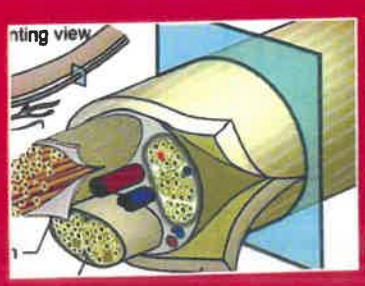
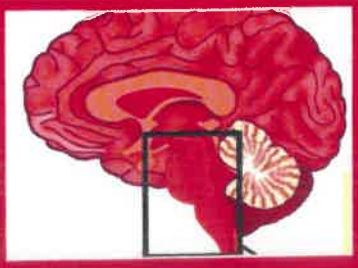
Cerebellum
Get the balance right

Cerebellum Physiology

For the Students
By the Teachers





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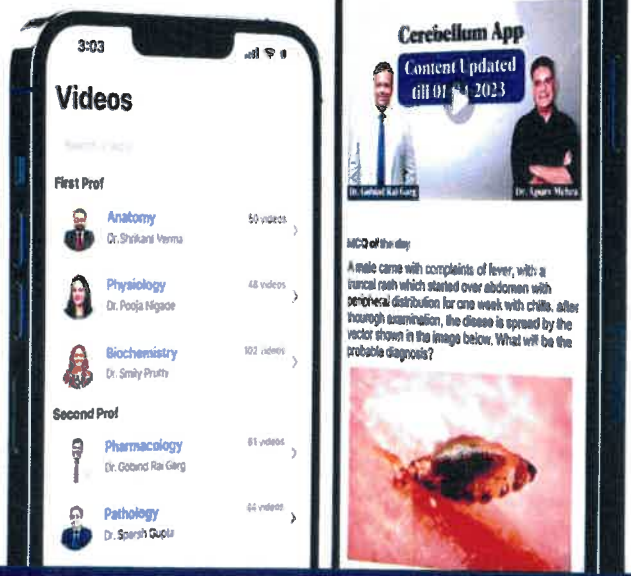

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Table of Content

Please Note

1. Extra Edge mentioned in respective chapters are important for INICET Exam
2. Boxes (Empty) on page no - 28, 37, 57, 58, 59, 64, 69, 82, 87, 92, 108, 113, 129, 132, 145, 146, 147, 152, 168, 181, 182, 193 and 195 are for the students to make notes along with the teacher while listening to the video

Unit 1
General Physiology

1.1 Chapter

GENERAL PHYSIOLOGY

HOMEOSTASIS

- Maintenance of constancy of internal environment of the body
- Term given by → Walter B. Cannon MCQ, he also coined term Flight or Fight response

Milieu interieur

- Term given by Claude Bernard → aka Father of Physiology
- Internal environment in which cells are nourished & maintained in an equilibrium state (ECF << Interstitial fluid)
- Ex: ↑Glucose → Insulin → ↓ Glucose back to normal

  ↓Glucose → Glucagon →↑ Glucose back to normal

Regulatory mechanism

- Feedback: response is seen **after** the change in the variable
- Feedforward: response even **before** the change in the variable

Ex: HR even before starting exercise MCQ

- ✓ Cephalic phase of gastric acid secretion MCQ
- ✓ Cold temperature: Shell Temperature MCQ

↓

Hypothalamus

↓

Shivering

↓

Heat generated

↓

↑Core body Temperature

Positive vs Negative feedback

Positive feedback MCQ:

- H → Head's paradoxical reflex
  → Hodgkin's cycle
- C → Clotting cascade
- L → LH surge
- A → Activation of digestive Enzyme
- M → Milk let-down reflex
- P → Parturition reflex

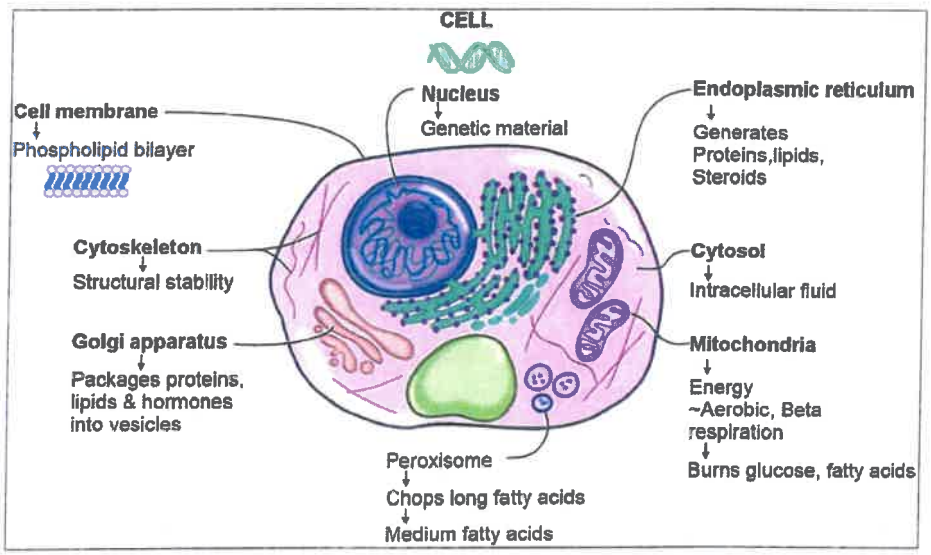
Negative feedback:

for e.g. BP/ANP

Efficiency of regulatory system MCQ

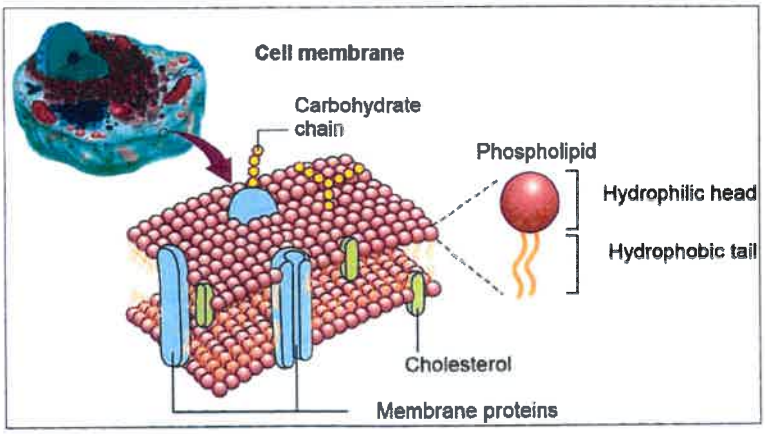
- Calculated by gain
  - Gain = correction / error
- What if the error is zero?
  - G = C / E = X/O = Infinite
  - Ex: Kidney in volume regulation

CELL PHYSIOLOGY → CM, CYTOSKELETAL



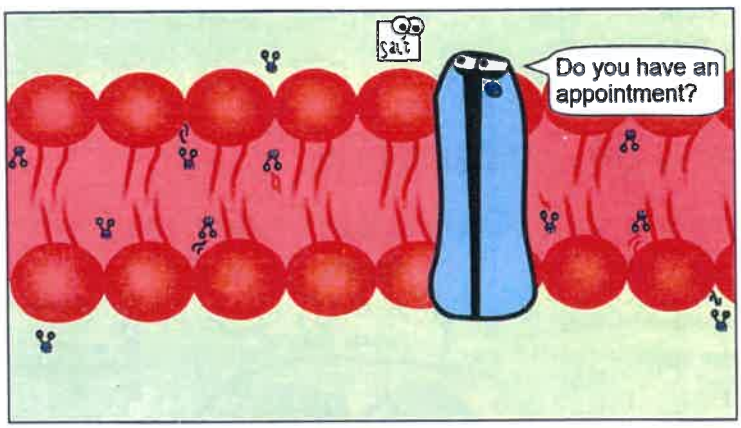
Cell

- Structural & functional unit of life
- Cell membrane model → Fluid Mosaic Model (fluid = Lipid, Mosaic = protein) given by **Singer & Nicholson**



Cell composition:-

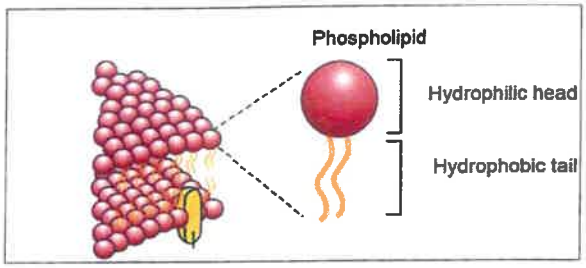
- Lipid → 40-45%
- Protein → 50-55% → highest MCQ → Inner Mitochondrial Membrane
  - Myelin → Lipid (70-80%) >> protein
- CHO → <5% (1-3%) → act as Cell marker & on RBC act as antigen so help in blood grouping



Semipermeable Cell Membrane

Lipid

- Main → Phospholipid, Glycolipid, Cholesterol
- Only Lipid which is absent in any cell membrane → Triglyceride
- Hydrophilic head: H_2O loving
- Hydrophobic tail MCQ: lipophilic (away from H_2O) → responsible for solublility



- **Significance**
  - Mode of drug → Lipid soluble drug easily cross the membrane → can apply topically
- **Functions of Lipid**
  - Structural integrity
  - Flexibility & fluidity → Maintained by cholesterol MCQ

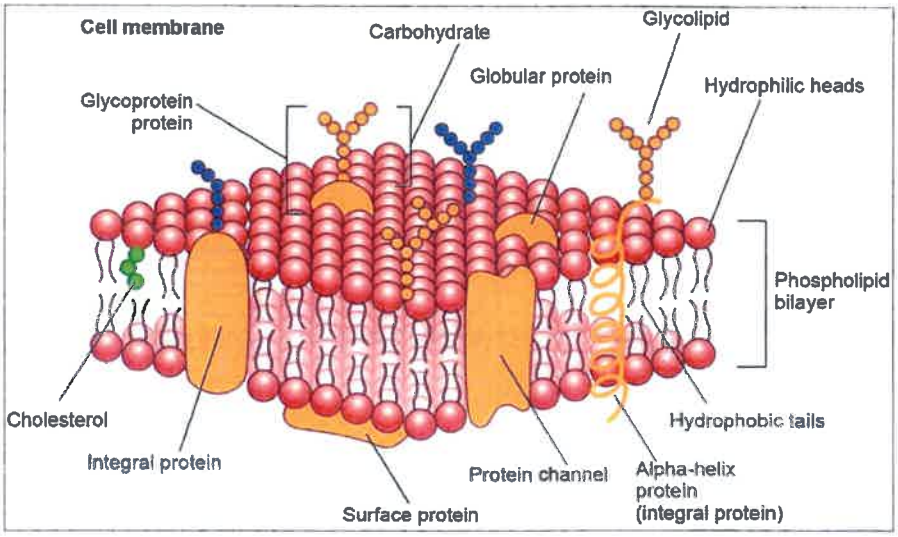
Extra edge

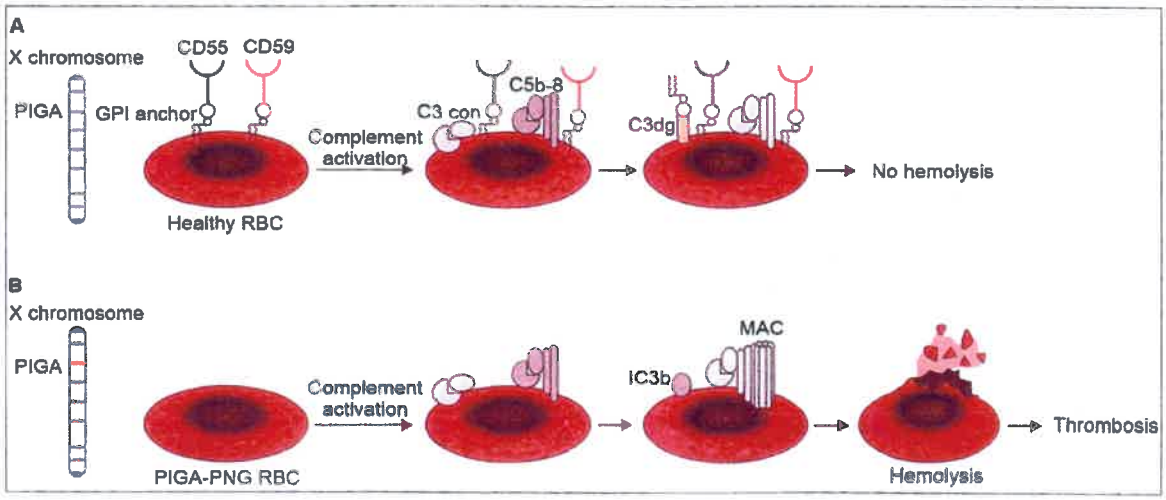
- Tm (Melting temperature) → transition temperature
  - If temp < Tm → ↑fluidity
  - If temp > Tm → ↓fluidity

  - Solubility → Lipid soluble molecule can easily cross the membrane
    - Ex:- gases: O_2, CO_2, N_2
    - Hormones: Thyroid, Steroid
    - Vitamin: A, D, E, K

Proteins

- Integral protein / Transmembrane protein MCQ
  - Work for water soluble substances
    - CSR → GPCR
    - Water soluble hormones (Large polypeptide) - Examples LH, TRH, Insulin, GIP, VIP, GLP
    - Carriers → GLUT → Glucose transporter MCQ
    - (Configurational change)
    - Ion channel / pump → Require ATP
    - Aquaporin MCQ





- GPI anchor protein → Glycosyl Phosphotidyl Inositol

  (DAF - CD55, MIRL - CD59 → prevent activation of complement system) MCQ

  Defect → PNH

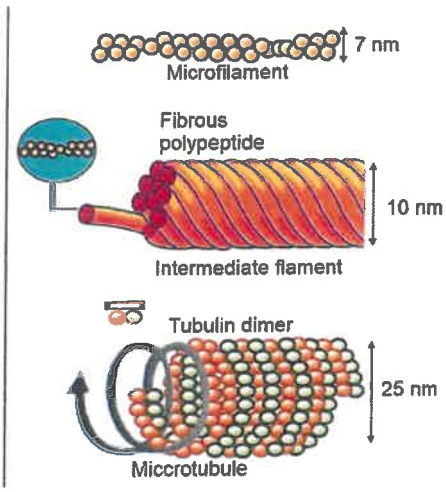
- Peripheral protein → act as Cell marker, Ag (MHC 1, 2)

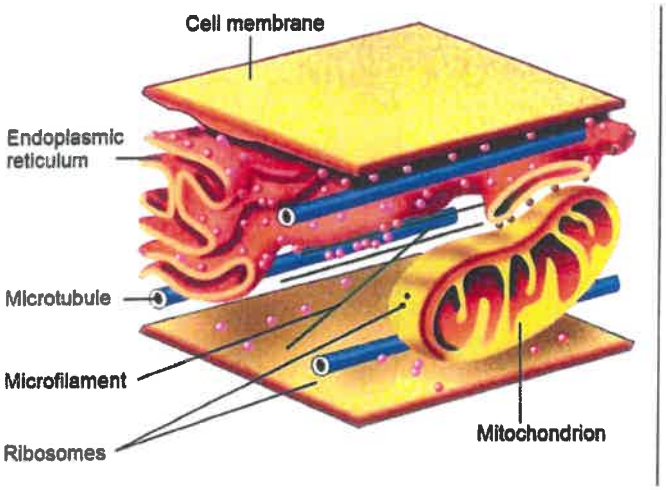
Extra edge

Cytoskeleton

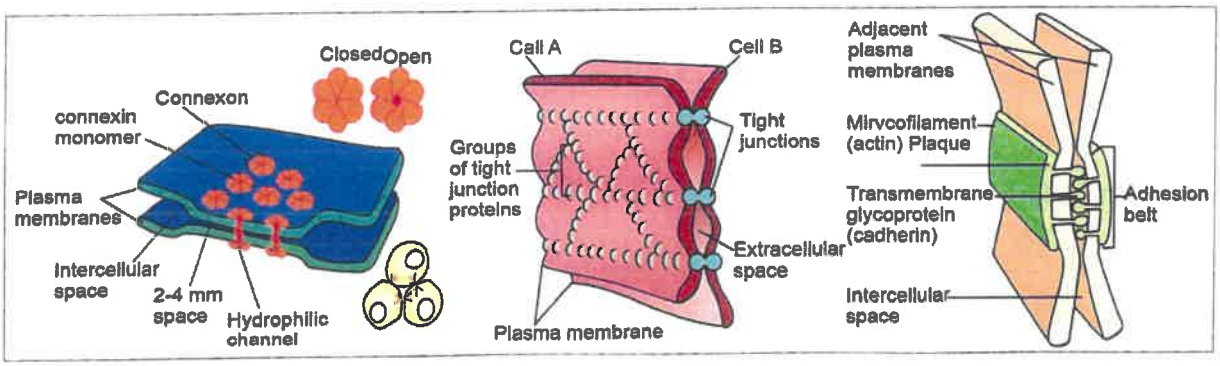
- Help in organization of the Intracellular transport and maintains shape

1. Static → Intermediate filament → made up of fibrous protein
   - Cell marker
   - GFAP → Astrocyte
   - Vimentin → Mesenchymal cell
   - Cytokeratin → Epithelial cell MCQ
   - Desmin → Skeletal muscle MCQ





2. Dynamic
   - Microtubules → organized by centrioles
     - Tubulin → α,β
     - Function :- cause Intracellular transport, Cell division
   - Microfilament
     - Actin (Globular, filamentous)
     - Function: Muscle contraction, support of cell, diapedesis (create psuedopodia)

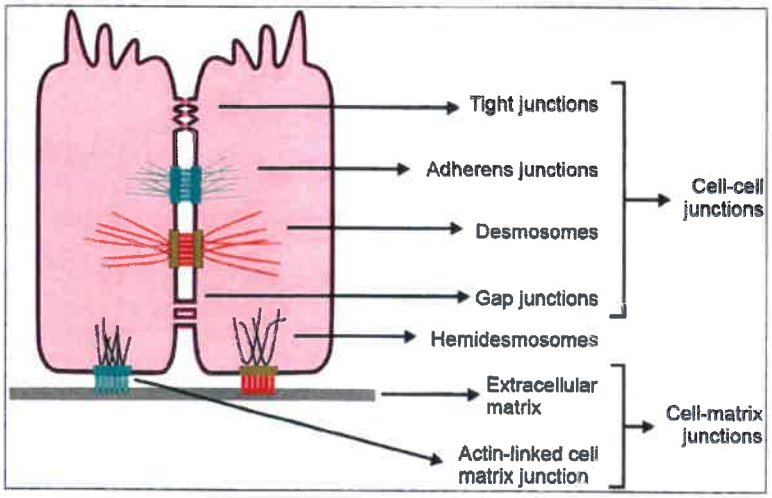


INTRACELLULAR JUNCTIONS

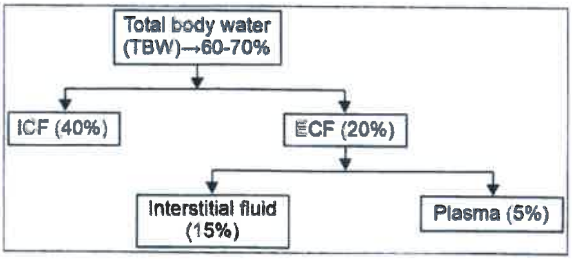
1. Gap junction → connection between 2 cells
   - Made up of connexin MCQ 6 subunit known as connexon

- Present on cardiac muscle cell & smooth muscle - act as syncytium

2. Tight junction → made up of claudin & occludin MCQ & JAM
   - Leaky tight
   - Tight tight → BBB, nephron (both)
3. Adherens junction
   - Give strength & support Desmosomes – Desmoglein
   - Anchor the cell
   - Made up of cadherin, catenin,
4. Others → Hemidesmosomes
   - Focal adhesion molecules → also made up of integrin



BODY FLUIDS → BODY WEIGHT (100%)



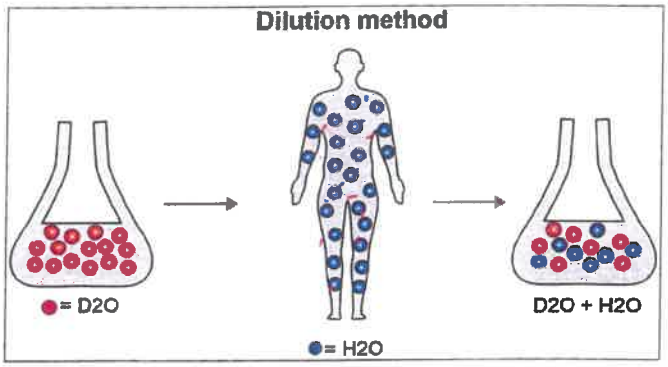
- 60:40:20 Rule → TBW : ICF : ECF MCQ
- TBW: In female → 50% (have more fat)

Transcellular fluid - Fluid within epithelial lining ~1L

Extra edge

- New born → 75% (Premature 75 - 90%)
- At 3-4 month → ICF ~ ECF
- 1 year → ≈ adult

Estimation of body fluids



- Dye Dilution/Indicator method MCQ
- FPD: Freezing point depression
- Stewart Hamilton principle
  - Volume = Amount of Dye - Excretion / Concentration of Dye MCQ
  - If there is leakage of Dye → ↓Concentration → false high volume

Direct & indirect measurements MCQ

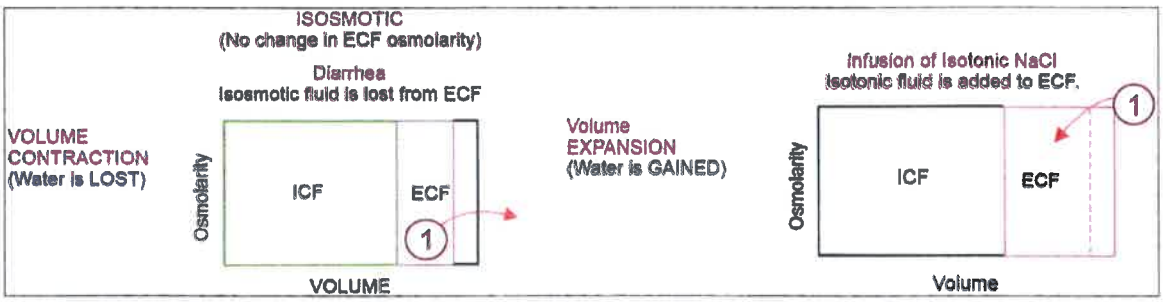
- Direct →
  - TBW → D_2O, T_2O , aminopyrine MCQ
  - ECF →
    - S - Sucrose
    - I - Inulin MCQ
    - Ma - Mannitol MCQ
    - N - Na+ thiosulfate
  - Plasma MCQ → Evans plasma dye , Radiolabelled Albumin
  - RBC → Cr / Fe labelled RBC
  - Blood volume = Plasma / 1- Haematocrit
- Indirect MCQ →
  - ICF = TBW - ECF
  - Interstitial fluid = ECF - plasma

Extra edge

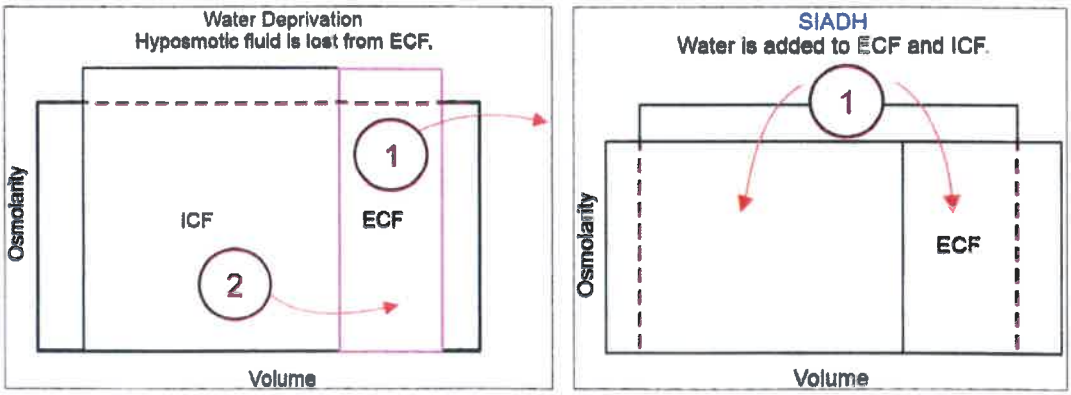
SHIFTS OF BODY WATER → OSMOLARITY

Darrow Yannet diagram MCQ

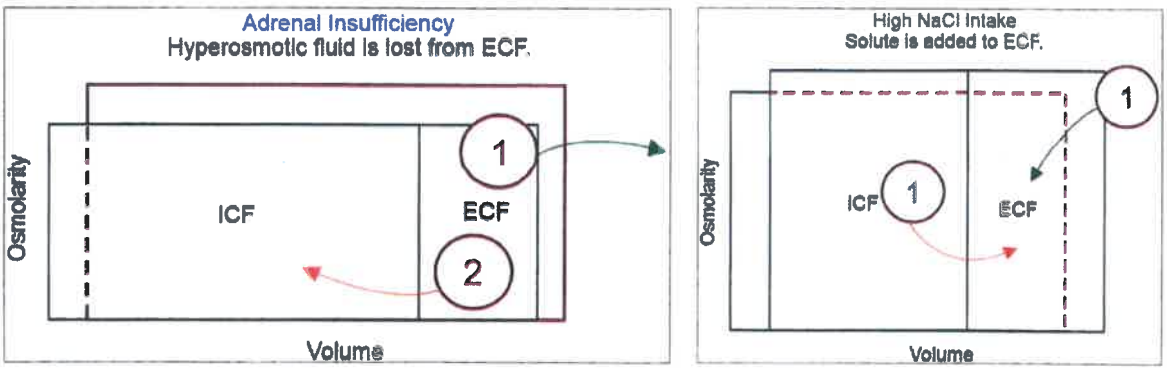
- Isotonic
- Volume contraction MCQ → Ex: Diarrhea, Haemorrhage, Vomiting
- Volume expansion → Ex: 0.9% NaCl, 5% Dextrose



- Hypotonic
- Loss → Water deprivation → Ex: DI
- Gain MCQ → SIADH → ↑ water reabsorption, Decreases Osmolarity



- Hypertonic
- Loss → Adrenal Insufficiency
- Gain → 2% NaCl infusion



Osmolarity

- Normal: Plasma osmolarity 285 – 295 mosm/L
- Calculated Osmolarity MCQ: 2 (Na^+ + K^+) + Glucose/18 + BUN /2.8

Tonicity vs Osmolarity

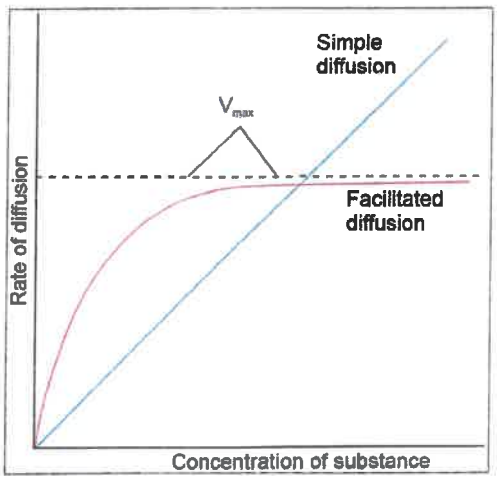
- Isotonic solutions-
  - 0.9% Normal saline (0.9% NaCl)
  - Lactated Ringer's solution → known as Hartmann's solution
  - 5% Dextrose (in vitro) → in vitro → metabolized → decrease Osmolarity → initially isotonic later becomes hypotonic MCQ
- **Hypotonic solutions**- Used for Osmotic Fragility Testing (OFT) MCQ
  - 0.5% - 0.7% NaCl
- **Hypertonic solutions**-
  - 10% mannitol
  - 2% - 3% NaCl

TRANSPORT ACROSS CELL MEMBRANE

Passive Transport:

- Osmosis
- Diffusion

Diffusion: MCQ



- Simple → along gradient, Ex: Gases
- Facilitated → require carrier protein, saturation, specificity, competition - Ex: GLUT
- Non ionic → Nephron
- Fick's Law
  - Rate of diffusion $= K_D \times A \times (P2 - P1)$

    $= K_D \times A \times \Delta P/T \rightarrow$ Gas

    $= K_D \times A \times \Delta C/T \rightarrow$ solution

- K_D = Diffusion coefficient $K_D = \frac{S}{\sqrt{MW}}$
- A = Surface area of cell membrane
- ΔP or C = Pressure or concentration gradient
- T = Thickness of membrane

Active Transport:

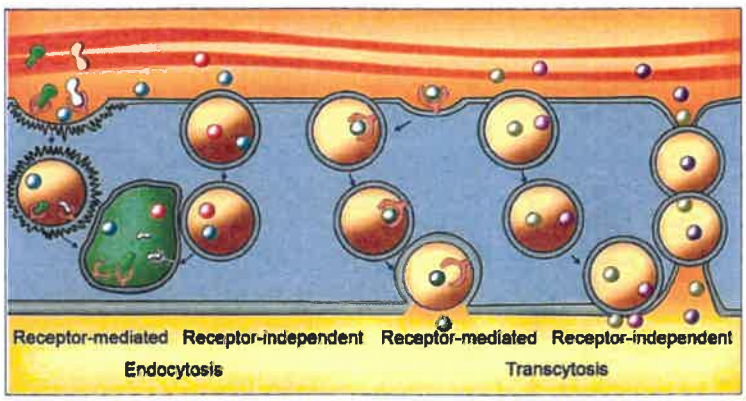
- Primary → Directly use ATP . Ex:- Na^+ - K^+ pump, H^+ pump
- Secondary → Indirectly use ATP , symport / antiport
  - Dependent on 1° transport
  - Ex:- SGLT , Na/Ca^{++} exchanger (cardiomyocytes) MCQ

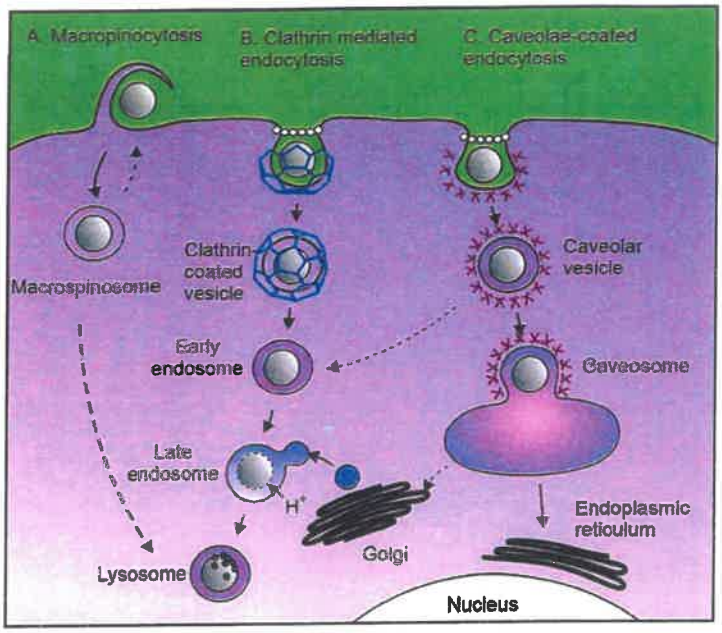
Vehicular transport

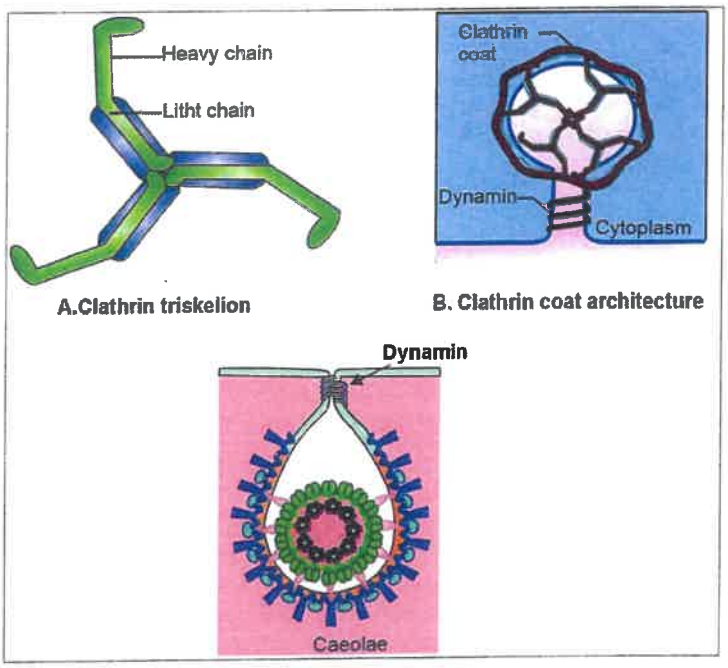
I. Endocytosis
   - Phagocytosis
   - Pinocytosis
   - Receptor mediated endocytosis → require protein → Clathrin MCQ, Caveolin → they coat the vesicle & form endosome

II. Exocytosis
   - Consecutive pathway → Continuous
   - Non consecutive
   - Vesicle: Pre processing → storage → exocytosis

III. Transcytosis → through the cell




A. Macropinocytosis
B. Clathrin mediated endocytosis
C. Caveolae-coated endocytosis
Macrospinosome
Clathrin coated vesicle
Caveolar vesicle
Early endosome
Caveosome
Late endosome
H+
Endoplasmic retioulum
Golgi
Lysosome
Nucleus


Heavy chain
Litht chain
A.Clathrin triskelion
Clathrin coat
Dynamin
Cytoplasm
B. Clathrin coat architecture
Dynamin
Caeolae

Unit 2
Nerve Muscle

2.1 Chapter

INTRODUCTION TO NERVE MUSCLE PHYSIOLOGY

- Cell membrane:-
  - Is semipermeable
  - Lipid soluble substance can pass through the membrane but water soluble cannot
  - The membrane allows potassium > chloride ions to pass which are called diffusible ions & do not allow Na^+, Ca^{+2}, Po_4^-, protein etc called as non diffusible ions.
- Unequal distribution of Ions

Cations	Anions	
ICF	K^+ , Mg^{2+}	PO_4^{-3}, Protein
ECF	Na^+, Ca^{2+}	Cl, HCO_3^-

  - Most abundant intracellular divalent cation is:- **Magnesium**
  - (Potassium is univalent)
  - **Gibb's Donnan equilibrium:-** The effect of non diffusible ions on diffusible ions at rest which will cause unequal distribution.
  - A point where the concentration gradients will be equal & opposite to the electrical gradients. At that point K+ starts diffusing out of ICF, that's known as **Euilibrium Potential.**
- **Nernst potential:-**
  - If the cell membrane is freely permeable to any ion it will create a potential difference between in & out of the cell
  - So, we put the electrode on the surface of membrane & microelectrode below the surface and measure the potential
  - If the ion is freely movable then the magnitude of potential difference for that ion at equilibrium is known as **Nernst potential aka Equilibrium Potential**
  - Normal polarity of cell is usually negative
- **Equilibrium Potential:-**

$$\text{Eq pot} = RT/ZF \log_n Co/Ci$$

$$61/z \log 10\ (Co)/(Ci)$$

R = Gas Constant, T = Temperature (37°C), Z = Valance F = Faraday's constant, Co = concentration outside, Ci = concentration inside

- **Permeability:**
  - Sign as P = between 0-1 (1 = fully permeable, 0 = not permeable)
  - At rest k(1) >> Cl (0.45) >>>> Na^+(0.04)
- **Effects of ions on RMP:**
  - K^+:
    - In case of **Mild - Moderate hyperkalaemia**:- decreased gradient towards outside so, K+ will not move outside & hence accumulates inside the cells causing depolarization. It also increases excitability
    - **Severe hyperkalemia** leads to persistent depolarization which inactivates the Na^+ channels & decreases the excitability
  - Na^+:
    - No effect on RMP

Extra edge

- Ca^{2+}:
  - Is a membrane stabilizing agent
  - If there is hypocalcemia, means less inhibitory regulation, so, ↑↑ Na^+ gets entry inside the cell which increases excitability
  - If hypercalcemia, decreases excitability
- Mg^{2+}:-
  - Also acts as membrane stabilizing agent specially in neurons
  - Severe deficiency of this can lead to seizures
- GHK equation
  - (Goldman Hodgkin's Katz equation)
  - RMP = £(EPx × Px) + (EPy × EPy) + (EPz × EPz)