HANDWRITTEN NOTES

DAMS

PHYSIOLOGY

CRISP, CONCISE, CONCEPTUAL

Integrated Edition

Student first @DAMS

DAMS Publications

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Delhi Academy of Medical Sciences (P.) Ltd.
House No.: 3, Green Park,
New Delhi-110 016
Phone : 011-4009 4009, 9899664533
http://www.damsdelhi.com
Email: info@damsdelhi.com

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HOW TO MAKE BEST USE OF NOTES?

A Message by Mentor Duo Specially for you,

- *Read the notes thoroughly, they are absolutely concise, crisp & conceptual and hence it is best advised not to add a lot of extra information to them as that will dilute the quality.*
- *Images have been provided alongside to aid in better understanding and also help you solve image-based questions, these images have been specially picked by the faculty so have a high probability of being asked in exams.*
- *Notes are handwritten in a way to help make them easier to retain, a lot of tables, graphs and algorithms have been used to simplify the learning.*
- *While reading notes try and use the CFAQ technique —*
  - *A. Use the C to denote concept part in the notes and ensure you are clear with this part in the first go if not then it's advisable to listen to this part of the video from your course.*
  - *B. Use the F To denotes facts in your notes, it is okay if you can't remember them in first go but will need repeat reading. But these facts are important for exams as they could be integrated to clinical questions.*
  - *C. Use A to denote applied parts, this is how concepts and facts are asked indirectly in exams. This will also help you develop MCQ solving skill.*
  - *D. Use Q to denote areas where faculty has said it's a direct question or a PYQ or a potential question.*
- *This technique will help you summarize your notes In way that your second reading will become easy and faster.*
- *Active space has been provided with these notes to make your own annotations alongside and this will help you maintain one single notebook for one subject.*
- *Try and solve MCQs with every topic from DQB. Your goal should be to start with at least 30 MCQs every day and then increase to at least 50 MCQs every day. Also, when you do a topic wrong write it alongside the notes that this topic needs to be read again but mark only the specific area that you have done wrong not the whole topic.*
- *After the topic is covered then in the active space try and summarize the topic in the form of mind map. This will help in active recall and make your revision easier.*

Best Wishes & Happy Learning!!!!!

INDEX

PHYSIOLOGY

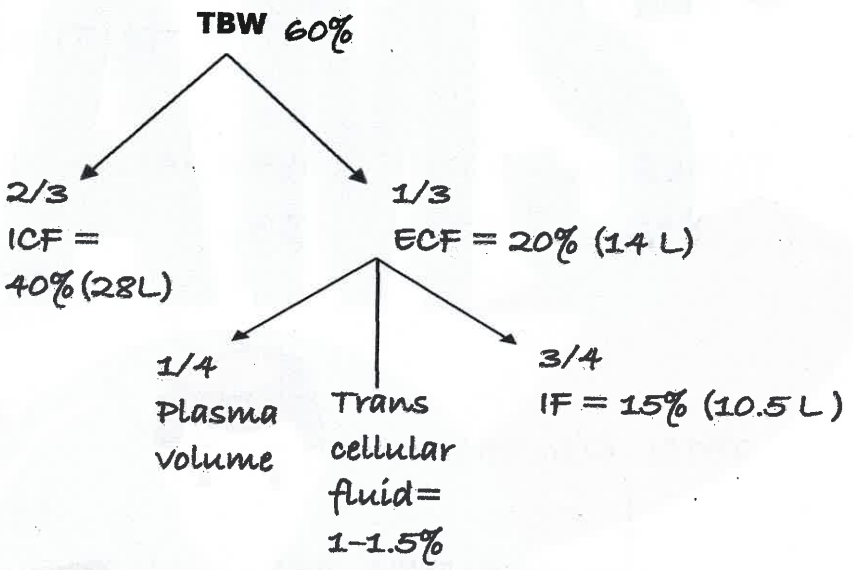
1. General Physiology

Body Composition: Measurement Value as % of Body weight

Water	60%* TBW
Proteins	18%
Fats	15%
Minerals	6%
Glycogen	1%

male= 60%
Females = 50% due to high fat
Infant = 70% due to low fat

Distribution of Total Body Water



Measurement of the various body fluid compartments

Dye Dilution Method or Principle of volume distribution of body fluids

This is done by the dye dilution technique or the principle of volume of distribution. A known quantity of a suitable dye/ indicator is added to an unknown volume. After equilibration a sample is withdrawn and the concentration of the indicator/ dye is measured in the sample. The volume of the fluid compartment is measured by using the following:-

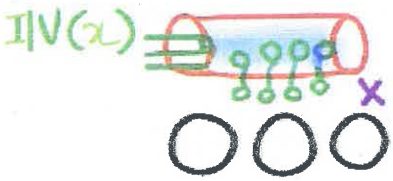
$V = \frac{Q-e}{C}$ where

V = volume

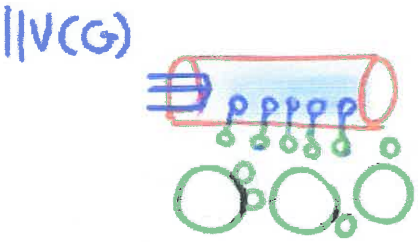
Q = quantity of indicator given

C = concentration of the indicator

e = the amount of indicator which has either been lost or metabolized

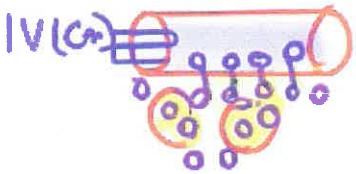


PLASMA-VOL — EVANS BLUE & RADIO-IODINE LABELLED S-ALBUMIN



ECF

- S → SUCROSE
- I → INULIN
- Ma → MANNITOL
- Na → RADIOACTIVE Nx
  - Na THIOSULFATE
  - Na Thiocyanate



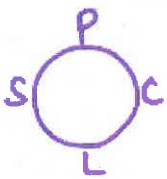
TBW

- D → DEUTERIUM OXIDE
- A → AMINO/ANTI PYRINE
- T → TRITIUM OXIDE

TOTAL BLOOD VOL = PLASMA-VOL + RBC-VOL

8% (TBV) 3% 3%

TRACING OF RBC



51Cr
32P
59Fe

TOTAL BLD-VOL → PLASMA VOL × $\frac{ICF}{(100 - HCT)}$

HEMATOCRIT IS VOL OF PACKED RBC

① ♂ 60 Kg CALCULATE TBV GIVEN HCT IS 40%

$$3 \times \frac{100}{100-40} = \frac{300}{60} = 5\ L$$

Mole (or mol)

Definition: It is ***molecular weight*** of a substance ***in grams*** i.e. it is gram molecular weight.

Example:

a) Calcium → Molecular weight = 40; therefore, 40 gm = 1 mol of calcium

b) NaCl → Atomic weight of Na = 23 and that of Cl = 35.5
Therefore, 23+35.5 = 58.5 gm of NaCl = 1 **mol** of NaCl

Note: In S.I. system, mole is the standard used to express amount of any substance
Millimole is 1/1000 of a mole. 58.5 mg of NaCl = 1 mmol

Equivalent (Eq.)

$$1 \text{ Equivalent} = \frac{\text{Molecular weight of substance}}{\text{valency}}$$

Example: 1EQ of sodium = $\frac{23\ g}{1}$ 1EQ of calcium = $\frac{40\ g}{2} = 20\ g$

Osmole

$$1 \text{ osmole} = \frac{1 \text{ mole}}{\text{Number of freely dissociable particles liberated in solution}}$$

Examples:	
1 mole of NaCl	2 osmoles of sodium chloride
1 mole of $CaCl_2$	3 Osmoles of calcium chloride
1 mole of Glucose	1 osmole of glucose
1 mole of albumin	1 osmole of Albumin

Osmolarity and Osmolality:

Osmolarity is the number of osmoles or milliosmoles ***per litre*** of solution.

Osmolality is the number of osmoles or milliosmoles ***per kg of solvent.*** Osmolality is not affected by presence of other solutes in solution or by temperature.

Plasma Osmolality

Normal plasma osmolality is 290 milliosmoles/L (280-290 milliosmoles/L).
Out of the 290 mosm,

1) Na^+ and its associated ions (Cl & HCO_3^-) Maximum	270
2) Urea	5
3) Glucose	5
4) Remaining ions	8
5) Plasma proteins Minimum	Only 2

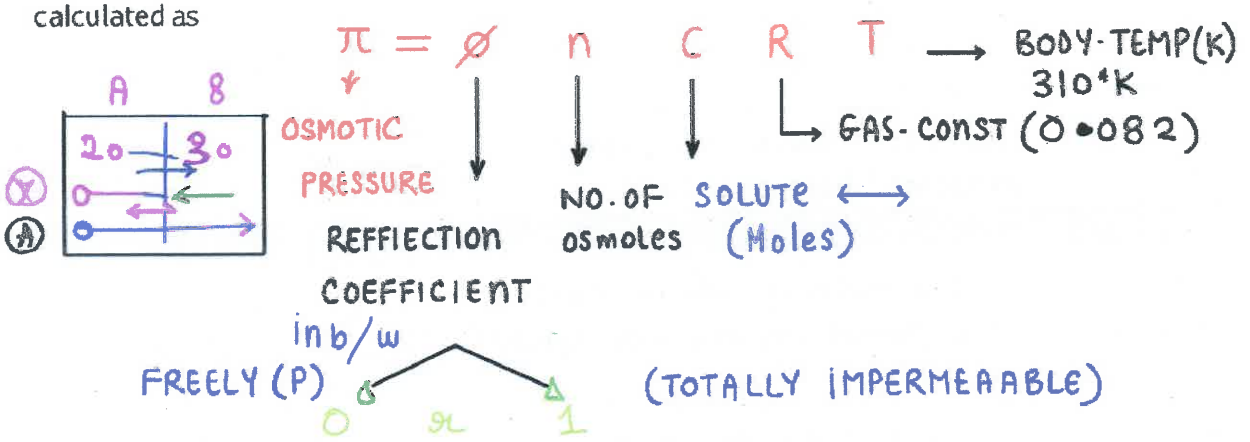
Approximate formula for finding the Plasma Osmolality:

Plasma osmolality (in mOsm/L)
= 2 [Na^+ + K^+concentration (in mmol/L)] + Glucose (mmol/L) + BUN (mmol/L)

Plasma osmolality (in mOsm/L)
= 2 [Na^+ + K^+concentration (in mEq/l)] + glucose(mg/dL)/18 + BUN (mg/dL)/2.8

Osmotic Pressure

- Osmosis of water molecules across a selectively permeable membrane can be opposed by applying a pressure in the direction opposite that of the osmosis.
- The precise amount of pressure required to prevent the osmosis or solvent migration is called osmotic pressure.
- Expressed mathematically, according to the **van't Hoff's law,** osmotic pressure (π) can be calculated as



a) CALCULATE (π) OF TOTALLY IMPERMEABLE Non-DISSOCIABLE SOLUTE = 1 Mole/L

π = ø n C C R T

= 1 x 1 x 1 x 1 x 0.082 x 310

= 25.4 atm

25.4 x 760 mmHg
19,300 mmHg

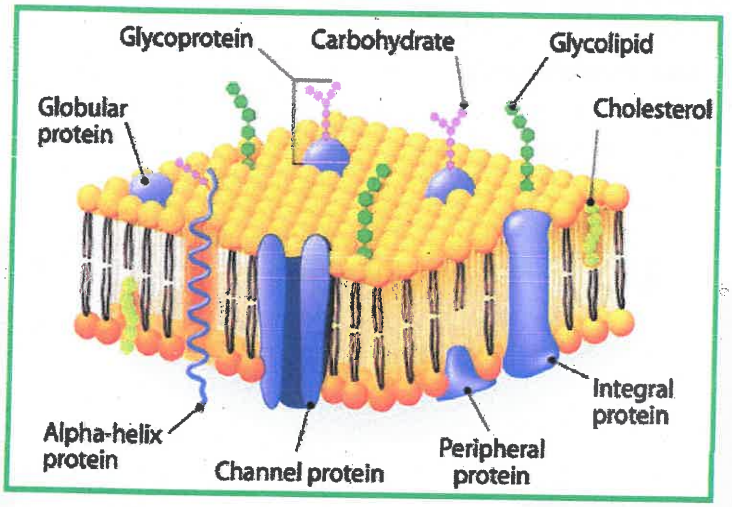
b) CALCULATE (π) OF CaCl2 SOLUTION = 1m/Mole/L (TOTALLY IMPERMEABLE)

ø n C R T
1 1 1
1 1 1 Mole / 1000

3 x 19.3 = 57.9 mmHg

Cell Membrane

Proteins= 55%
Lipids = 42%
Phospholipids
Cholesterol
Carbohydrates = 3%
Glycoproteins
Glycolipids



Fluid Mosaic model

- Thickness- 7.5 nm (or 75 Å).
- Proteins: Lipids : : By weight 52%: 48%

Maximum: inner mitochondrial membrane:3:2
Least : myelin sheath 0.23:1

	ECF	ICF
Osmolarity	290 mosm /L	290 mosm /L
Major Cation	Sodium	Potassium
Major Anion	Chloride> HCO3	Phosphate> proteins
Most osmotically active ion	Sodium	Potassium
pH	7.4 (higher)	7.1
Major Buffer	HCO3	Phosphate
M. Imp. Buffer	HCO3	Proteins—> PKa closer to intracellular pH
Proteins	6–8 g/dL	16 g/dl

Darrow-Yannet Diagram

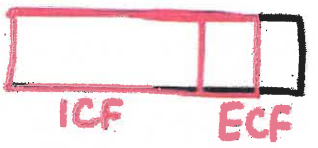
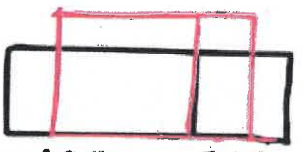
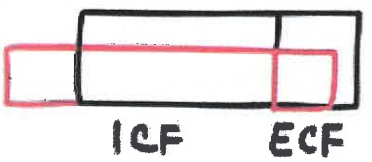
- Darrow-Yannet Diagram shows the osmolality and volume changes of body fluids.
- X axis represents volume.
- Y axis represents solute concentration.

RULES TO PLOT DYD

3 important principles-

- loss/gain of fluid always occurs from ECF
- ECF osmolarity changes
  - Hypotonic loss/hypertonic gain → ICF volume decreases → ICF osmolarity increases
  - Hypertonic loss/hypotonic gain → ICF volume increases → ICF osmolarity decreases
  - Isotonic loss/isotonic gain → ICF volume remains constant → ICF osmolarity remain same
- shift of fluid occurs in between ICF and ECF, till osmolarity is same

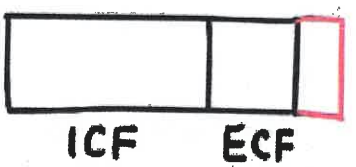
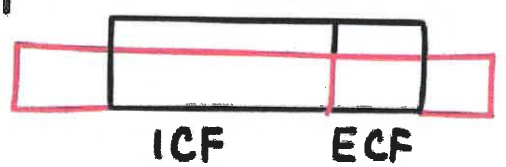
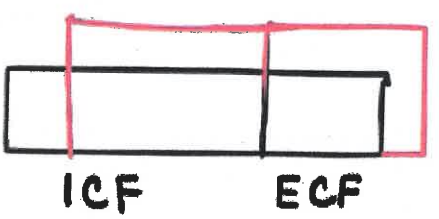
LOSS OF FLUIDS

	ECF VOL	ECF OSM	ICF VOL	D-V-D
A) ISOTONIC HEMORHAGE, DIARROHIEA VOMITTING, BURAS	↓	↔	↔	
B) HYPOTONIC SWEATING, FEVER D.I, ALCOHOL ⊖ ADH	↓	↑	↓	
C) HYPERTONIC Addison's disease	↓	↓	↑	

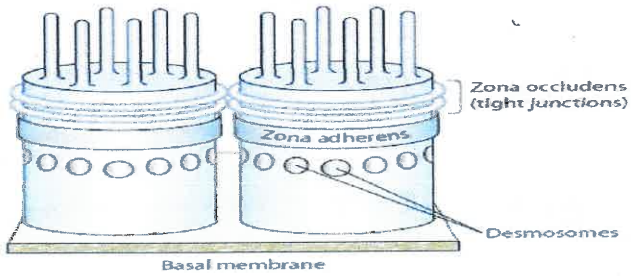
HYPER-OSMOTIC DEHYDRATION

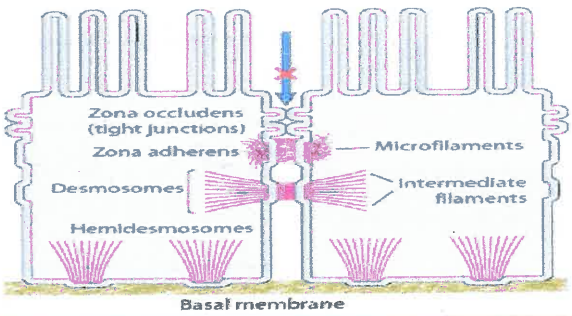
HYPO-OSMOTIC - DEHYDRATION

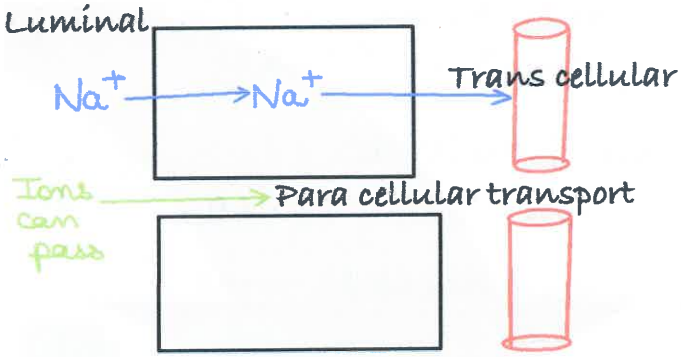
GAIN OF FLUIDS

	ECF VOL	ECF OSM	ICF VOL	D-V-D
A. ISOTONIC I/v 0.9% NaCl	↑	↔	↔	
B. HYPOTONIC PRIMARY - POLYDIPSIA SIADH	↑	↓	↑	
C. HYPERTONIC I/v 5% HYPERTONIC SALINE (NaCl)	↑	↑	↓	

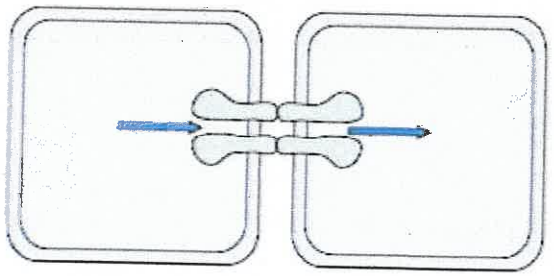
Intercellular connections Fasten cells to each other and to the cell membrane.

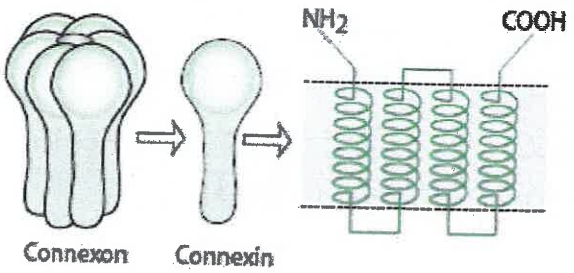






POSITION ON CELL	INTERACTION/ JUNCTIONS	PROTEINS IN-VOLVED
Apical portion of cell	Tight junctions/ Zona occludens • Tight TJ- no molecules can pass • Leaky TJ- some ions can pass (Paracellular transport)	Occludin, Claudin, Junctional Adhesion Molecules (JAM)
Below tight junction	Adherens junction/ Zona adherens Intracellularly attach to actin filament	Cadherin
Below adherent junction	Desmosome Attach intracellularly to intermediate filament	Desmoglein
Below desmosome	Gap junctions • Passage b/w cells • Allows some ions & molecules to pass • Impermeable to proteins	Connexons
Lowermost part	Cell matrix Junction- attached to BM Two types – Focal adhesions & Hemidesmosomes Focal adhesion is a labile structure attached intracellularly to actin filament and helps in movement of cells from one place to another	Integrins





Transport across cell membranes

Passive transport	Active transport
"Downhill" transport Higher concentration lower concentration	"Uphill" transport Lower concentration to higher concentration
Along an electrochemical gradient	Against an electrochemical gradient
Does not require energy	Requires energy
Types of passive transport: - Simple diffusion Facilitated diffusion Non-ionic diffusion Osmosis	Types of active transport: - Primary Secondary, can be Co-transport or symport Counter- transport or antiport Endocytosis Exocytosis Transcytosis | Cytopempsis

Passive transport

a. Simple diffusion

- All gases and lipid soluble substances move across the cell membrane by simple diffusion.
- No carrier molecule involved.
- No Tm (No transport maximum i.e., not saturable).
- **Examples:**
  - O_2/CO_2 exchange in alveoli.
  - Alcohols, Steroids and other Lipid Soluble Substances.

- Follows *Fick's law* of diffusion. The Fick's Law of diffusion states that

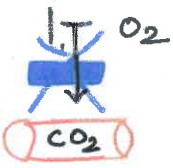
$$J = -D \times A \times \frac{\Delta C}{\Delta x}$$

J → RATE OF DIFFUSION

D → DIFFUSION CONSTANT OR COEFFICIENT

$$D = \frac{\text{LIPID SOLUBILITY} \times \text{M.WT.}}{\text{MOL. SIZE} \times \sqrt{\text{MOL WEIGHT}}}$$

- HIGHER TO LOWER Conc.
- AREA FOR DIFFUSION
  - in EXERCISE ↓ OPENING OF INACTIVE CAPS (↑) A
  - (↓) AREA ↓ OR DESTRUCTION OF ALVEOLAR WALLS (↑Δx)
    - PULM FIBROSIS
    - ILDs
    - PULM EDEMA
    - PNEUMOCONIOSES
- $\frac{\Delta C}{\Delta x}$ → CONC. GRADIENT
- Δx → THICKNESS OF MEMB or DIFFUSION-DISTANCE
  - in EMPHYSEMA ↑ (Δx)



b. Facilitated diffusion:

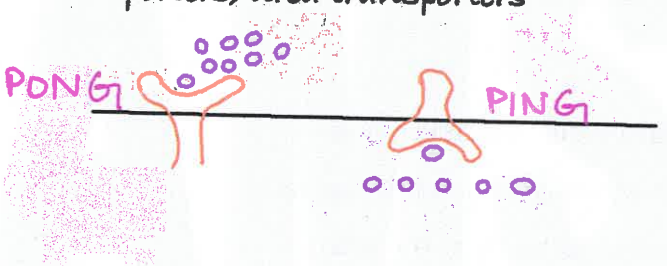
Characteristics:

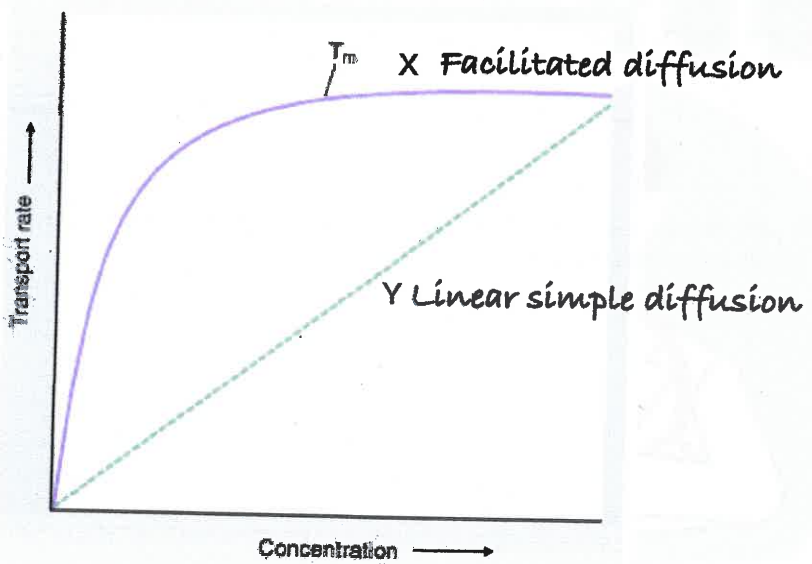
- No energy is required and is therefore passive.
- Occurs along an electrochemical gradient similar to simple diffusion.

Carrier mediated Transport

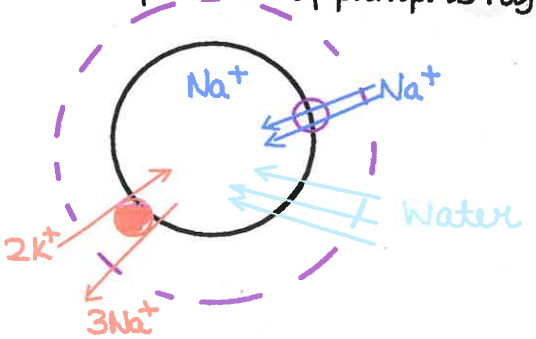
- Specificity
- Competitive
- Saturability
  Rate of Transport reaches maximum once all carriers are saturated (T max)

Examples: GLUT, AA transporters, urea transporters





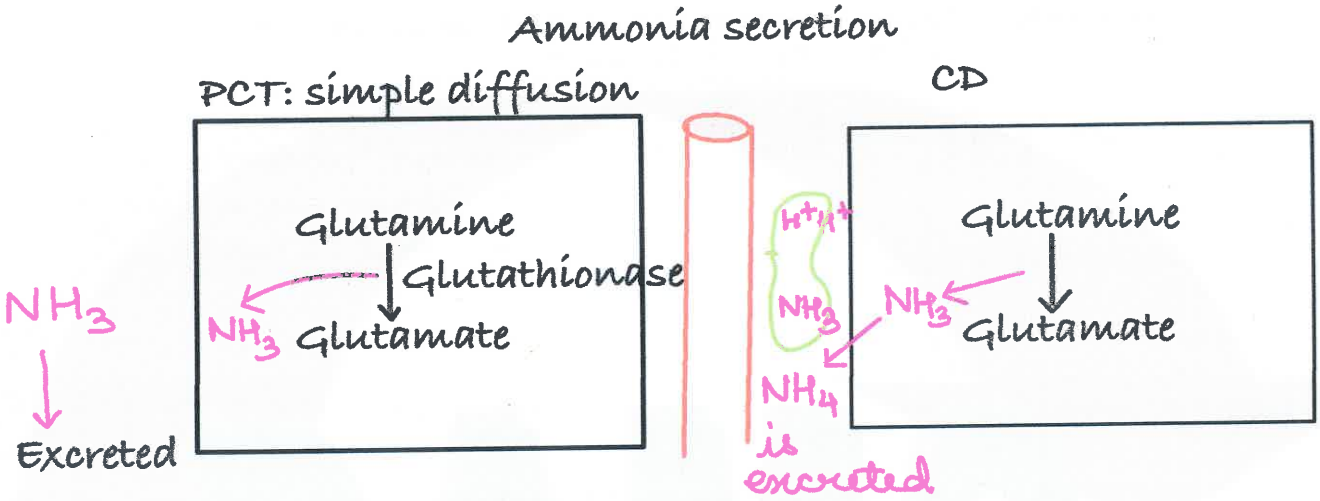
Main function of pump: is regulation of cell volume



Treatment of DKA
↓
IV insulin
↓
Hypokalaemia
↓
Muscle weakness

c. Non – ionic diffusion

- Non-ionic diffusion is seen in case of weak acids or bases, where the acid / base can cross the membrane in the non – ionized (undissociated) form but cannot cross the membrane in the ionized form.



Examples of Non ionic diffusion are -

- Absorption of salicylates in the stomach.
- Secretion of weak acids in the kidney
- Absorption of bile acids in the distal ileum.

d. Osmosis

- Diffusion of a solvent (water) from a dilute to a concentrated solution through a semi permeable membrane is known as osmosis.

Active Transport

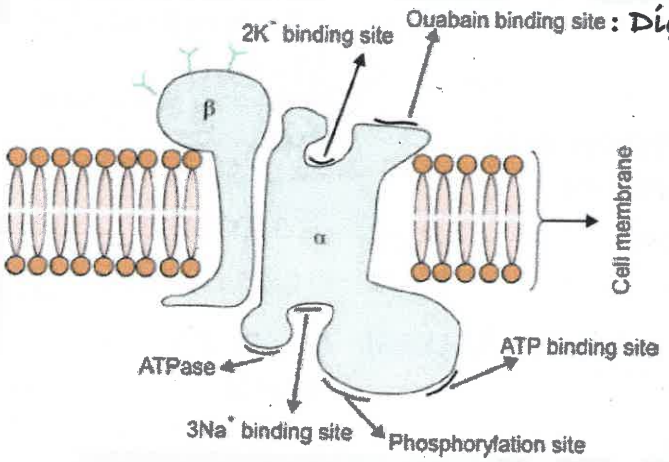
Transport is 'uphill', that is against an electrochemical gradient.
Energy is used.

Types:

- Primary active transport:
  - Energy is derived directly by hydrolysis of ATP by the transporter itself.

Examples of primary active transport -
Na^+- K^+ ATPase pump
H^+- K^+ ATPase in the parietal cells of stomach and in the collecting duct of the kidney
SERCA (sarcoplasmic endoplasmic reticulum calcium pump)

Na^+ K^+ ATPase — Heterotrimer



3:2 coupling ratio

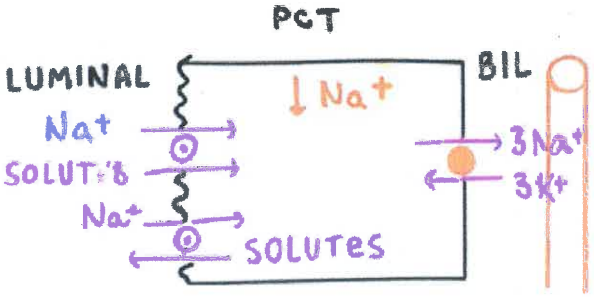
Pump contributes only

3.2 MV —> RMP(-70mV)
5mV—> RMP (-90mV)

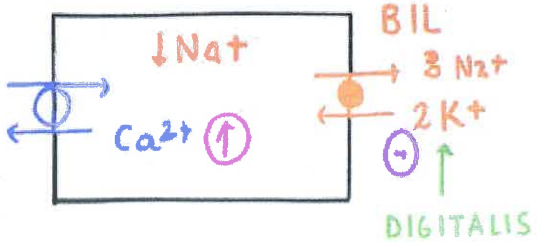
Regulation of Na– K ATPase activity

	Synthesis (Genomic)	Activity (Non-Genomic)
Thyroid	↑	↔
Aldosterone	↑	↑
Insulin	↔	↑
Epinephrine	↔	↑
Dopamine	↔	↓
ANP	↔	↓

- Secondary active transport
  - Does Not Use ATP directly..



MYOCARDIAL CELL



Examples of secondary active transport co-transport are:

PCT → Na+ Glucose-CT | SGLT-2 SYMPORT
Na+-AA-CT
Na+-Pi-CT ⊖ ← PTH
Na+-LACTATE-CT

TAL OF DCT → Na+-K+RCl-CT (NKCC)

DCT → Na+-Cl-CT (NCC)

TERMINAL TUQULE → Na+-GLUC-LNE-CT

INTESTINAL EPITHIAL CELLS

Na+ Glucose-CT | SGLT-1
Na+-AA-CT
Na+-Pi-CT
Na+-I- SYMPORTER (NIS)
S → STOMACH, Salivary Glands
P → Placenta
I → Int-Epit cell
T → Thyroid
Gum → GESTATIONAL Breast

SMALL INTECINETINTE

Examples of secondary active troo-transport are:

PCT → Na+H+ EXCHANGER ANTI-PORT

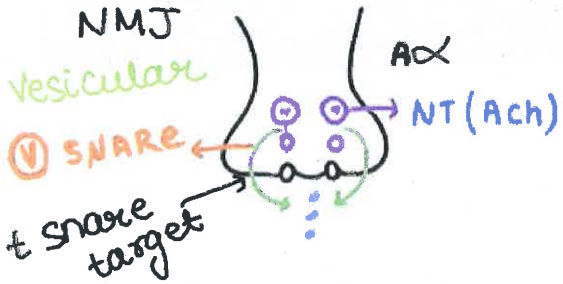
MYOCARDIAL CEIIS → 3Na+-Ca2+ EXCHANGER

RELEASE OF FLUID TO OUTSIDE
Emeiocytosis/ Reverse Pinocytosis

Exocytosis
- Requires Ca^{2+}, energy and docking proteins.
- Docking proteins are-
  - Synaptobrevin (v-snare protein) ⊖
  - Syntaxin (also known as t-snare protein) ⊖
  - SNAP-25 (t-snare protein) ⊖

BOTULINUM TOXIN
↓ Ach → NMJ
FLACCID PARALYSIS

DOCKING THEORY | LOCK & KEY THEORY



TETANUS TOXIN
⊥ ⊖
SYNAPTOBREVIN
↓
↓ GABA
↓ Glycine
] in CNS SPASTIC PARALYSIS