



# *Physiology*

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# INTRODUCTION

- **Definition of physiology**
  - **The task of physiological research**
    - \* **How**
    - \* **Why**
    - \* **Influence of environment**
    - \* **Adaptation and regulation**



- Physiology / is one of basic medical science that seeks to understand the function of living organisms and their constituent parts.





- **Body fluid (60% of body weight)**

- \* **Intracellular fluid (40%)**

- \* **Extracellular fluid (20%)**

- Plasma (5%)

- Interstitial fluid (15%)

- Lymph (<1%)

- Cerebrospinal fluid (<1%)

- Aqueous humor (<1%)



## Cell:

- Basic living unit of structure & fix of the body.
  - > 100 trillion cells in body.
  - very small ( $10^{-5}$  m in diameter).
  - highly organized.
  - variety of shapes & sizes.
  - each type of cells has a special feature .



# Cell

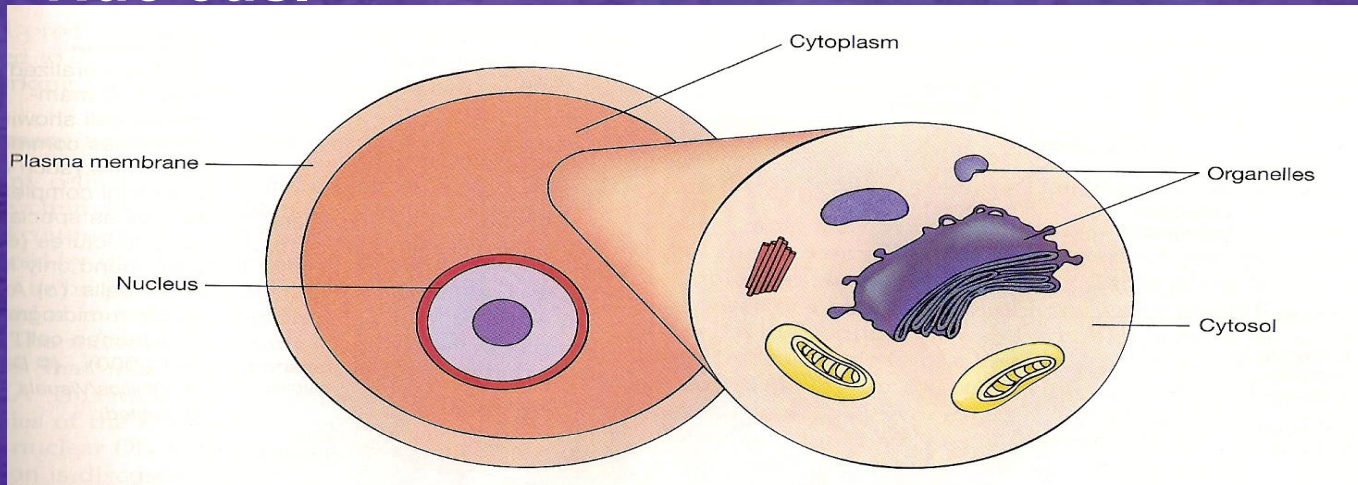
- All Cells share certain characteristics:
  - general cell structure & components.
  - general mechanisms for changing nutrients to Energy.
  - deliver end products into their surrounding fluid.
  - almost all have the ability to reproduce.





# General Cell structure:

- 3 principal parts:
  - Plasma (cell) membrane.
  - Cytoplasm & organelles.
  - Nucleus.



- The cell has two major compartments: the nucleus & the cytoplasm.

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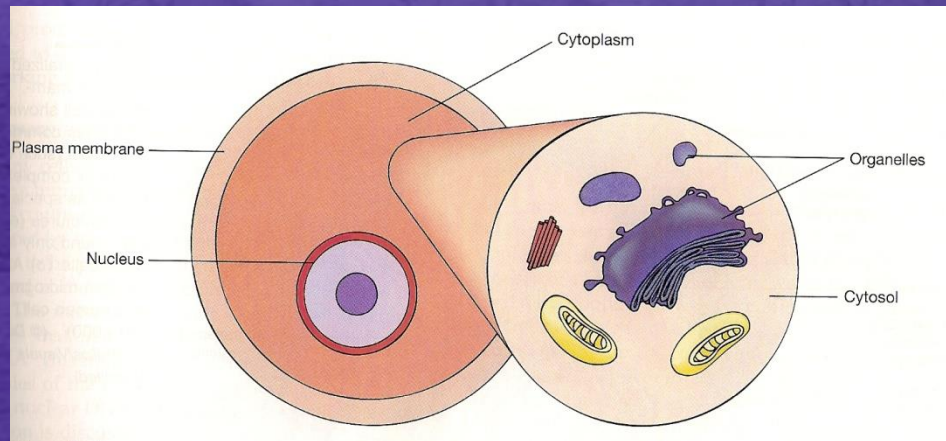
# General Cell Structure & Function

Component	Structure	Function
<b>Plasma (cell) membrane</b>	Membrane composed of double layer of phospholipids in which proteins are embedded	Surrounds, holds cell together & gives its form; controls passage of materials into & out of cell
<b>Cytoplasm</b>	Fluid, jellylike substance , cell membrane & nucleus in which organelles are suspended	Serves as matrix substance in which chemical reactions occur.
<b>Nucleus:</b>		
- Nuclear envelope	Double-layered membrane that surrounds nucleus, composed of protein & lipid molecules	Supports nucleus & controls passage of materials , nucleus & cytoplasm
- Nucleolus	Dense nonmembranous mass composed of protein & RNA molecules	Produces ribosomal RNA for ribosomes
- Chromatin	Fibrous strands composed of protein & DNA	Contains genetic code that determines which proteins (including enzymes) will be manufactured by the cell





# Plasma (cell) membrane



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## General composition of cell membrane

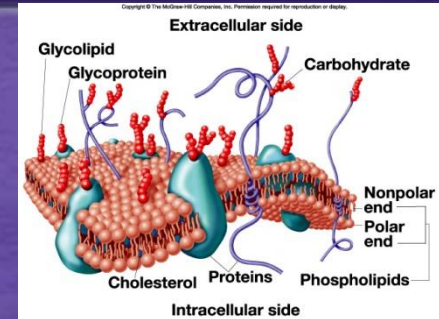
- Proteins ..... 55%
- Lipids ..... 41%
  - Phospholipids ... 25%
  - Cholesterol ..... 12%
  - Glycolipids ..... 4%
- Carbohydrates ..... 3%

} Lipids



# General functions of cell membrane proteins

1. Provide structural support.
2. Transport molecules across the membrane.
3. Enzymatic control of chemical reactions at cellular surface.
4. Some of it as receptors for hormones.
5. Some of it as regulatory molecules, that arrive at outer surface of the membrane.
6. Some serve as 'markers' (antigens), that identify tissue type of an individual.



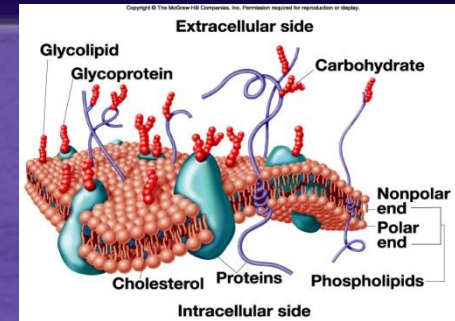
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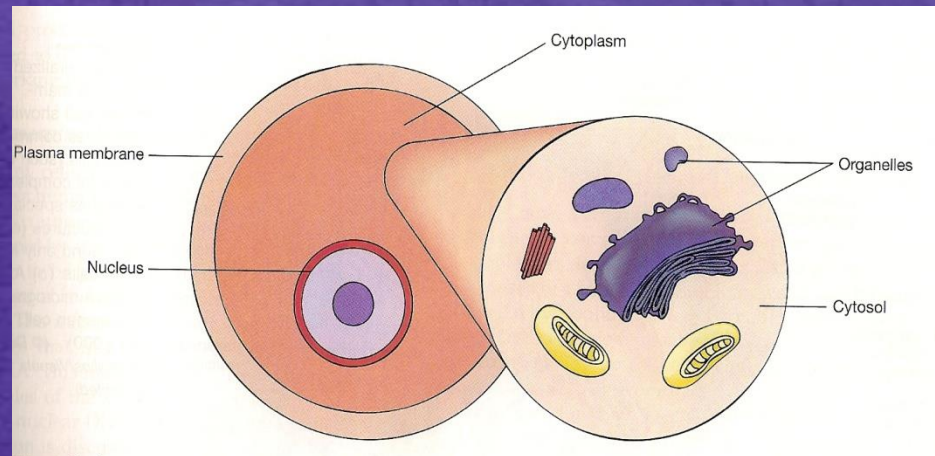
# General functions of cell membrane carbohydrates

1. Attach cells to each other.
2. Act as receptor substances.
3. Some enter in immune reactions.
4. Give most of cells overall surface charge, which affects the interaction of regulatory molecules w the membrane.





# Cytoplasm & Organelles



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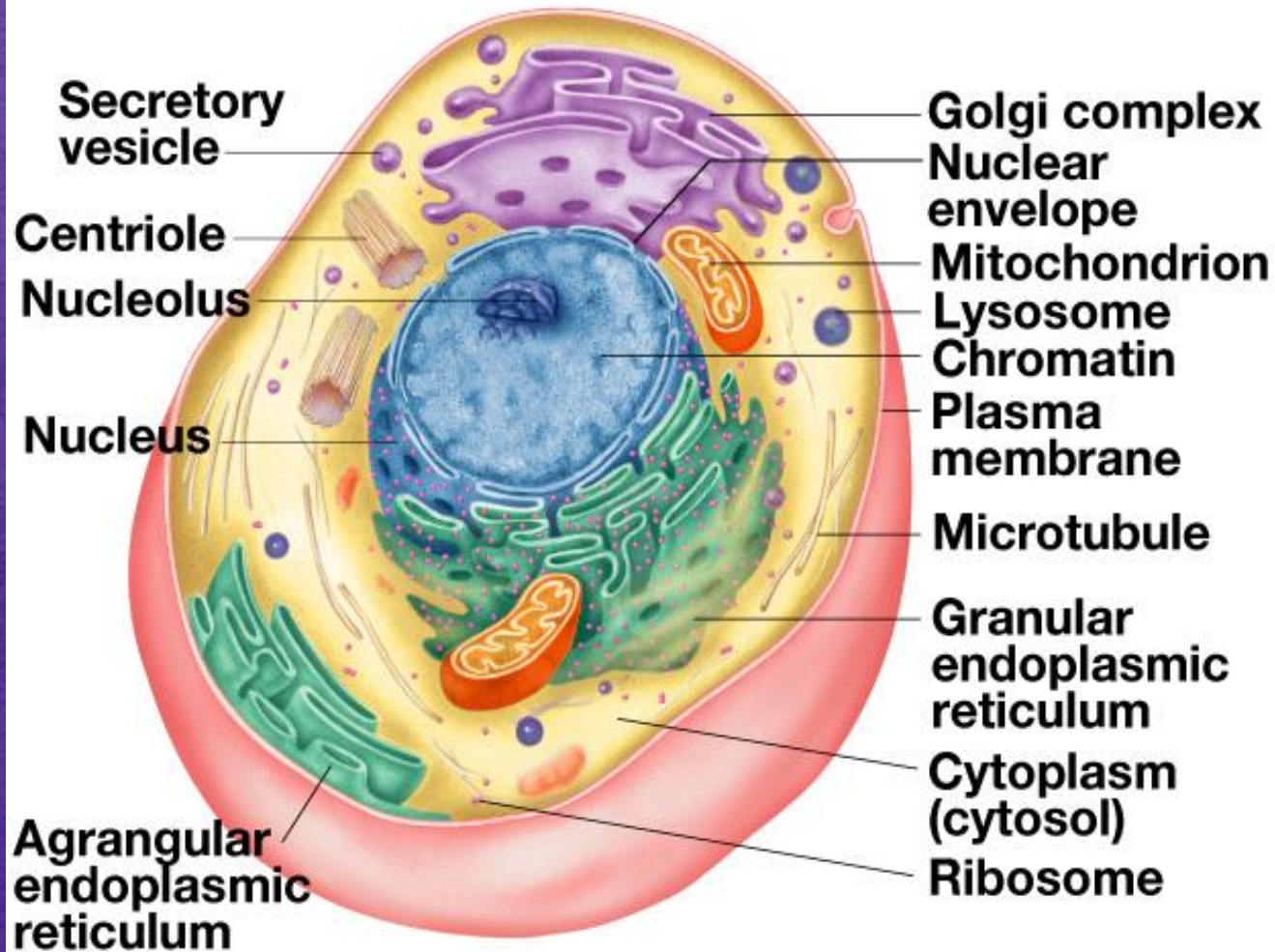
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# Cytoplasm, Organelles, Nucleoli (continued)

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# Cytoplasm

- The aqueous content of a cell (fluid, jellylike substance), that lies between cell membrane & nucleus in which organelles are suspended.
- Serves as matrix substance in which chemical reactions occur.
- 'cytosol' is the term used to describe fluid portion of the cytoplasm.



# Cytoplasmic Organelles: Structure & Function

Component	Function
<b>Endoplasmic reticulum</b>	Agranular (smooth) ER metabolizes nonpolar compounds & stores $\text{Ca}^{2+}$ in striated muscle cells; granular (rough) ER assists in protein synthesis
<b>Ribosomes</b>	Synthesize proteins
<b>Golgi complex</b>	Synthesizes carbohydrates & packages molecules for secretion. Secretes lipids & glycoproteins
<b>Mitochondria</b>	Release energy from food molecules & transform energy into usable ATP
<b>Lysosomes</b>	Digest foreign molecules & damaged organelles

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# Cytoplasmic Organelles: Structure & Function

(continued)

	Component	Function
	<b>Peroxisomes</b>	Contain enzymes that detoxify harmful molecules & break down hydrogen peroxide
	<b>Centrosome</b>	Helps to organize spindle fibers & distribute chromosomes during mitosis
	<b>Vacuoles</b>	Store & release various substances within the cytoplasm
	<b>Microfilaments &amp; microtubules</b>	Support cytoplasm & work as cytoskeleton, transport materials within the cytoplasm
	<b>Cilia &amp; flagella</b>	Move particles along cell surface, or move the cell

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A small, white cartoon ghost with large eyes and a blue tongue, positioned above the word "OR" in the "Trick or Treat" text.

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# Body Fluids





# Body composition

- In average young adult male:

Body composition	% of body weight
Protein, & related substances	18%
Fat	15%
Mineral	7%
Water	<b>60%</b>



# Body Fluids

- **Water content in body is divided into 2 compartments:**
  - 1. Extracellular fluid (ECF):** (internal environment)
    - fluid outside the cells.
    - ≈ 1/3 volume of fluids in body (≈ 33% of total body water).
    - contains ions & nutrients needed for cellular life.
  - 2. Intracellular fluid (ICF):**
    - fluid inside the cells.
    - ≈ 2/3 volume of fluids in body (≈ 67% of total body water).





# Fluid Compartments

≈ 60% of body weight

Extracellular fluid  
(≈ 1/3)  
≈ 33% of TBW  
**20% of body wt**

Intracellular fluid  
(≈ 2/3)  
≈ 67% of TBW  
**40% of body wt**

Plasma

≈ 25% of ECF  
**5% of body wt**

Interstitial fluid

≈ 75% of ECF  
**15% of body wt**

Transcellular fluid

CSF  
Intraocular  
Pleural  
Peritoneal  
Pericardial  
Synovial  
Digestive  
secretions



# Differences between ECF & ICF

## ECF

### Cations:

**Na<sup>+</sup> (142mmol/L)**

**K<sup>+</sup> (4.2)**

**Mg<sup>2+</sup> (0.8)**

### Anions:

**Cl<sup>-</sup> (108)**

**HCO<sub>3</sub><sup>-</sup> (24)**

### Nutrients:

**O<sub>2</sub>, glucose, fatty acids, & amino acids.**

### Wastes:

**CO<sub>2</sub>, Urea, uric acid, excess water, & ions.**

## ICF

### Cations:

**Na<sup>+</sup> (14)**

**K<sup>+</sup> (140)**

**Mg<sup>2+</sup> (20)**

### Anions:

**Cl<sup>-</sup> (4)**

**HCO<sub>3</sub><sup>-</sup> (10)**

**Phosphate ions**

### Nutrients:

**High concentrations of proteins.**

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# Control of body fluids

- Thirst
- Sweating
- Renal control (aldosterone)
- Neuronal (osmoreceptors, baroreceptors)





# Cell membrane transport

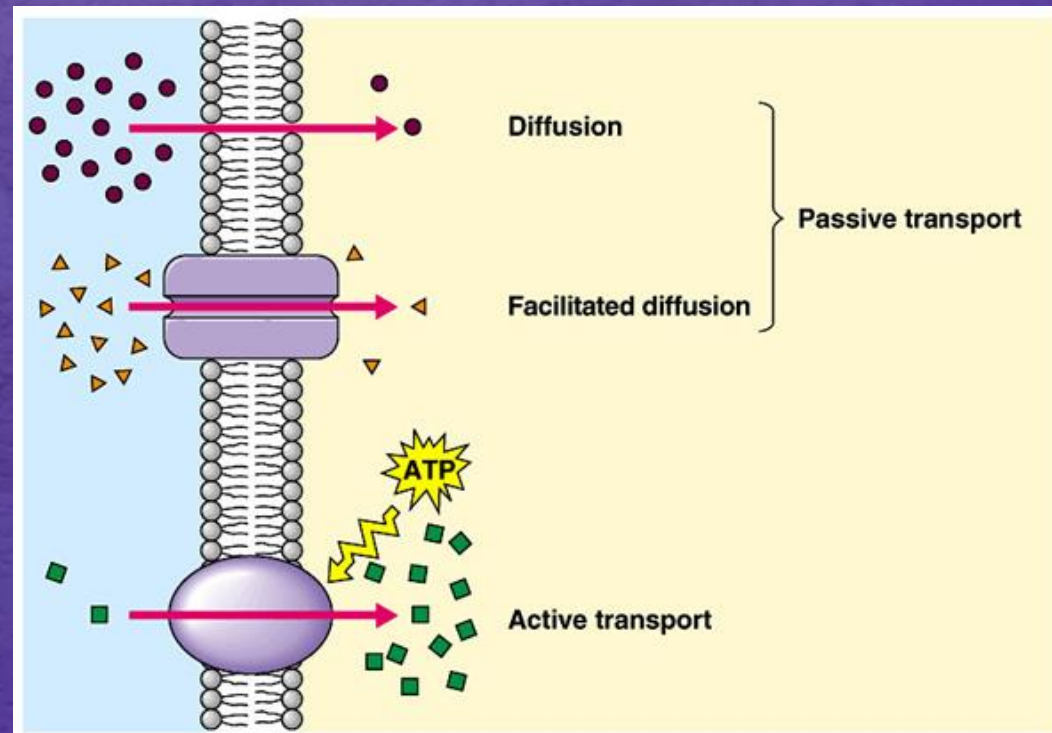
- There are 2 types of cell membrane transport:

- **Passive Transport**

- Things flow from High to low

- **Active Transport**

- Things flow from Low to high



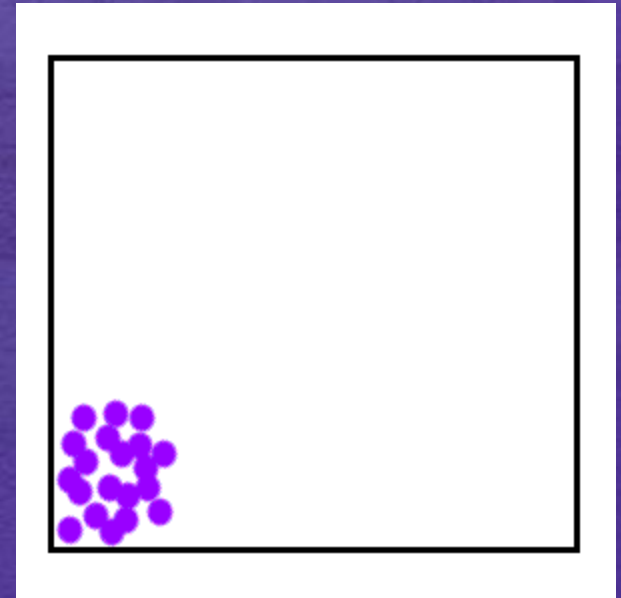


# Passive Transport

- Diffusion
  - The movement of particles from areas of high concentration to low concentration



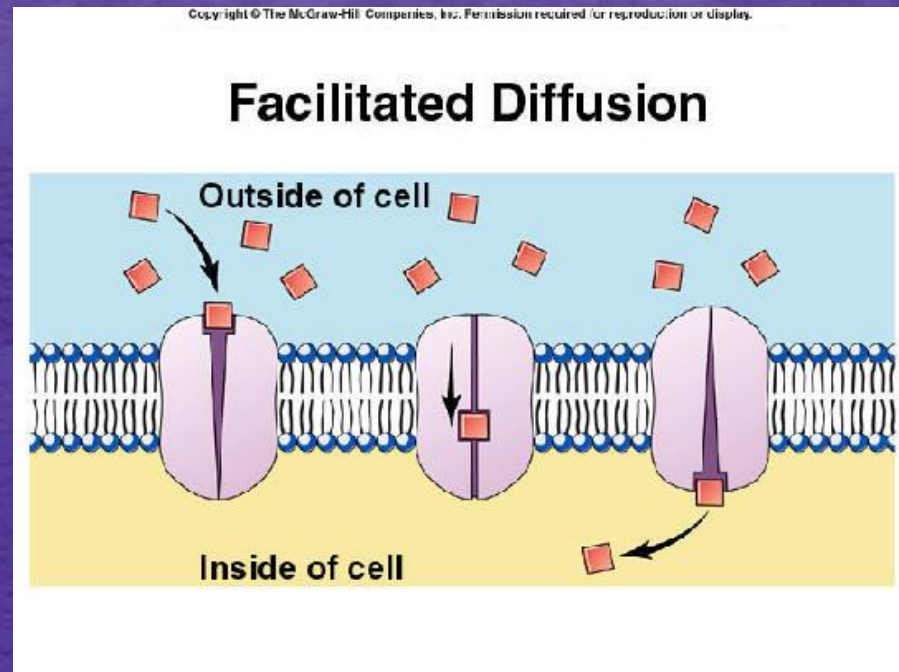
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# Facilitated Diffusion

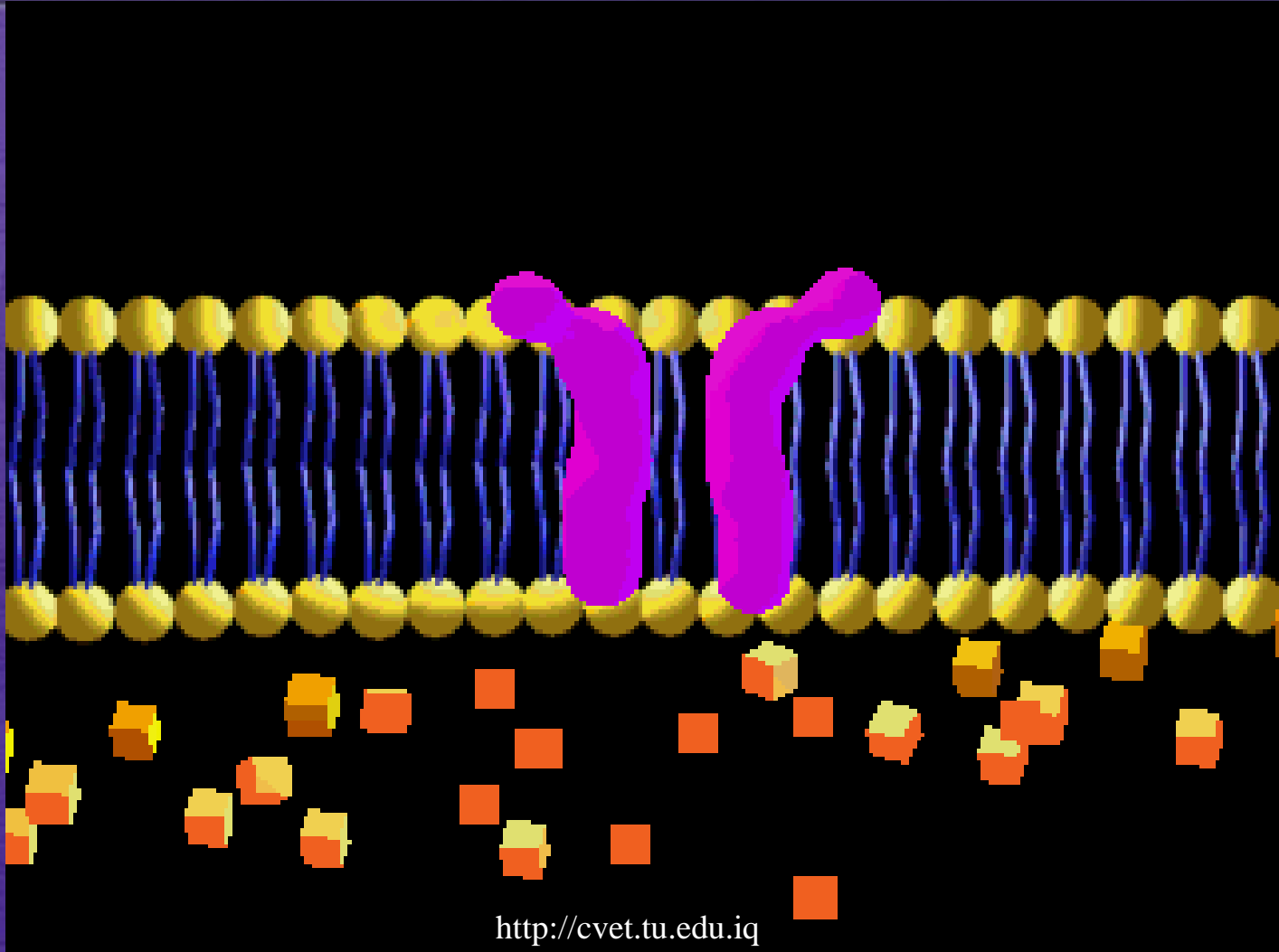
- Particles flow from high concentration to low concentration but this time they need the help of proteins to get through the cell membrane.







# Facilitated diffusion

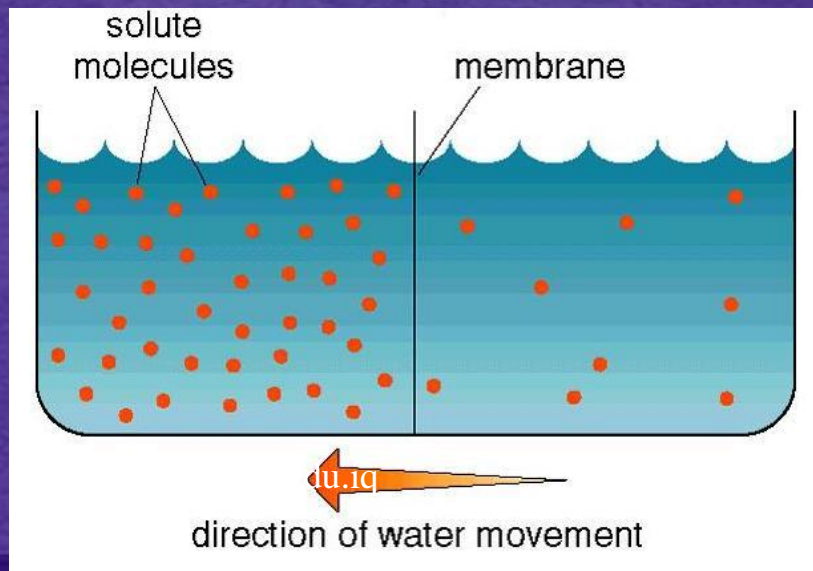




# Passive transport

- Osmosis

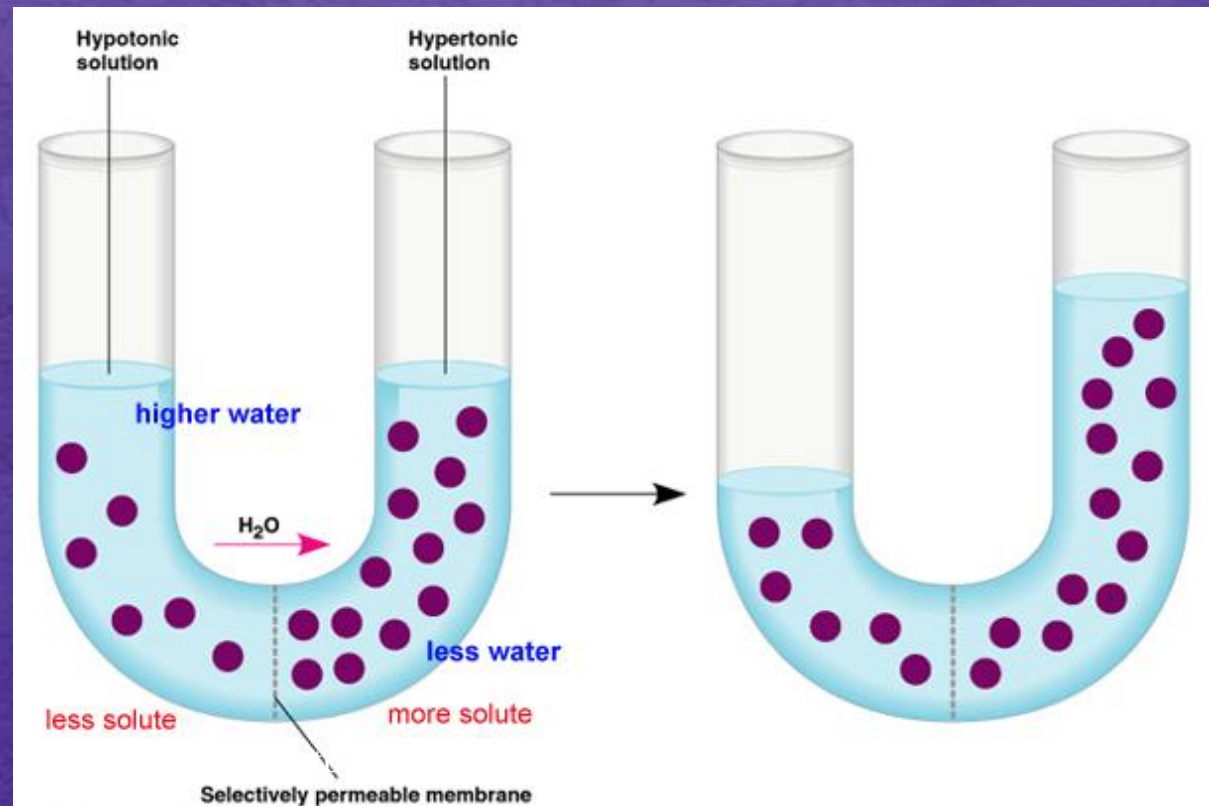
- The diffusion of water across a selectively permeable membrane
- Important in maintaining cell homeostasis
- Water flows to side of membrane where the water concentration is lower until equilibrium is reached





# Osmosis

- Osmosis is controlled by the amount of solutes on either side of a membrane

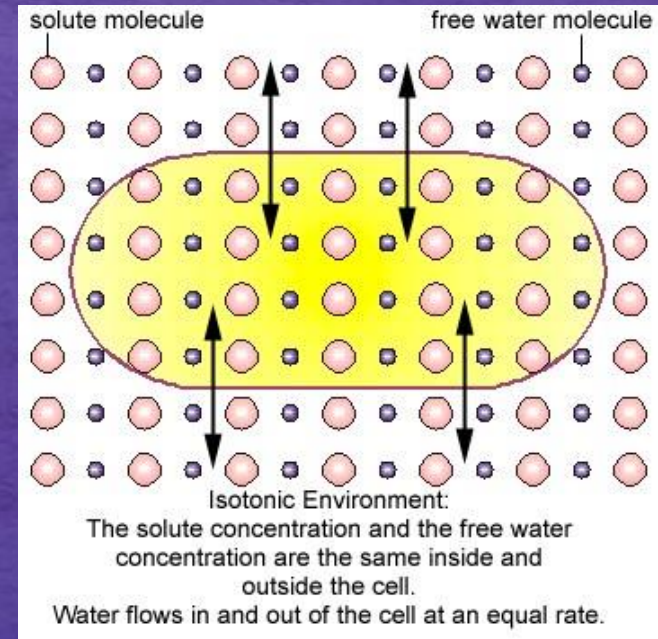
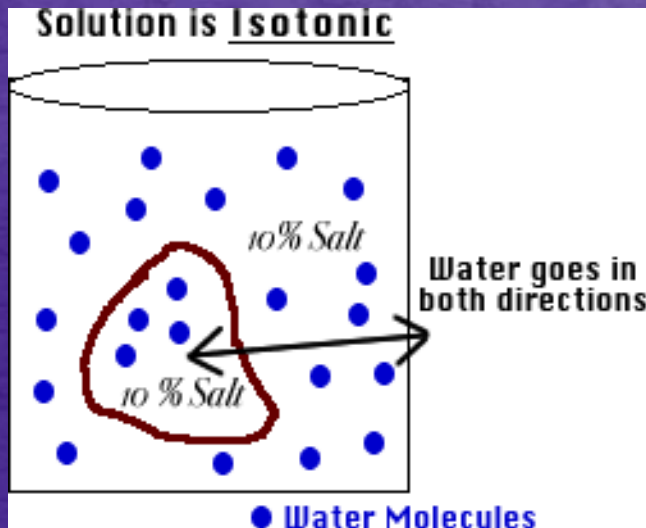






# Isotonic Solution

- Isotonic solution – Concentration of solute is the same in the cell and the area around the cell.

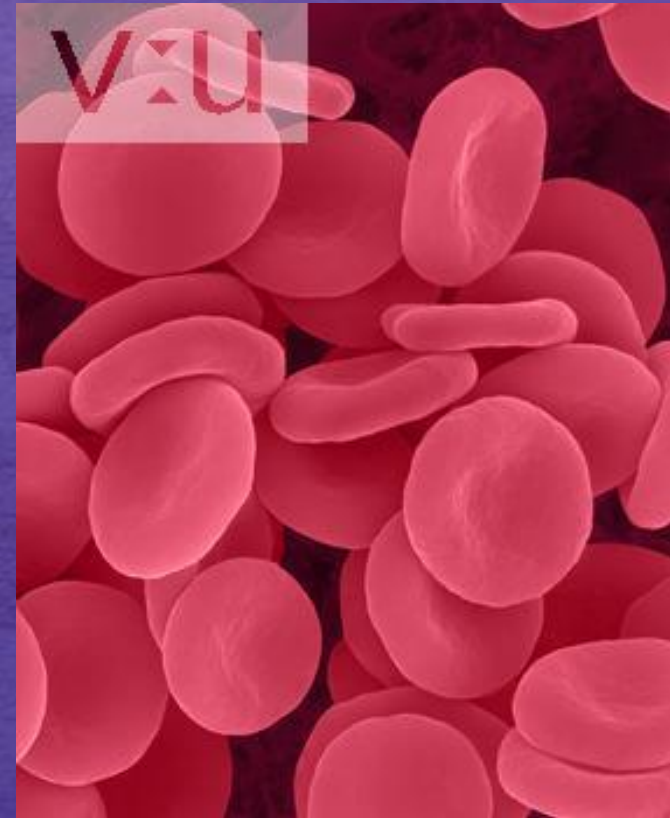
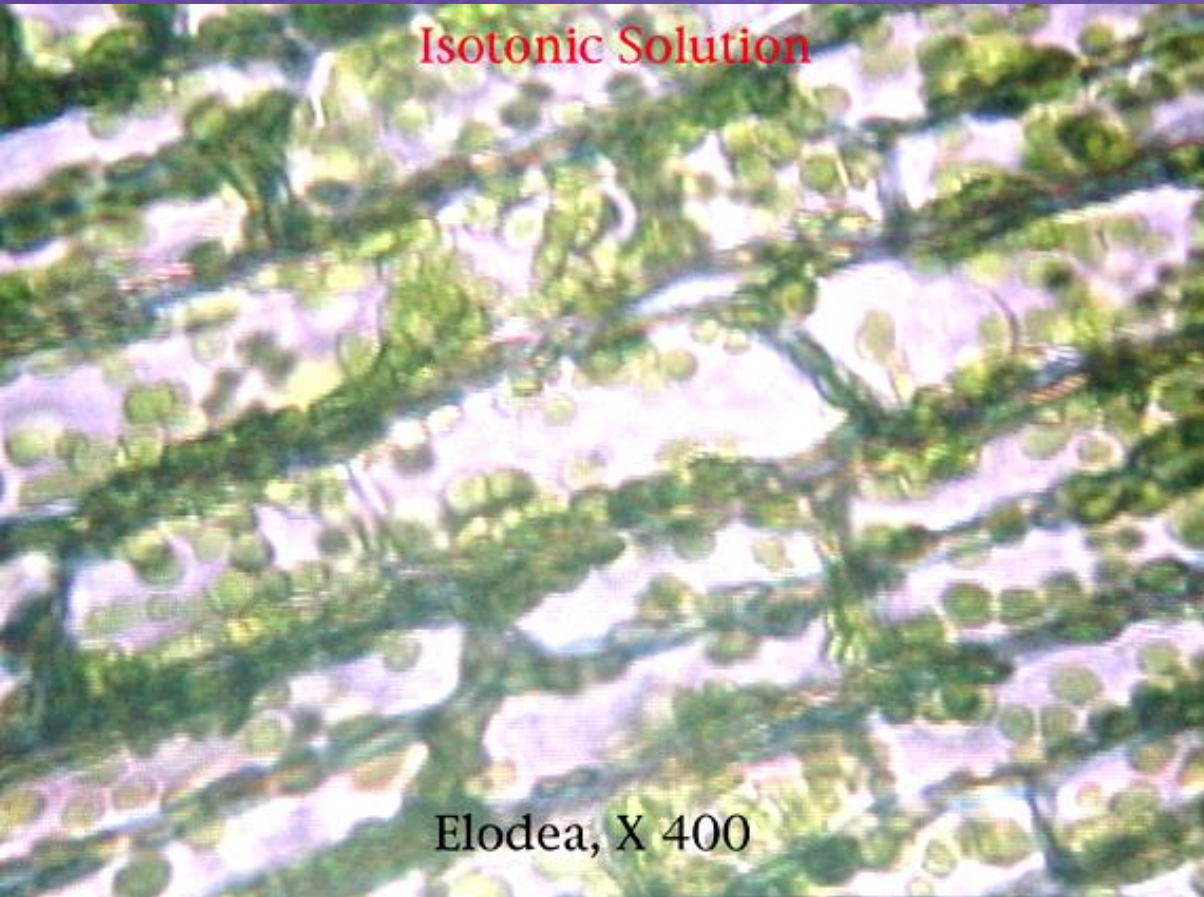


- Give me an example of an isotonic solution that some of you use everyday

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# Isotonic solution



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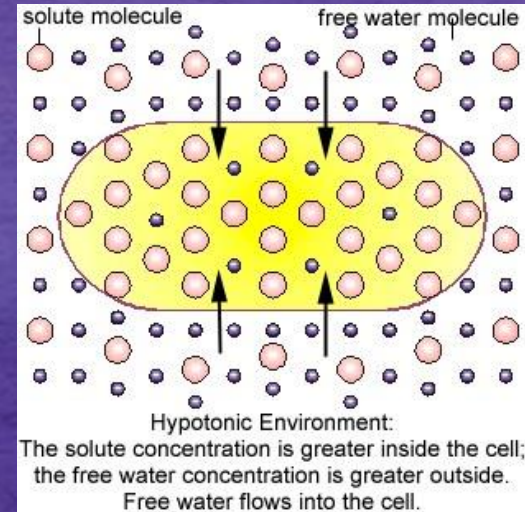
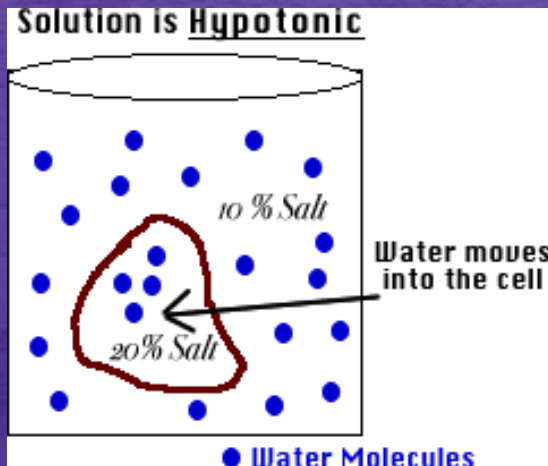
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# Hypotonic Solution

- Hypotonic Solution – Concentration of solute is lower in the solution than in the cell.



- Where is water going to move in order to reach equilibrium (Equal concentrations)?
  - Inside the cell

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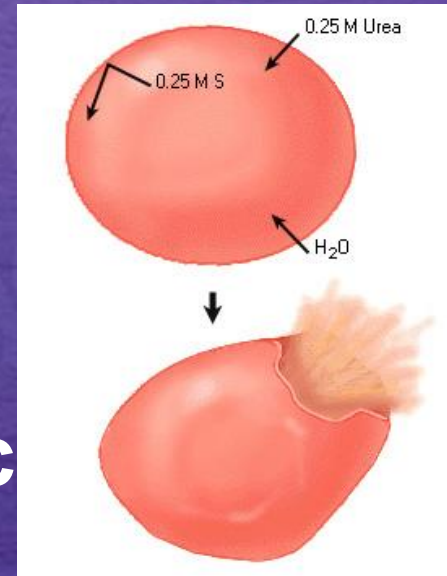




# Hypotonic solutions

- Since water moves into the cell the cell can explode

- So, Hypotonic solution, low c of solute, cell can explode on





# Plant and animal cells in a hypotonic solution



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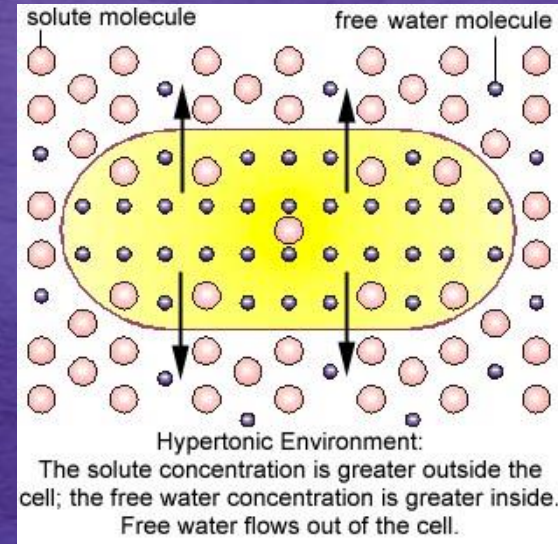
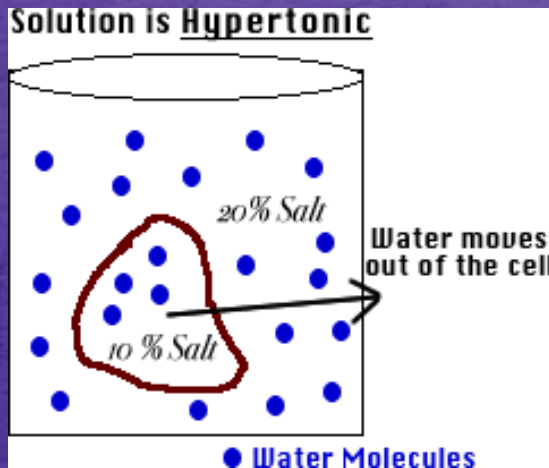
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# Hypertonic Solution

- Hypertonic solution – concentration of solute is higher in the solution than in the cell.



- Where is water going to move in order to reach equilibrium (Equal concentrations)?
- Outside the cell

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# Hypertonic solutions

- Since water moves out of the cell the cell will shrink
- So, Hypertonic solution, high concentration of solute, cell will shrink





# Plant and animals cells in a Hypertonic Solution

Hypertonic Solution

Elodea, X 400



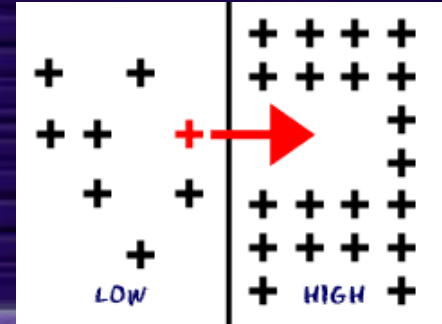
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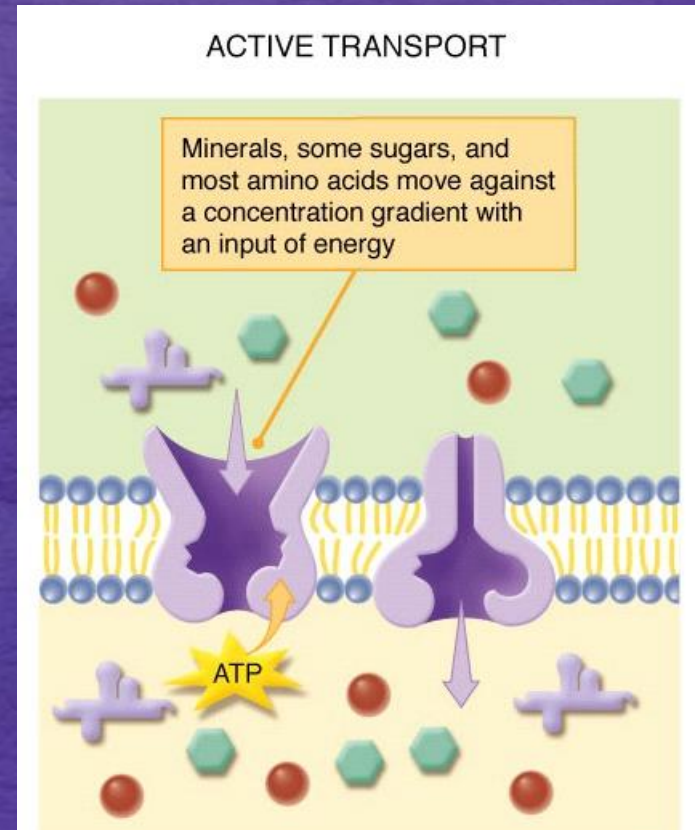
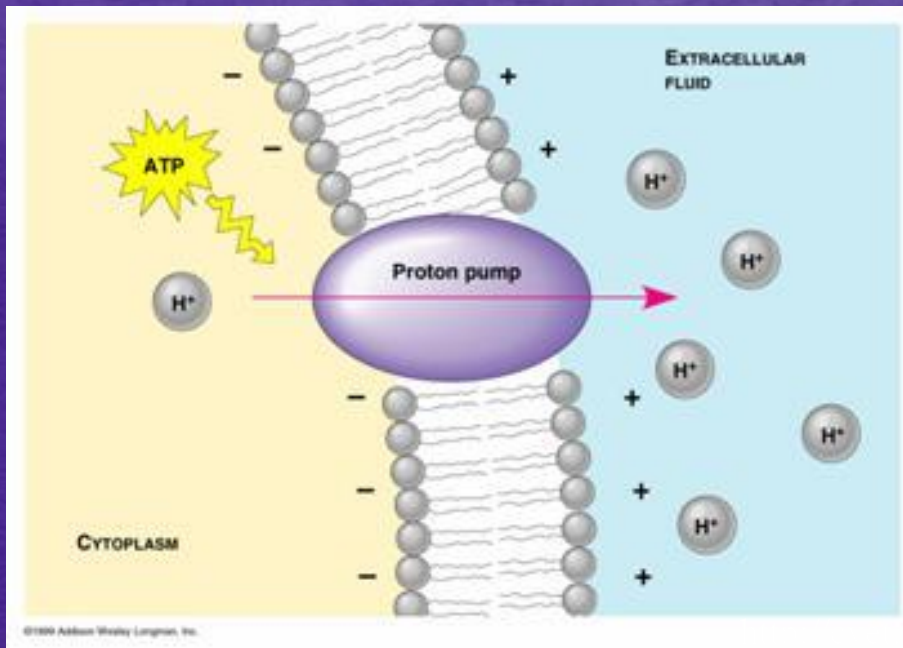




# Active Transport



- Molecules move from low concentration to high concentration
- Requires energy....why?



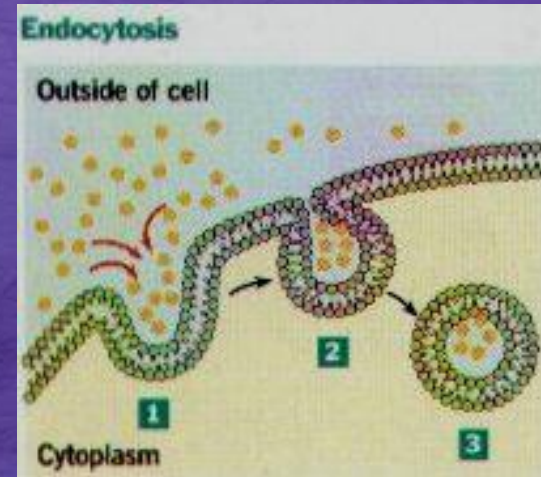
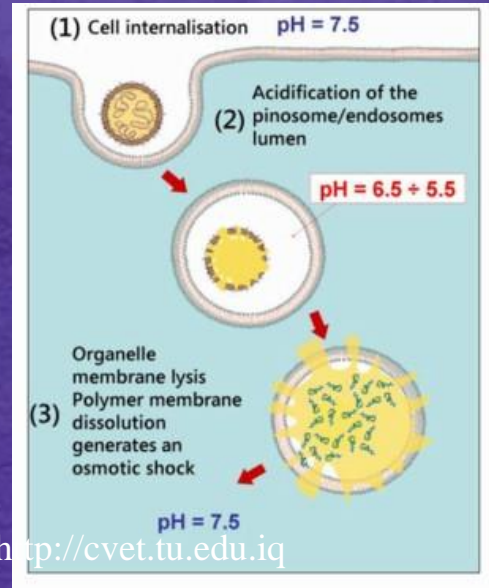
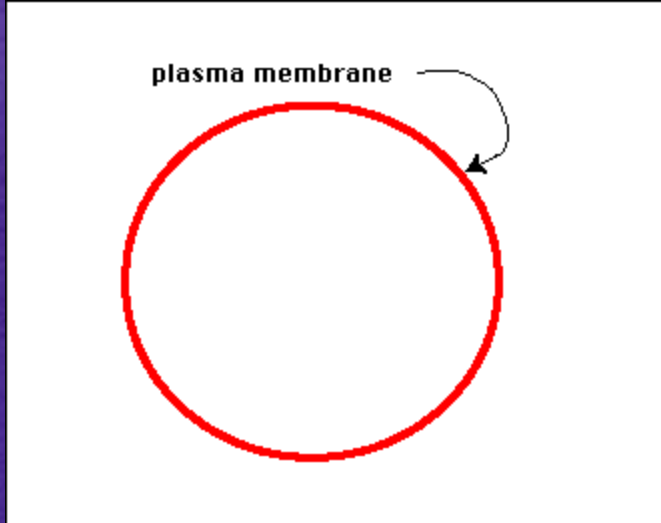
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# Other membrane transport activities that require energy

- Endocytosis
  - Engulfing of large particles or liquids from outside the cell



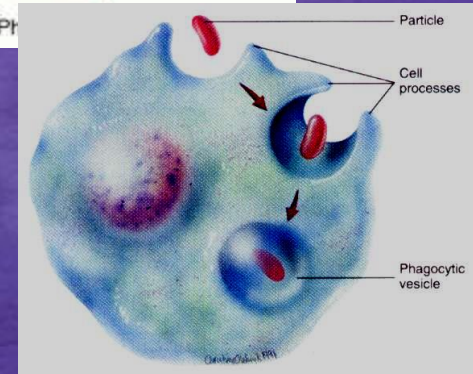
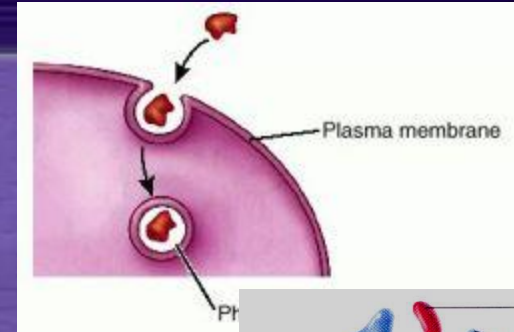
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# 2 types of Endocytosis

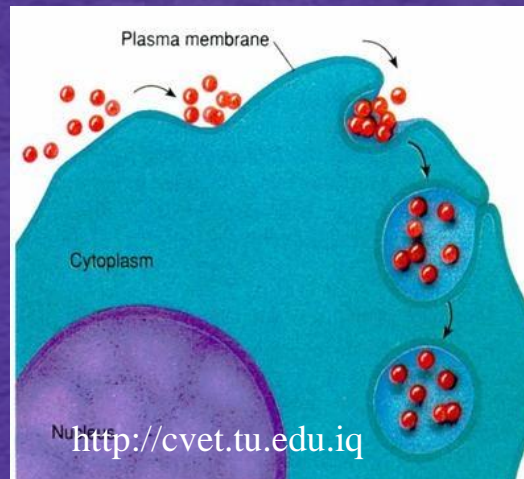
- **Phagocytosis**

- Engulfing of large particles from outside the cell

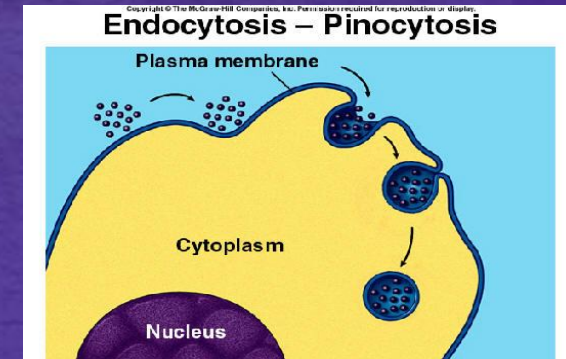


- **Pinocytosis**

- Engulfing of liquids from outside the cell



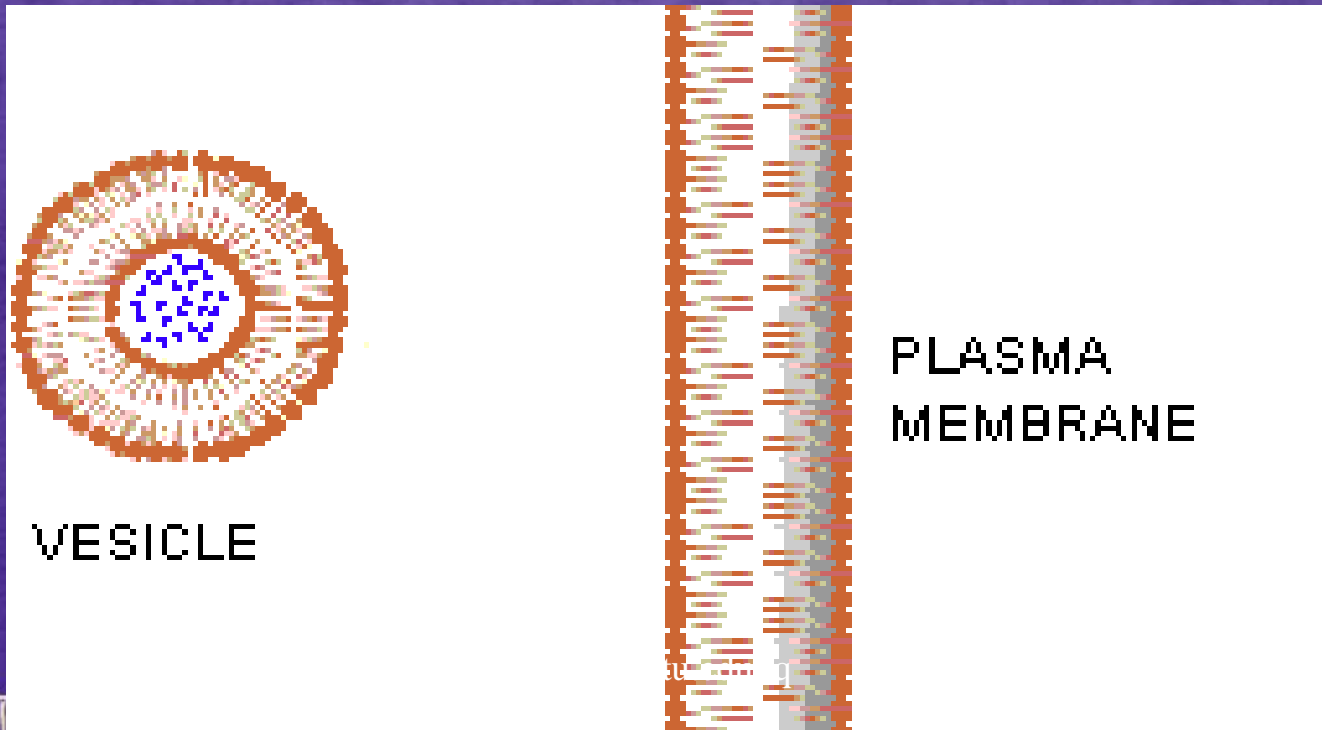
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# Other membrane transport activities that require energy

- **Exocytosis**
  - Release of large particles or liquids from inside the cell



Inside  
the cell

Outside  
the cell