CELL TRANSPORT

2nd Sem (Hons), Paper-IV

Lecture No.2

Types of Transport Across the Cell Membrane

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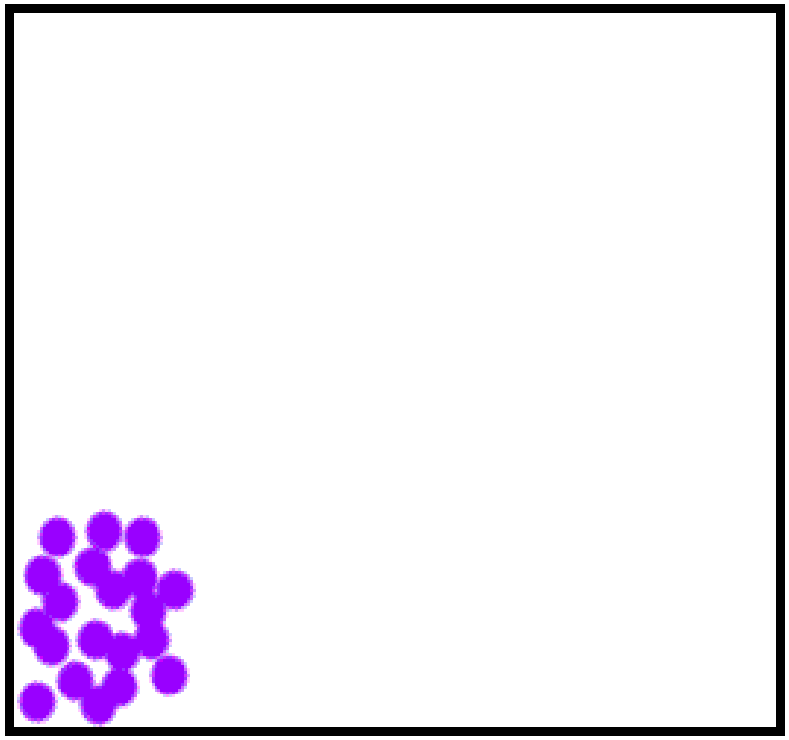
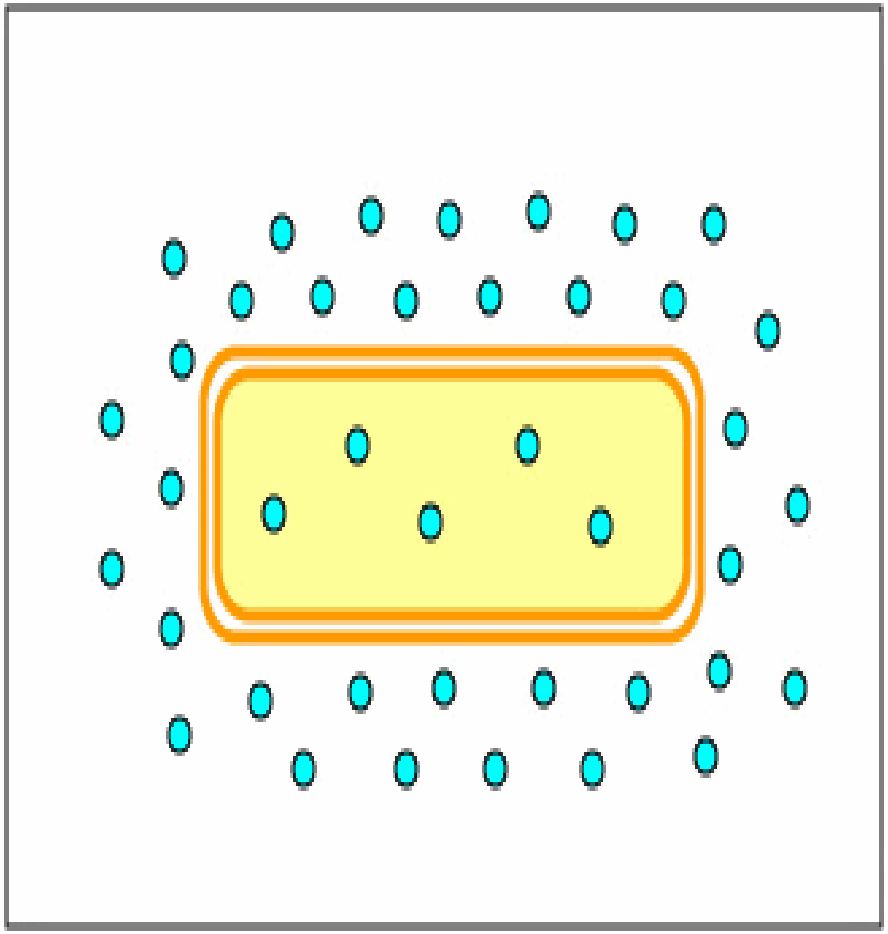
Simple Diffusion



- Requires NO energy
  - Molecules move from area of HIGH to LOW concentration

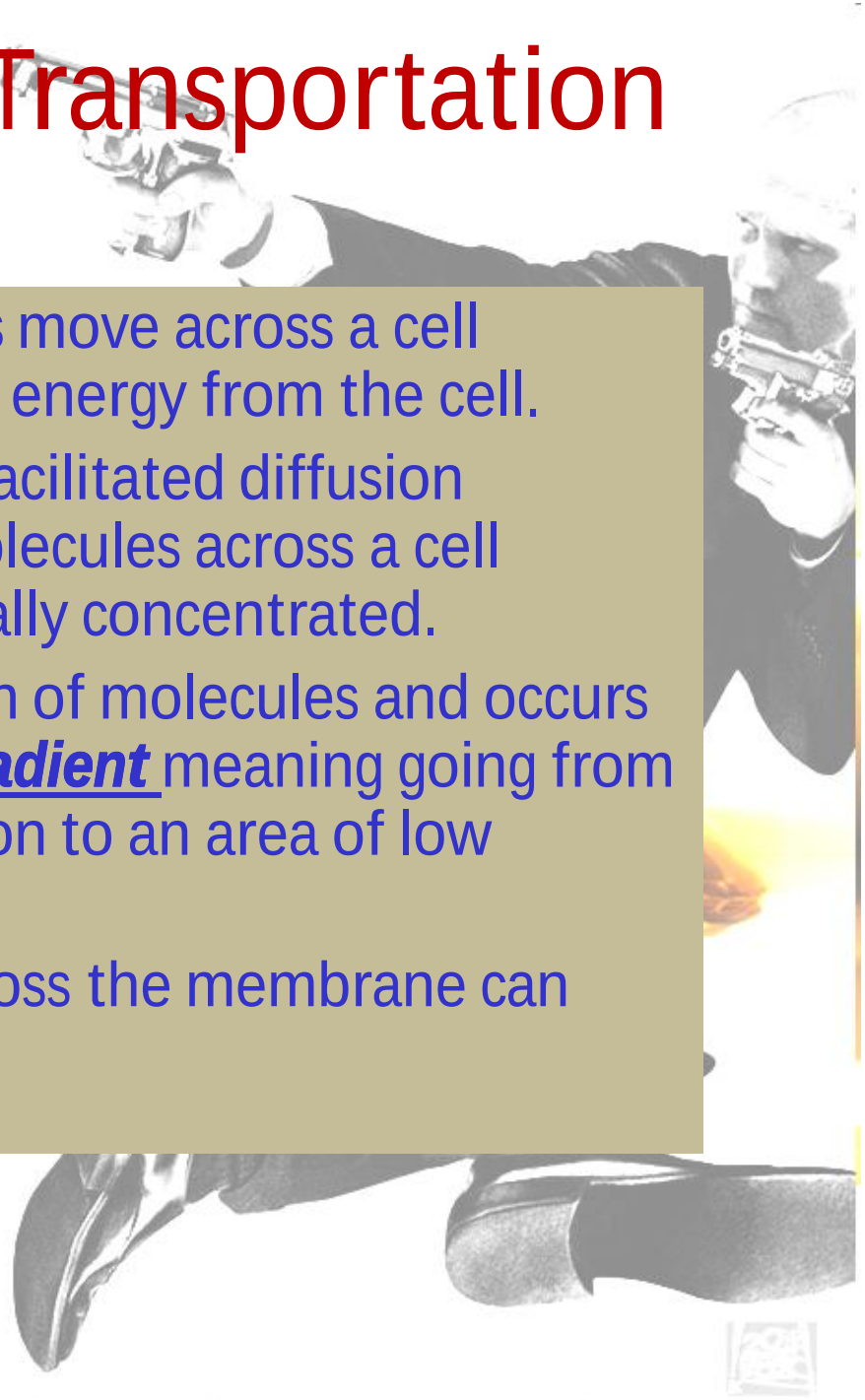
Diffusion

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



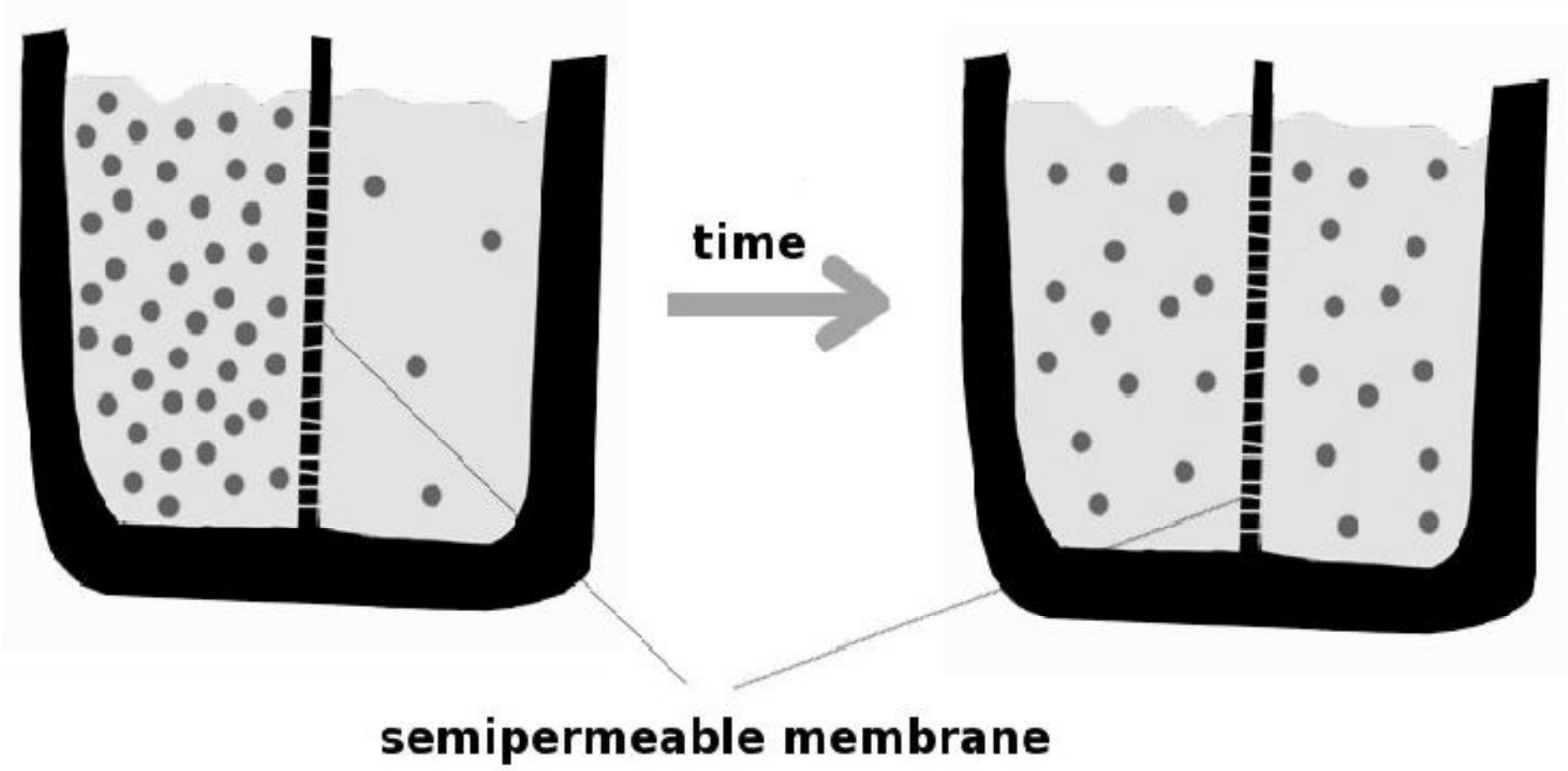
Types of Passive Transportation

- **Passive Transport-** substances move across a cell membrane but do not require energy from the cell.
  - Ex. Diffusion, osmosis and facilitated diffusion
- ***Diffusion-***spreading out of molecules across a cell membrane until they are equally concentrated.
  - Comes from random motion of molecules and occurs along the ***concentration gradient*** meaning going from an area of high concentration to an area of low concentration
  - Substances able to pass across the membrane can diffuse in or out of a cell.

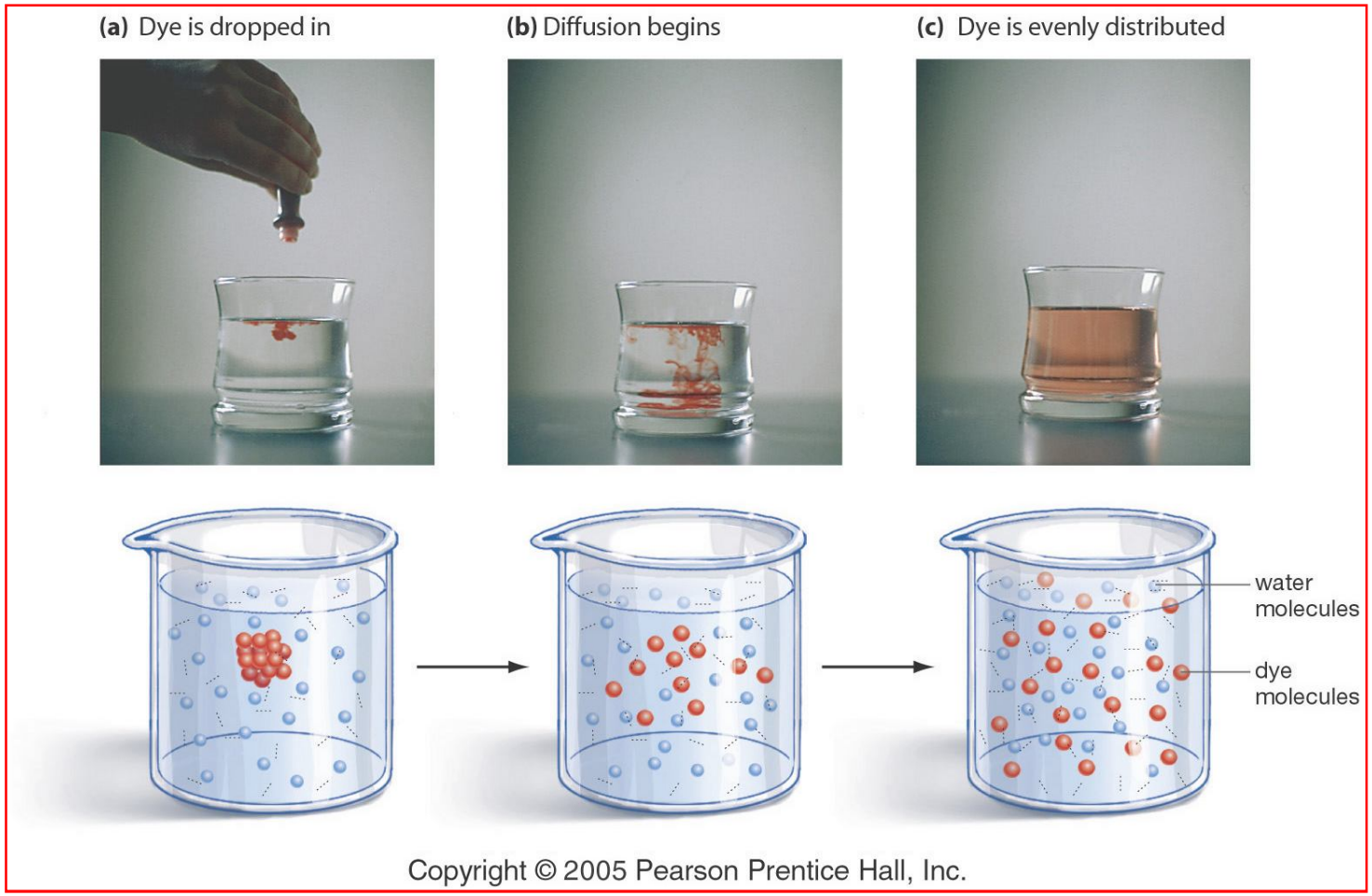


Picture of Diffusion

Diffusion across a semipermeable membrane



Diffusion of Lipids



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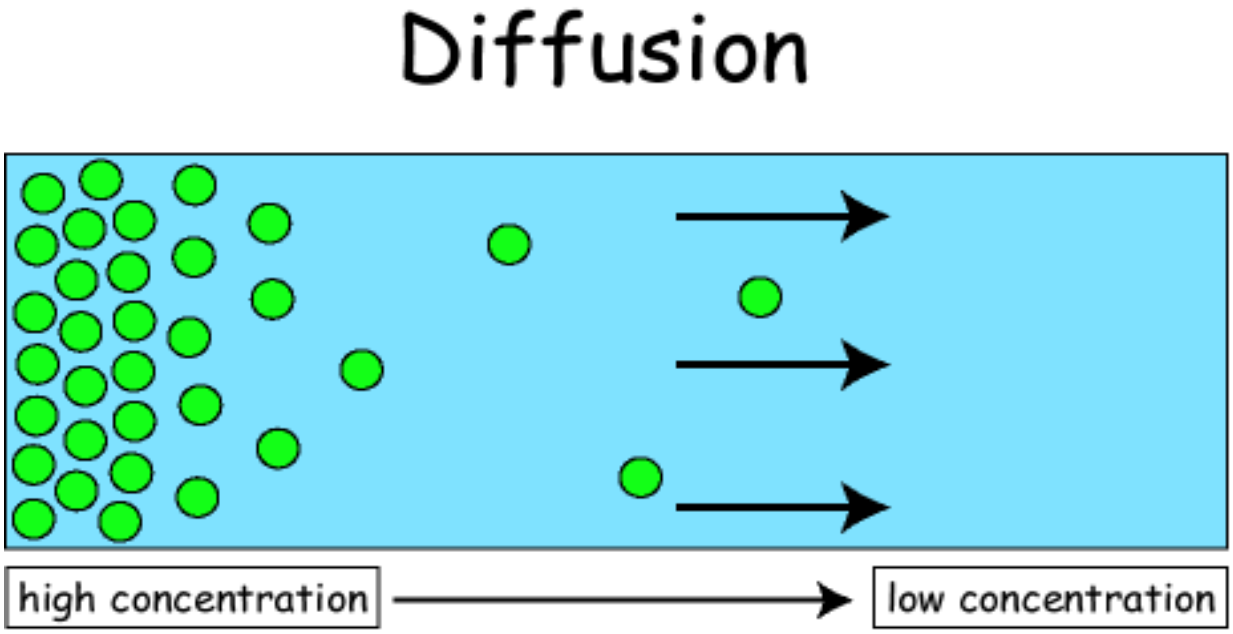
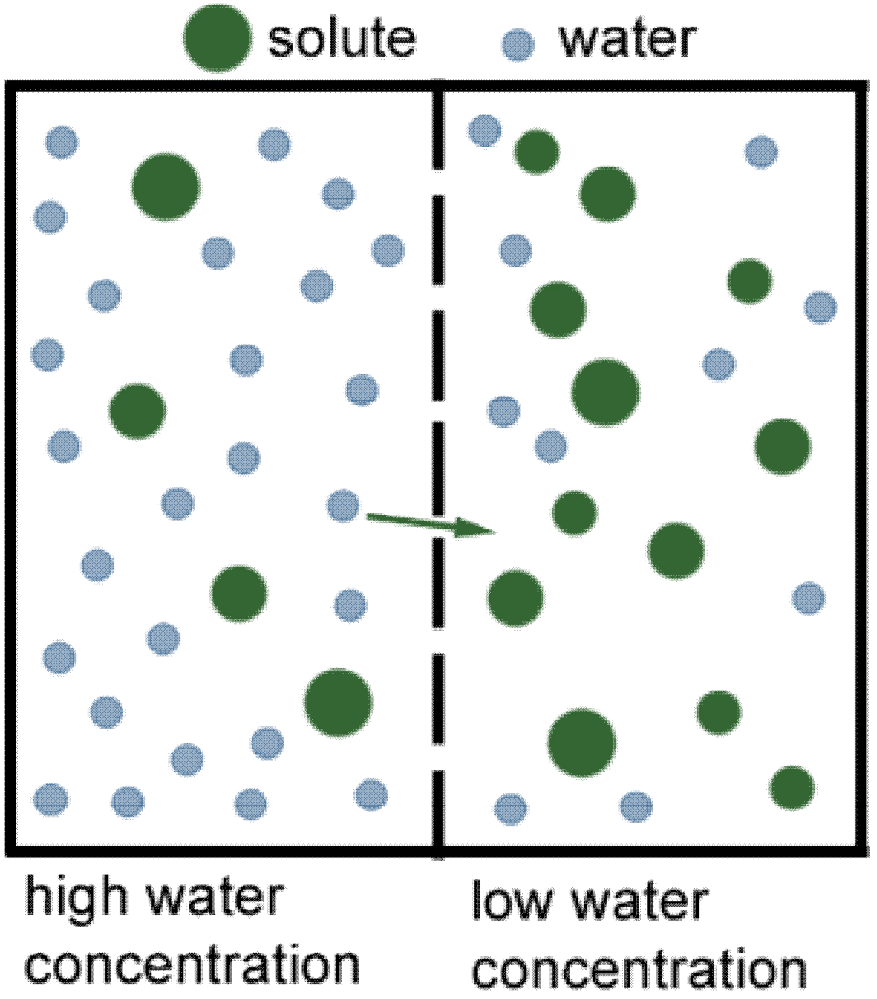
Diffusion Through a Membrane



- Solute moves DOWN the concentration gradient. (HIGH to LOW)

Osmosis

- Diffusion of water across a membrane
  - Moves from HIGH water concentration to LOW water concentration
    - Water is attracted to solutes (like salt) so it will also travel to areas of low solute concentration to high solute concentration.



Types of Passive Transportation

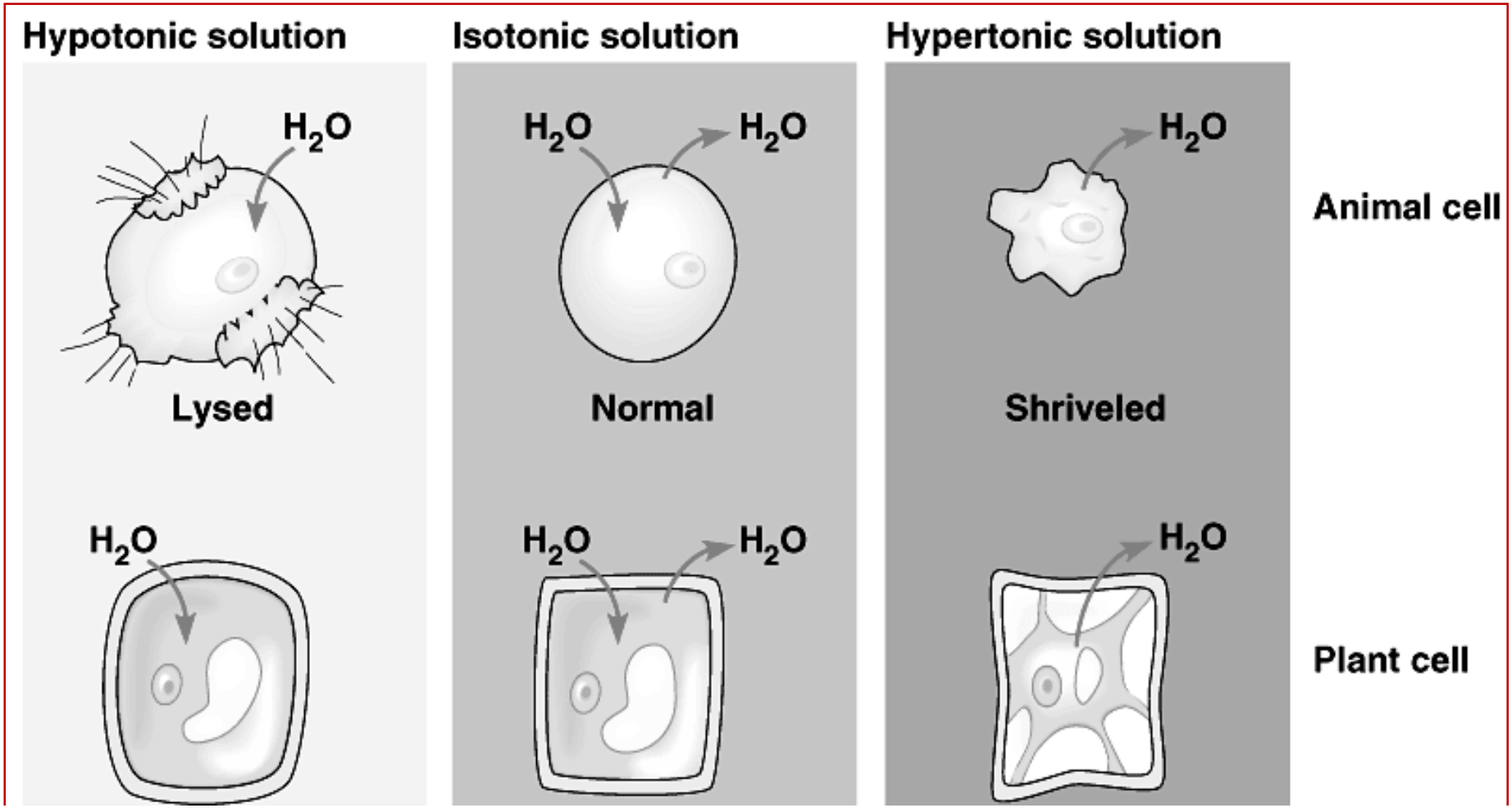
- ***Osmosis-*** diffusion of H_2O molecules through a semipermeable membrane from greater to lower concentration.
  - If two solutions have the same concentration are separated by a semipermeable membrane, H_2O molecules will pass through it in both directions at the same rate so concentration of solutions will stay the same.
  - Passive transport because cell does not use energy
  - Cells placed in solutions of different concentrations from the cell, the cell may be damaged or ***lyse-*** burst

Pictures of Osmosis

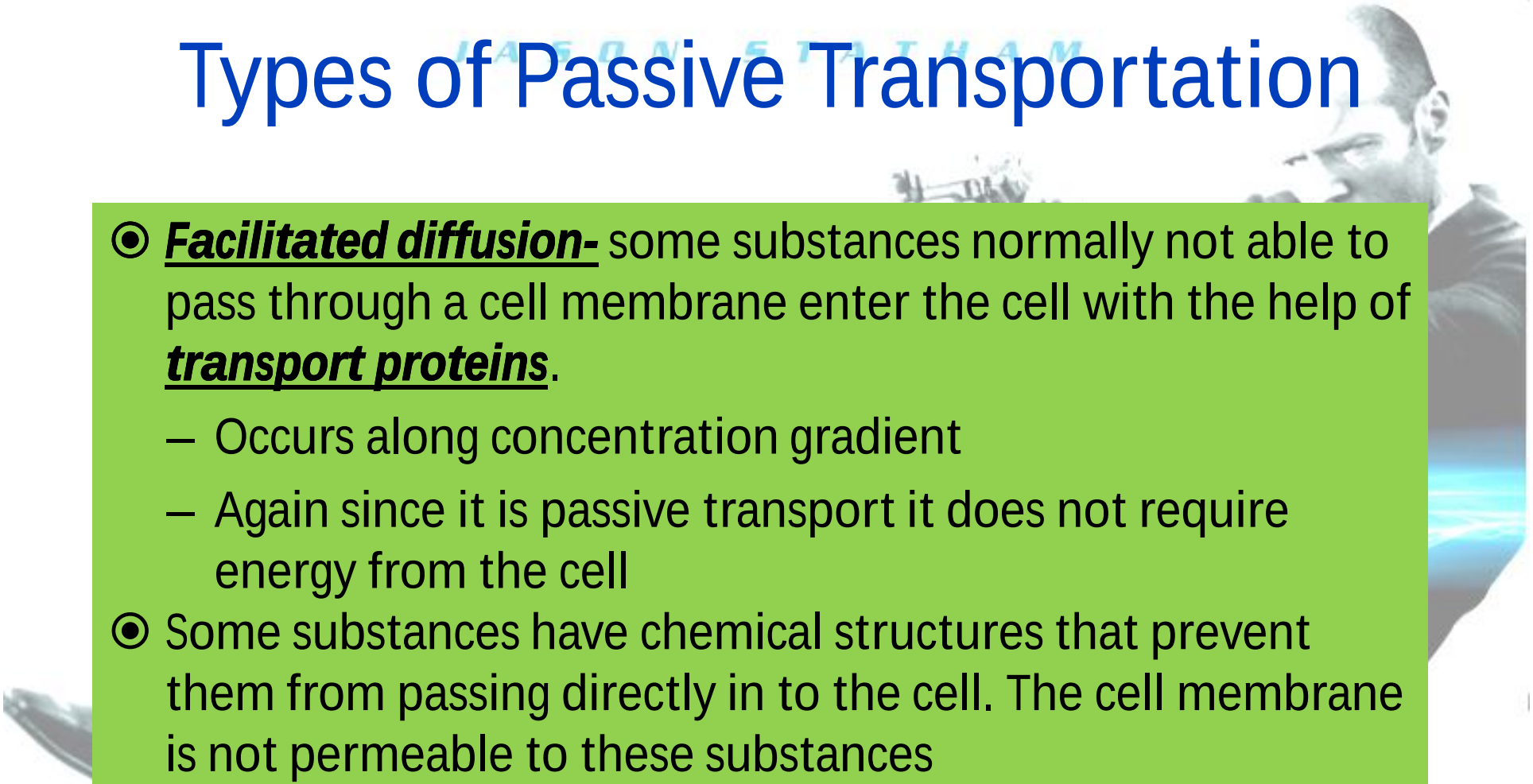
Water concentration greater outside the cell than inside so water moves into the cell

Water concentration the same inside and outside the cell so there is no net movement of water

Water concentration greater inside the cell than outside so water moves out of the cell

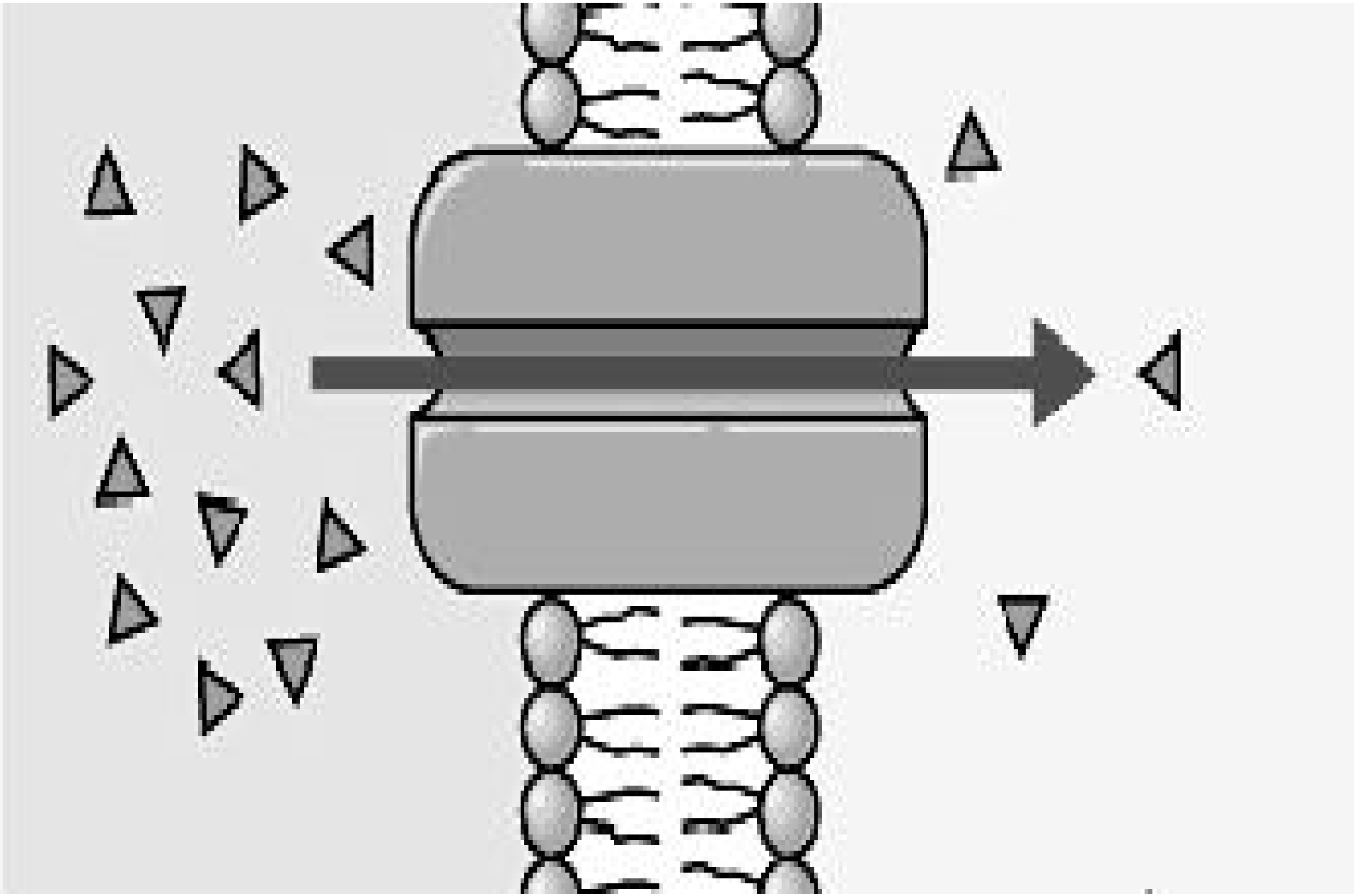


Types of Passive Transportation



- ***Facilitated diffusion-*** some substances normally not able to pass through a cell membrane enter the cell with the help of ***transport proteins***.
  - Occurs along concentration gradient
  - Again since it is passive transport it does not require energy from the cell
- Some substances have chemical structures that prevent them from passing directly in to the cell. The cell membrane is not permeable to these substances
- ***Transport proteins –*** provide access across the membrane
- ***Ex.*** Glucose passes through a cell membrane using facilitated diffusion

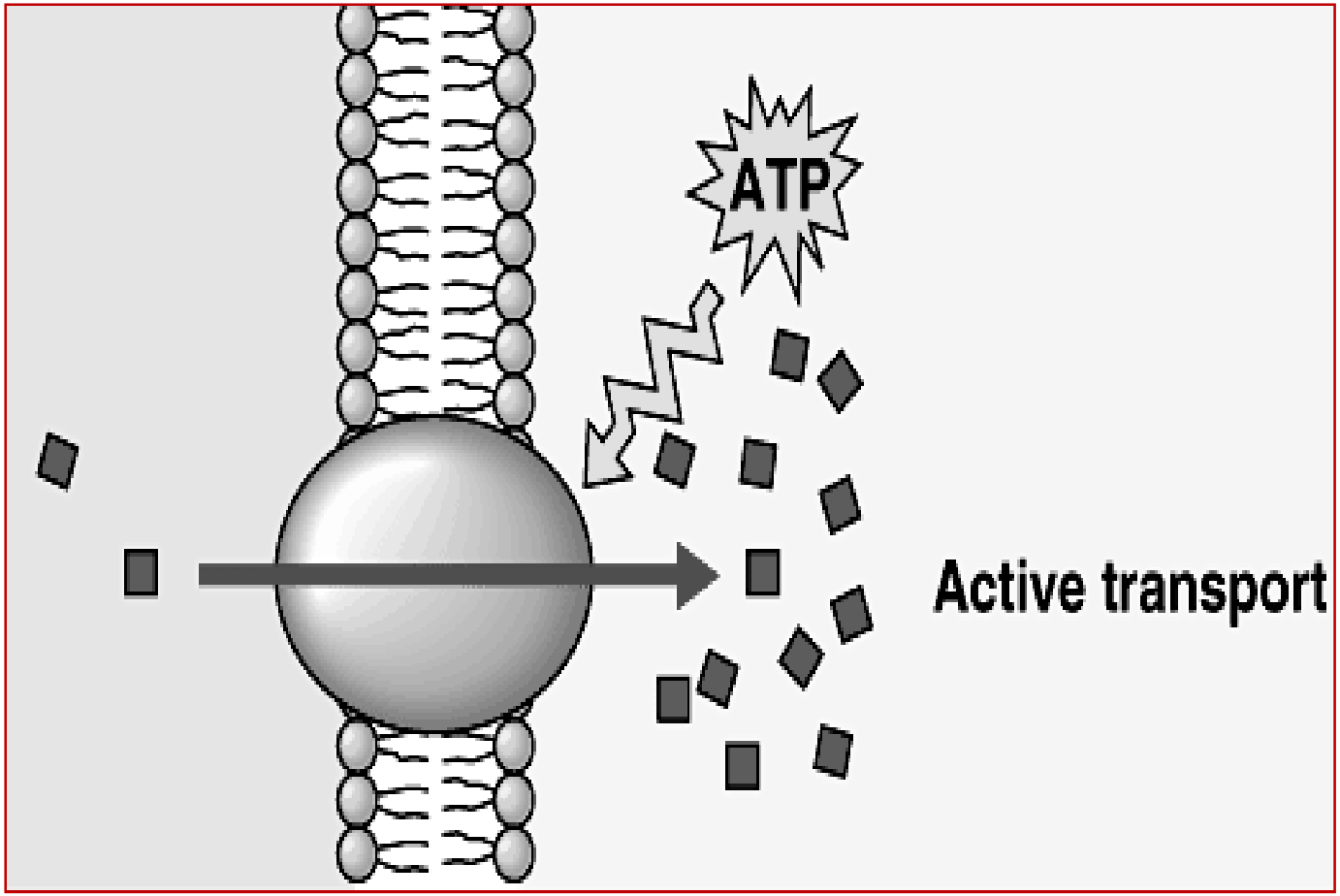
Picture of Facilitated Diffusion



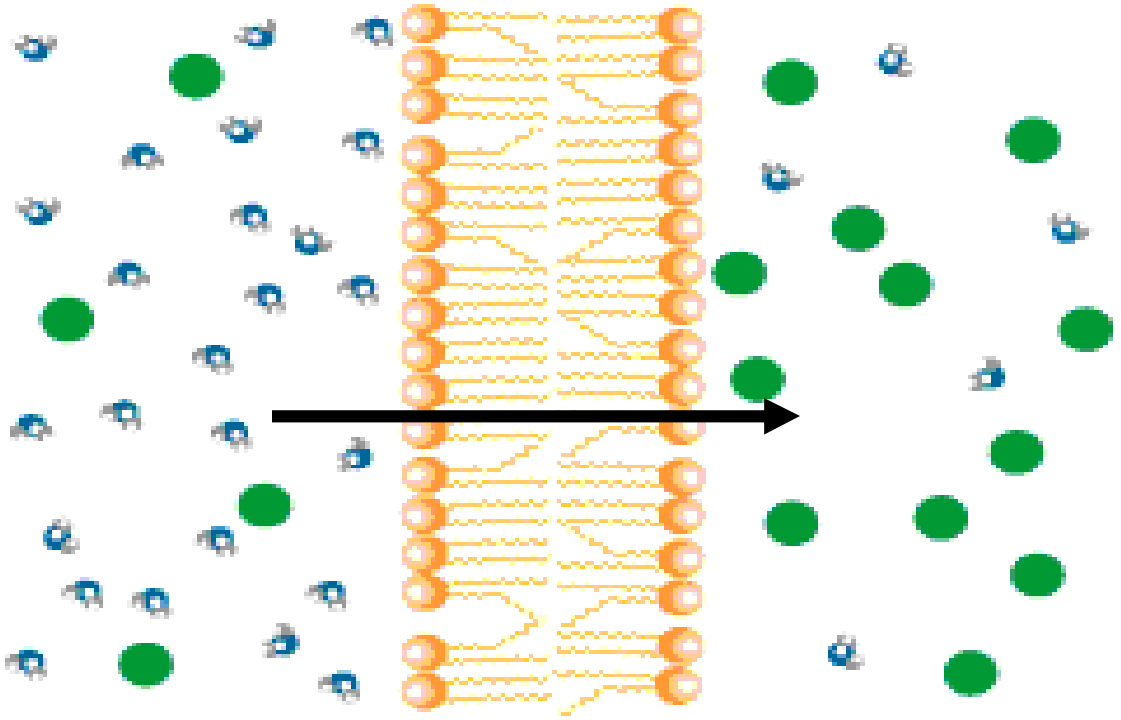
Active Transport : The Other Way

- ***Active Transport***- molecules move ***against*** the ***concentration gradient*** and go from a ***LOW*** area of concentration to a ***HIGH*** area of concentration
  - ***This requires energy***
- This can happen when cells pump molecules through the cell membrane
  - This "pumping" of molecules requires energy
- Since this process does not depend of diffusion, cells use it to concentrate molecules within the cell or remove waste
- Ex. Ca^{+}, K^{+}, and Na^{+} must be forced across using the cell membrane using active transport

Active Transport



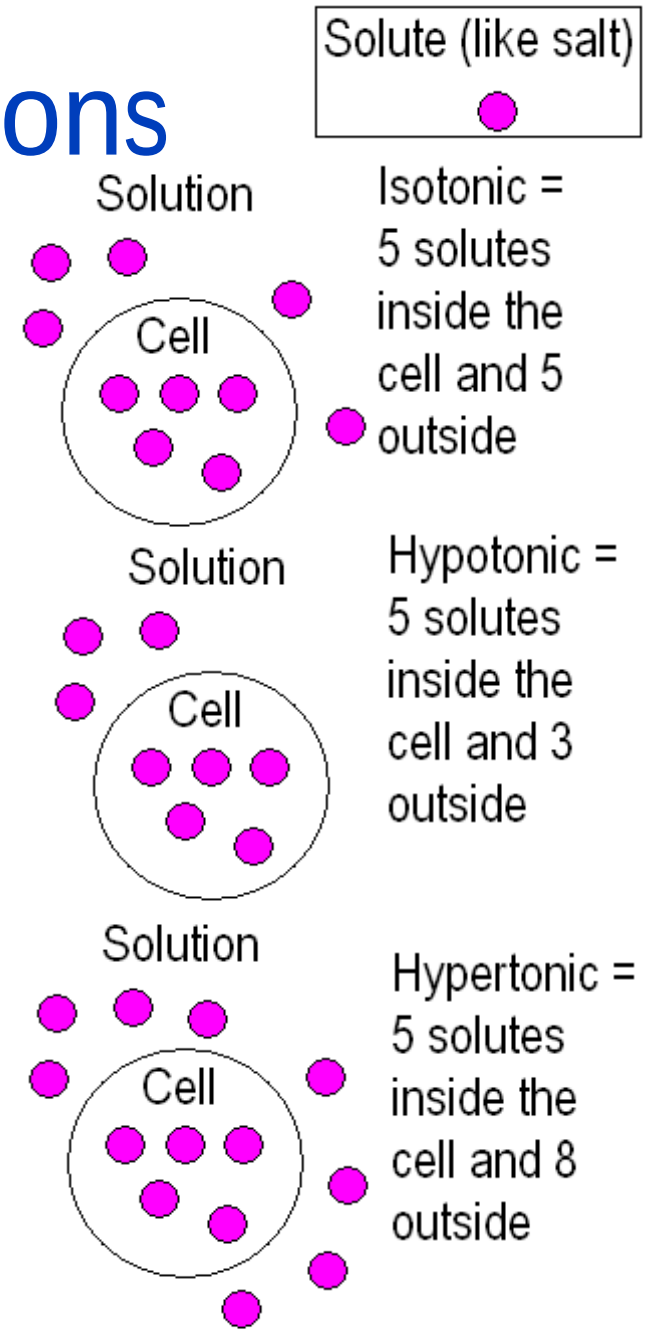
Diffusion of Water Across A Membrane



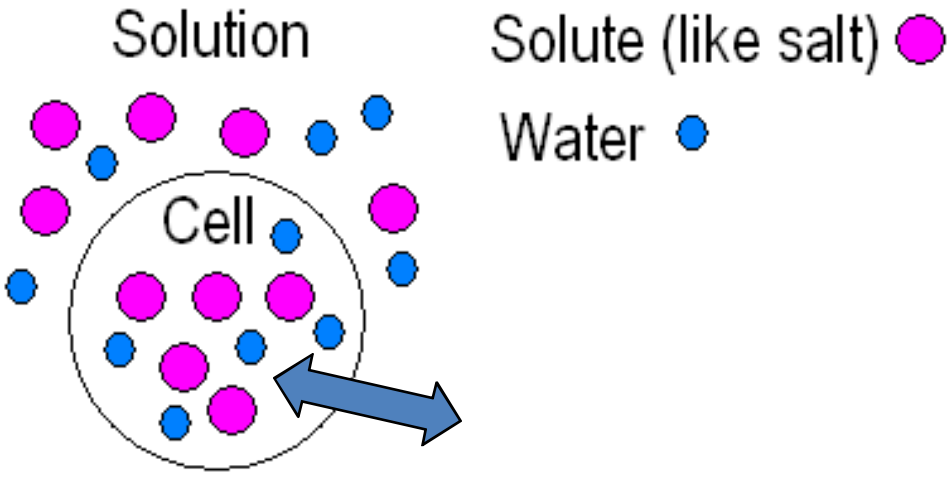
- High water concentration ⟶ Low water concentration
- Low solute concentration ⟶ High solute concentration

Cells in Solutions

- Isotonic
  - A solution whose solute concentration is the same as the solute concentration inside the cell.
- Hypotonic
  - A solution whose solute concentration is lower than the solute concentration inside a cell
- Hypertonic
  - A solution whose solute concentration is higher than the solute concentration inside a cell.



Cell in Isotonic Solution

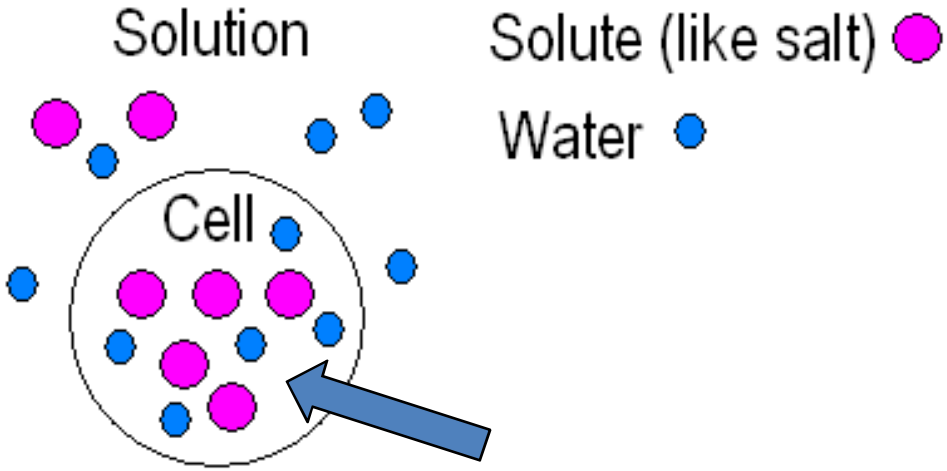


The solute and water concentrations are the same inside and outside the cell.

- What is the direction of water movement?
  - The cell is at EQUILIBRIUM
  - Water will flow in both directions outside and inside the cell.

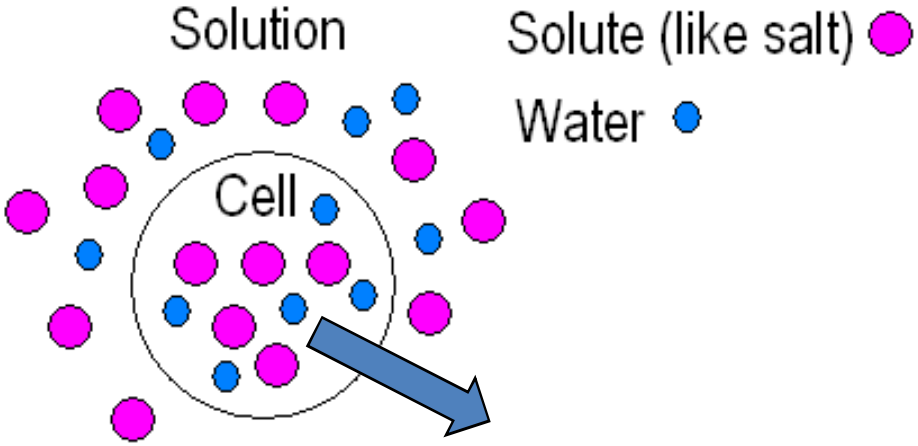
Cell in Hypotonic Solution

- What is the direction of water movement?
  - The water is going INSIDE the cell.
    - Water is attracted to the solute inside the cell.



The solute concentration is greater inside the cell than outside, therefore water will flow into the cell.

Cell in Hypertonic Solution

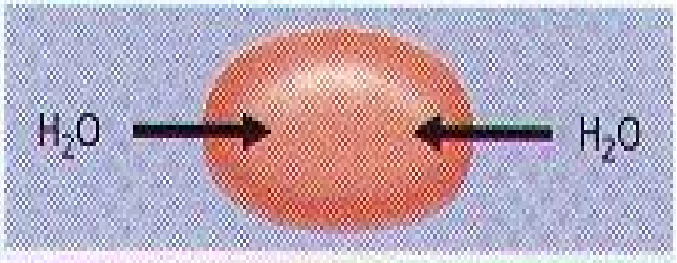
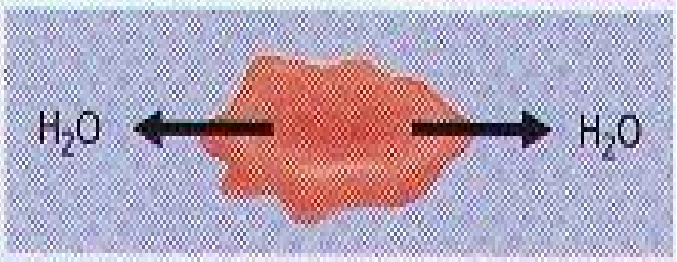
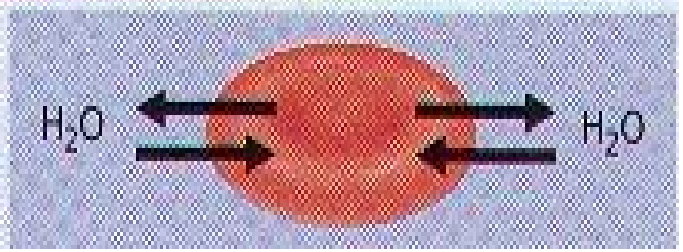


The solute concentration is greater outside the cell, therefore water will flow outside the cell.

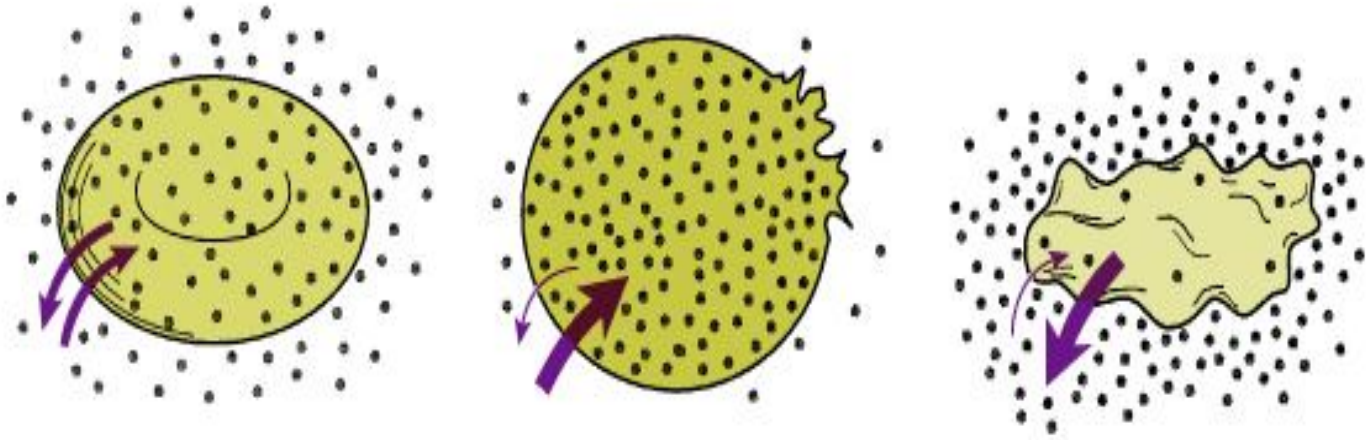
- What is the direction of water movement?
  - The water is GOING OUT of the cell.

Cells in Solutions

TABLE 5-1 *Direction of Osmosis*

Condition	Net movement of water	
External solution is hypotonic to cytosol	into the cell	
External solution is hypertonic to cytosol	out of the cell	
External solution is isotonic to cytosol	none	

Cells in Solutions

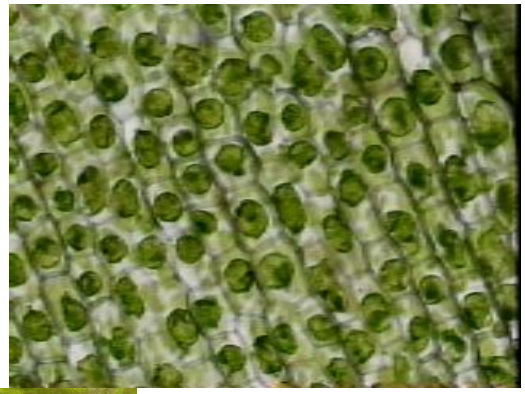


- **Isotonic solution** → No net movement of water. EQUAL amounts leaving and entering
- **hypotonic solution** → **CYTOLYSIS**
- **hypertonic solution** → **PLASMOLYSIS**

Cells in Solutions

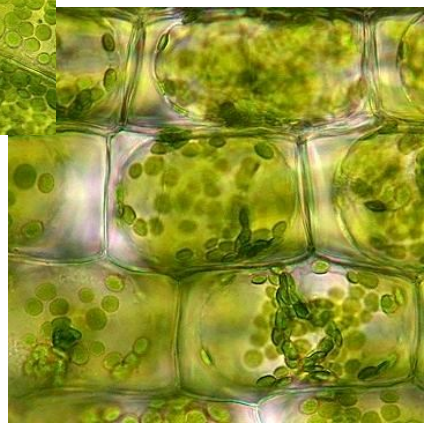
- Cytolysis
  - The destruction of a cell.
    - Cells swell and burst
- Plasmolysis
  - The shrinking of a cell.
    - Cells shrink and shrivel

cytolysis in elodea.

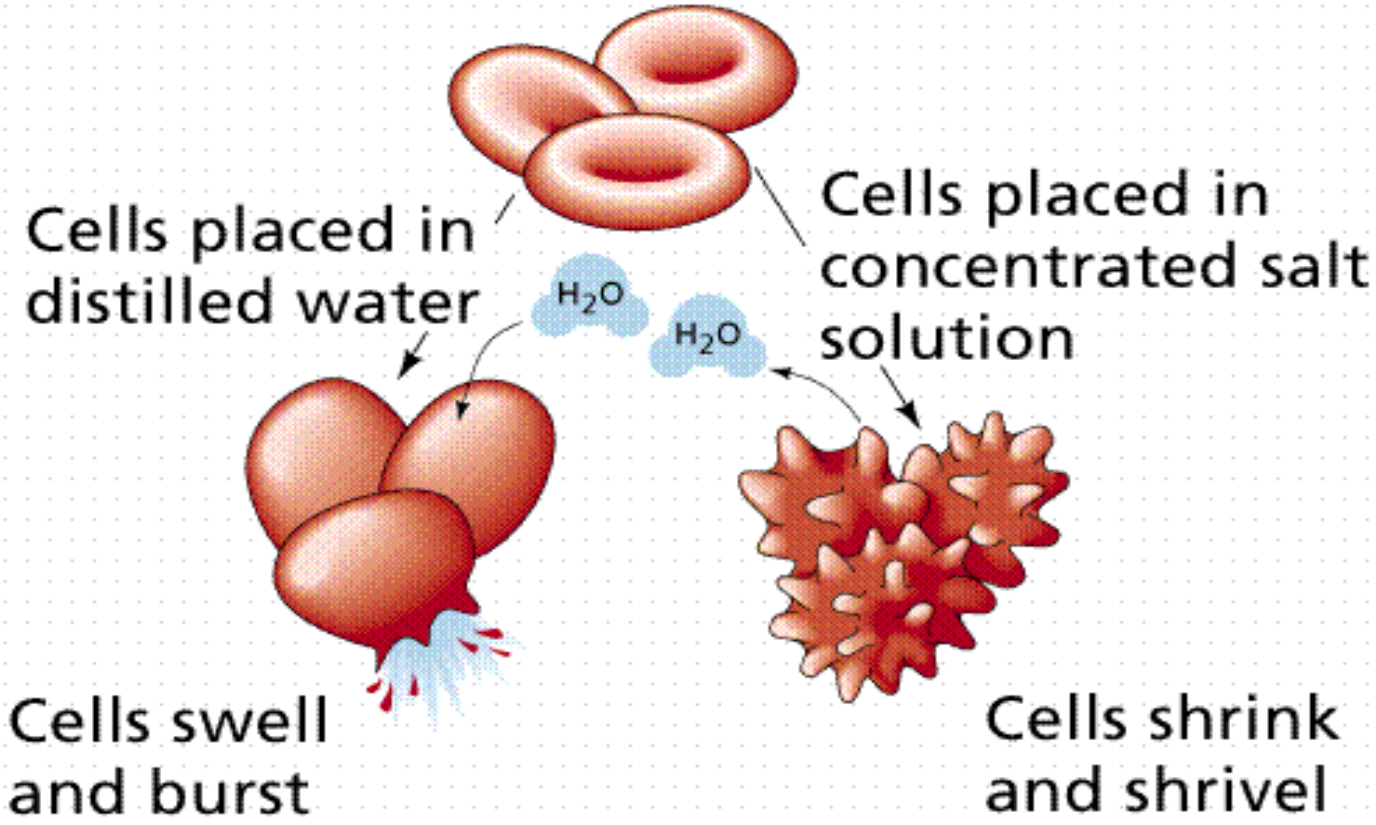


Normal elodea plant cell

Plasmolysis in elodea.

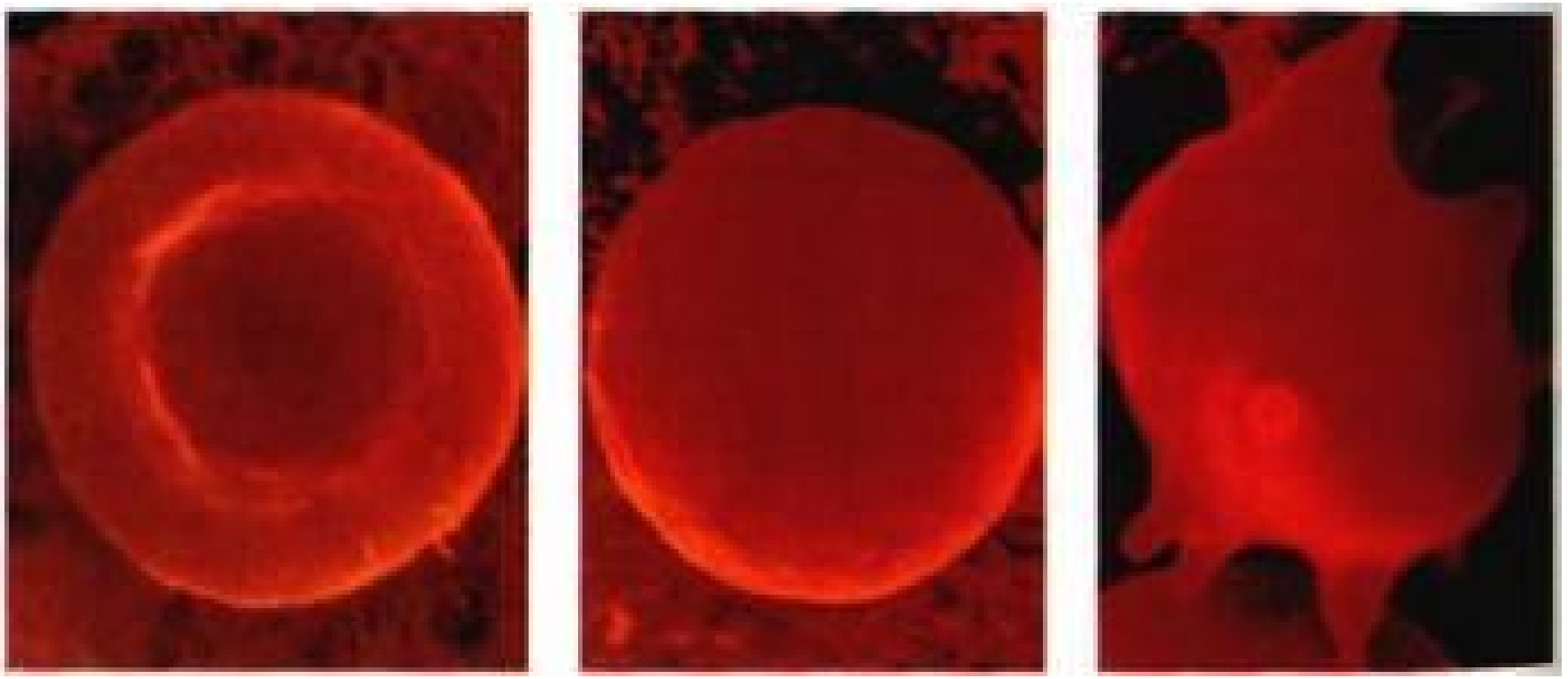


Cytolysis & Plasmolysis



- Cytolysis Plasmolysis

Osmosis in Red Blood Cells



- Isotonic

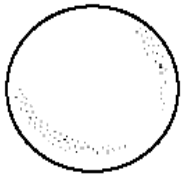
Hypotonic

Hypertonic

Osmosis in Plant and Animal Cells

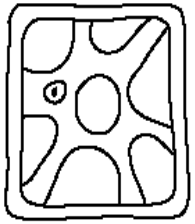
STRUCTURES AND FUNCTIONS The drawings below show the appearance of a red blood cell and a plant cell in isotonic, hypotonic, and hypertonic environments. Label each environment in the spaces provided.

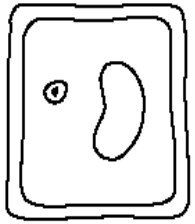
RED BLOOD CELL



a _____ b _____ c _____

PLANT CELL





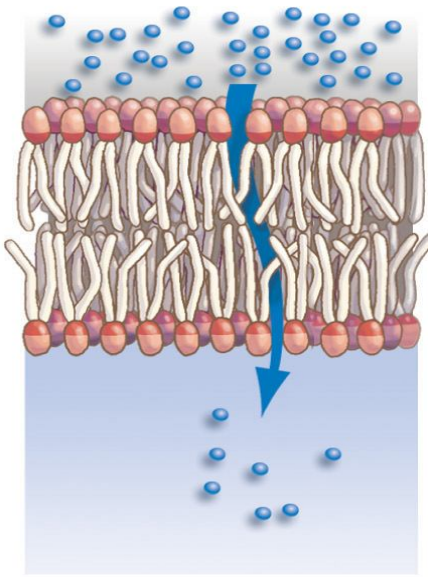
d _____ e _____ f _____

Three Forms of Transport Across the Membrane

- Passive Transport

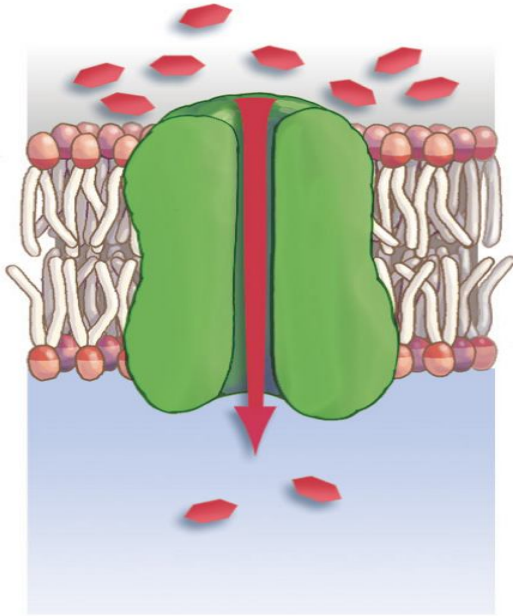
Active Transport

simple diffusion



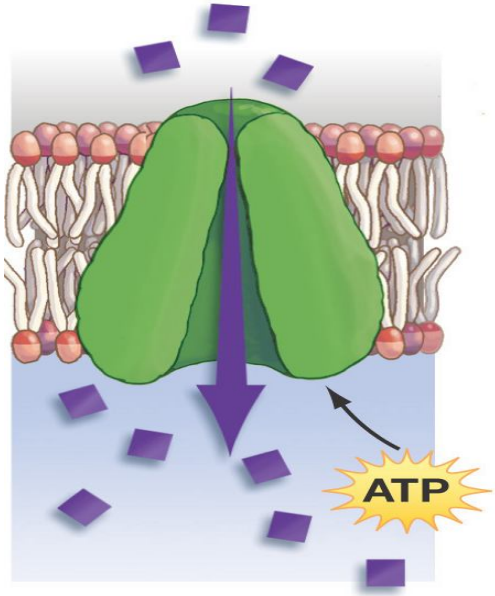
Materials move down their concentration gradient through the phospholipid bilayer.

facilitated diffusion



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

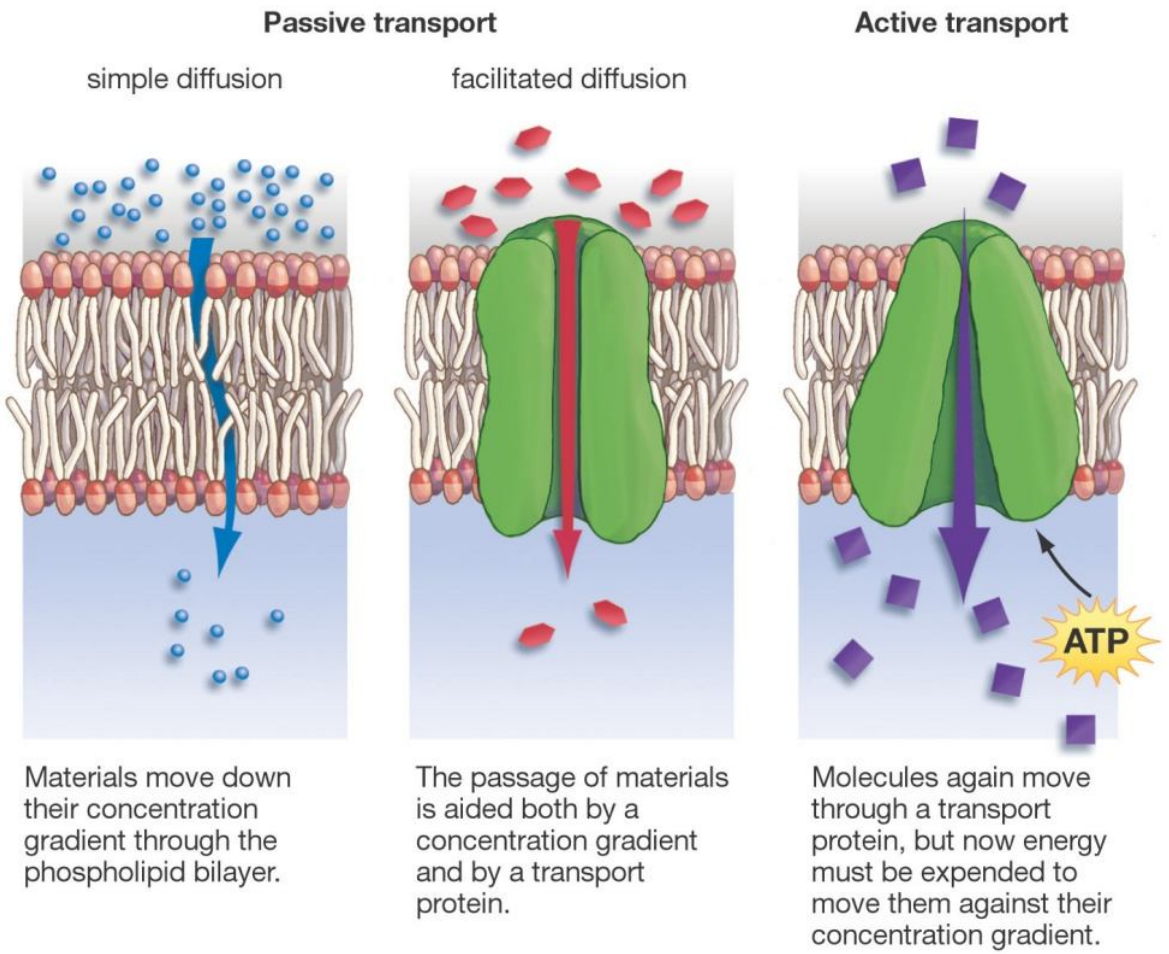
Active transport



Molecules again move through a transport protein, but now energy must be expended to move them against their concentration gradient.

Passive Transport: Simple Diffusion

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



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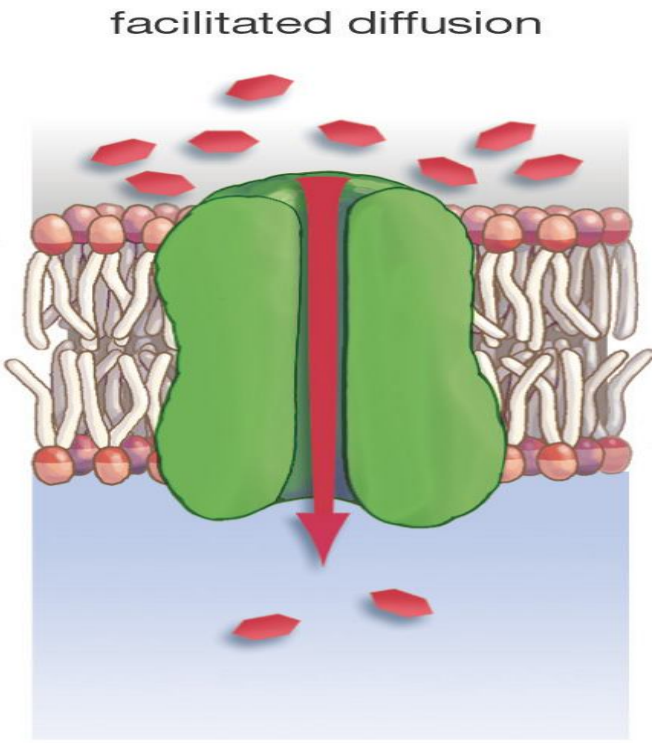
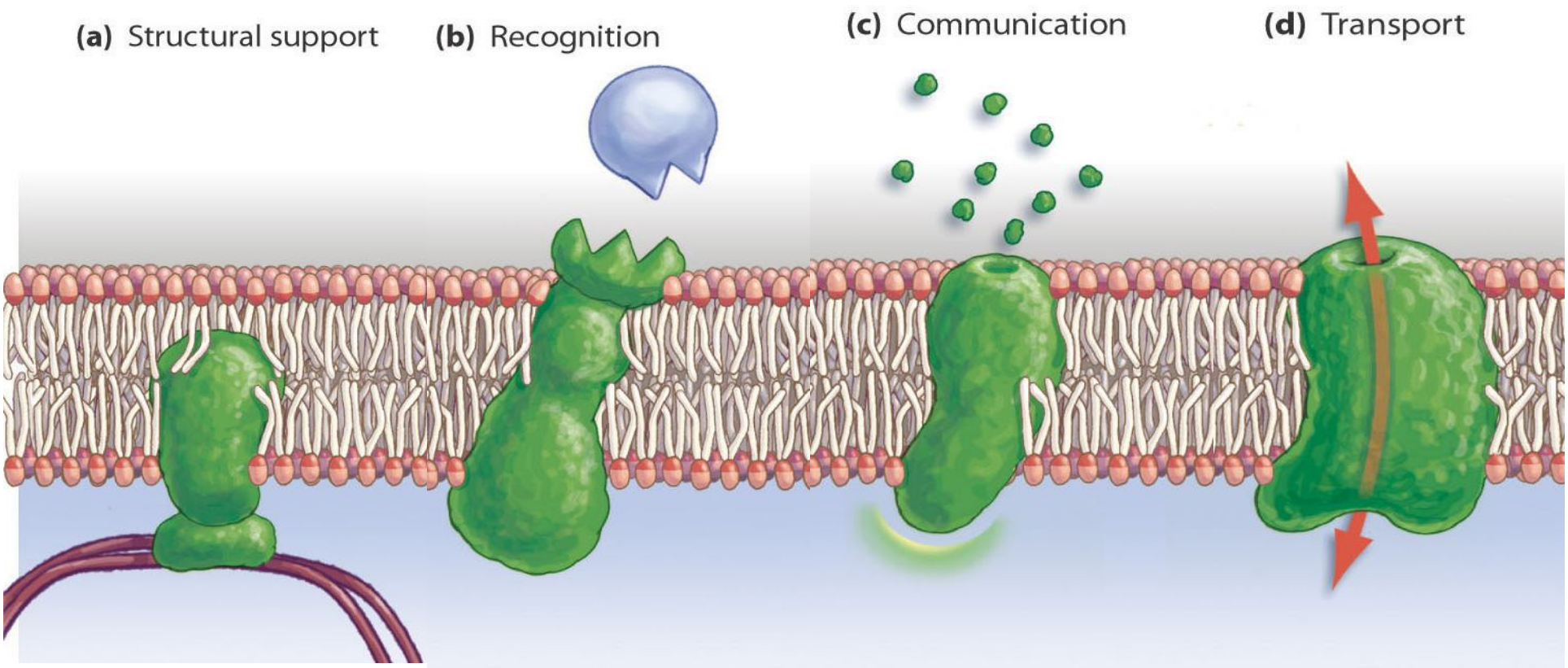
Passive Transport: Facilitated Diffusion



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

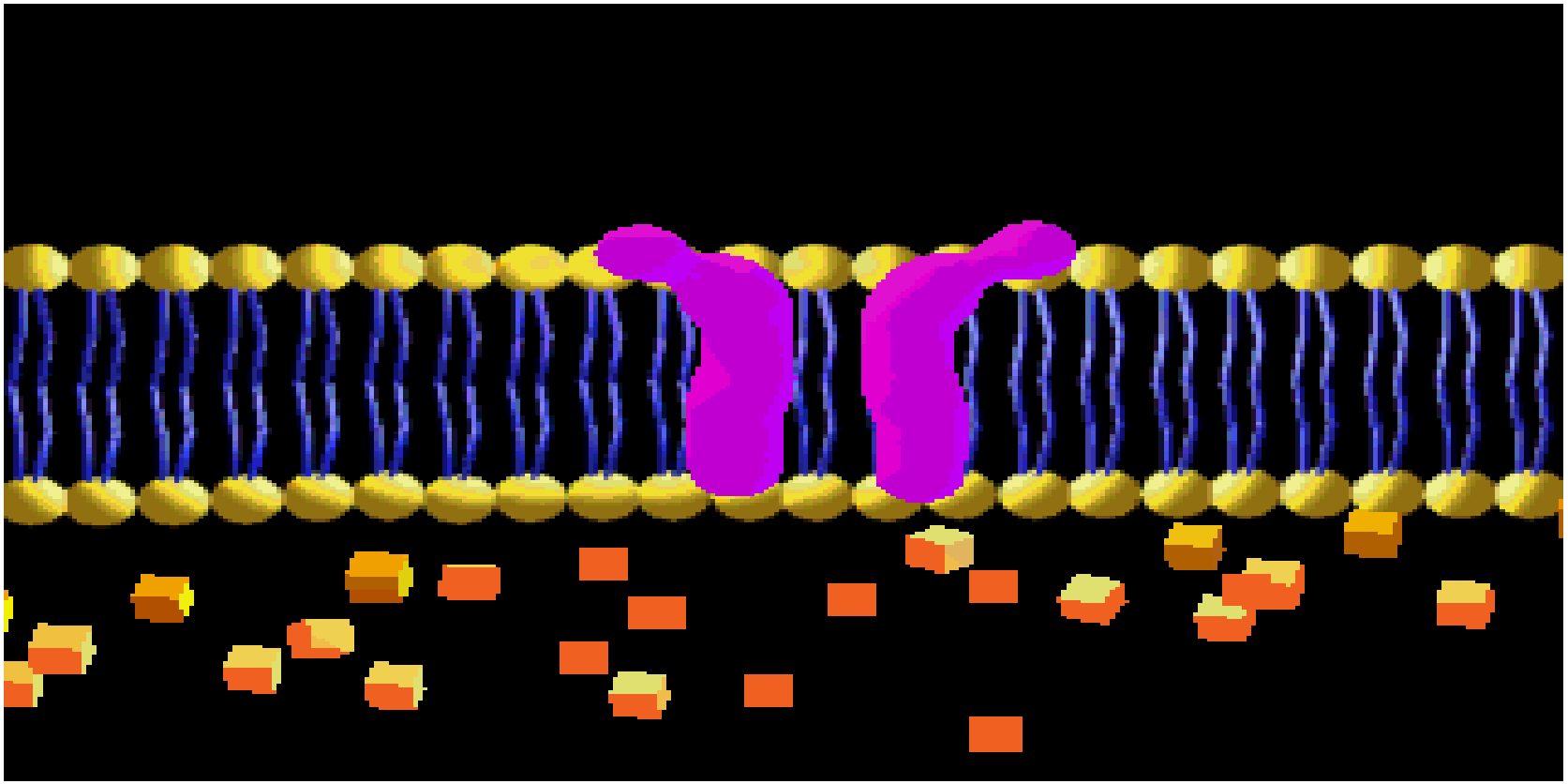
- Facilitated Diffusion
  - Does not require energy
  - Uses transport proteins to move high to low concentration
    - Examples: Glucose or amino acids moving from blood into a cell.

Proteins are Crucial to Membrane Function



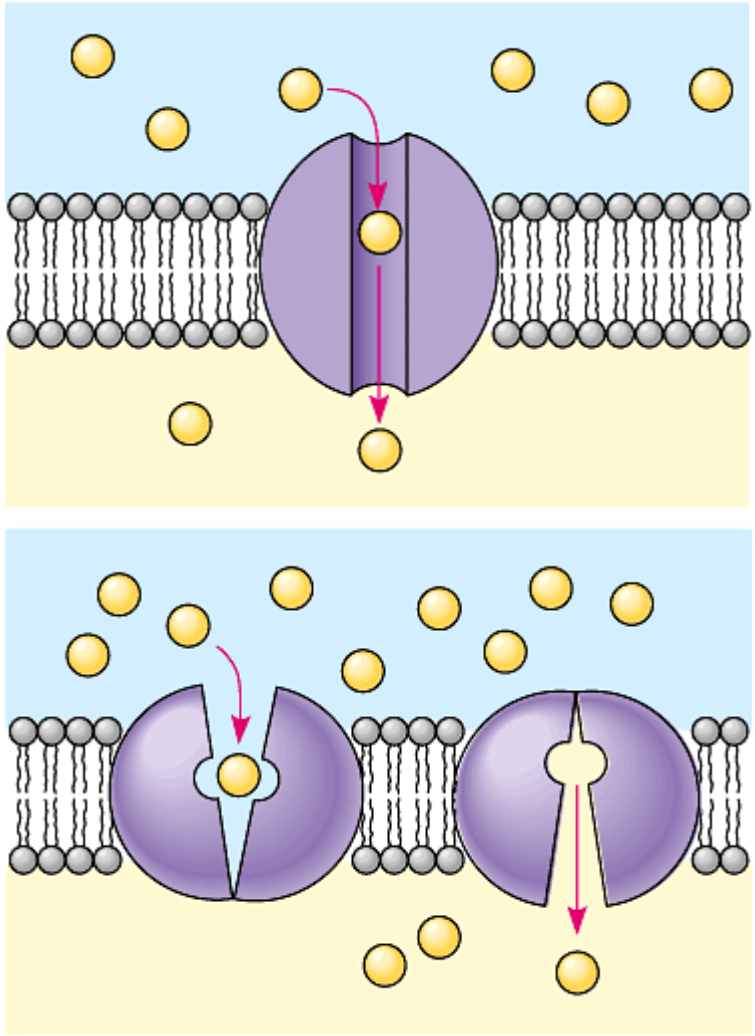
Facilitated Diffusion

Molecules will randomly move through the pores in Channel Proteins.



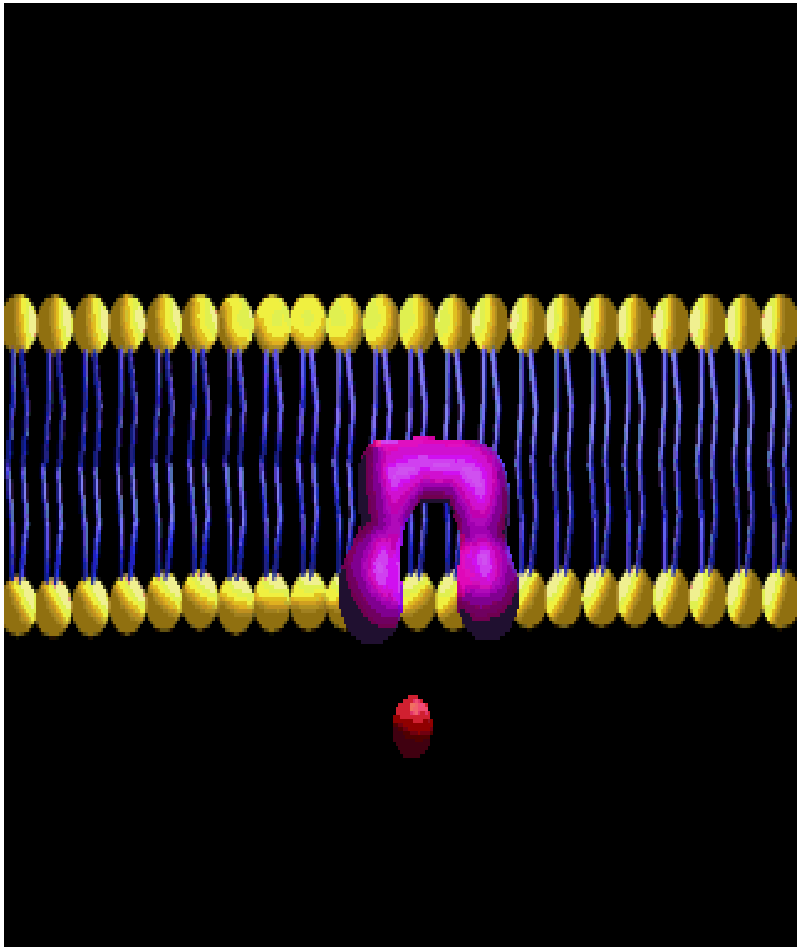
Types of Transport Proteins

- 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



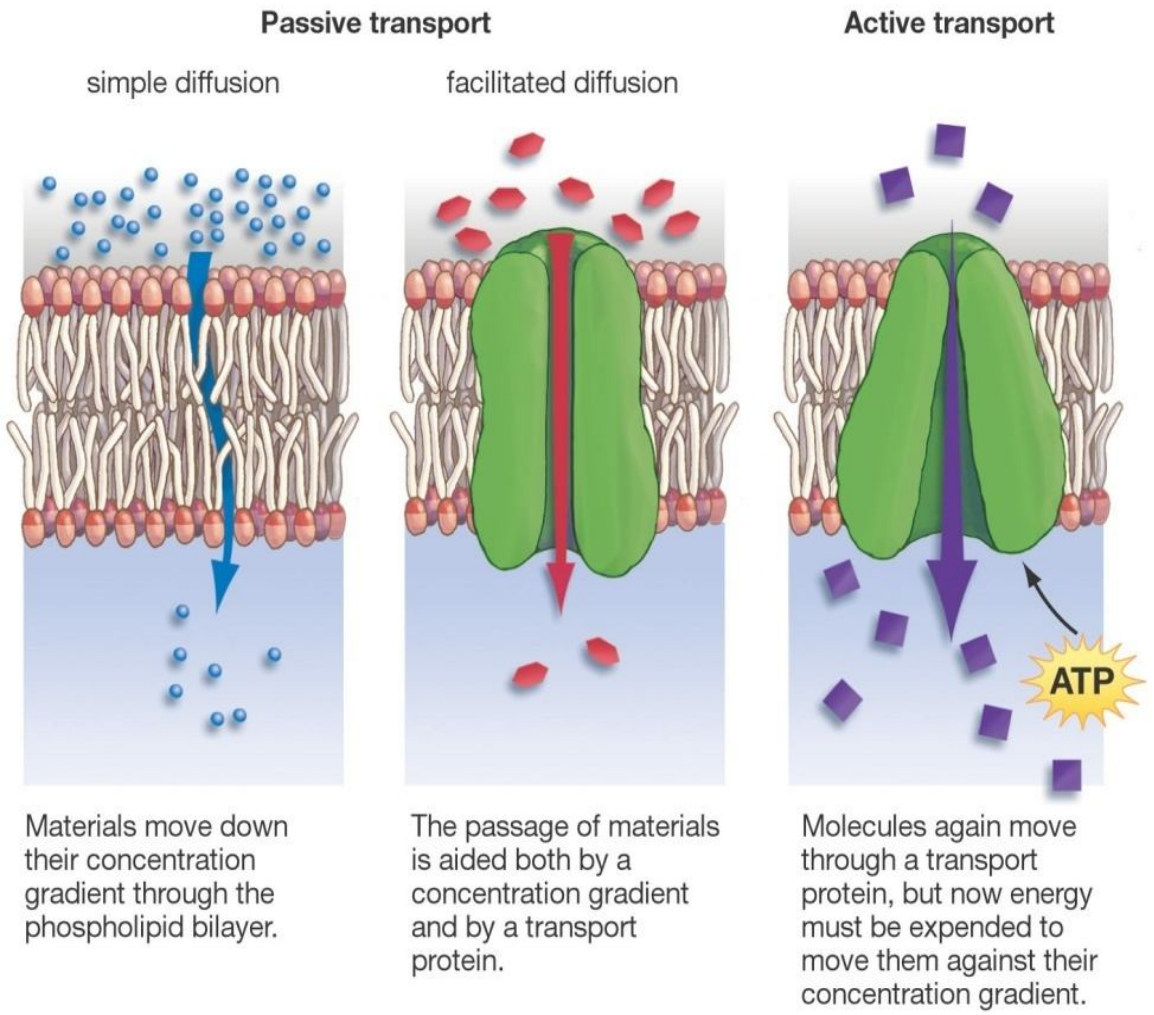
Facilitated Diffusion

- 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.



Active Transport

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



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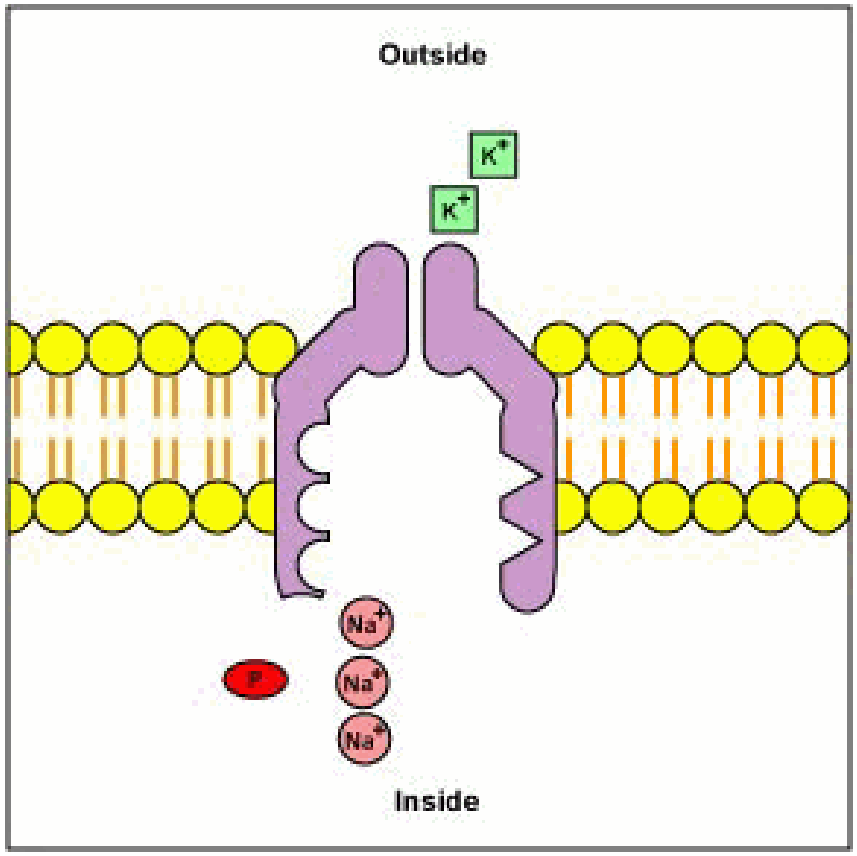
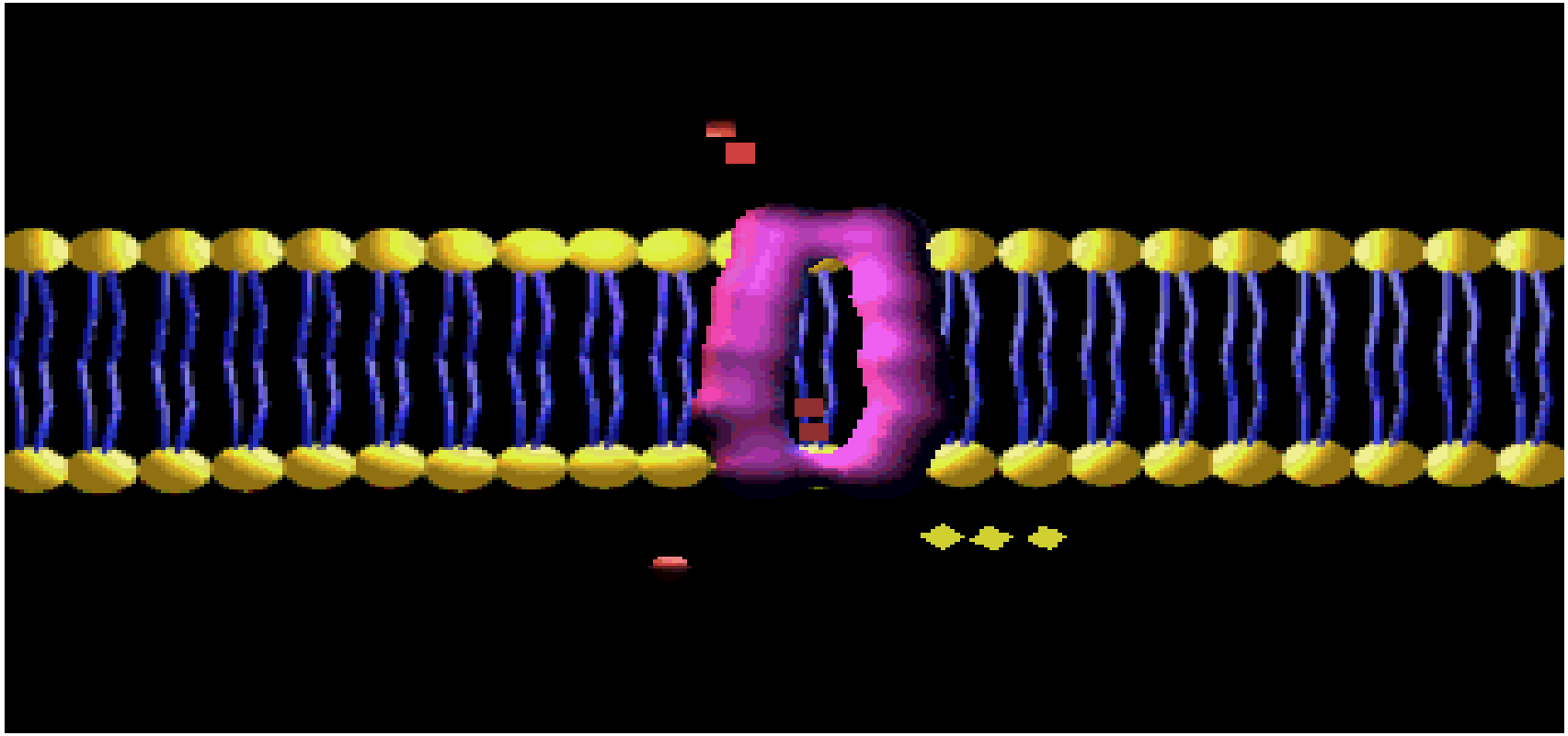
Active Transport



- Examples: Pumping Na+ (sodium ions) out and K+ (potassium ions) in—against concentration gradients.
  - Called the Sodium-Potassium Pump.

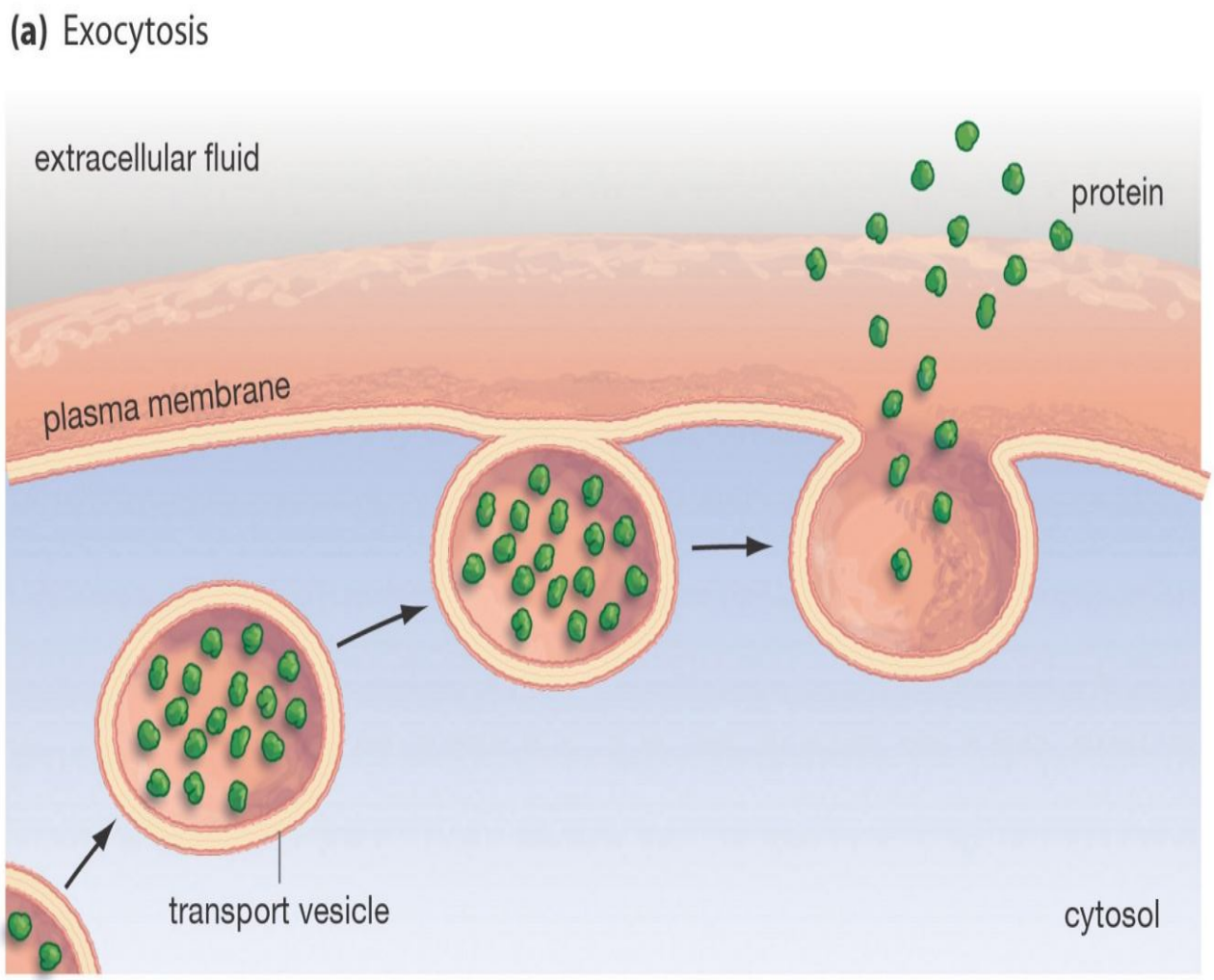
Sodium-Potassium Pump



- 3 Na+ pumped in for every 2 K+ pumped out; creates a membrane potential.

Active Transport--Exocytosis

- Exocytosis
  - Type of active transport
  - Moving things OUT
    - Molecules are moved out of the cell by vesicles that fuse the with the plasma membrane.
    - This is how many hormones are secreted and how nerve cells communicate with each other.



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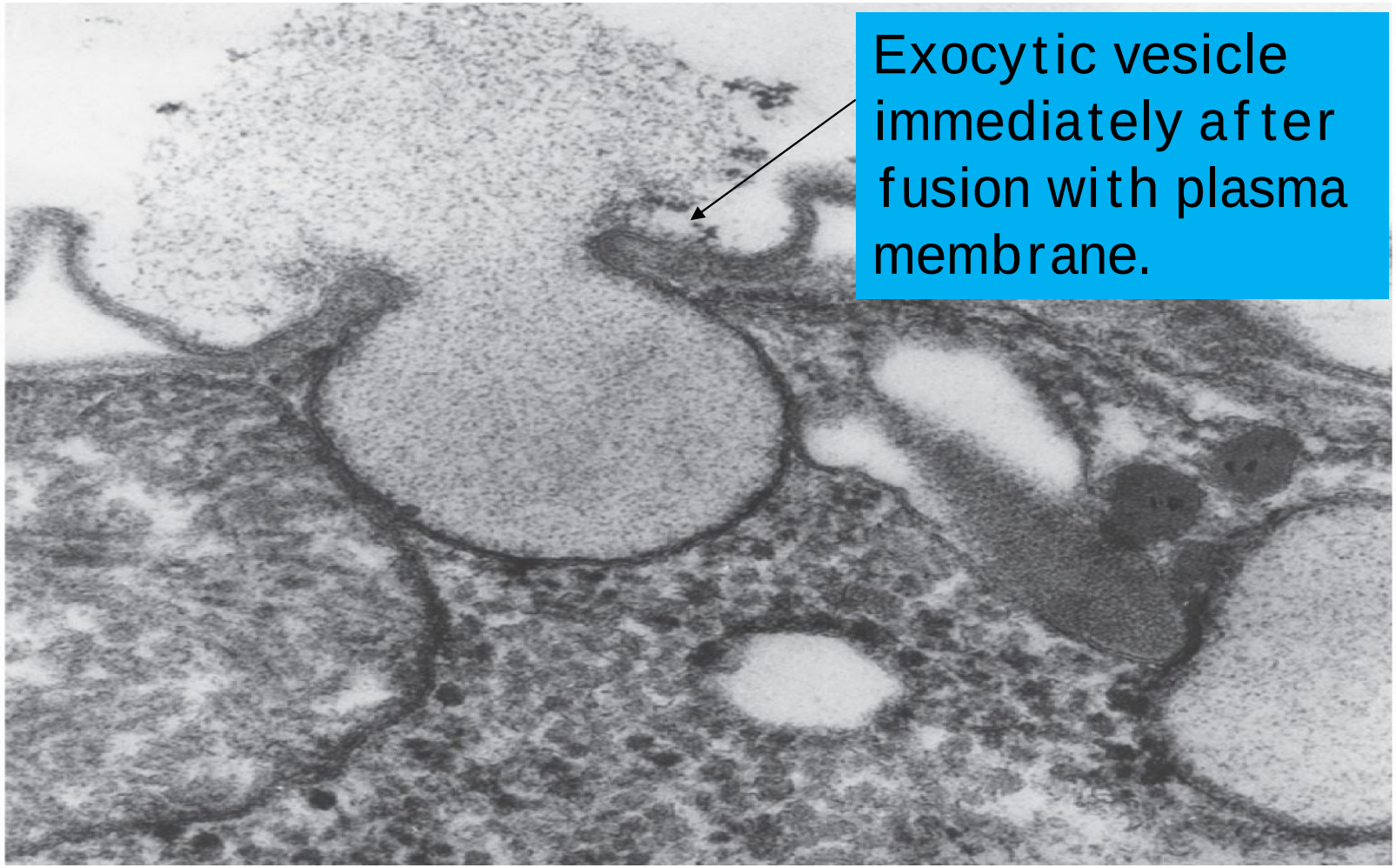
Active Transport : The Other Way

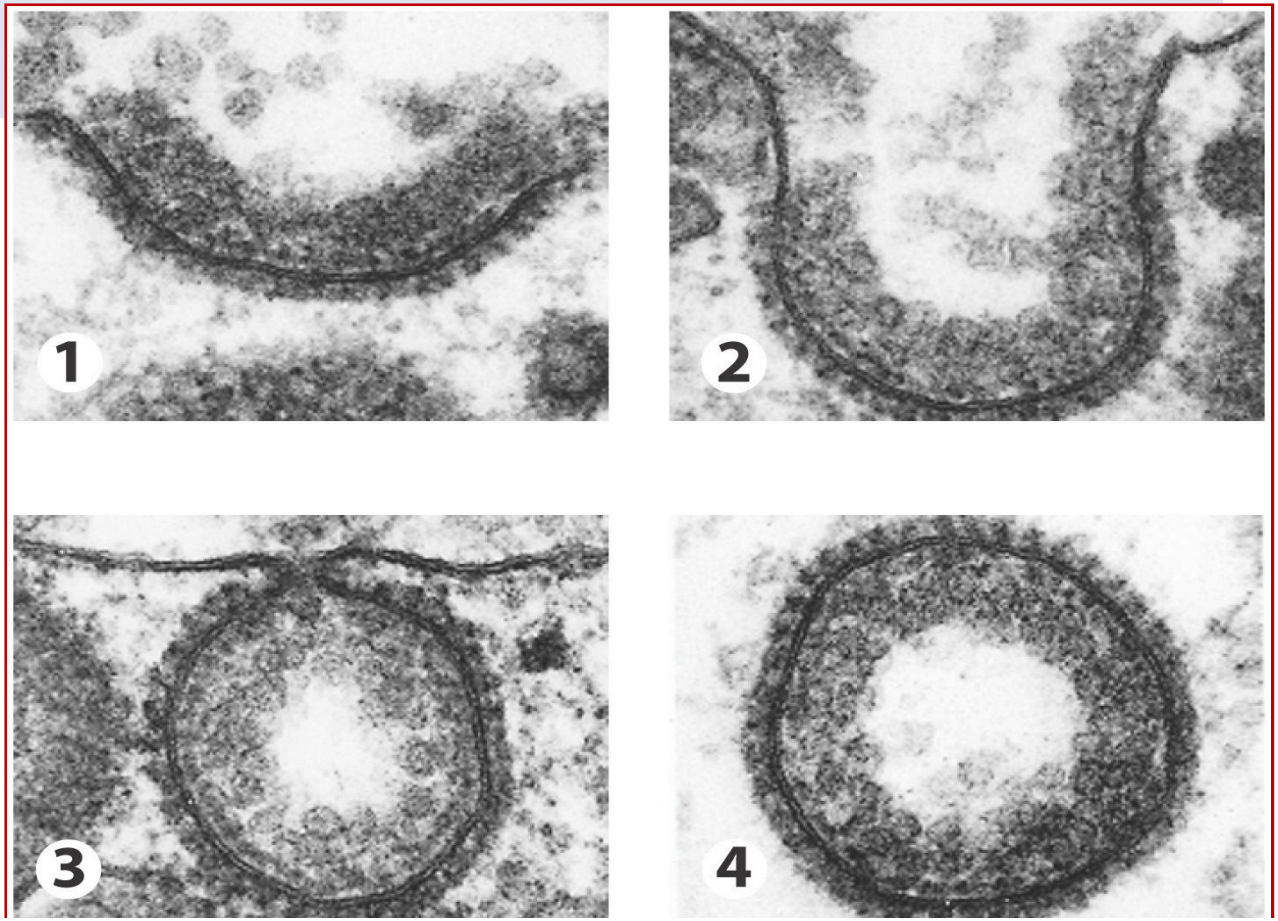
- Another process of active transport occurs when molecules are too big to pass through the cell even with the help of transport proteins.
- This requires the use of ***vesicles-*** that help large molecules across membranes
- If a large molecule is passing into the cell it is called ***endocytosis.***
- If a large molecule is passing out of a cell it is called ***exocytosis.***

Exocytosis

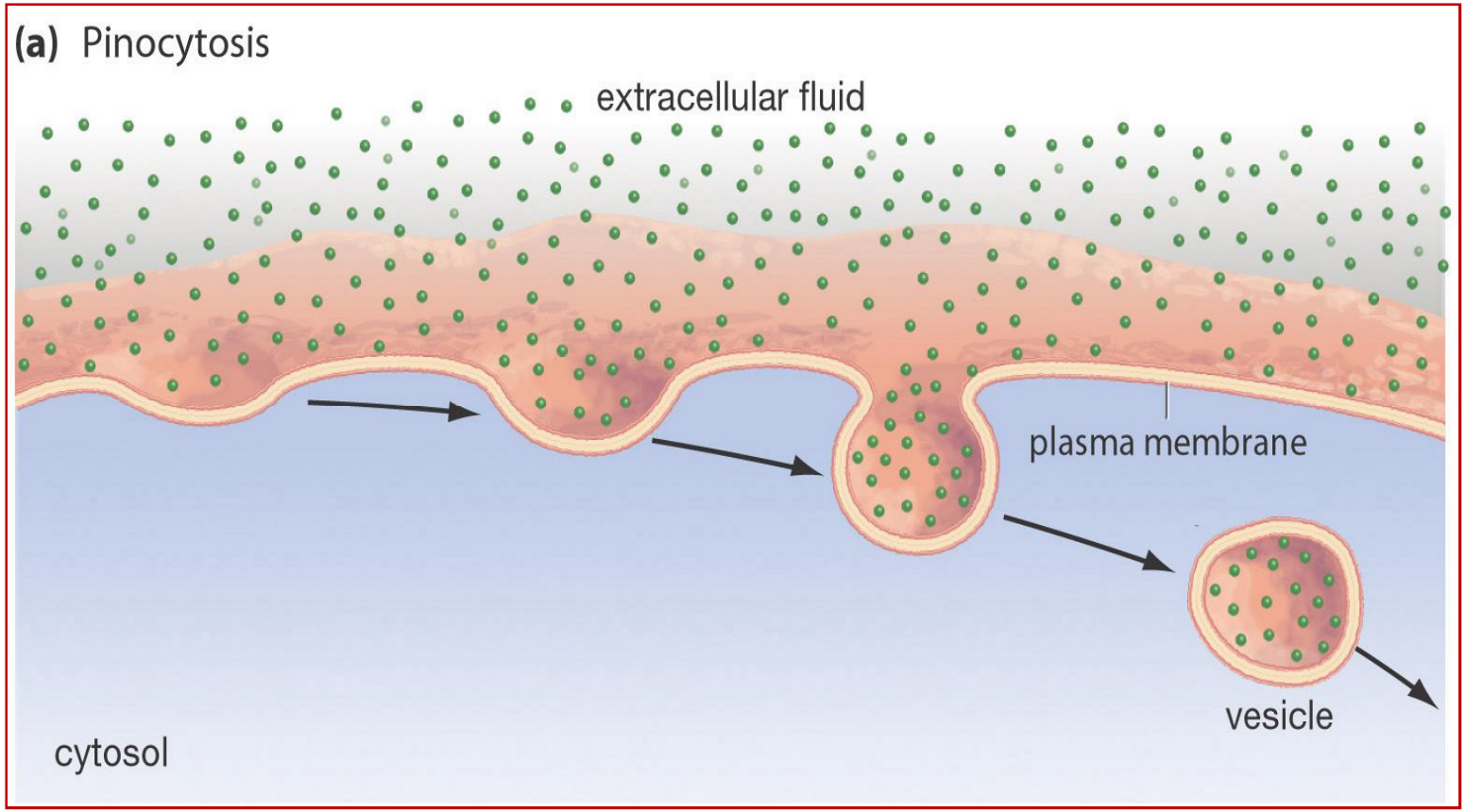

Exocytic vesicle immediately after fusion with plasma membrane.

Active Transport--Endocytosis

- Large molecules move materials into the cell by one of three forms of endocytosis.
  - Pinocytosis
  - Receptor-mediated endocytosis
  - Phagocytosis



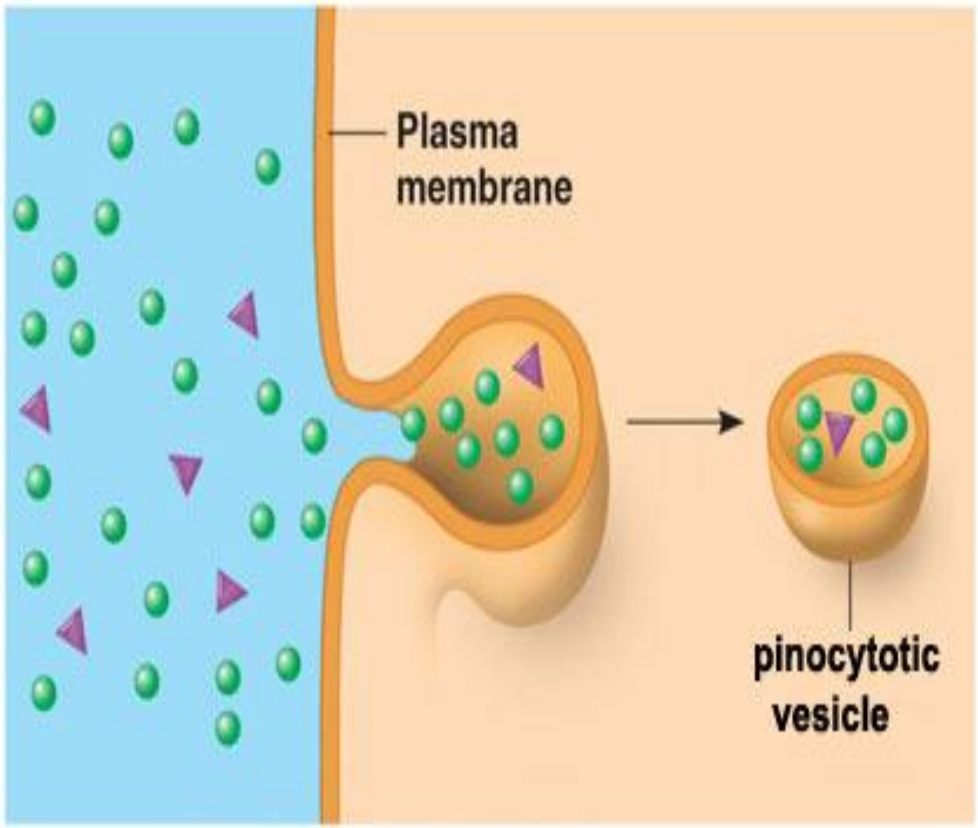
Active Transport-Pinocytosis

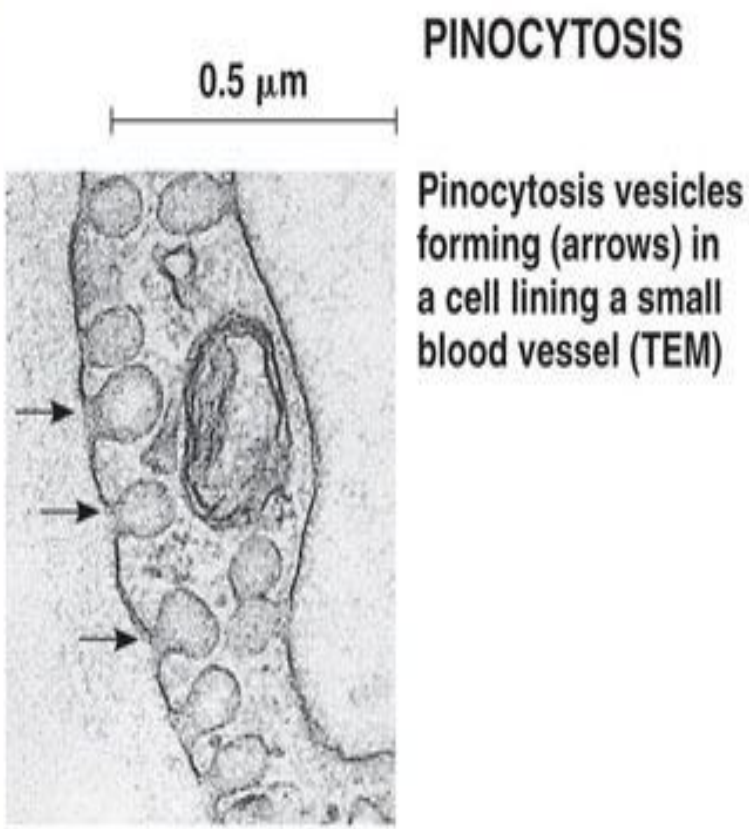


- Most common form of endocytosis.
  - Takes in dissolved molecules as a vesicle.

Active Transport-Pinocytosis

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





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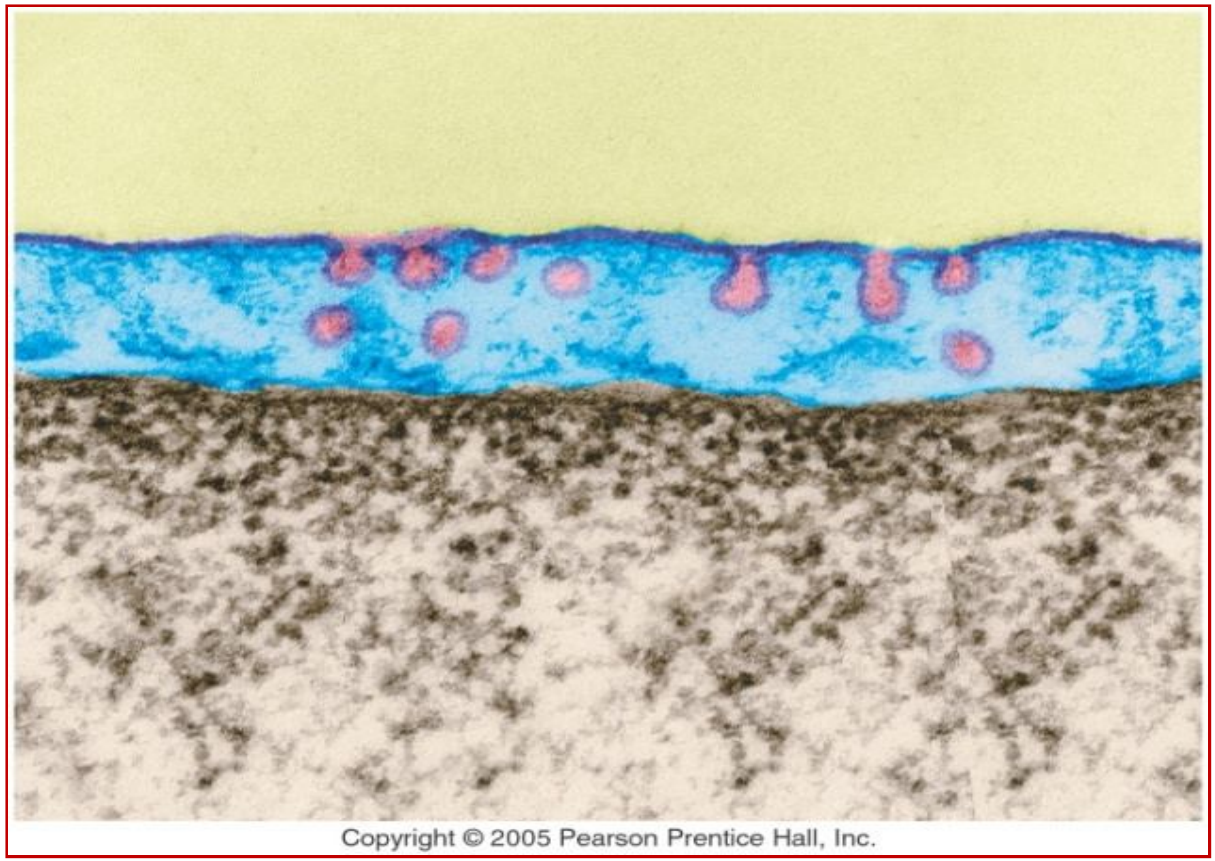
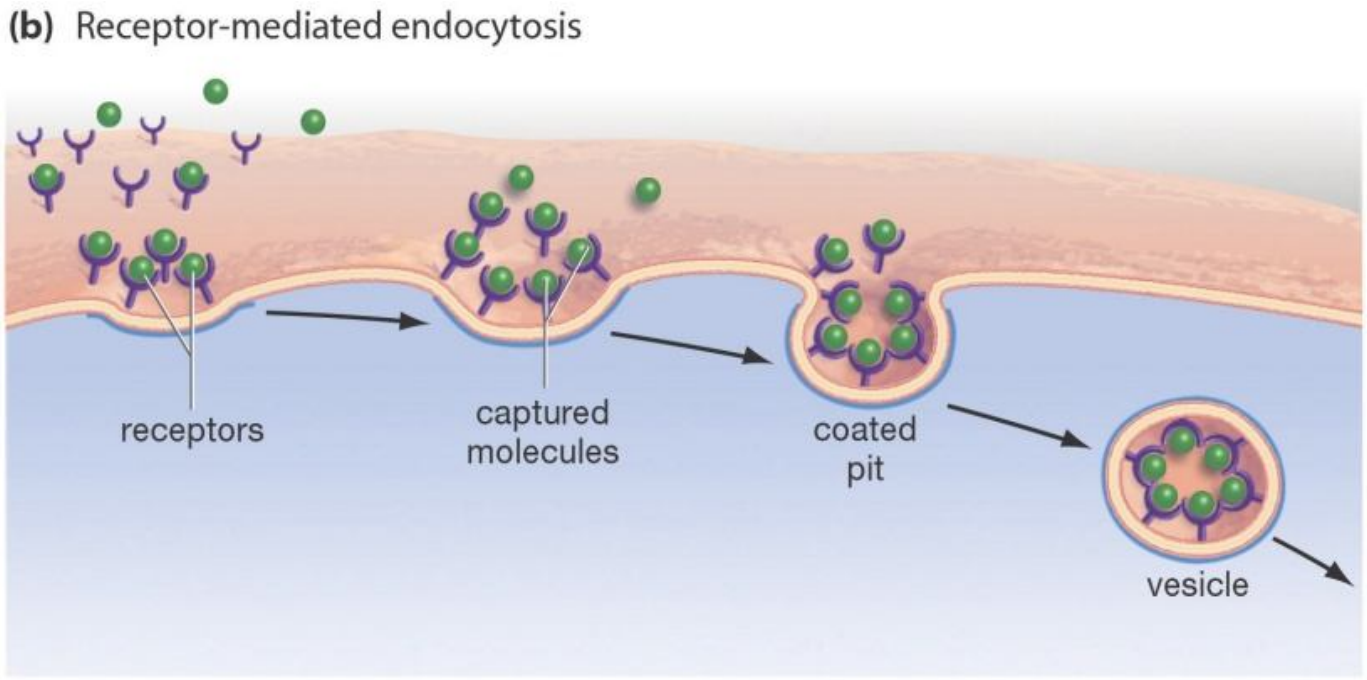
Example of Pinocytosis



- Transport across a capillary cell (blue).

Receptor-Mediated Endocytosis



In receptor-mediated endocytosis, many receptors bind to molecules. Then, while holding on to the molecules, the receptors migrate laterally through the cell membrane, arriving at a depression called a coated pit. The coated pit pinches off, delivering its receptor-held molecules into the cytoplasm. Micrographs at right: formation of an RME vesicle.

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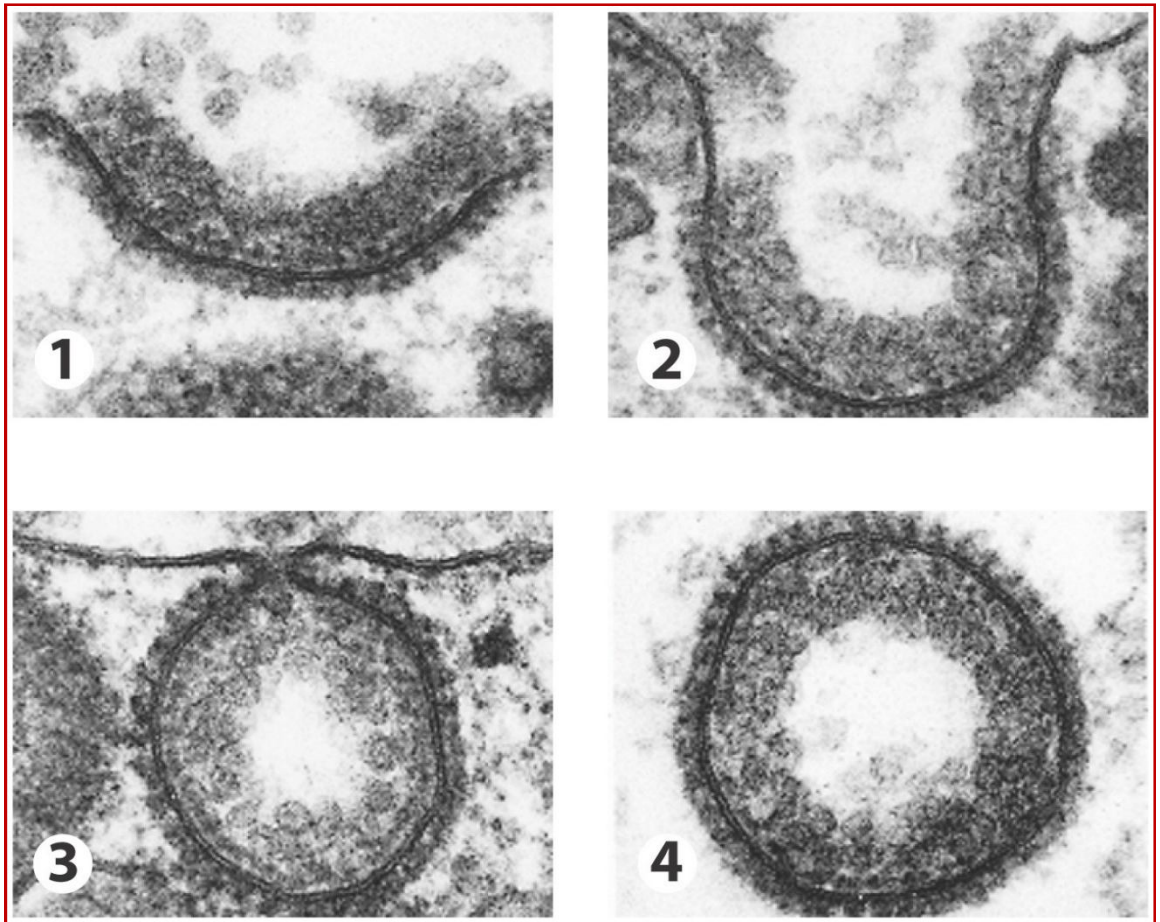
Some integral proteins have receptors on their surface to recognize & take in hormones, cholesterol, etc.

Active Transport--Receptor-Mediated Endocytosis



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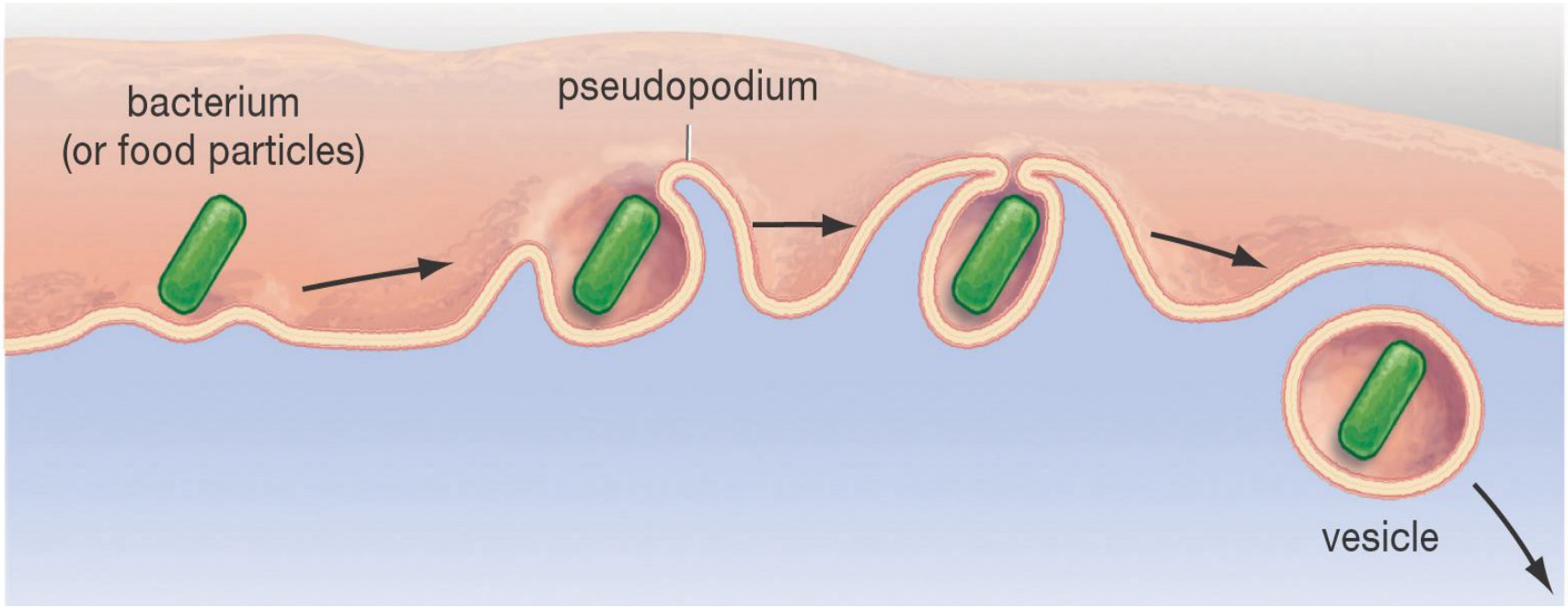
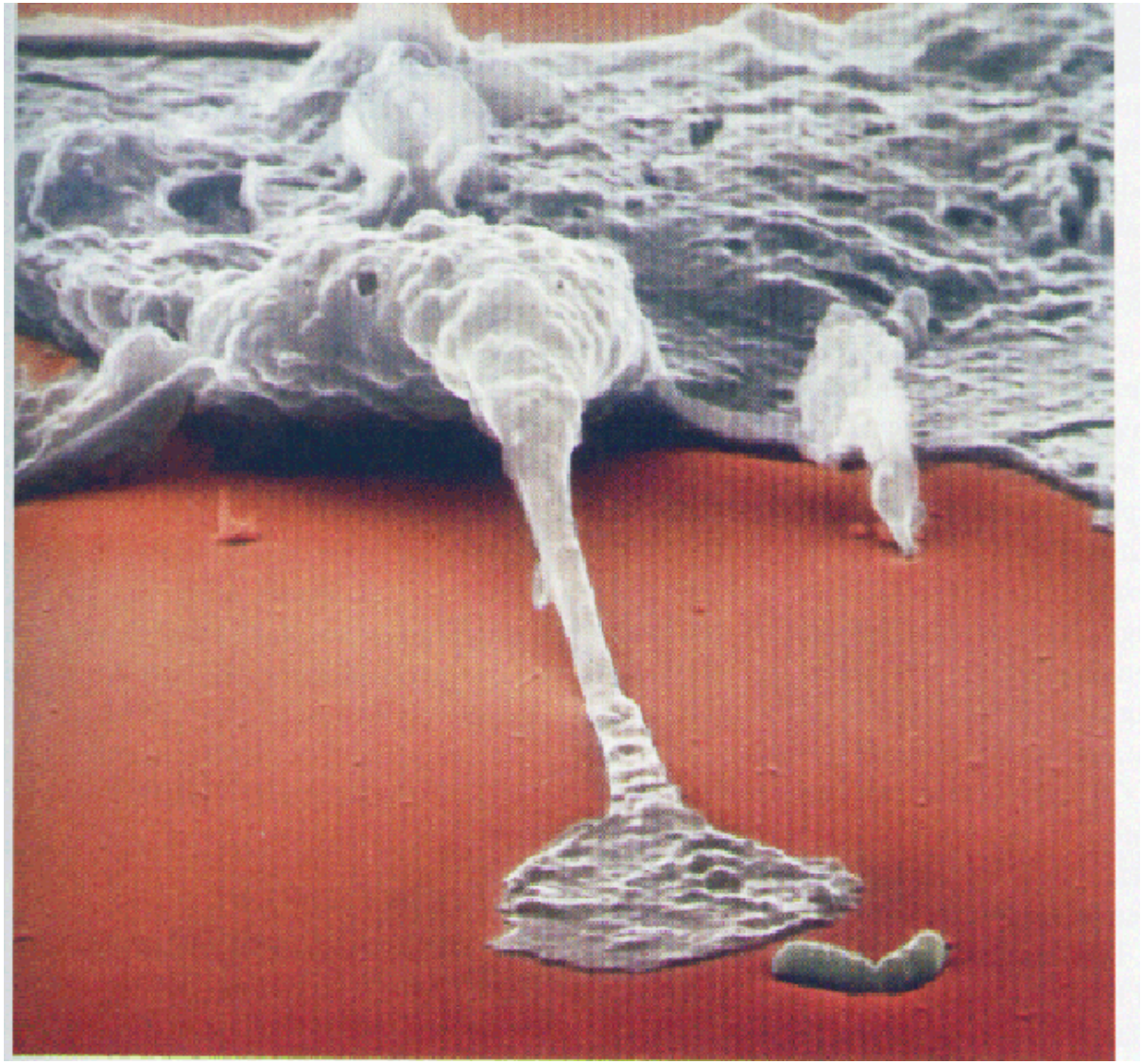
Active Transport--Phagocytosis



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

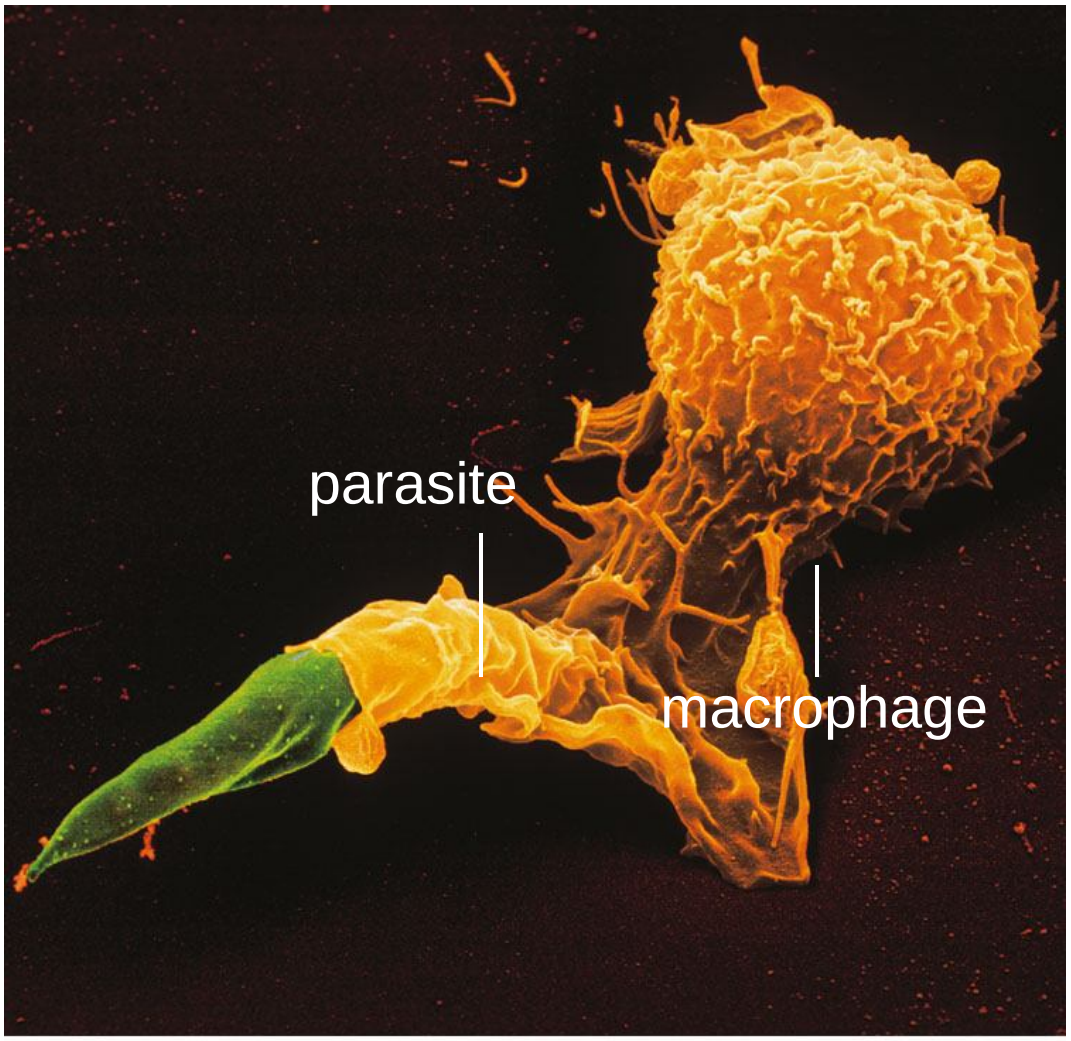
Called “Cell Eating”

Phagocytosis About to Occur



Phagocytosis

Phagocytosis -
- Capture of a parasite (green) by Membrane Extensions of an Immune System Cell (orange)



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Active, Passive and Facilitated Transport

Explain how active and passive and facilitated transport serve to maintain the homeostasis of the cell.

Why do cells transport anything?

- The reason is ***Homeostasis***
  - The need of an organism to maintain constant or stable conditions
- All organisms respond to outside forces called stimuli to maintain homeostasis and keep conditions in their bodies conducive to life.
  - Shiver when we're cold
  - Sweat when we're hot
- Homeostasis depends on appropriate movement of materials across the cell membrane.

To Maintain Homeostasis

- Materials needed for cellular processes must pass into cells to be used.
  - Ex. O_2 and glucose are needed continuously for cellular respiration
- Waste from processes in the cell must pass out of cells as they are made.
  - Ex. CO_2 is produced and removed during cellular respiration
- Cell Membrane regulates the passage of material in and out of the cell.
  - Determined by needs of cell, excess substances must move out needed substances must move in.

To Maintain Homeostasis

- Cells exist in a fluid environment also within the cell is a fluid environment (cytoplasm). That liquid makes it possible for substances like nutrients, O_2, waste products to move in and out of the cell.
- The cell membrane is selectively permeable or semipermeable – meaning some substances pass directly through the membrane and others cannot.
- Materials enter and exit the cell membrane through Active and Passive transport

THANKS for Your Patience

15.02.2019