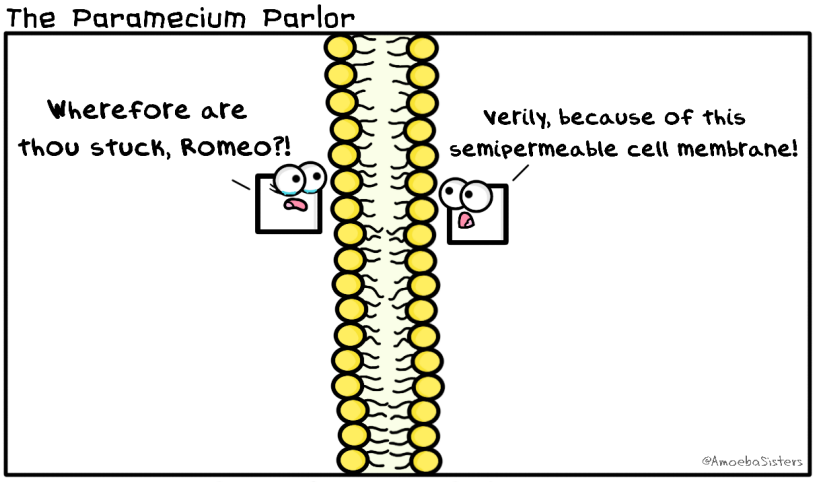
# 02 – CELLS AS THE BASIS OF LIFE

## *2.3a - Transport Across Membranes*




# The Major Transport Processes

**2.3.1** Substances move in and out of cells by processes such as:

- diffusion
- facilitated diffusion
- osmosis
- active transport
- endocytosis
- exocytosis.

☑ Explain how the **structure** of a membrane facilitates different processes of movement through it.

☑ Explain the roles of **transport proteins**, including channel proteins (such as aquaporins), and carrier proteins.

☑ Explain how the exchange of materials across membranes is **affected by factors** including:

- surface-area-to-volume ratio of the cell
- concentration gradients
- the physical and chemical nature of the materials being exchanged.

# Selectively Permeable

**Certain materials cross the cell membrane more readily than others.**

**Due to:**

**Structure of the phospholipid bilayer**

**Transport proteins (channel and carrier)**

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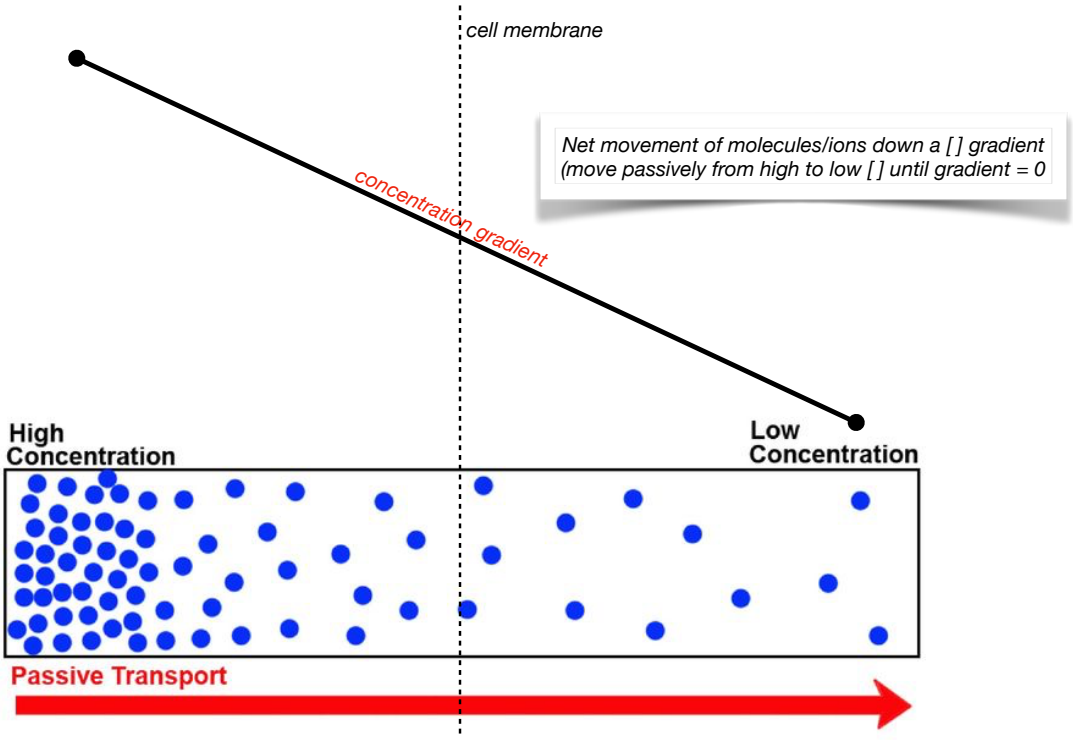
**TRANSPORT**

**Passive vs Active**

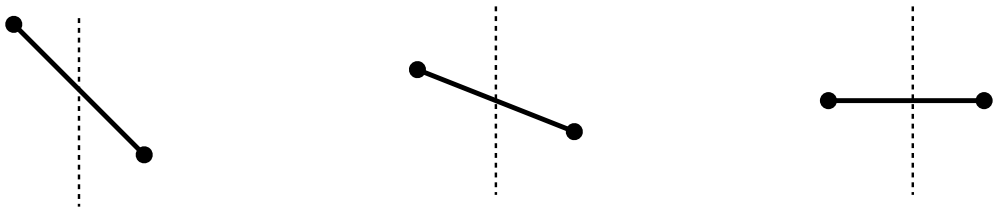


# Diffusion




*Concentration gradient = difference in concentration between the two sides of the membrane*

# Diffusion



**Rate of diffusion affected by:**

1. Concentration gradient (steep or no?)
2. Permeability of solute in the lipid bilayer
3. Surface area of membrane
4. Thickness of the membrane

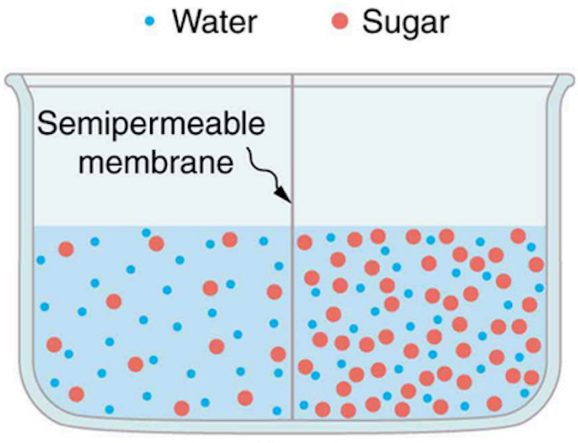


# Osmosis

Diffusion of water molecules from high to low [ ] across selectively permeable membrane.

*Water is also affected by solute concentration (dissolved molecules/ions, eg. salt):*

**Rule:** water always 'follows' the higher solute concentration (tries to dilute it)




**sugar is prevented from diffusing*

# Osmosis

Diffusion of water molecules from high to low [ ] across selectively permeable membrane.

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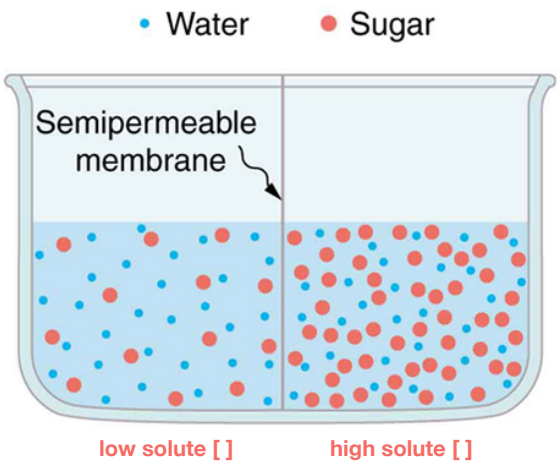
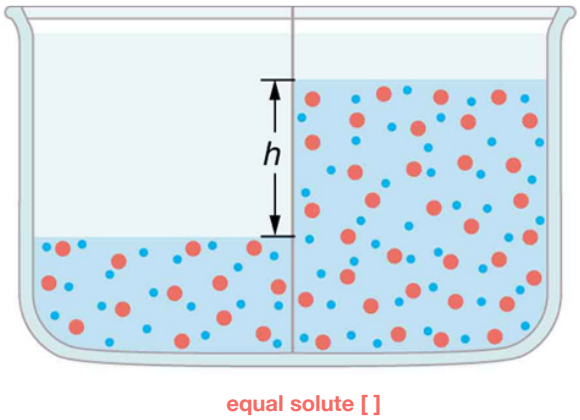
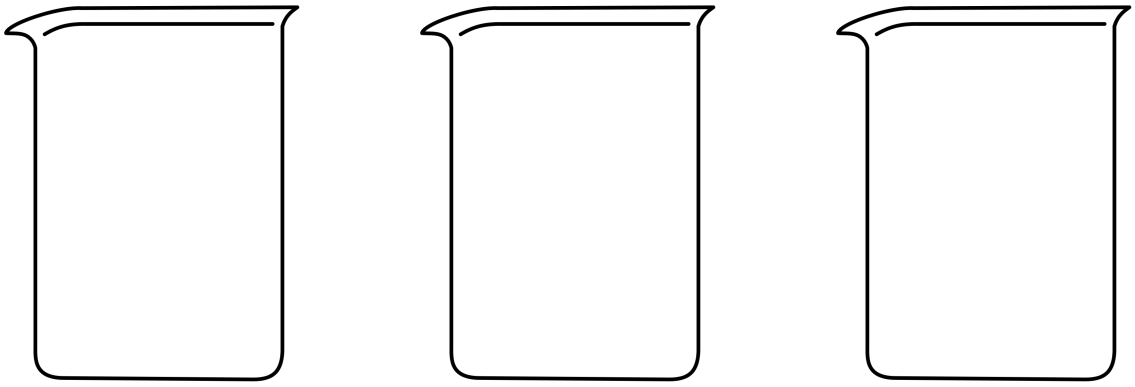


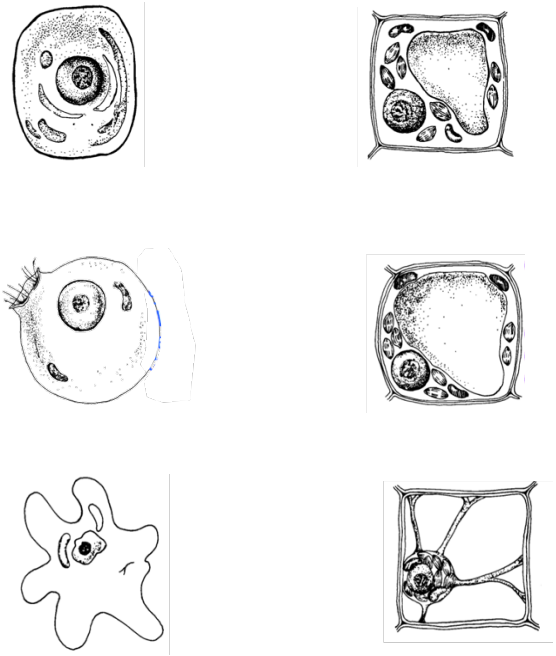

# Osmosis

| | |
|---|---|
| Isotonic | Solute [ ] outside cell is equal to solute [ ] inside cell<br>No net osmosis! |
| Hypotonic | Where the solute [ ] is lowest<br>Watery here; water will move to the hypertonic region |
| Hypertonic | Where the solute [ ] is highest<br>More sugary/salty/etc; water will move to this region |



# Osmosis

**Animal Cell** **Plant Cell**



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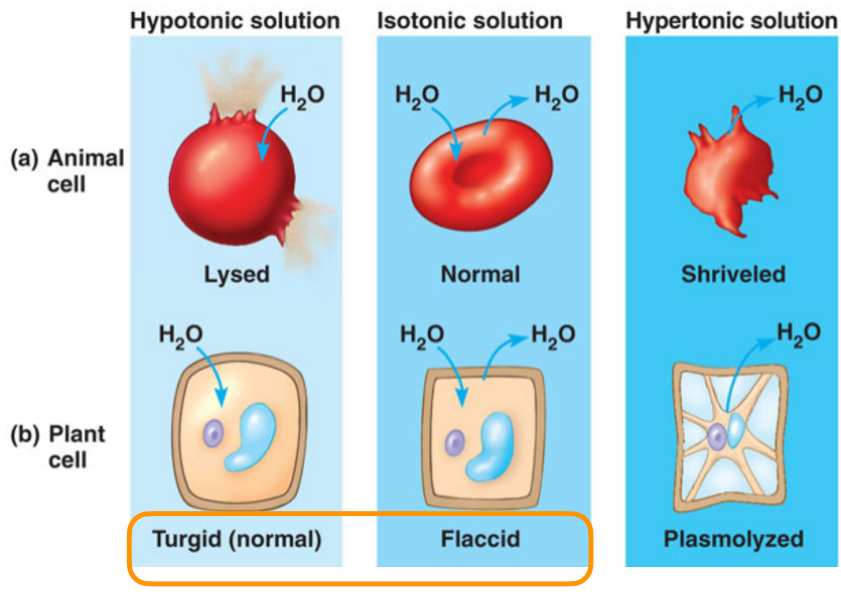
# Osmosis

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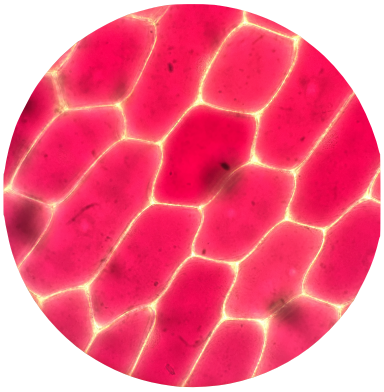
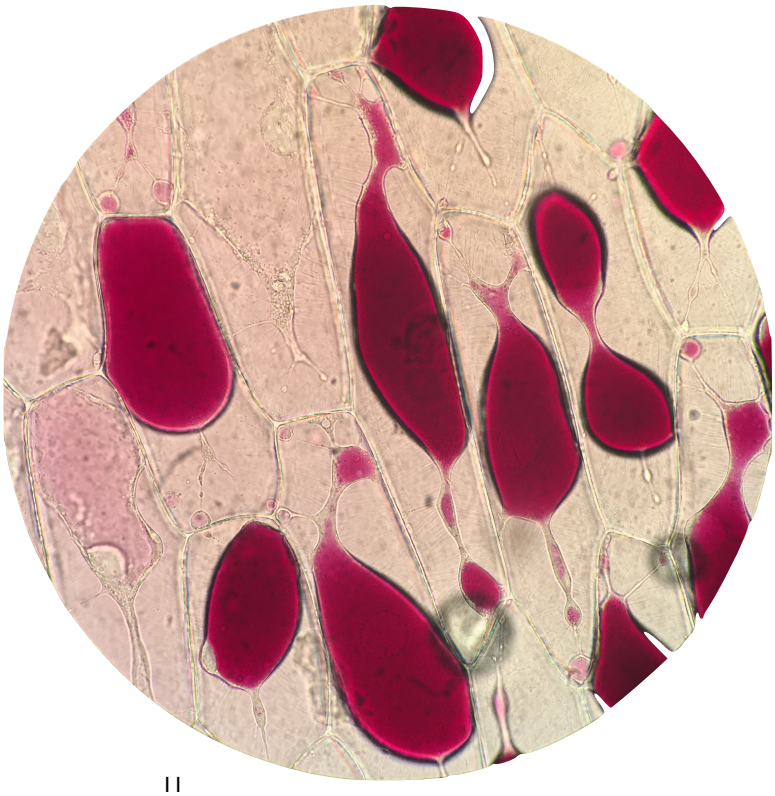
# Purple Onion Cells





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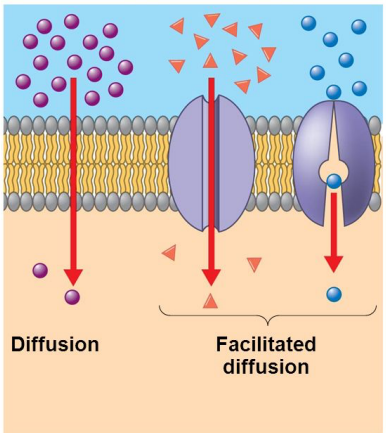
☑ Explain the roles of **transport proteins**, including <u>channel</u> proteins (such as aquaporins), and <u>carrier</u> proteins.

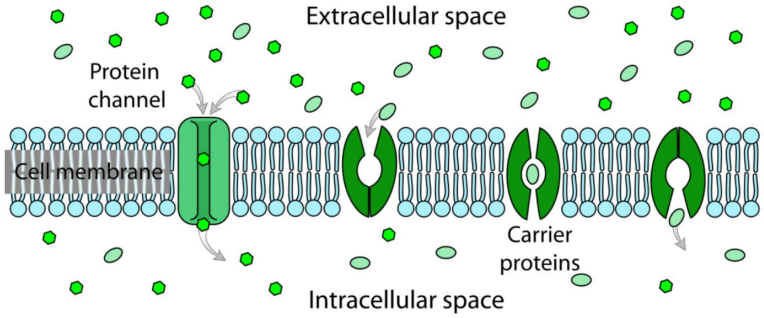
# Facilitated Diffusion

**Define:**

**channel proteins vs carrier proteins**

**Passive transport**

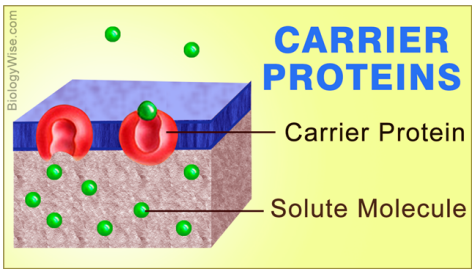


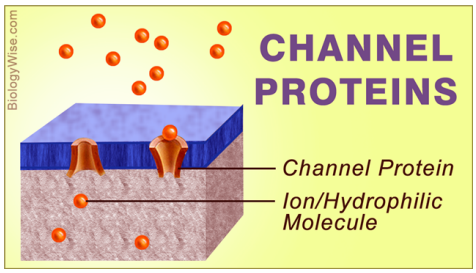

**eg. aquaporin*

# Carrier vs Channel

☑ Explain the roles of **transport proteins**, including <u>channel</u> proteins (such as aquaporins), and <u>carrier</u> proteins.

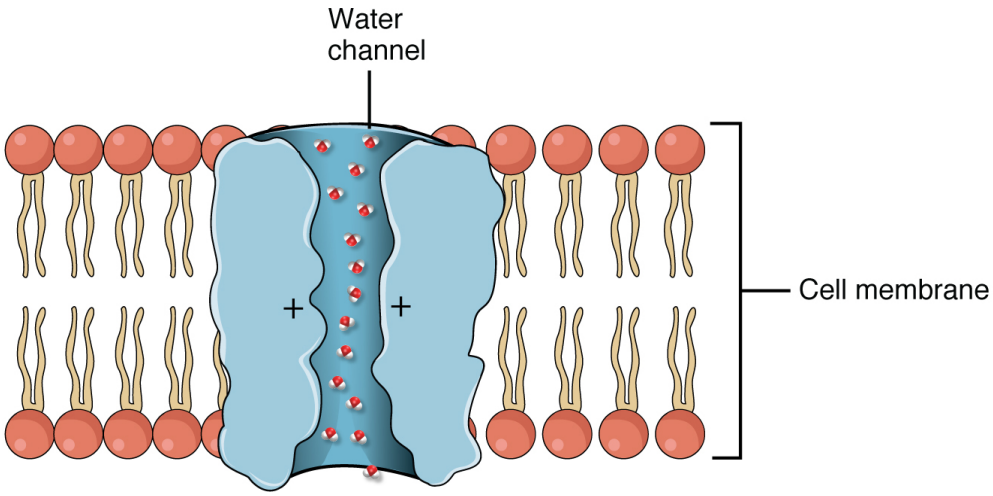



★ larger solutes (charged or not)
★ eg. glucose into intestine cells
★ up to $10^4$ per second




★ small charged solutes
★ eg. $Na^+$ into cells
★ up to $10^8$ per second!

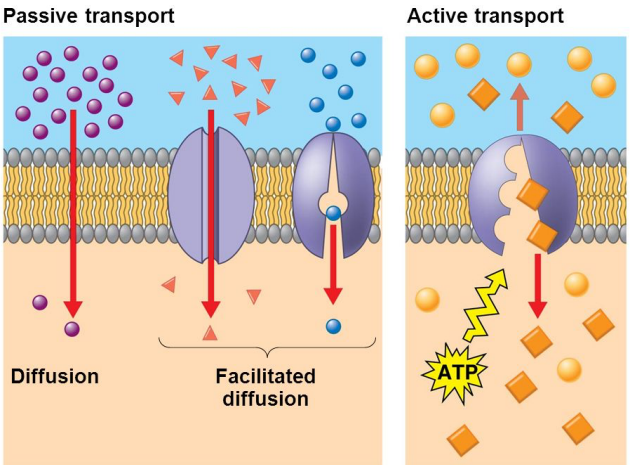
# e.g. Aquaporin




*Water is negatively charged - the aquaporin transport protein facilitates it crossing the membrane.*

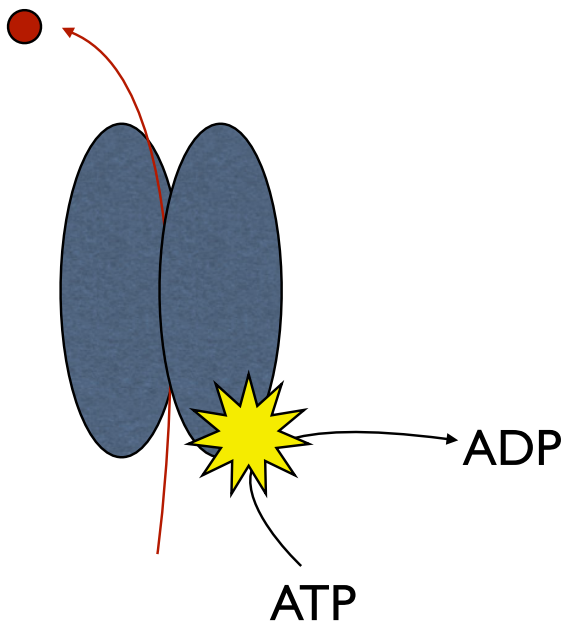
# Active Transport Types

**Define:**



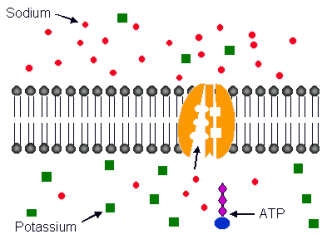

***can be used against the [ ] gradient!***

# Active Transport



# Adenosine TriPhosphate (active transport)

1.

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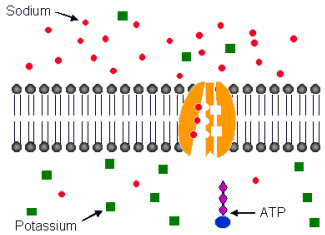


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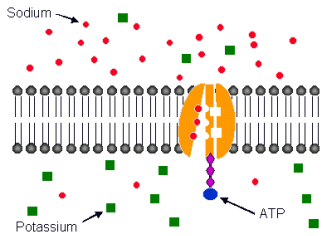


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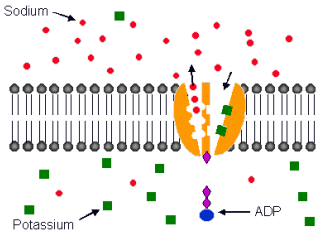


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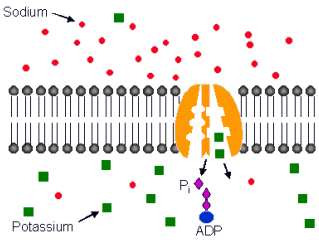
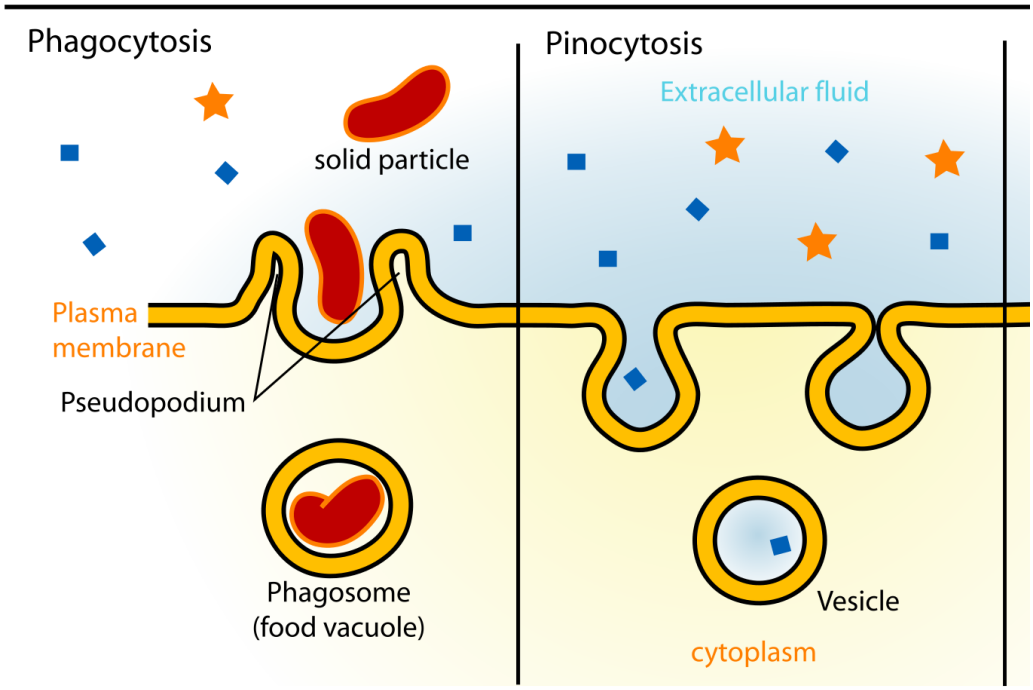
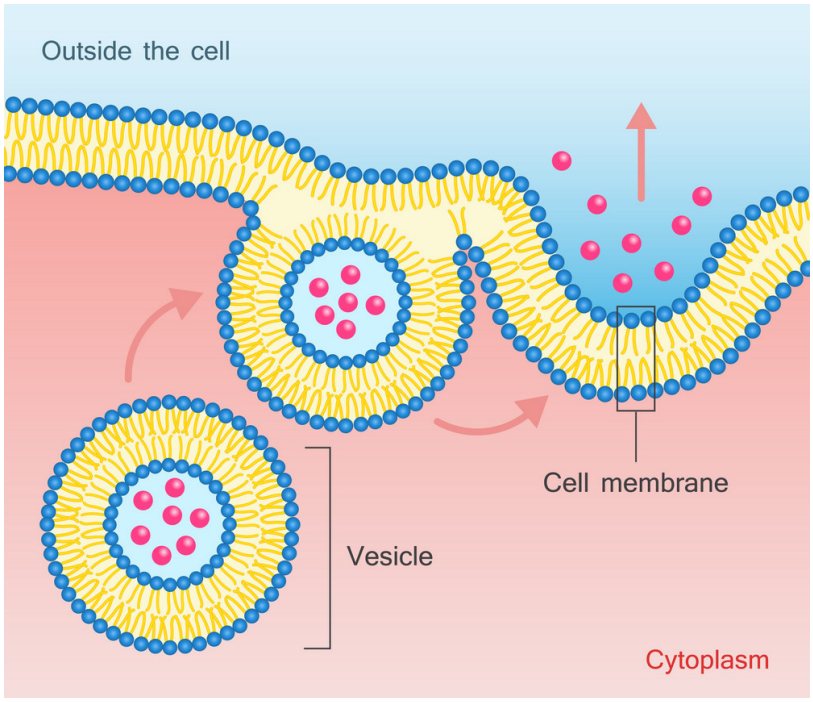


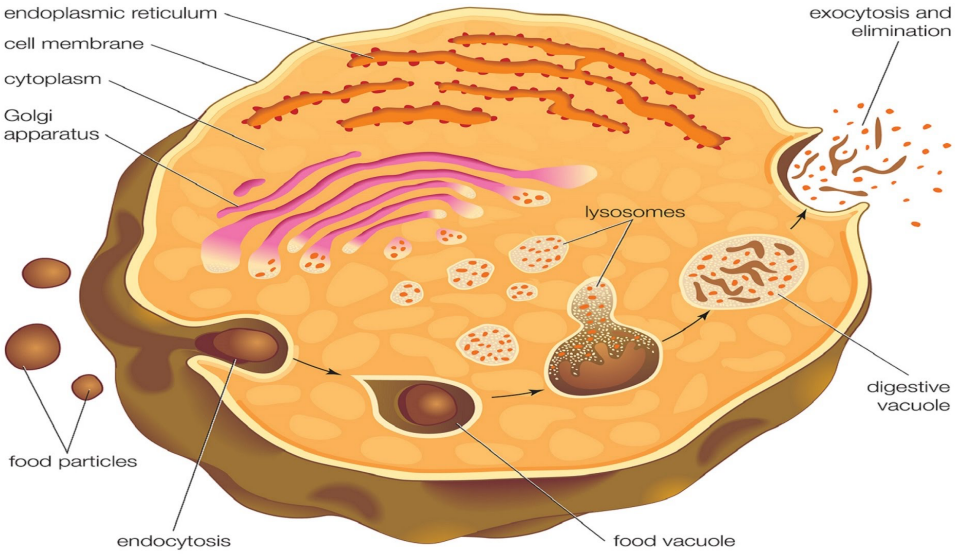

# Endocytosis



# Exocytosis




# Exocytosis & Endocytosis



# Surface Area to Volume Ratio

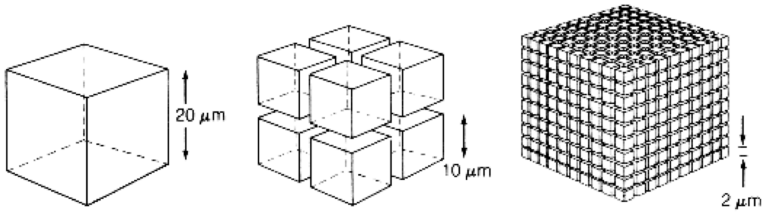
To maximise the efficiency of transport in/out of cells you ideally want:

- heaps of **surface area** (area covered by outer surface)
- minimal **volume** (3D space inside cell)

As a cell gets bigger both SA and V increase. But V increases much more quickly (3 dimensions) than SA (two dimensions). So the bigger you get the LESS effective transport will be as you will have less SA in relation to the V.

A Surface Area to Volume (SA:V) ratio example:

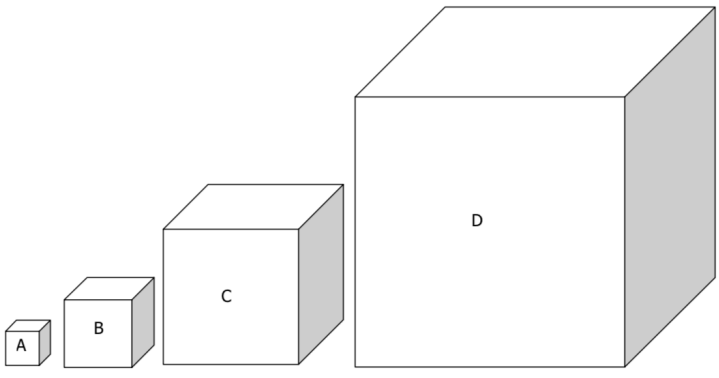
3:1 vs 1:1 Which is better for transport?






# Surface Area to Volume Ratio

| Cell Cube A (1cm³) | |
|---|---|
| Surface Area | |
| Volume | |
| S:V ratio (reduced) | |
| **Cell Cube B (2 cm³)** | |
| Surface Area | |
| Volume | |
| S:V ratio (reduced) | |
| **Cell Cube C (3 cm³)** | |
| Surface Area | |
| Volume | |
| S:V ratio (reduced) | |
| **Cell Cube D (4 cm³)** | |
| Surface Area | |
| Volume | |
| S:V ratio (reduced) | |



# Physical and Chemical Properties of Materials Being Transported

**Solutes (molecules or ions) dissolve more/less readily based on:**

**Size**

**Charge (- or +)**

* most charged solutes cannot cross without transport proteins

**Hydrophobic**

* diffuse through cell membrane more easily (due to internal hydrophobic)

**Hydrophilic**

*almost always need transport proteins

**transport proteins are folded in way that places hydrophilic amino acids on inside of channel to help!