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

1. Types of Cell Membranes

- **Permeable Membrane** = allows substances to move freely across cell membrane. (eg. Gases like O2, CO2)

- **Selectively Permeable Membrane** = is selective in what it lets across membrane. Small particles (ex: gases & uncharged ions) go easily, **but** large particles (charged ions and glucose) are regulated.
2. Types of Cellular Transport

1. **Passive transport** = when substances diffuse across a membrane from high to low concentration (with gradient), it requires no energy (ATP)

2. **Active transport** = When substances moving across membrane from low to high concentration (against gradient) it requires energy.

### 1) 5 types of Passive Transport: Pg 16 Wiki Text

**a) Simple Diffusion**

= movement of particles freely across membrane from high to low concentration (with concentration gradient)  
Ex. O2, CO2.  
Click [HERE](#) for online GIF
1) Passive Transport (5 types):

a) Simple Diffusion

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

b) Simple Diffusion with Channels

= movement of particles freely across membrane from high to low concentration, by moving through channels that open & close. Ex: charged ions (Na+, Cl-, K+, Ca+2)

Often involve a neurotransmitter binding to
Open the ion channel!

Click HERE for online GIF

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c) Facilitated Diffusion with Carriers

= movement of particles across membrane from high to low through use of revolving membrane carriers. Ex. Glucose, amino acids. (Click HERE for online GIF)
d) **Osmosis** = movement of water from high to low concentration.

Another way of thinking about it is:

Water wants to move to the side of the membrane that has a higher solute concentration (to dilute it)

Click [HERE](#) for online GIF

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**Osmosis depends on “Tonicity”**

- **Hypertonic solution** = solute concentration is higher outside the cell than inside, and water leaves the cells, causing shrinking (crentation) and cell death.

- **Hypotonic solution** = solute concentration is lower outside the side than inside, and water enters the cell, causing swelling (possible bursting and cell death).

- **Isotonic solution** = Concentration of solute is the same on either side of the membrane. Water doesn’t move across membrane.

(ex. Normal or physiologic saline)
e) Filtration

= when substances move across a membrane due to fluid pressure being higher on one side of the membrane than the other.

Ex. Filtration of solutes through glomerulus of kidney nephron based on arterial blood pressure entering nephron.
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
keeps Ca+2 concentrations low inside cells. (important in cardiac and smooth muscle)

ii) Hydrogen (H+) Pump
used to increase acidity.
Ex. Parietal cells of stomach have H+ pumps.
Nexium® targets these cells for those with GERD.

iii) Sodium – Potassium (Na+/K+) Pump
3 Na+ exit for every 2 K+ that enter cell.
Helps maintain cell membrane resting potential.

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

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.
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+ by osmosis into cells, and into bloodstream. Patient gets hydrated.

So, ORT with salt AND glucose is vital!

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

A) Endocytosis
   i) phagocytosis = endocytosis of large particles
   ii) Pinocytosis = endocytosis of fluid
   iii) Receptor-mediated endocytosis = A receptor on cell is bound by hormone or other molecule causing it to allow substance to move into cell.

B) Exocytosis = bulk movement of molecules out of a cell.
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

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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 concentration of K+
### Action Potential - Changes In Membrane Potential

**4 AP steps:**

1. **Stimulus above MP threshold opens initial 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.

Click [HERE](#) for GIF

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### Cell Transport - Review

“Permeability” of membranes

**Passive transport** = no energy, with concentration gradient (“downhill”)
- Simple diffusion
- Simple diffusion w/channels
- 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

**Bulk transport**
- Endocytosis
- Exocytosis

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