MEMBRANE TRANSPORT

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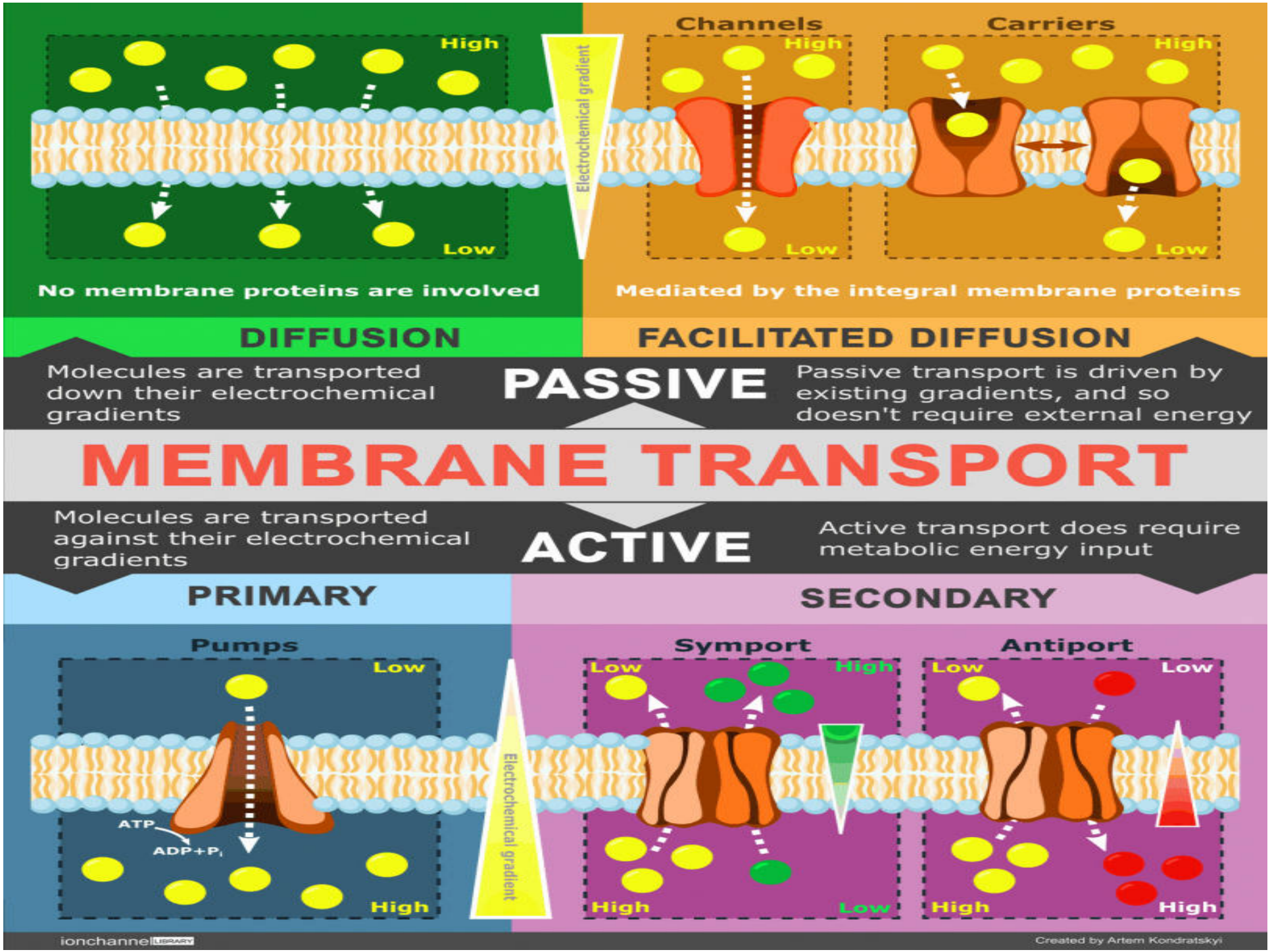

High
Low
Electrochemical gradient
Channels
Carriers
High
High
Low
Low
No membrane proteins are involved
Mediated by the integral membrane proteins
DIFFUSION
FACILITATED DIFFUSION
Molecules are transported down their electrochemical gradients
PASSIVE
Passive transport is driven by existing gradients, and so doesn't require external energy
MEMBRANE TRANSPORT
Molecules are transported against their electrochemical gradients
ACTIVE
Active transport does require metabolic energy input
PRIMARY
SECONDARY
Pumps
Low
ATP
ADP+Pi
High
Electrochemical gradient
Symport
Low
High
High
Low
Antiport
Low
Low
High
High
ionchannel LIBRARY
Created by Artem Kondratskyi

Introduction

The surrounding extracellular fluid is the source of many molecules and ions that are required

by the cell so there is in and out of the cell through its plasma membrane.

Examples: glucose, Na+, Ca2+.

In eukaryotic cells, there is also transport in and out of membrane-bounded intracellular compartments such as the nucleus, endoplasmic reticulum, and mitochondria

The membrane is permeable to:

•H_2O

•Gases (O_2, CO_2, N_2)

•Lipids

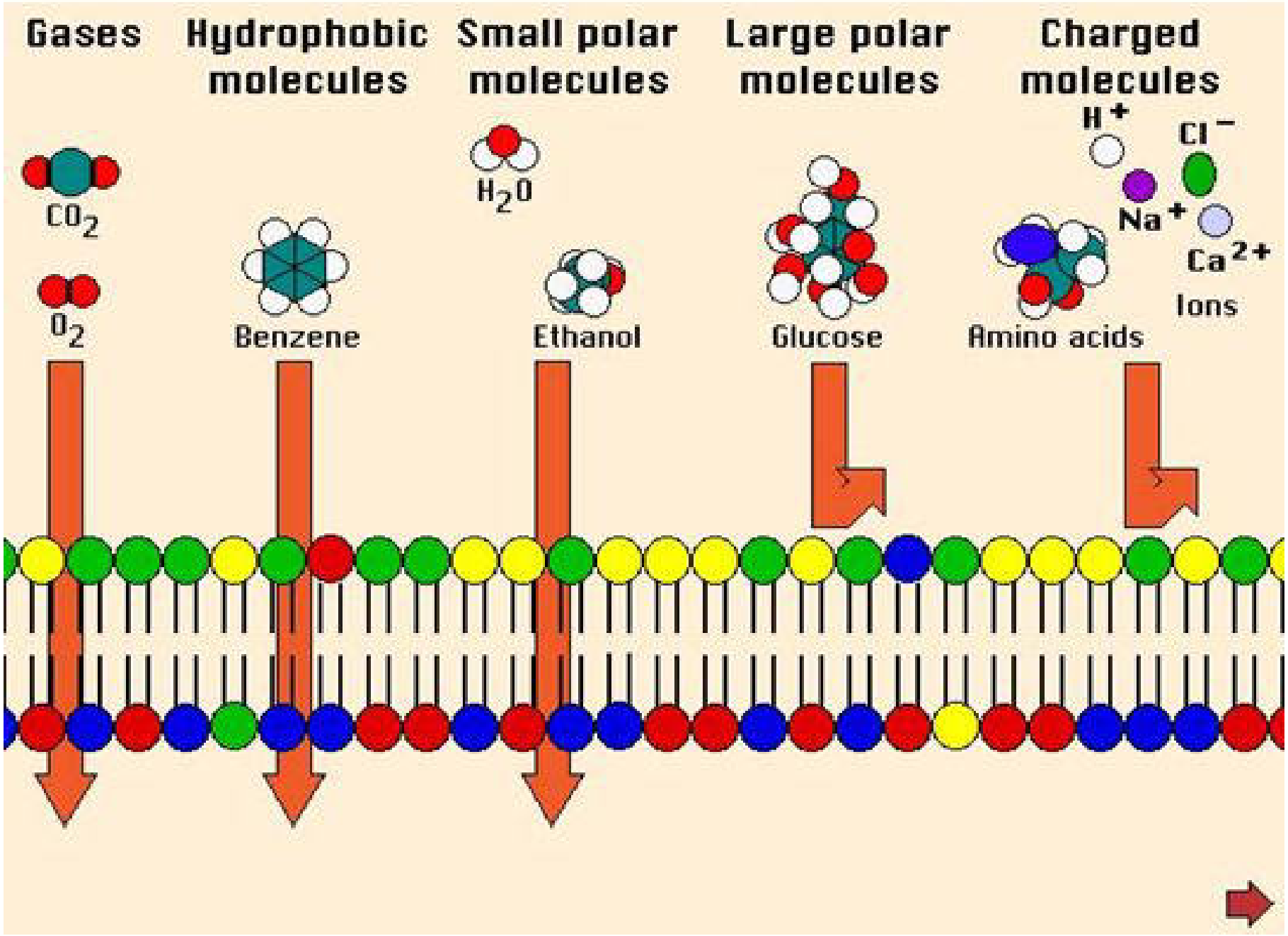
•Small, neutral molecules (such as urea)

The membrane is impermeable to:

•Small, charged molecules

•large molecules such as amino acids, glucose and larger

• These compounds must go through channels present in the membrane in order to enter or exit the cell


Gases
Hydrophobic molecules
Small polar molecules
Large polar molecules
Charged molecules
CO_2
O_2
Benzene
H_2O
Ethanol
Glucose
Amino acids
H^+
Cl^-
Na^+
Ca^{2+}
Ions

Passive Transport

Movement of molecules through the membrane with the concentration gradient (from high to low concentration)
Does not use energy

Simple diffusion

Movement of molecules through the membrane and **down** their concentration (from **high** concentration to **low)** with

-No protein transporter
-No energy is required
-Molecules move in response to a concentration gradient(Driving force is the concentration gradient)

Facilitated diffusion

Movement of a molecule from **high** to **low** concentration with the help of **protein transporter** .

- Specific
- Passive
- Saturates when all carriers are occupied

The types of facilitated diffusion

Carrier proteins

Permeases are those proteins that traverse through the plasma membrane and are also called transmembrane proteins.

Every protein carrier binds to a corresponding molecule uniquely.

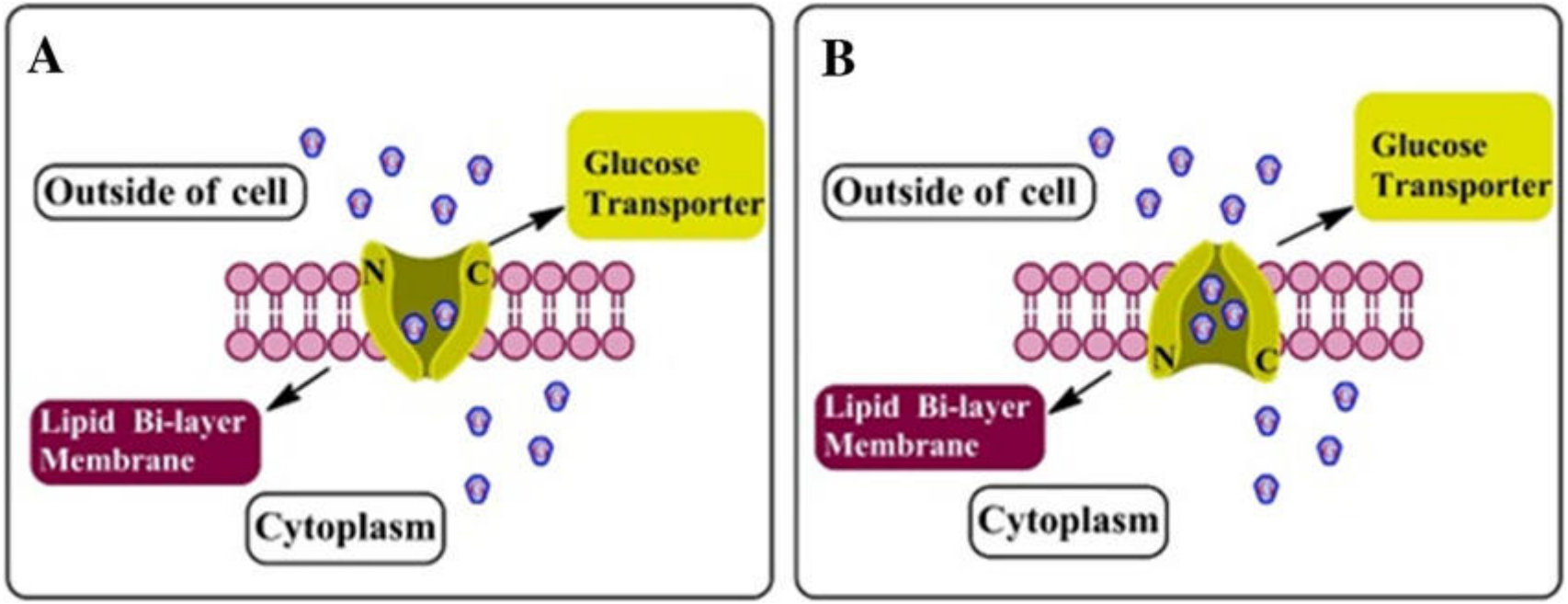
The molecules attach to the carrier protein on the one side of the plasma membrane (greater concentration of chemicals).

Then the carrier changes the conformational shape, changing the binding site from one to the other side of the membrane, releasing molecules to the other side of the membrane

Exemple: GLUT

Glucose transporter (**GLUT4**) is a facilitative transport protein involved in glucose translocation across the cell membrane

GLUT 4 is localized in the vesicles inside the cytoplasm of cells migrate and open when insulin binds to the insulin receptor on the plasma membrane



Leak channels: Always open

Na+, K+, Cl- leak channels

Ion channel proteins

Ion channel proteins contain a gate to govern the movement of substances crossing the cell membrane along their electrochemical gradient, which is normally controlled by a **voltage-gated ion channel**, **ligand-gated ion channel**

Ligand-gated ion channels

Many ion channels open or close in response to binding a small signaling molecule or **"ligand"**

Acetylcholine (**ACh**). The binding of the **neurotransmitter** acetylcholine at certain synapses opens channels that admit Na^+ and initiate a nerve impulse or muscle contraction.

Voltage-gated ion channels

Channels which open or close in response to changes in the charge (measured in volts) across the plasma membrane are known as voltage gated channels as in neurons and muscle cells.

Example: As impulse passes down a neuron, the reduction in the voltage opens **sodium** channels in the adjacent portion of the membrane. This allows the influx of Na+ into the neuron and thus the continuation of the nerve impulse.

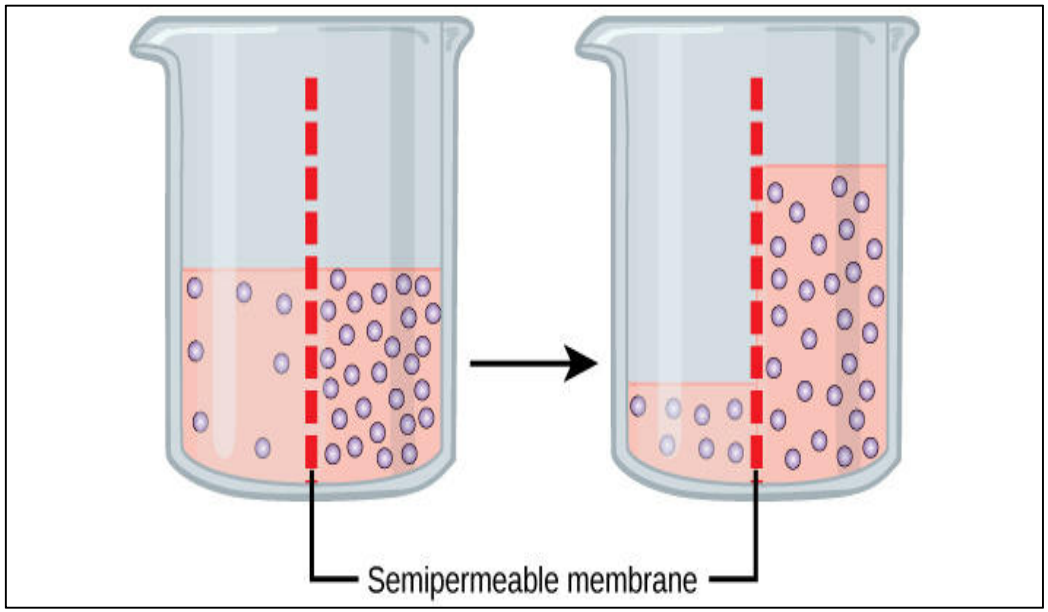
Aquaporins

Much water movement through membranes also involves facilitated diffusion. There are special channel proteins, called **aquaporins** that facilitate the movement of water at a rate needed for cell activities.

Osmosis

Movement of water from an area of high to low concentration of water

Movement of water toward an area of high solute concentration



In an **aqueous solution** (solvent + solutes)
-Water is the **solvent**
-Dissolved substances are the **solutes**

Hypotonic Solution

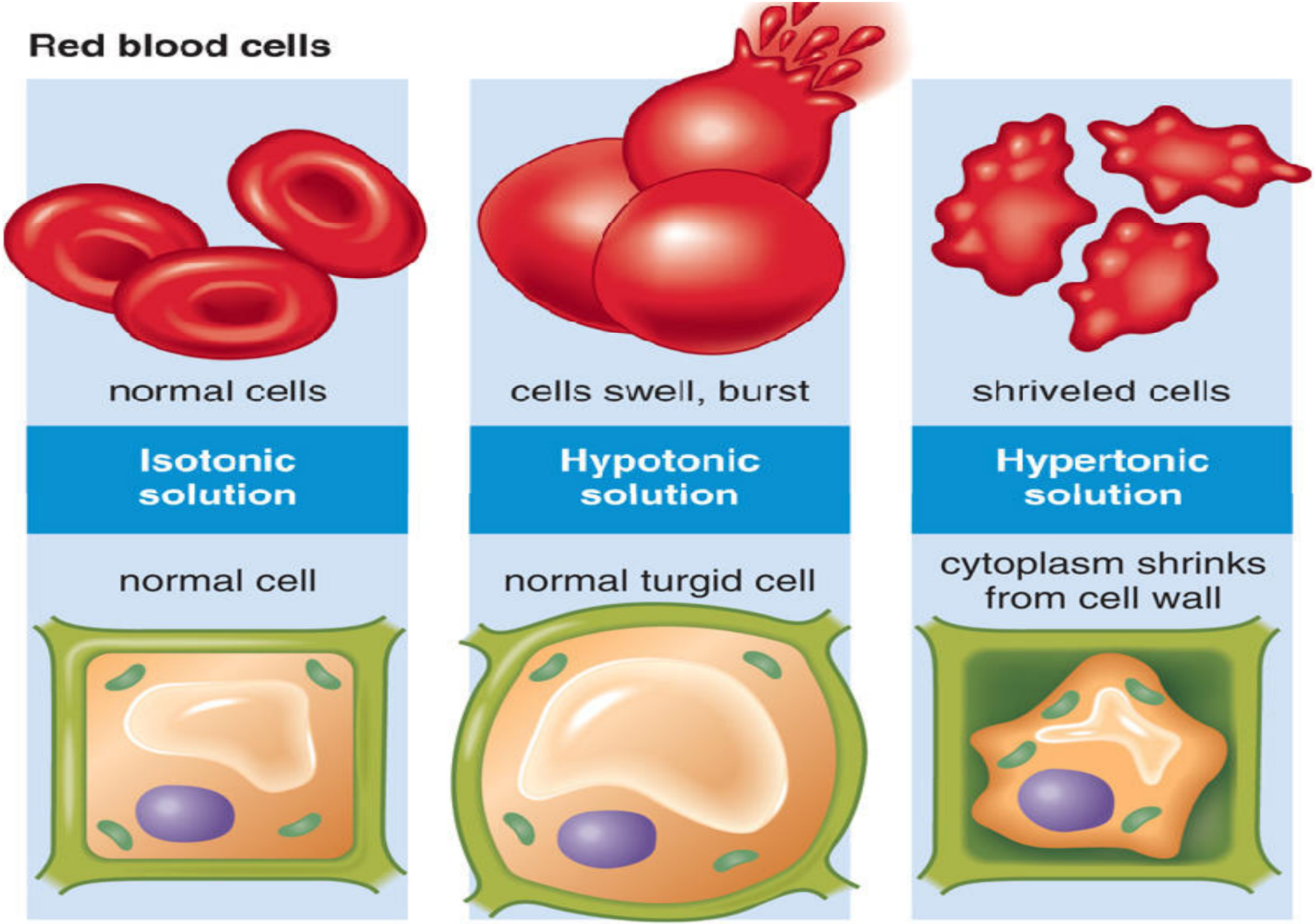
The solution has a lower concentration of solutes and a higher concentration of water than inside the cell. **(Low solute; High water).** Water moves from the solution to inside the cell: Cell Swells and bursts open = increasing the internal pressure (**cytolysis***)*

Isotonic Solution

Solution with the same solute concentration as the cell. There will be no net movement of water in either direction. Water moves equally in both directions and the cell remains same size. (**Dynamic Equilibrium**)

Hypertonic solution

The solution has a higher concentration of solutes and a lower concentration of water than inside the cell. **(High solute; Low water)**. Water moves from inside the cell into the solution: Cell shrinks = dehydrating it (**Plasmolysis**)


Red blood cells
normal cells
cells swell, burst
shriveled cells
Isotonic solution
Hypotonic solution
Hypertonic solution
normal cell
normal turgid cell
cytoplasm shrinks from cell wall
Plant cells

Active transport

-Particles move across the cell membrane **against** their concentration

-Requires energy: ATP is used directly or indirectly to fuel active transport

-Moves substances from low to high concentration

-Requires the use of carrier proteins

Transporter molecules are of three types:

Uniporters : move one molecule at a time

Symporters : move two molecules in the same direction

Antiporters : move two molecules in opposite directions .

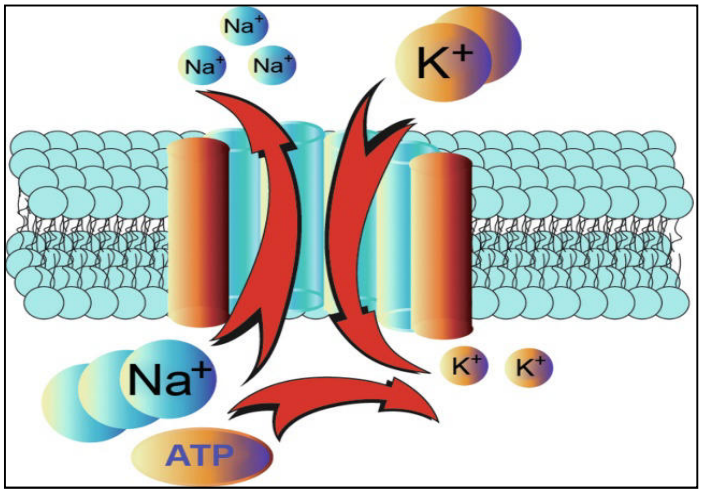
Primary active transport

Some transporters bind ATP directly and use the energy of its hydrolysis to drive active transport. And are known as ATP driven pumps

Sodium-potassium (Na^+-K^+) pump

It moves three Na^+ ions out of the cell and two K^+ ions into the cytoplasm at the expense of ATP hydrolysis to ADP and inorganic phosphate.

ATP energy is used to change the conformation of the carrier protein



The H+/K+ ATPase	The parietal cells of your stomach use this pump to secrete gastric juice
Ca2+ ATPase	Located in the plasma membrane of all eukaryotic cells. It uses the energy provided by one molecule of ATP to pump one Ca2+ ion out of the cell

Secondary active transport

transporters use the energy already stored in the gradient of a directly-pumped ion and this is also known as coupled transport. Direct active transport of the ion establishes a concentration gradient(Na+/K+ ATPase.)

Symport Pumps

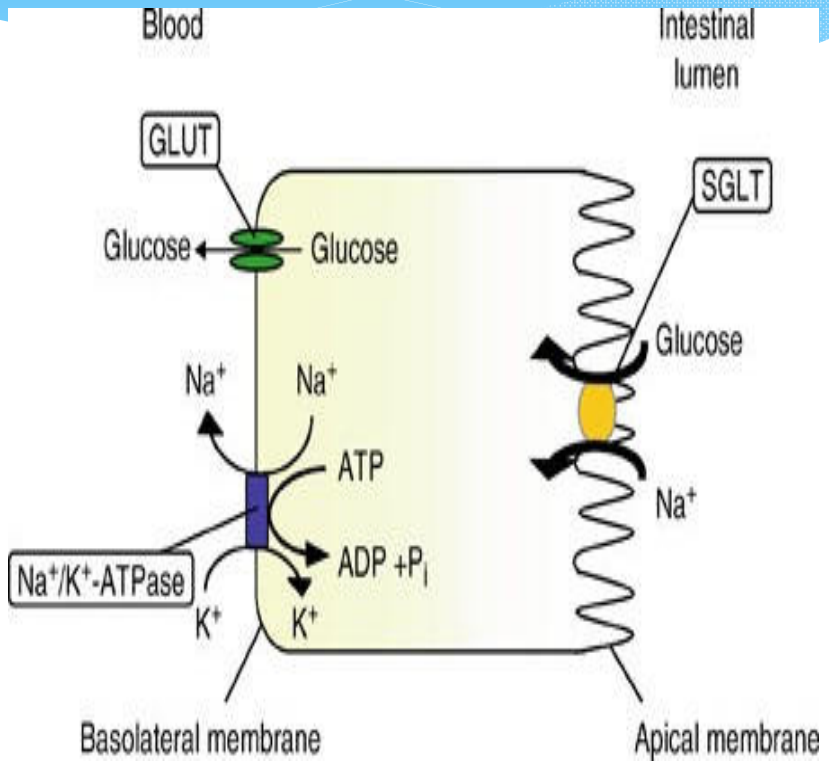
In this type of indirect active transport, the driving ion (Na+) and the pumped molecule pass through the membrane pump in the same direction.

The Na+/glucose transporter: Located in apical of cell
This transmembrane protein allows sodium ions and glucose to enter the cell together. The sodium ions flow **down** their concentration gradient while the glucose molecules are pumped up theirs. Later the sodium is pumped back out of the cell by the Na+/K+ ATPase.

SGLT, sodium glucose transporter; symporters

The transcellular transport of glucose across an **intestinal epithelial cell**

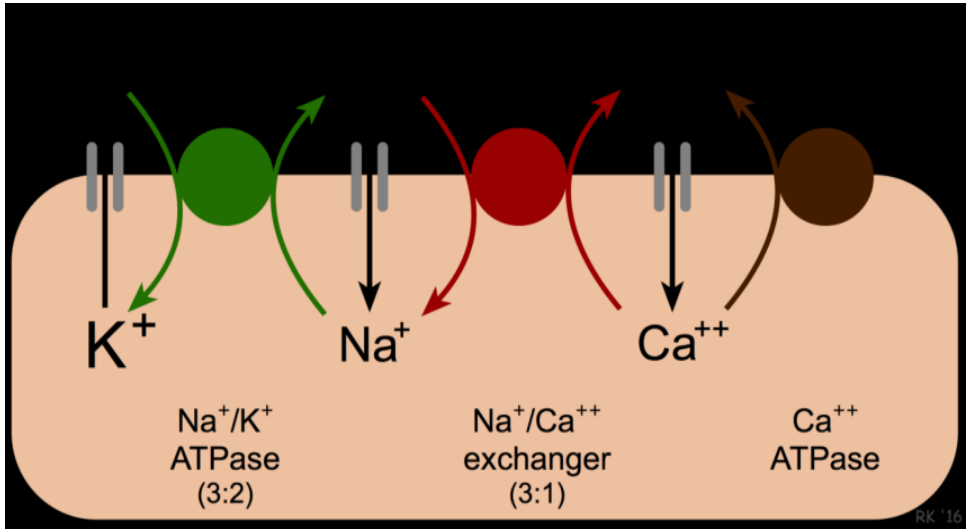
Glucose is pumped into the cell through the **apical** domain of the membrane by a Na+ -powered glucose **symport**. Glucose passes out of the cell (**down** its concentration gradient) by passive transport mediated by a different **glucose carrier protein** in the **basal** and **lateral** membrane domains



Antiport Pumps

In **antiport** pumps, the driving ion (again, usually sodium) diffuses through the pump in one direction providing the energy for the active transport of some other molecule or ion in the opposite direction.

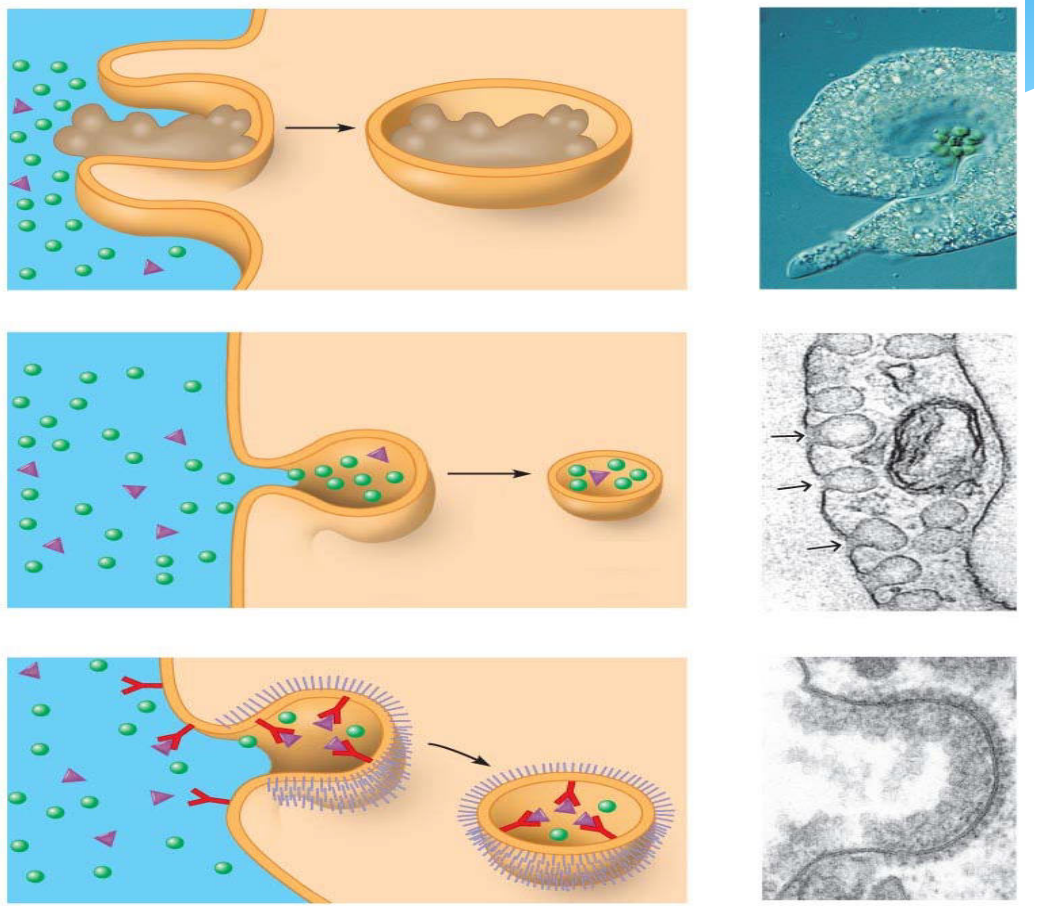
Sodium-calcuim exchanger (**NXC**): Ca2+ ions are pumped out of cells by Sodium-driven antiport pumps (cardiac muscle cell)



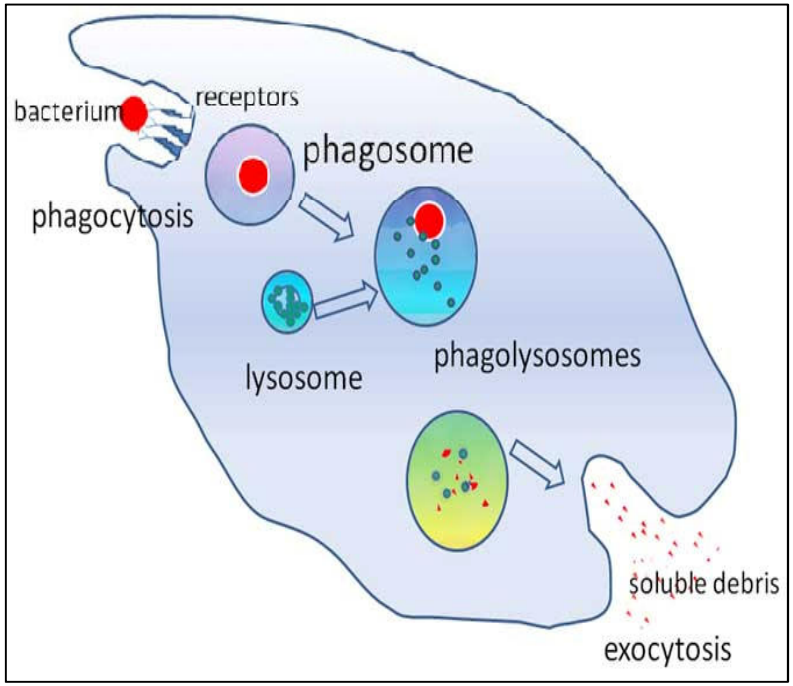
Bulk Transport

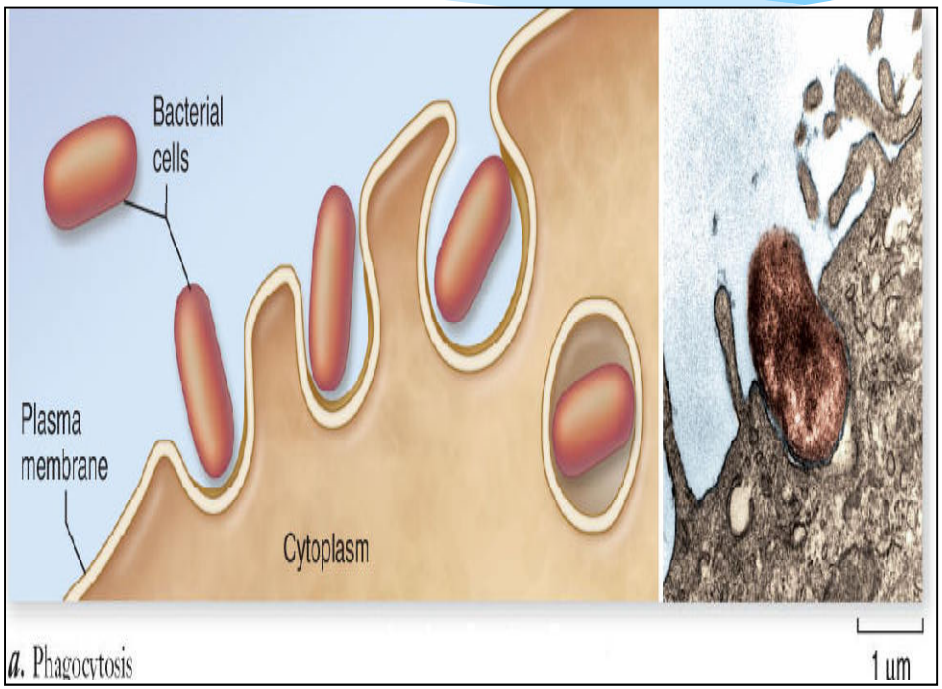
Endocytosis : movement of substances into the cell occurs when the plasma membrane envelops food particles and liquids.

Three kinds of endocytosis

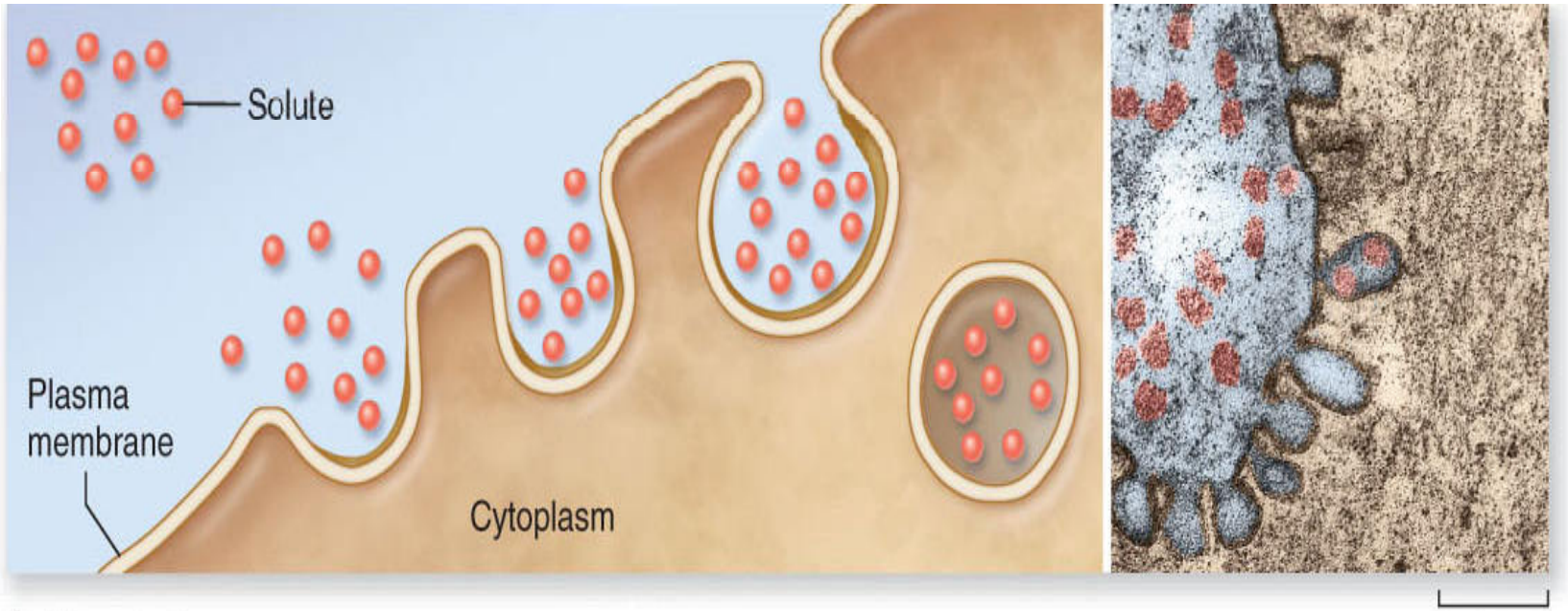


Phagocytosis: the cell membrane surrounds the particle and pinches off to form an intracellular vacuole



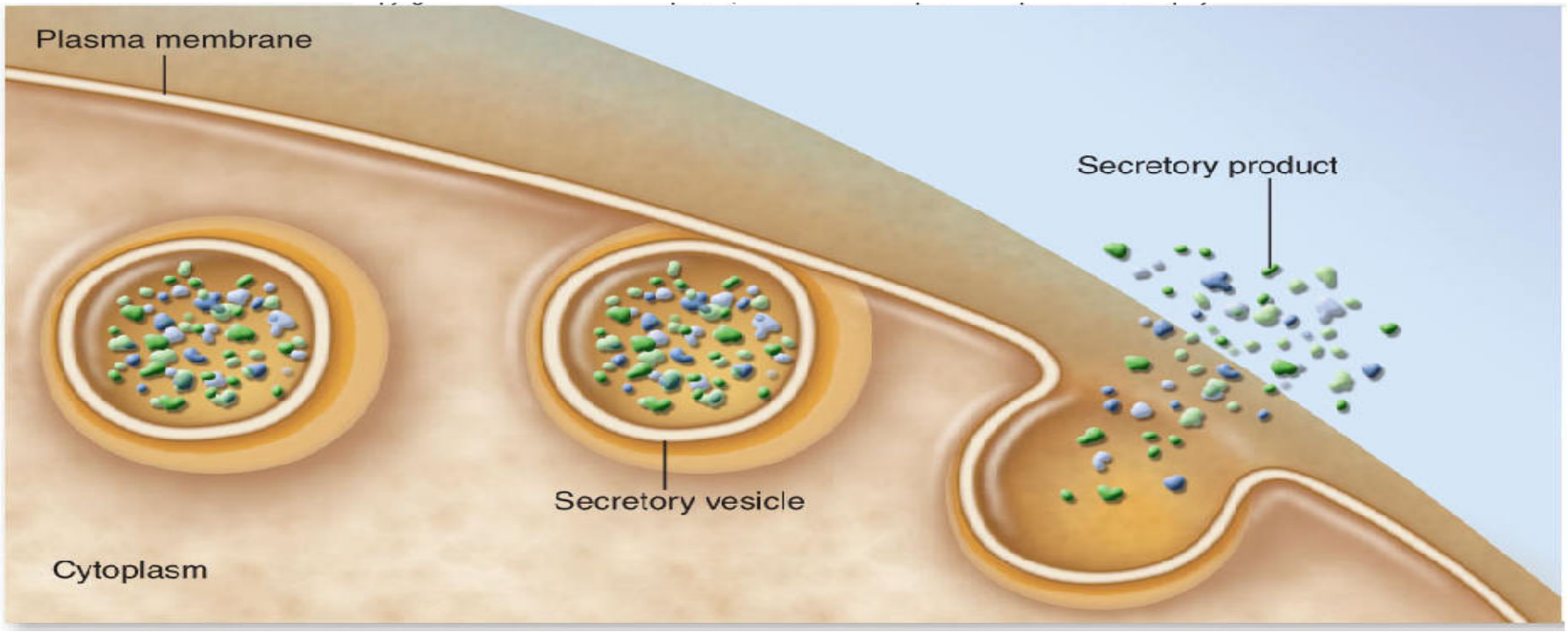


Pinocytosis : the cell membrane surrounds a small volume of fluid and pinches off



b. Pinocytosis

Receptor-mediated endocytosis – specific molecules are taken in after they bind to a receptor



Exocytosis

Materials can be exported from the cell by fusing vesicles with the plasma .membrane, a process called exocytosis.
Materials for export are packaged in a Golgi body and the vesicles formed travel along the cytoskeleton until they reach the plasma membrane.