Foundation Block

Physiology team 441

2-
Body Fluids & Electrolytes

Team Leaders

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Editing File

Color index

- Main Text
- Important
- Dr's notes
- Female
- Male
- Extra

Objectives

At the end of this lecture you should be able to:

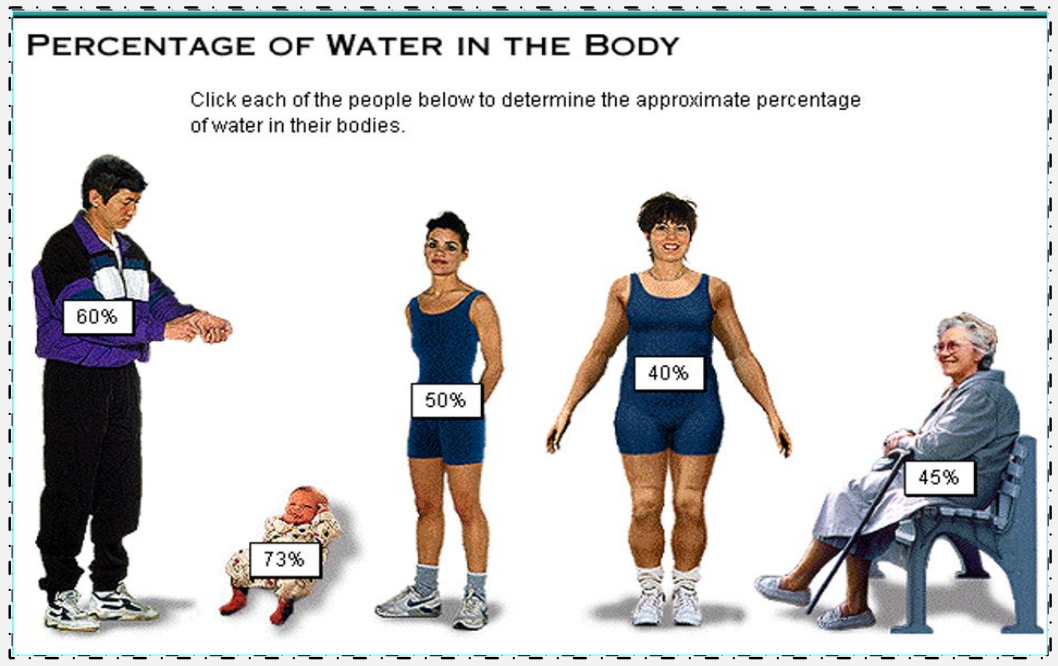
- Identify and describe daily intake and output of water and maintenance of water balance.
- List and describe of body fluid compartments as intra-cellular fluid (ICF), Extracellular fluid (ECF), interstitial fluid, transcellular fluid and total body water(TBW).
- Describe the composition of each fluid compartment, in terms of volume and ions and represent them in graphic forms.
- Physiology factor influencing body fluid: age, sex, adipose tissue, etc. Pathological factors: Dehydration, fluid infusion.

★ Factors that affect the TBW

Human body contain 40-70% water.

	Percentage of body water	clarification
Infants	73% or more 70-73%	Have low body fat, low bone mass.
Healthy males adult	60%	Lower body fat, larger amount of skeletal muscle.
Healthy females adult	40-50%	Higher body fat, smaller amount of skeletal muscle.
Older age	45%	Total body water declines throughout life.
Obese	45%	-

Example:
70 Kg man has 42 L of water.
1 Kg of water = 1L of water.



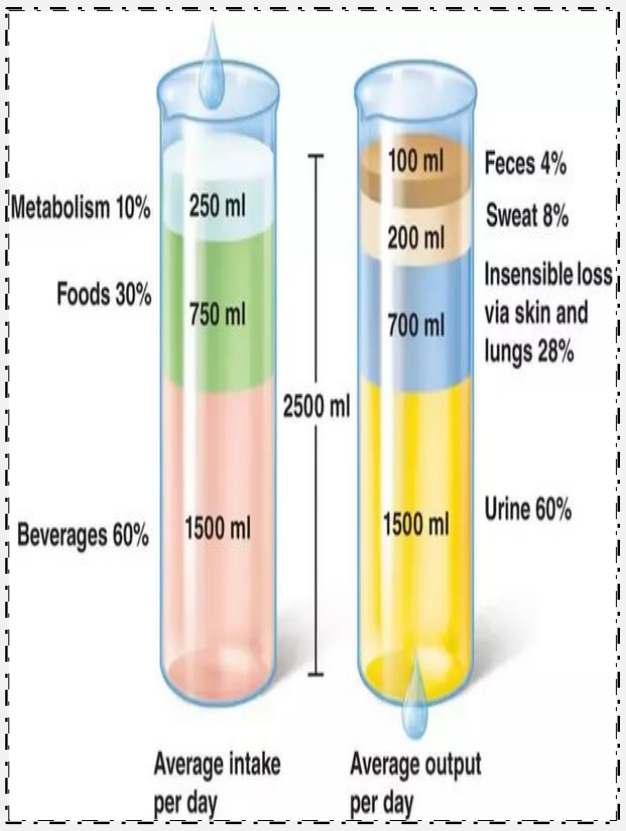
★ Daily Intake and output Of Water

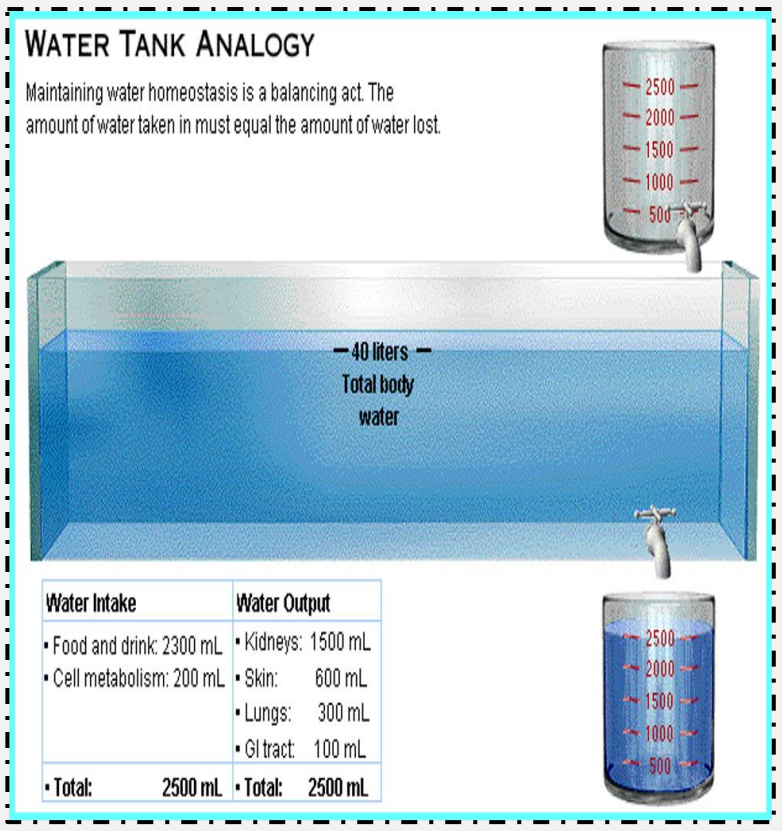
Total intake = Total output

Table 25-1

Daily Intake and Output of Water (ml/day)

	Normal	Prolonged, Heavy Exercise
Intake		
Fluids ingested	2100	?
From metabolism	200	200
Total intake	2300	?
Output		
Insensible—skin	350	350
Insensible—lungs	350	650
Sweat	100	5000
Feces	100	100
Urine	1400	500
Total output	2300	6600





Main output can change by changing in the physiological condition

★ Regulation of water intake depends on:

Climate

Habits

Level of physical activity

★ Regulation of water intake

- The **hypothalamic thirst center** is stimulated according to the following table:

Factor of stimulation	Increase or decrease	Percentage of stimulation (%)
Plasma volume	Decrease	10% - 15%
Plasma osmolality (Concentration)	Increase	1% - 2%

In steady body state water intake =water loss

The hypothalamic thirst center is more sensitive to plasma osmolality than plasma volume Due to osmolality's low percentage of stimulation.

★ Factors that affect the TBW

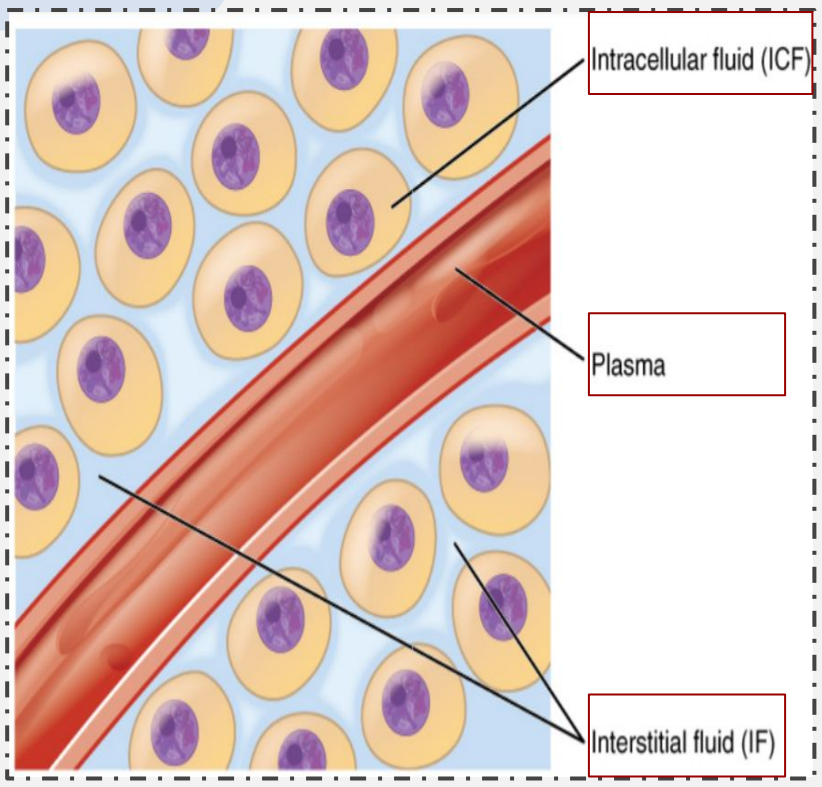
- **Physiological** factors:
  1. Age.
  2. Sex.
  3. Body fat.
  4. Climate.
  5. Physical activity.

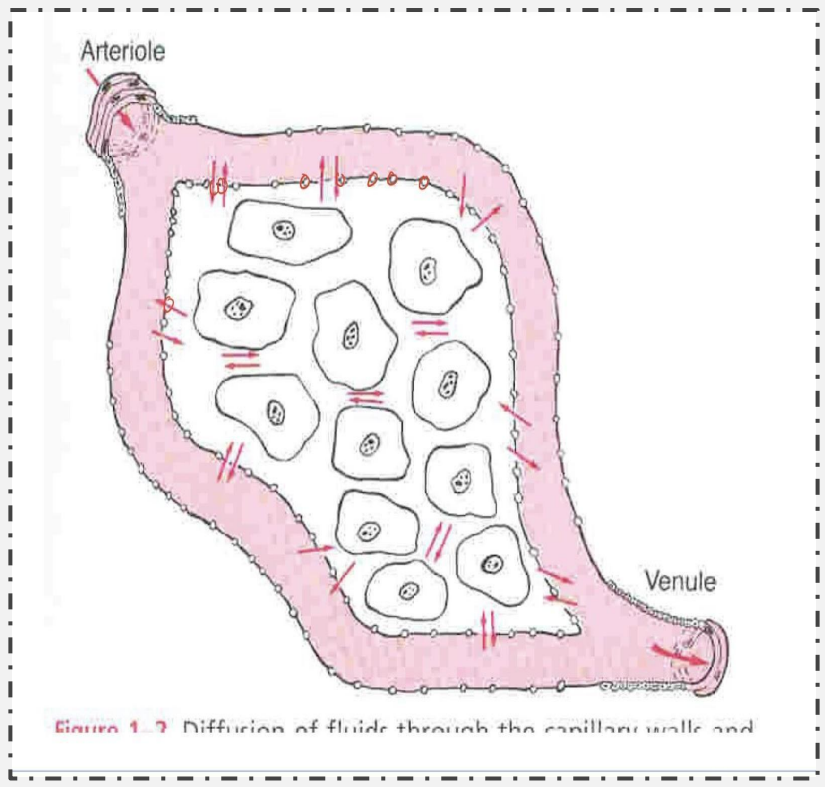
- **Pathological** factors:
  1. Vomiting .
  2. Diarrhea .
  3. Diseases with excessive loss of water(excessive sweating,diabetes mellitus (DM)).
  4. Blood loss.

★ Fluid Compartments :

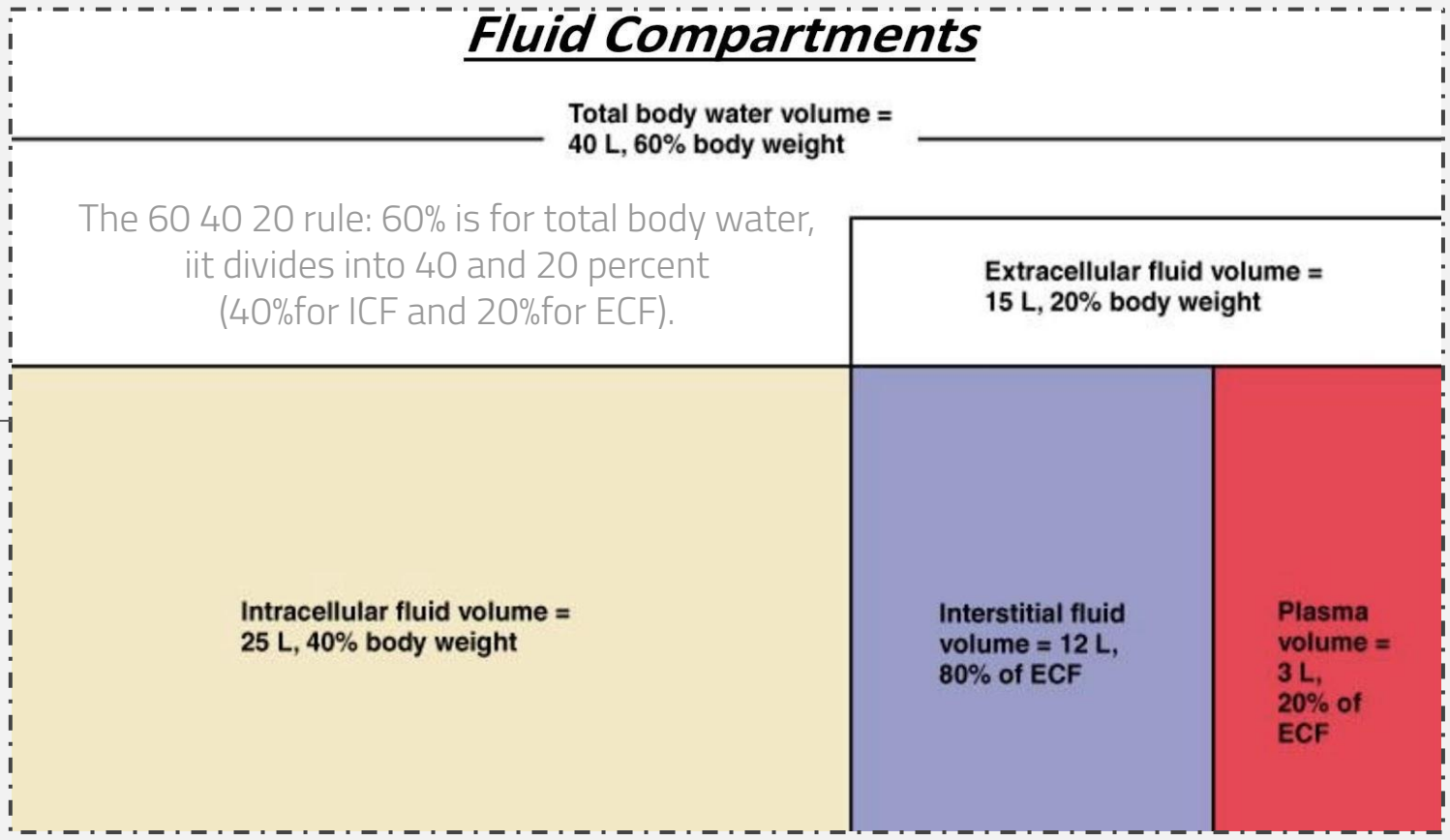
- Water contains 2 fluid compartments:

- Intracellular fluid (ICF).
- Extracellular fluid(ECF): which contains plasma and interstitial fluid (IF).

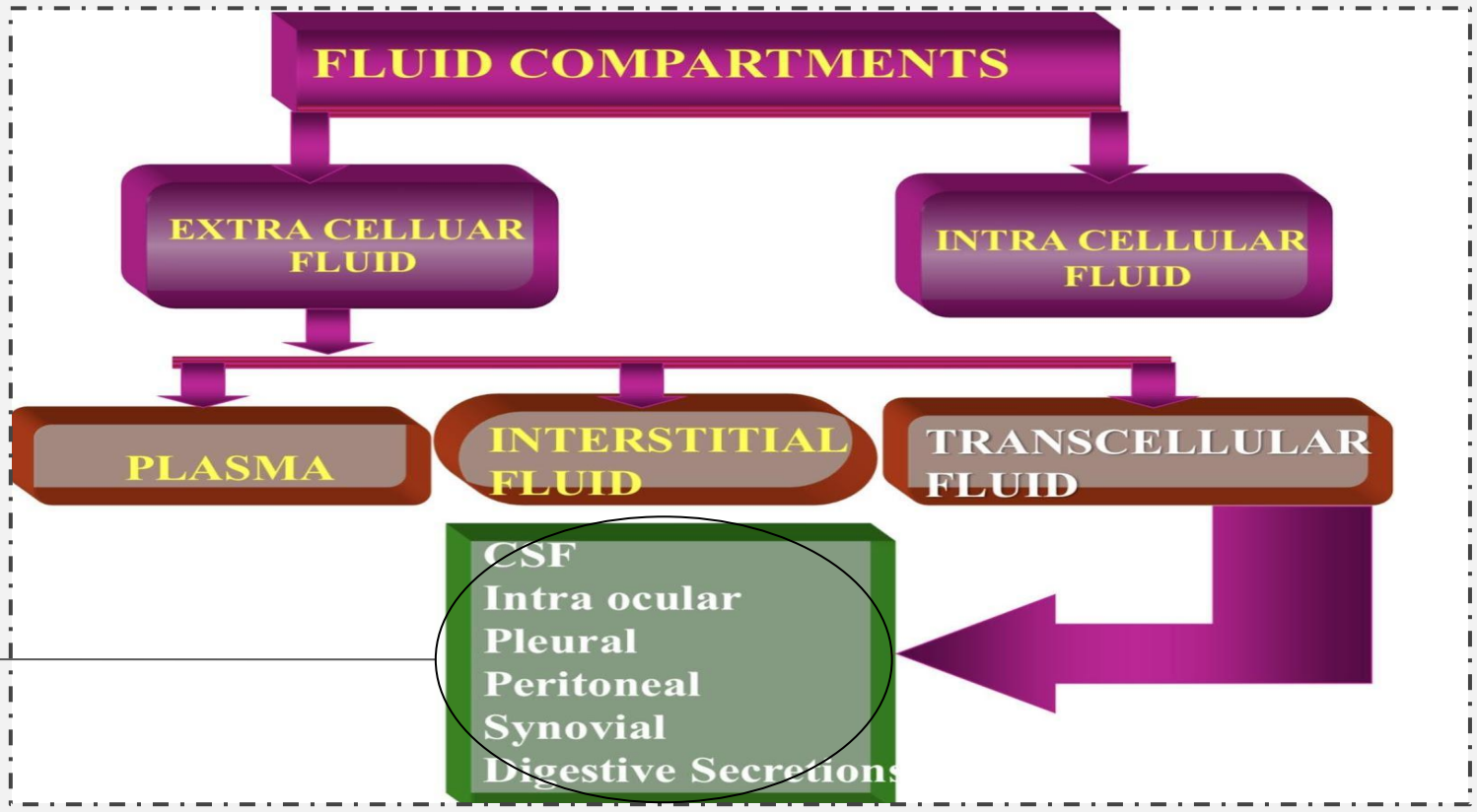




Dr.Nervana Mostafa notes these tables is Very very Important;



Dr.Nervana Mostafa notes this isn't important ;



★ Fluid Compartments :

Total Body Water (TBW)
(70 Kg man) 42 litres

Extracellular Fluid Volume (ECF)
1/3 of Total Body Weight = 14 Litres

- Interstitial Fluid 3/4 of ECF = 10.5 Litres
- Plasma 1/4 of ECF = 3.5Litres

Intracellular Fluid Volume (ICF)
2/3 of Total Body Weight = 28 Litres

Dr.Nervana notes this is Very Important;

TBW = 0.6 x Body weight

Note:
Interstitial fluid Ranges between 75%-80% Of ECF
Plasma ranges between 20%-25% of ECF.

★ Intracellular and extracellular fluid

- Intracellular fluid (ICF):

Inside the cell.
⅔ of TBW .
High concentration of protein.

- Extracellular fluid (ECF):

Outside the cell.
⅓ of TBW.

- Consists of:

1. Plasma: fluid circulating in blood vessels.
   20%=¼ of ECF.
2. Interstitial fluid: fluid bathing the cell.
   Ultra filtration of plasma.
   80% =¾of ECF.
3. Transcellular Fluid Compartment (TCF);

- Small amount

★ Example: [Dr.Nervana notes this isn't important ;]

- CSF , GIT Fluid , Biliary Fluid , Synovial Fluid , Intrapleural Fluid ,Intraperitoneal Fluid ,Intrapericardial Fluid and Intraocular Fluid .

- Plasma and interstitial fluid are almost having the same composition except for high protein concentration in plasma.
  Protein concentration : ICF>ECF>plasma>interstitial fluid.
  Internal environment is; plasma+interstitial fluid (if).
  -Interstitial fluids are composed from ultrafiltration of plasma in capillary walls.

Calculate the total body water content of a 40-year-old 70kg man?
TBW=0.6*70=42L.

- How many (L) lie intracellularly?
  ICF=TBW*⅔=42*⅔=28L.
- How many (L) lie extracellularly?
  ECF=TBW*⅓=42*⅓=14L.
- How many (L) constitute the interstitial fluid (IF)? IF=ECF*¾=14*¾=10.5L
- How many (L) are in plasma?plasma=ECF*¼=14*¼=3.5L

Thanks to 439 team

★ Composition Of Body Fluid:

Solutes are broadly classified into :

- Electrolytes : inorganic salts , all acids and bases , and some proteins.
- Nonelectrolytes : examples include glucose , lipids , creatinine and urea .

Concentration:

Dr.Nervana notes this isn't important ;

Amount = in moles , osmoles .

- ❏ Molarity = moles/liter (M/L).
- ❏ Osmolarity = osmoles/liter (osm/L).
- ❏ Osmolality = osmoles/Kg (osm/kg).

In Biological Solution : [بحكم انه الكميات قليلة]

Dr.Nervana notes this isn't important ;

- Milimoles per liter (mM/L)
- Miliosmoles per liter (mOsm/L)

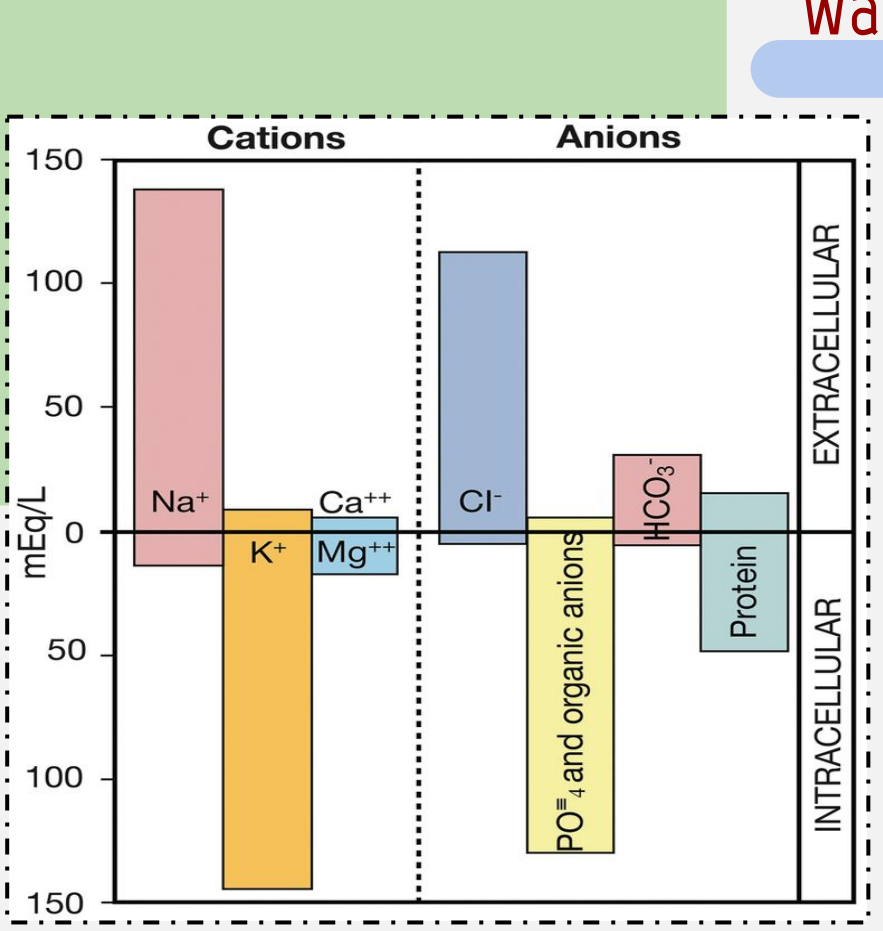
1mM=1/1000 M

1mOsm=1/1000 Osm

Water is the universal solvent

Electrolytes in other words are Charged molecules

→ Each compartment must have almost the same concentration of positive charge (cations) as of negative change (anion) .
(Electroneutrality)



Dr.Nervana notes this is Very Important;

Electroneutrality [Extra information]:

- Electroneutrality means the concentration of Anions almost equal to the concentration of cations In each compartment (ECF or ICF).
- By a simple calculation;

Cations: { Na= 141, K=4.5, Ca=2.5, Mg=2} = 150 mEq/L
Anions:{Cl=103, HCO3=25, PO4=3.5, Proteins*=15}=146.5mEq/L.

All values are for example and may be vary

*Proteins are found with higher concentrations in the Interstitial fluid than the plasma

★ Electrolyte Concentration

Dr.Nervana notes this isn't important ;

- Expressed in **milliequivalents per liter (mEq/L)** , measure of number of **electrical charges** in one liter of **solution**.
- mEq/L = (concentration of ion in [mq/L]/ the atomic weight of ion) x number of electrical charges on one ion .
- For single charged ions , 1 mEq=1 mOsm
- For bivalent ions , 1 mEq = ½ mOsm

★ Extracellular and Intracellular Fluids

➔ Each fluid compartment of body has a distinctive pattern of electrolytes.

➔ Extracellular fluid are similar (except for the high protein content of plasma)

❖ Sodium is the chief cation (Positive charge).

❖ Chloride is the major anion (Negative charge).

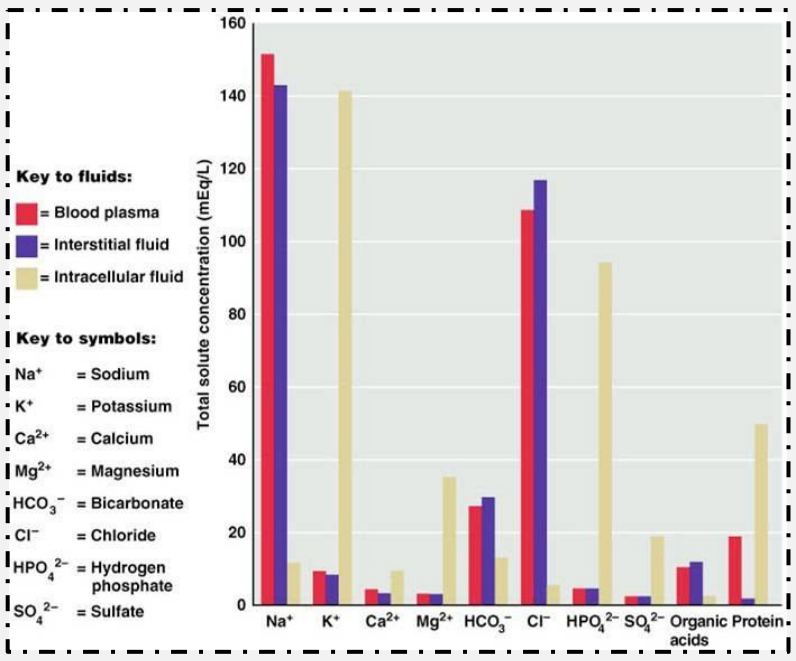
➔ Intracellular fluid has has low sodium and chloride .

❖ Potassium is the chief cation (Positive charge).

❖ Phosphate is the chief anion (Negative charge).

Body constitutes are normally regulated within a range rather than a fixed values.

Constituents of ECF and ICF



Extracellular Fluids	Intracellular fluids
Have low potassium and phosphate	have low sodium and chloride
Sodium is the major cation	Potassium is the major cation
Chloride is the major anion	Phosphate is the major anion

Thanks to 439 Team 🙏 x2

➔ Normal Range of:

Na+ = 135-145 mEq/L
K+ = 3.6-5.2 mEq/L
All ranges may be vary depends on the laboratory's reference

Hypo- = less
Hyper- = more

Hypo**k**alemia : decrease in **K** concentration in the **ECF** .
1-2 mEq/L

Hyper**k**alemia : increase in **K** 60-100%above normal.

Remember K with K

Hypo**na**tremia : decrease in **Na** concentration in **ECF** .

Hyper**na**tremia : increase in **Na** concentration in the **ECF**

Remember Na with Na

★ Regulations of fluid exchange between extracellular fluid and intracellular fluid (through cell membrane);

★ intracellular fluid (ICF):

cell membrane

★ extracellular fluid (ECF):

- Highly permeable to water .
- Relatively impermeable to small ions . i.e. only water is moving.
- Osmotic effect of electrolytes (Na,K,Cl)

Test yourself

★ MCQs

Q1:Compared with the ICF, the ECF has ..... Phosphate ion concentration			
A- higher	B-lower	C-equal	D-zero
Q2:What is the chief cation in the ECF			
A- phosphate	B-sodium	C-chloride	D-potassium
Q3:When someone is thirsty the plasma osmolality			
A-increases	B-declines	C-doubled	D-tripled
Q4: sweat represents ..... Of daily average output of water			
A-4%	B-8%	C-28%	D-60%
Q5: If the Na+ concentration in the interstitial fluid is 138 mmol/l , Which one of these choices is the approximate plasma concentration for normal person			
A- 141	B- 130	C-14	D-274

1-B 2-B 3-A 4-B 5-A

★ SAQ

Calculate the plasma volume (in liters) in a 32-year-old male weighs 60kg

10 liters

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