20/9. # Transport across cell membrane.

Cell membrane is selectively permeable.

- Protein channels.
  (1) Ion channels
  (2) water channels, aquaporins.

Ion channels.

Integral proteins.

polypeptide subunit forms a gate at one end of the channel that opens in response to a specific stimulus.

Type of ion channels.

- Sodium channels.
- Blocked by tetrodotoxin

→ potassium channel.
- Blocked by 4-amino pyridine & tetraethyl ammonia

Gating of Ion channels ⇒ opening of ion channels.

- ligand gating
- voltage gating → when membrane polarity change, gate open
- Mechanical gating → mechanical stimulus
  - stretching
  - temp change
  - pressure
  - pain.

Study of Ion channels.

- ★impt & mcq
- patch clam technique : method of study of different ion channels.

Types of carriers.

- Uniport - Na^+ channel.
- symport - transports Na^+ & glucose from lumen of intestine.
- antiport - Na^+ - K^+ pump.

Types of transport.

(1) Passive → Simple diff
Facilitated diff.
Osmosis.
Filtration.
Bulk flow.
Solvent drage.

(2) active → • primary act. trans
• Secondary act. trans.

(3) Vesicular.
- Exocytosis
- Endocytosis

(4) Transport across epithelia.
- transcellular transport
- Paracellular transport

Passive transport.

- transport along gradient
- Downhill movement.
- No energy expenditure.

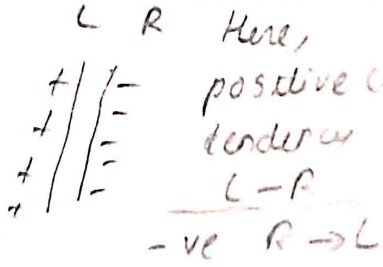
Diffusion.

- movement of molecules from area of higher concentration to area of lower concentration.
- If diffusion happens without energy and without help of any carrier protein - simple diffusion.
- If diffusion happens without energy and with the help of carrier protein - facilitated diffusion.

Simple diffusion.

- Simple diffusion is the passive movement of molecule down their concentration gradient due to random molecular movement.

Factors determining rate of diffusion.



- properties of substance.
  (1) conc and electrical gradients of the substance.
  (2) permeability of the substance.
  - → lipid solubility.
  - → molecular size.
  - → charge on molecule.
  - → temp.
  - → distribution of channels in the membrane

-ve ions have more tend to diffuse outside the cell
-ve ion have less tendency to diffuse inside the cell.
+ve ions have less tendency to diffuse outside the cell.

(2) properties of membrane.

(1) Cross sectional area of membrane.

rate $\propto$ Area

(2) thickness of membrane.

rate $\propto \frac{1}{\text{thickness}}$.

FICKS Law.

speed of diffusion.

$$J = -DA \frac{\Delta C}{\Delta X}$$

J = speed of diffusion.

D = diffusion coefficient

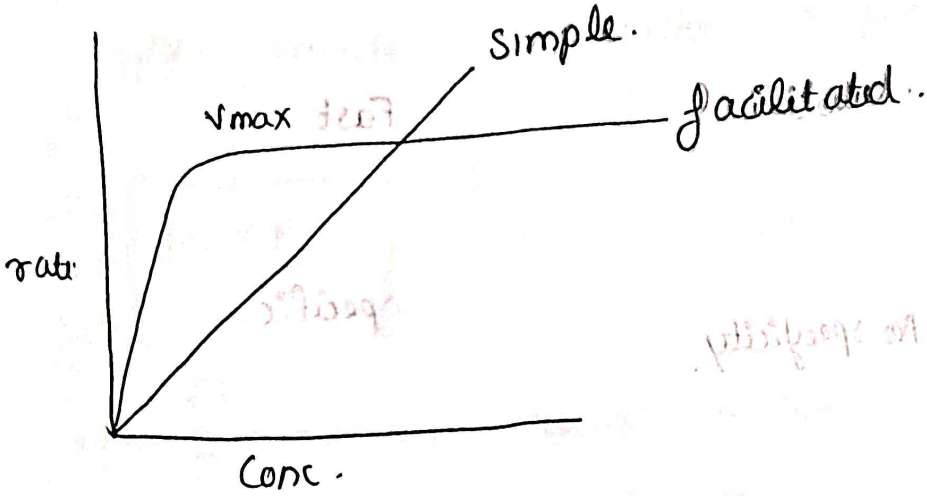
A = area through which diffusion has to occur.

C = concentration.

X = distance

mechanism of facilitated diffusion.

- Carrier mediated diffusion.
- features of facilitated diffusion.
  - ✓ faster rate of transport.
  - ✓ saturation kinetics.
  - ✓ Competitive inhibition. {eg: glucose & galadose} one in higher conc. inhibits the other transport
  - ✓ specificity



	Simple.	Facilitated.
1. Mode of diffusion	no carrier molecule involved	Carrier molecule is involved.
2. Saturation Kinetics.	No saturation kinetics, diffusion is linear	Has saturation kinetics
3. Competitive Inhibition.	Absent	present
4. Rate of diffusion.	Slow	Fast
5. Specificity.	No specificity.	Specific.

Osmosis.

- movement of solvent from solution with the lower concentration of solutes to the solution with higher concentration of solute, when both solutions are seperated by a semipermeable membrane.

Osmotic pressure.

- Minimum pressure applied to the solution with the higher solute concentration to prevent Osmosis.

21/9

$$P = \frac{nRT}{V}$$

- Osmotic pressure depends on number of molecules or ions dissolved in solution.
- Conc. of osmotically active particle is expresses as osmoles.
- Biological solution - milliosmole.
- Glucose 1 Osm
- NaCl - 2 Osm.

Colloidal osmotic pressure.

- Osmotic pressure due to colloidal.

Oncotic pressure : due to plasma protein (25 mm Hg).

Osmolality : no. of osmoles per Kilogram of solvent.

Osmolarity : no. of osmoles per litre of solution.

Inspt. MCQ. plasma osmolality - normal 290 mOsm per kg.

Measurement of Osmotic pressure.

- By freezing point depression
- 1 mol of an Ideal solution depressing freezing point by 1.86°C.
- for human plasma, average freezing point is -0.54°C, which corresponds to an osmolality of 290 mOsm/kg

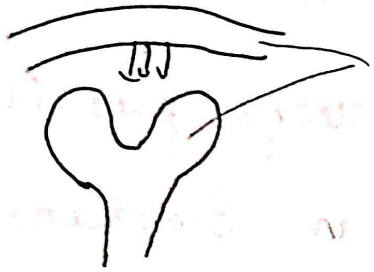
Tonicity.

- Isotonic : same osmolarity of plasma.
- hypotonic :
- hypertonic :

Applied aspects.

- Hyperosmolal coma. (high sugar condition)
- Normal saline (0.9% NaCl) is preffered in volume depletion. #(5%) ~~dextrose~~ Dextrose is not preferred as it gets metabolised.

Filtration - due to difference in hydrostatic and oncotic pressure on two sides.



Hydrostatic → due to fluid pressure.
Oncotic press → due to plasma protein.

In vessels.

- When hydrostatic pressure is hig → favour filtration
- when oncotic pressure is high → does not favour filtra
  [act as more conc].

In Bowman's capsule.

- high. oncotic pressure.
- low hydrostatic presure

] favours filtration.

Bulk flow.

- mass movement of liquids or gases according to pressure or temperature gradient.
- Eg: movement of gas molecules from trachea down to alveoli

Solvent drag.

Solvent will drag some solutes when solvent undergoes bulk flow.

eg: when water undergoes bulk flow it carries some ions like Na^+.

ACTIVE TRANSPORT.

- Utilize energy & occurs against con. gradient.

Characteristics.

* uphill transport.
* utilize metabolic energy.
* Exhibit saturation Kinetics

Types of active transport.

(1) 1°
(2) 2°.

Primary active transport.

- directly utilize metabolic energy for transport proces.
- Ions pumps.
- Energy derived directly from breakdown of ATP.

eg: Na^+ K^+ ATPase.
H^+ K^+ ATPase.
Ca^{2+} ATPase.

Na^+ K^+ ATPase structure (Na+ - K+ pump)

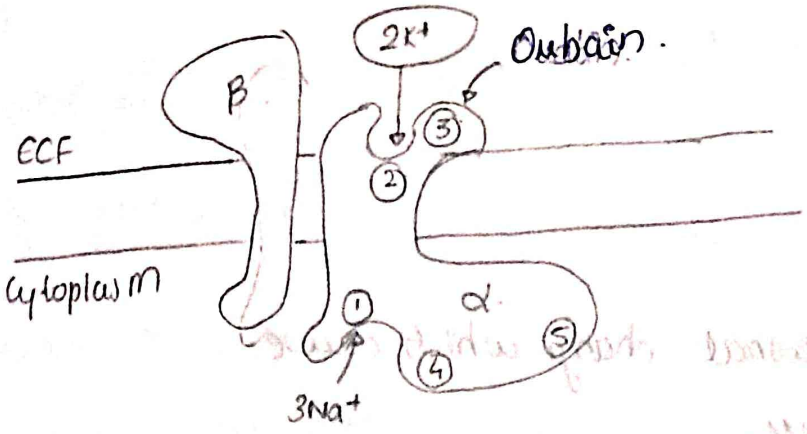
(V. V. repeated univ question)

Figure ✓

* Electrogenic.

* Hetero dimeric

as α & β are not similar.



β → function not known.

α → EC part. → K+ binding site (2)
Cytoplasmic part → ~~outhein~~ binding site (3).
Ouabain.

α → Cytoplasmic part.
~~Extracellular part.~~
- Na+ binding site (1)
- ATP binding site (5)
- phosphorylation site. (4).

⇒ 3:2 coupling ratio → Since it creates a potential difference (2 & 3)
∴ called Electrogenic pump.

Mechanism of operation.

(1) 3 Na^+ bind to

(2) ATP binds to

(3) ATP → ADP + Pi

(4) Pi bind to.

(5) Pi causes conformational change which cause 3 Na^+ to out of cell.

when,

2 K^+

Everything will reverse & 2 K^+ moves in.

Functions.

1. cytosolic ion concentration - high conc of K^+ & low conc of Na^+ in cell.
2. cell volume. - maintains intracellular water content.
3. protein synthesis - high intracellular conc. of K^+.
4. maintains RMP.
5. Hormone action - thyroxine, aldosterone, insulin.

Expl.

- It pumps excess (+ve charge) outside., thereby preventing bursting.

↓ osmotically active

→ normally, it is negative. Inside cell, when +ve charge.

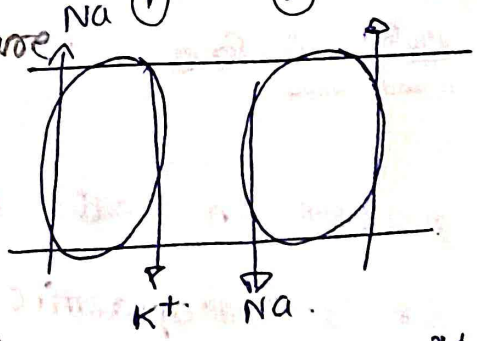
~~Main~~

✓ Regulations of $Na^+ - K^+$ pump.

activation of $Na^+ K^+$ pump - thyroxine, insulin, aldosterone.

Inhibition of Na^+, K^+ pump - dopamine digitalism.

Figure



✓ Applied aspect.

- Digitalis inhibit $Na^+ - K^+$ pump. (used to treat myocardial infarction)
  - digitalis inhibits $Na^+ - K^+$ pump.
  - as a result, Na, Ca conc. ↑.
  - as Ca con ↑, contractility ↑ so heart failure condition improves.

$Na^+ - Ca^{2+}$.

→ ratio.

22/9/23.

$H^+ - K^+$ ATPase.

- present on luminal membranes of parietal cells of stomach and Intercalated cells of distal nephrons.
- stomach - pump proton into gastric lumen in exchange of K^+
- Kidney secretes H^+ into tubular fluid & reabsorb K^+.

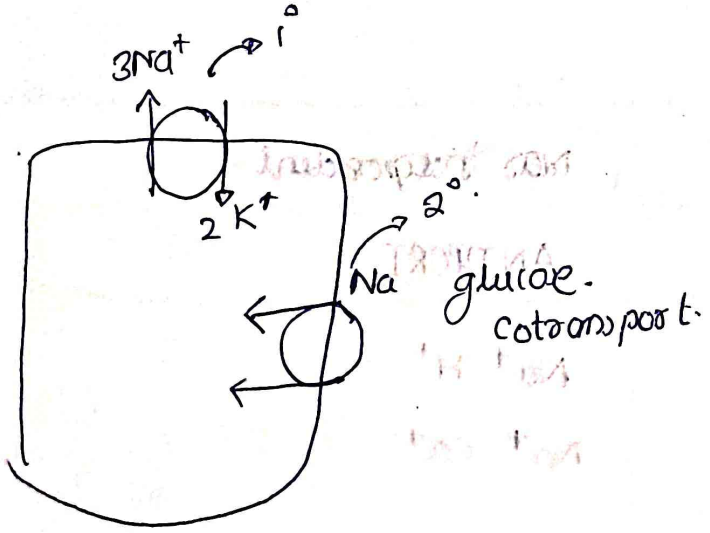
Ca^{2+} ATPase.

- present in all cell membrane, membranes of ER, & Sarcoplasmic reticulum
- Ca^{2+} pump present on cell membrane transport Ca out of the cell.
- Ca^{2+} pump present on membrane of ER & SR. transport ca from cytoplasm into these organelles

Secondary active transport

eg: Na-glucose co-transporter.

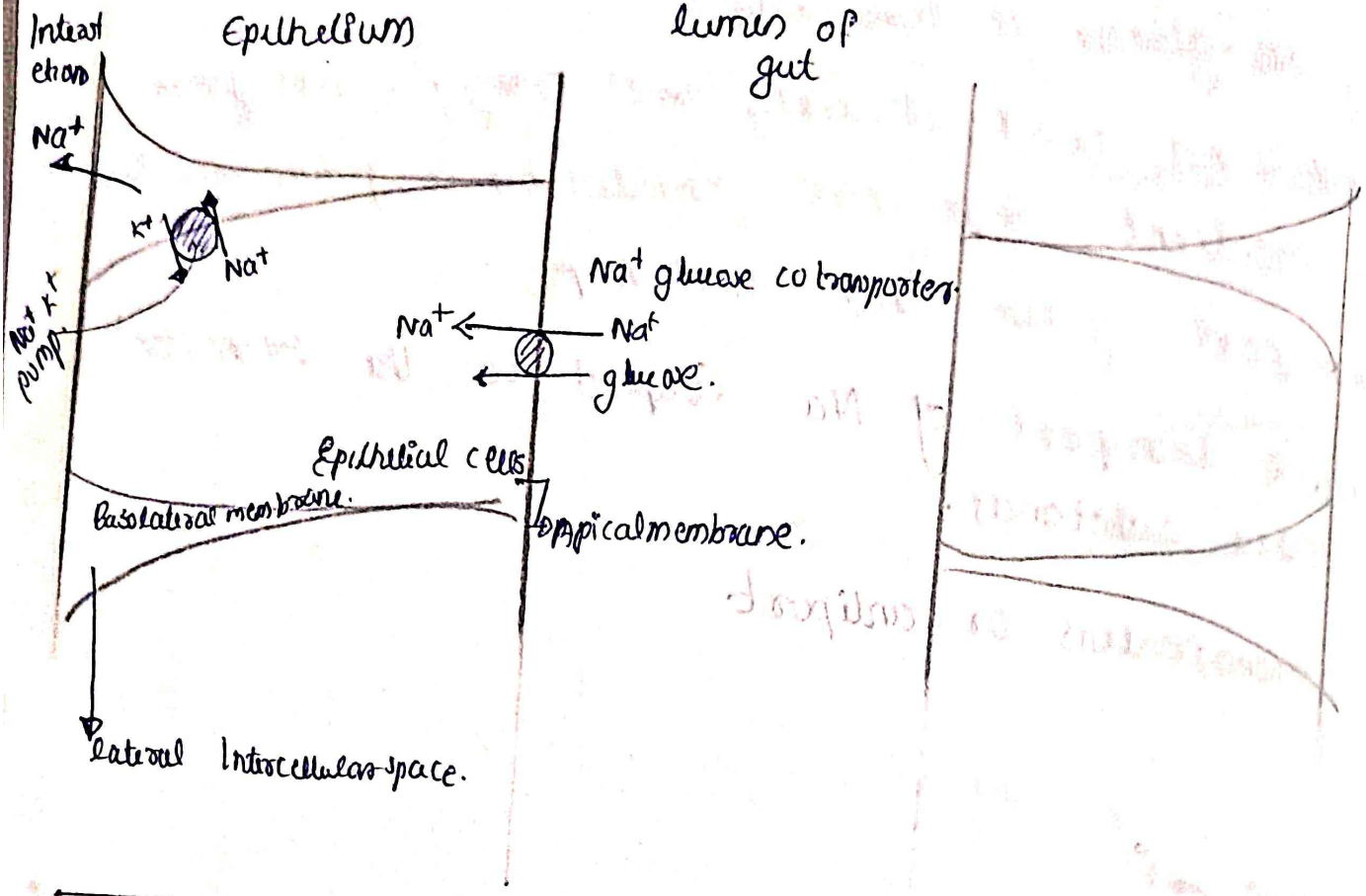
- ATP is not used directly and energy comes from a gradient that was created by a primary active transport system that used ATP.
- Active transport of Na coupled to the transport of other substances.
- Co transporters or antiport.



Na → along conc. gradient.

glucose → against conc. gradient along Na.

Mechanism.



Na dependent.	~~Na~~ Na Independent.
SYMPORT	ANTIPORT
Na^+ - glucose. Na^+ - aminoacid. Na^+ K^+ $2Cl^-$ Na^+ - bile salt Na^+ - choline uptake Na^+ - NT uptake. ~~Sodium~~ ~~Independent.~~	Na^+ H^+ Na^+ Ca^+.

Na^+ Independent

- HCO_3^- - Cl^-

H^+ - K^+

Applied aspect.

- ORS : we use both Na^+ & glucose to allow Na-glucose 2° active transport mechanism.

Vesicular transport.

- Transport process that occurs by either fusion of vesicle