Toppersnotes
Unleash the topper in you

NEET-PG

PART-A

VOLUME-II

Physiology

SIERRA INNOVATIONS
Private Limited

PHYSIOLOGY

GENERAL PHYSIOLOGY

Total body water [TBW]:

- 60% of Body wt.
  - 2/3 ICF (40%)
  - 1/3 ECF (20%)
    - ↳ Plasma (5%)
    - ↳ ISF (15%)
    - ↳ Transcellular fluid (1.5%)
      - • Pleural fluid
      - • Pericardial fluid
      - • Joint space
      - • Aq. Humor
      - • CSF

'60 - 40 - 20 Rule'

↓ TBW ↓ ICF ↓ ECF

Transcellular fluid : 1.5% Body wt.
OR,
< 1kg in 70kg man.

Factors affecting:

(a) Age:

As Age ↑ TBW ↓

- Infants - 70%
- Adults - 60%
- Elderly - < 60%

(2) Fat:

↑ Fat ↓ TBW

- Obese person → TBW less than (N) person.

♂	♀
60%	50%

Toppersnotes
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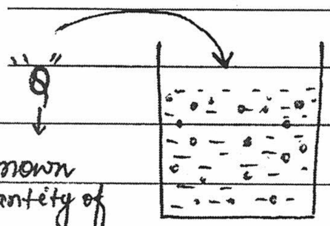
Water content of lean body tissue → constant
(Body tissue − Fat)
- 71 − 72%
- 71-72 ml/100g of lean body tissue

TBW is same in ♂ & ♀ ⇒ Pre-pubertal age group.
(10 - 18 yrs)

Measurement:

Dye dilution technique / Principle of volume distribution:

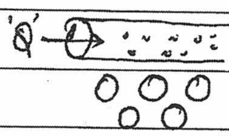


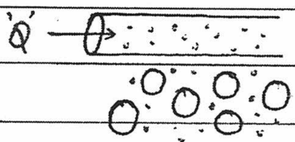
Known quantity of suitable dye / Indicator / Tracer.

→ Withdraw sample
↓
Concn. of Dye 'C'

$V = \frac{Q - e}{C}$, e = Amount of dye metabolized / excreted during procedure.

Plasma Dye − Evan's Blue (T1824)
RAI labelled Albumin

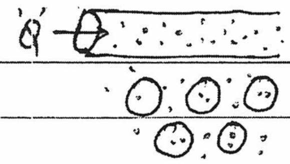




Plasma + ISF
ECF

- Inulin (Most accurate)
- Sucrose
- Mannitol
- Radioactive Sodium

'Q'



TBW
- D_2O (Most frequently used)
- Tritium oxide
- Aminopyrine

Indirect
- ICF = TBW − ECF
  (D_2O, Inulin)
- ISF = ECF − Plasma
  (Inulin, Evan's Blue)
  ↓ Best dye.

ECF vol^m = ?

Q = 10g of Inulin = 10000 mg of Inulin

Then after EQUILIBRATION

Plasma inulin = 50 mg/dl = 0.5 mg/ml

e = 10% = 1g = 1000 mg

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

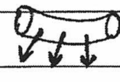
$$= \frac{10000-1000}{0.5}$$

$$= 18000\ ml$$

$$= 18L$$

Dye ('XYZ') – used to determine Plasma Vol.

Replace by → 'ABC' – diffuses out of tissue capillaries.



• # Plasma vol c̄ Dye 'ABC'

ⓐ Same as c̄ Dye 'XYZ'

ⓑ Falsely low

✓ⓒ Falsely high

$V = \frac{Q-e}{C}$, $e = 0$

$V = \frac{Q}{C\downarrow}$

Measurement of Solute concentration :

MOLE : Gram molecular weight

32g of O_2 = 1 mole of O_2

58·5g of NaCl = 1 mole of NaCl

67000g of Albumin = 1 mole of ALB.

↓

6.023×10^{23}

Millimole = $\frac{1}{1000}$ th of mole.

OSMOLE :

$$1\ OSM = \frac{1\ \text{mole}}{\text{No. of freely moving particles liberated in solution}}$$

eg: 1 OSM of NaCl = $\frac{1\ \text{mole of NaCl}}{2}$

1 mole of NaCl = 2 OSM

1 " " KCl = 2 OSM

" " " $CaCl_2$ = 3 OSM

" Na_2SO_4 = 3 OSM

" $C_6H_{12}O_6$ = 1 OSM

" ALB = 1 OSM

" UREA = 1 OSM

Milli OSM = $\frac{1}{1000}$ th of OSM.

OSMOLALITY	OSMOLARITY
• No. of osmole of solute per kg of solvent.	• No. of osmole of solute per litre of solution.
• Not affected.	• Affected by tempr.
• Better to use.	

Plasma Osmolality :

A) 260-270 mOsm/L
B) 270 - 280 mOsm/L
C) 280 - 290 mOsm/L ✓
D) 290 - 300 mOsm/L

A) 270 mOsm/L
B) 280 mOsm/L
C) 290 mOsm/L ✓
D) 300 mOsm/L

Maxm contribution to plasma osmolality is by—

A) Sodium & its associated anions → 270 mOsm ✓
B) Glucose → 5 mOsm
C) BUN → 5 mOsm
D) Plasma proteins → 2 mOsm
E) Remaining ions → 8 mOsm

290 mOsm.

↑ Plasma osmolality → Stimulates Osmoreceptor (Ant. Hypothalamus)

(Eg. Sweating)

5 mOsm/L ↳ Supraoptic nucleus
↑ ADH

10 mOsm/L ↳ Lateral hypothalamus
↑ THIRST

• Called ADH - Thirst mechanism for regulation of Plasma Osmolality.

Ⓝ Plasma protein → 6-8 g/dl

ALB → 3.5 - 5.0 g/dL

35-50 g/L (Fairly high concⁿ)

67000 g of ALB = 1 mole of ALB = 1 osm of ALB

50 g of ALB = $\frac{1}{67000} \times 50$

= 0.00075 mole of ALB

= 0.00075 osm of ALB

No. of mole/osm of protein = $\frac{\text{conc (g/L)}}{\text{Molecular Weight}}$ ↑ ↑↑

Proteins → Contribute only 2 mOsm to plasma osmolality bcoz

A) High molar conc. ; High molecular weight.
B) Low " " ; Low " "
C) High " " ; Low " "
D) ✓ Low " " ; High " "

Plasma protein → 2 mOsm ∵

A) ✓ High concⁿ ; High molecular weight
B) Low " ; Low " "
C) High " ; Low " "
D) Low " ; High " "

Calculation of Plasma Osmolality: mOsm/L

$= 2[Na^+ + K^+] + 0.055[GLU] + 0.36[BUN]$

- $2[Na^+ + K^+]$: mmol/L or mEq/L; ≈ $2[Na^+]$
- GLU: mg/dL ↓ 1/18
- BUN: mg/dL ↓ 1/2.8

Q. Na^+ = 140 mmol/L
K^+ = 5 mmol/L
GLU = 5 mOsm/L
BUN = 5 mOsm/L

Plasma Osmolality = 2 [140+5] + 5 + 5
= 2 × 145 + 5 + 5
= 300 mOsm/L

Measurement of Plasma Osmolality by Freezing point depression:

- 1 osm of solute depresses freezing point by 1.86 °C.
- 1mosm of solute depresses freezing point by 0.00186 °C

Q. Freezing point of Plasma:
A) 0°C
B) + 0.54 °C
C) − 0.54 °C ✓
D) −1.86 °C

1 mOsm/L = − 0.00186 °C
290 mOsm/L = 29 × −0.00186 °C
≈ −0.54 °C

Q 1 osm/L ; Freezing point
① 0°C
② +1.86 °C
③ −1.86 °C ✓

Fpt. → Freezing point
$\underline{c}$ → Which

No. of mOsm/L = – (F.pt.) / –.00186°C
(PL. osmolality)

Plasma Osmolality by F.pt. depression → More accurate.

(N) difference b/w PL. Osm by Fpt. depression & PL. Osm by using formula ≤ 10 mOsm.

If difference b/w 2 methods > 10 mOsm
→ K/A OSMOLAL GAP

OSMOLAL GAP + A/E
A) Mannitol ✓
B) Ethylene glycol ✓
C) Methanol ✓
D) Hyperglycaemia ✗ (No osmolal gap)

- Osmolal gap is seen in presence of extraneous substance in plasma.

Q. Into $\underline{c}$ solⁿ have RBCs been suspended (RBC swell up)
✓A) 140 mmol. GLU = 140 mOsm = Hypotonic
B) 280 mmol GLU = 280 mOsm = Isotonic
C) 140 mmol NaCl = 280 mOsm = "
D) 280 mmol NaCl = 560 mOsm = Hypertonic

	ECF	ICF
OSMOLALITY	290 mOsm/L	290 mOsm/L
MAJOR CATION	Na^+	K^+
MAJOR ANION	Cl^-	Miscellaneous phosphates > Protein
MOST OSMOTICALLY ACTIVE	Na^+	K^+
MAJOR BUFFER	HCO_3^-	Proteins >>> phosphate (Bcoz of PK of protein is close to intracellular pH) PK = Equilibrium constant
pH	7.35 – 7.45	7.1 H^+ concn → Slightly more than ECF

Q. Which is higher in ECF

A) Osmolality

B) Phosphate

C) Protein

D) pH ✓

Osmotic Adaptation:

- Seen in Chr. hypernatremia
  ↳ > 24-48hrs
  ↓
  Brain cells show osmotic adaptation
  i) ↑ intracellular synthesis of osmolytes
  - Betaine
  - Inositol
  - Glutamine

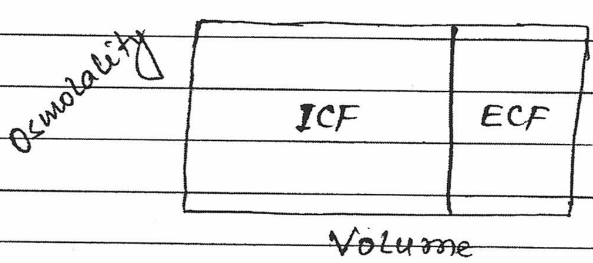
  ii) Import of Sodium

- Chr. hyponatremia (> 24-48hrs)
  → i) ↓ intracellular synthesis of osmolytes
  - Betaine
  - Inositol
  - Glutamine

  ii) Export of K^+

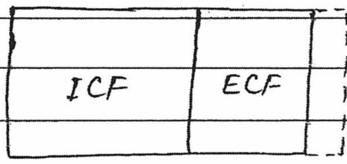
- Rapid correction of chr. hyponatremia results in Central pontine myelinosis.

DARROW - YANNET DIAGRAM (D-Y DIAGRAM):



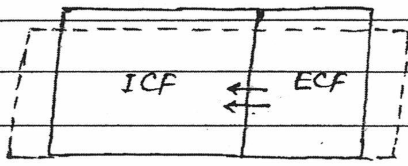
① Add^n / loss of fluid is from ECF
② ECF osmolality determines shift of fluid.
③ Shift of fluid occurs till ECF & ICF osmolality is same.

Addition of isotonic saline



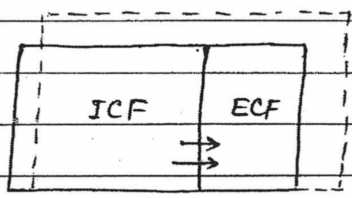
↑ ECF Vol.
ECF osm → Same
ICF Vol] Same.
ICF osm]

Addⁿ of hypotonic saline :



↑ ECF Vol
↓ ECF Osm
↑ ICF Vol
↓ ICF Osm.

Addⁿ of hypertonic saline :

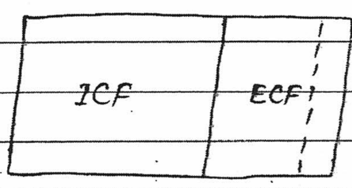


↑ ECF Vol.
↑ ECF Osm
↓ ICF Vol.
↑ ICF Osm

→ Cellular dehydration

Loss of isotonic fluids :

Hemorrhage
Burns
Initial stages of Diarrhoea or Vomitting



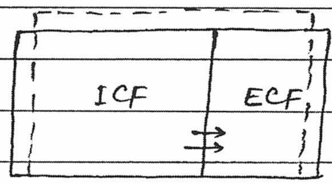
ICF ~~Vol~~] Same
ICF Osm]

↓ ECF vol
ECF osm → Same.

Loss of hypotonic fluids:

- Excessive sweating.
- Diabetes Insipidus

→ Hyperosmotic dehydration.

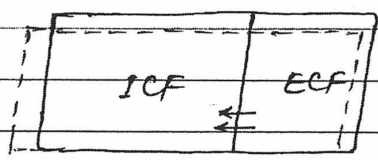


↓ ECF Vol
↑ ECF Osm
↓ ICF Vol.
↑ ICF Osm.

Loss of hypertonic fluids: Hypoosmotic dehydration

- Addison's ds.

(Mineralocorticoid deficiency)



↓ ECF Vol
↓ ECF Osm
↑ ICF Vol
↓ ICF Osm

OSMOTIC PRESSURE [OP]

- Pressure applied to stop the Osmosis.

1 mOsm of Solute → Exerts OP of 19.3 mm of Hg.

Q. O.P. of Plasma

A) 3500 mm
B) 4500 mm
C) 5500 mm ✓
D) 6500 mm

1 mOsm → 19.3
290 mOsm → 290 × 1.93
≃ 5597 mm of Hg.

O.P. = no. of mOsm of solute × 19.3 × Osmotic coefficient (Reflection coefficient)

Impermeable solute
Reflection Co-efficient, $\sigma = 1.0$

Permeable solute
$\sigma = 0$

Substance have reflection cofficient b/w 1 & 0.

COLLOID OSMOTIC PRESSURE / ONCOTIC PRESSURE:

- Pressure exerted by colloid in plasma (↓ protein)
- 25–28 mm of Hg ⇒ (2 × 19.3 × 0.7)

Q. Which protein contribute the max^m to colloid osmotic pressure:

A) Albumin ✓
B) Globulin
C) Fibrinogen
D) Prothrombin

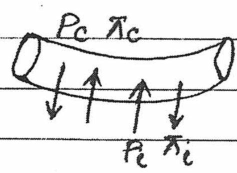
Q. Why ALB contributes max^m to Colloid Osmotic pressure

A) High conc. ; High molecular wt.
B) Low " ; Low "
C) High " ; Low " ✓ (Out of all proteins.)
D) Low " ; High "

Starling forces in Tissue Capillary:

Push force = Hydrostatic pressure
Pull " = Colloid Osmotic pressure.

P_c = Capillary hydrostatic pressure
π_c = Capillary colloid Osmotic pressure.



P_i = ISF hydrostatic pressure
π_i = ISF colloid OP

Net pressure = $P_c - \pi_c - P_i + \pi_i$

P_c = 35 mm of Hg
π_c = 25 mm of Hg
P_i = −1 mm of Hg (∵ of continuous drainage of ISF into lymphatics)
π_i = 0 mm of Hg.

Net pressure = $35 - 25 - (-1) + 0$
= 11 mm of Hg (out of capillary)

Q. P_c = 25 mm Hg
π_c = ?
P_i = 2 mm Hg
π_i = 7 mm Hg
Net pressure = 3 mm Hg.

Net pressure = $P_c - \pi_c - P_i + \pi_i$
$3 = 25 - \pi_c - 2 + 7$
π_c = 27 mm of Hg.

Rate of Tissue fluid formation $\propto$ Net pressure.

i.e. $\propto (P_c - \pi_c - P_i + \pi_i)$

$= \boxed{K_f (P_c - \pi_c - P_i + \pi_i)}$

K_f = Ultrafiltration constant.
= Permeability (1) × Surface area (2).

Hypoalbuminemia ⇒
- ↓ π_c
- ↑ Tissue fluid formation
- Edema.

Q. Organ c̄ max^m P_c → Kidney

P_{GC} = 45 mm of Hg.

Q. Organ c̄ max^m K_f → Kidney.

Q. Organ c̄ most permissible capillary → Liver (Sinusoidal)

Blood volume : 8% of Body wt.
Cell : 3% " "
Plasma : 5% " "

$\boxed{\text{Blood volume} = \frac{100}{100 - Hct} \times \text{Plasma Vol.}}$

OR,

Bl. Vol. = [redacted] $\frac{1}{1 - Hct}$ × Pl. Vol.

Where Hct = Hematocrit

CELL MEMBRANE :

Thickness = 7·5 nm or 75 A°

• Lipid bilayer + Proteins

↓ Symm. arranged.

↳ • Receptors
• Channels
• Antigens
• Transport
• Structural
• Enzymes. (Always peripheral protein)

• Protein → Integral, Peripheral

• 'Fluid-Mosaic model'
  • Gel like

Q. In terms of dry wt. of cell membr; maxm amount
A) Lipid
B) Protein – 52% of Dry wt.

Lipid : protein = 1:1