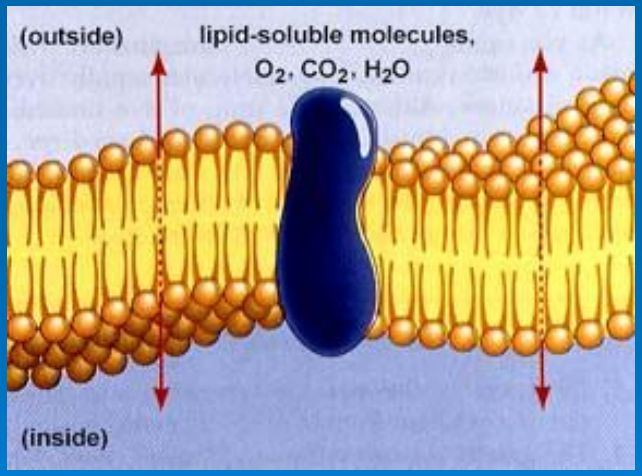
Transport through cell membranes

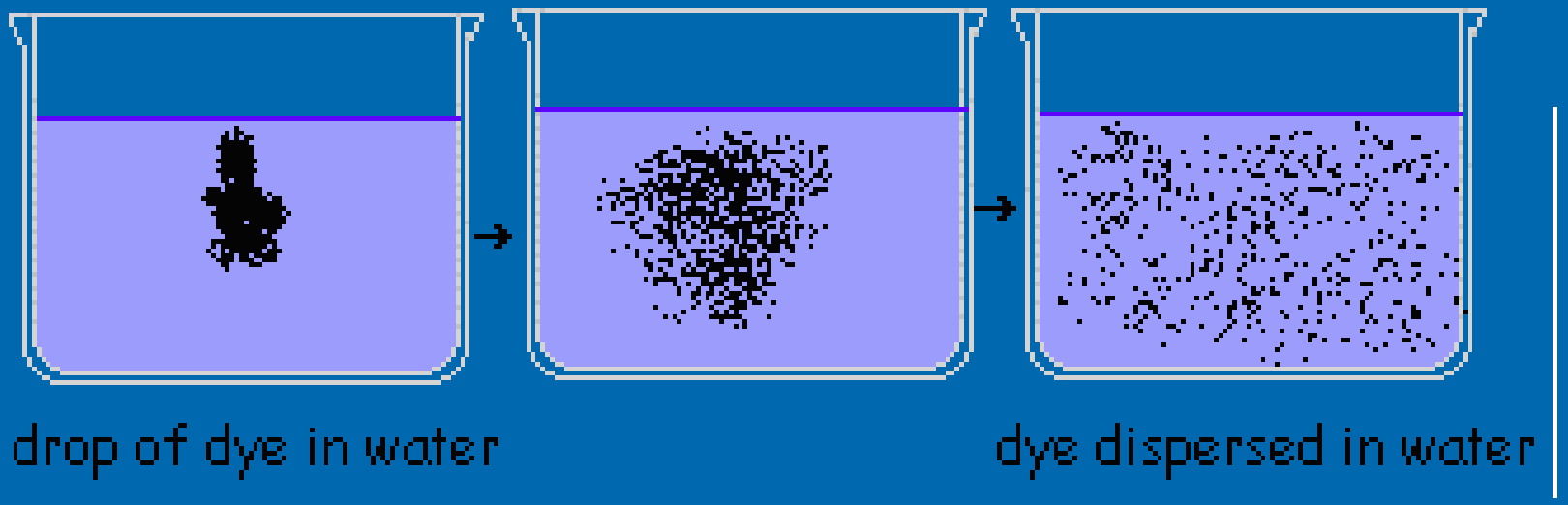


Transport through cell membranes

- The phospholipid bilayer is a good barrier around cells, especially to water soluble molecules. However, for the cell to survive some materials need to be able to enter and leave the cell.
- There are 4 basic mechanisms:

1. DIFFUSION and FACILITATED DIFFUSION
2. OSMOSIS
3. ACTIVE TRANSPORT
4. BULK TRANSPORT

Diffusion of liquids



- Diffusion is the net movement of molecules (or ions) from a region of their high concentration to a region of their lower concentration.

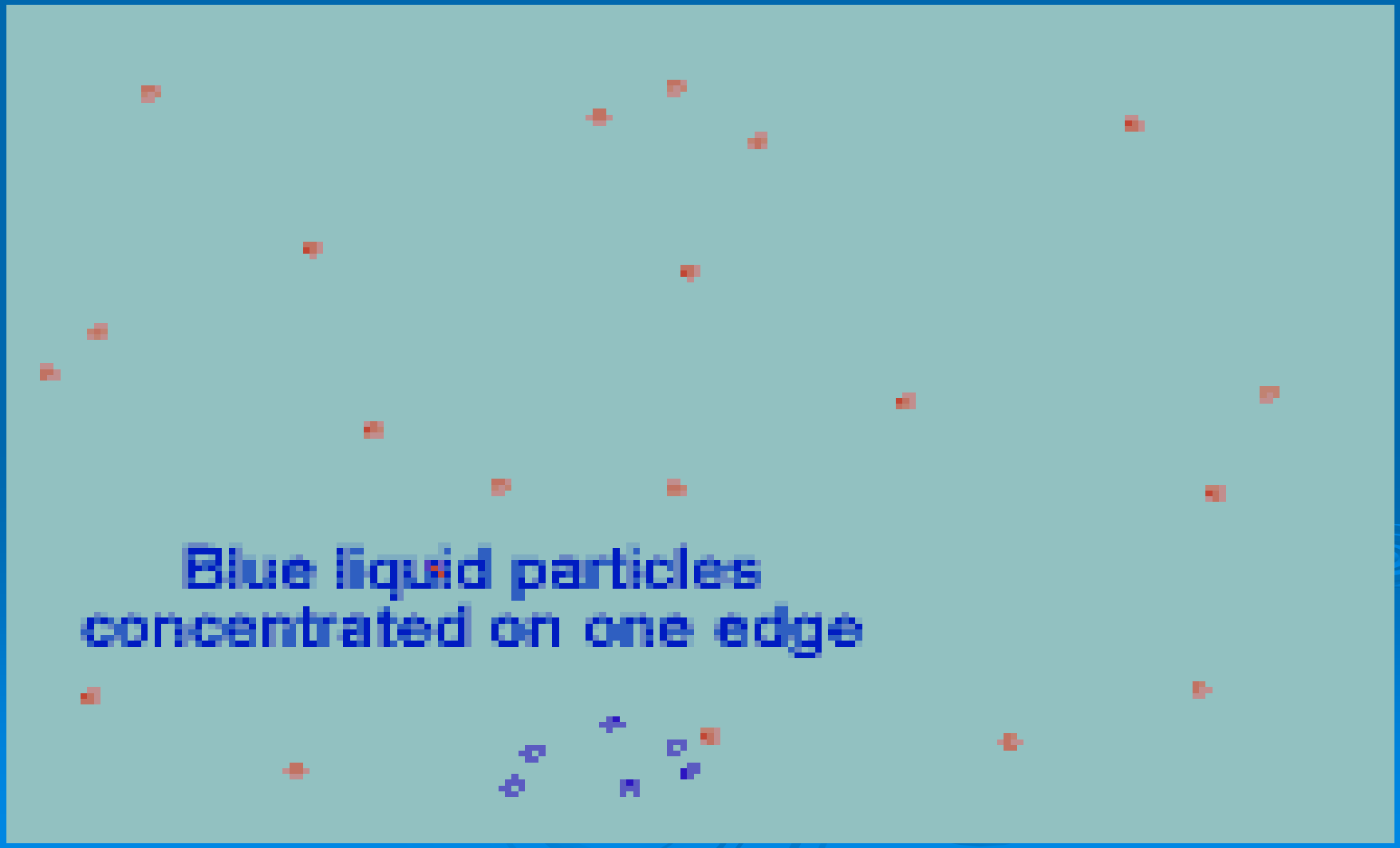
The molecules move down a concentration gradient.

Molecules have kinetic energy, which makes them move about randomly.

As a result of diffusion molecules reach an equilibrium where they are evenly spread out. This is when there is no net movement of molecules from either side.

DIFFUSION

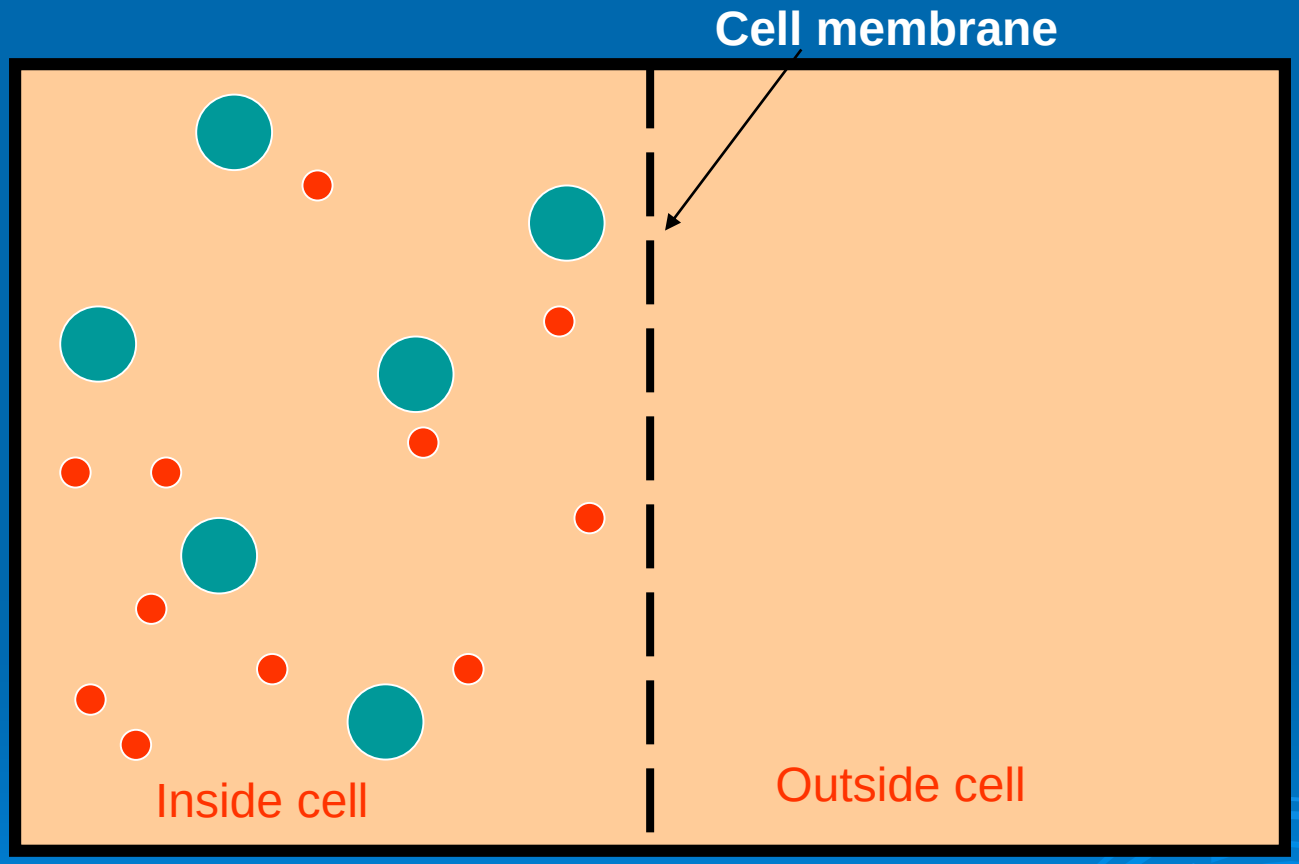
Diffusion is a PASSIVE process which means no energy is used to make the molecules move, they have a natural kinetic energy.



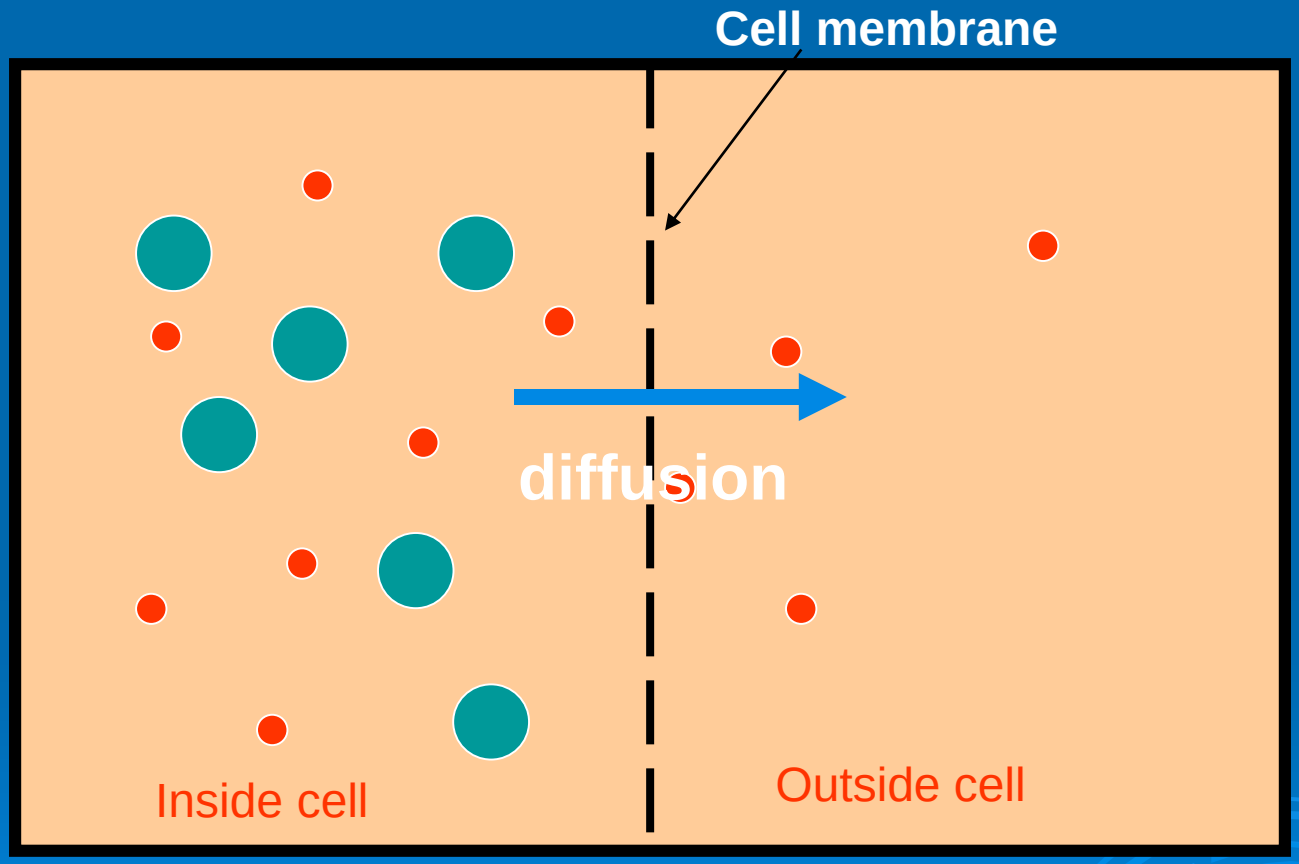
Diffusion of Bromine

Diffusion of Bromine

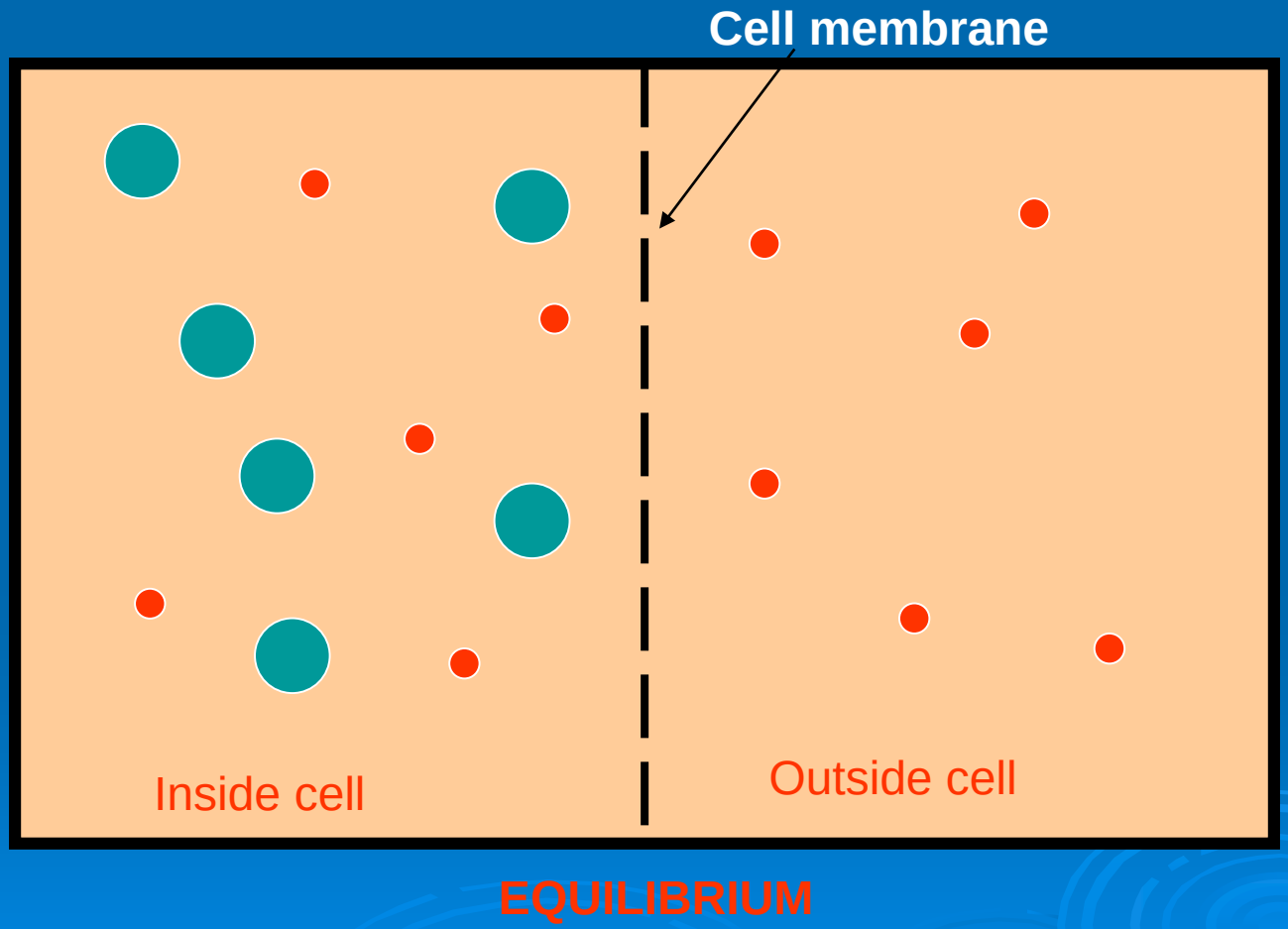
Diffusion through a membrane



Diffusion through a membrane



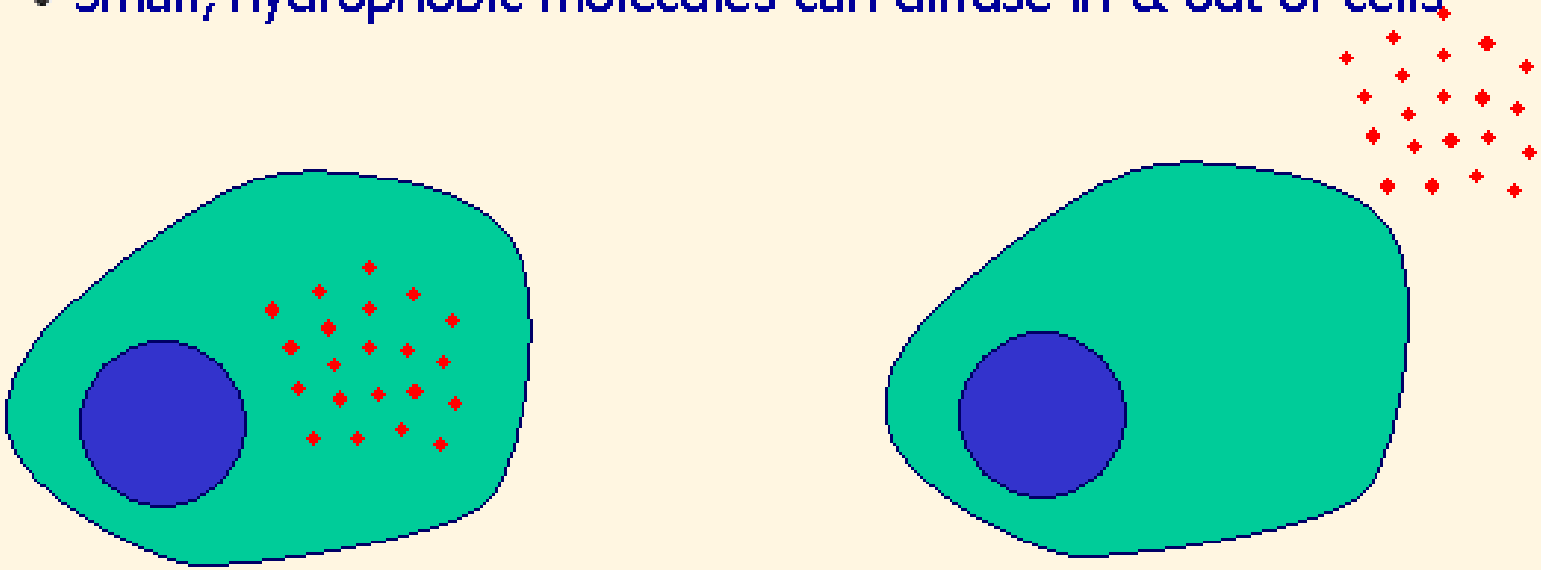
Diffusion through a membrane



How Molecules Cross the Membrane

Diffusion

- Molecules move constantly and randomly
- Over time, they will distribute themselves evenly
- Small, hydrophobic molecules can diffuse in & out of cells



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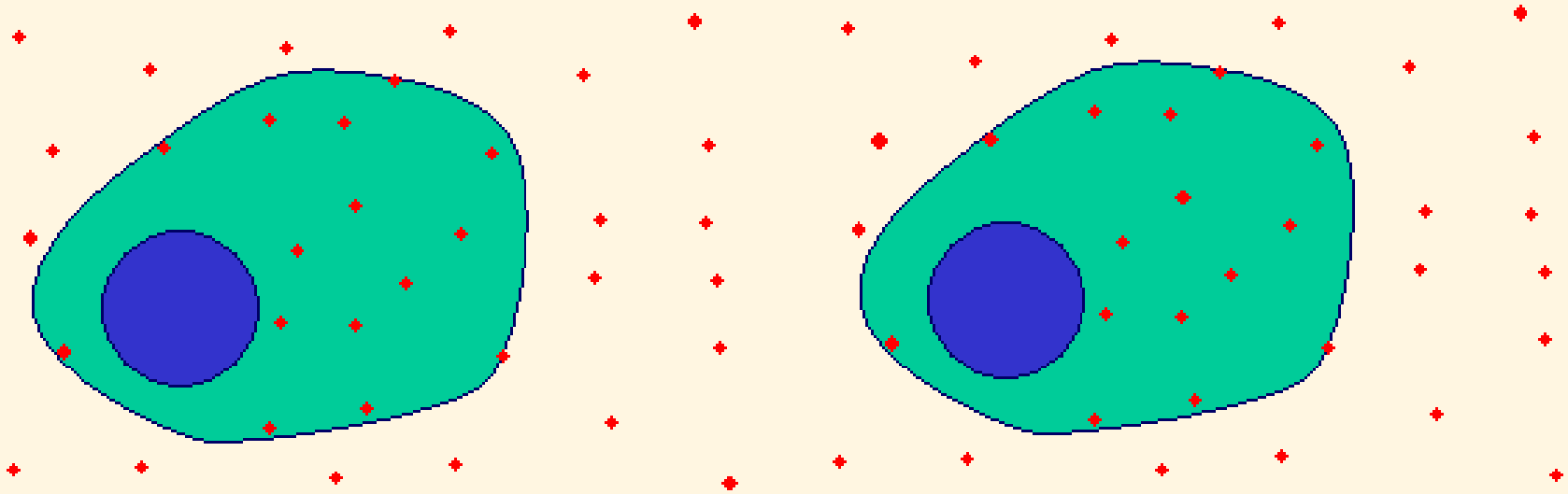


What determines the rate of diffusion? There 4 factors:

1. The steepness of the concentration gradient. The bigger the difference between the two sides of the membrane the quicker the rate of diffusion.

2. Temperature. Higher temperatures give molecules or ions more kinetic energy. Molecules move around faster, so diffusion is faster.

3. The surface area. The greater the surface area the faster the diffusion can take place. This is because the more molecules or ions can cross the membrane at any one moment.

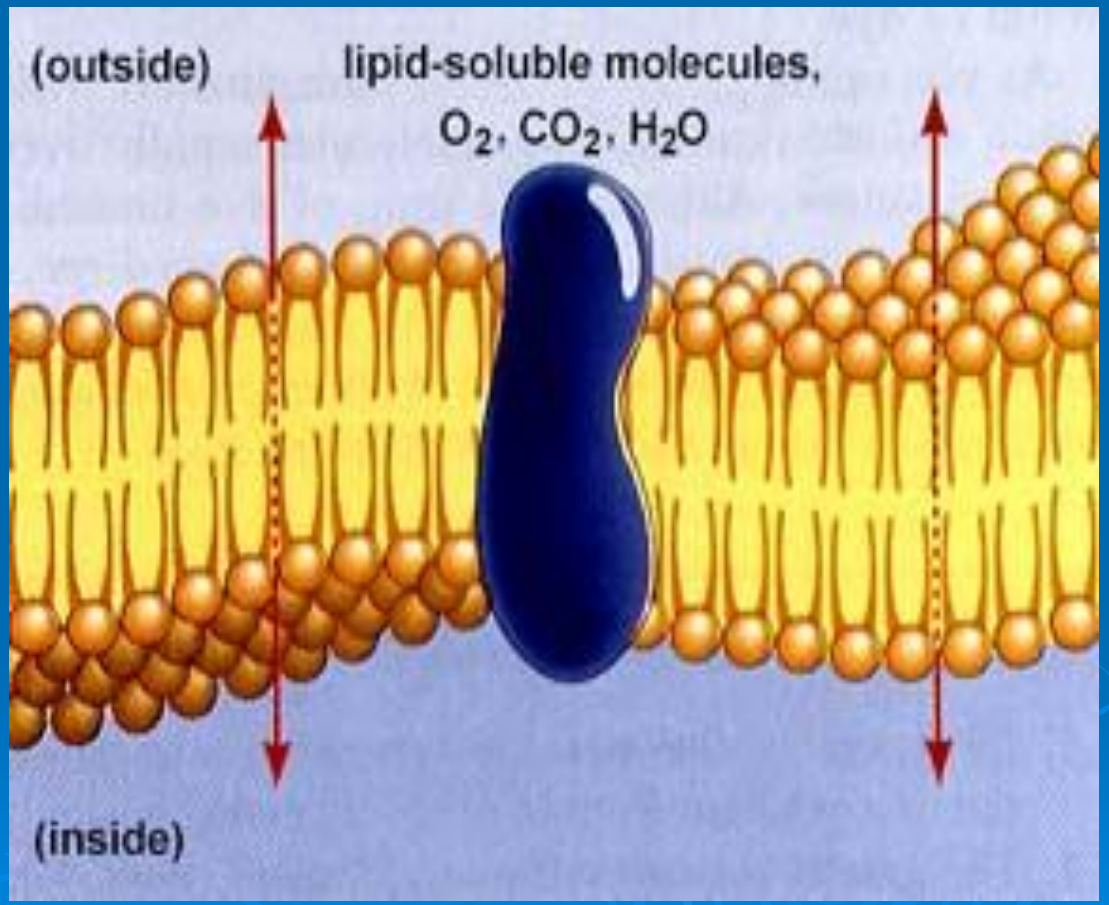
4. The type of molecule or ion diffusing. Large molecules need more energy to get them to move so they tend to diffuse more slowly. Non-polar molecules diffuse more easily than polar molecules because they are soluble in the non polar phospholipid tails.

Molecules that diffuse through cell membranes

1. Oxygen – Non-polar so diffuses very quickly.

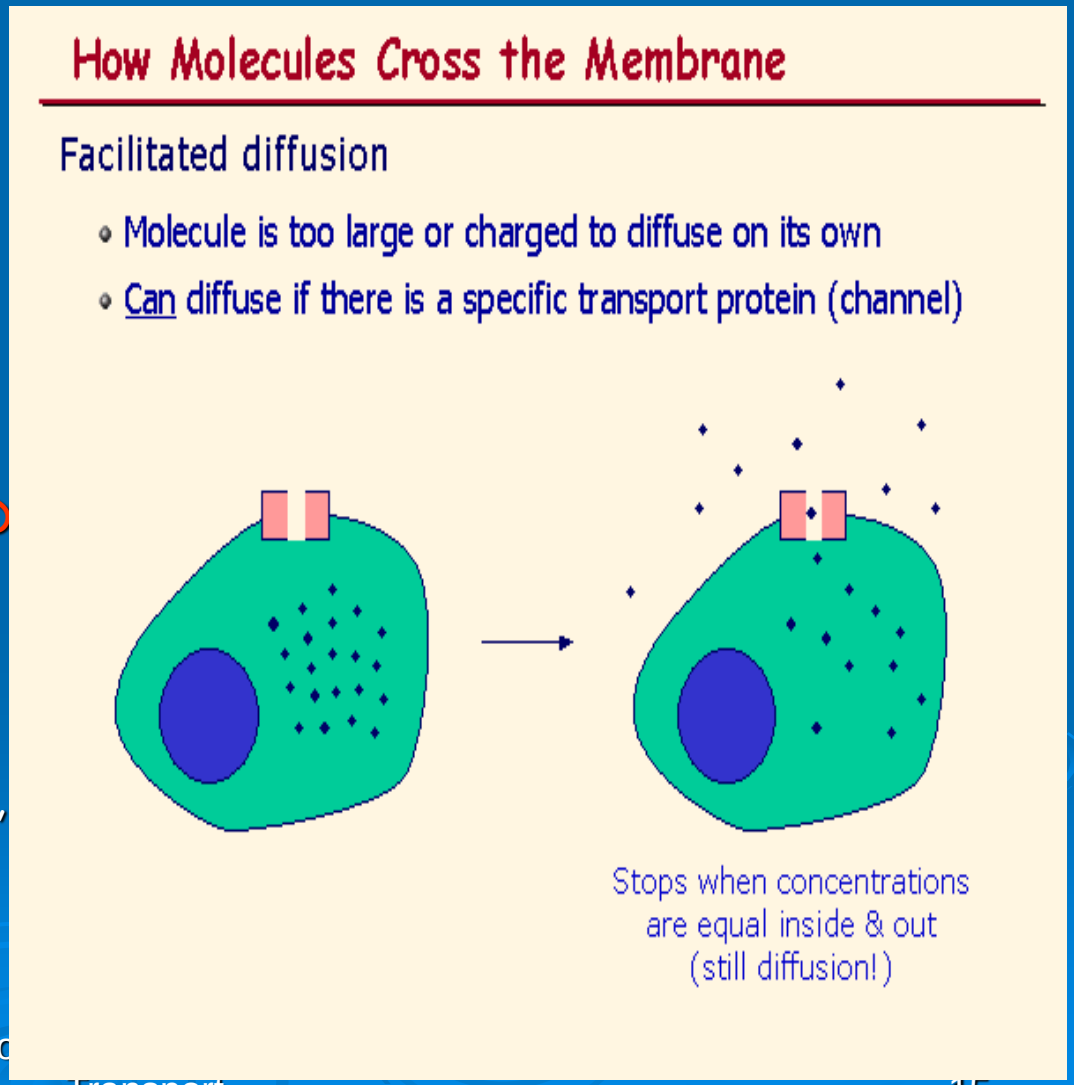
1. Carbon dioxide – Polar but very small so diffuses quickly.

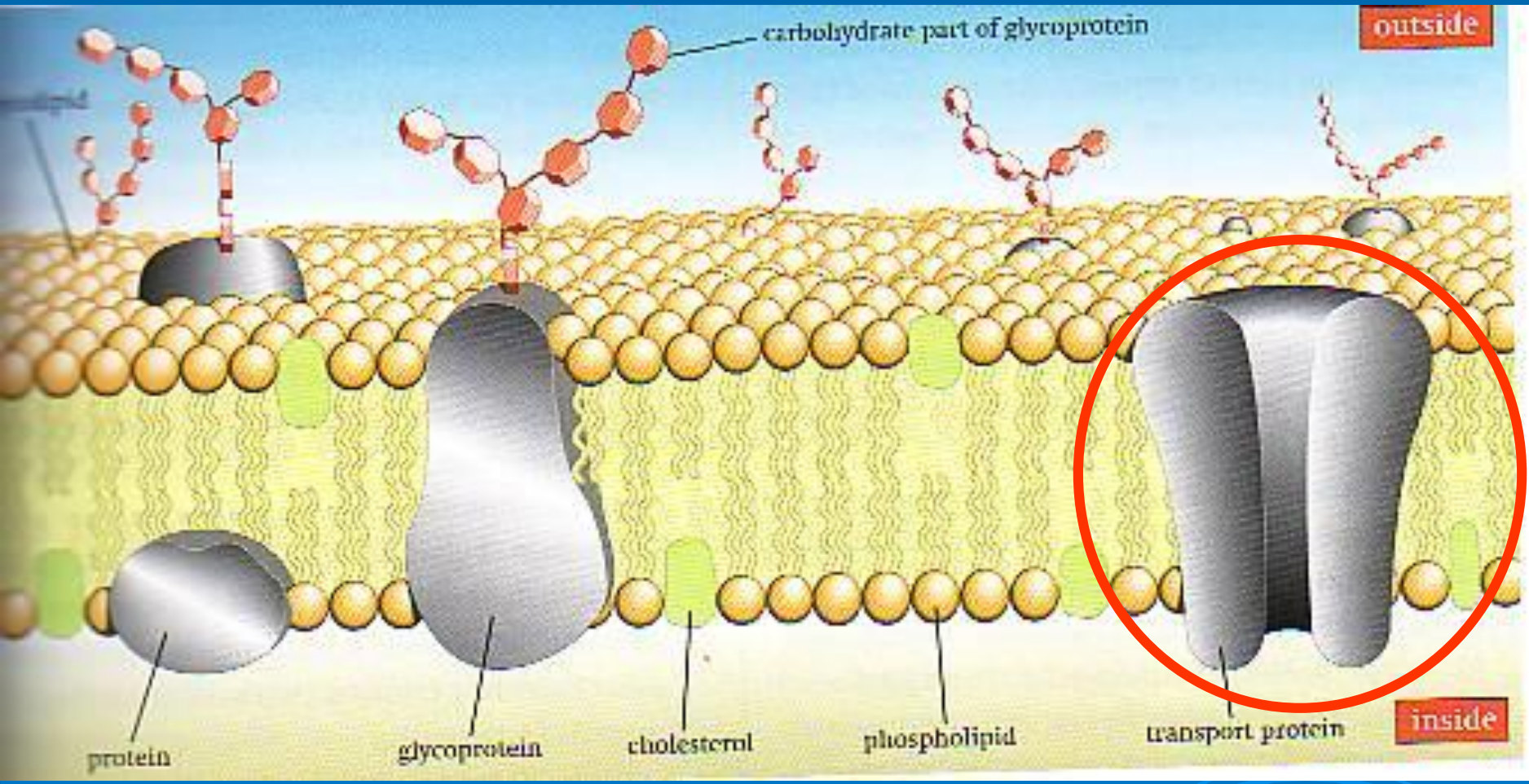
2. Water – Polar but also very small so diffuses quickly.



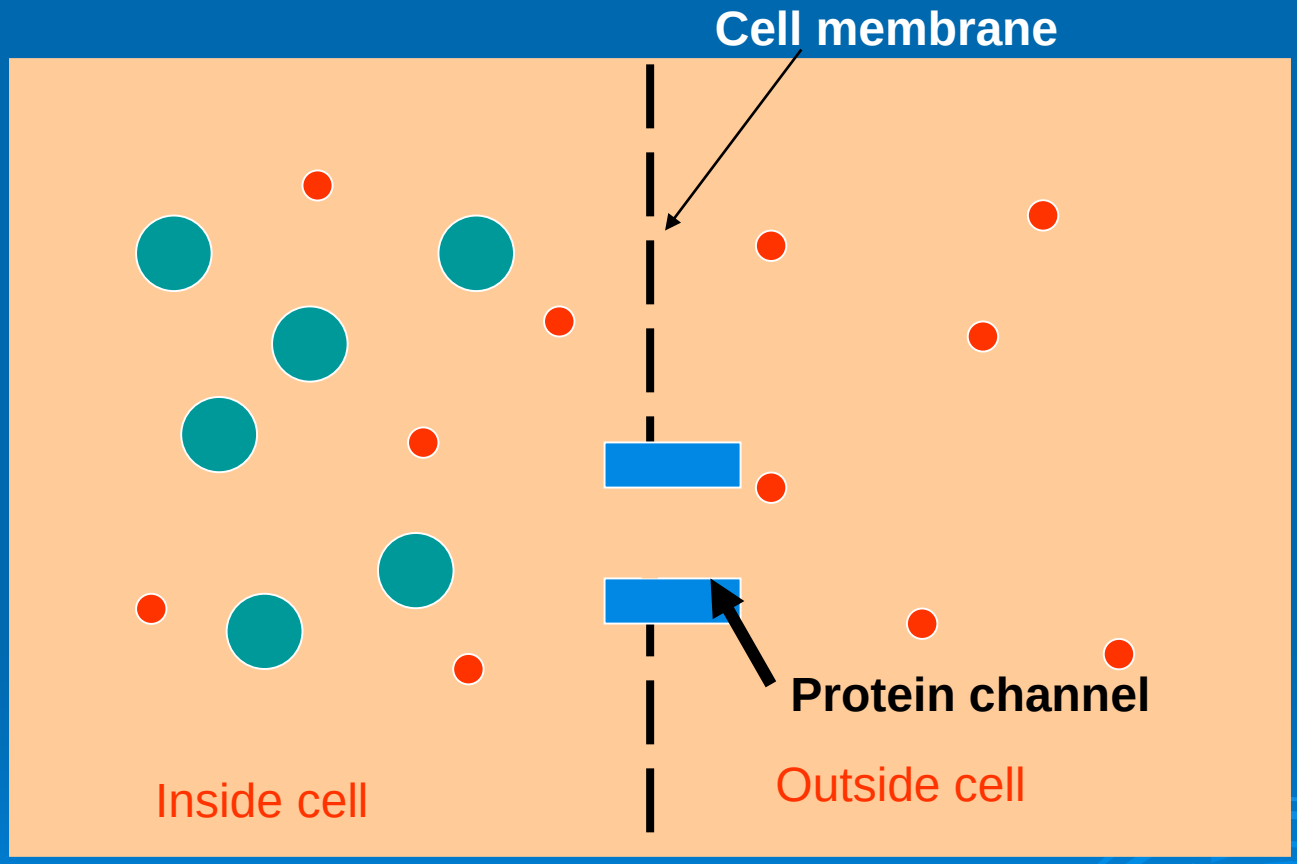
Facilitated diffusion

- Large polar molecules such as glucose and amino acids, cannot diffuse across the phospholipid bilayer. Also ions such as Na^+ or Cl^- cannot pass.
- These molecules pass through protein channels instead. Diffusion through these channels is called FACILITATED DIFFUSION.
- Movement of molecules is still PASSIVE just like ordinary diffusion, the only difference is, the molecules go through a protein channel instead of passing between the phospholipids.

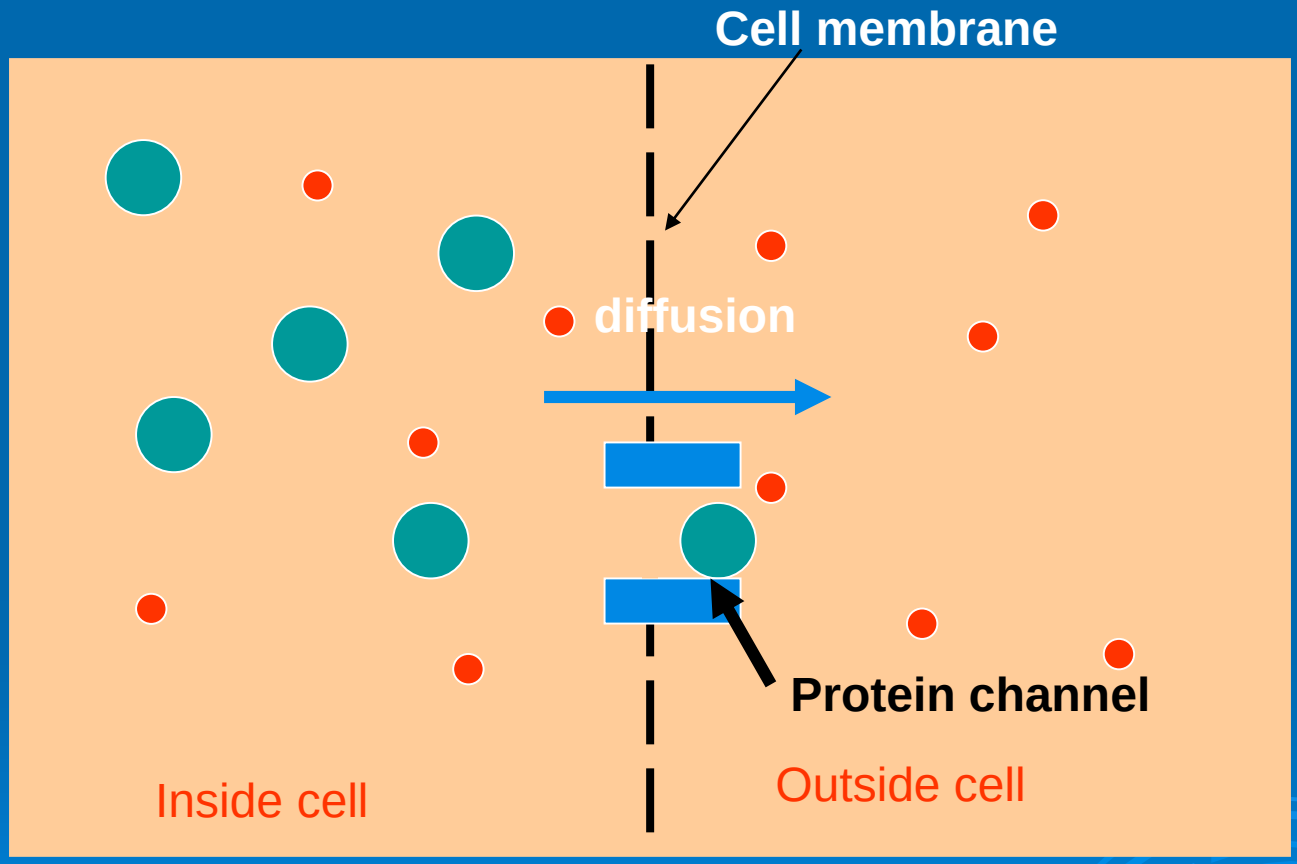



carbohydrate part of glycoprotein
outside
protein
glycoprotein
cholesterol
phospholipid
transport protein
inside

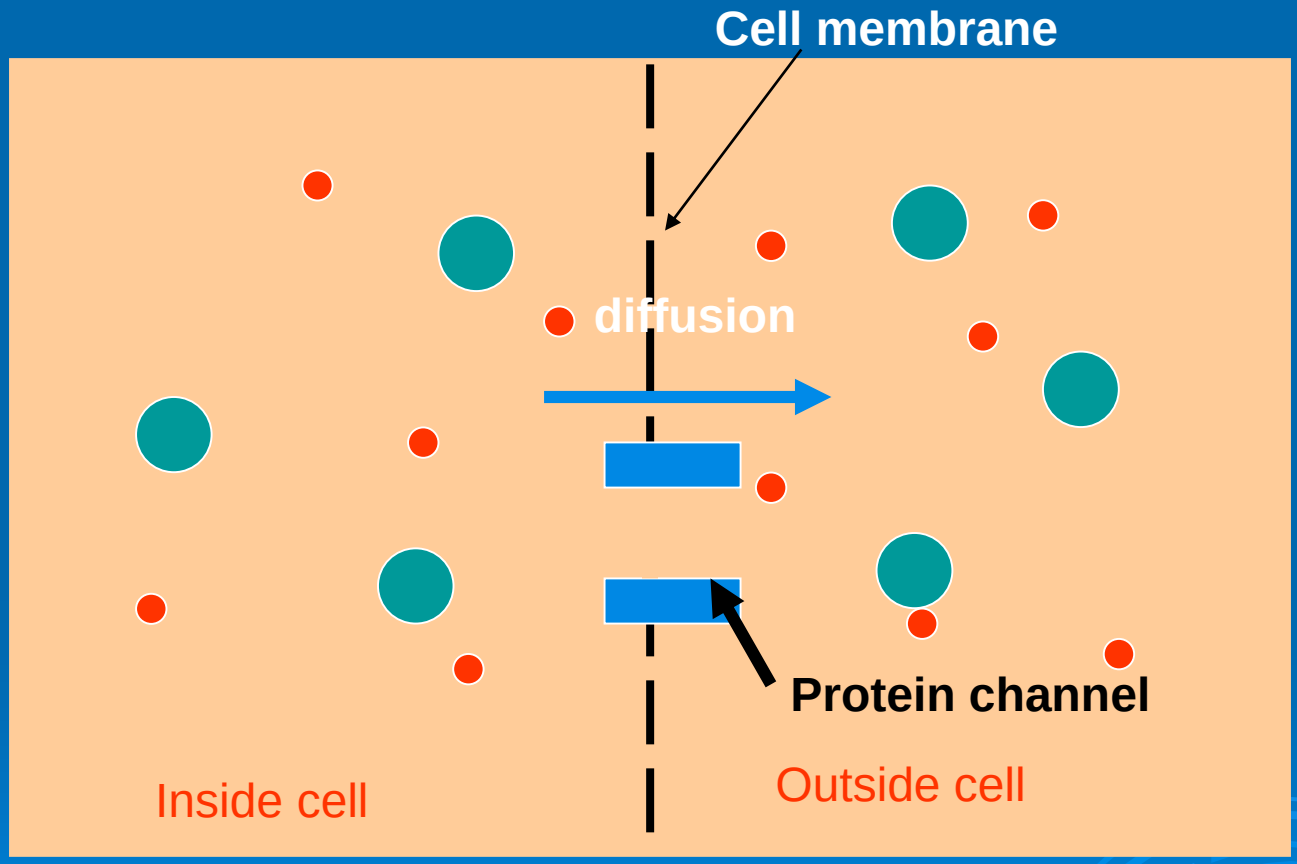
Facilitated Diffusion through a membrane



Facilitated Diffusion through a membrane

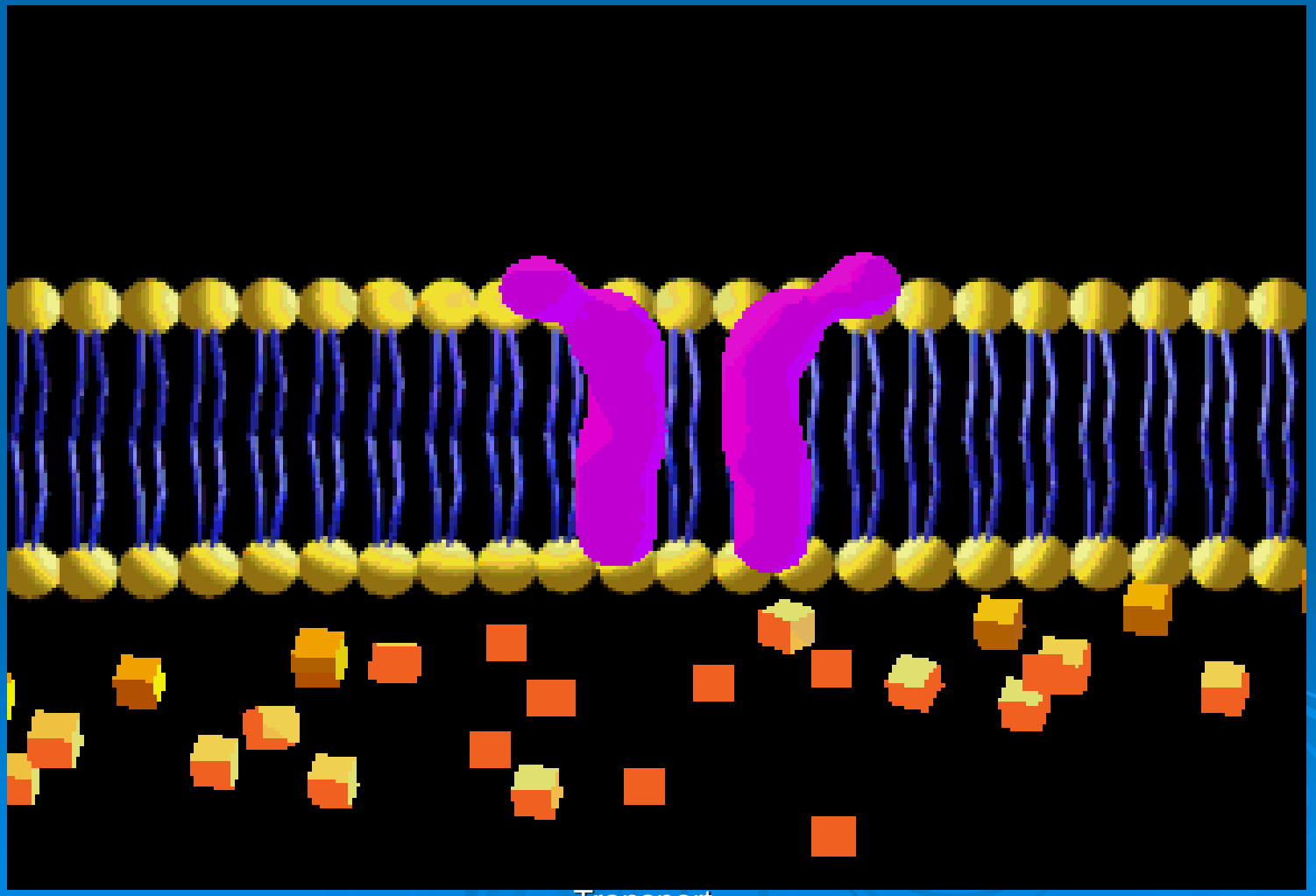


Facilitated Diffusion through a membrane



EQUILIBRIUM

Facilitated Diffusion:
Molecules will randomly move through the opening like pore, by diffusion. This requires no energy, it is a PASSIVE process.
Molecules move from an area of high concentration to an area of low conc.

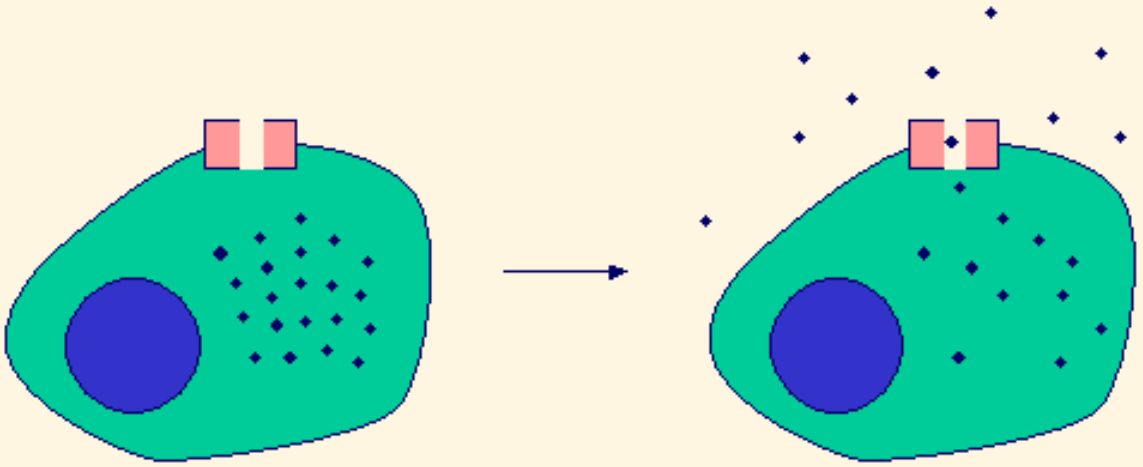


Facilitated diffusion

How Molecules Cross the Membrane

Facilitated diffusion

- Molecule is too large or charged to diffuse on its own
- Can diffuse if there is a specific transport protein (channel)

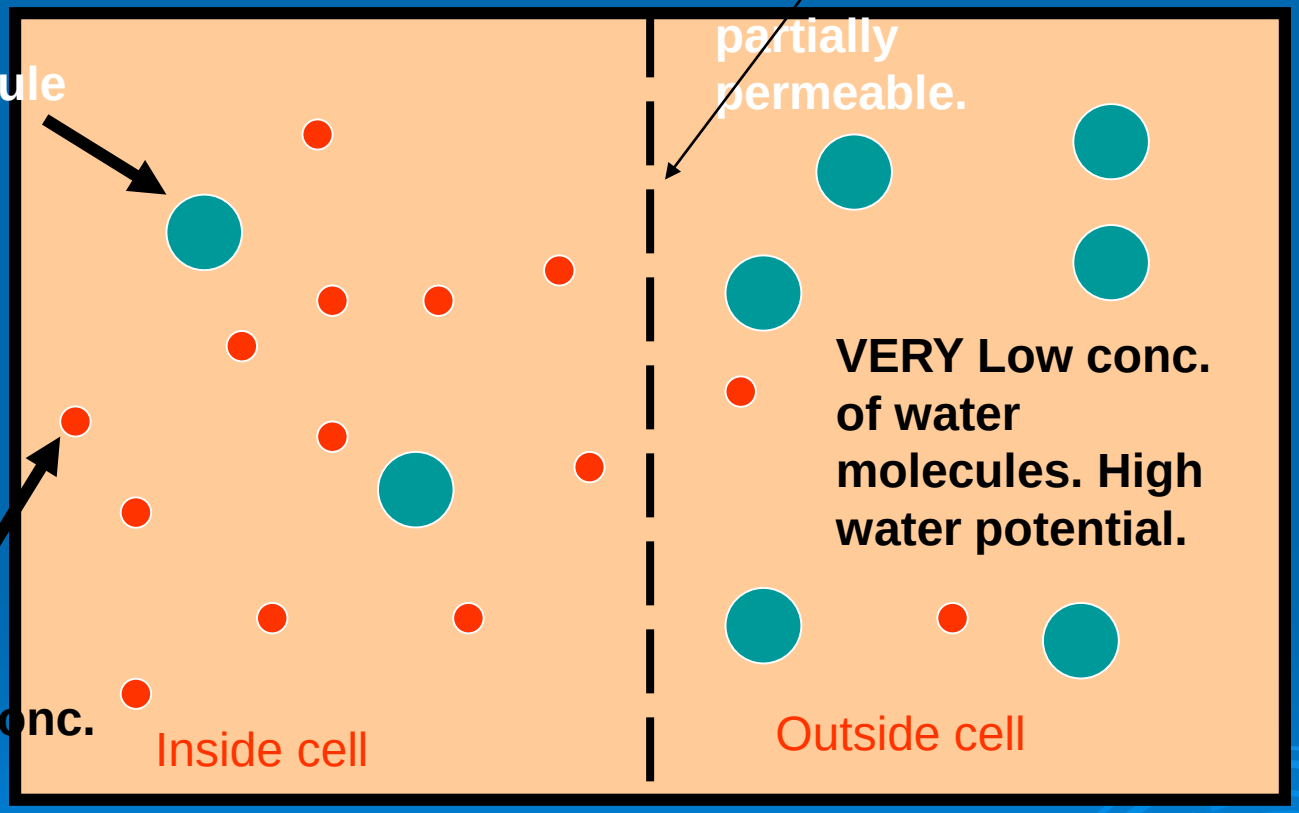


Stops when concentrations are equal inside & out (still diffusion!)

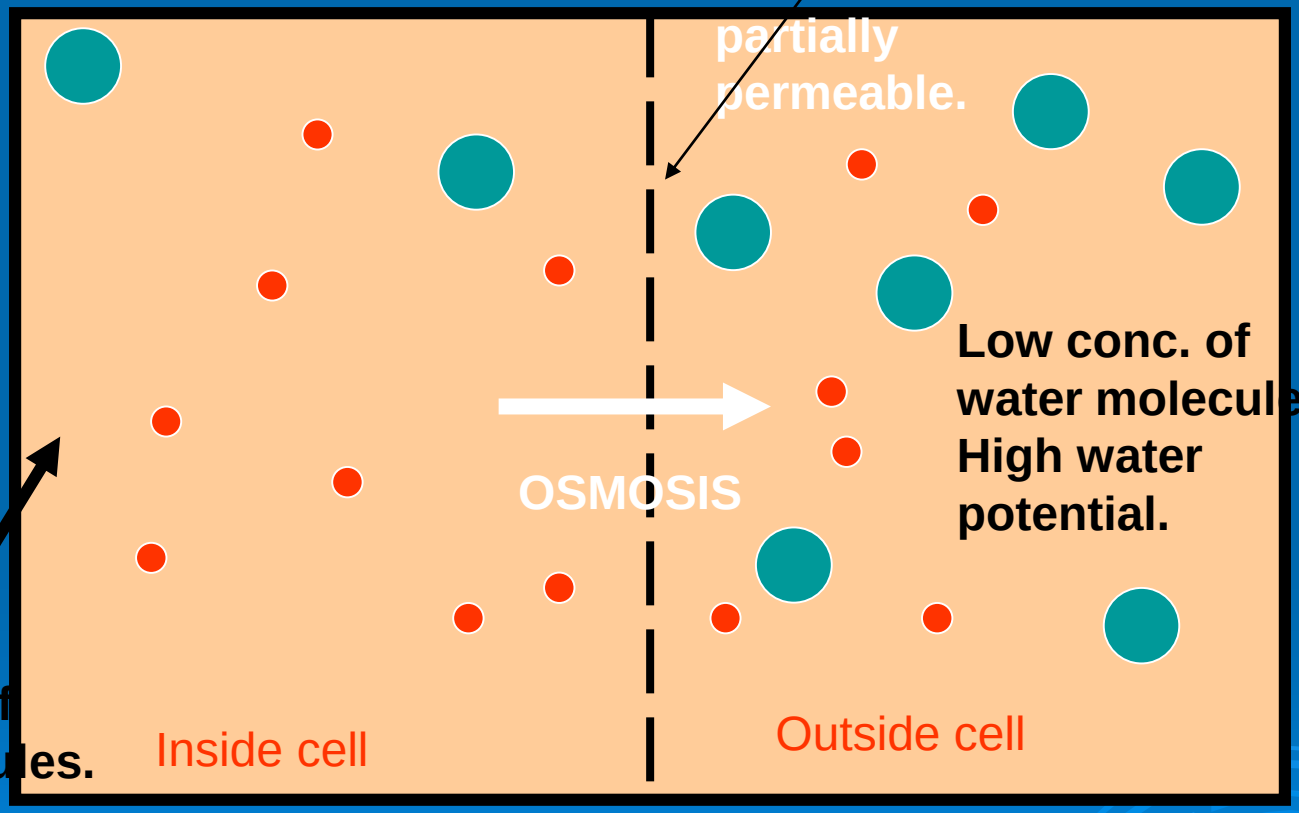
Osmosis

'The diffusion of water from an area of high concentration of water molecules (high water potential) to an area of low concentration of water (low water potential) across a partially permeable membrane.'

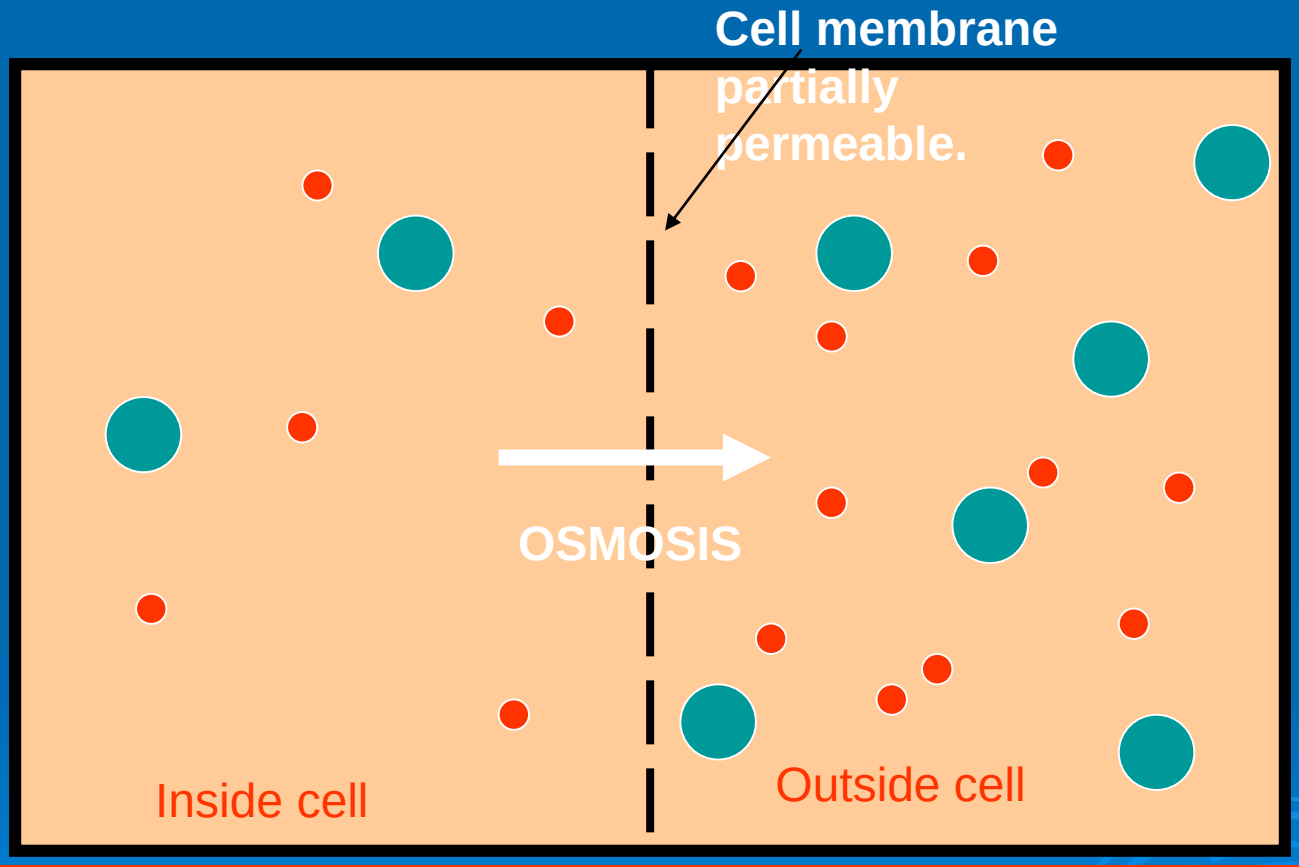
Osmosis


DILUTE SOLUTION
CONCENTRATED SOLUTION
Cell membrane partially permeable.
Sugar molecule
VERY Low conc. of water molecules. High water potential.
VERY High conc. of water molecules. High water potential.
Inside cell
Outside cell

Osmosis


Cell membrane partially permeable.
Low conc. of water molecules. High water potential.
OSMOSIS
High conc. of water molecules. High water potential.
Inside cell
Outside cell

Osmosis

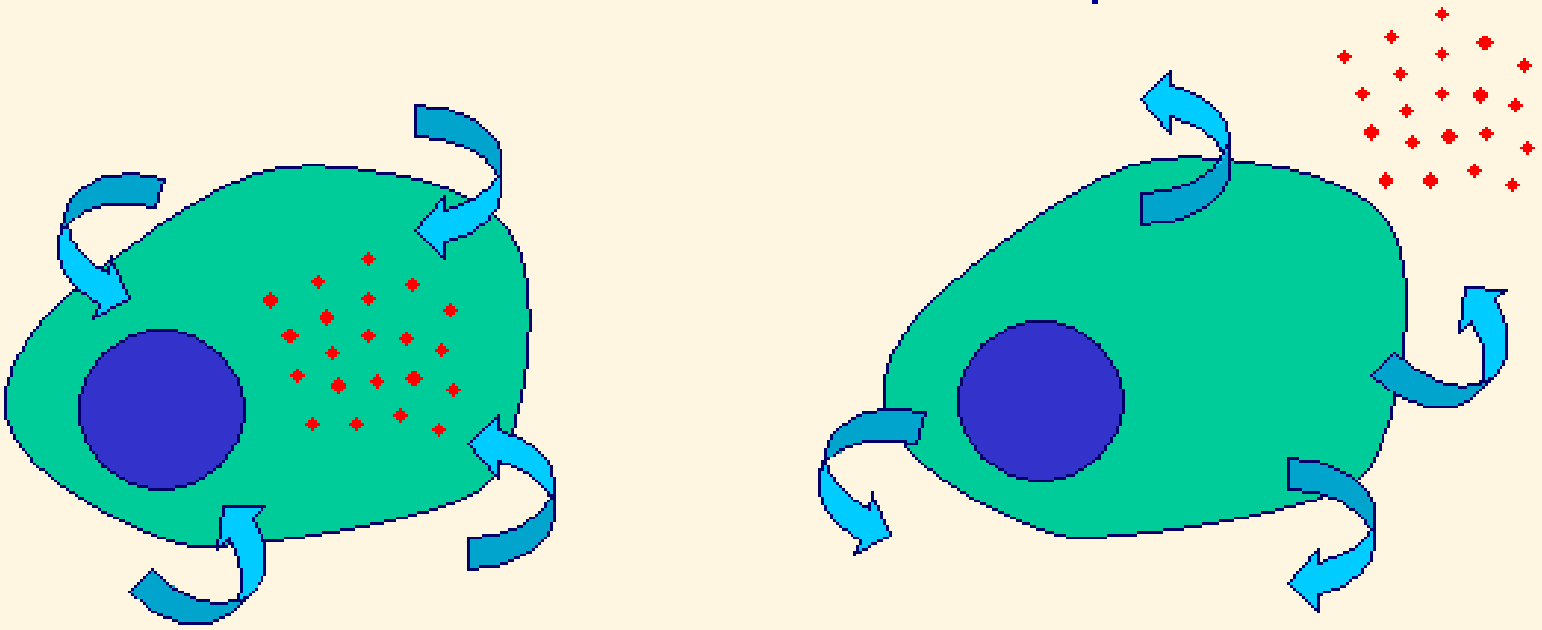


EQUILIBRIUM. Equal water concentration on each side. Equal water potential has been reached. There is no net movement of water

How Molecules Cross the Membrane

Osmosis

- Water can diffuse across a membrane
- Water tries to dilute out molecules that can't move across the membrane until the concentration is equal



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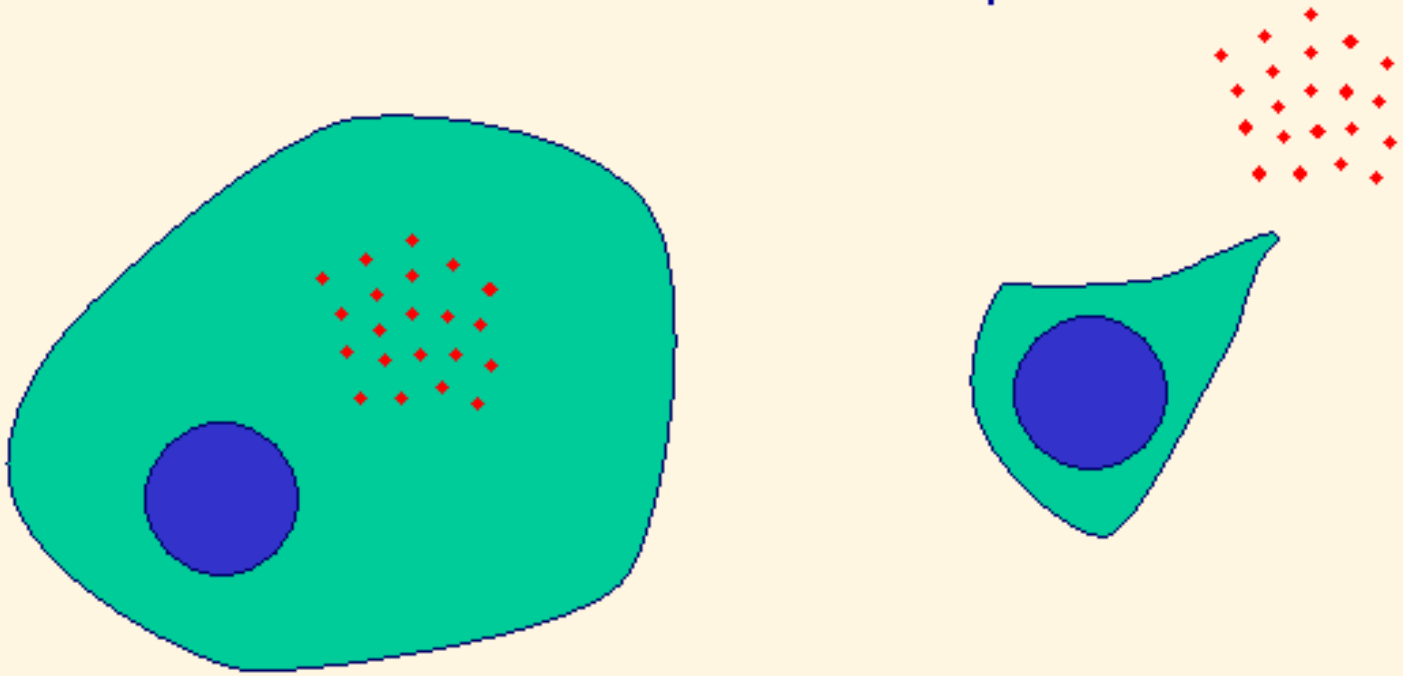
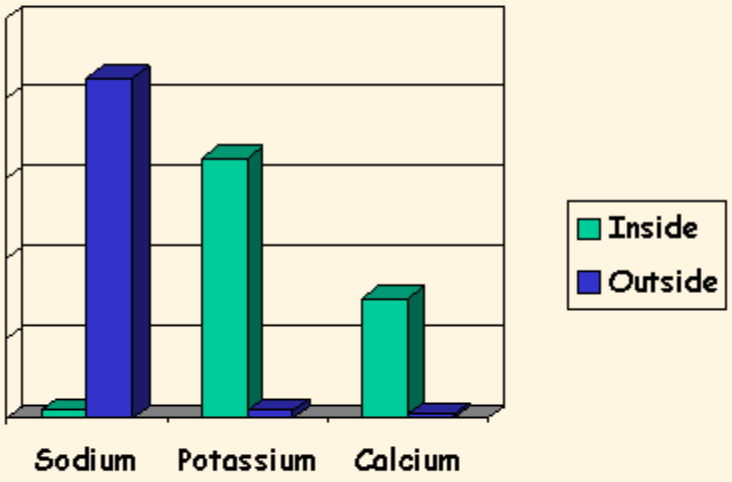


How Molecules Cross the Membrane

Active transport

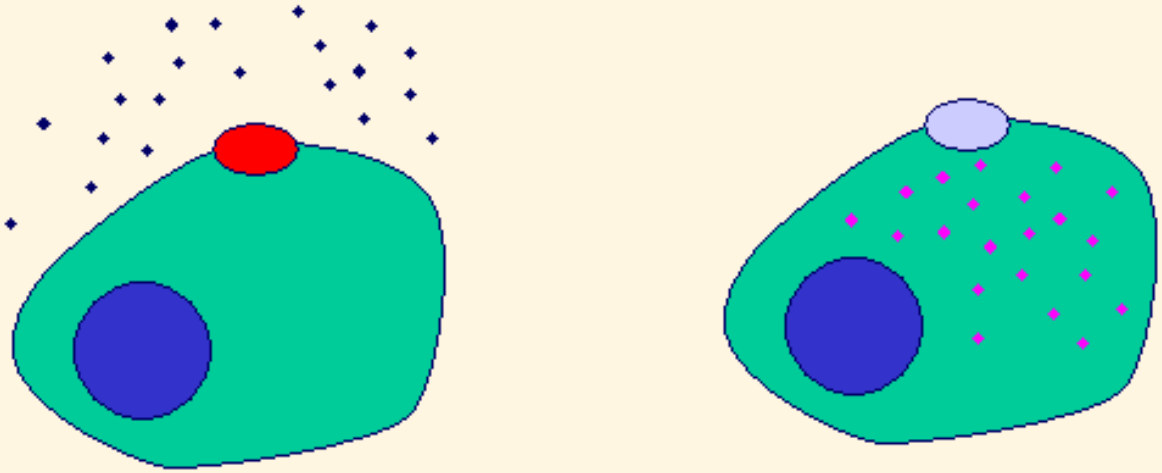
- Cells must maintain very high or low levels of some molecules
  - Passive transport can't do this!



How Molecules Cross the Membrane

Active transport

- Cells must maintain very high or low levels of some molecules
- Active transport proteins use energy to "pump" a molecule in or out of the cell



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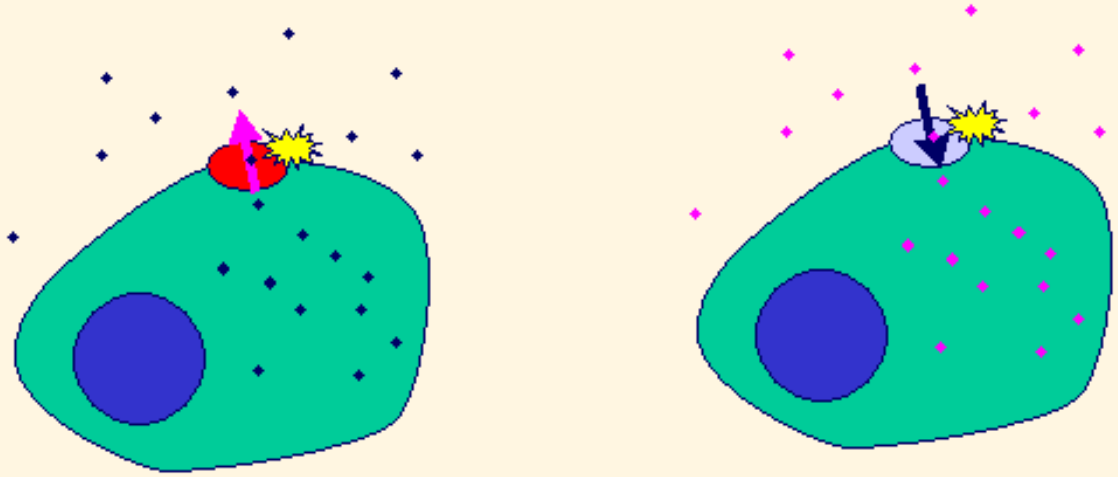
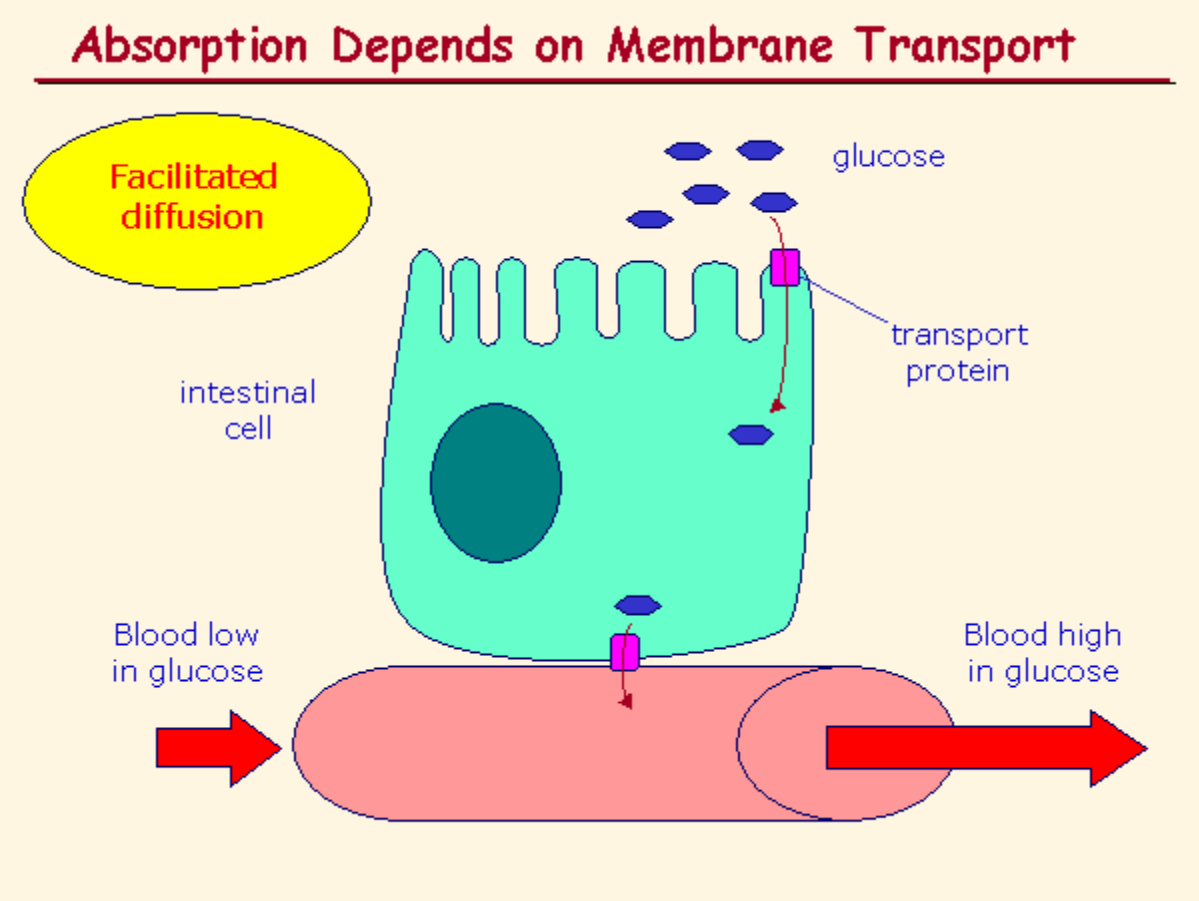
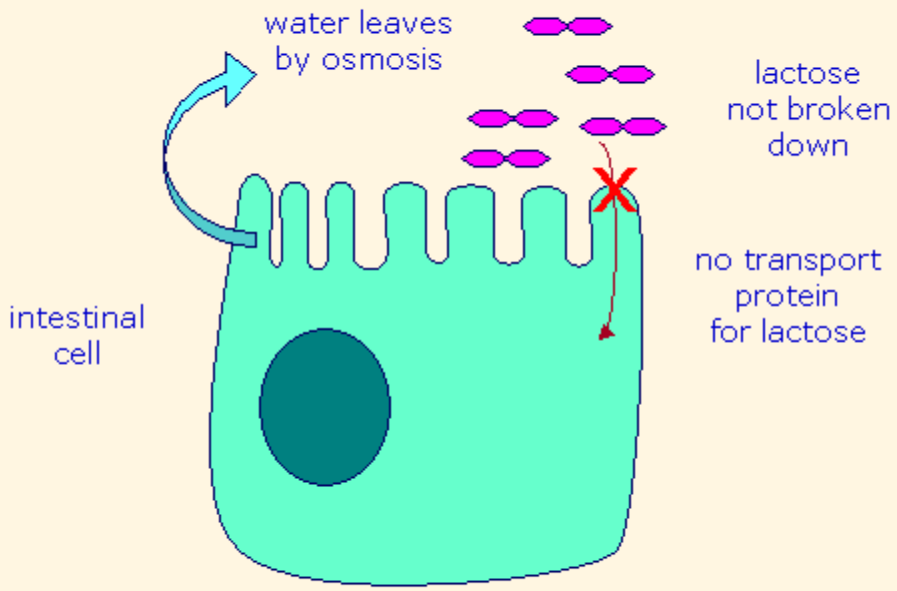


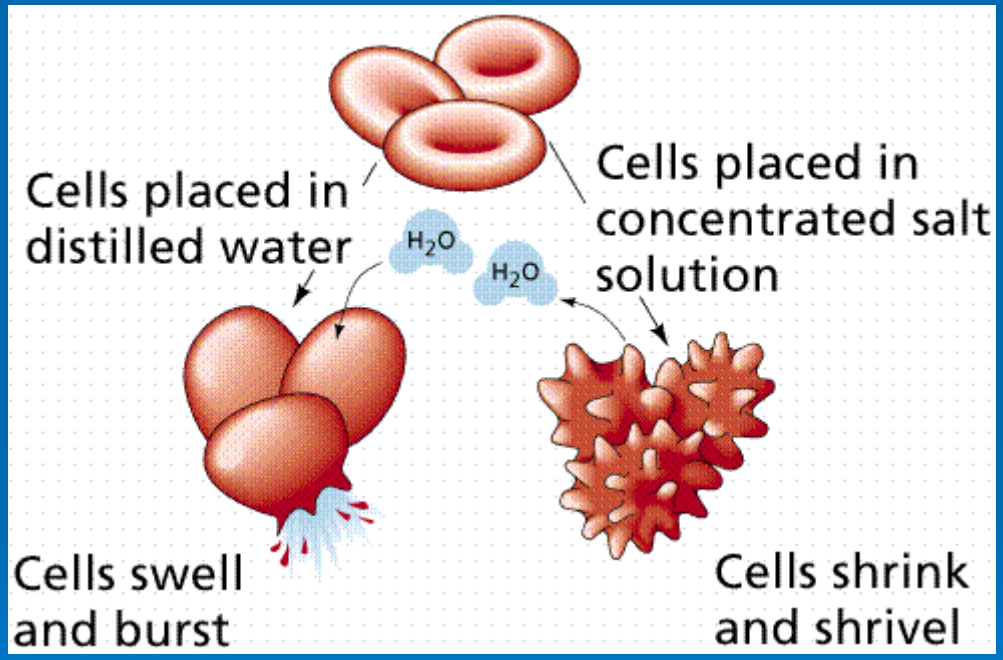
How Molecules Cross the Membrane

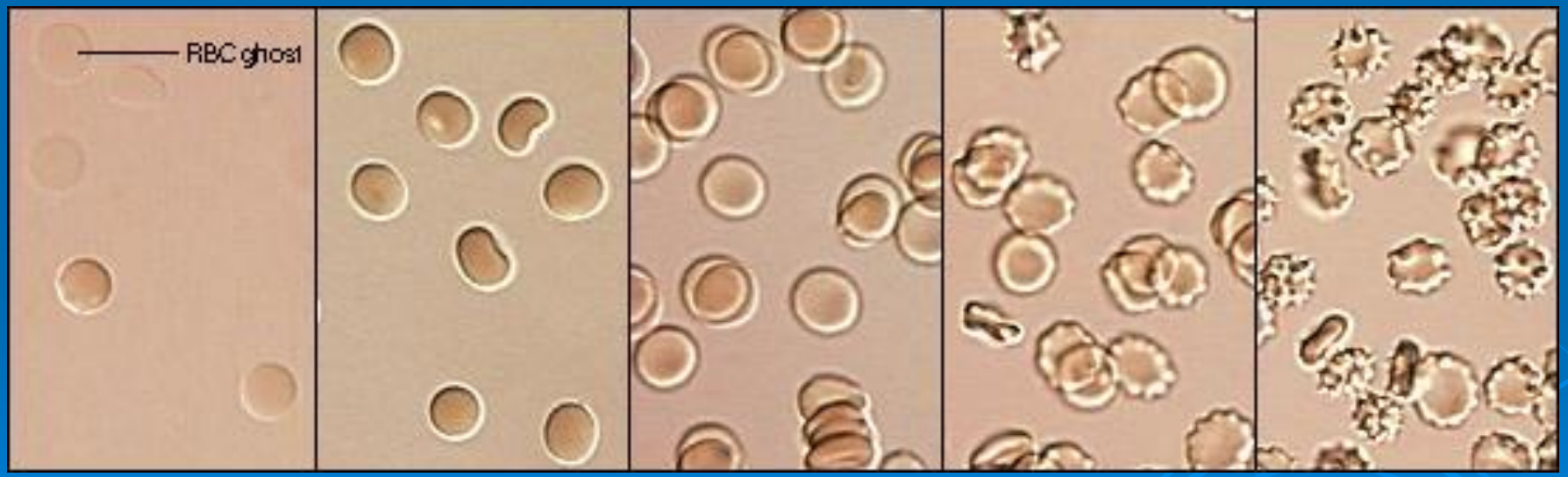
	Active/ Passive	Molecules that Move	Direction	Energy Needed?	Protein Needed?
Diffusion	Passive	small, hydrophobic	down gradient (toward low conc.)	no	no
Osmosis	Passive	water	toward high conc. of solutes	no	no
Facilitated Diffusion	Passive	any (specific transporter)	down gradient (toward low cons.)	no	yes
Active Transport	Active	any (specific transporter)	specific: in or out, dep. on transporter	yes	yes


Absorption Depends on Membrane Transport
Facilitated diffusion
glucose
transport protein
intestinal cell
Blood low in glucose
Blood high in glucose

Lactose Intolerance

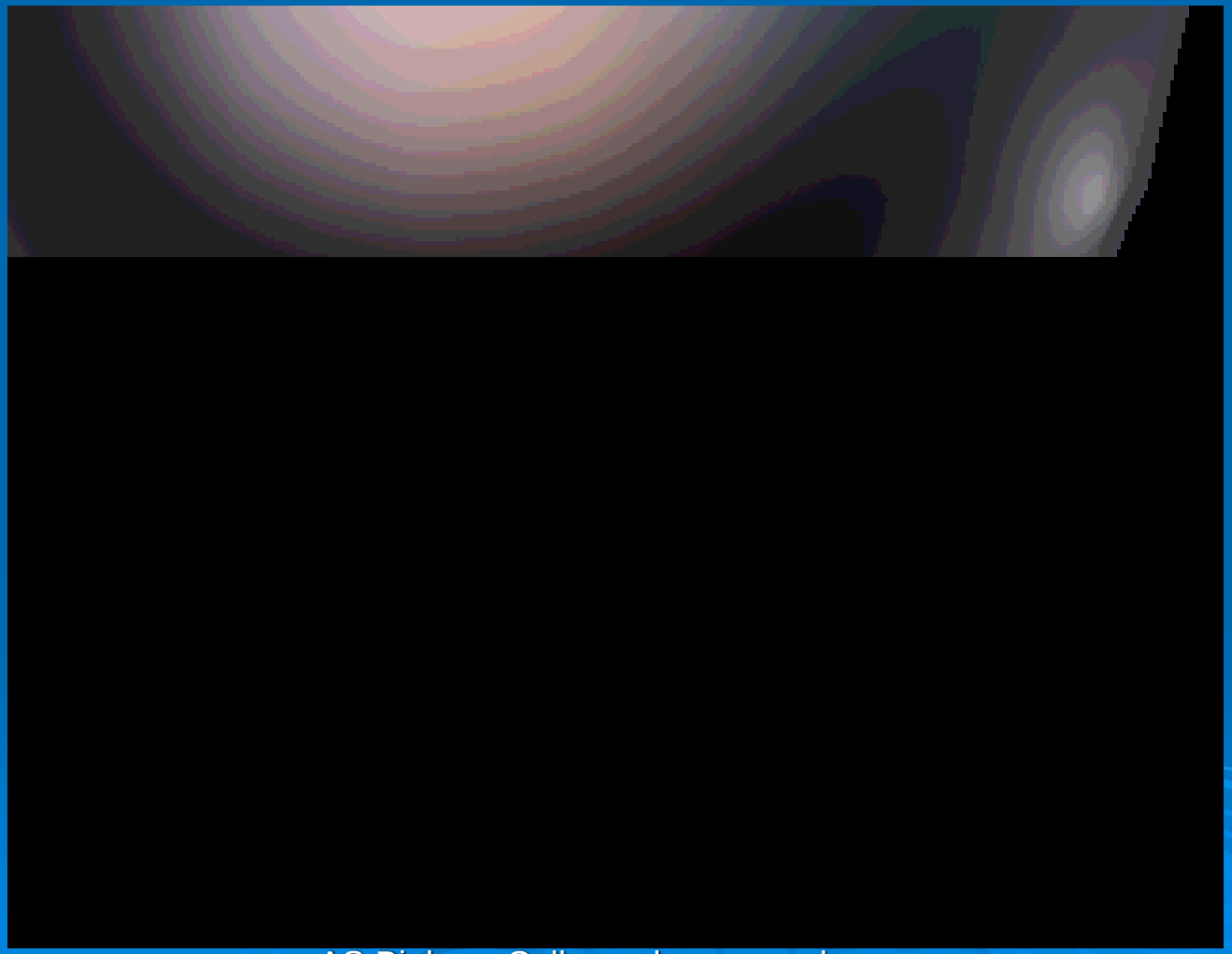


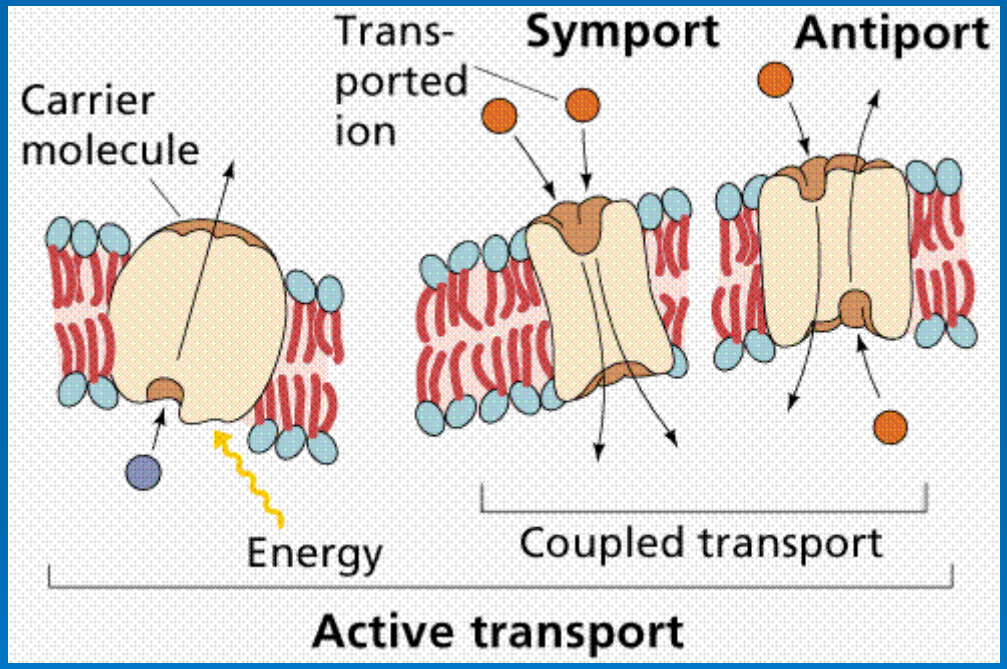

Cells placed in distilled water
H_2O
H_2O
Cells placed in concentrated salt solution
Cells swell and burst
Cells shrink and shrivel

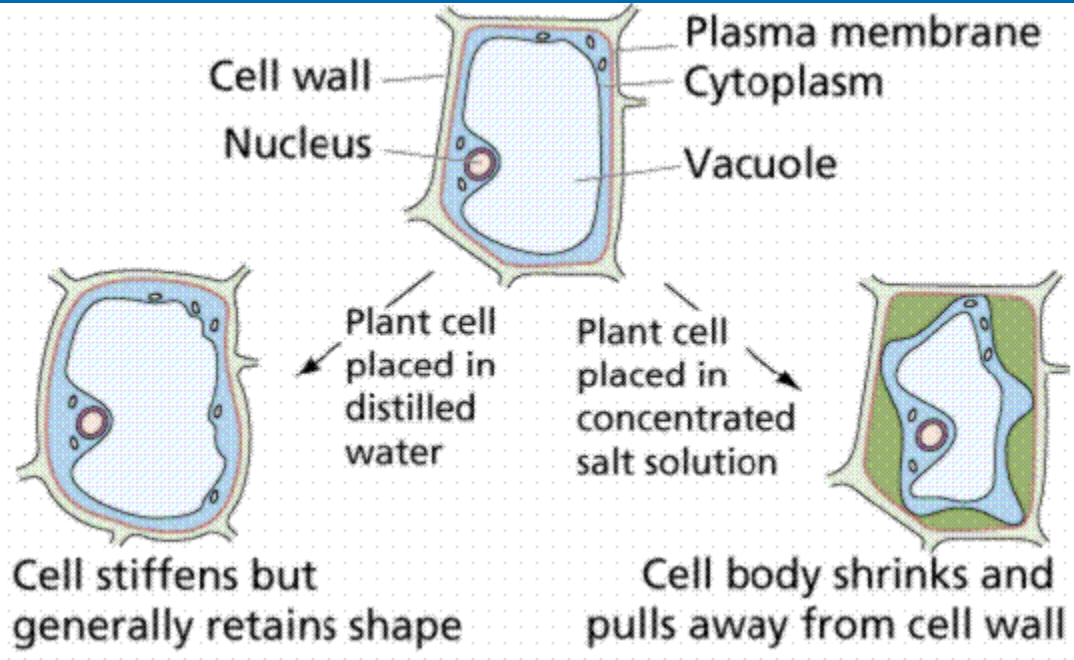

RBC ghost

Exocytosis

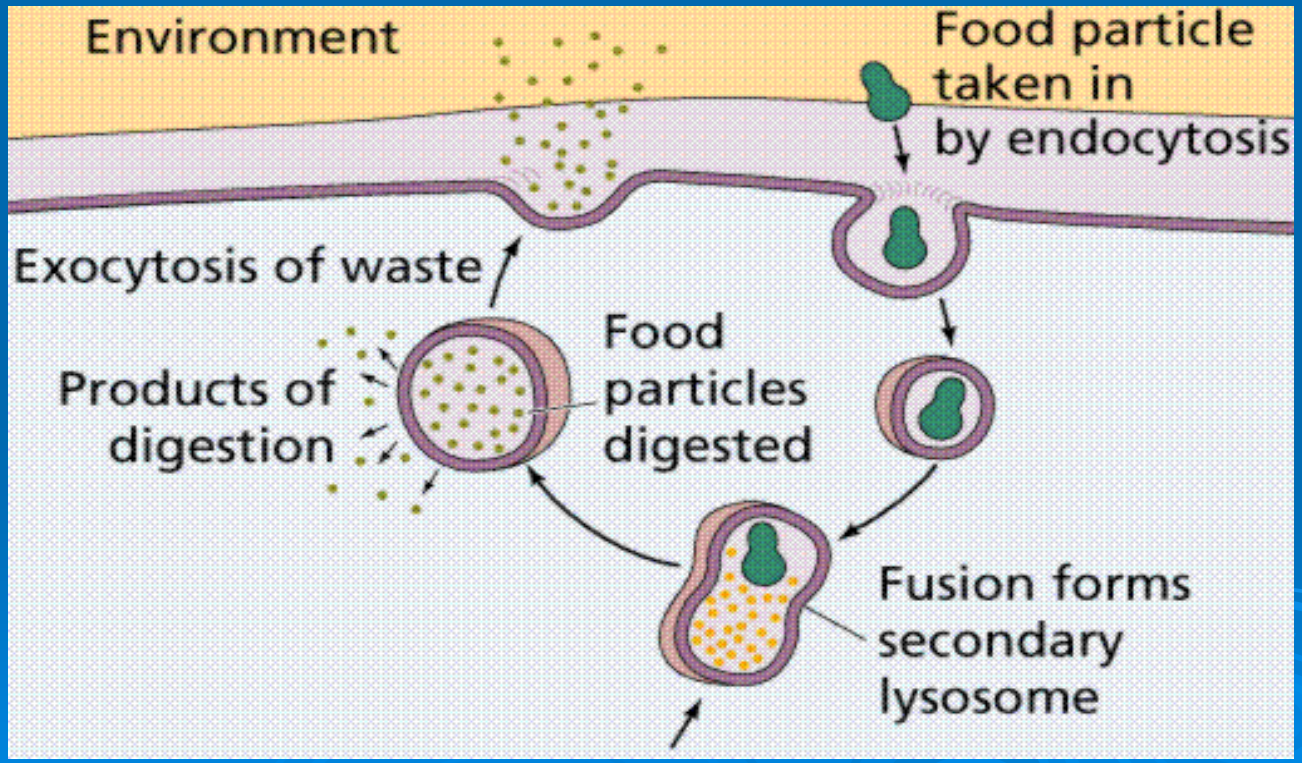
The opposite of endocytosis is exocytosis. Large molecules that are manufactured in the cell are released through the cell membrane.

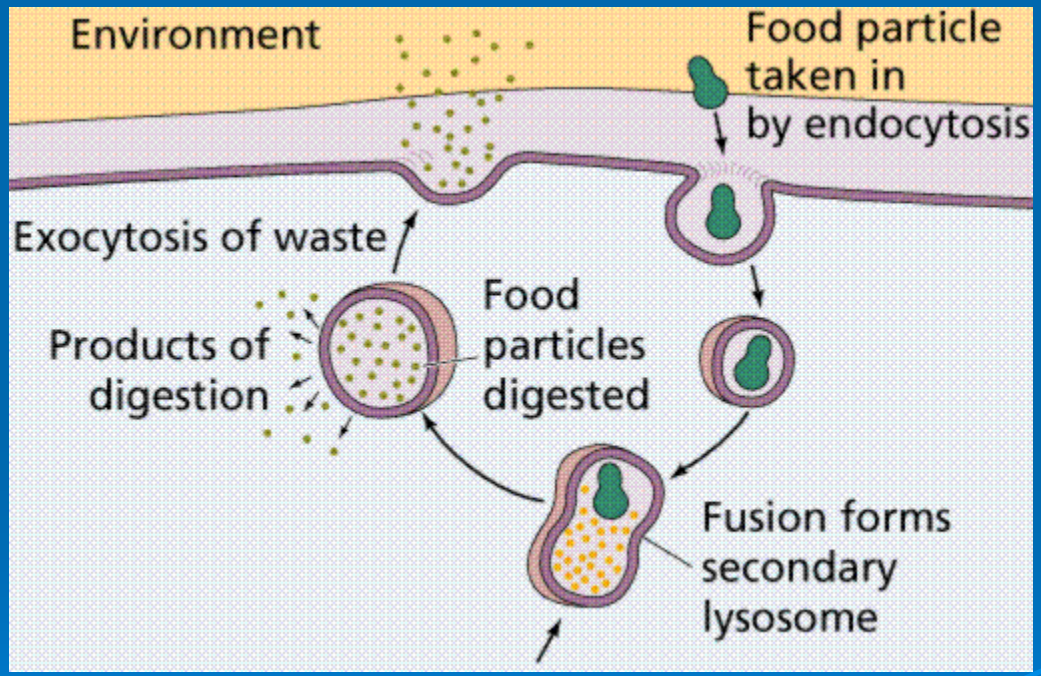



Trans-
ported
ion
Symport
Antiport
Carrier
molecule
Energy
Coupled transport
Active transport

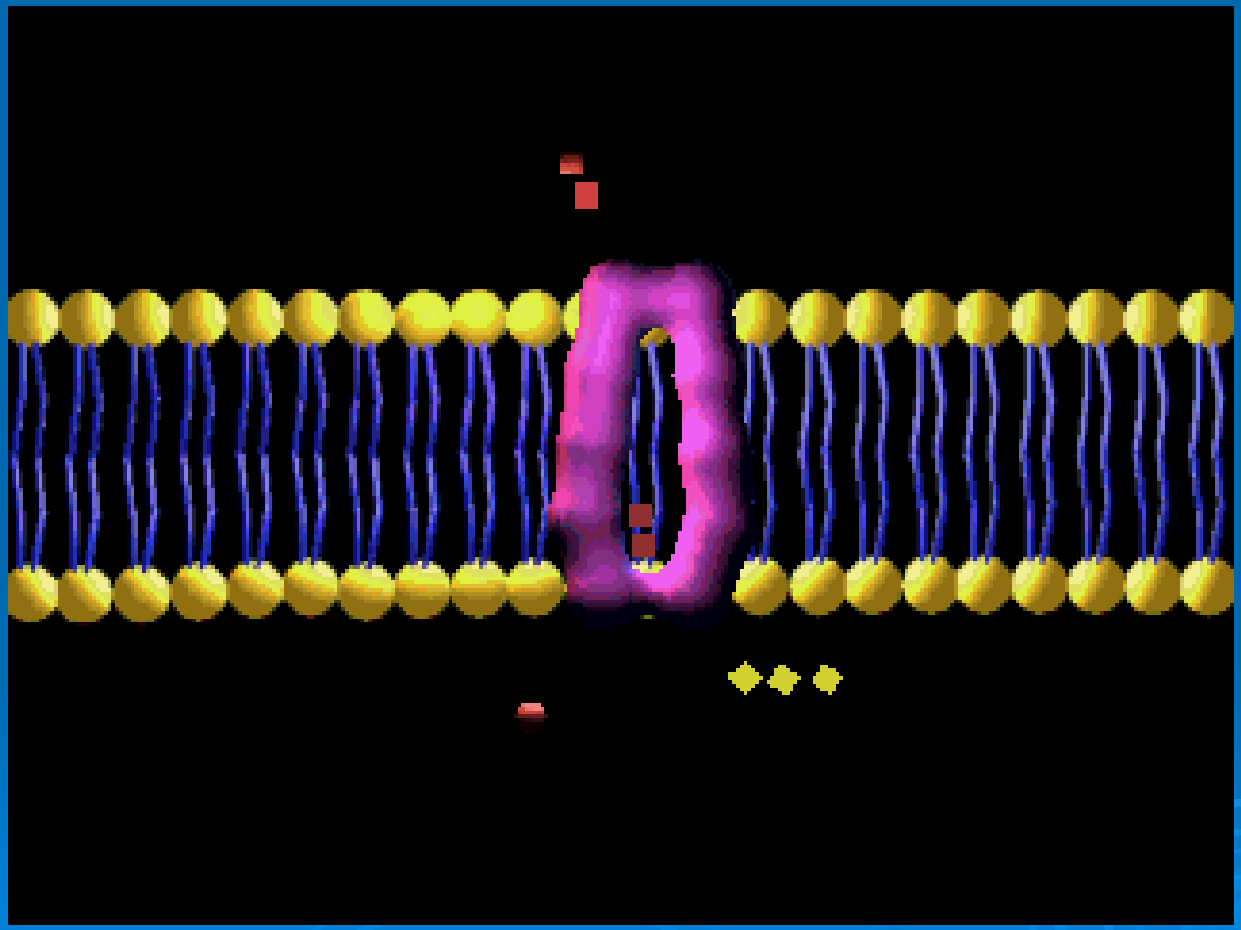

Cell wall
Nucleus
Plasma membrane
Cytoplasm
Vacuole
Plant cell placed in distilled water
Plant cell placed in concentrated salt solution
Cell stiffens but generally retains shape
Cell body shrinks and pulls away from cell wall

Endocytosis is the case when a molecule causes the cell membrane to bulge inward, forming a vesicle. Phagocytosis is the type of endocytosis where an entire cell is engulfed. Pinocytosis is when the external fluid is engulfed. Receptor-mediated endocytosis occurs when the material to be transported binds to certain specific molecules in the membrane. Examples include the transport of insulin and cholesterol into animal cells.



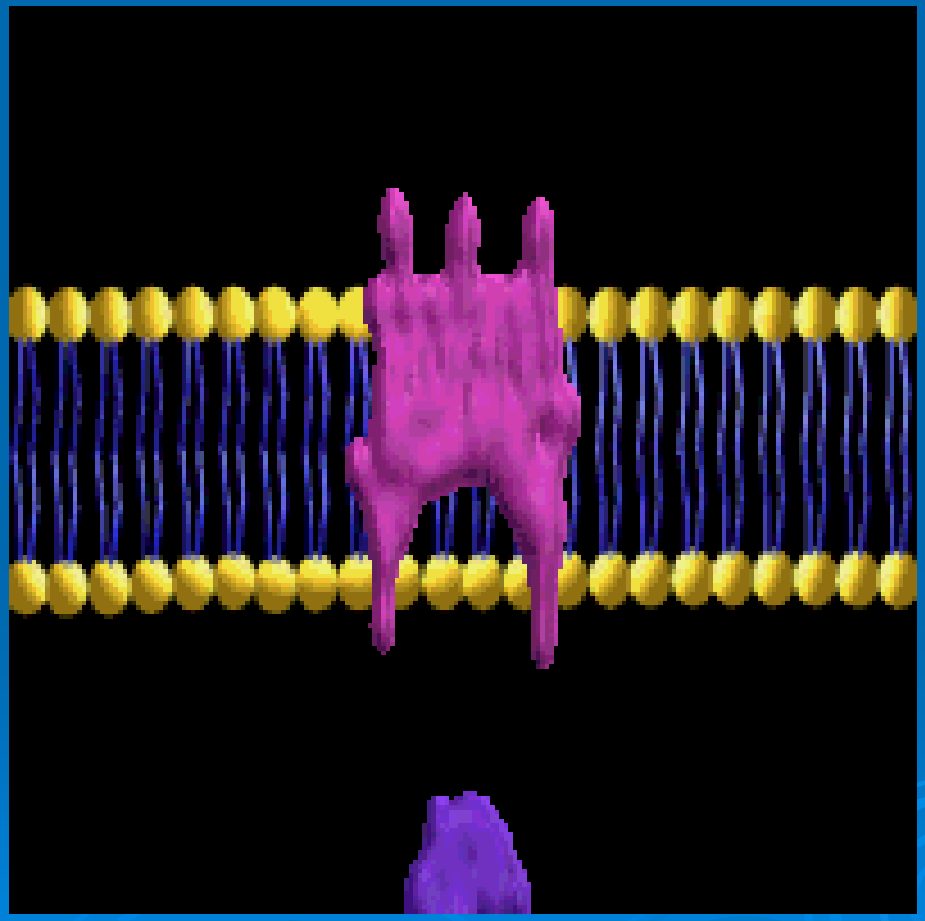

Environment
Food particle taken in by endocytosis
Exocytosis of waste
Products of digestion
Food particles digested
Fusion forms secondary lysosome

Cotransport also uses the process of diffusion. In this case a molecule that is moving naturally into the cell through diffusion is used to drag another molecule into the cell. In this example glucose hitches a ride with sodium.



Receptor Proteins

These proteins are used in intercellular communication. In this animation you can see the a hormone binding to the receptor. This causes the receptor protein release a signal to perform some action.



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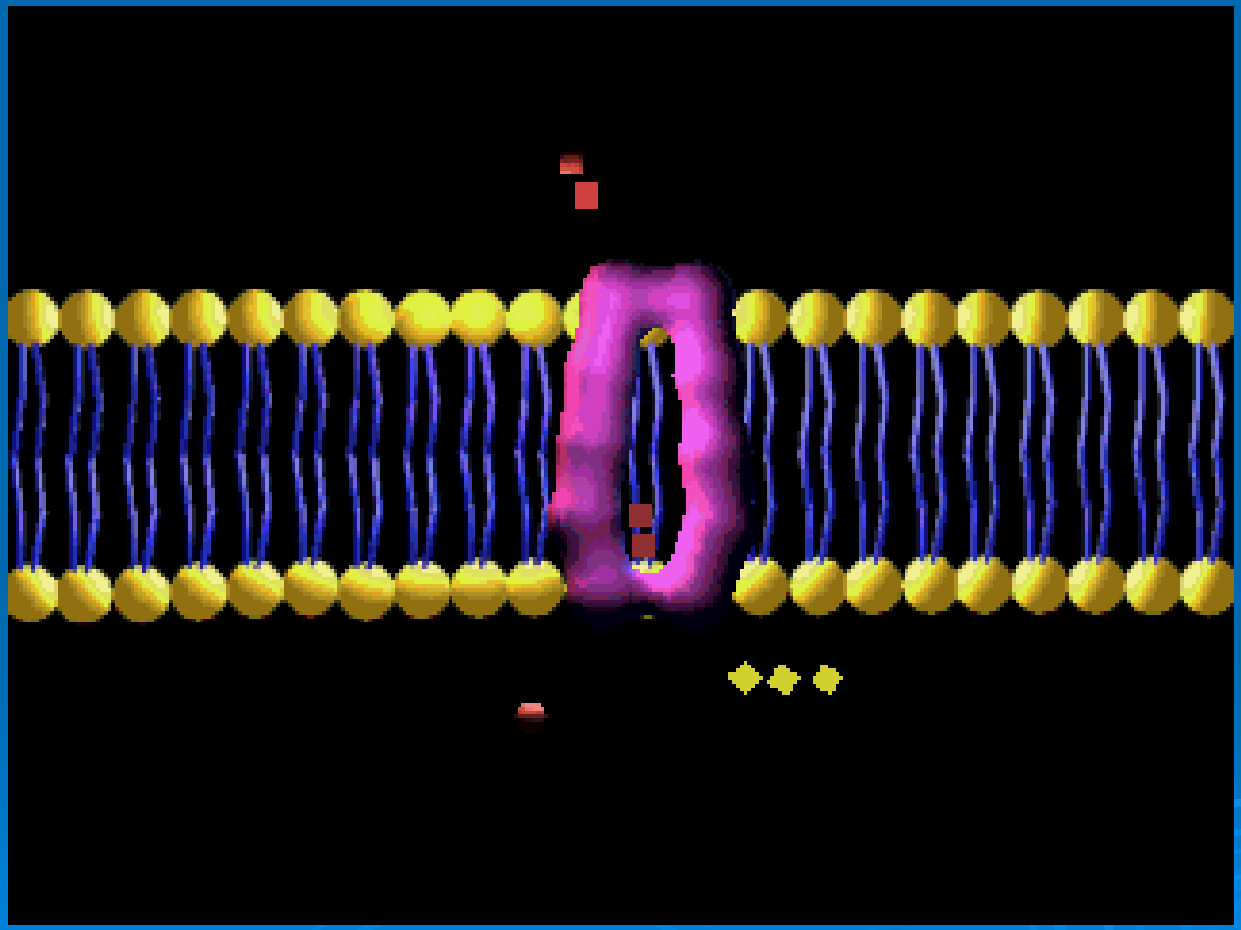
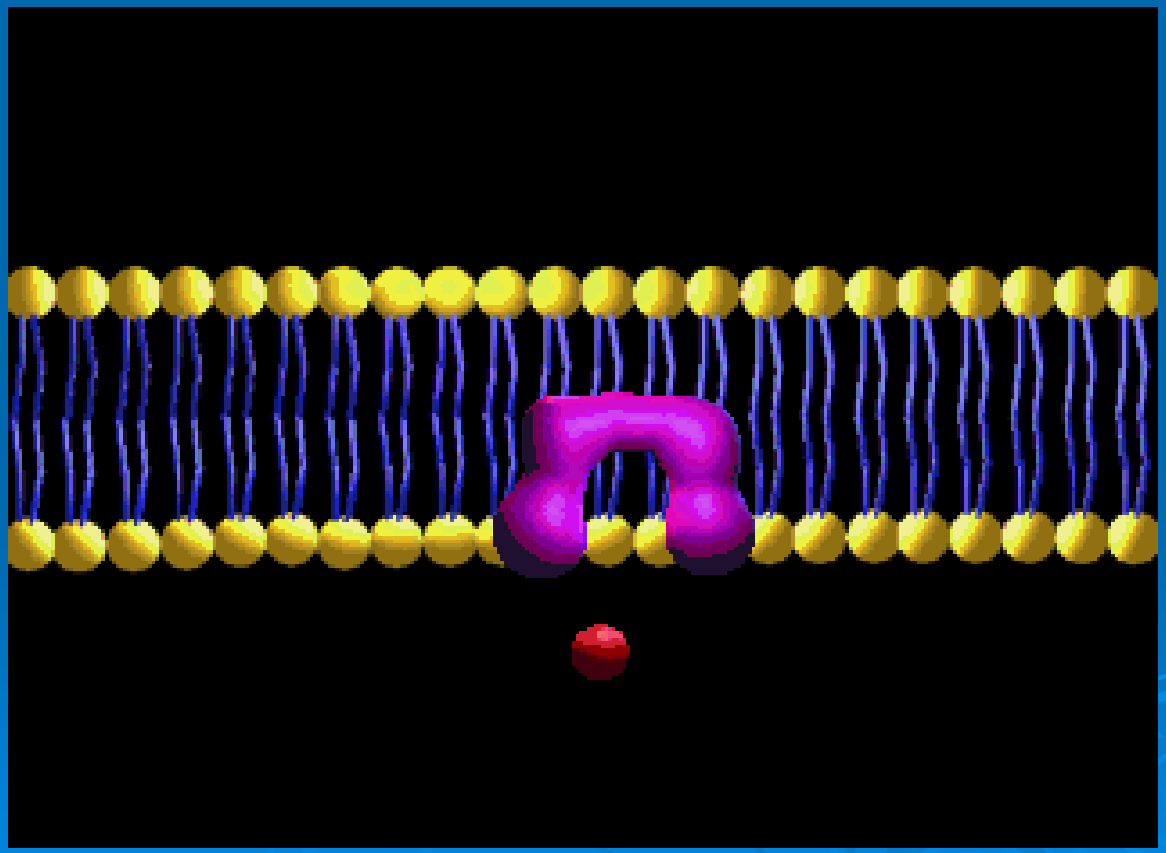
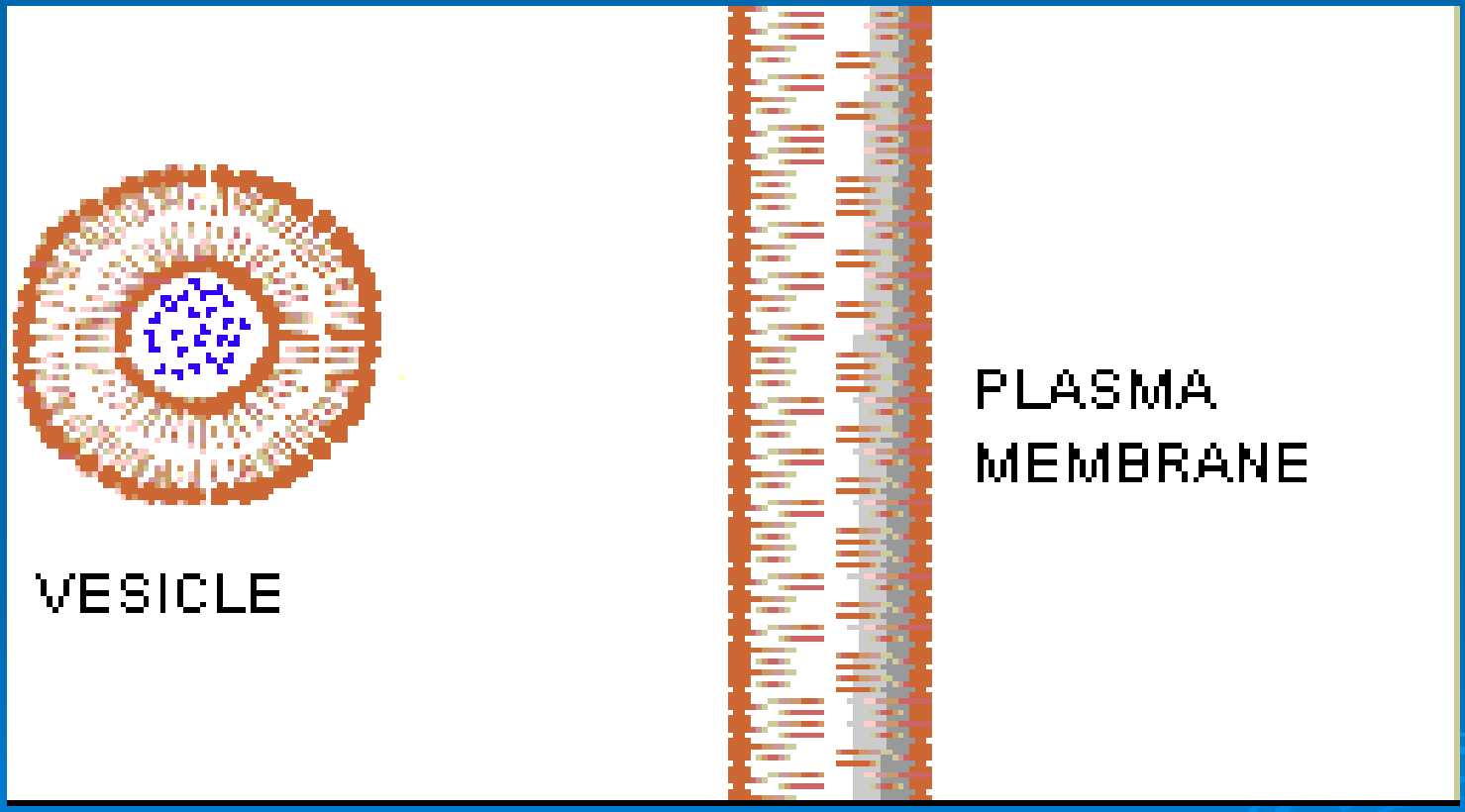


These are carrier proteins. They do not extend through the membrane. They bond and drag molecules through the bilipid layer and release them on the opposite side.



Vesicle-mediated transport

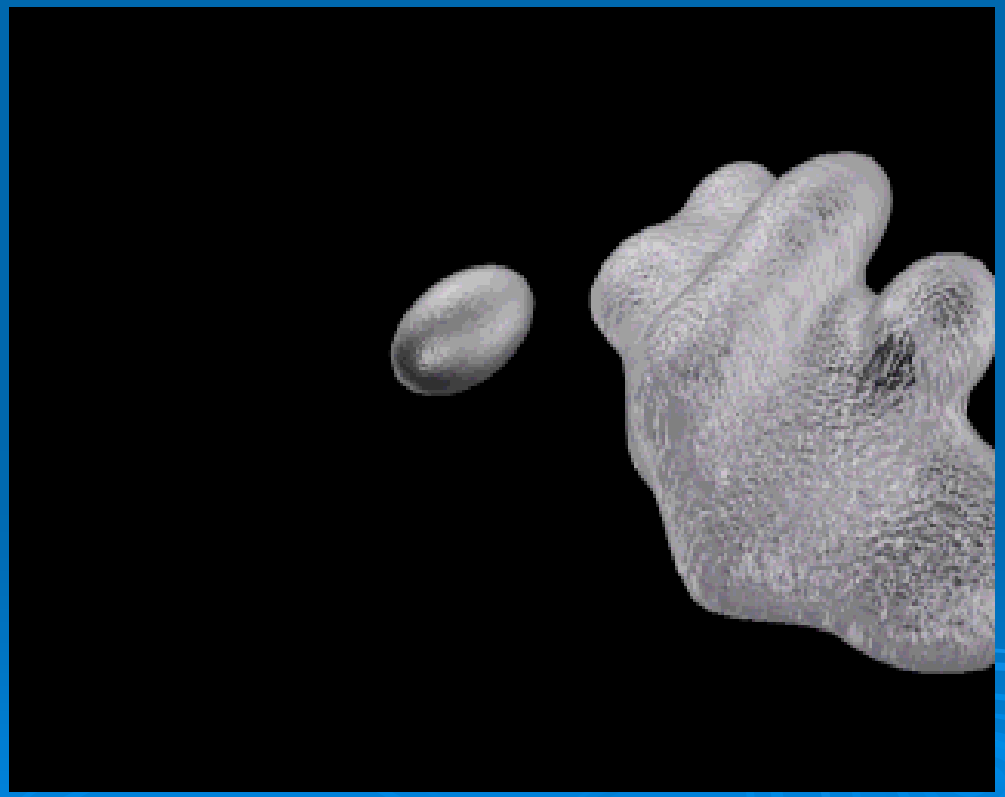
Vesicles and vacuoles that fuse with the cell membrane may be utilized to release or transport chemicals out of the cell or to allow them to enter a cell. Exocytosis is the term applied when transport is out of the cell.



Cell Membrane - Function - Endocytosis

The cell membrane can also engulf structures that are much too large to fit through the pores in the membrane proteins this process is known as endocytosis. In this process the membrane itself wraps around the particle and pinches off a vesicle inside the cell. In this

animation an ameba engulfs a food particle.



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