◉Sheet ○Slides

Number

13

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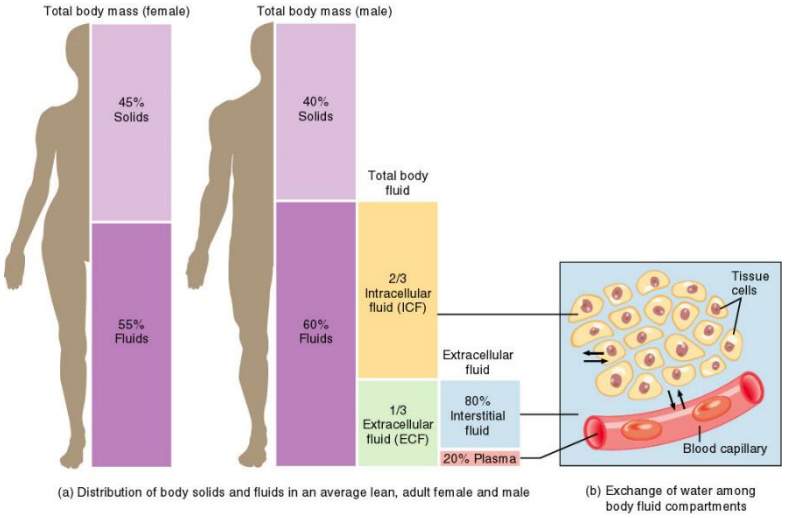
Body Fluids

Fluid Compartments

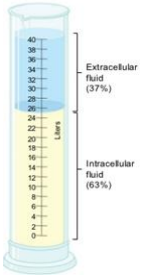
we have a lot of fluids at IC compartment and in EC.



Q: are we have some composition between EC and IC?

A: NO we have a lot of differences which they are:

1- We have high amount of Fluid in IC rather than EC compartments.
2- The amount of fluid in Female regard to total body fluid around 55% and in male around 60% **because** female have more fat.
3- Also we have differences in tissues, the amount of water in each type of tissue. For example, blood tissue have higher amount of fluids while bone have less amount of fluid.

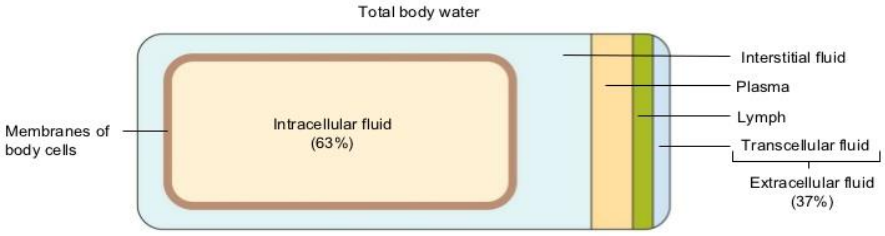


In our cells we can have more compartment of fluids. Some part of these fluids found outside the cell which called intravascular fluid (plasma= around RBC and WBC). And the other part of fluid we can be founded between cells and outside the cells which called interstitial fluid.

- Of the 40 L of the water in the adult average body, about two-thirds is intracellular fluid and one-third is extracellular fluid.

- An average adult female is about 52% water by weight, and an average male about 63% water by weight.

Water Distribution



Transcellular Fluids (inside cavities which it has small amount of Fluids)

- Synovial (found in synovial joint of knee)

- Pericardial (around heart)

- Pleural (Inside the cavity which lies between the pleural membranes lining the lungs and the membrane lining the internal chest wall.)

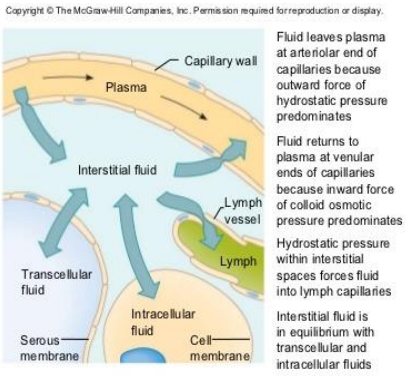
- Peritoneal (Is lining of the abdominal cavity and covers the abdominal organs.)

- Ocular (Inside our eyes)

- Cerebrospinal (around neurons tissue)

Q: Are Fluids Static?

A: No, there's always exchange in composition and exchange of water between the compartments (by osmosis).



Movement of Fluids between Compartments

Major factors that regulate movements:

- Osmotic pressureit: water moves from the compartment with lower osmotic pressure (higher free water concentration) to the compartment with the higher osmotic pressure (less water concentration), the osmotic pressure is responsible of re-absorption of water in the venular part of the capillary (from the interstitial fluid to the venular part of the capillary).

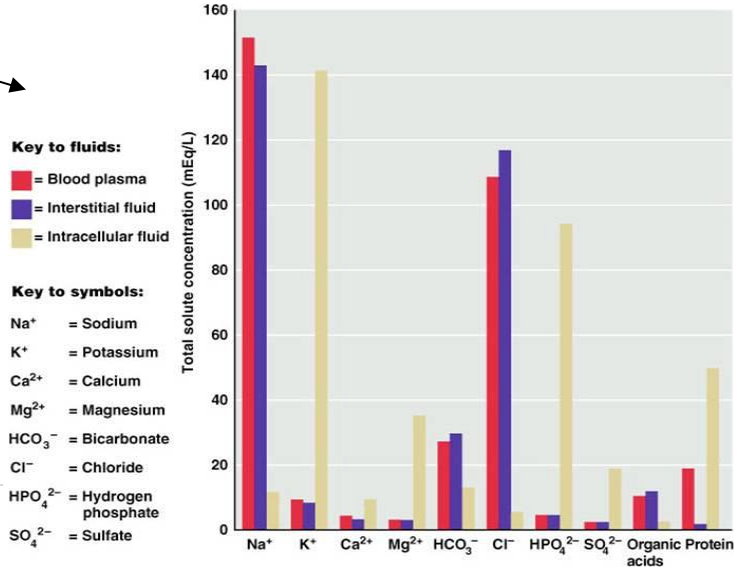
- Hydrostatic pressure (from high pressure to low pressure = filtration towards the interstitial fluid in the arteriolar part of the capillary.)

Q: What will happen if low protein inside?

A: 1- No filter of protein 2- the Osmatic pressure of the blood will reduce leading to movement of fluid from the plasma to the interstitial fluid resulting in edema. because protein concentration inside the cell is 10 times more than interstitial fluid.

composition of Body Fluids

- With regard to Sodium we have similar concentration of Sodium in interstitial fluid and in blood plasma. While we have much lower concentration ICF.
- With regard to potassium we have similar concentration of potassium



in interstitial fluid and in blood plasma. While we have much higher concentration in ICF.

- Also Mg+2 for example exists in higher amount inside the cell and at lower amount outside the cell. As for proteins, there are higher amounts inside the cell while there is a lower amount in the plasma and the least amount of these proteins exists in the interstitial fluid.

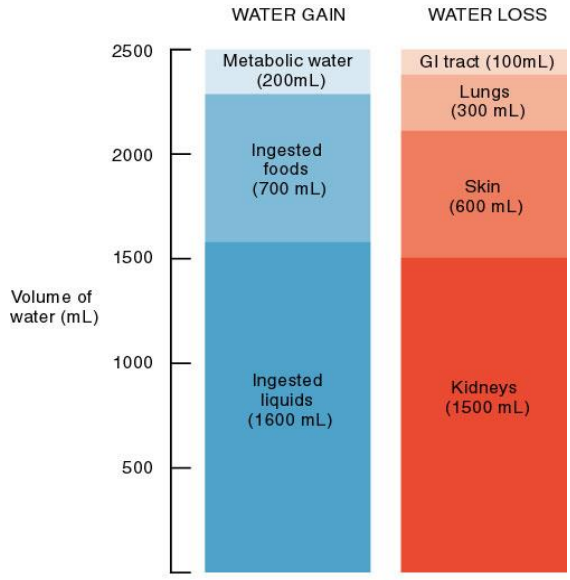
Note: The Unit that we used to measure concentration of solute is = milliequivalent per liter (mEq/l)

Water Balance

There is balance all the time.

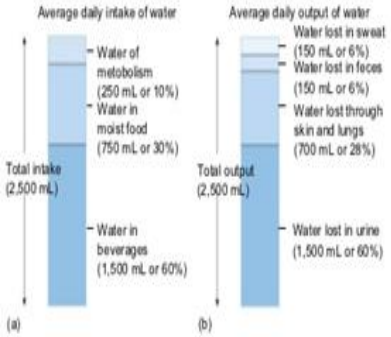
Water output each day	
Urines	1.5 litres
Feces	0.1 litre
Breathing and sweating	0.9 litre
TOTAL	2.5 litres

Water input each day	
Water contained in food	0.8 litre
Water produced by the cells	0.2 litre
Water you drink	1.5 litres
TOTAL	2.5 litres



Note: there`s no need for the specific numbers, they are just for further understanding.

Water input



- The volume of water gained each day varies among individuals about 2500 mL daily for an adult:
- 60% from drinking
- 30% from moist food
- 10% as a bi-product of oxidative metabolism of nutrients called water of metabolism. (like when the glucose bearing in mitochondria the outcome is some amount of water)

Water output

- Water normally enters the body only through the mouth, but it can be lost by a variety of routes including:

- Urine (60% loss)
- some of the water is lost in the gastrointestinal tract with feces (6% loss)
- Sweat (sensible perspiration) (6% loss)
- Evaporation from the skin (insensible perspiration)
- The lungs during breathing

(Evaporation from the skin and the lungs in a 28% loss)

-The most amount of water we get (intake) is by drinking, and most amount of water we lose (output) is lost by urination.

Note: sensible perspiration: we sense that we loose water

insensible perspiration: we don't sense that we loose water **like** breathing

Water and Electrolytes Homeostasis

Systems involved in the regulation of fluids and electrolytes (highly regulated by many physiological process)

1- Kidneys
2- Cardiovascular system (controlling blood pressure, blood flow through the tissues, also stimulating other tissues to change the composition).
3- Endocrine system (different hormones are secreted in case of an increase in fluid volume to decrease the volume and vice versa (it can also change the composition and not only the volume).
4- Lungs are also involved in controlling the pH.
5- Urinary system.

Notes:

1- Loosing water in ECF= high osmolality and the diffuse from IC to EC (from the region of low osmotic pressure (inside the cell) to the region of high osmotic pressure (outside the cell), so this will cause in shrinkage of the cells. This is what happens in case of body **Dehydration**.)
2- Isotonic = No change
3- Loosing NA+ ONLY = low osmolality.
4- add pure water to the ECF the osmolarity will decrease = cause a swelling of the cells which causes Edema.

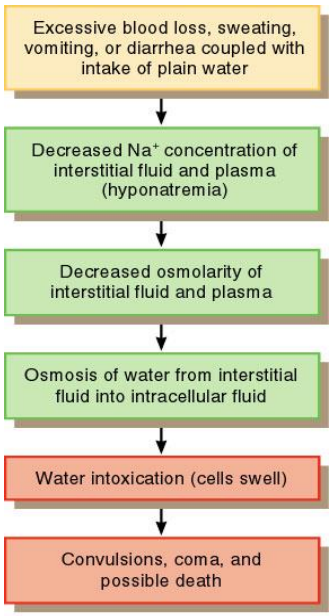
Regulation of Na+ and Water

Involves regulation of:

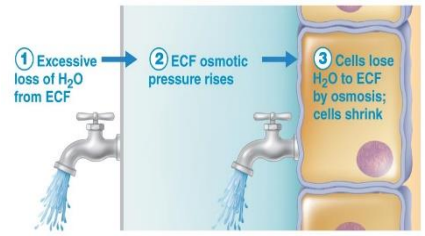
- Osmolality
- Volume of ECF

different regulations with many overlapping mechanisms.

Importance of Na+ and Water regulation



Cell shrinks due to excessive lose of water from ECF



(a) Consequences of dehydration. If more water than solutes is lost, cells shrink.

Cell swells due to excessive water enters the ECF

(b) Consequences of hypotonic hydration (water gain). If more water than solutes is gained, cells swell.

$$\text{Volume B} = \frac{\text{Volume A} \times \text{Concentration A}}{\text{Concentration B}}$$

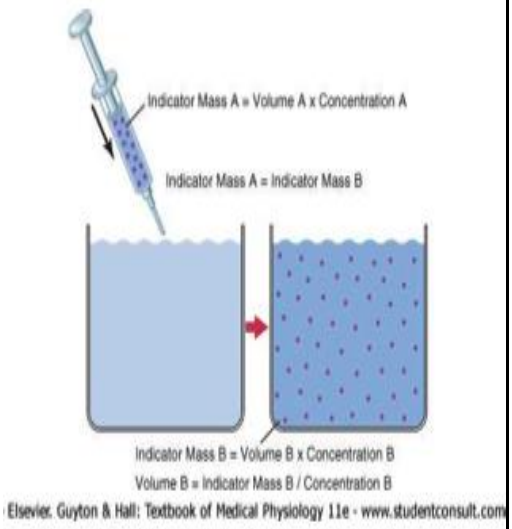
Measurements of Body Fluids

Dilution Principle

Dilution method for calculating fluid volume

If 1ml of a 10mg/ml solution is injected into a fluid compartment, and the final concentration is 0.01mg/ml, the volume of the fluid compartment is,

$$\text{Volume B} = \frac{1\ \text{ml} \times 10\ \text{mg/ml}}{0.01\ \text{mg/ml}} = 1000\ \text{ml}$$



$C_1V_1=C_2V_2$

Properties of tracers used for calculation of volumes

- Properties of an Ideal Tracer The tracer should:
- be nontoxic
- be rapidly and evenly distribute throughout the nominated compartment not enter any other compartment.

- not be metabolized. (because if this tracer can be metabolized its volume will be decreased because of the high metabolic reaction and this will affect the accuracy of measuring the volume of that fluid)

For example we can't use radioactive glucose as a tracer because high amounts of it are going to be metabolized and in this case we are losing big amount of this radioactive glucose which in turn will affect the measurement.

- not be excreted (or excretion is able to be corrected for) during the equilibration period
- be easy to measure
- not interfere with body fluid distribution

Measurement of Total Body Water

* Radioactive water ($^{3}H_2O$, Tritium) or heavy water ($^{2}H_2O$, Deuterium).

This will mix with the total body water in just a few hours and the dilution method for calculation can be used.

* Antipyrine, which is lipid soluble, so it can pass throw the membranes and be distributed evenly all over body fluids, so when we measure it we can estimate the total volume of body fluids.

Measurement of ECF volumes

- $^{22}Na+$, (Sodium Space) Radioactive sodium (and that make sense because the ECF has a high concentration of Na+
- ^{125}I-iothalamate,

No need to Know how to be calculated

- Thiosulfate, And the common feature that exists in all these materials is that they can't inter the cell and this makes sense because it is used to measure the volume of the ECF.
- Inulin (Inulin Space)

(Measured in 30-60 minutes)

Calculation of ICF
(Intra- Cellular Volume) → **ICF= Total Body water – ECF**