Ch. 2, part 2: Cells & Their Environment

This PowerPoint has been updated 1/15/25

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** = substances move across cell membrane using no channels, no protein carriers (eg. For gases like O2, CO2)

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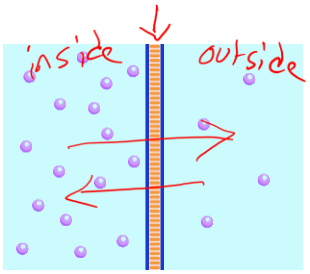

- **Selectively Permeable Membrane** = most of our cell membranes are like this. Some substances (especially small things) pass through, but other things (especially if large) don't pass easily

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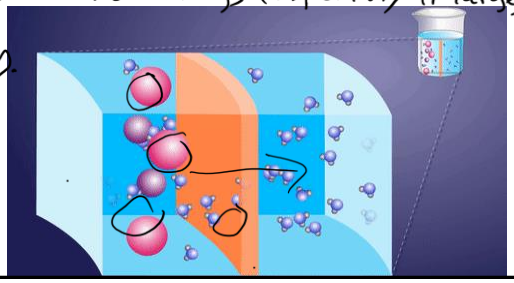

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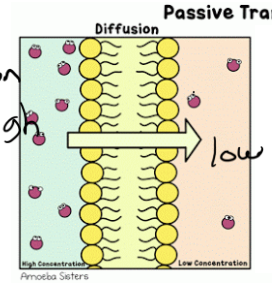
2. Types of Cellular Transport (how substances get across cell membrane)

1. **Passive transport =** substances move across cell membrane from high concentration to low concentration. No Energy (ATP) needed

OR moving with concentration gradient high



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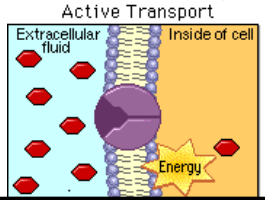
2. **Active transport =** substances move across cell membrane from low to high concentration (against concentration gradient)



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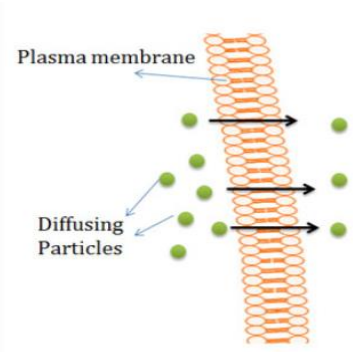
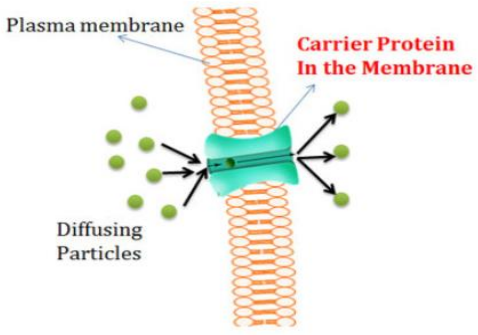
4 types of Passive Transport (Pg 16 Wiki Text)

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



Simple Diffusion



Facilitated Diffusion

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4 types of Passive Transport (Pg 16 Wiki Text)

1) Simple Diffusion - movement of particles from high across a membrane

= to low concentration without cell channels or protein carriers.

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Passive Transport (4 types):

1) Simple Diffusion

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

2) Facilitated Diffusion (2 types!) ***

2a. facilitated diffusion with ion channels

= ion channel opens to allow ions into or out of cell.

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

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

Ex. when a neurotransmitter binds to Na+ ion channel it opens the channel.

Click HERE for online GIF

Facilitated Diffusion w/ion channels

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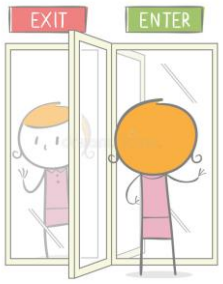
Passive Transport (4 types):

1) Simple Diffusion

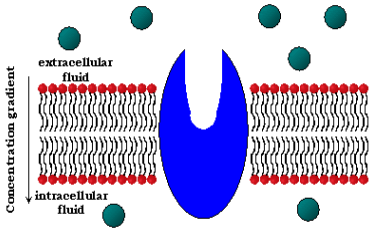
= movement of particles freely across membrane from high to low concentration (with concentration gradient)
Ex. O2, CO2



2) Facilitated Diffusion (2 types!)

2a. facilitated diffusion with ion channels

Facilitated Diffusion



2b) Facilitated Diffusion with Carriers

= particles cross membrane using cell protein carriers.

Facilitated Diffusion

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H_2O

3) Osmosis = movement of water across a membrane from high to low concentration of water.

Or

Water "wants" to cross the membrane to side with higher ~~conc~~ solute concentration (where ions, salts, sugars)

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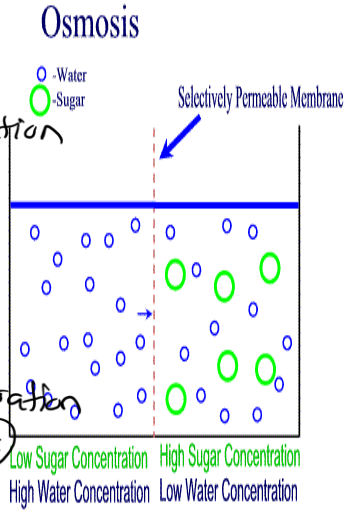

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Osmosis depends on "Tonicity"

concentration of salts, sugars, proteins

Normal (isotonic) saline

Hypertonic solution =
cell is in a solution with a higher solute concentration compared to inside the cell. Cell shrinks.

Hypotonic solution = Cell is solution with lower solute concentration than inside cell. cells swell & rupture.

Isotonic solution = cell in solution with same solute concentration as inside cell. Water doesn't move. Cell remains same

(ex. Normal or physiologic saline)

shrink

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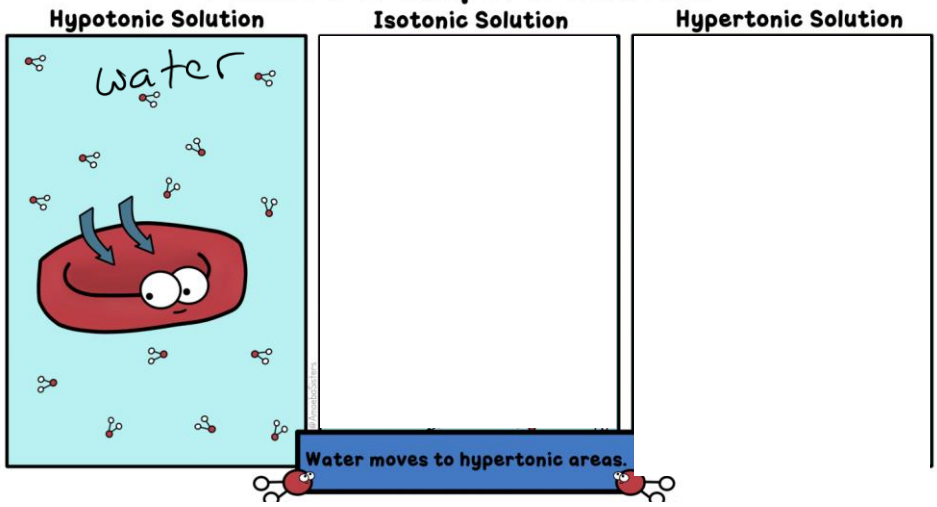
Passive Transport: Osmosis



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4) Filtration (or "dialysis")

= movement of fluids (Solvents) & particles (Solutes) across membrane with fluid pressure.

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

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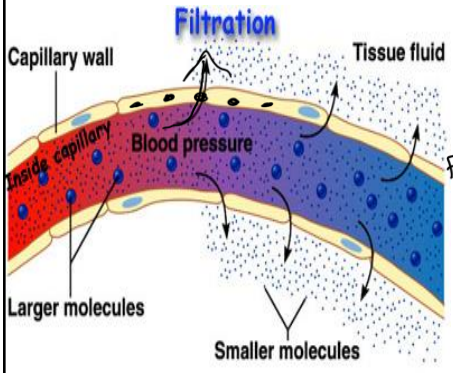

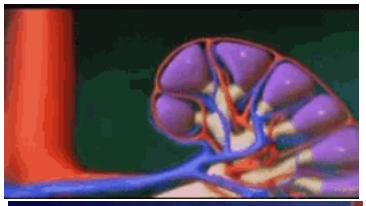

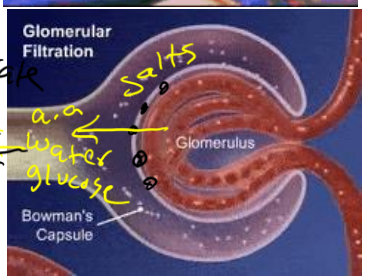

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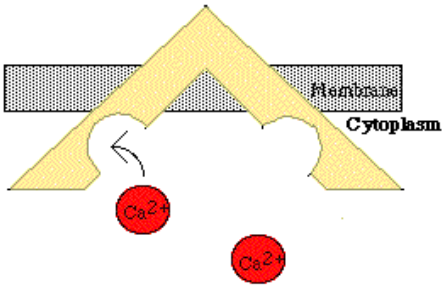
2. Active Transport Pg 17 Wiki text

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

Move substances against concentration gradient

i) Calcium (Ca+2) Pump

important in regulation contraction of heart muscle and intestinal smooth muscle.



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2. Active Transport Pg 17 Wiki text

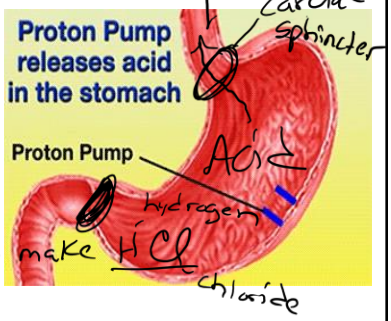
a) **Primary Active Transport =** movement of ions with a pump fueled by ATP.

i) Calcium (Ca+2) Pump

provide acidity

ii) Hydrogen (H+) Pump

important for stomach acid.



Ex. Parietal cells of stomach have H+ pumps. to
Nexium® (esomeprazole) or Prilosec
(Omeprazole) targets these cells for those with
GERD. gastro-esophageal reflux disease

Slide updated 1/15/25

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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

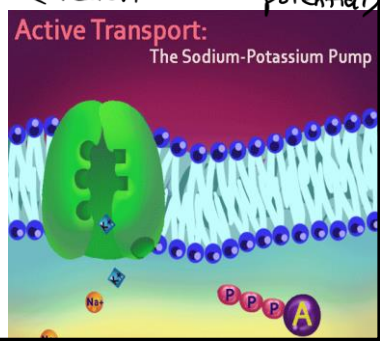
ii) Hydrogen (H+) Pump

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

iii) Sodium – Potassium (Na+/K+) Pump

pumps 3 Na+ out of a cell to every 2 K+ inside cell.

important to allow cells to rest (reach resting Membrane potential)



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

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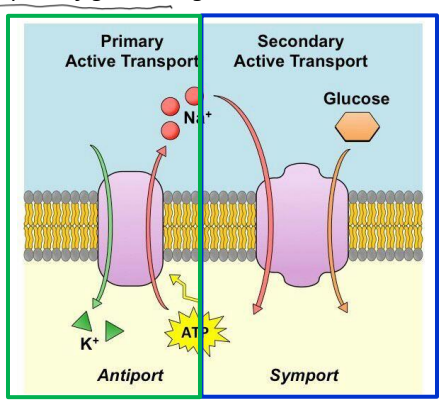
b) Secondary Active Transport: Coupled transport *slide updated 1/15/25*

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.



Click HERE for YouTube video of cotransport of Na+ and glucose, AND explanation of difference between primary and secondary active transport.

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

Ex. Na+ / H+ pump – regulates cell pH by transporting Na+ into cell and pumping H+ out

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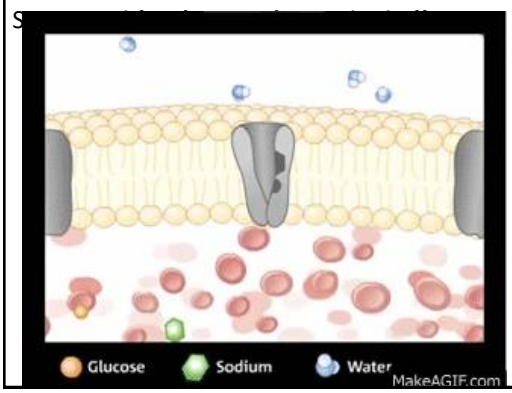
The importance of co-transport of Na+ and glucose in Oral Rehydration Therapy (ORT):

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 membrane, and into bloodstream**. Patient gets hydrated.



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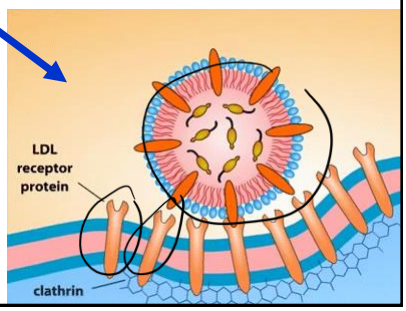
BulkTransport = form of active transport to move large substances across membrane.

A) **Endocytosis** – taking in large particles within cell

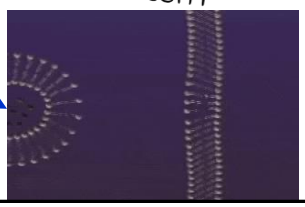
i) **phagocytosis** = movement of large particles into cell.

ii) **Pinocytosis** = movement of fluid into cell.

iii) **Receptor-mediated endocytosis** = substances bind to cell receptor to enter cell.



B) **Exocytosis** = exit of large substances from cell. exit cell



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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

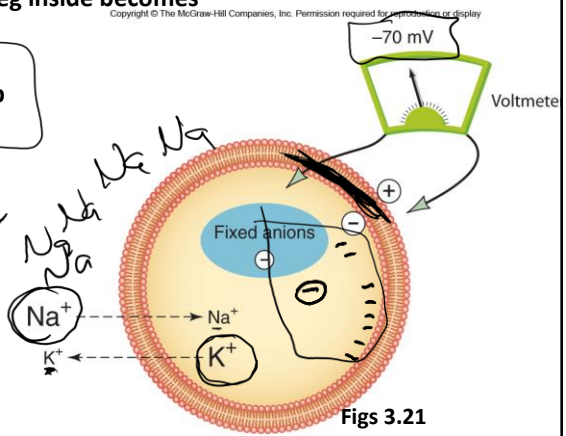
- The more K+ exits, the more neg inside becomes

- The more K+ enters, the less neg inside becomes

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

Na^+ is stimulatory

K^+ is inhibitory



Figs 3.21

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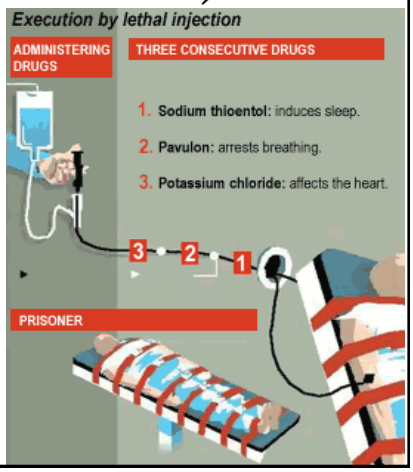
Click HERE on the PDF of this powerpoint to see Clinical App reading on hyperkalemia & Lethal Injections

Lethal injection is potassium chloride.

Hyperkalemia = high blood potassium (K^+)



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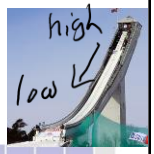
Action Potential - Changes In Membrane Potential

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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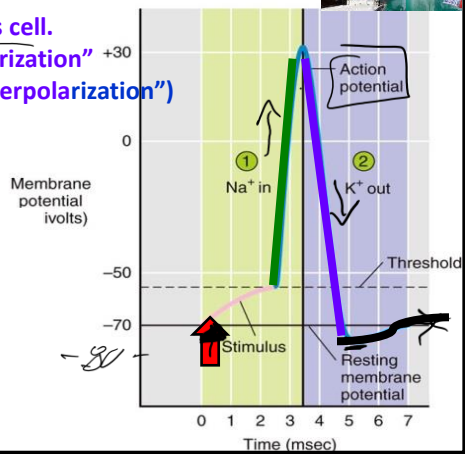

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Cell Transport - Review

"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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