

Editing file



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Body fluids & electrolytes



objectives




1- Identify and describe daily intake and output of water and maintenance of water balance.

2- List and describe of body fluid compartments as intra-cellular fluid(ICF), Extra-cellular fluid (ECF), interstitial fluid, trans-cellular fluid and total body water (TBW).



3- Describe the composition of each fluid compartment, in terms of volume and ions and represent them in graphic forms.

4-Physiology factor influencing body fluid: age, sex, adipose tissue,etc.
Pathological factors: Dehydration, fluid infusion.





Body Water Content

In general Human body contain 50-70% or 40%-70% water.

- kg of water = Liter of water

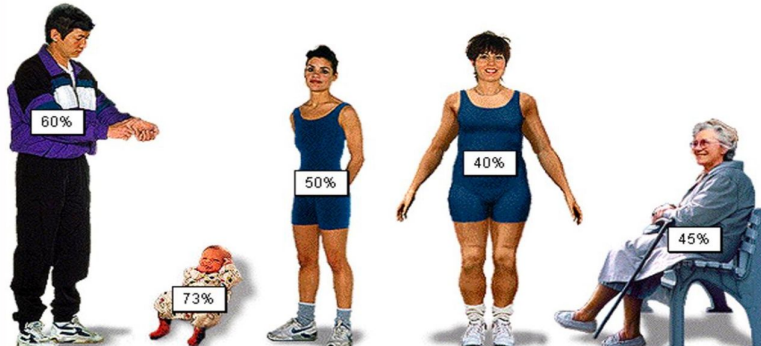
Example:

-70 kg man has 42L of water

So —> he has 42kg of water

PERCENTAGE OF WATER IN THE BODY

Click each of the people below to determine the approximate percentage of water in their bodies.



	Percentage of body water	clarification
Infants	70 - 73% or more	low body fat, low bone mass
Healthy males adult	60%	Low 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%	In general Higher body fat Means less body water

Daily intake of water

The amount of water taken = the amount of water lost

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

These numbers are average numbers so if there is a little changes in exams no problem.

For E.g:
The urine output in normal status equals:

1500

200

100

350

Regulation of Water Intake

In steady state water intake = water loss

- Regulation of water intake depends on:

Climate

Habits

Level of physical activity

- The hypothalamic thirst center is stimulated:

By a **decline** in plasma volume of 10%–15%

By **increases** in plasma osmolality of 1–2%

decline in plasma volume stimulates hypothalamic thirst center, but not as strongly as increased in plasma osmolality.

إذا نقص البلازما فوليوم بنسبة 10 الى 15 وهي نسبة عالية بيتحفز ال thirst center لكن لو نقص البلازما فوليوم بنسبة 1الى2 ما رح يحفز ال thirst center في المقابل نفس هذه النسبة البسيطة 1الى2 لو حصلت ف ال thirst center الزيادة في البلازما اوزمولاليتي بيتحفز ال

So that is why the hypothalamic thirst center is more sensitive to plasma osmolality

Factors that affect the TBW

1) Physiological factors:

- Age
- Sex
- Body fat
- Climate
- Physical activity

2) Pathological factors:

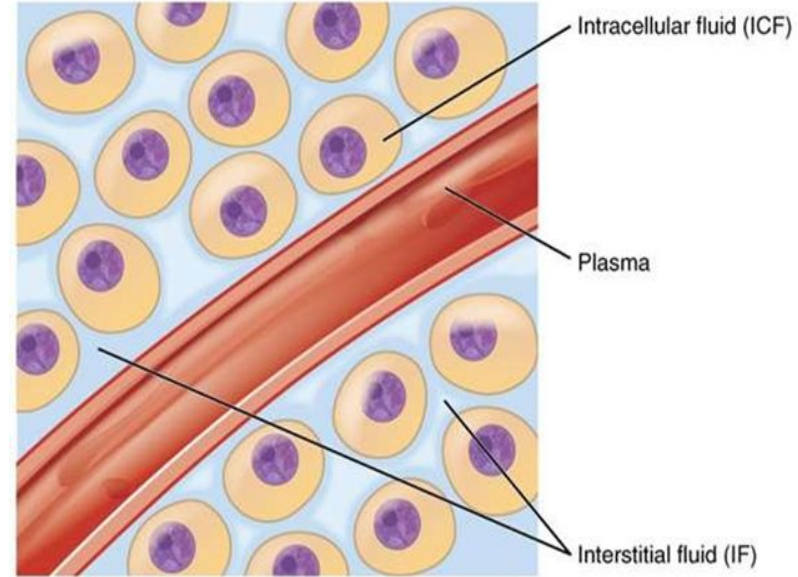
- Vomiting (القيء)
- Diarrhea (اسهال)
- Diseases with excessive loss of water (Diabetes mellitus DM, excessive sweating)
- Blood loss



Fluid Compartments :

Water occupies two main fluid compartments:

- 1) Intracellular fluid (ICF)
- 2) Extracellular fluid (ECF)
 - Plasma
 - Interstitial fluid (IF)



1) Intracellular fluid (ICF)

- Location: Inside the cell.
- Amount: 2/3 of Total body water (TBW).
- High concentration of protein

لأن البروتينات حجمها كبير فهي لا تنتقل للخارج بسهولة عبر غشاء الخلية

2) Extracellular fluid (ECF)

Location: outside the cell.

Amount: 1/3 of Total body water (TBW).



1) Plasma:

- Location: Fluid circulating in the blood vessels.
- Amount: 1/4 of ECF

2) Interstitial fluid:

- Location: Fluid bathing the cell.
- This fluid come from: Ultra filtration of plasma.
- Amount: 3/4 of ECF

3) Transcellular fluid compartment:

- Amount: small amount
- Location:

CSF سوائل حول الدماغ والحبل الشوكي

GIT fluid سوائل تفرز في القناة الهضمية

biliary fluid العصارة الصفراوية الذي يخرج من الكبد أو المرارة

synovial fluid سائل داخل المفاصل

Intrapleural fluid سائل في الغشاء حول الرئتين

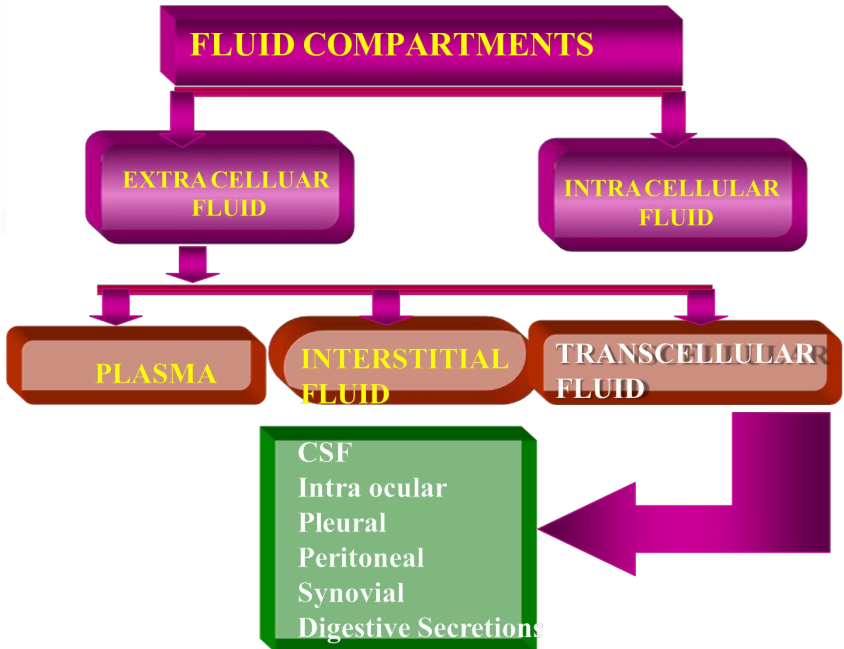
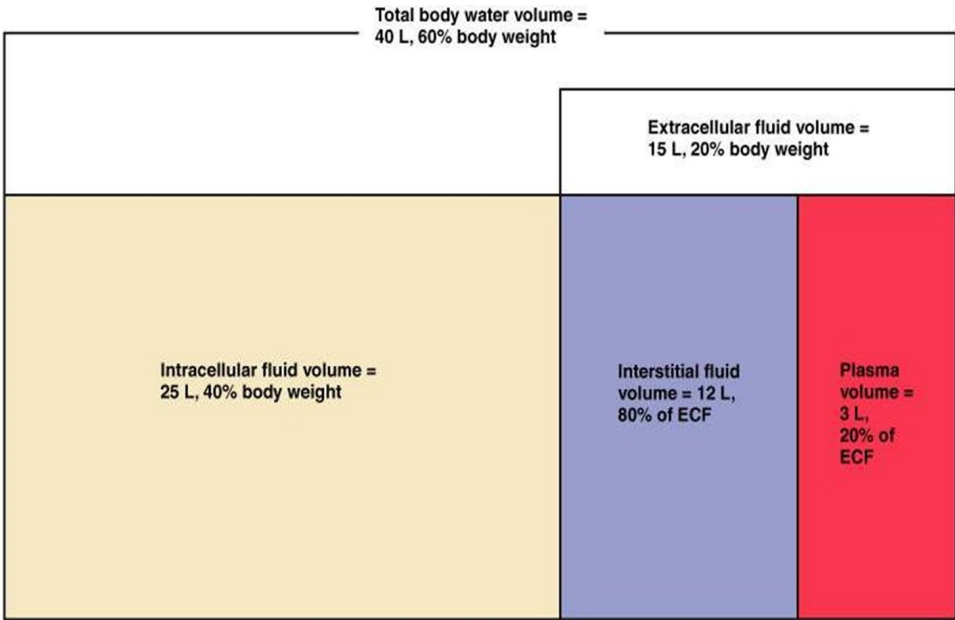
intraperitoneal fluid السوائل بداخل غشاء يغلف المعدة

intrapericardial fluid السوائل بداخل غشاء يغلف القلب

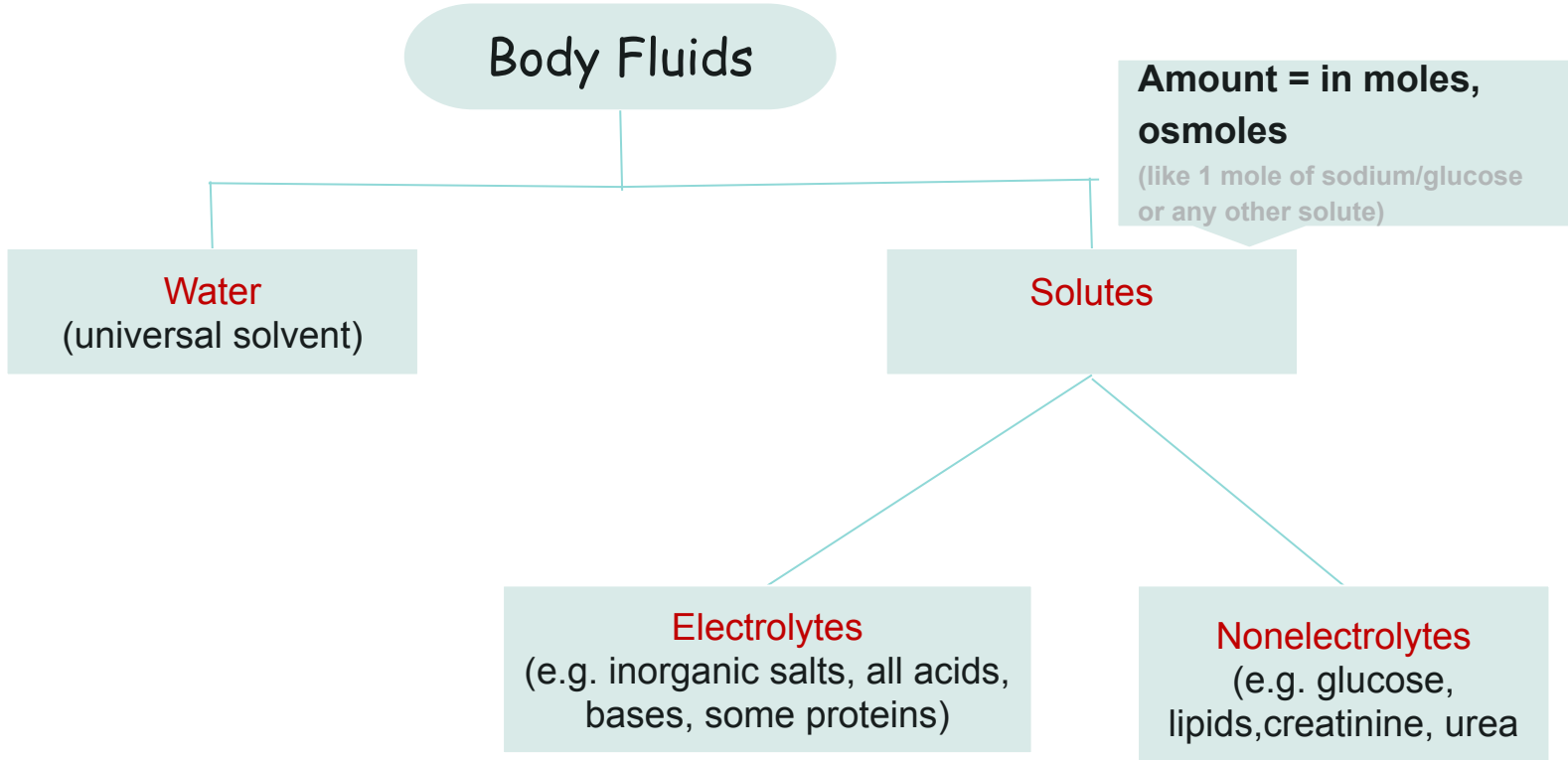
intraocular fluid سوائل داخل العينين

Plasma & interstitial fluid are almost having the same composition except for **high protein concentration in plasma**.

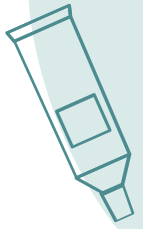
لان لما تصير عملية الفلترة البروتينات حجمها كبير ولا تستطيع الانتقال عبر غشاء اوعية الدم فتبقى في البلازما(الدم)



Composition of Body Fluids



Concentration



In general:-

Molarity =
moles/Liter
(M/L)

Osmolarity =
Osmoles/Liter
(Osm/L)

Osmolality =
Osmoles/kilogram
(Osm/kg)

Moles vs Osmoles:-

Moles are a certain solutes number (doesn't actually need to be a solute). While Osmoles (needs to be in a solute) are the number of moles that contribute to Osmotic pressure (1 Mole of NaCl dissolves into 2 Osmoles).

Which is why osmoles have the "Os" part of "Osmosis".

In Biological solutions:-

- Millimoles per liter

(mM/L)

- Milliosmoles per

(mOsm/L)

- $1\text{mM} = 1/1000\text{ M}$

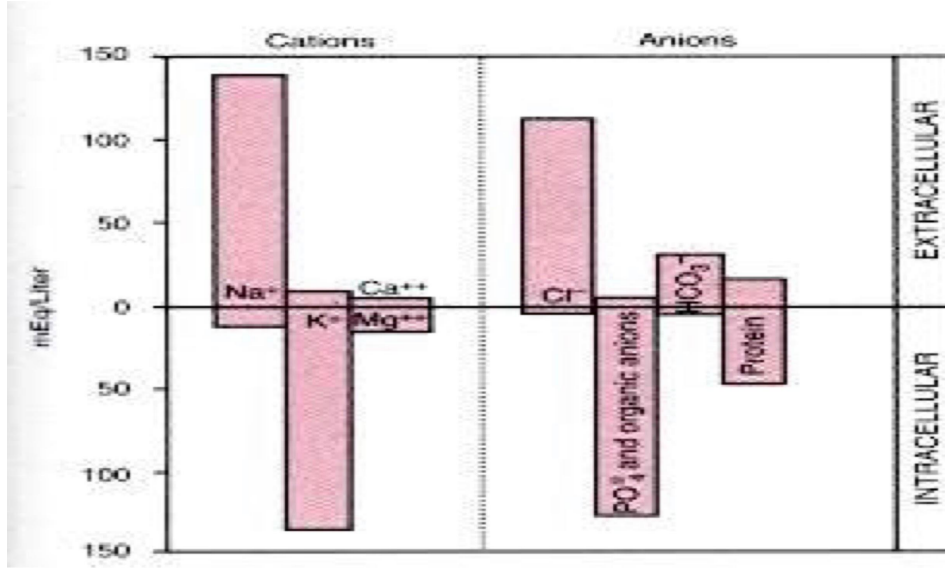
- $1\text{mOsm} = 1/1000\text{ Osm}$

In Electrolytes:-

- Expressed in milliequivalents per liter (mEq/L), a measure of the number of electrical charges in one liter of solution.
- $\text{mEq/L} = (\text{concentration of ion in [mg/L]}/\text{the atomic weight of ion}) \times \text{number of electrical charges on one ion.}$
- For single charged ions, $1\text{ mEq} = 1\text{ mOsm}$
- For bivalent ions, $1\text{ mEq} = 1/2\text{ mOsm}$



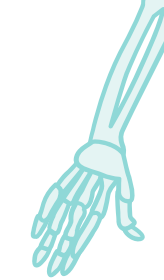
Constituents of ECF & ICF



Constituents of ECF & ICF

TABLE 20-2 OSMOLAR SUBSTANCES IN EXTRACELLULAR AND INTRACELLULAR FLUIDS

	Plasma (mOsm/liter of H ₂ O)	Interstitial	Intracellular
Na ⁺	142	139	14
K ⁺	4.2	4.0	140
Ca ⁺⁺	1.3	1.2	0
Mg ⁺⁺	0.8	0.7	20
Cl ⁻	108	108	4
HCO ₃ ⁻	24	28.3	10
HPO ₄ ⁻ , H ₂ PO ₄ ⁻	2	2	11
SO ₄ ⁻	0.5	0.5	1
Phosphocreatine			45
Carnosine			14
Amino acids	2	2	8
Creatine	0.2	0.2	9
Lactate	1.2	1.2	1.5
Adenosine triphosphate			5
Hexose monophosphate			3.7
Glucose	5.6	5.6	
Protein	1.2	0.2	4
Urea	4	4	4
Others	4.8	3.9	10
Total mOsm/liter	301.8	300.8	301.2
Corrected osmolar activity (mOsm/liter)	282.0	281.0	281.0
Total osmotic pressure at 37° C (mm Hg)	5443	5423	5423



ECF & ICF

Each fluid compartment of the body has a **distinctive pattern of electrolytes**.

Extracellular fluids are similar (except for the **high protein content of plasma** relative to interstitial fluids)

ECF

- **Extracellular fluid** has low Potassium and Phosphate.
- **Sodium** is the chief **cation**
- **Chloride** is the major **anion**

ICF

- **Intracellular fluid** has low sodium and chloride.
- **Potassium** is the chief **cation**
- **Phosphate** is the chief **anion**

Each compartment must have almost the **same concentration of negative charges (anions)** as the positive charges (Cations).

(Electroneutrality)



Abnormalities of ECF & ICF



- **Hypokalemia**: Abnormal **decrease** (1-2 mEq/L) of Potassium (**K**) concentration in ECF.
- **Hyperkalemia**: abnormal **increase** (60-100% above normal) of potassium(**K**) Concentration in ECF.

Hypernatremia: Abnormal **increase** of **Na** concentration in ECF.

Hyponatremia: Abnormal **decrease** of **Na** concentration in the ECF.

Normal range of Na and K:-

Na (135-145 mEq/L)

K (3.5-4.5 mEq/L)

The slides are hyperfocusing on ECF (specifically plasma/blood) values and Abnormalities because they are easier to measure and take compared to ICF

	Extracellular fluid	Intracellular fluid
Na ⁺	142 mEq/L	10 mEq/L
K ⁺	4 mEq/L	140 mEq/L
Ca ⁺⁺	2.4 mEq/L	0.0001 mEq/L
Mg ⁺⁺	1.2 mEq/L	58 mEq/L
Cl ⁻	103 mEq/L	4 mEq/L
HCO ₃ ⁻	28 mEq/L	10 mEq/L
Phosphates	4 mEq/L	75 mEq/L
SO ₄ ⁻	1 mEq/L	2 mEq/L
Glucose	90 mg/dl	0 to 20 mg/dl
Amino acids	30 mg/dl	200 mg/dl ?
Cholesterol	0.5 gm/dl	2 to 95 gm/dl
Phospholipids		
Neutral fat		
PO ₂	35 mm Hg	20 mm Hg ?
PCO ₂	46 mm Hg	50 mm Hg ?
pH	7.4	7.0
Proteins	2 gm/dl (5 mEq/L)	16 gm/dl (40 mEq/L)



Regulation of fluid exchange

This whole
slide is
from the
boys' side

Intracellular:-

Cell membrane

1- Highly permeable to water (I disagree, unless we include the water pumps {aquaporins})

2- Relatively impermeable to small ions (only water is moving)

Extracellular

1- Osmotic effect of electrolytes (e.g. Na, K, Cl)

Overall this boys' slide seems to be with no actual substance (Low-yield)





MCQs



1-Composed of ultrafiltration of plasma			
A) Intracellular fluid	B) Interstitial fluid	C) Transcellular Fluid	D) Both A and B
2-What is the chief cation in the ECF			
A) phosphate	B) sodium	C) chloride	D) potassium
3-When someone is thirsty the plasma osmolality			
A) increases	B) declines	C) doubled	D) tripled
4-Which of these fluids have high concentration of protein?			
A) Intracellular fluid	B) Plasma	C) Interstitial fluid	D) Both A and B
5-Which of the following is considered the “Internal Environment” of the body?			
A) Capillary walls	B) Extracellular fluid	C) interstitial fluid	D) Transcellular fluid

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



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Abdulaziz Nasser



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Lama Alahmari



Meshari Alharbi



Ziyad Bukhari



Hessah Alyousef



Samiyah Sulaiman



abdulmohsen alrahaimi



Khaled Aldukhyel



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