LECTURE 2

- Red : important
- Black : in male / female slides
- Pink : in girls slides only
- Blue : in male slides only
- Green : notes, Extra

MED438

Reviewed by Razan AlRabah & Khalid Alkhani

BODY FLUIDS

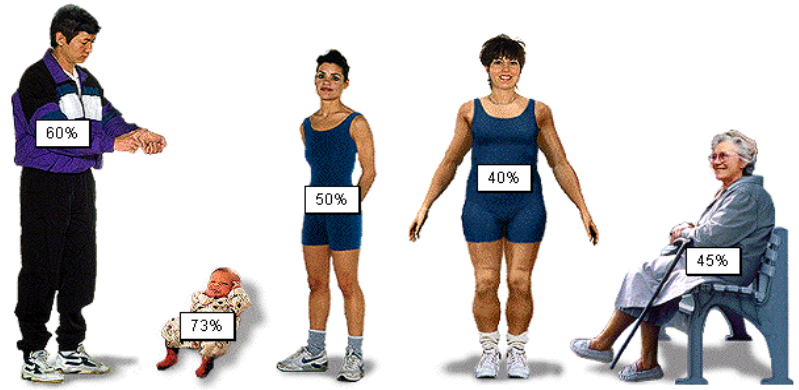
OBJECTIVES

- 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), Extra-cellular fluid (ECF), interstitial fluid, trans-cellular 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.
- Describe the physiological and pathological factors influencing the body fluid.

FACTORS EFFECTING BODY FLUIDS

AGE		
INFANTS	70%	**lower fat and low bone weight (Fleshy = قطعة لحم)**
MIDDLE AGE	40-60	Heavy bones and ,more fats.
OLDE AGE	LESS THAN 45%	Declines over time due to the shrinking of cells.

SEX		
MALES	60%	More Skeletal muscles, less fat.
FEMALES	40% - 50%	Less Skeletal muscles, More fat.



Other		
Obesity	Have less total body fluid	Due to the high amount of fats

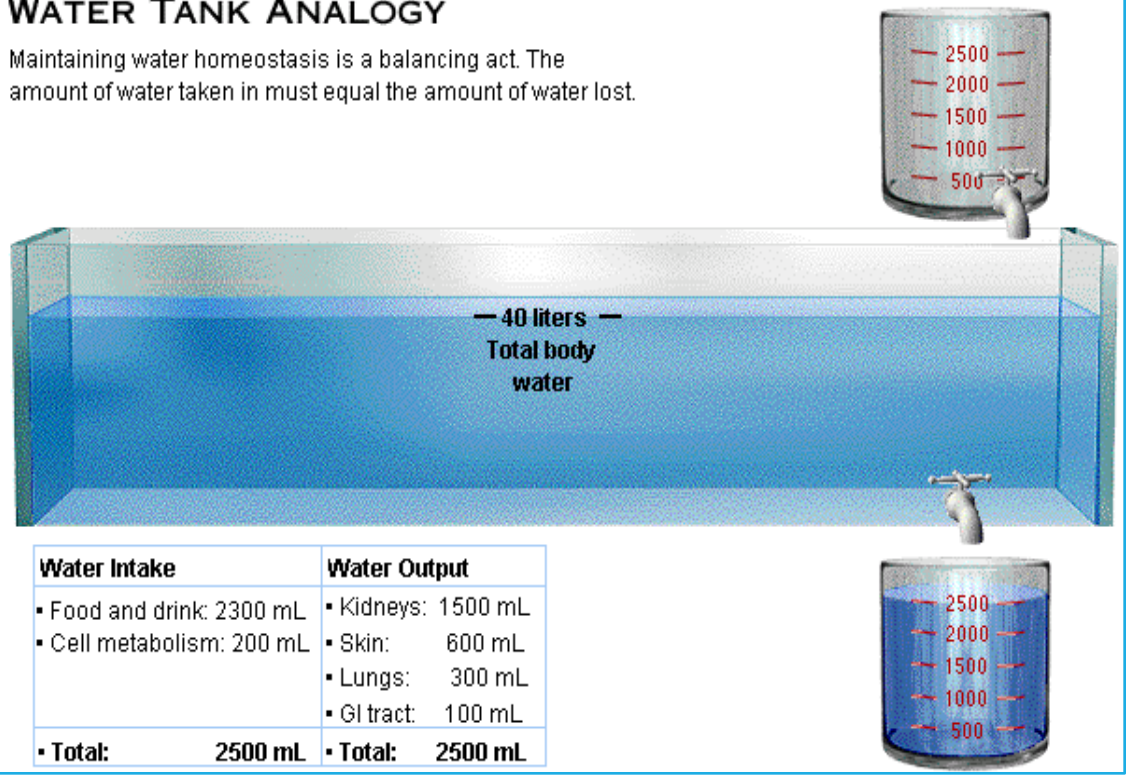
Example
70 kg man has 42 L of water. Kg of water = L of water

Total body water	
MUSCLES	50%
SKIN	20%
ORGANS	20%
BLOOD	10%

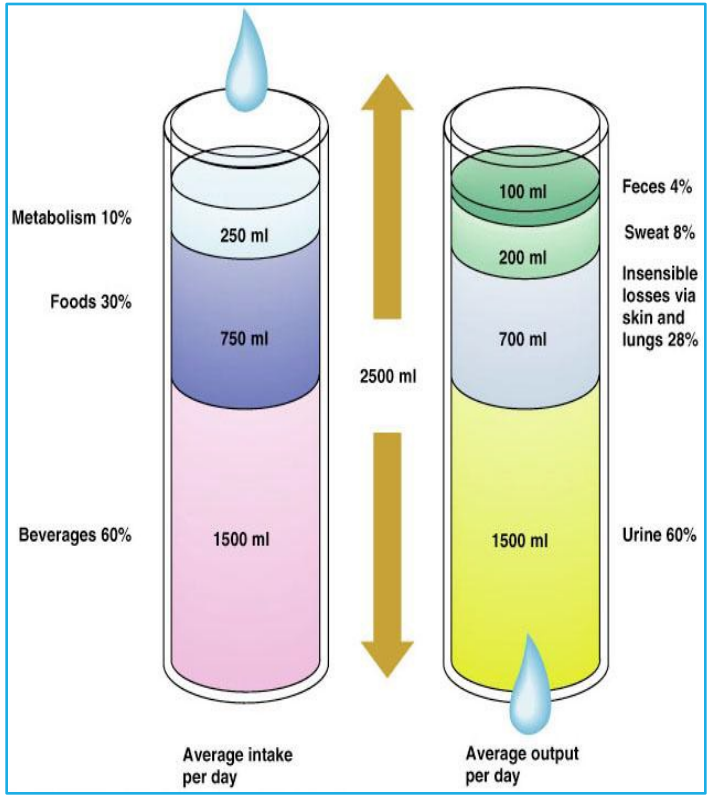
DAILY INTAKE AND OUTPUT OF WATER (ML/DAY)

WATER TANK ANALOGY

Maintaining water homeostasis is a balancing act. The amount of water taken in must equal the amount of water lost.



Water Intake		Water Output	
• Food and drink: 2300 mL		• Kidneys:	1500 mL
• Cell metabolism: 200 mL		• Skin:	600 mL
		• Lungs:	300 mL
		• GI tract:	100 mL
• **Total:**	**2500 mL**	• **Total:**	**2500 mL**



	Normal	Prolonged, Heavy Exercise
Intake		
Fluids ingested	2100	? 6400
From metabolism	200	200
Total intake	2300	? 6600
Output		
Insensible—skin	350	350
Insensible—lungs	350	650
Sweat	100	5000
Feces	100	100
Urine	1400	500
Total output	2300	6600

Total intake = Total output

TOTAL BODY FLUID

The hypothalamic thirst center is stimulated:

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

-By increase in plasma osmolality of 1% – 2%

(most sensitive to osmolality change)

FLUID COMPARTMENTS

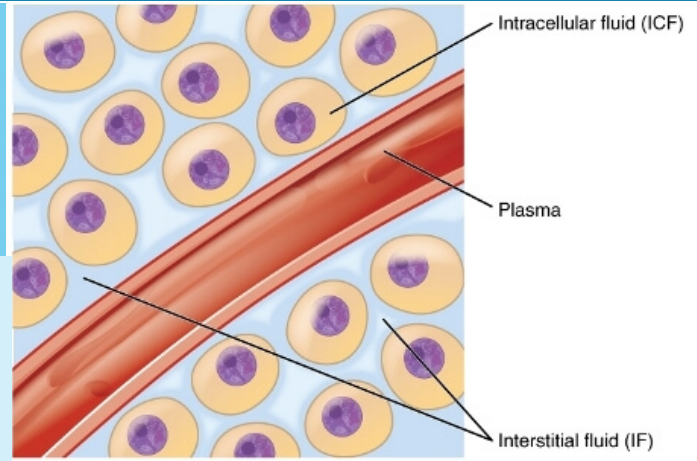
1-INTRACELLULAR FLUID (ICF)

2-EXTRACELLULAR FLUID (ECF)

2.1-INTERSTITIAL FLUID (IF)

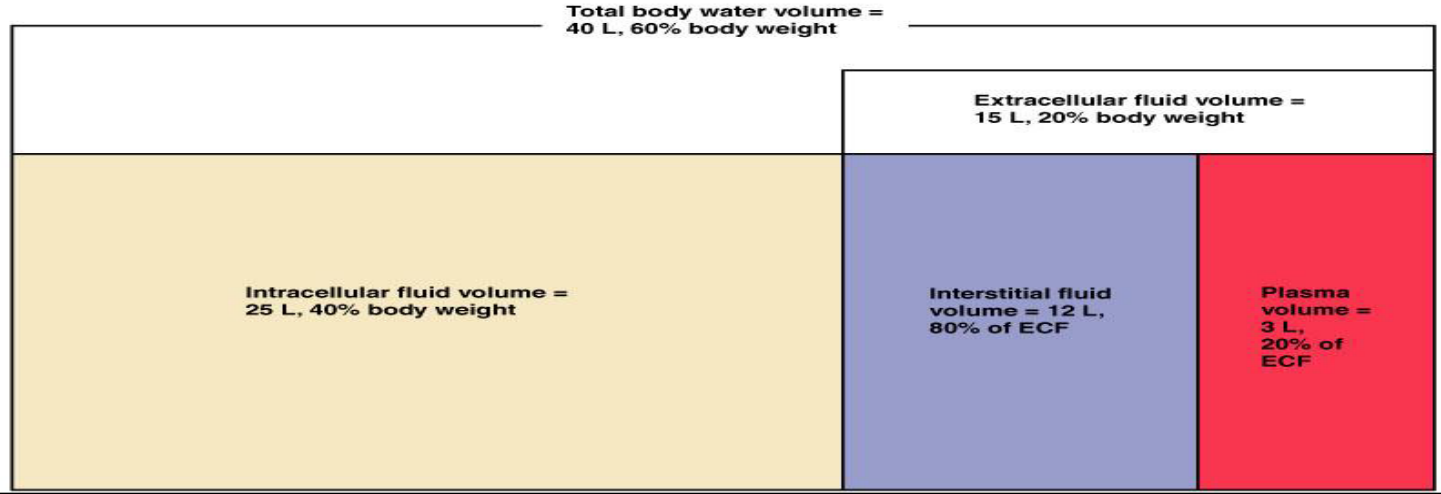
2.2-PLASMA

2.3TRANSCELLULAR FLUID



FACTORS THAT AFFECT THE TBW AND REGULATION OF WATER INTAKE:

Physiological factors	Pathological factors
Age	Vomiting
Sex	Diarrhea
Body fat	Diseases with excessive loss of water (DM, excessive sweating)
Climate and habits	
Physical activity	Blood loss

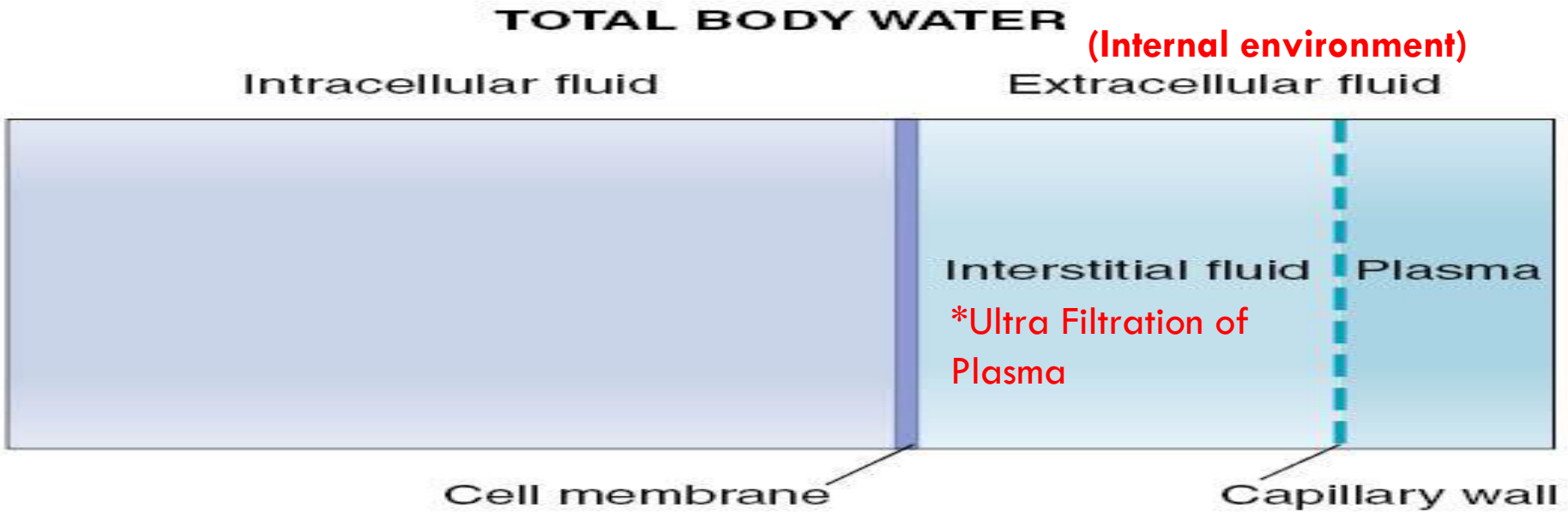


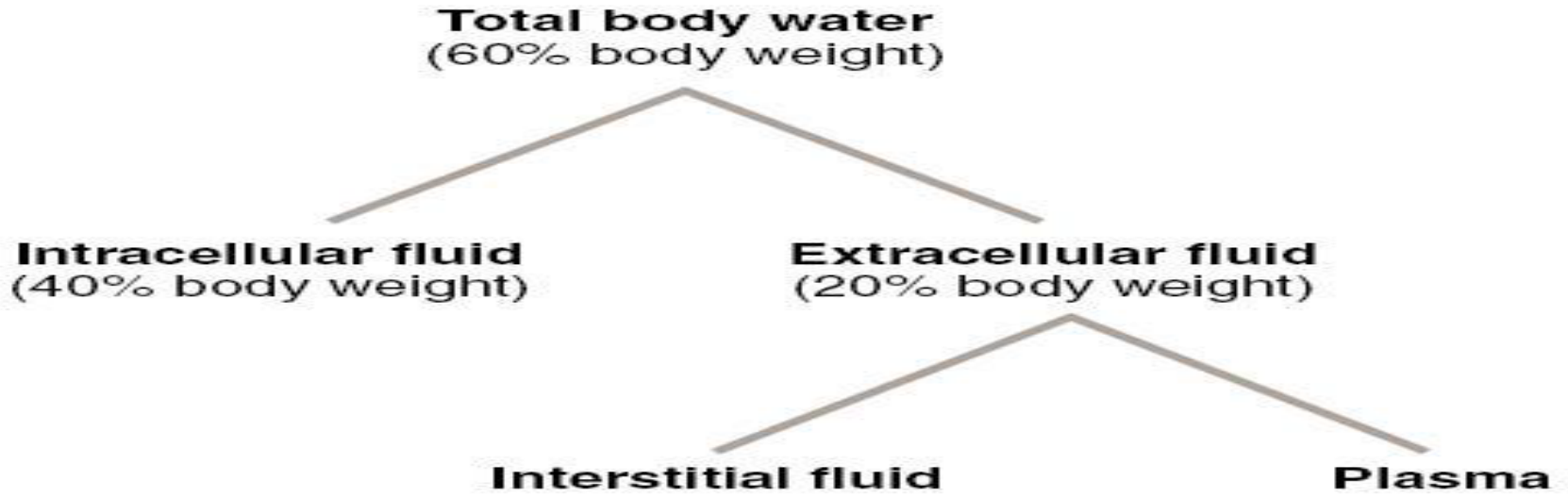
REGULATION OF FLUID BALANCE

Water Deficit	Water Excess
Leads to: ▪ Hypovolemia ▪ Dehydration Physiologic Regulation: 1. Activates hypothalamic thirst center which increases the fluid intake. 2. ADH secretion increases by posterior pituitary which leads to increasing the water reabsorption by the kidney.	Leads to: ▪ Hypervolemia ▪ Edema Physiologic Regulation: 1. ADH decreases so the water reabsorption decreases and the water excretion by the kidney increases. 2. Decreases thirst.

Extra

ADH = Anti-diuretic hormone, it acts to maintain blood pressure, blood volume and tissue water content by controlling the amount of water and hence the concentration of urine excreted by the kidney.


TOTAL BODY WATER
(Internal environment)
Intracellular fluid
Extracellular fluid
Interstitial fluid
Plasma
*Ultra Filtration of Plasma
Cell membrane
Capillary wall
*One cell thick layer


Total body water
(60% body weight)
Intracellular fluid
(40% body weight)
Extracellular fluid
(20% body weight)
Interstitial fluid
Plasma

FLUID COMPARTMENTS

INTRACELLULAR FLUIDS (ICF)

1. INSIDE THE CELL.
2. 2/3 OF TBW.
3. HIGH CONCENTRATION OF PROTEIN.

EXTRACELLULAR FLUIDS (ECF)

OUTSIDE THE CELL
1/3 OF TBW.

INTERSTITIAL FLUID

1. FLUID BATHING CELL.
2. ULTRA FILTRATION OF PLASMA
3. 3/4 OF ECF

Are almost having the same composition except for high protein concentration in plasma

PLASMA

1. FLUID CIRCULATING IN THE BLOOD VESSELS.
2. 1/4 OF ECF

TRANSCELLULAR FLUID

CSF, INTRA OCULAR, PLEURAL, PERITONEAL, SYNOVIAL, DIGESTIVE SECRETIONS

COMPOSITION OF BODY FLUID

Water is the universal solvent

Solutes are broadly classified into:

Electrolytes – inorganic salts, all acids and bases, and some proteins

Nonelectrolytes – examples include glucose, lipids, creatinine, and urea

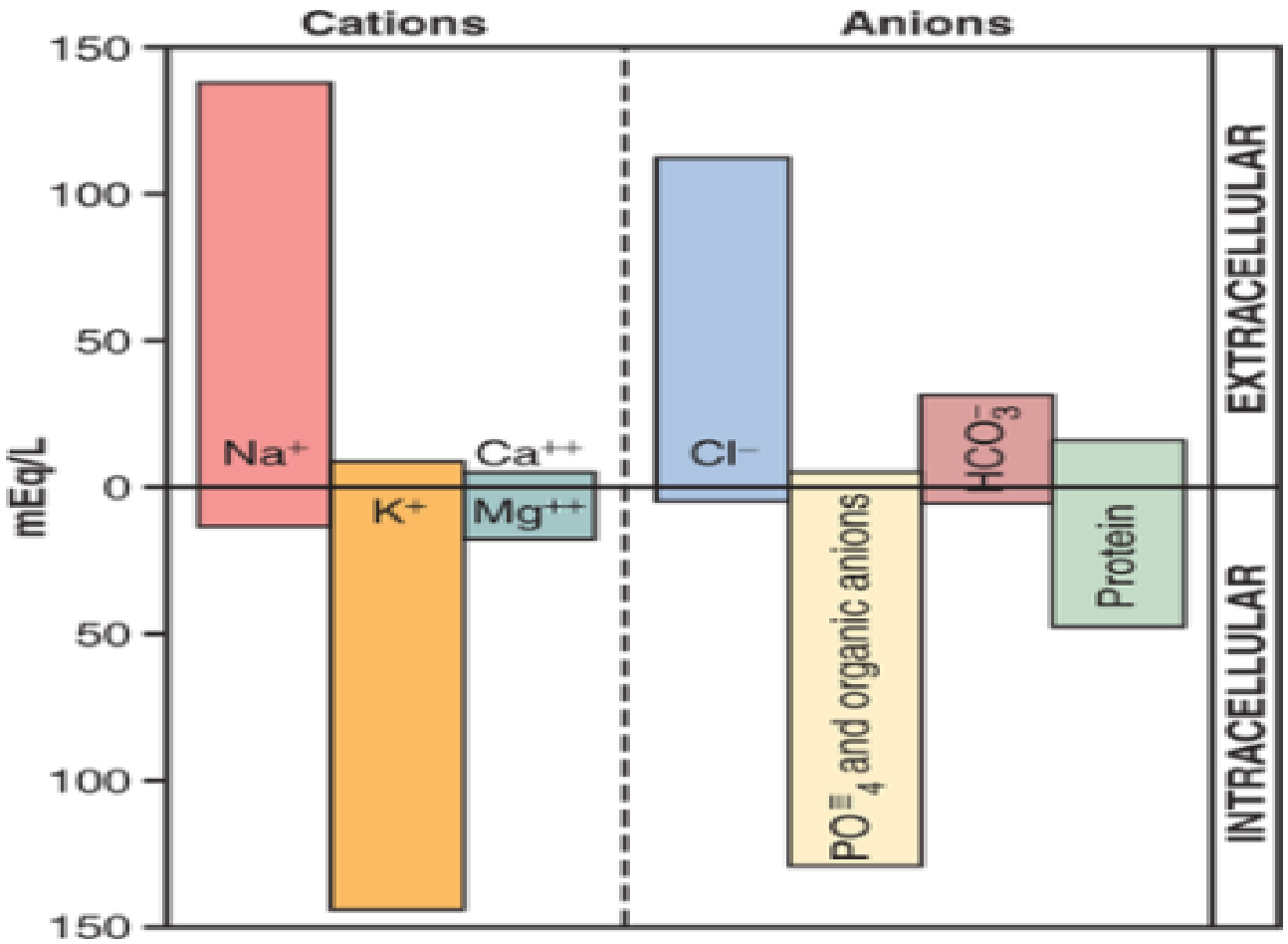
(**Amount** = in moles, osmoles)

a unit of osmotic pressure equivalent to the amount of solute that dissociates in solution to form one mole (Avogadro'snumber) of particles (molecules and ions)

Concentration	
Molarity	moles/liter M/L.
Osmolarity	osmoles/liter Osm/L.
Osmolality	osmoles/kg Osm/kg.
In biological solution	
Millimoles per liter	Millimoles/liter M/L.
Milliosmoles per	Milliosmoles/liter Osm/L.

CONSTITUENTS OF EXTRACELLULAR AND INTRACELLULAR FLUIDS

	Plasma (mOsm/L H_2O)	Interstitial (mOsm/L H_2O)	Intracellular (mOsm/L H_2O)
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
$HPO_4^=, H_2PO_4^-$	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/L	301.8	300.8	301.2
Corrected osmolar activity (mOsm/L)	282.0	281.0	281.0
Total osmotic pressure at 37°C (mm Hg)	5443	5423	5423



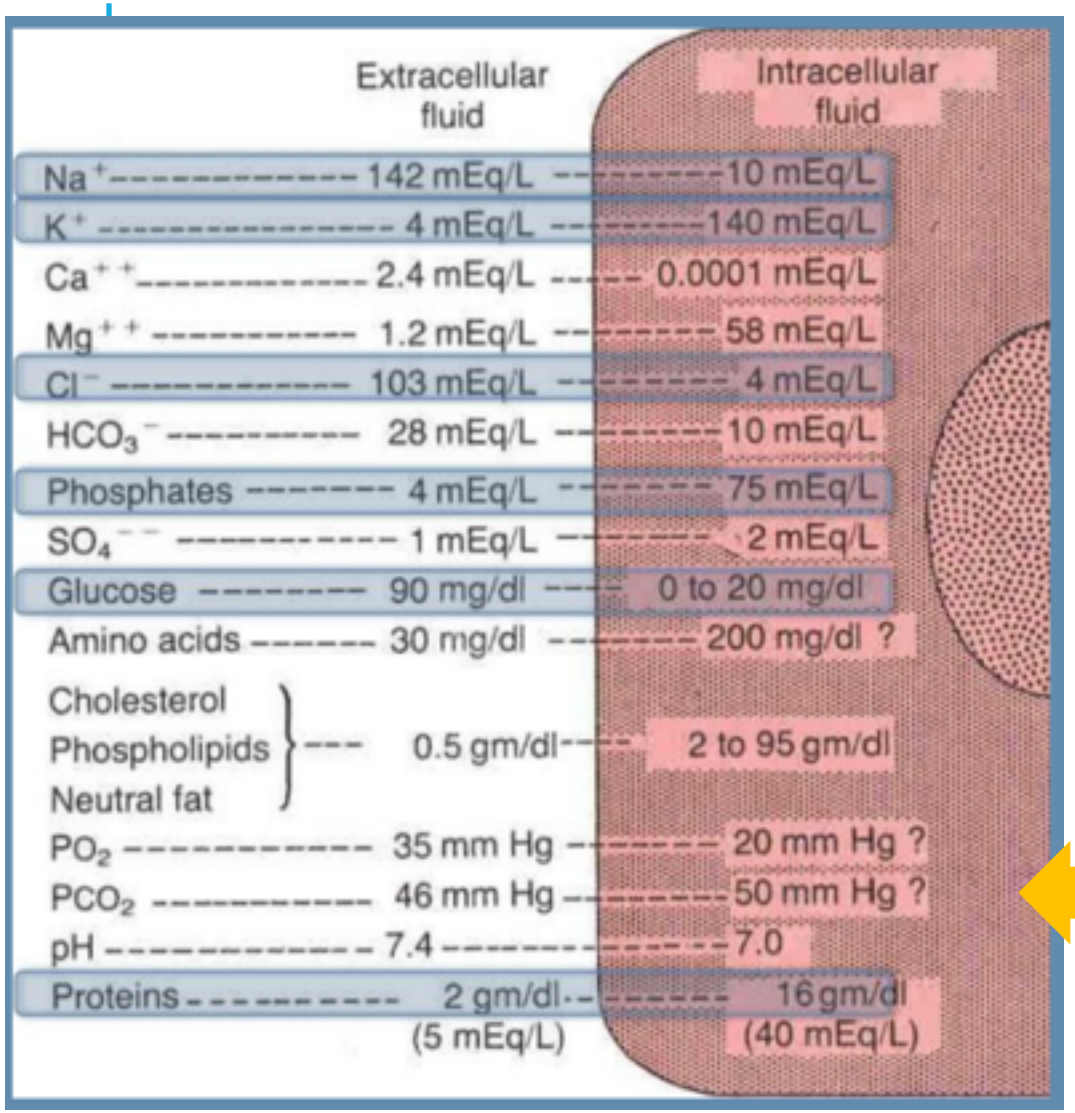
EXTRACELLULAR AND INTRACELLULAR FLUIDS

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

Intracellular fluids have low sodium and chloride
- potassium is the chief cation
- Phosphate is the chief anion

Extracellular fluids are similar (except for the high protein content of plasma)
- Sodium is the chief cation
- Chloride is the major anion

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



Potassium Ion

Hypokalemia: decrease in K concentration in the ECF. 1-2 mEq/L

Hyperkalemia: increase in K 60-100% above normal

Sodium Ion

Hypernatremia: increase in Na concentration in ECF

Hyponatremia: decrease in Na concentration in the ECF

Calcium ,chloride ,sodium ,protein , phosphate , potassium , glucose "IMPORTANT"

Protein is highly concentrated in intracellular fluids and plasma

QUIZ

Which of the following isn't a physiological factors?			
a/ blood lose	b/age	c/sex	d/body fat

ECFs are constantly mixing and have the same composition except for proteins.			
T	F	——	——

Intracellular compartment represent 33% of the total body water, about 20 % of total body weight.			
T	F	——	——

Key answers:
1-a
2-T
3-F

SPECIAL THANKS TO:

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KING SAUD UNIVERSITY

THANK YOU

Boys team members	Girls team members
• عمر الدوسري	• اروى الامام
• زياد الدوسري	• ديما المزيد
• عبدالله الغامدي	• جود الخليفة
• محمد الحمد	• جود العتيبي
• عوض العنزي	• ريناد المطوع
• فيصل القفاري	• ريما المطوع
• عبدالله باسمح	• طرفة آل كلثم
	• مي بابعير
	• نجود العلي
	• نورة المزروع

Team leaders:

- عمر الشيناوي
- ايلاف المسيحل

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