients.

- In secondary active transport, the movement of the sodium ions down their gradient is coupled to the uphill transport of other substances by a shared carrier protein (a **co-transporter**).
- A carrier protein lets sodium ions move down their gradient, but simultaneously brings a glucose molecule up its gradient and into the cell. The carrier protein uses the energy of the sodium gradient to drive the transport of glucose molecules.

- In secondary active transport, the two molecules being transported may move either in the same direction (i.e., both into the cell), or in opposite directions (i.e., one into and one out of the cell).
- When they move in the same direction, the protein that transports them is called a **symporter**, while if they move in opposite directions, the protein is called an **antiporter**.


Symporter
A
B
Antiporter
A
B