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team



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Body Fluids and electrolytes

Simple quote: “In three words I can sum up everything I've learned about life:
it goes on.”
Robert Frost



Objectives



At the end of this session, the students 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), 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.



Body Fluids



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- ◆ Human body contains 50-70% water.
- ◆ Factors that affect total water in our bodies

Physiological Factor

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

Pathological factors

- Vomiting
- Diarrhea
- Some diseases that cause sweating like diabetes mellitus
- Blood loss "We know that 55% of the blood is plasma, and 92% of the plasma is water so if we lose blood we lose a lot of water"



1) have low body fat.
2) low bone mass.
73% or more water



60% of total body weight is water.



1) Higher body fat than male
2) Smaller amount of skeletal muscle
50% of total body weight is water.



only about 45% of body weight is water



Daily intake and output of water



- In steady state **water intake = water loss**

Output:

1) Insensible Water loss: (700 ml)

Termed insensible water loss because we are not consciously aware of it.

- Via skin(350 ml) → sweating through evaporation (present even in people who are born without sweat gland)
- Via respiratory tract(350 ml)

2) Fluid loss is sweat.(100ml)

by sweat gland

3)Water loss is Feces.(100ml)

4)Water loss by the kidney. (1400ml)

	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



Hypothalamic thirst center



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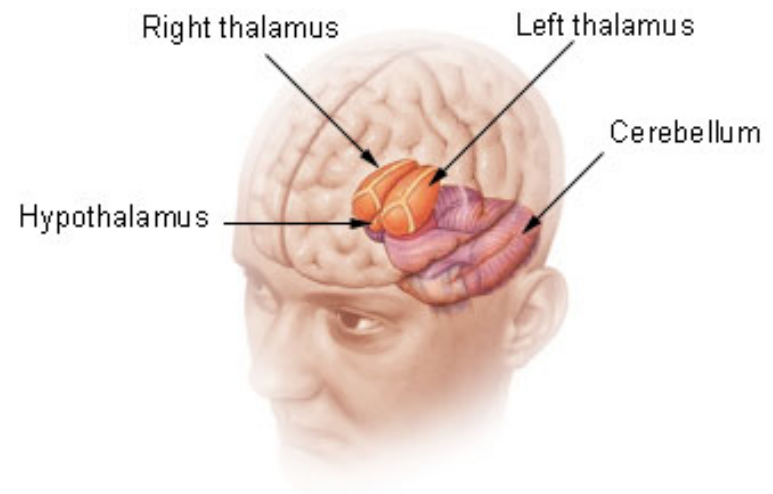
The hypothalamic thirst center is stimulated:

- By a decline in plasma volume of 10% – 15%
- By increases in plasma osmolality of 1 – 2%

More explanation:

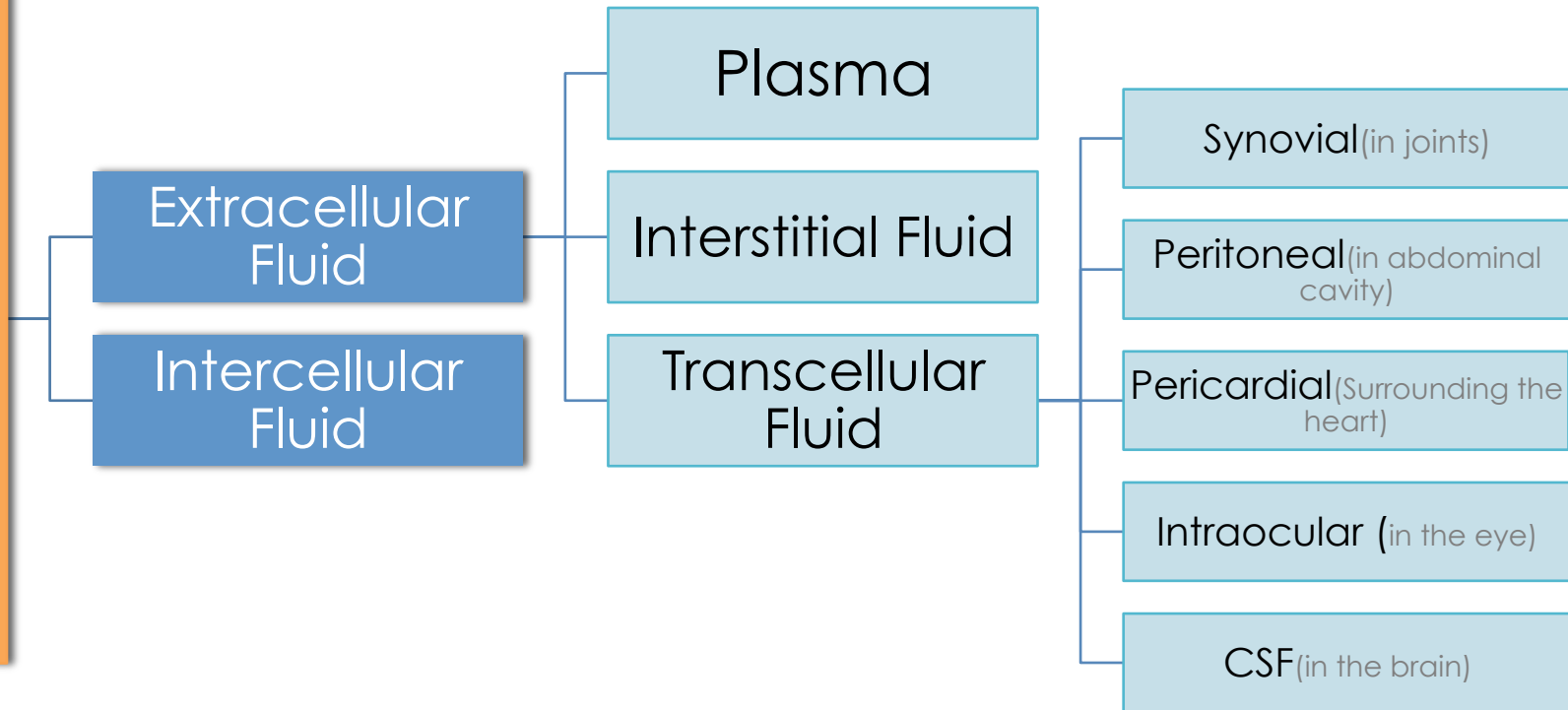
So if there is decline or a decrease in the plasma volume by 10-15% the thirst center in the hypothalamus will be stimulated.

Diencephalon



Body Fluid compartments

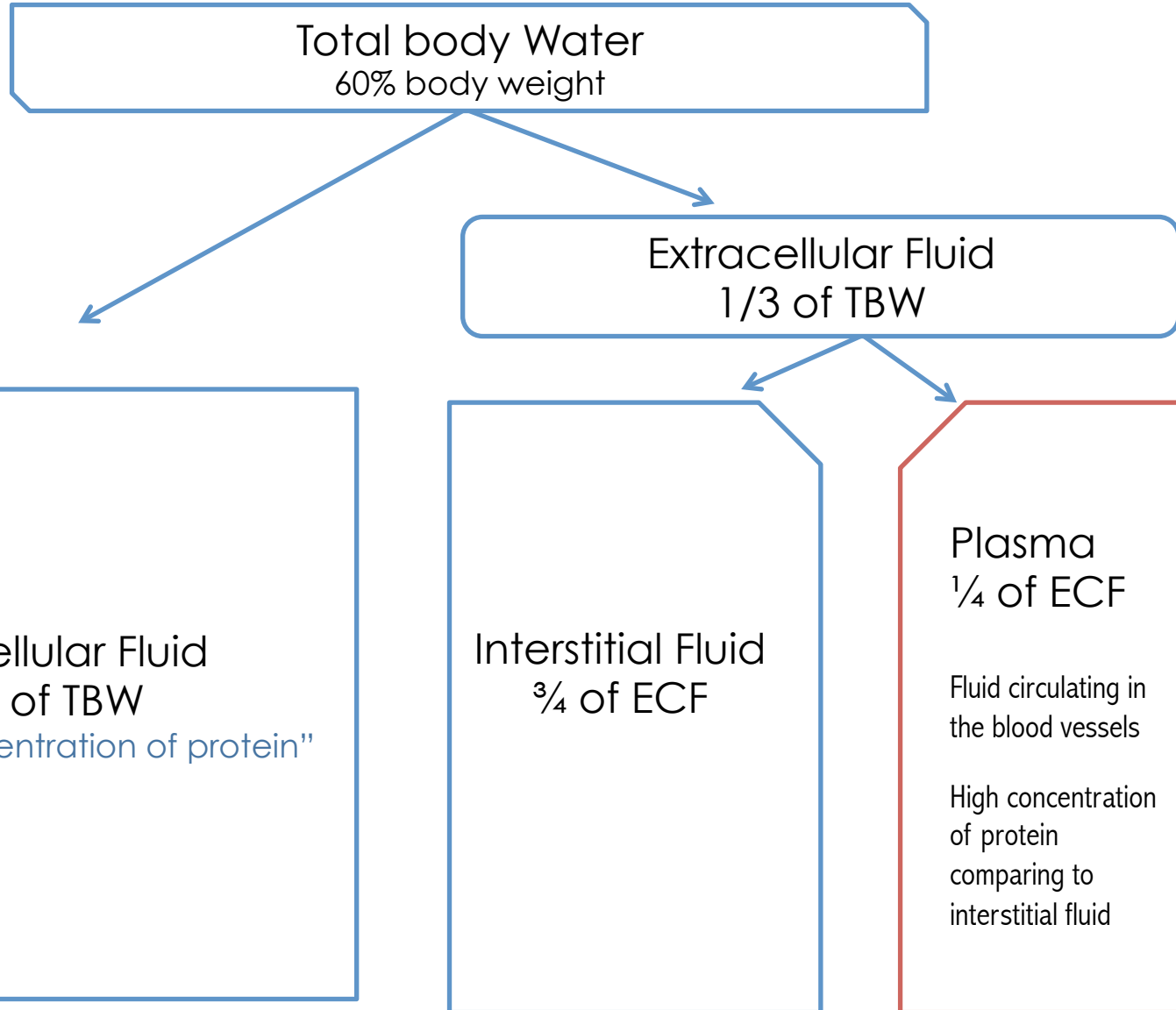
Body fluid compartments



The transcellular Fluid is not important, the dr talked about it briefly.



Body Fluid compartments





Composition of body fluid



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Solvent
"water"

Solutes

Electrolytes

nonElectrolytes

inorganic salts, all
acids and bases, and
some proteins

examples include
glucose, lipids,
creatinine, and urea

• **Concentration: it is measured by:**

- 1) **Molarity** = moles/liter \rightarrow M/L.
- 2) **Osmolarity** = osmoles/liter \rightarrow Osm/L.
- 3) **Osmolality** = osmoles/kg \rightarrow Osm/kg.
- 4) **Milliosmoles** per liter \rightarrow (mOsm/L)

More explanation:

Assume that in our body there is 301 mOsm/L in the ECF, that means if we get 1L of plasma from our bodies we will have 301 moles of solutes



Composition of body fluid



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Extracellular fluids

- Sodium is the chief cation(+)
- Chloride is the chief anion (-)

Intracellular fluids

- Potassium is the chief cation(+)
- Phosphate is the chief anion(-)

The blue coloured substances are important

	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)



Composition of body fluid



- Electroneutrality**

Each of the ECF or ICF must have the same concentration of cation(+) and anions(-).

	Plasma (mOsm/L H ₂ O)	Interstitial (mOsm/L H ₂ O)	Intracellular (mOsm/L H ₂ O)
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/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

We can see that the ECF and ICF have the same osmolality.





Clinical abnormalities of fluid volume regulation



Abnormalities related to potassium ion

Hypokalemia

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

Hyperkalemia

- increase in K 60-100% above normal

Abnormalities related to Sodium ion

Hypernatremia

- increase in Na concentration in ECF

Hyponatremia

- decrease in Na concentration in the ECF

So if you took a blood sample from a patient and he has 8 mOsm/L of potassium that mean he has hyperkalemia.



Some Videos



1) <http://bk.psu.edu/clt/bisc4/ipweb/systems/buildframes.html?fluids/bodfluid/01>

(change the title from the top to

- Fluid compartment
- Composition of body fluid
 - Electrolytes
 - more...)



Check your understanding!



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- 1. Vomiting is a physiological factor that affect the TBW:**
 - a) True
 - b) False
- 2. Infants have 73% of their weight is water because :**
 - a) low bone mass
 - b) Low body fat
 - c) Smaller amount of skeletal muscles
 - d) A + b
 - e) All of the options
- 3. Healthy female, her weight is 50kg approximately her TBW is**
 - a) 20 l
 - b) 25 l
 - c) 30 l
 - d) 35 l
- 4. A healthy male has a weight of 70kg, he has _____ L of plasma.**
 - a) 2
 - b) 2.5
 - c) 4
 - d) 3.5
- 5. An infant is 10kg weight, he has _____ L of interstitial fluid**
 - a) 5.5
 - b) 1.8
 - c) 3
 - d) 2



Check your understanding!



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6. A patient has 170 mOsm/L sodium in his bloodstream, he has :
- a) Hyperkalemia
 - b) Hyponatremia
 - c) Diabetes
 - d) Hypernatremia
7. The Osmolarity in ECF and ICF is the same
- a) True
 - b) False

Done by :

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Razan Alsubhi

ANSWERS:
1.B
2.D
3.B
4.D
5.B
6.D
7.A