Body fluids and its compartments

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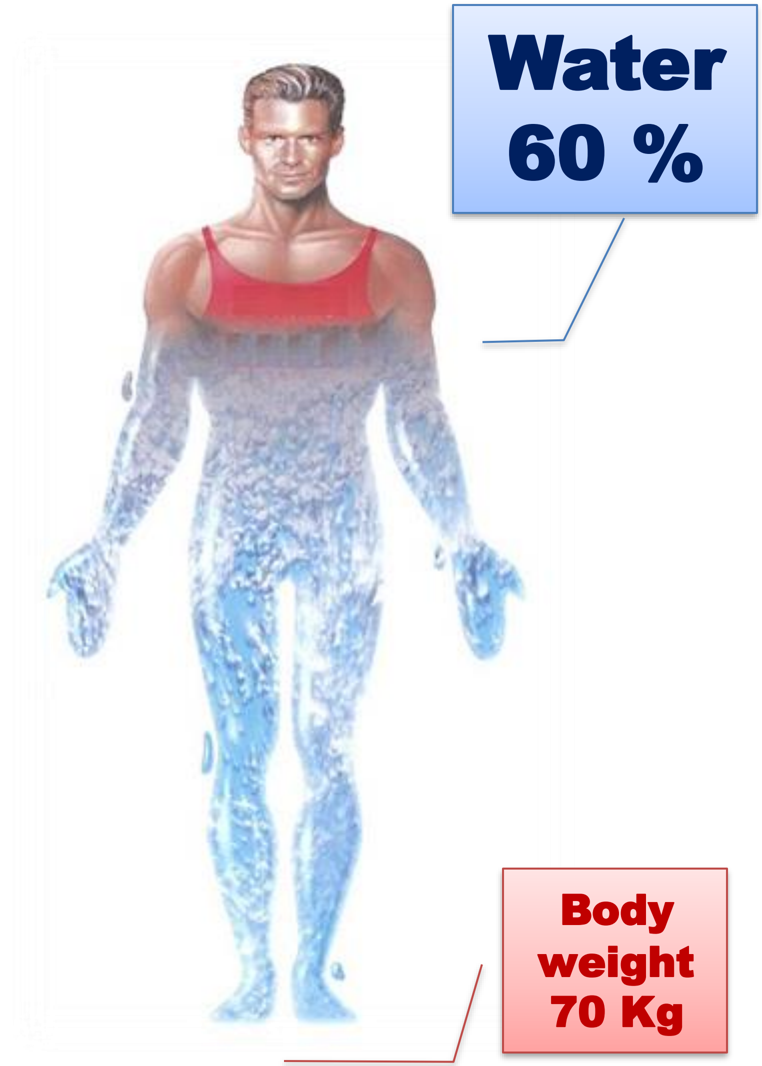
-Water is the most abundant constituent in our bodies.

- It forms 60% of total body weight of normal adult male weighing 70 Kg.



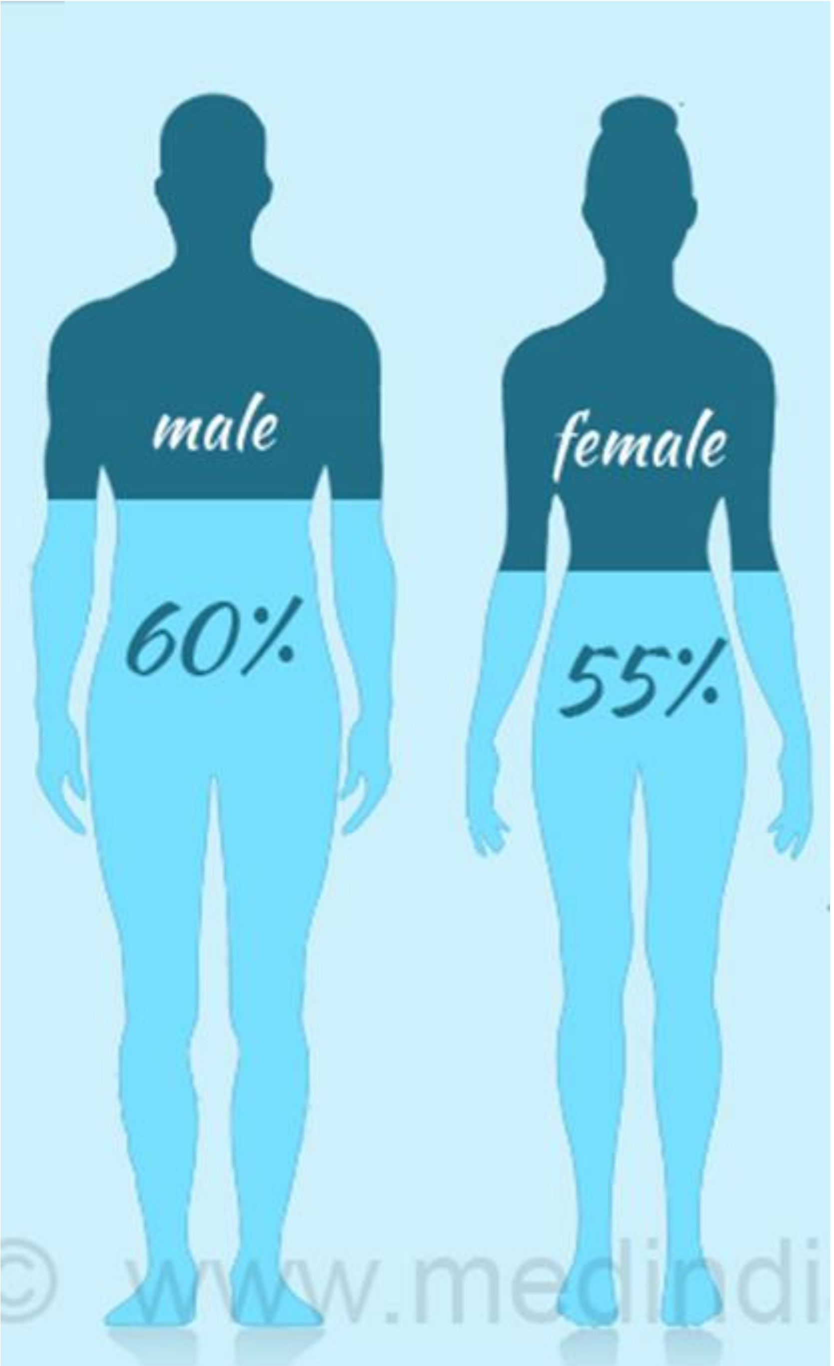
Water Content in the Human Body

Age

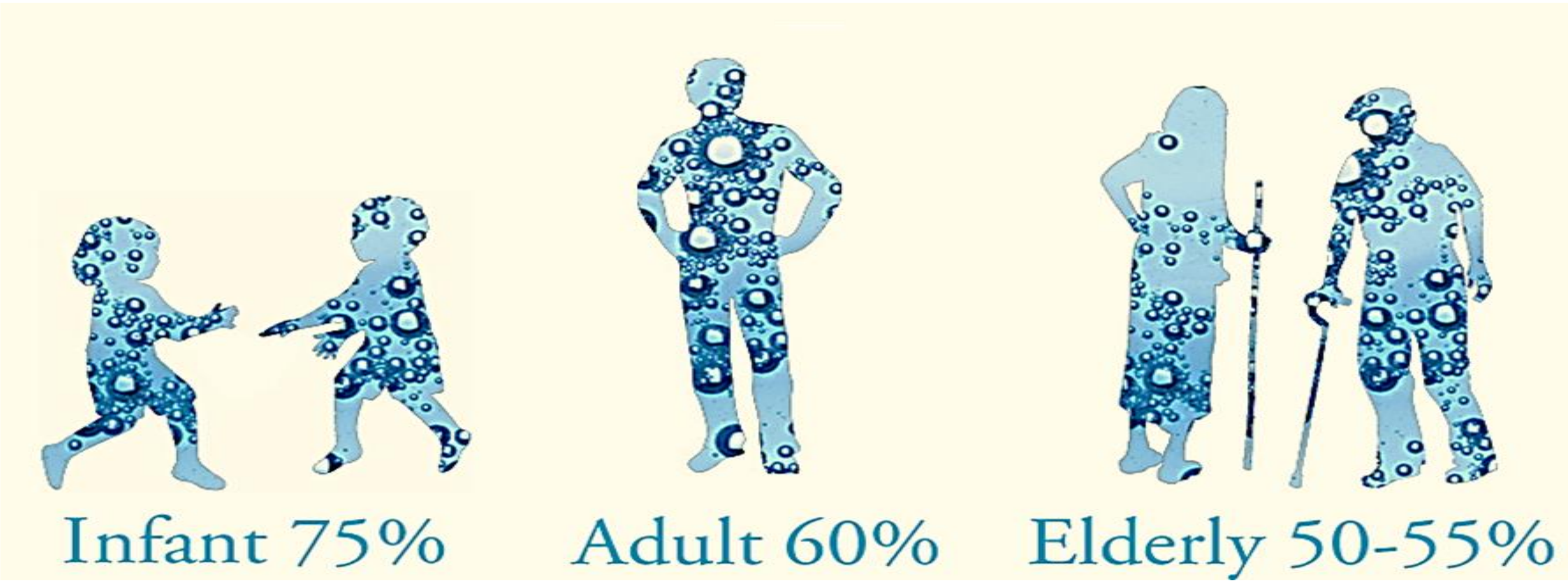
Sex

Sex

Fat cells contain less water and thus females (being fattier than males) contain slightly less water.



Age



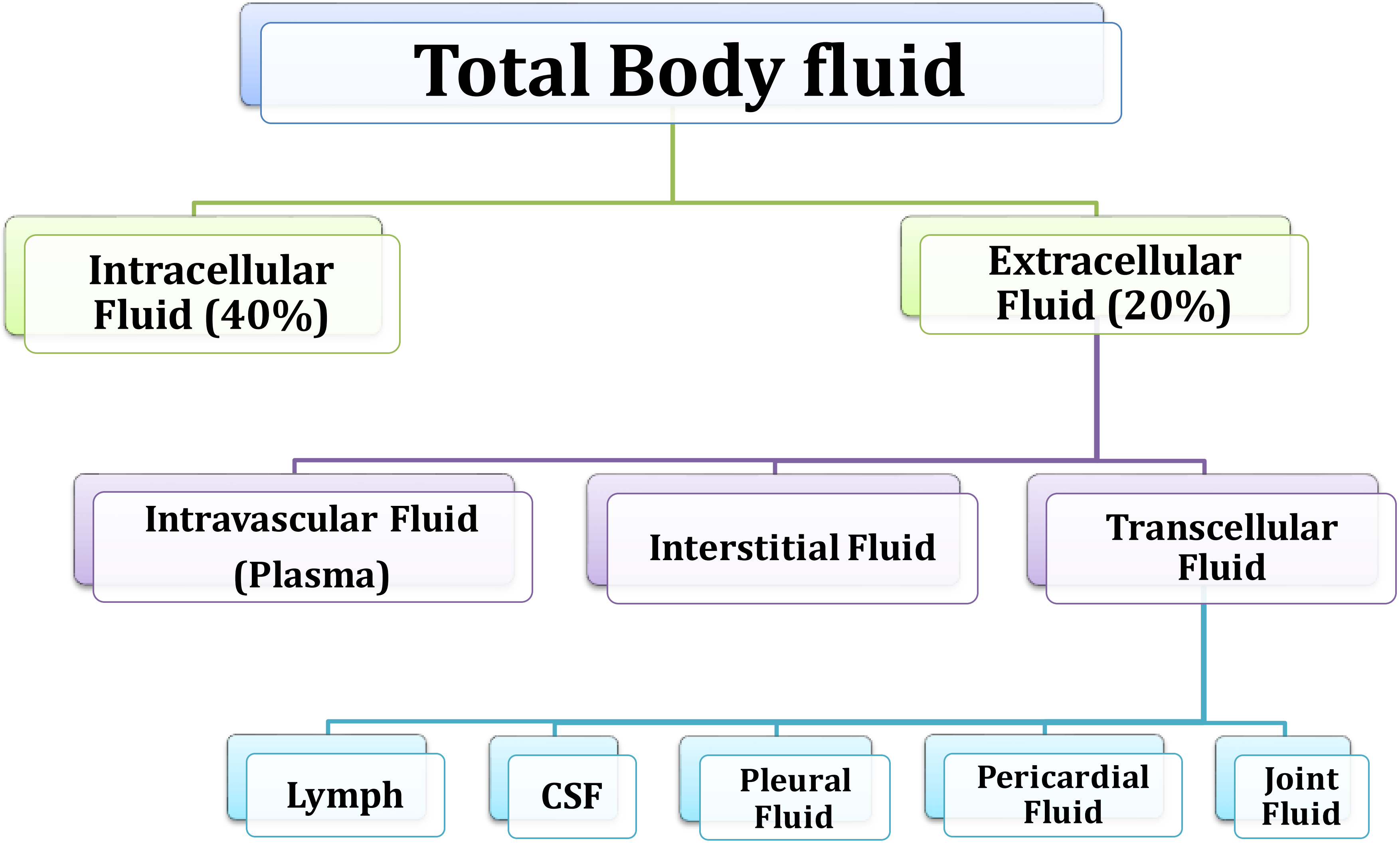
Although the newly born have more percentage of their body as water than adults, yet **most** of their body water is **intracellular** and the percentage of **their ECF is less than adults** thus they are **more liable** to **dehydration** in cases of vomiting and diarrhea than adults.

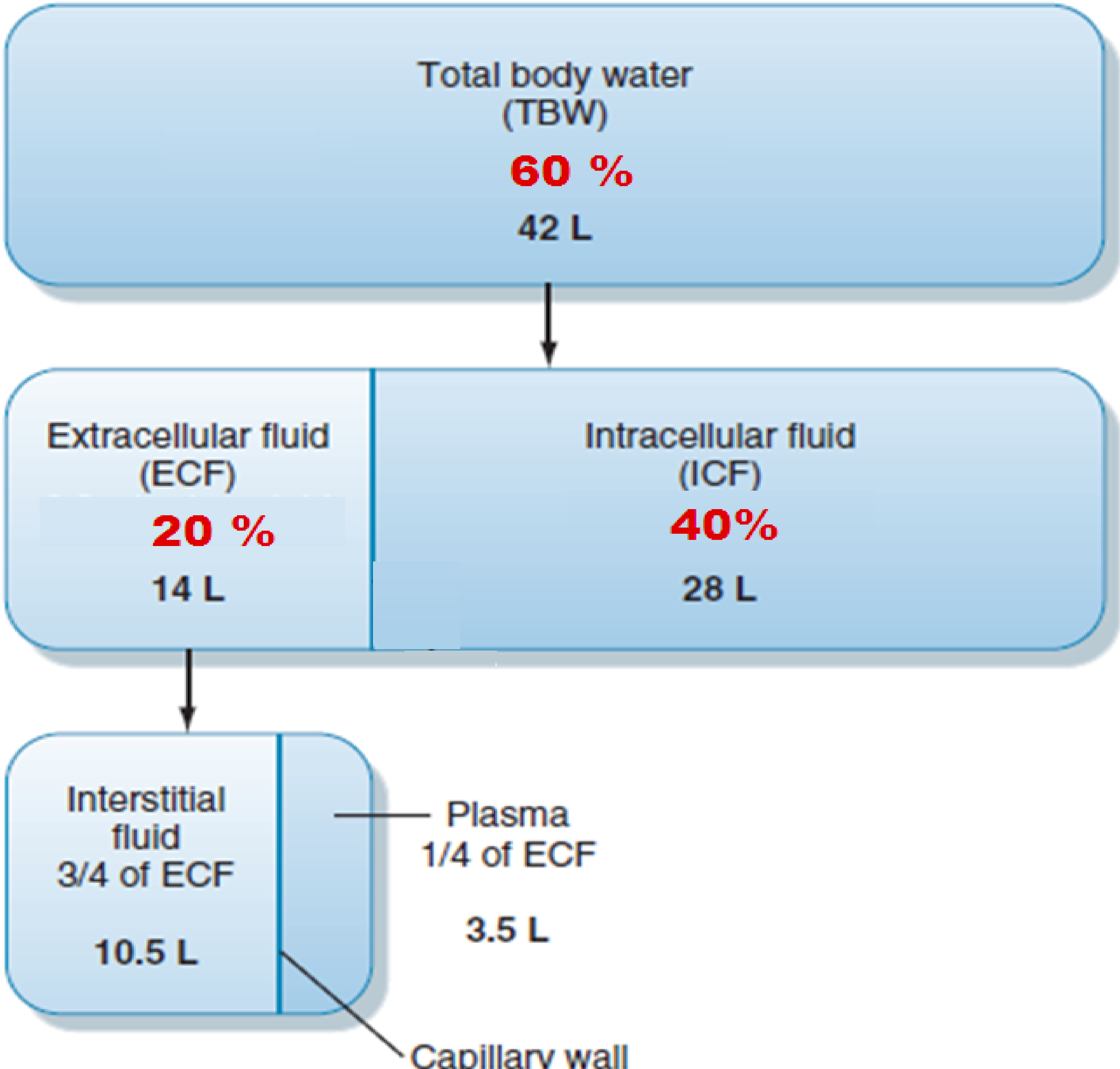
Composition & distribution of body fluids

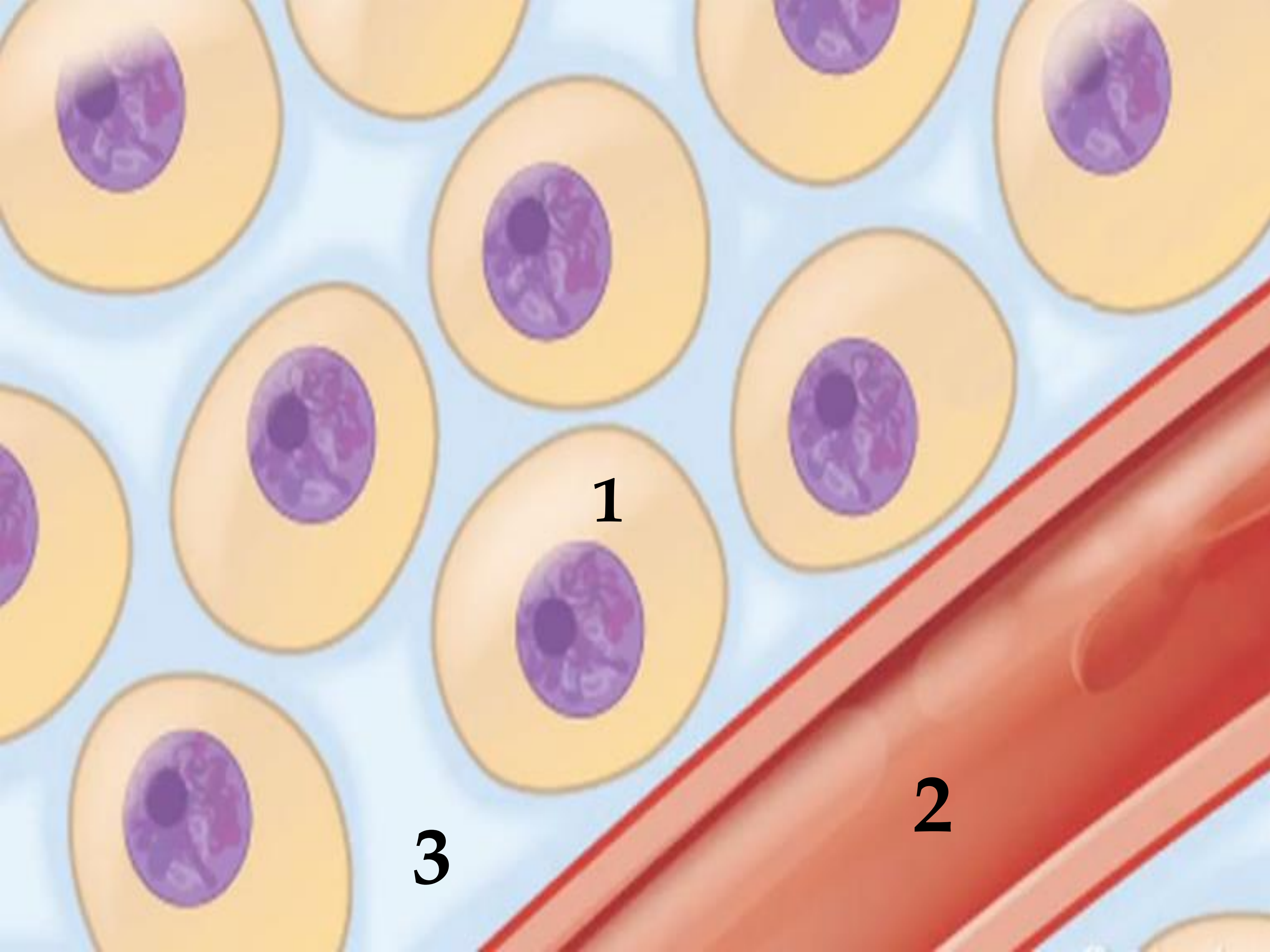
1- Composition of body fluids

- Body fluid
  - Water
  - Solids
    - **Organic:**
      - -Glucose.
      - -Amino acids.
      - -Enzymes.
      - -Hormones.
    - **Inorganic** = ions
      - Na+, K+, Ca++..

2- Distribution of body fluids




Total body water
(TBW)
60 %
42 L
Extracellular fluid
(ECF)
20 %
14 L
Intracellular fluid
(ICF)
40%
28 L
Interstitial
fluid
3/4 of ECF
10.5 L
Plasma
1/4 of ECF
3.5 L
Capillary wall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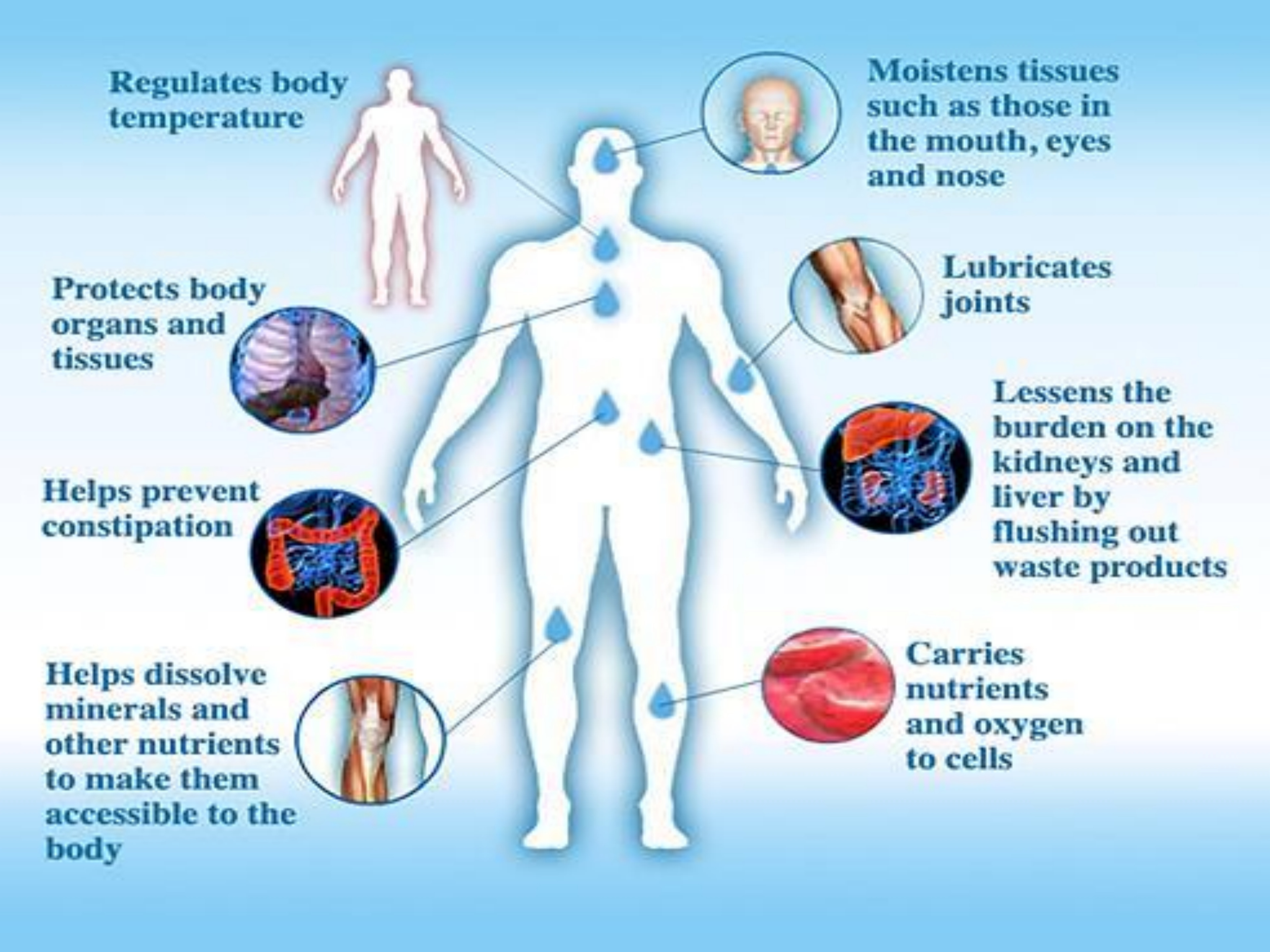
What is the importance of body fluid ?

- Water is the origin of life, and there is no form of life can be maintained without water. Moreover, all the chemical & biological reactions in the body must be performed in an aqueous media.
- Some other vital functions of water are:

1. It favors ionization of dissolved salts.
2. It regulates body temperature via both heat loss and heat gain balance.
3. It gives the blood its fluidity to reach all cells and to maintain BP.


Regulates body temperature
Moistens tissues such as those in the mouth, eyes and nose
Protects body organs and tissues
Lubricates joints
Lessens the burden on the kidneys and liver by flushing out waste products
Helps prevent constipation
Helps dissolve minerals and other nutrients to make them accessible to the body
Carries nutrients and oxygen to cells

Body water balance

❖ It is the balance between water intake and water loss.

❖ In comfortable zone of body temperature (22 $_{o}$C) it was estimated that ***water intake*** by normal adult 70kg male= ***2500 ml/day*** which distributed as follow: **1500 ml** is taken as pure water and beverages (tea for example), **800 ml** from food as fruits and vegetables and **200ml** from metabolic processes.

❖ The ***water loss*** normally = **2500ml/day** which distributed as follow:

1500 ml excreted as **urine**, **900ml** evaporated **from the skin** and **lungs** and **100 ml excreted in feces**.

❖ The amount of water lost by sweating is highly variable, depending on physical activity and environmental temperature.

- The volume of **sweat** normally is about **100 ml/day.**

Obligatory water loss: = **1 L/day**. So, minimal intake of 1 L/day is essential for life as there is **No reserve of water** in the body.

Regulation of Water Intake (Thirst Sensation)

The stimuli of thirst sensations are:

1. Increased plasma osmolarity either due to pure water loss or excessive intake of salts.

2. Loss of large amount of ECF fluid (following vomiting or diarrhea).

3. Hemorrhage and shock.

4. Dryness of mouth (from inhibition of salivary secretion).

5. Increased **angiotensin II** secretion.

Thirst center located in the hypothalamus.

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**

- A serious problem that faces us that there is **no reserve of water in our bodies** despite the large amount present.
- A reduction of 5% of water content makes the person very thirsty, a loss of 10% makes him very ill while a reduction of 20% will kill him.
- without water intake there is obligatory water loss = 1 liter/day (in urine, insensible perspiration and in expired air) thus death occurs even in cool climate if water is not totally taken ***after 4-6 days.***
- A minimal intake of **liter/day** is essential for life.
- Antidiuretic hormone "**ADH**" controls water loss by the kidney.

How can we measure body fluid volume??

DILUTION PRINCIPLE

- **Based on using a marker whose concentration can be measured.**

Inject **x gm** of marker into compartment

measure concentration at equilibrium **(y gm/L)**

Since concentration = mass / volume

Volume = mass / concentration

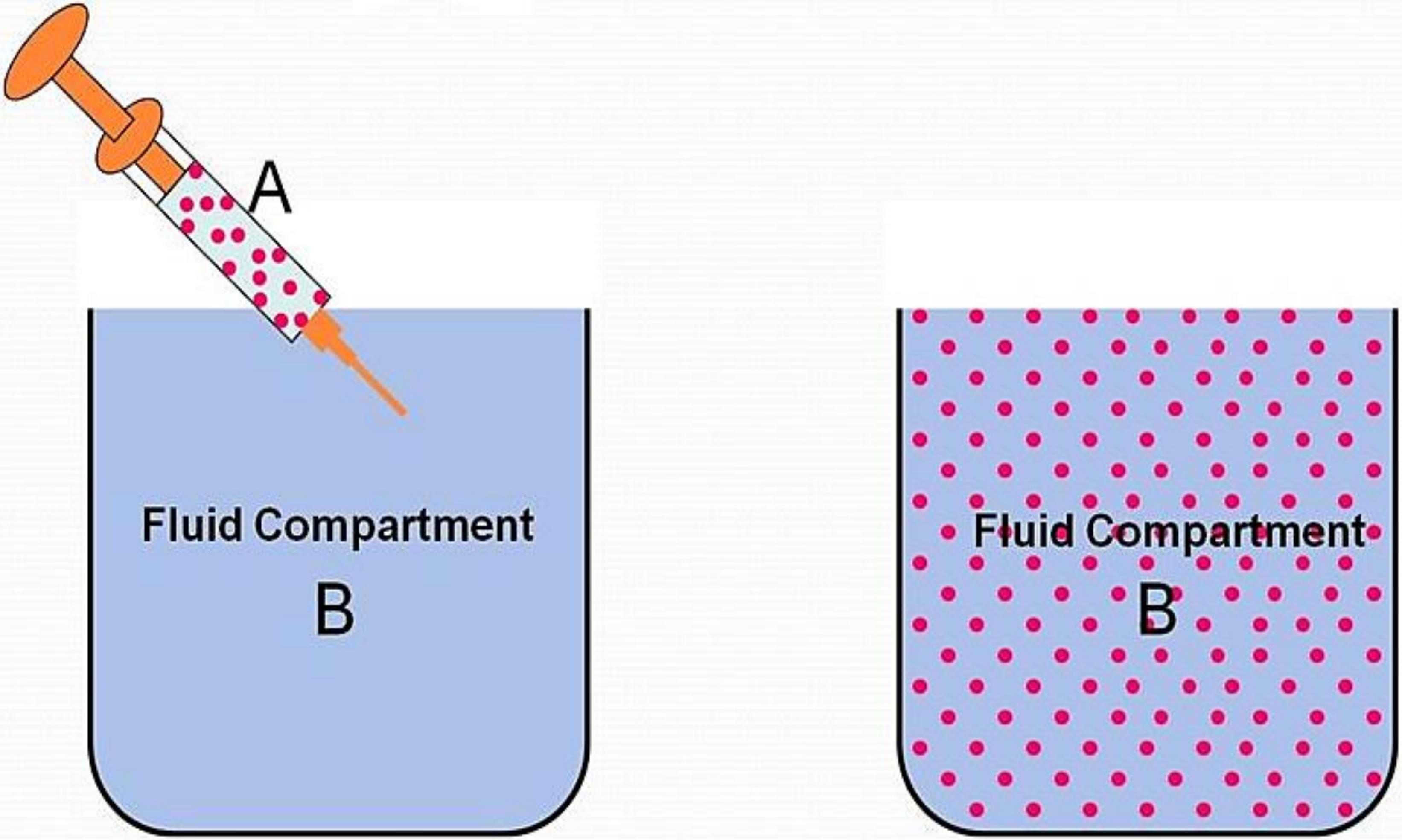
- V **= x/y L**

Total body water volume

- It is measured by the application of the **Indicator dilution principle** or **dye dilution principle.**

$$C_A \times V_A = C_B \times V_B$$

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



Determination of compartmental volume

1. Place indicator A in the compartment B.
2. Allow it to disperse evenly though out the compartment's fluid
3. Analyze the extent to which the substance is diluted

Indicators used for measuring plasma volume, ECF volume and total body H_2O

Compartment	Criterion	Indicators
1. Plasma	Substance should not cross capillaries	1. Evans blue dye; 2. radioiodinated fibrinogen; 3. radioiodinated albumin
1. ECF volume	Substance should cross capillaries but not cross cell membranes	Isotonic solutions of sucrose, inulin, mannitol, NaCl
1. Total body H_2O (TBW)	Substance distributes evenly in ICF & ECF	Heavy H2O, tritiated H2O, aminopyrine, antipyrine

CRITERIA FOR A SUITABEL DYE.

BODY FLUID MARKER

1. Must mix evenly throughout the compartment
2. Non toxic, no physiological activity
3. Even mixing
4. Must have no effect of its own on the distribution of H_2O or other substances in the body
5. Either it must be unchanged during the experiment or if it changes , the amount changed must be known.
6. The material should be relatively easy to measure.

Compartments with no Compartment-Specific Substance

1. Determine by subtraction:
2. How would you measure ICF volume?
3. Cannot be measured; it is calculated (estimated)..
4. ICF volume = Total body H_2O – ECF volume
5. Interstitial volume
    1. Can not be measured directly
6. Interstitial Fluid Volume (ISFV). ISFV = ECFV - PV

Activity time!

- In 1mL of solution a certain mass of dye is dispersed resulted in concentration equal **(10mg/mL)** then dye in chamber B and final concentration in the chamber is **0.01mg/mL** .
- What is the volume in chamber B?


Thank you !