Ch. 2, part 2: Cells & Their Environment

This PowerPoint has been updated 5/29/23

OBJECTIVES:

1. **Understand cell membrane permeability**
2. **To recognize different types of cellular transport (passive vs active)**
3. **To understand membrane potential and action potentials**

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1. Types of Cell Membranes

- **Freely Permeable Membrane =**

  (eg. For gases like O2, CO2)

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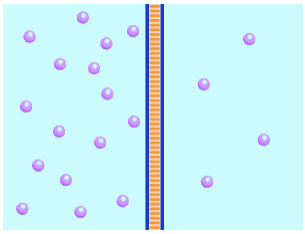

- **Selectively Permeable Membrane =**

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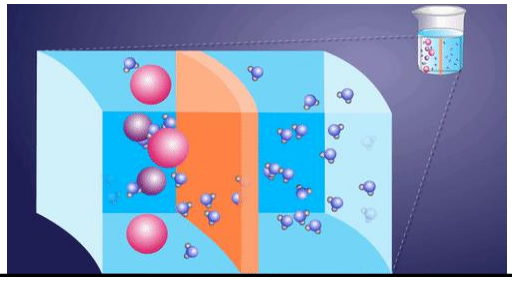

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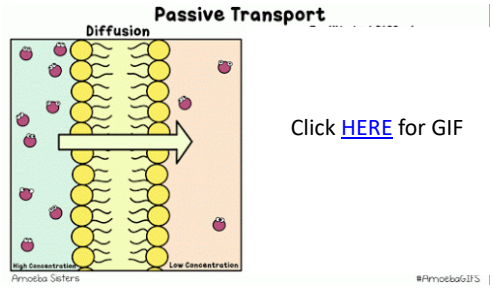
2. Types of Cellular Transport (how substances get across cell membrane)

1. **Passive transport =**



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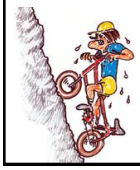
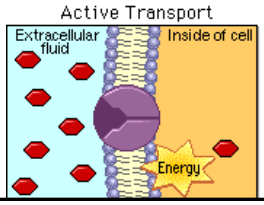
2. **Active transport =**





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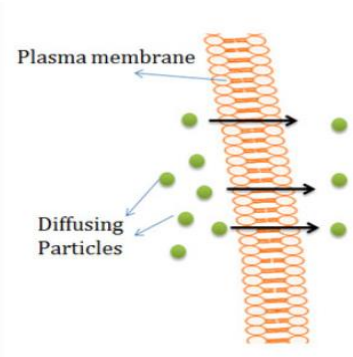
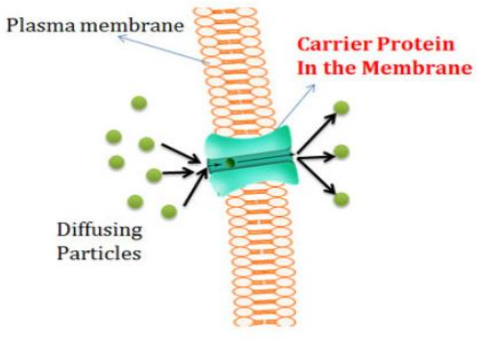
4 types of Passive Transport (Pg 16 Wiki Text)

1) Simple Diffusion (no protein carrier on cell)
2) Facilitated Diffusion (has protein carrier on cell)





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4 types of Passive Transport (Pg 16 Wiki Text)

1) Simple Diffusion

=

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Passive Transport (4 types):

1) Simple Diffusion

= movement of particles freely across membrane high to low concentration (with concentration gra
Ex. O2, CO2

2) Facilitated Diffusion (2 types!)

2a. facilitated diffusion with ion channels

=

Ex: charged ions (Na+, Cl-, K+, Ca+2)

Often involve a **neurotransmitter** binding to open the ion channel!

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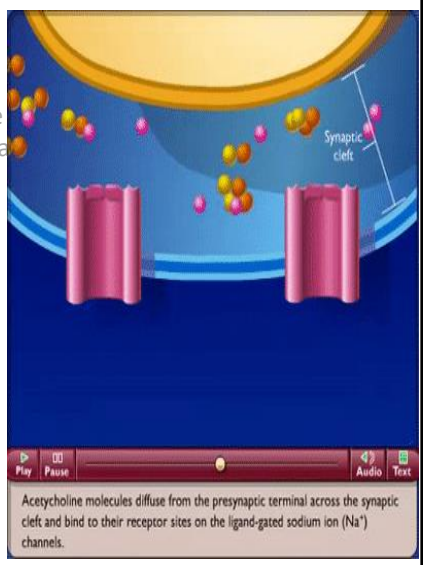

Facilitated Diffusion w/ion channels

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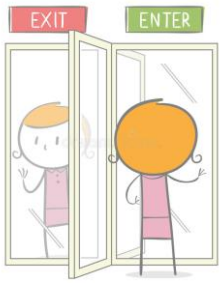
Passive Transport (4 types):

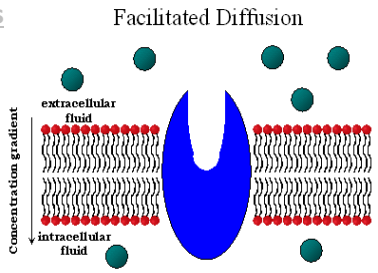
1) Simple Diffusion

= movement of particles freely across membrane from high to low concentration (with concentration gradient)
Ex. O2, CO2



2) Facilitated Diffusion (2 types!)

2a. facilitated diffusion with ion channels



2b) Facilitated Diffusion with Carriers

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Facilitated Diffusion

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3) Osmosis =

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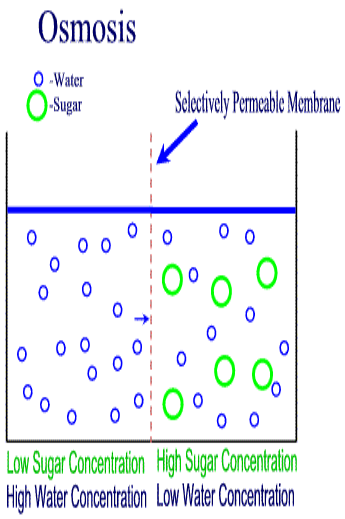

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Osmosis depends on "Tonicity"

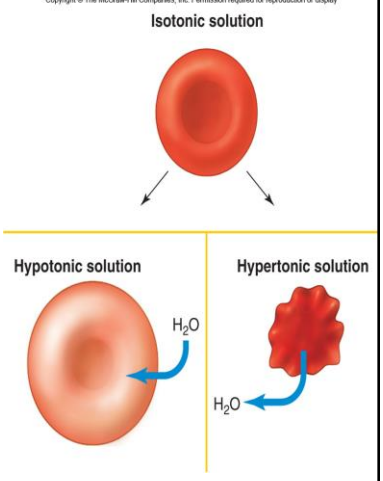
Hypertonic solution =

Hypotonic solution =

Isotonic solution =

(ex. Normal or physiologic saline)

Normal (isotonic) saline



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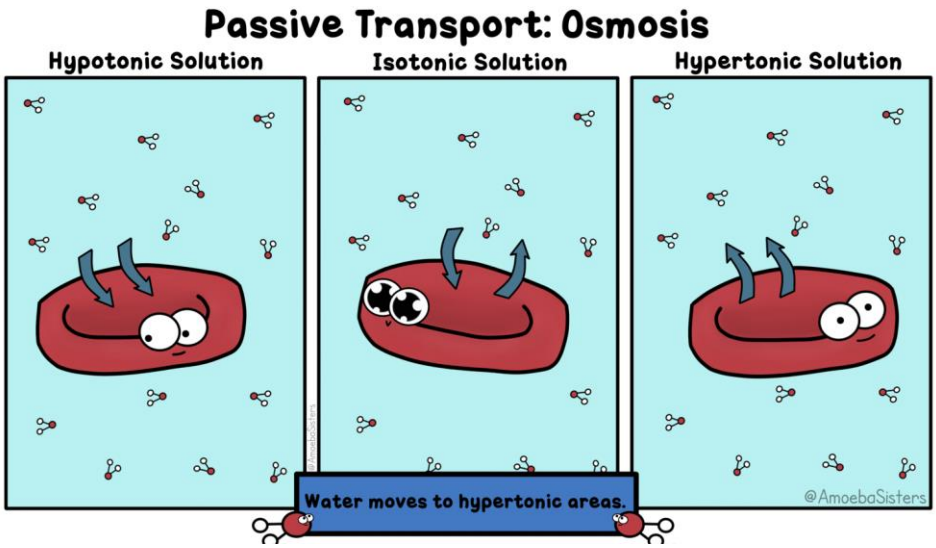

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4) Filtration (or "dialysis")

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Ex. **Filtration** of solutes through glomerulus of kidney nephron based on arterial blood pressure entering nephron.

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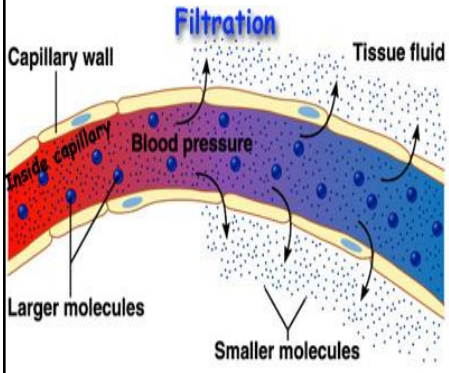

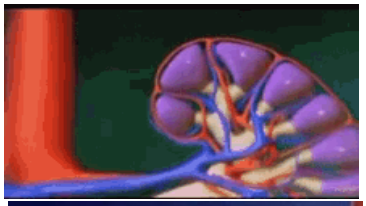

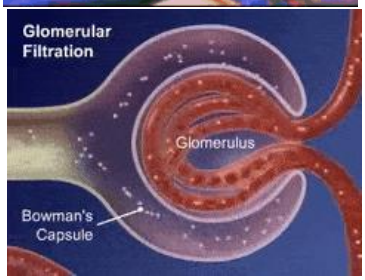

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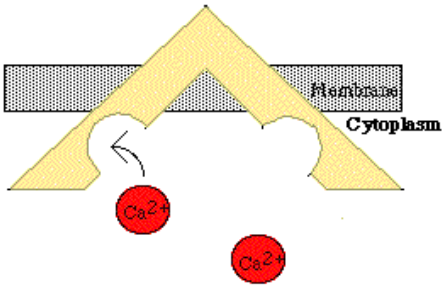
2. Active Transport Pg 17 Wiki text

a) **Primary Active Transport =** movement of ions with a pump fueled by ATP.

i) Calcium (Ca+2) Pump



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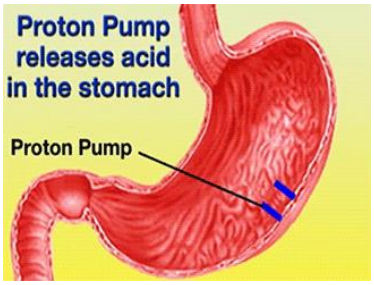
2. Active Transport Pg 17 Wiki text

a) Primary Active Transport = movement of ions with a pump fueled by ATP.

i) Calcium (Ca+2) Pump

ii) Hydrogen (H+) Pump



Ex. Parietal cells of stomach have H+ pumps. *Nexium®* targets these cells for those with GERD.

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2. Active Transport Pg 17 Wiki text

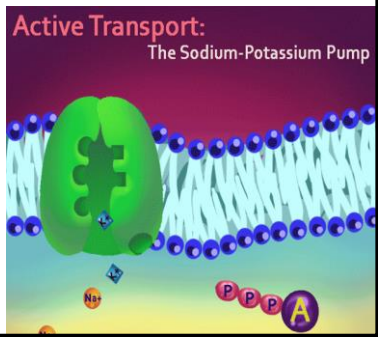
a) Primary Active Transport = movement of ions with a pump fueled by ATP.

i) Calcium (Ca+2) Pump

ii) Hydrogen (H+) Pump

Ex. Parietal cells of stomach have H+ pumps. *Nexium®* targets these cells for those with GERD.

iii) Sodium – Potassium (Na+/K+) Pump



Click HERE for online GIF. Click **HERE** for video showing the Na+/K+ pump.

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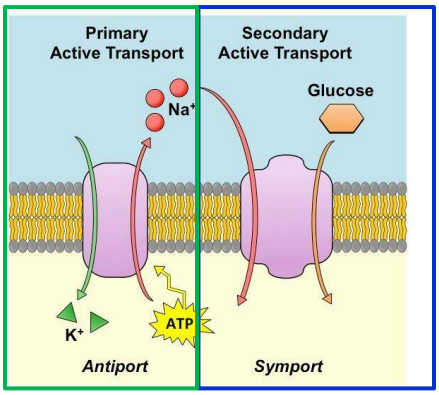
b) Secondary Active Transport: Coupled transport

i) Co-transport ("symport") = Energy gained from passive transport of one ion fuels the active transport of another ion ***in the same direction***.

Ex. Passive transport of Na+ with its concentration gradient helps fuel the active transport of glucose against its concentration gradient.



ii) Counter-transport ("antiport") = Energy gained from passive transport of one ion fuels the active transport of another ion ***in the opposite direction***.

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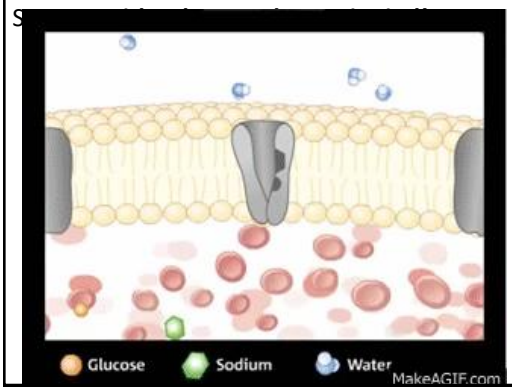
The importance of co-transport of Na+ and glucose in Oral Rehydration Therapy (ORT):

Chronic diarrhea (from acute gastroenteritis, cholera, etc…) limits ability of intestines to reabsorb salt & water, leading to risk of dehydration (life-threatening in children).

BUT diarrhea doesn't interfere with co-transport of Na+ & glucose in intestines. **Water follows Na+ and glucose, by osmosis, across intestinal membran, and into bloodstream**. Patient gets hydrated.



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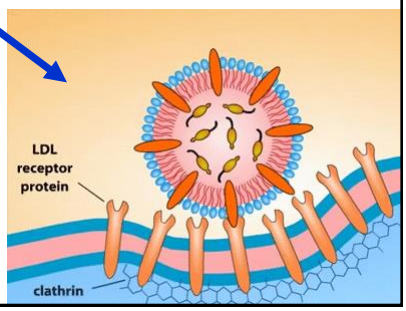
BulkTransport = <u>form of active transport</u> to move large substances across membrane.

A) Endocytosis

i) phagocytosis =

ii) Pinocytosis =

iii) Receptor-mediated endocytosis =



<u>B) Exocytosis</u> =

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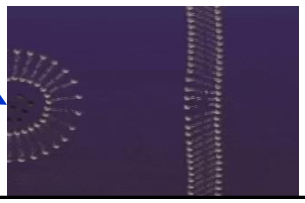

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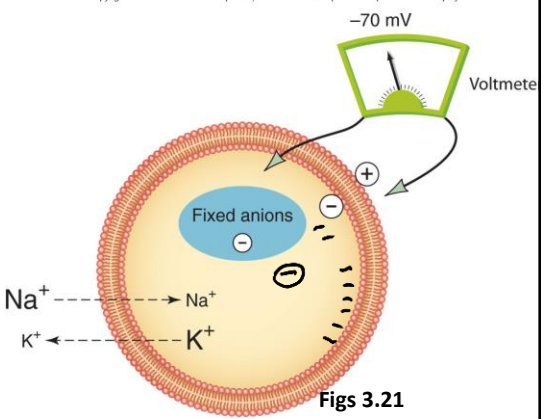
4. Membrane Potential

Resting cell membrane potential (MP)= -70 mV

- **inside of cell has "fixed number of anions" (neg charged particles)**

> number of K+ ions entering /leaving cell changes intracellular negativity
- **The more K+ exits, the more neg inside becomes**
- **The more K+ enters, the less neg inside becomes**

- **MP maintained by Na+/K+ pump**



Figs 3.21

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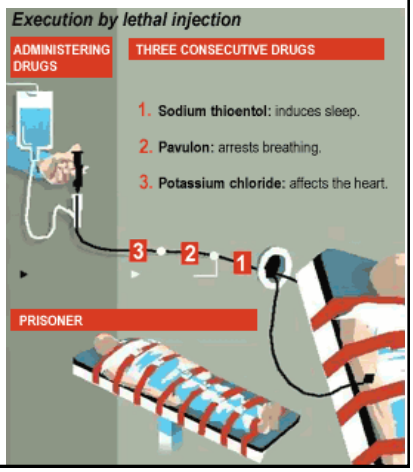
Click HERE on the PDF of this powerpoint to see Clinical App reading on hyperkalemia & Lethal Injections

Lethal injection is potassium chloride.

Hyperkalemia = _____



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Action Potential - Changes In Membrane Potential

4 AP steps:

1. - Stimulus above MP thresh hold opens intital Na+ channels.

2. Opens more Na+ voltage gated channels (Na+ floods inward)
- **drives MP from -70 to +30 mV = "depolarization"**
- **Na+ channels close**

3. - K+ voltage gated channels open, K+ exits cell.
- **drives MP back toward -70 mV = "repolarization"**
- **may overshoot MP & go to -80 mV ("hyperpolarization")**

4. Na+/K+ pump restores normal Resting MP (-70mV) by pumping Na+ out and K+ back in.

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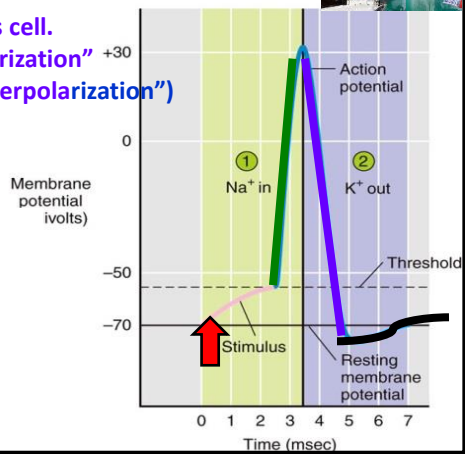

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Cell Transport - Review

"Permeability" of membranes

Passive transport = no energy, with concentration gradient ("downhill")
- **Simple diffusion**
- **Facilitated diffusion**
- **Osmosis**
- **Filtration**

Active transport = ATP required, against concentration gradient ("uphill")
- **Primary active transport (calcium, hydrogen, & Na+/K+ pumps)**
- **Coupled transport (co-transport & counter-transport)**
- **Bulk transport**

Cell membrane potential (MP)
- **Resting potential**
- **Action potential**

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