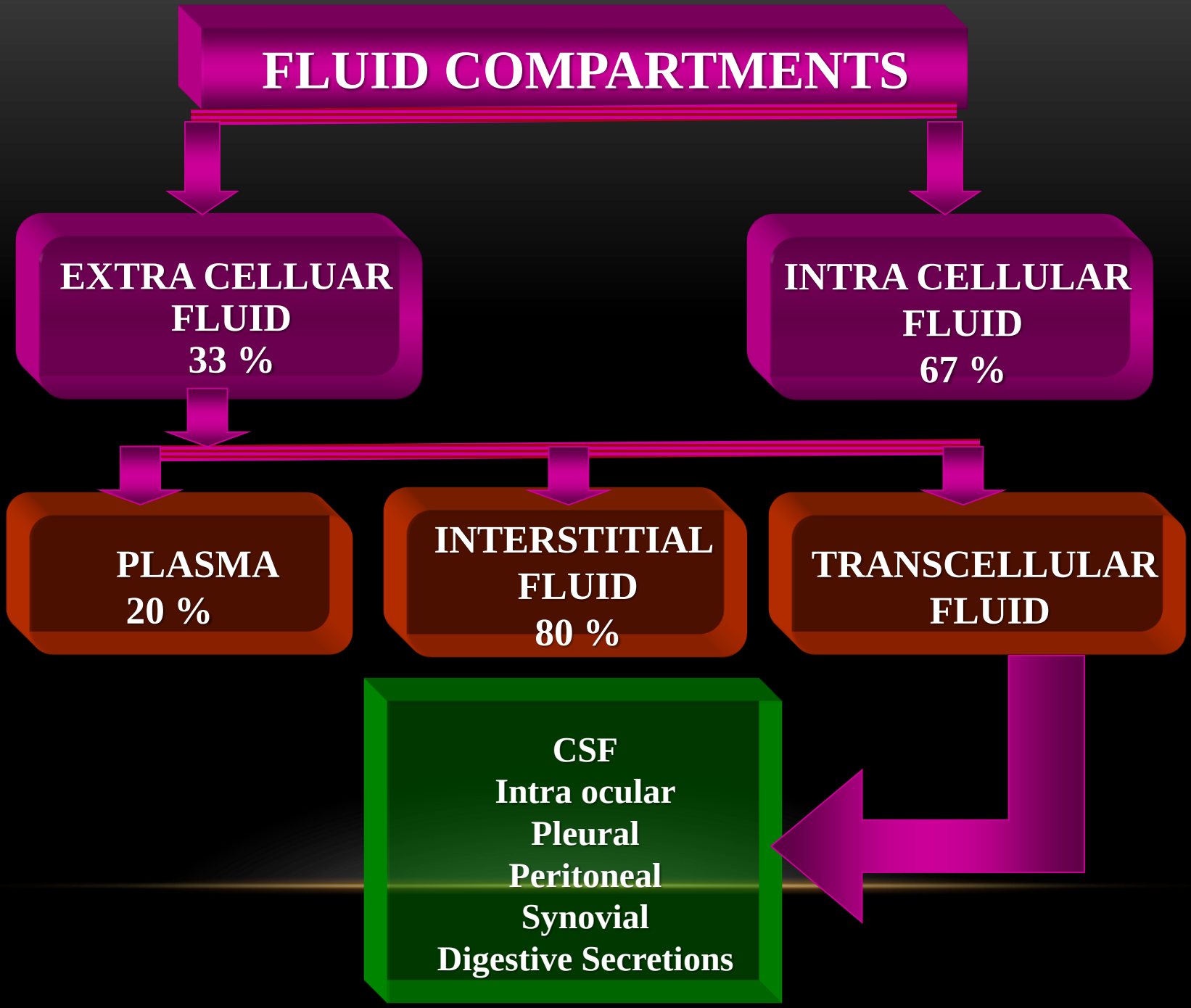

بسم الله الرحمن الرحيم

BODY FLUIDS

DISTRIBUTION

Dr. Taj


FLUID COMPARTMENTS
EXTRA CELLUAR FLUID 33 %
INTRA CELLULAR FLUID 67 %
PLASMA 20 %
INTERSTITIAL FLUID 80 %
TRANSCELLULAR FLUID
CSF
Intra ocular
Pleural
Peritoneal
Synovial
Digestive Secretions

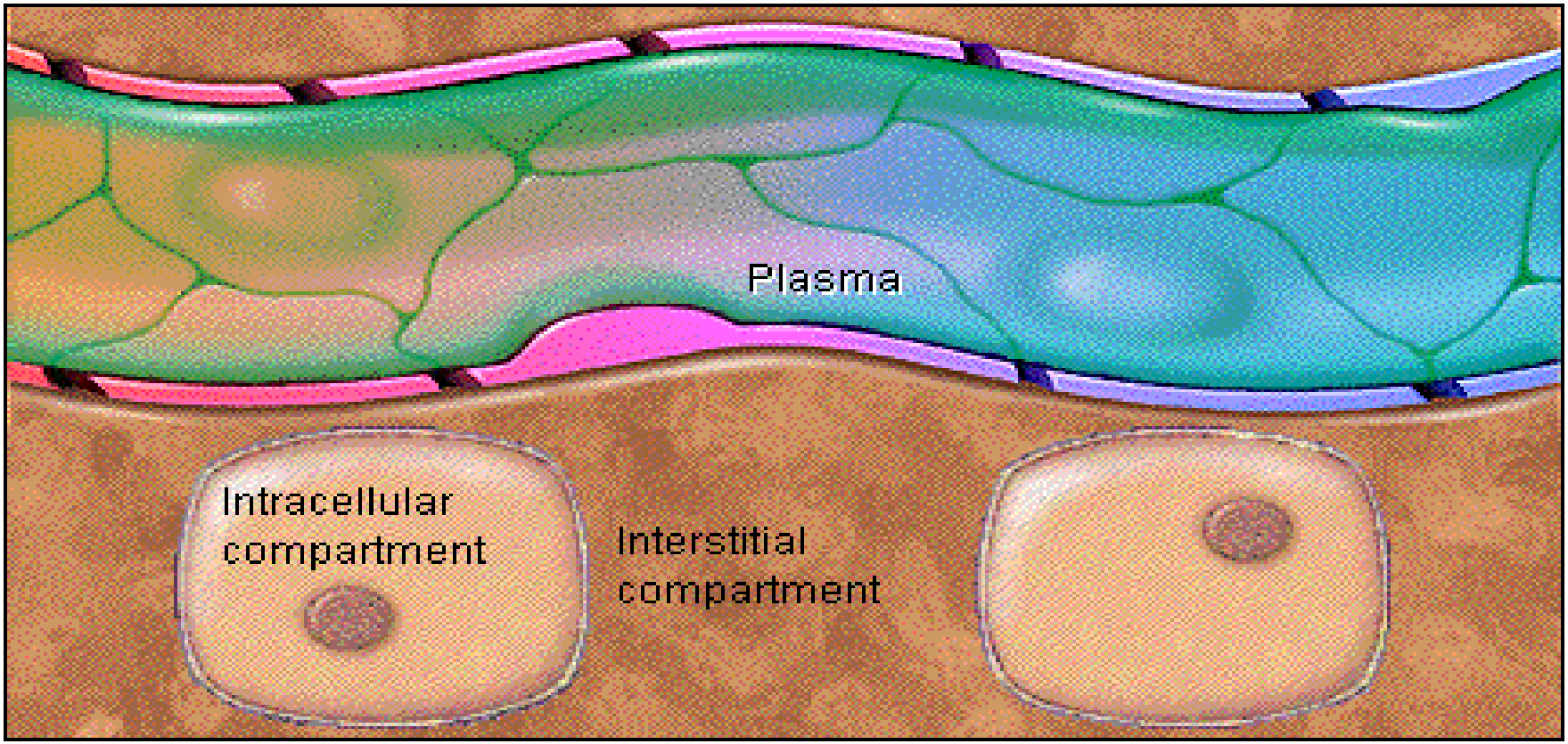
Fluid Compartments

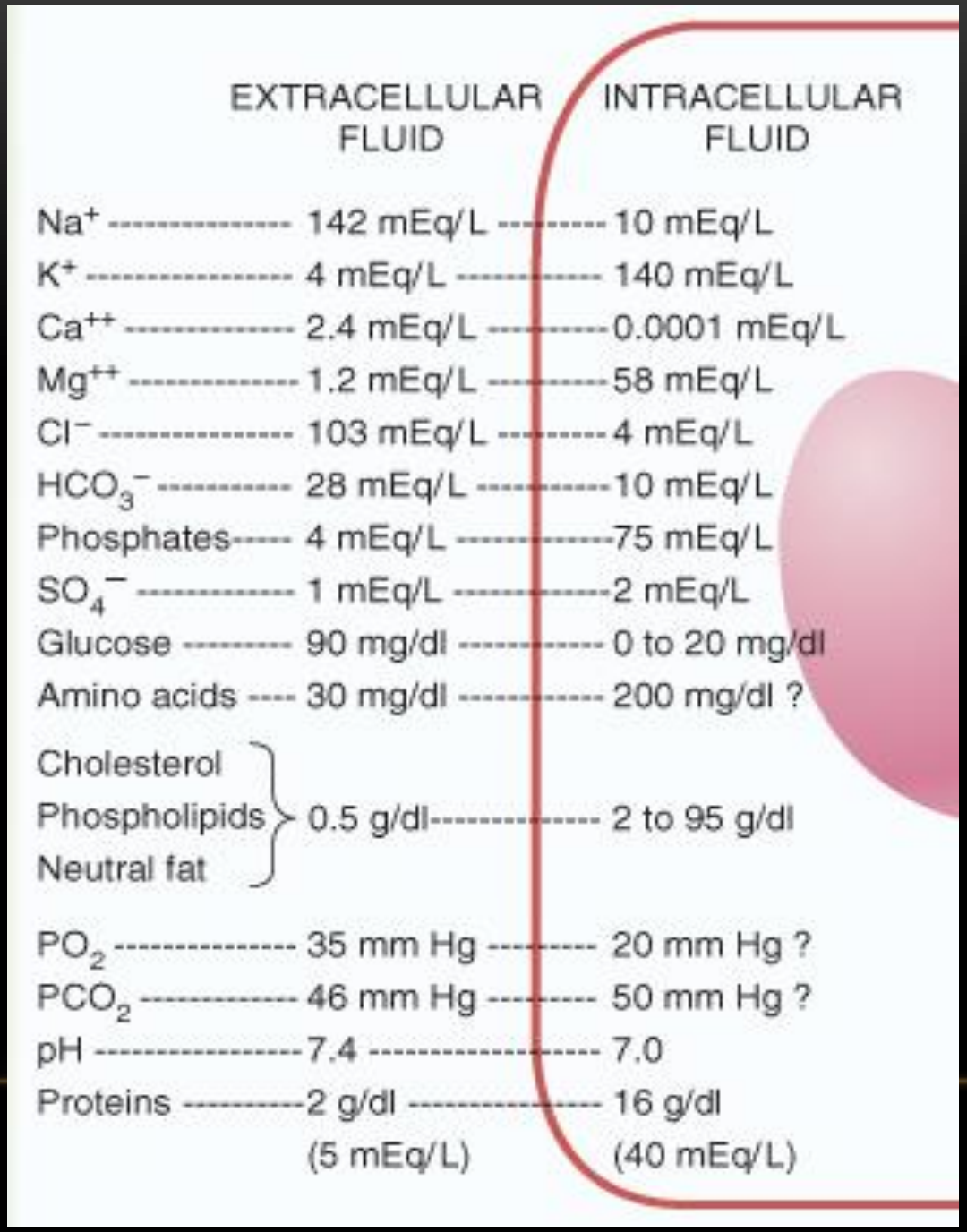
The three major fluid compartments:

- **Intracellular fluid** (**ICF**) is the fluid within cells, also known as cytosol.
- **Extracellular fluid** (**ECF**) is the fluid found outside of cells.

There are two major kinds of extracellular fluid:

- **Interstitial fluid** is the fluid surrounding the cells.
- **Plasma** is the fluid component of blood.

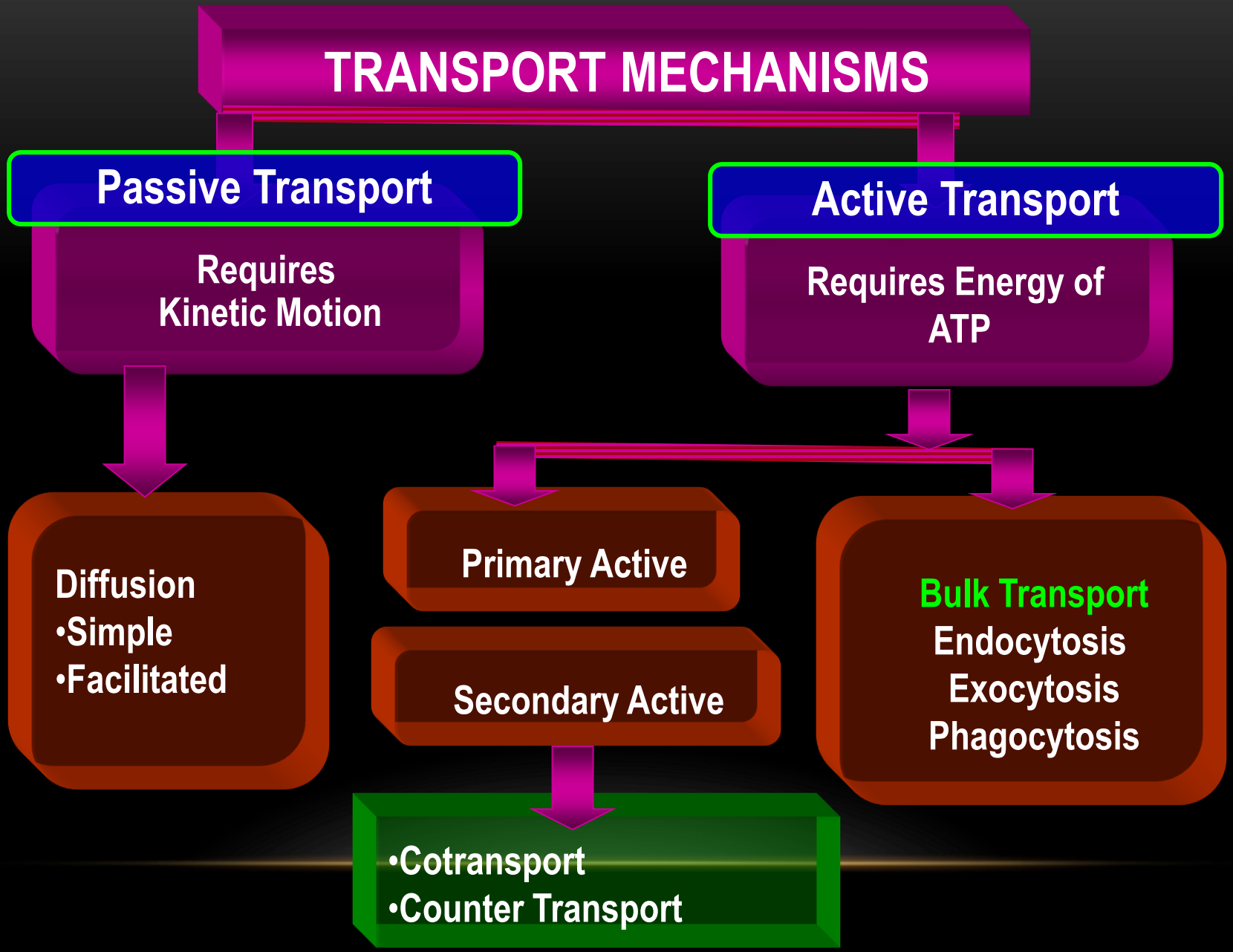



EXTRACELLULAR FLUID
INTRACELLULAR FLUID
Na^+ 142 mEq/L 10 mEq/L
K^+ 4 mEq/L 140 mEq/L
Ca^{++} 2.4 mEq/L 0.0001 mEq/L
Mg^{++} 1.2 mEq/L 58 mEq/L
Cl^- 103 mEq/L 4 mEq/L
HCO_3^- 28 mEq/L 10 mEq/L
Phosphates 4 mEq/L 75 mEq/L
SO_4^- 1 mEq/L 2 mEq/L
Glucose 90 mg/dl 0 to 20 mg/dl
Amino acids 30 mg/dl 200 mg/dl ?
Cholesterol
Phospholipids 0.5 g/dl 2 to 95 g/dl
Neutral fat
PO_2 35 mm Hg 20 mm Hg ?
PCO_2 46 mm Hg 50 mm Hg ?
pH 7.4 7.0
Proteins 2 g/dl 16 g/dl
(5 mEq/L) (40 mEq/L)

TRANSPORT MECHANISMS

- **Cell membrane is selectively permeable (semi-permeable) to some molecules and ions.**

- **Not permeable (impermeable) to proteins, nucleic acids, and other molecules.**


TRANSPORT MECHANISMS
Passive Transport
Requires Kinetic Motion
Active Transport
Requires Energy of ATP
Diffusion
•Simple
•Facilitated
Primary Active
Secondary Active
•Cotransport
•Counter Transport
Bulk Transport
Endocytosis
Exocytosis
Phagocytosis

CATEGORIES OF TRANSPORT ACROSS THE PLASMA MEMBRANE

- **Categorized by their energy requirements:**
  - **Passive transport:**
    - **Net movement down a concentration gradient.**
    - **Does not require metabolic energy (ATP).**
  - **Active transport:**
    - **Net movement against a concentration gradient.**
    - **Requires ATP.**

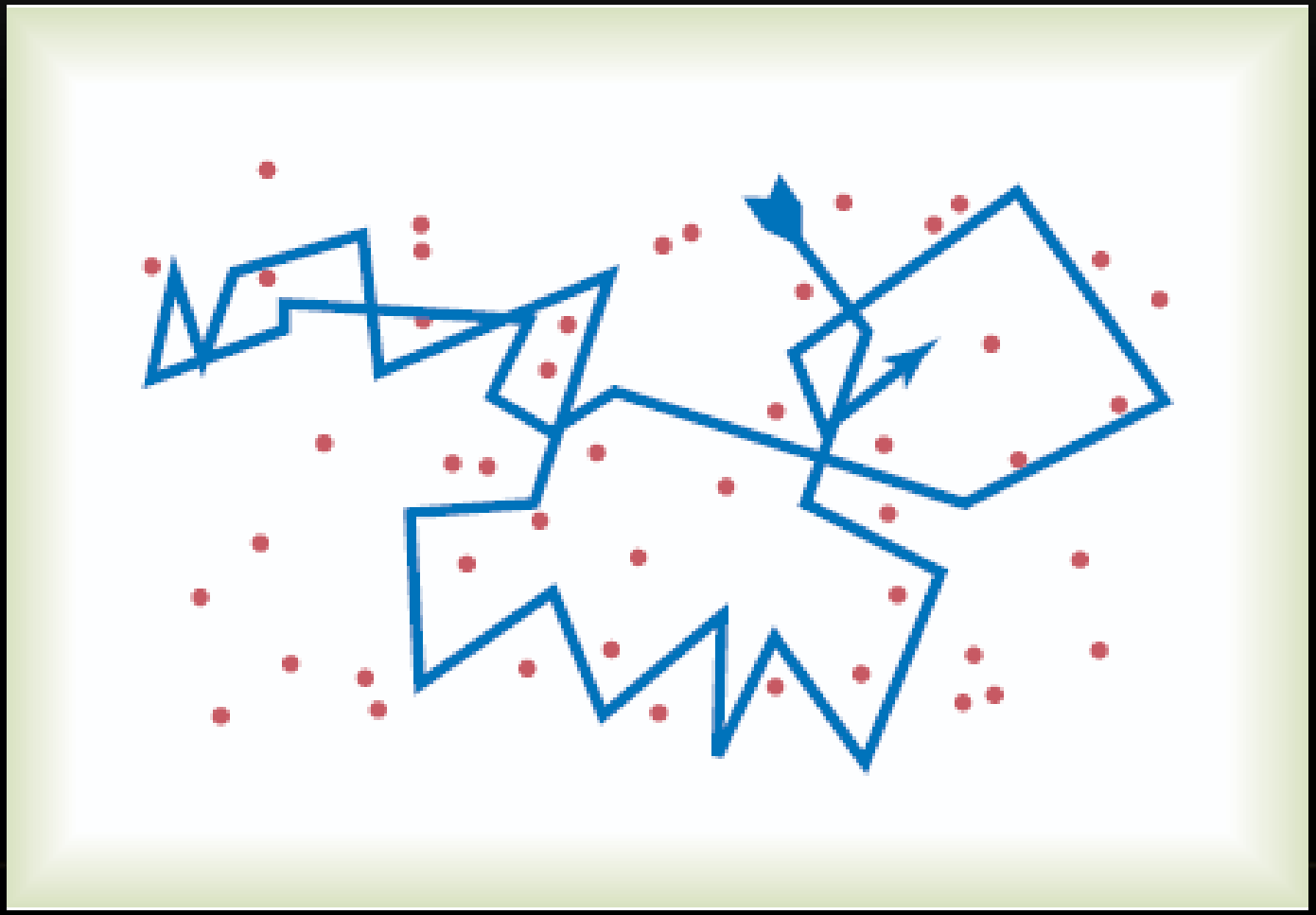
CATEGORIES OF TRANSPORT ACROSS THE PLASMA MEMBRANE

- **Mechanisms to transport molecules and ions through the cell membrane:**
  - **Carrier mediated transport:**
    - **Facilitated diffusion and active transport.**
  - **Non-carrier mediated transport.**
    - **Simple Diffusion and osmosis.**

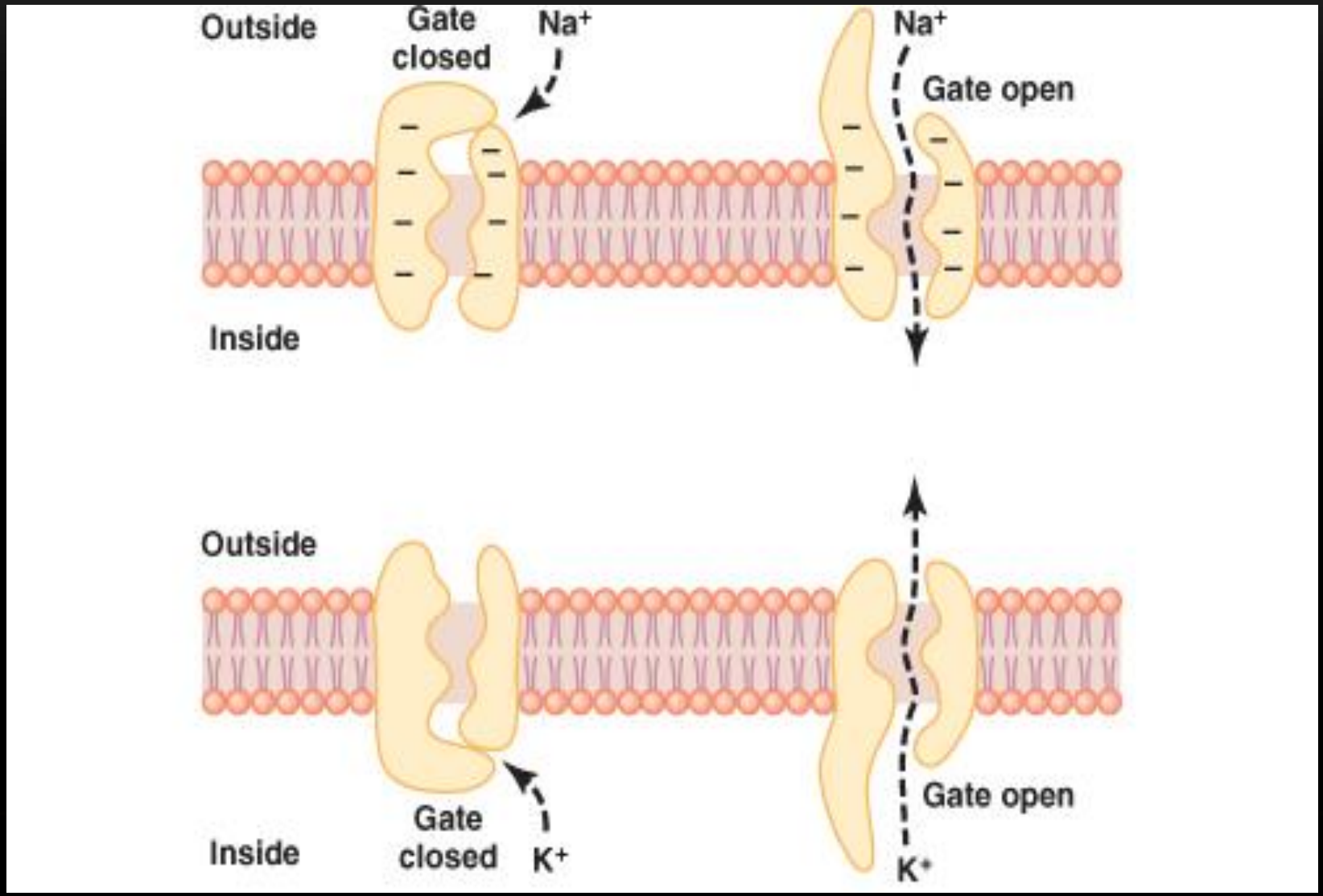
DIFFUSION

- Molecules/ions are in constant state of random motion due to their thermal energy.
- Eliminates a concentration gradient and distributes the molecules uniformly.
- Physical process that occurs whenever there is a concentration difference across the membrane and the membrane is permeable to the diffusing substance.

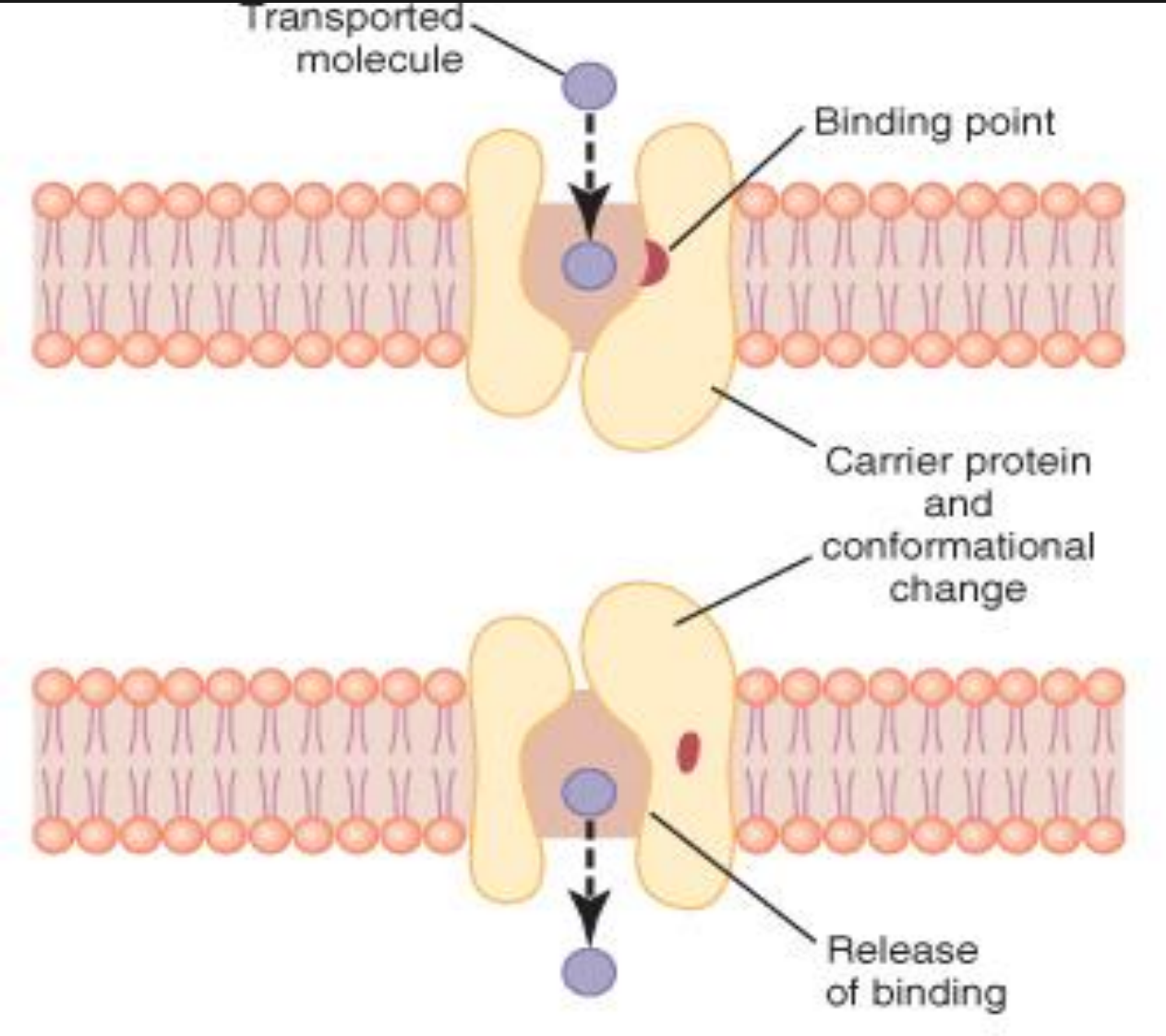
Simple Diffusion



Simple Diffusion



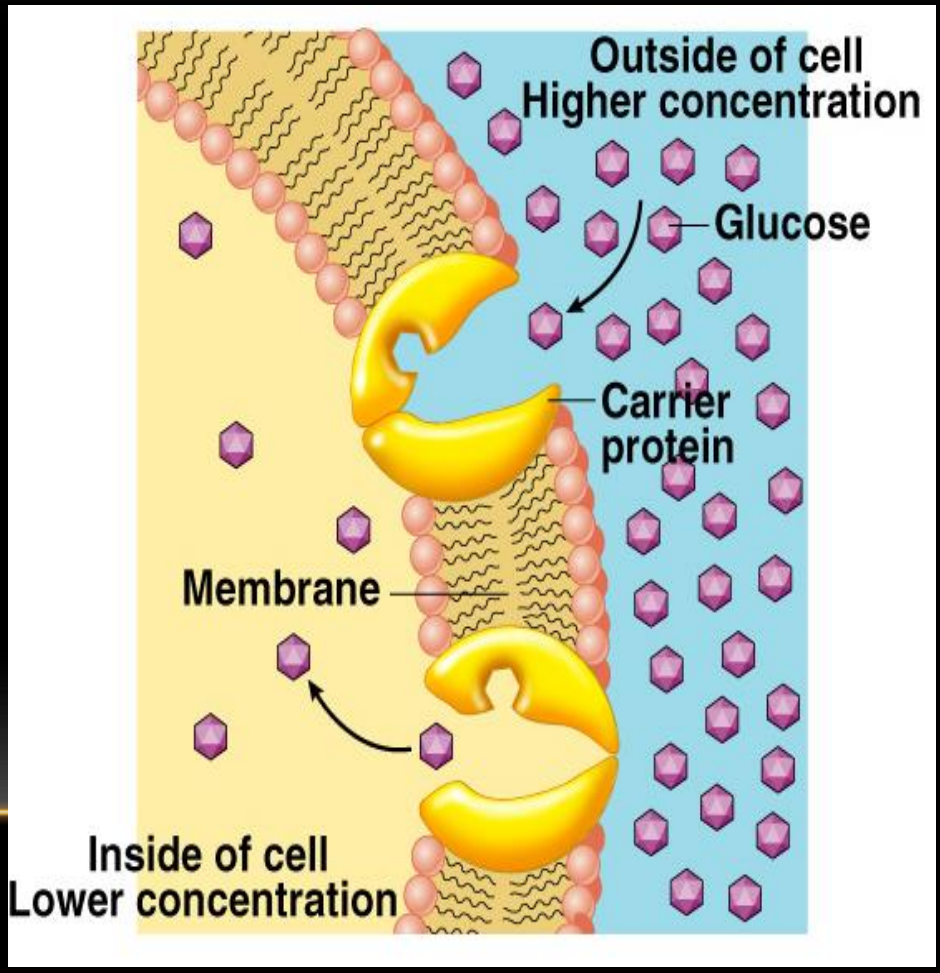
Facilitated Diffusion



FACILITATED DIFFUSION

It is Passive

- **ATP not needed.**
  - **Powered by thermal energy of diffusing molecules.**
- **Involves transport of substance through plasma membrane down concentration gradient by carrier proteins.**
  - **Transport carriers for glucose designated as GLUT.**



DIFFUSION THROUGH PLASMA MEMBRANE

- **Cell membrane is PERMEABLE to:**
  - **Non-polar molecules (0_2).**
  - **Lipid soluble molecules (steroids).**
  - **Small polar covalent bonds ($C0_2$).**
  - **H_20 (small size, lack charge).**

- **Cell membrane IMPERMEABLE to:**
  - **Large polar molecules (glucose).**
  - **Charged inorganic ions (Na^+).**

FACTORS AFFECTING NET RATE OF DIFFUSION

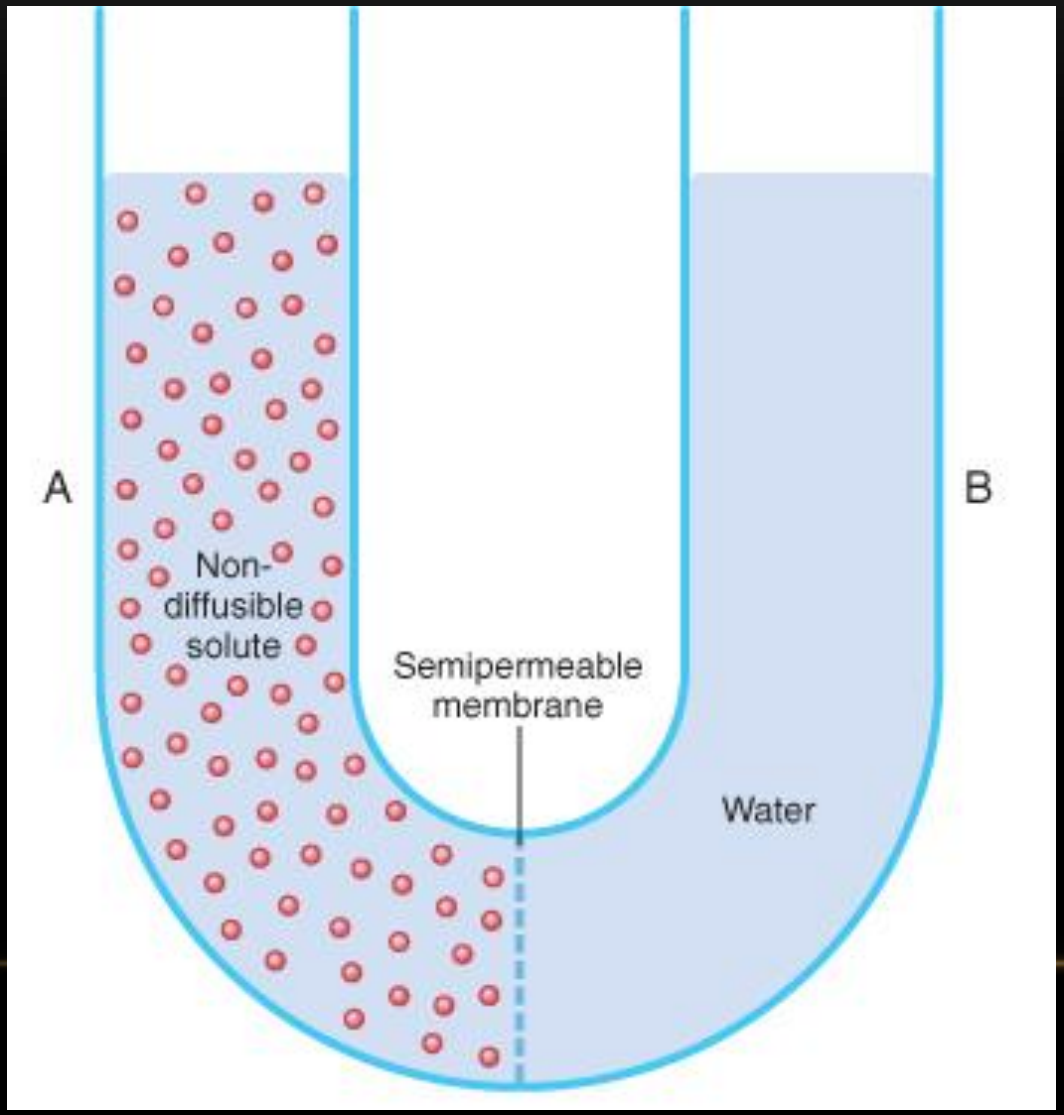
Permeability depends on:

- **Thickness of the membrane.**
- **Lipid Solubility of the substance.**
- **Presence of Protein Channels.**
- **Temperature of the compartments.**
- **Molecular weight of the substance.**
- **Surface Area of the membrane.**
- **Concentration Difference of the substances.**
- **Electrical Potential difference of the substances.**
- **Pressure Difference between the sides.**

NOTE:

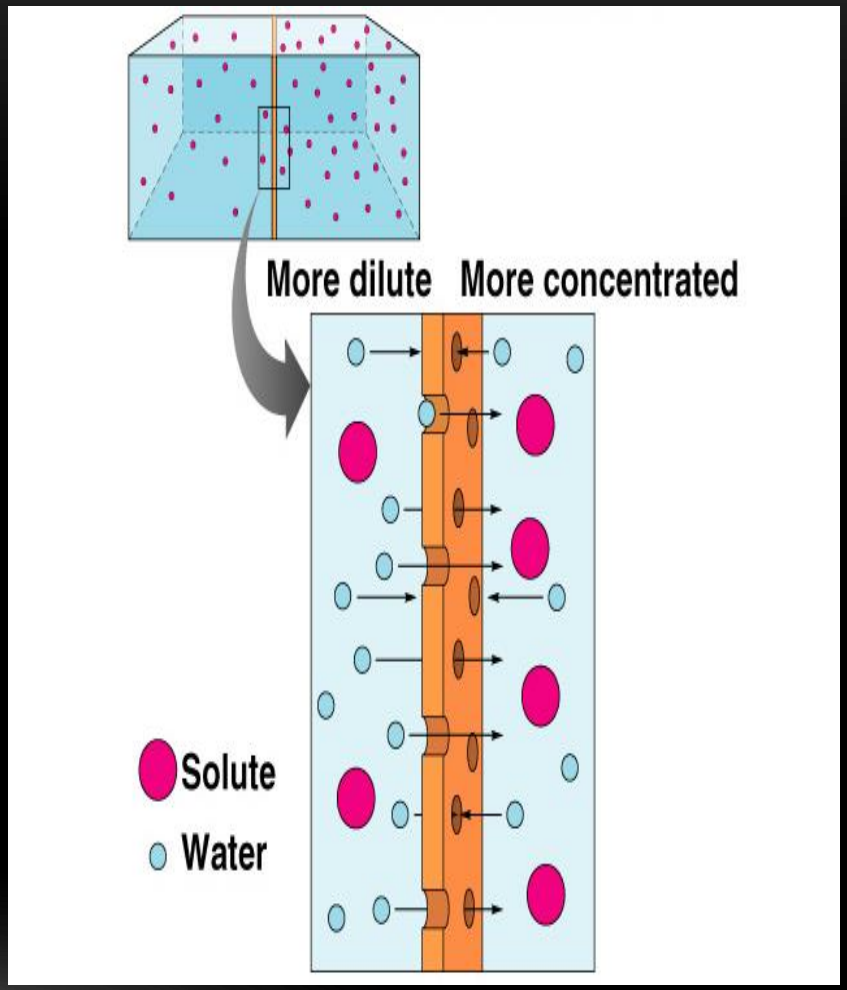
Neuronal plasma membrane is 20 x more permeable to K^+ than Na^+

Osmosis



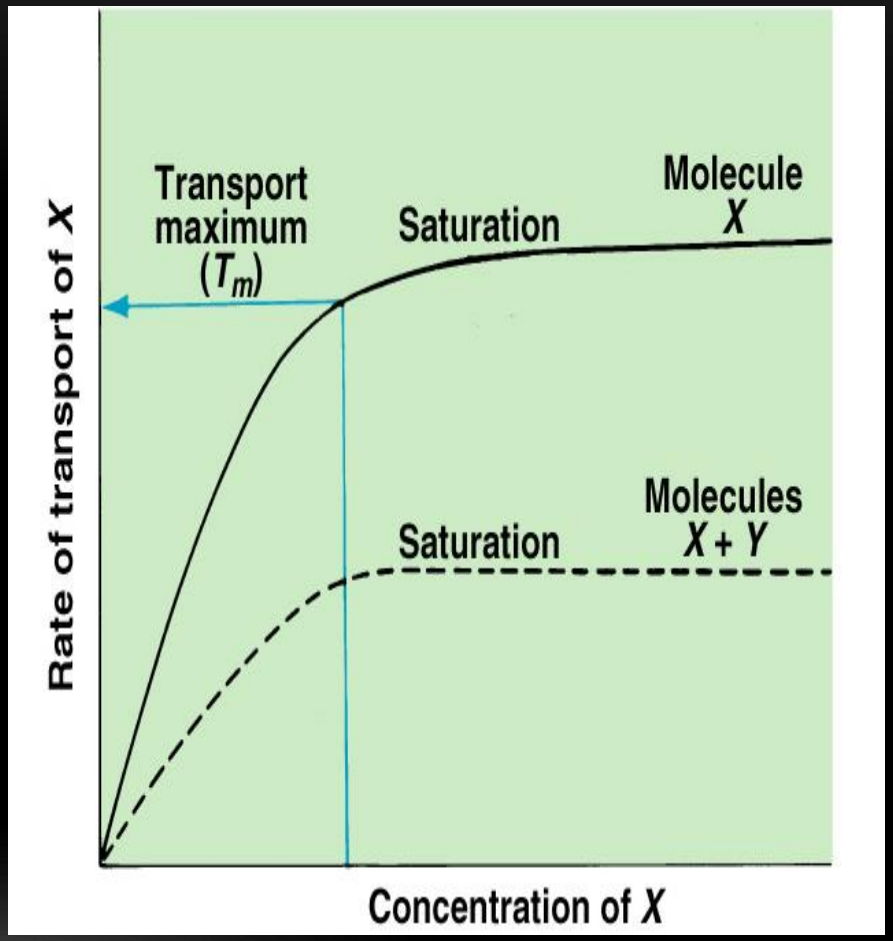
OSMOSIS

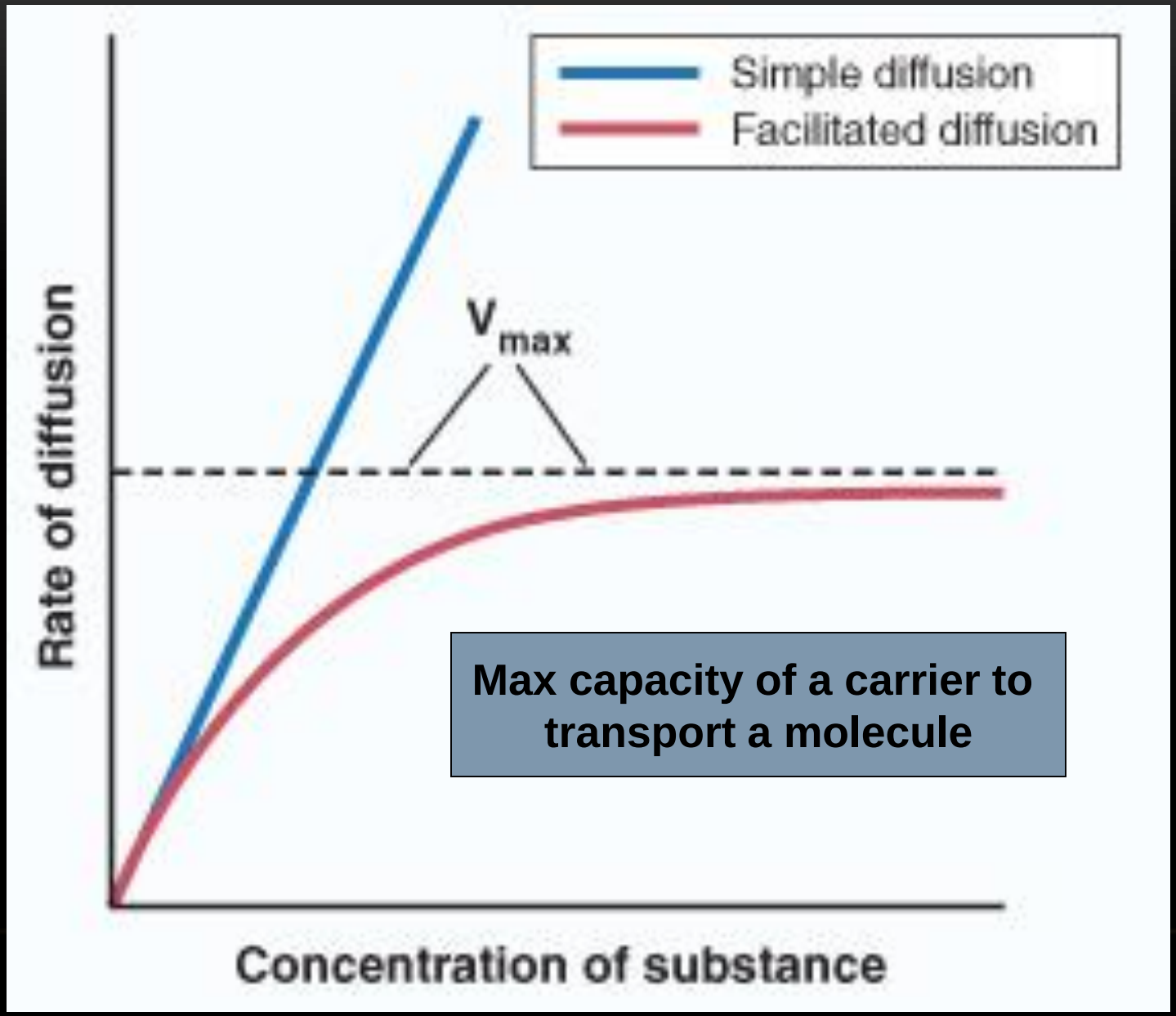
- **Net diffusion of H_20 across a selectively permeable membrane.**
- **Movement of H_20 from a high[H_20] to lower [H_20] area until equilibrium is reached.**
- **2 requirements for osmosis:**
  - **Must be difference in [solute] on the 2 sides of the membrane.**
  - **Membrane must be impermeable to the solute.**
- **Osmotically active solutes:**
  - **Solutes that cannot pass freely through the membrane.**



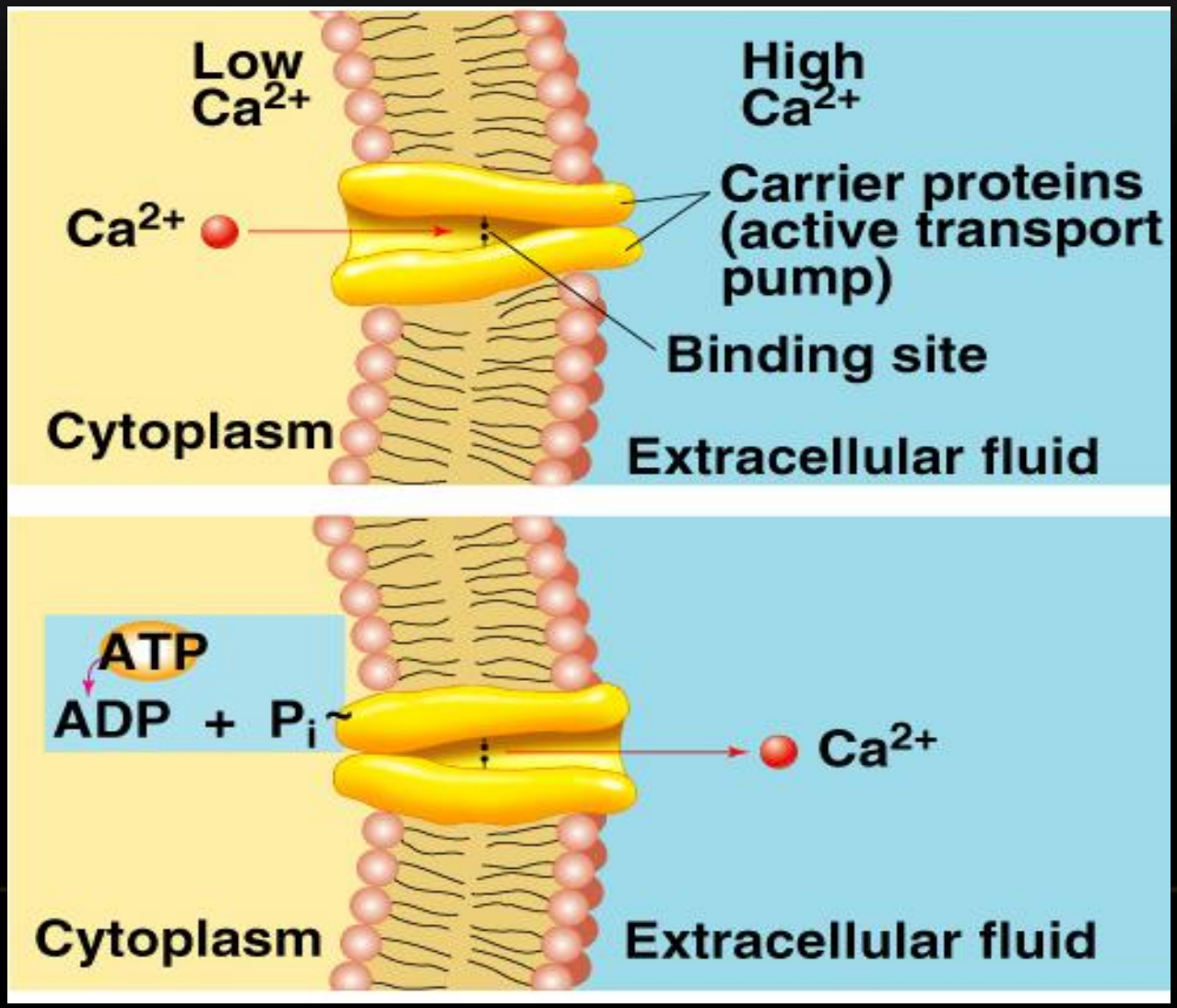
CARRIER-MEDIATED TRANSPORT

- **Molecules that are too large and polar to diffuse are transported across plasma membrane by protein carriers.**
- **Characteristics of protein carriers:**
  - **Specificity:**
    - **Interact with specific molecule only.**
  - **Competition:**
    - **Molecules with similar chemical structures compete for carrier site.**
  - **Saturation:**
    - **T_m (transport maximum):**
    - **Carrier sites have become saturated.**



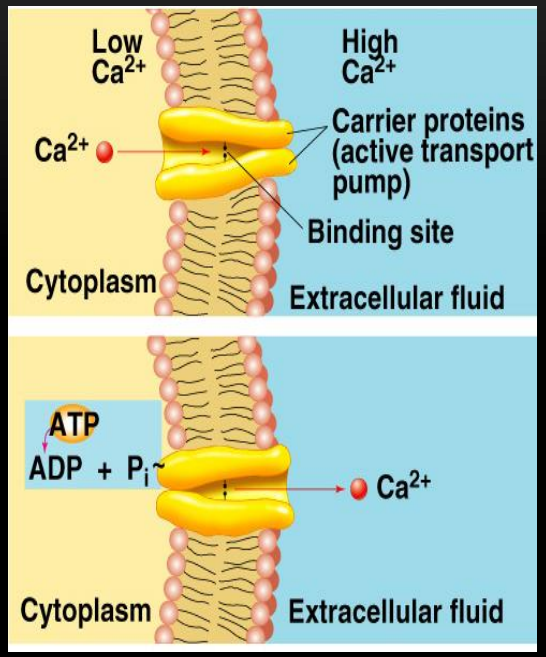

Simple diffusion
Facilitated diffusion
V_{max}
Rate of diffusion
Concentration of substance
Max capacity of a carrier to transport a molecule

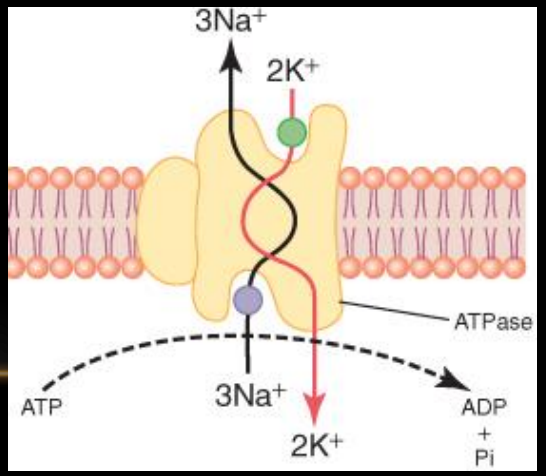
Primary Active Transport



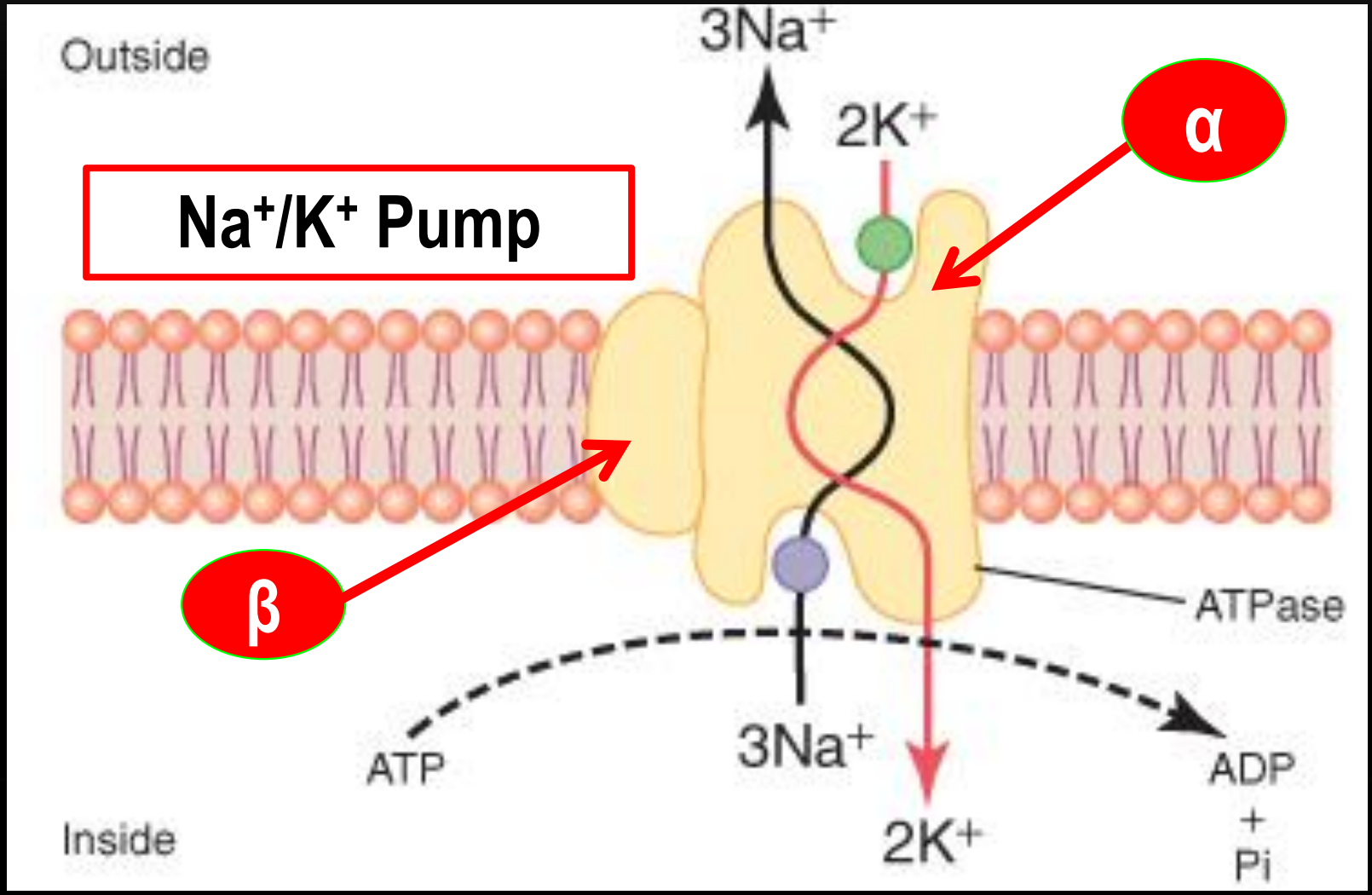
PRIMARY ACTIVE TRANSPORT

- **Hydrolysis of ATP directly required for the function of the pump.**
- **Molecule or ion binds to "recognition site" on one side of pump.**
- **Binding stimulates phosphorylation (breakdown of ATP) of carrier protein.**
- **Carrier protein undergoes conformational change.**
- **Hinge-like motion releases transported molecules to opposite side of membrane.**



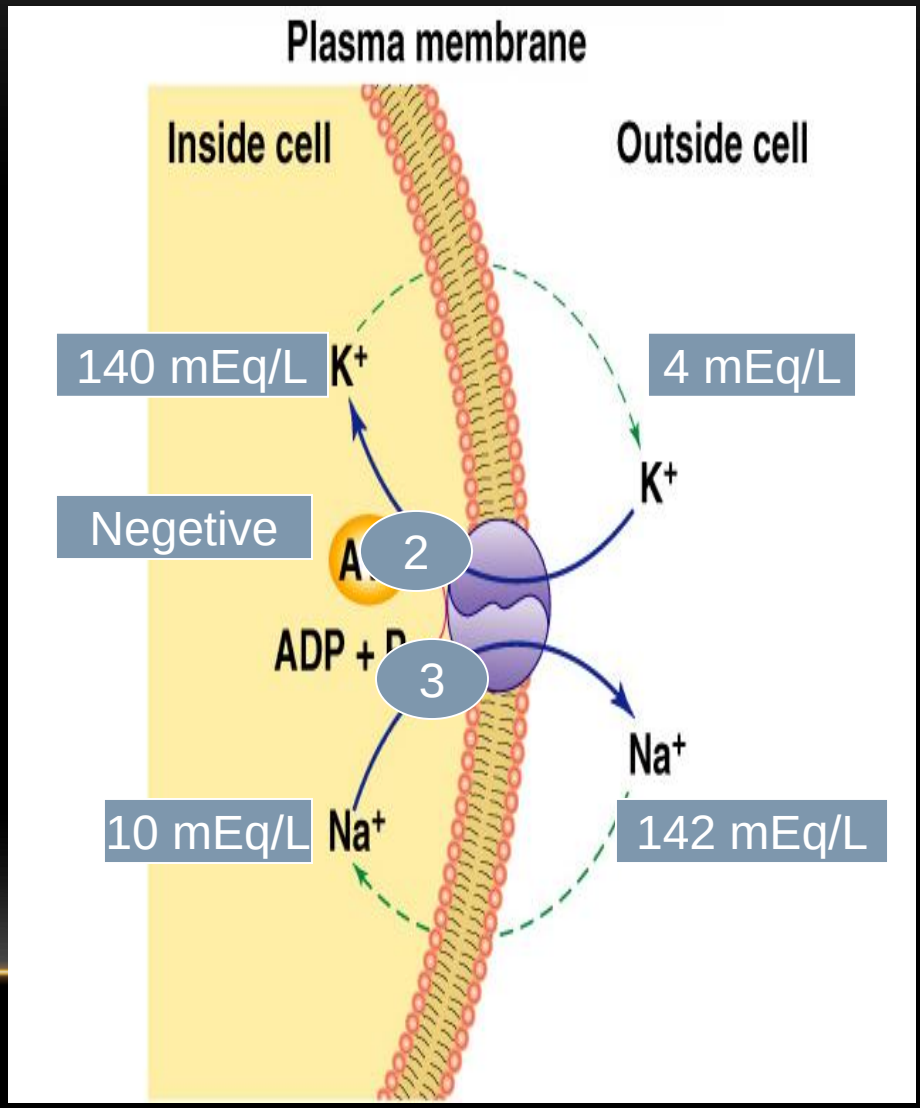


Primary Active Transport

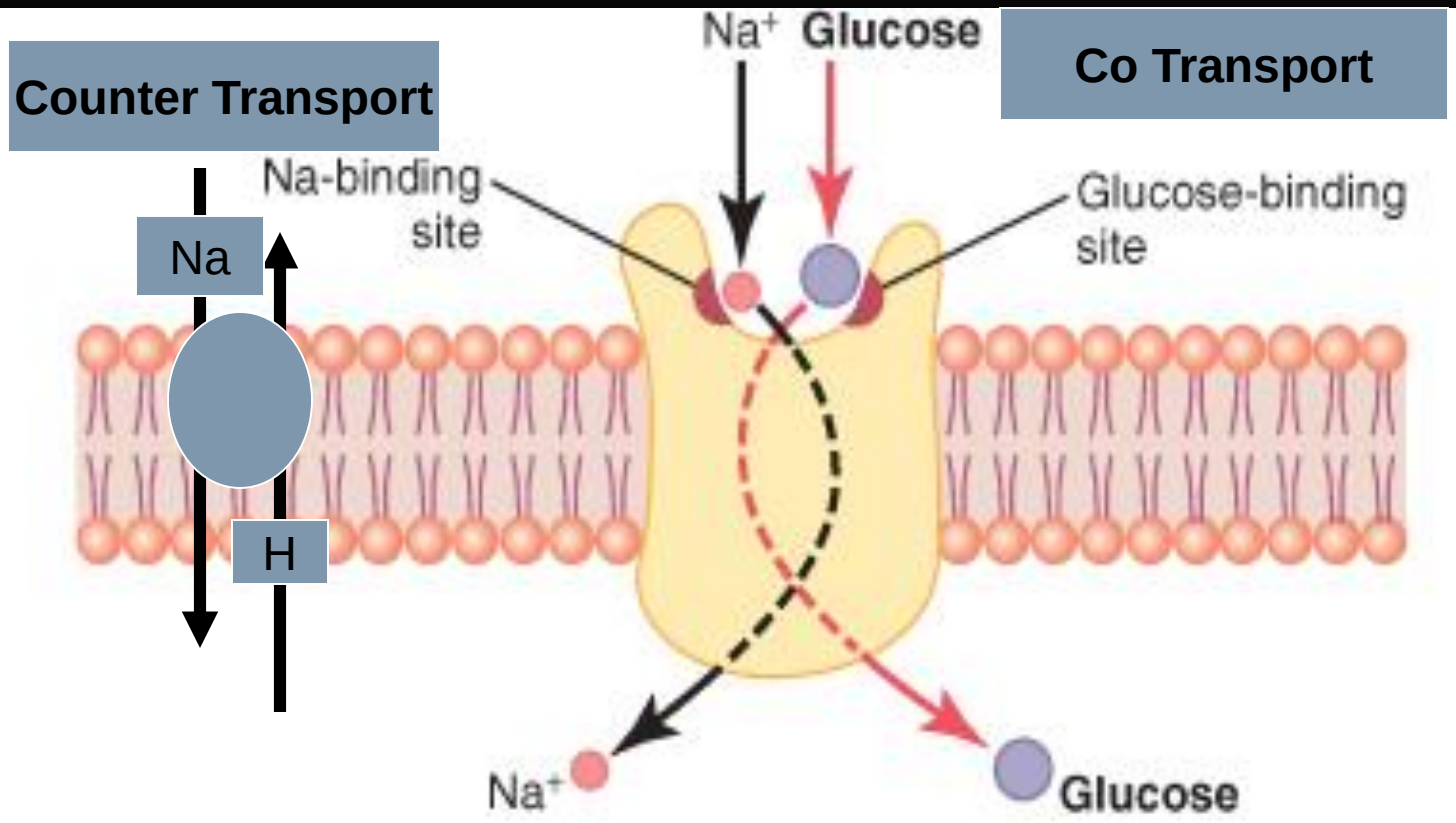


NA^+/K^+ PUMP

- **Carrier protein is also an ATP enzyme that converts ATP to ADP and Pi.**
  - **Actively extrudes 3 Na^+ and transports**
  - **2 K^+ inward against concentration gradient.**
- **Steep gradient serves 4 functions:**
  - **Provides energy for "coupled transport" of other molecules.**
  - **Regulates resting calorie expenditure and BMR.**
  - **Involvement in electrochemical impulses.**
  - **Promotes osmotic flow.**



Secondary Active Transport

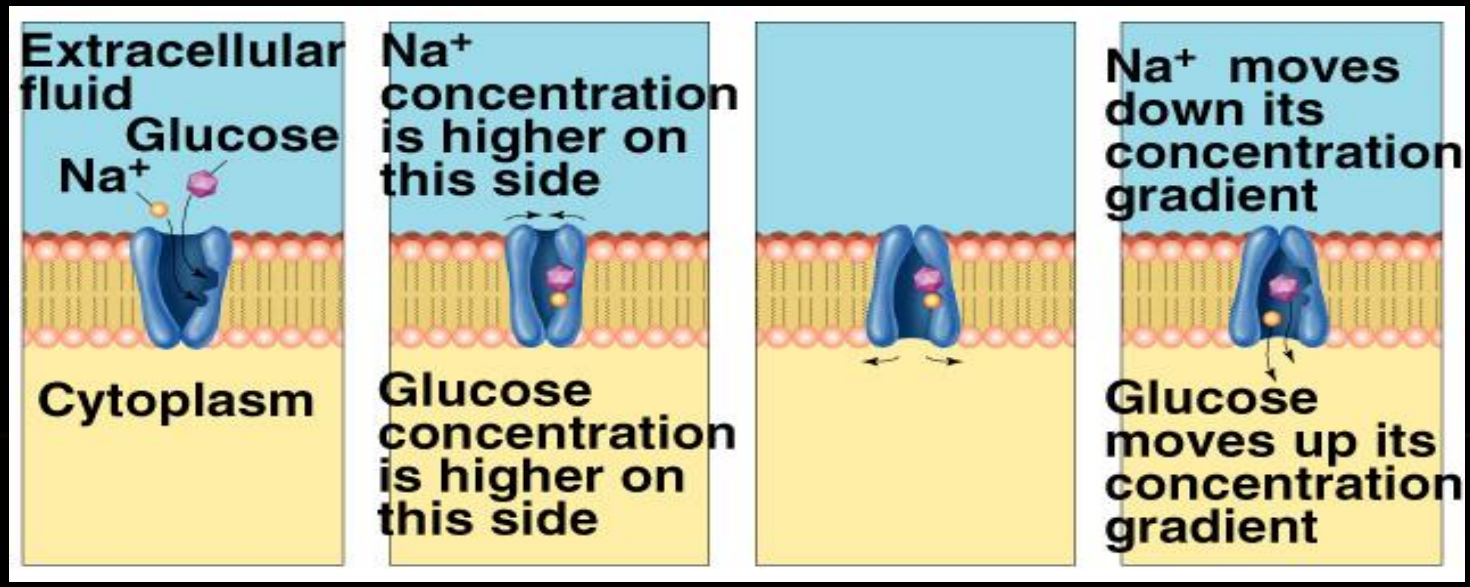


SECONDARY ACTIVE TRANSPORT

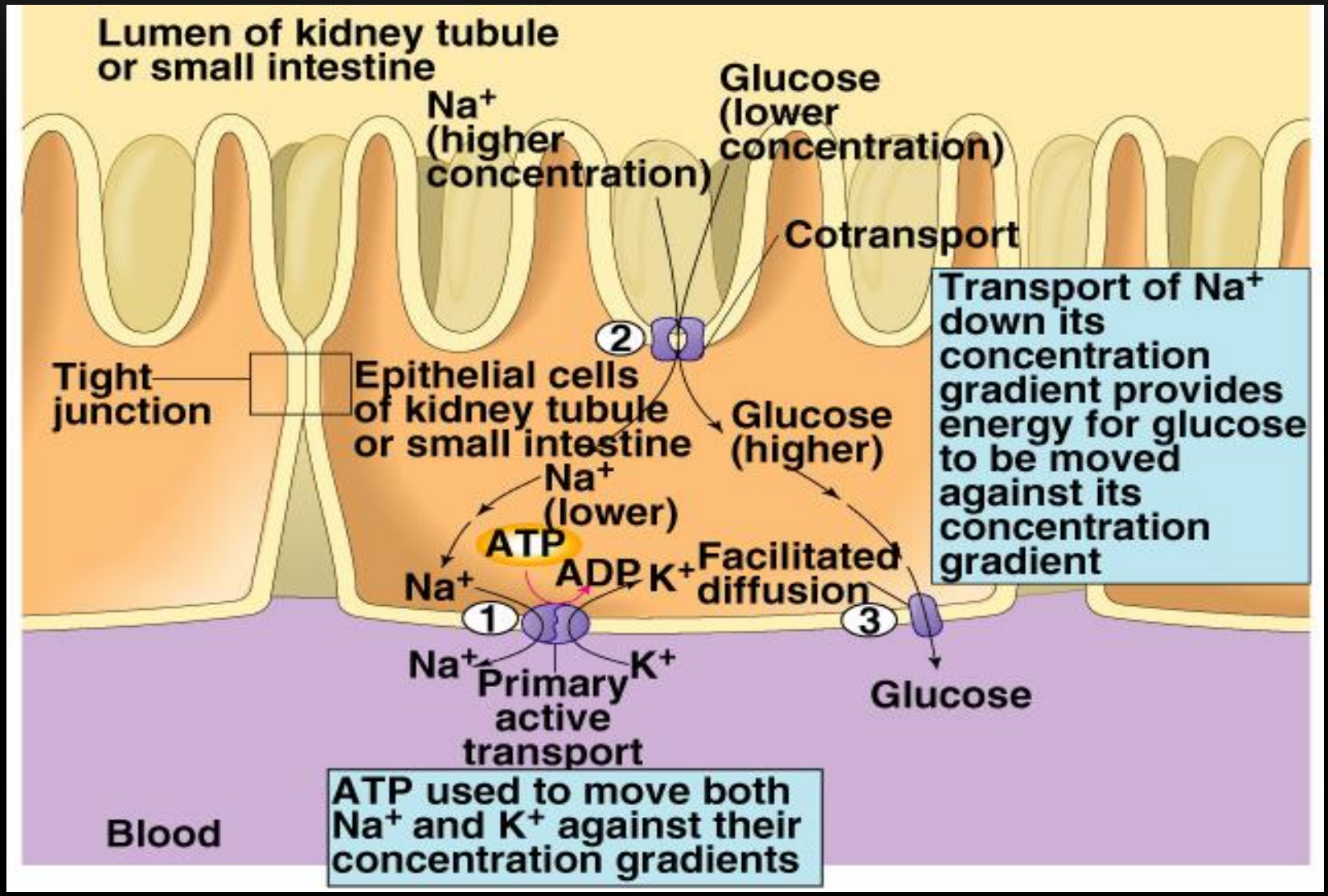
- **Co-transport (symport):**
  - **Molecule or ion moving in the same direction as Na^+.**
- **Counter-transport (antiport):**
  - **Molecule or ion moving in the opposite direction of Na^+.**
- **Glucose transport is an example of:**
  - **Co-transport.**
  - **Facilitated diffusion.**

Secondary Active Transport

- **Coupled transport.**
- **Energy needed for "uphill" movement obtained from "downhill" transport of Na^+.**
- **Hydrolysis of ATP by Na^+/K^+ pump required indirectly to maintain [Na^+] gradient.**

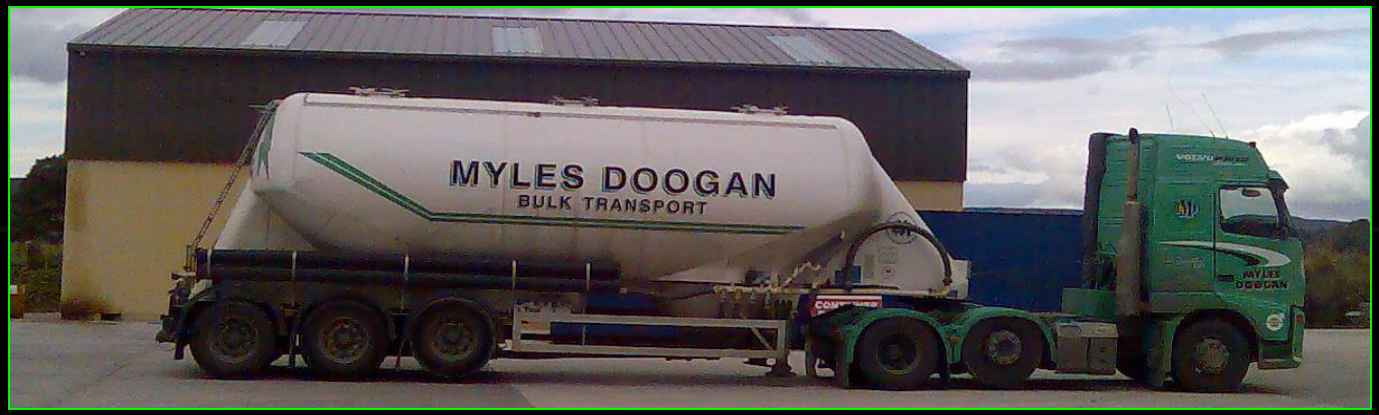


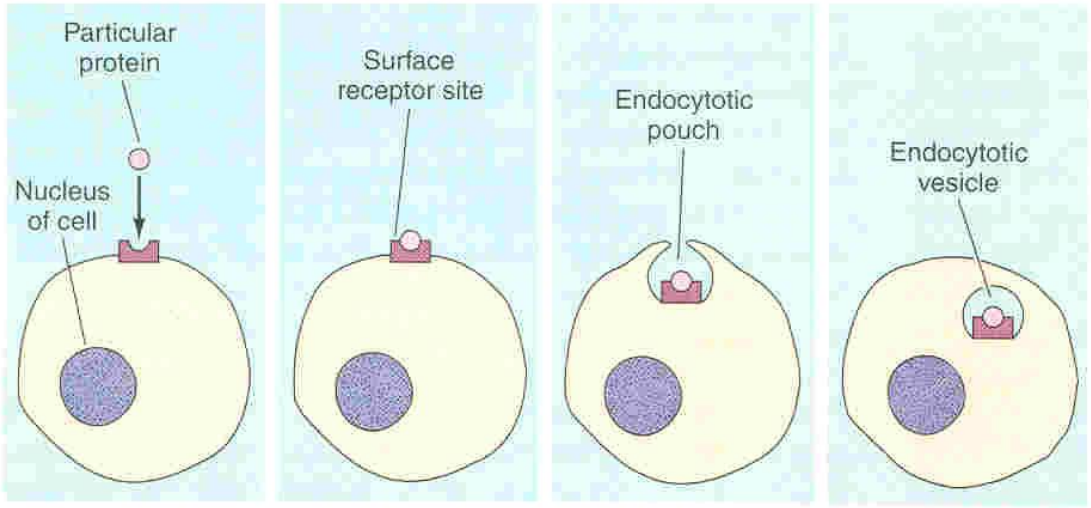
SECONDARY ACTIVE TRANSPORT (CONT…)



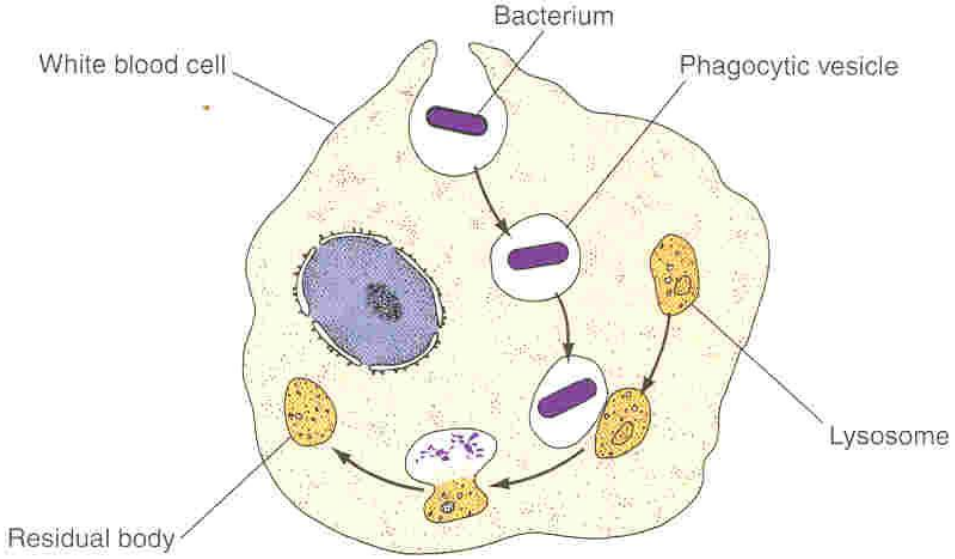
BULK TRANSPORT

- **Movement of many large molecules, that cannot be transported by carriers, at the same time.**
- **Exocytosis:**
  - **Fusion of the membrane-bound vesicles that contains cellular products with the plasma membrane.**
- **Endocytosis:**
  - **Exocytosis in reverse.**
  - **Specific molecules can be taken into the cell because of the interaction of the molecule and protein receptor.**

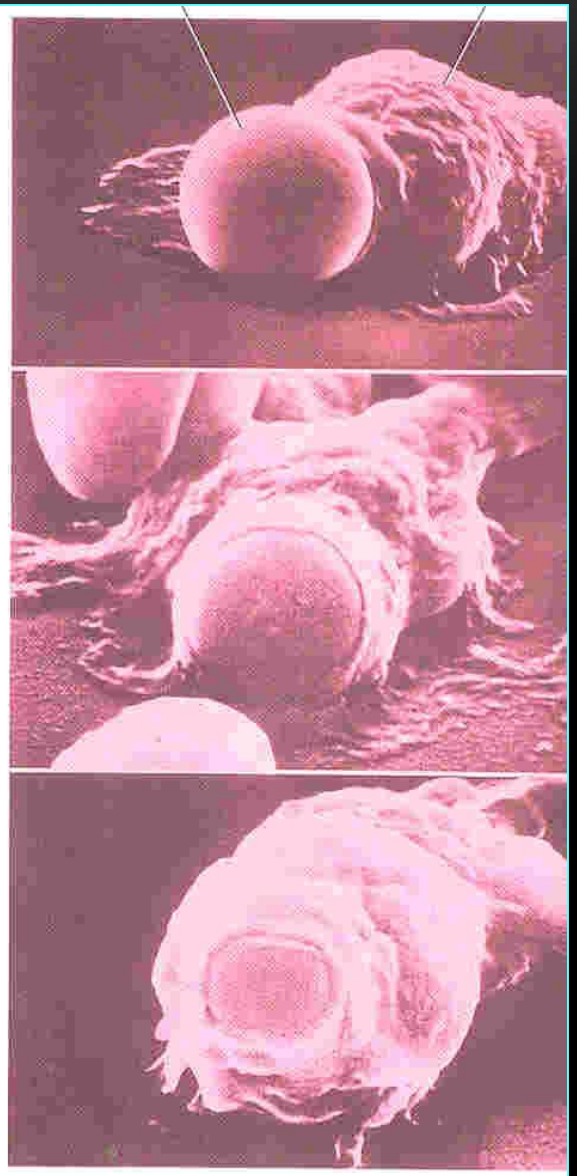




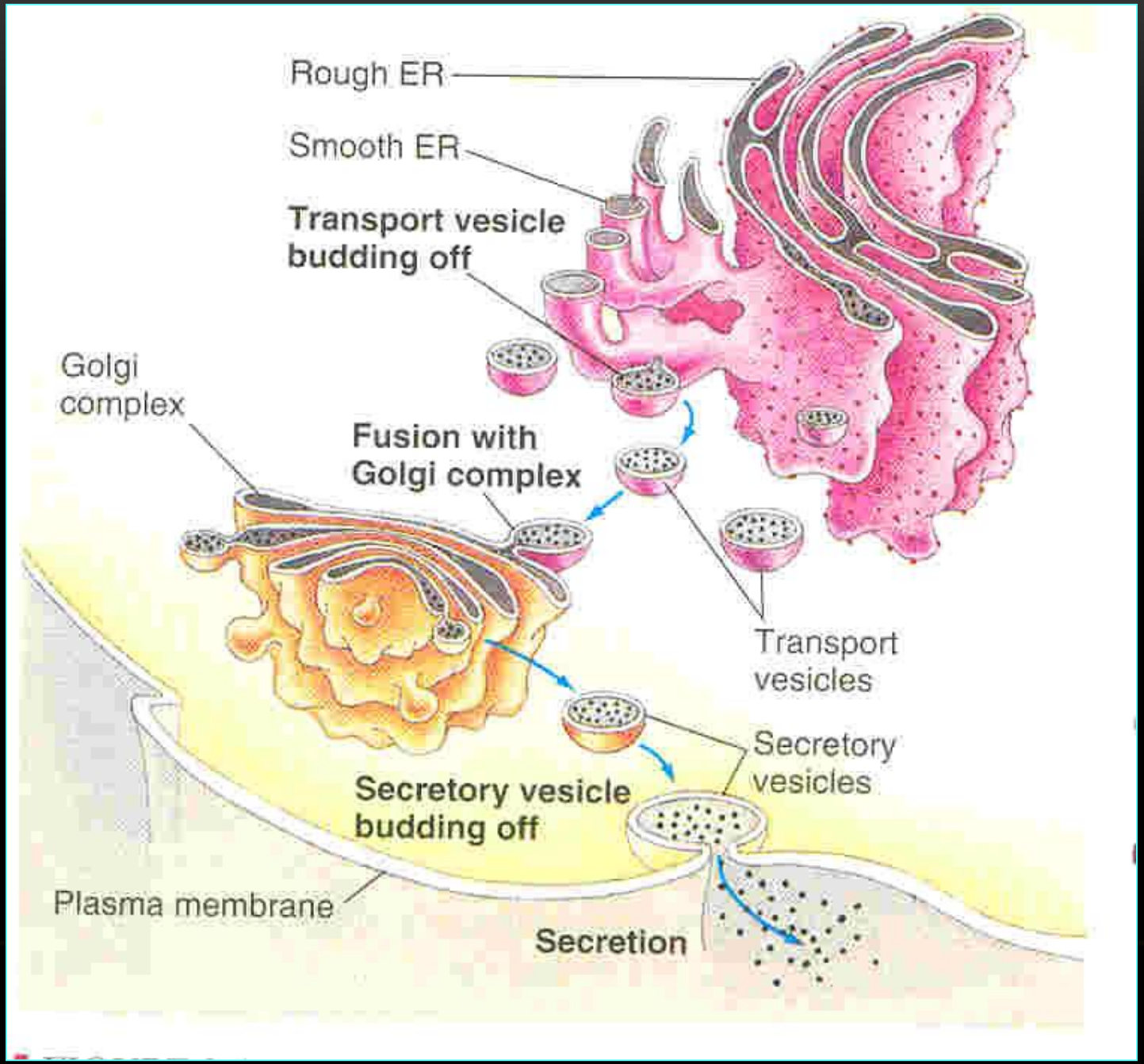
(a) Receptor-mediated endocytosis

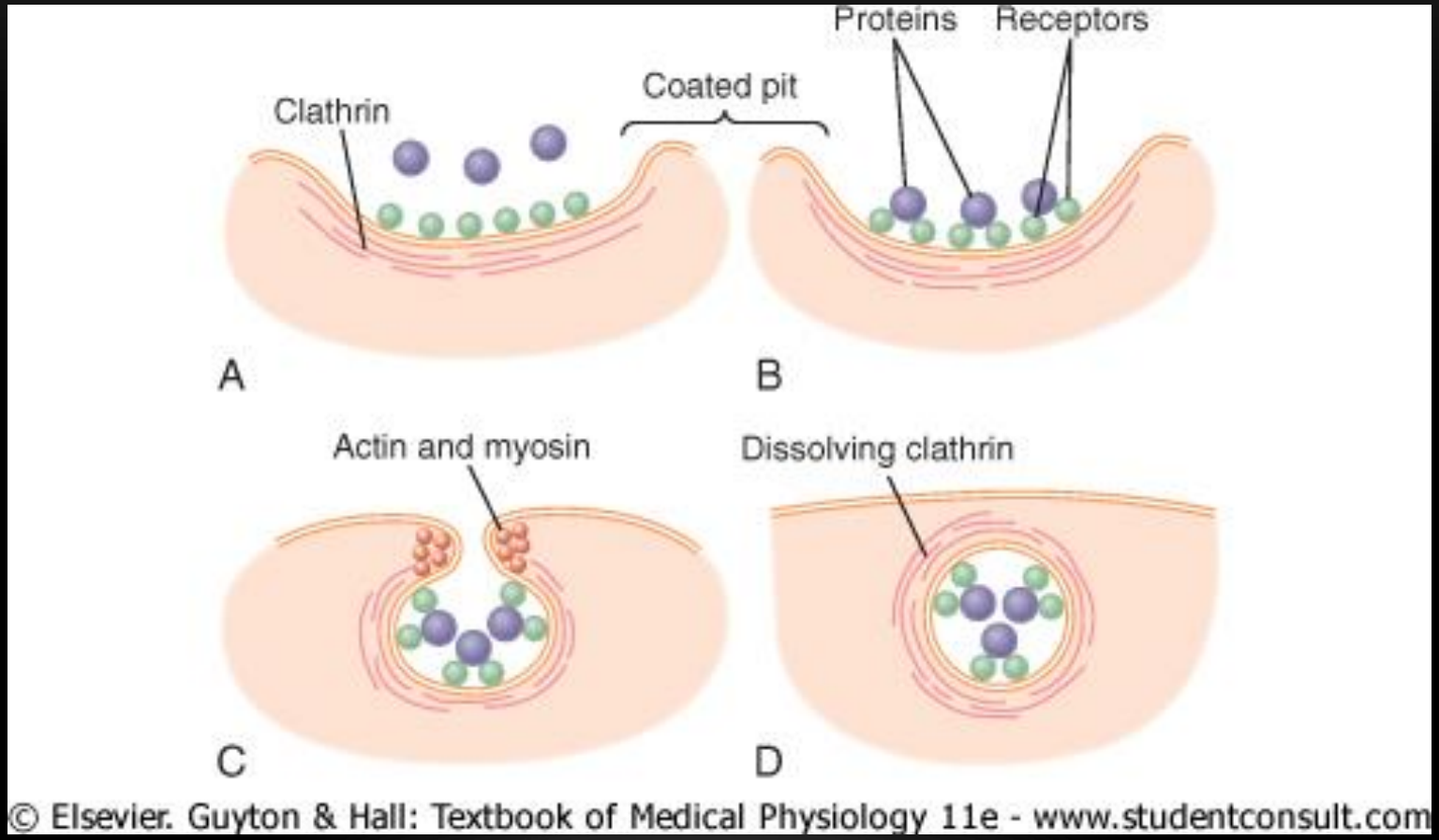


(b) Phagocytosis



(c)


Rough ER
Smooth ER
Transport vesicle budding off
Golgi complex
Fusion with Golgi complex
Transport vesicles
Secretory vesicles
Secretory vesicle budding off
Plasma membrane
Secretion


Proteins
Receptors
Coated pit
Clathrin
A
B
Actin and myosin
Dissolving clathrin
C
D
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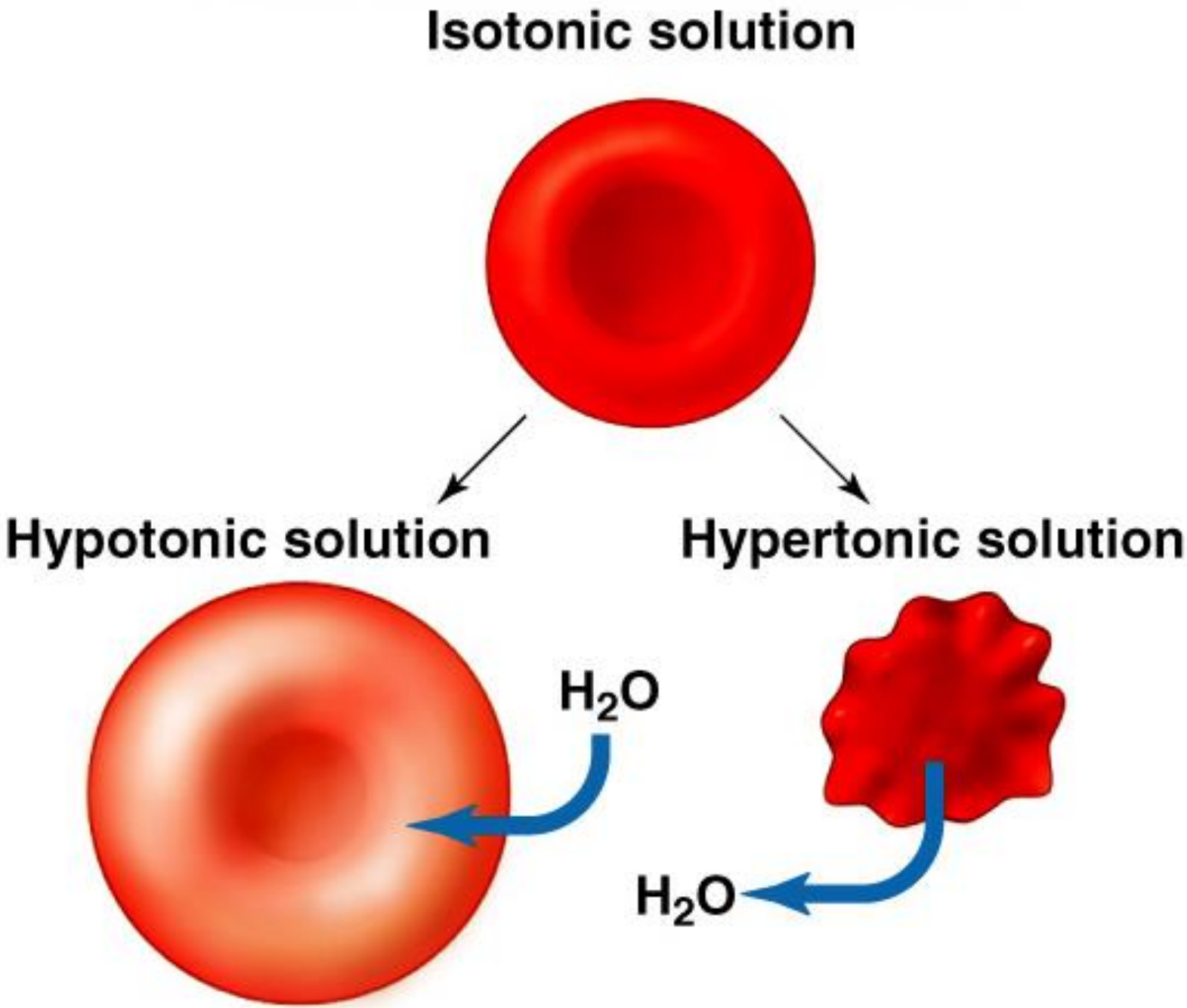
TONICITY AND ITS EFFECT ON MOVEMENT OF H_20

- **Isotonic:**
  - **Equal tonicity osmolality (300 mosm/l) to plasma.**
    - **RBCs will not gain or lose H_20.**
- **Hypotonic:**
  - **Osmotically active solutes in a lower osmolality and osmotic pressure than plasma.**
    - **RBC will hemolyse.**
- **Hypertonic:**
  - **Osmotically active solutes in a higher osmolality and osmotic pressure than plasma.**
    - **RBC will crenate.**

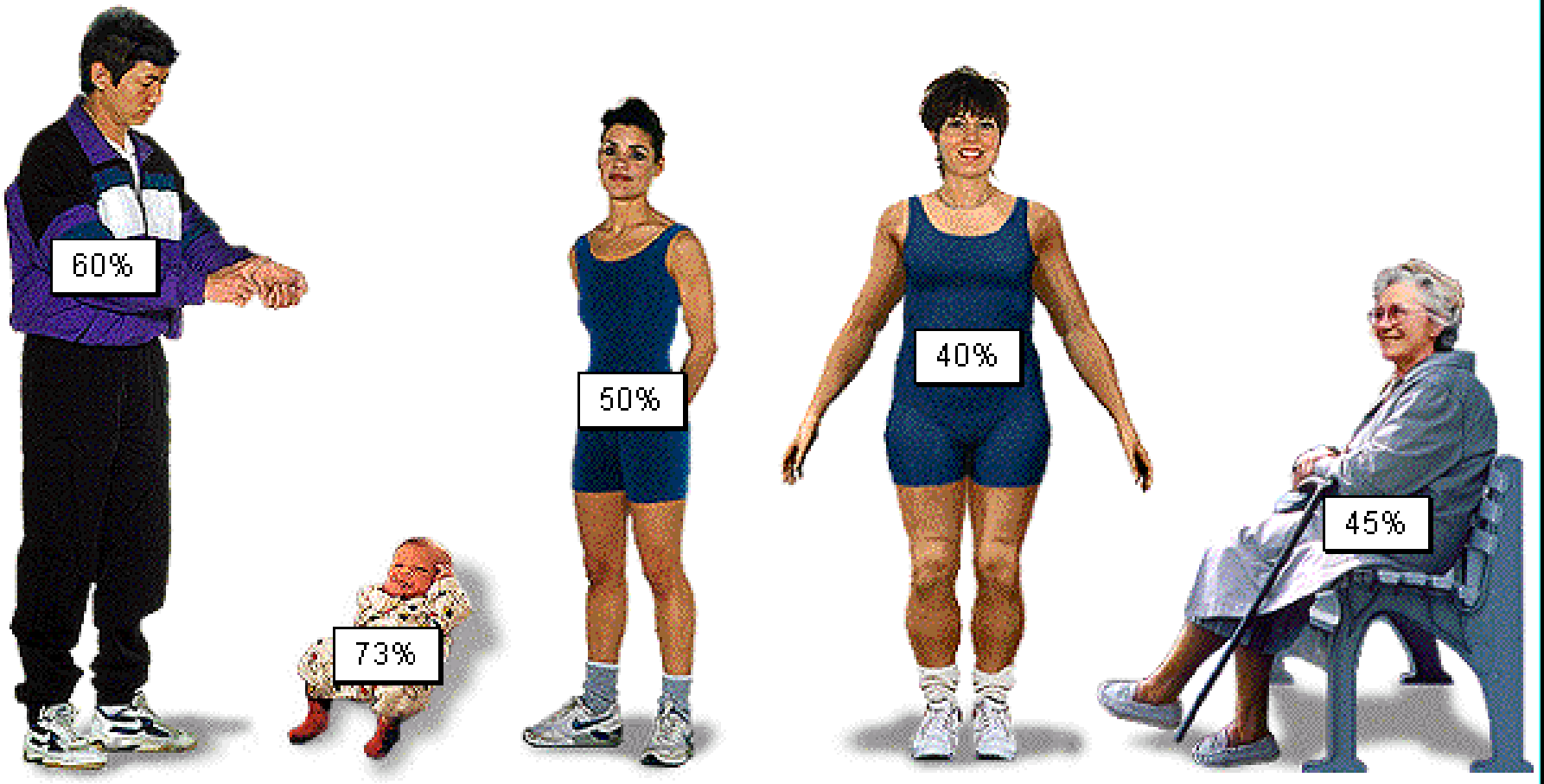

Isotonic solution
Hypotonic solution
Hypertonic solution
H_2O
H_2O

TRANSPORT ACROSS EPITHELIAL MEMBRANES

- **In order for a molecule or ion to move from the external environment into the blood, it must first pass through an epithelial membrane.**
  - **Absorption:**
    - **Transport of digestion products across the intestinal epithelium into the blood.**
  - **Reabsorption:**
    - **Transport of molecules out of the urinary filtrate back into the blood.**
  - **Transcellular transport:**
    - **Moves material through the cytoplasm of the epithelial cells.**
  - **Paracellular transport:**
    - **Diffusion and osmosis through the tiny spaces between epithelial cells.**

Percentage of Water in the Body

Click each of the people below to determine the approximate percentage of water in their bodies.



FACTORS AFFECTING

Total Body Water varies depending on body fat:

- infant: 73%
- male adult: 60%
- female adult: 40-50%
- effects of obesity
- Old age 45%

DEHYDRATION

- What are the common causes of dehydration?
- What are the common clinical features of dehydration?
- How is dehydration classified?

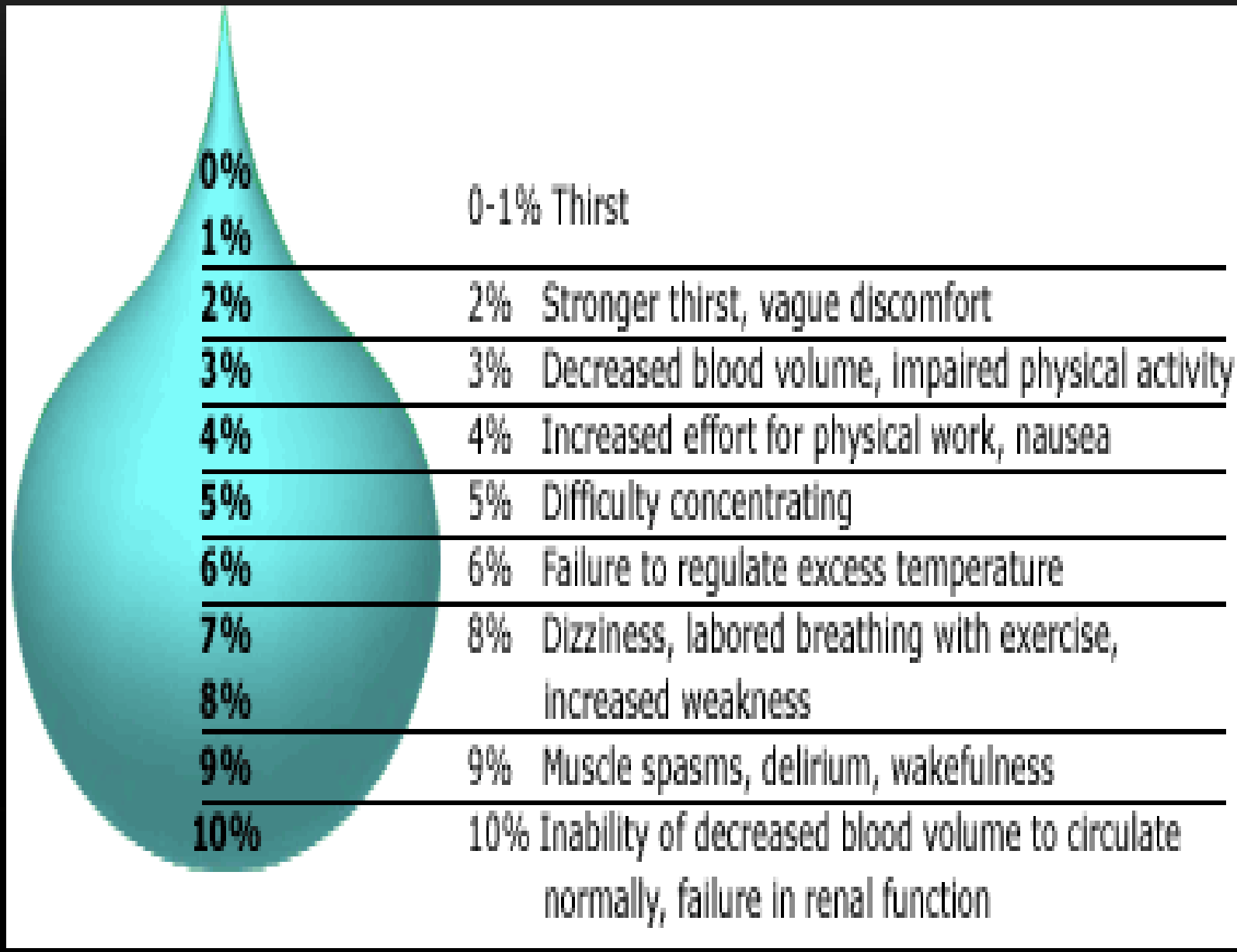
Are you dehydrated?

Check your urine

Sign and Symptoms of Dehydration

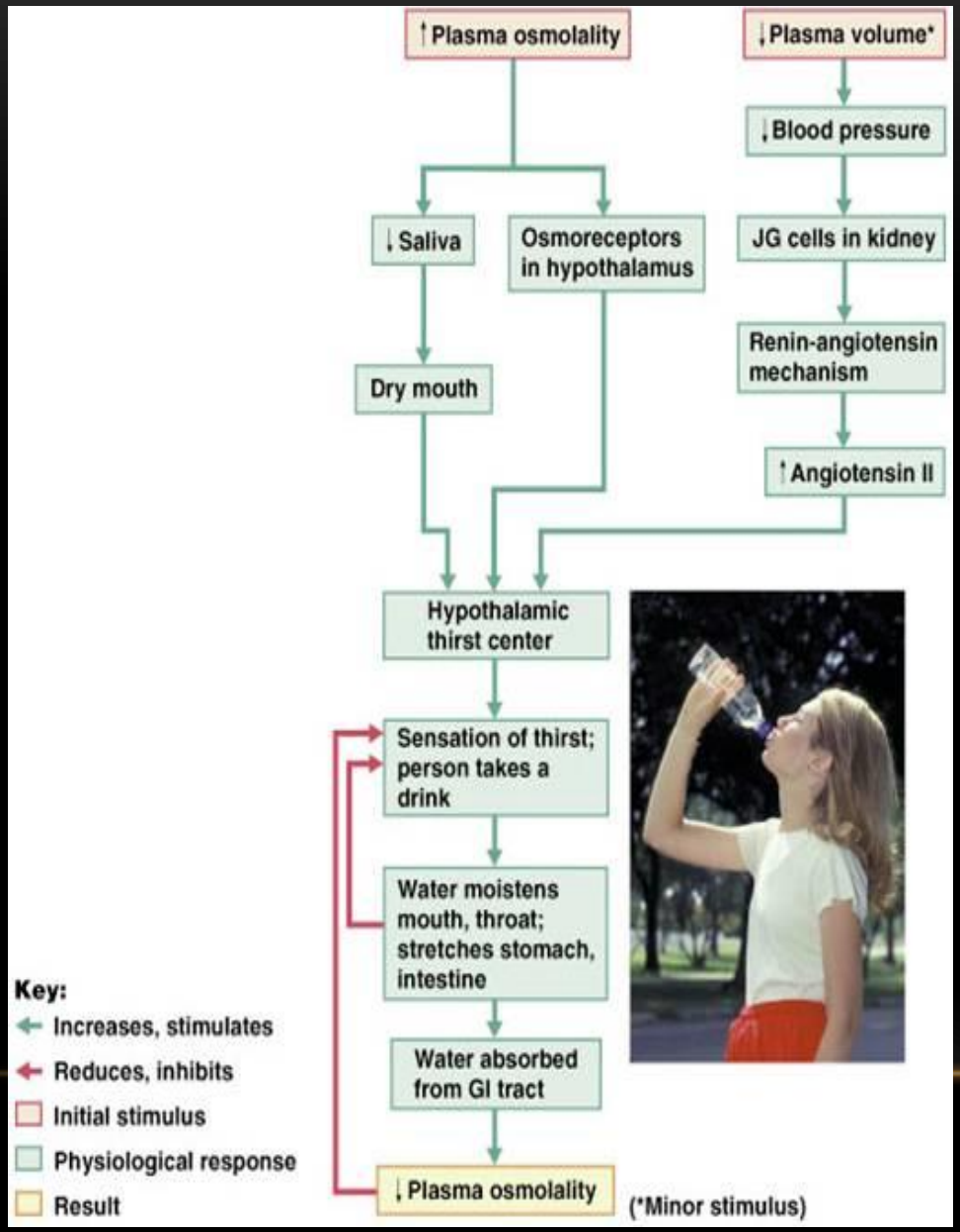
- Dry or sticky mouth
- Lethargy
- Sunken eyes
- Weight loss
- Low or no urine input
- Dark yellow urine
- Poor skin turgor
- Delayed capillary refill
- Dizziness
- Confusion/changes in mental status
- Lack of tears/sweat
- Falls/difficulty walking
- Low blood pressure
- Rapid heart rate
- Abnormal labs/electrolytes

SYMPTOMOLOGY OF DEHYDRATION



MANAGEMENT OF DEHYDRATION

- What are the different methods used for rehydration?
  - Volume replacement
  - Electrolyte replacement
- What are the substances used for rehydration?
  - Uses of Isotonic, Hypotonic and Hypertonic solution


↑Plasma osmolality
↓Plasma volume*
↓Blood pressure
↓Saliva
Osmoreceptors in hypothalamus
JG cells in kidney
Renin-angiotensin mechanism
Dry mouth
↑Angiotensin II
Hypothalamic thirst center
Sensation of thirst; person takes a drink
Water moistens mouth, throat; stretches stomach, intestine
Water absorbed from GI tract
↓Plasma osmolality
(*Minor stimulus)
Key:
Increases, stimulates
Reduces, inhibits
Initial stimulus
Physiological response
Result

Home Remedies for Dehydration

Increase Your Water Intake

Homemade ORS

Watery Fruits and Vegetables

Yogurt

Banana

Coconut Water

Additional Tips

- Rest in a cool place and avoid any further exertion.
- During dehydration, stick to bland foods for a couple of days.
- To prevent dehydration, take a refillable water bottle with you when going out.

To explore more, visit

Top 10 Home Remedies

www.Top10HomeRemedies.com

THANK YOU