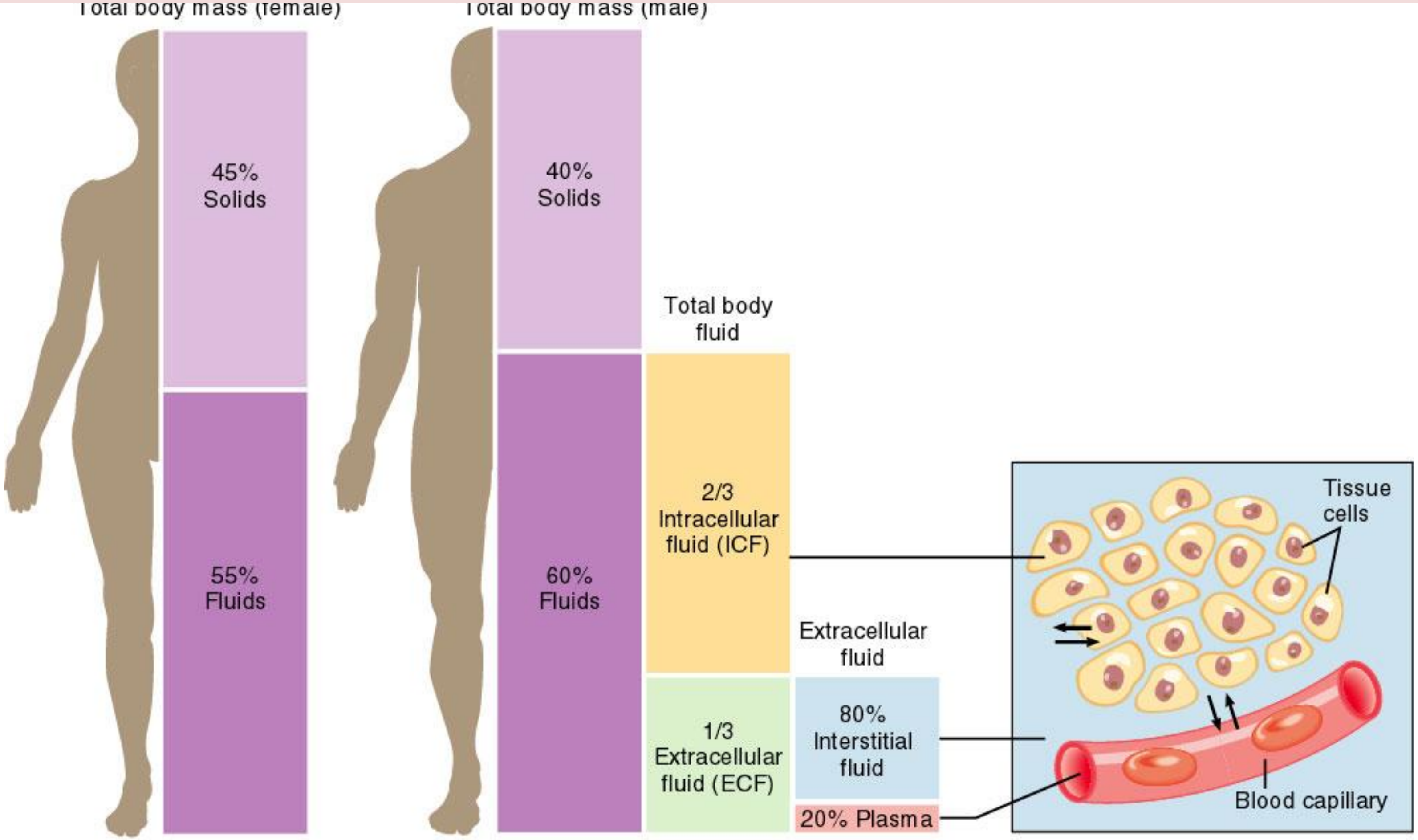
Body Fluids 1

Ref: Textbook of Medical Physiology
Guyton and Hall, 13th Edition, pp: 303-321, 12th Edition
pp: 285-297

Fluid Compartments



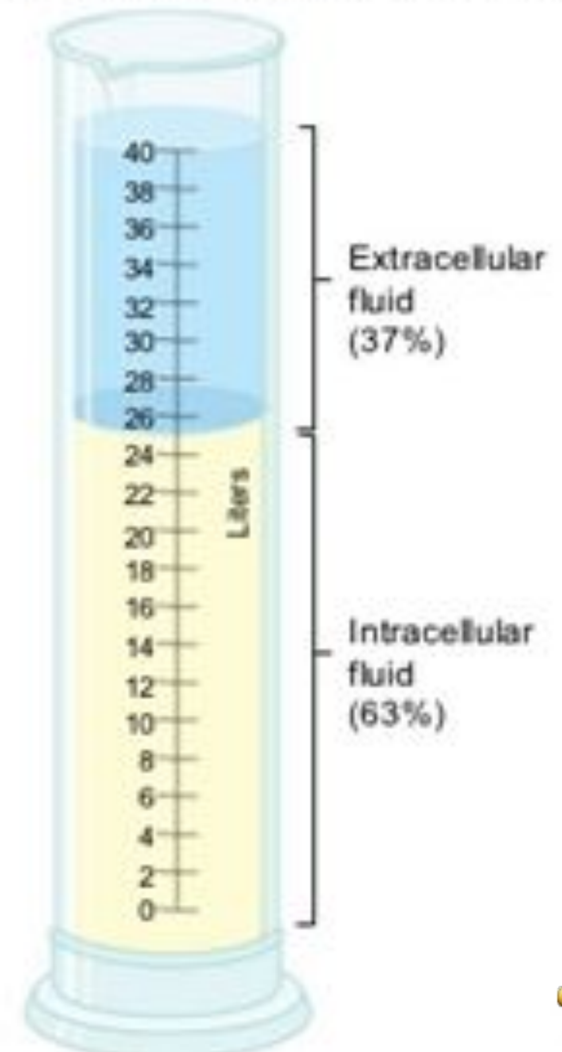
(a) Distribution of body solids and fluids in an average lean, adult female and male

(b) Exchange of water among body fluid compartments

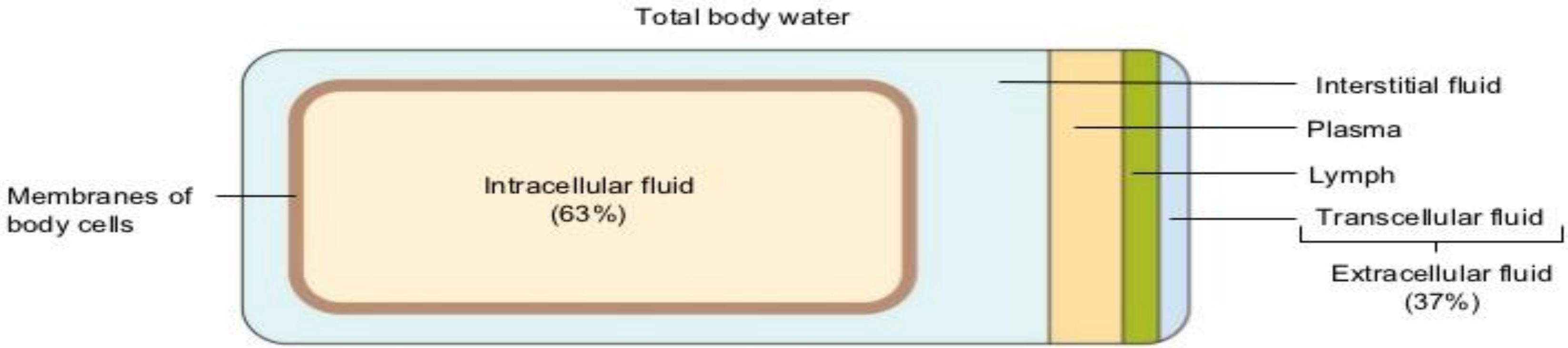
27.01

Fluid Compartments

- Of the 40 liters of water in the body of an average adult, 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



Water Distribution

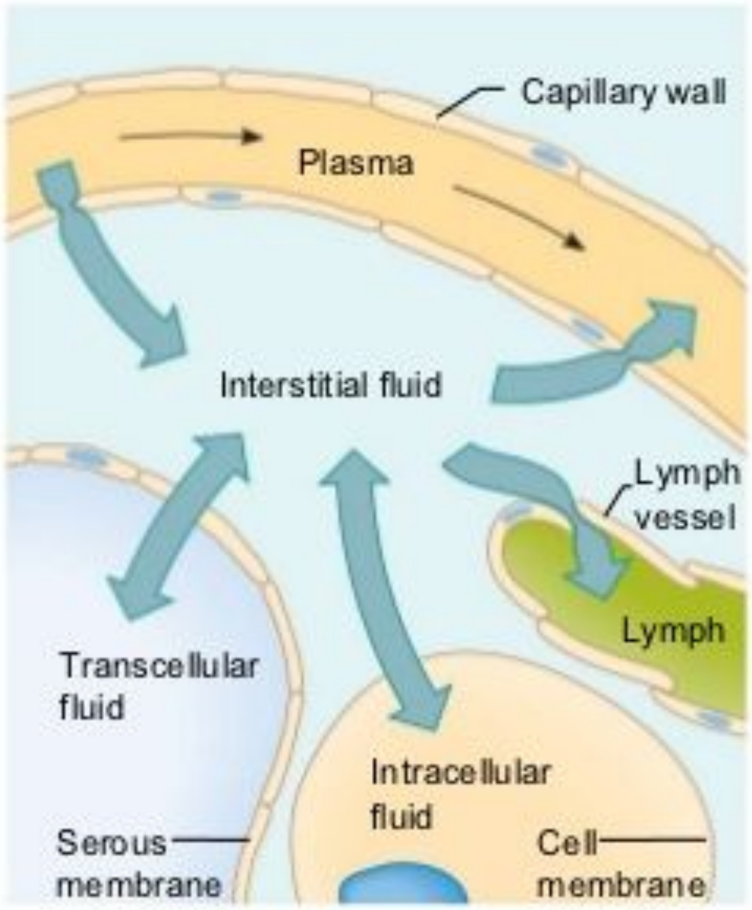
Transcellular Fluids

- Synovial
- Pericardial
- Pleural
- Peritoneal
- Ocular
- Cerebrospinal

Movement of Fluids between Compartments

Major factors that regulate movements:

- Osmotic pressure
- Hydrostatic pressure



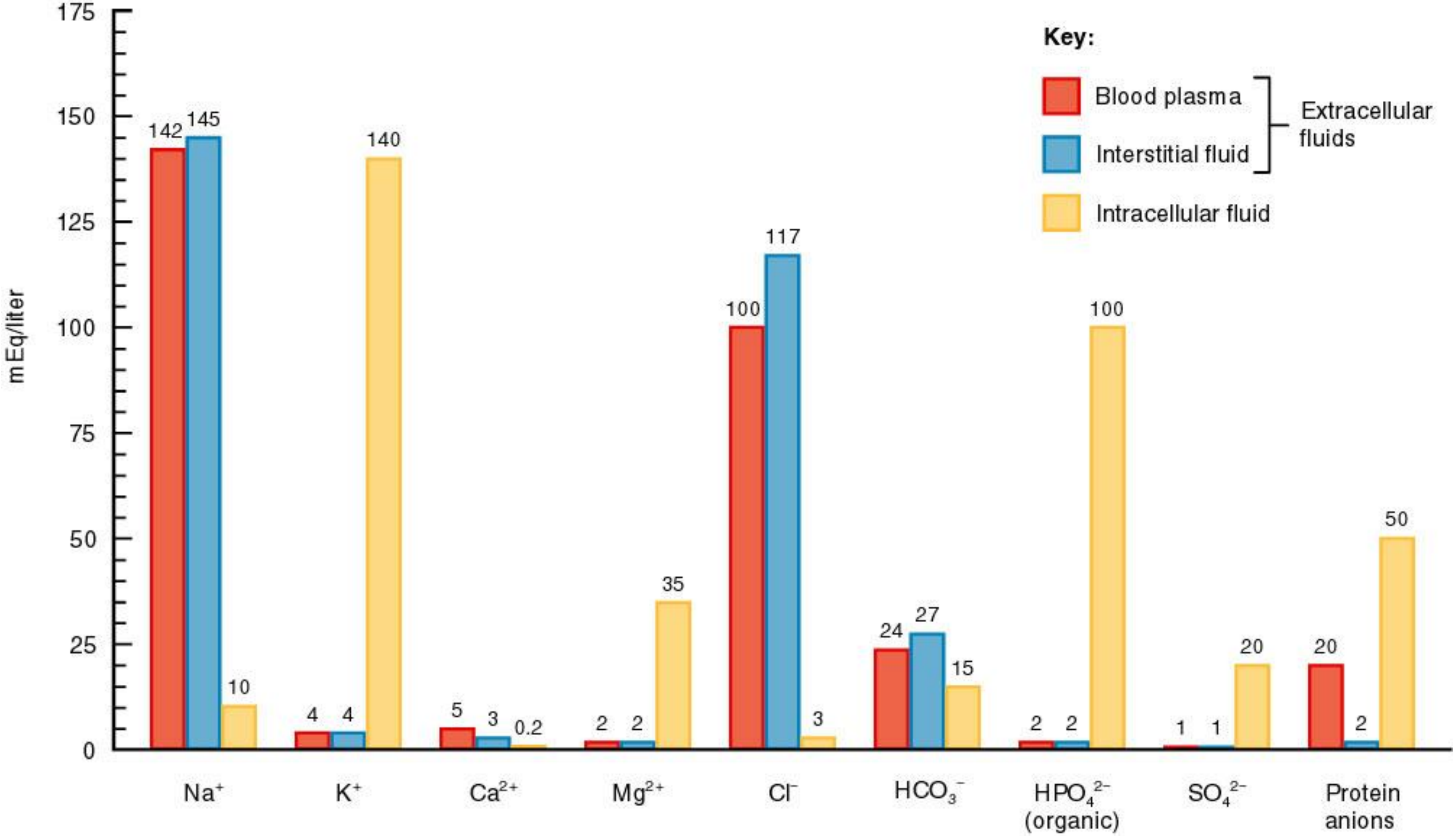
Fluid leaves plasma at arteriolar end of capillaries because outward force of hydrostatic pressure predominates

Fluid returns to plasma at venular ends of capillaries because inward force of colloid osmotic pressure predominates

Hydrostatic pressure within interstitial spaces forces fluid into lymph capillaries

Interstitial fluid is in equilibrium with transcellular and intracellular fluids

Composition of Body Fluids



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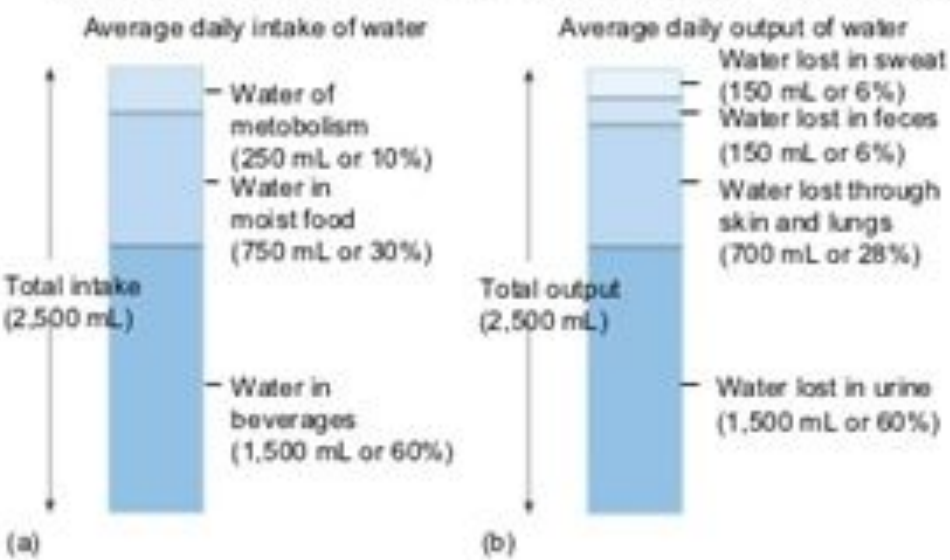
Water Balance

Water input = Water output

Water Inputs

- The volume of water gained each day varies among individuals averaging about 2,500 milliliters daily for an adult:
    - 60% from drinking
    - 30% from moist foods
    - 10% as a bi-product of oxidative metabolism of nutrients called water of metabolism

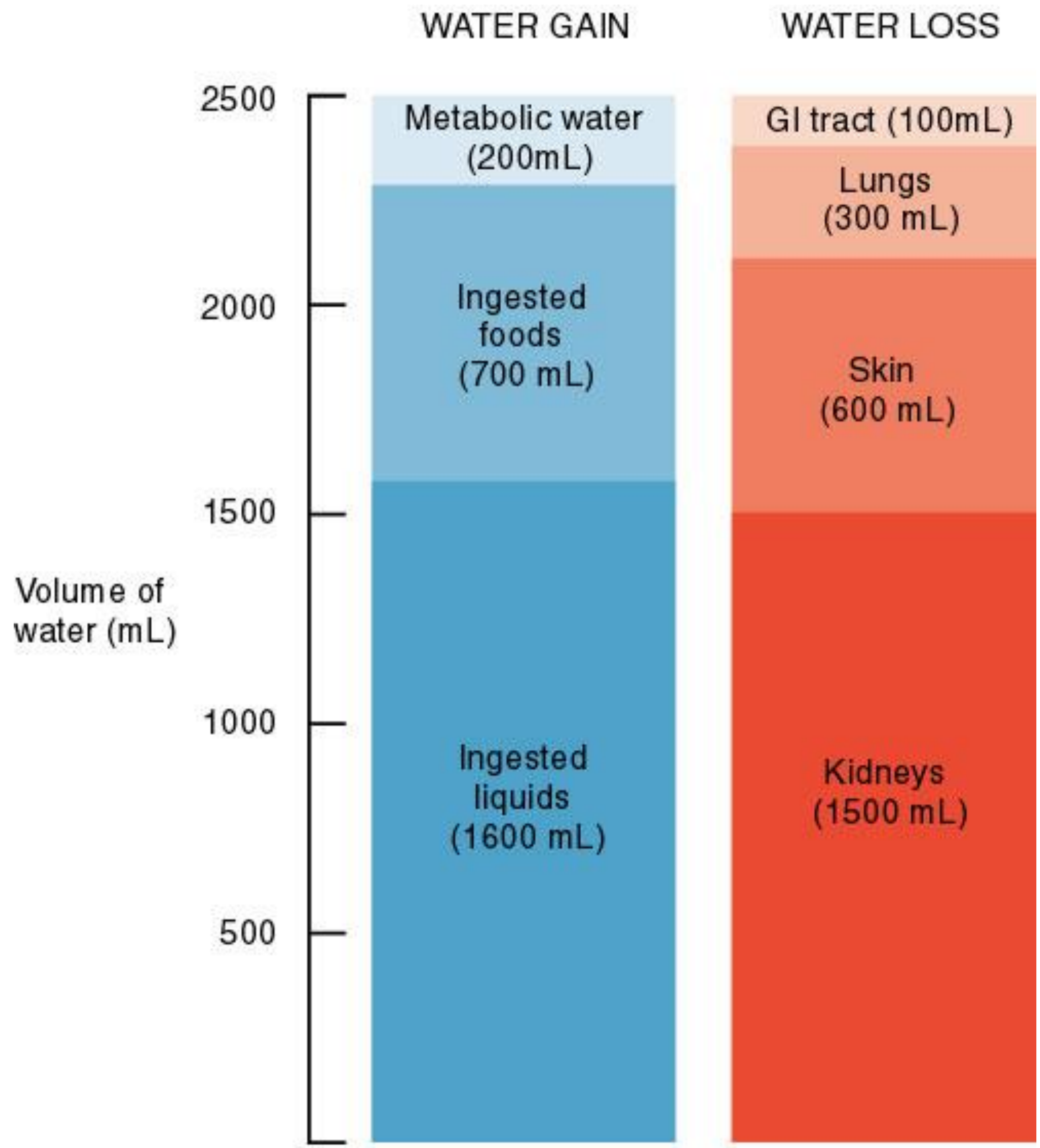


Water Output

- Water normally enters the body only through the mouth, but it can be lost by a variety of routes including:
    - Urine (60% loss)
    - 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 is a 28% loss)

Water Balance



27.02

Water and Electrolytes Homeostasis

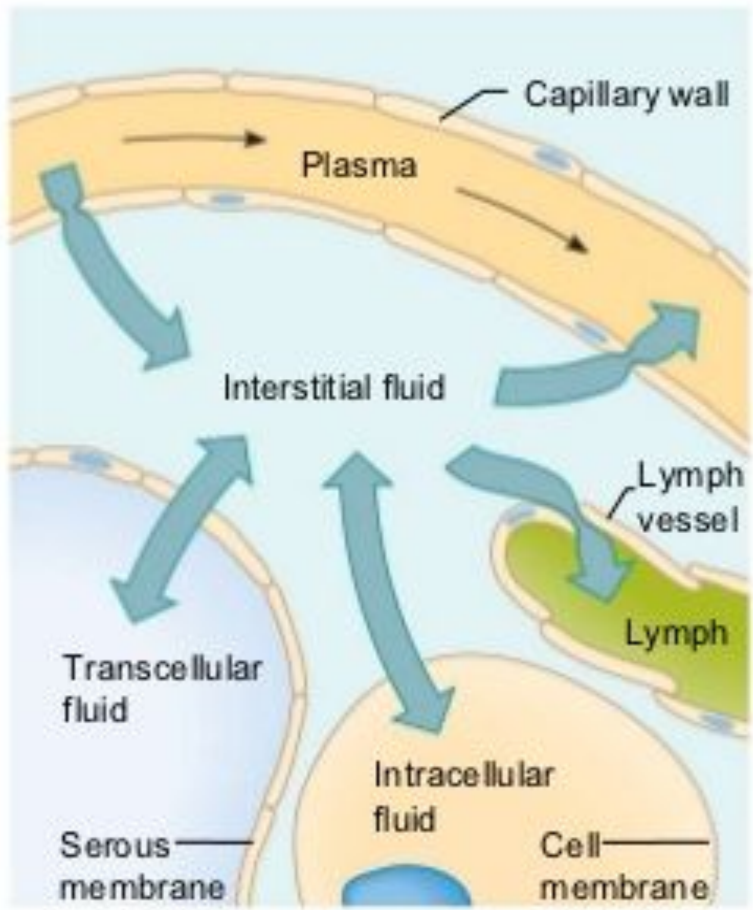
Systems involved in the regulation of fluids and electrolytes

- Kidneys,
- Cardiovascular system,
- Endocrine (Pituitary, Parathyroids, Adrenal glands)
- Lungs

Movement of Fluids between Compartments

Major factors that regulate movements:

- Osmotic pressure
- Hydrostatic pressure



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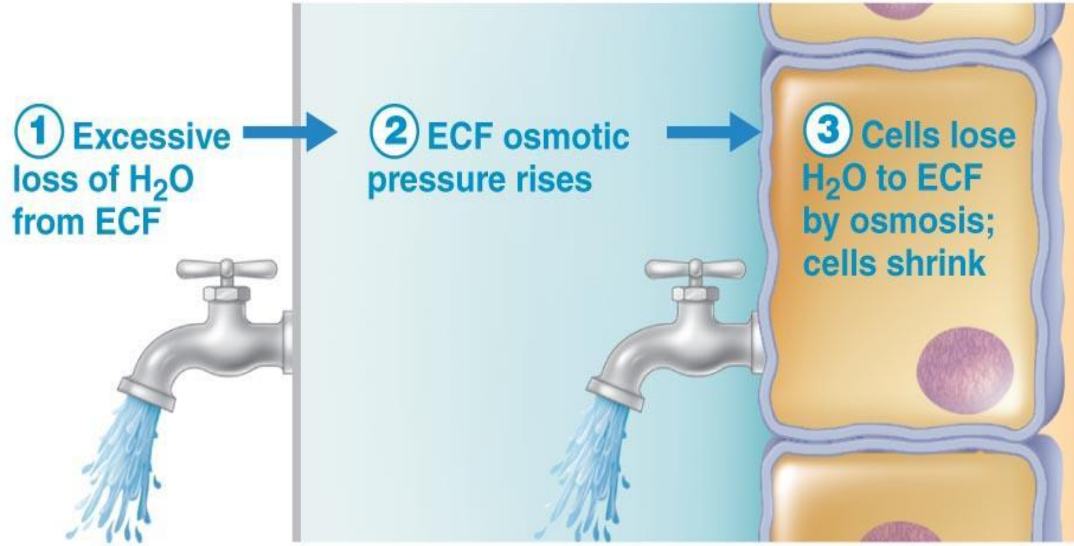
Regulation of Na+ and Water

Involves regulation of:

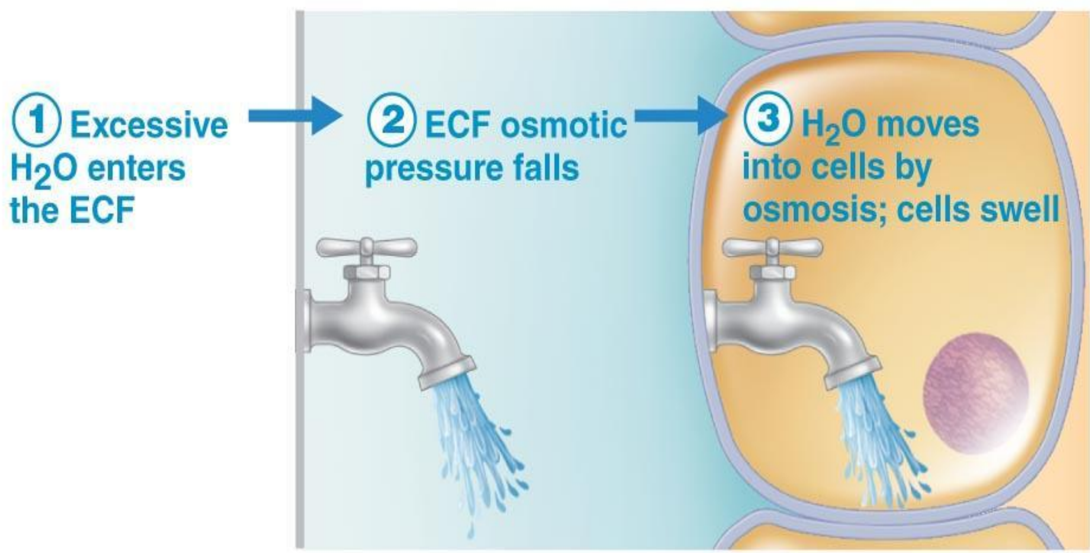
- Osmolality
- Volume of ECF

different regulations with many overlapping mechanisms.

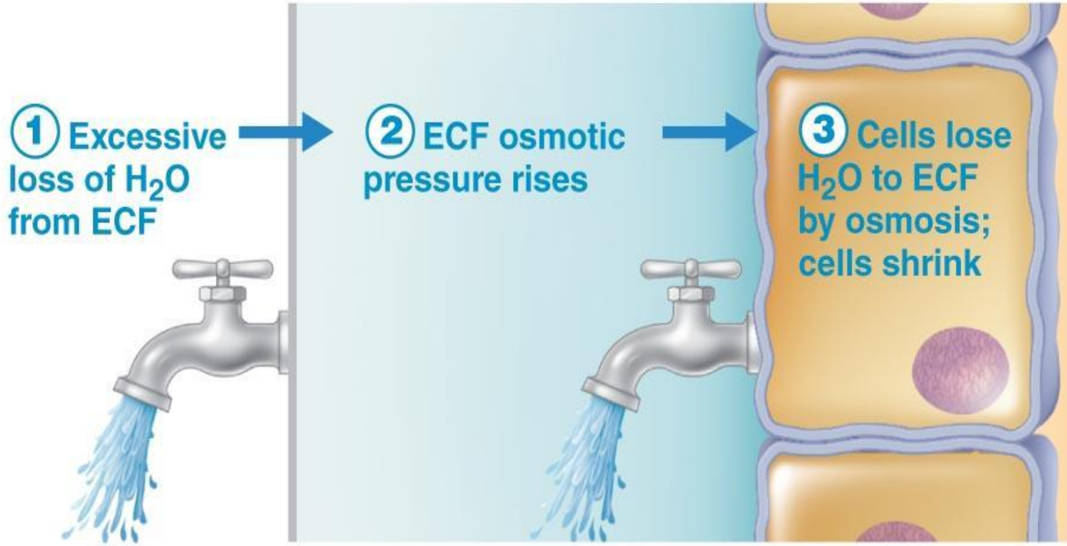
Importance of Na+ and Water regulation



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



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



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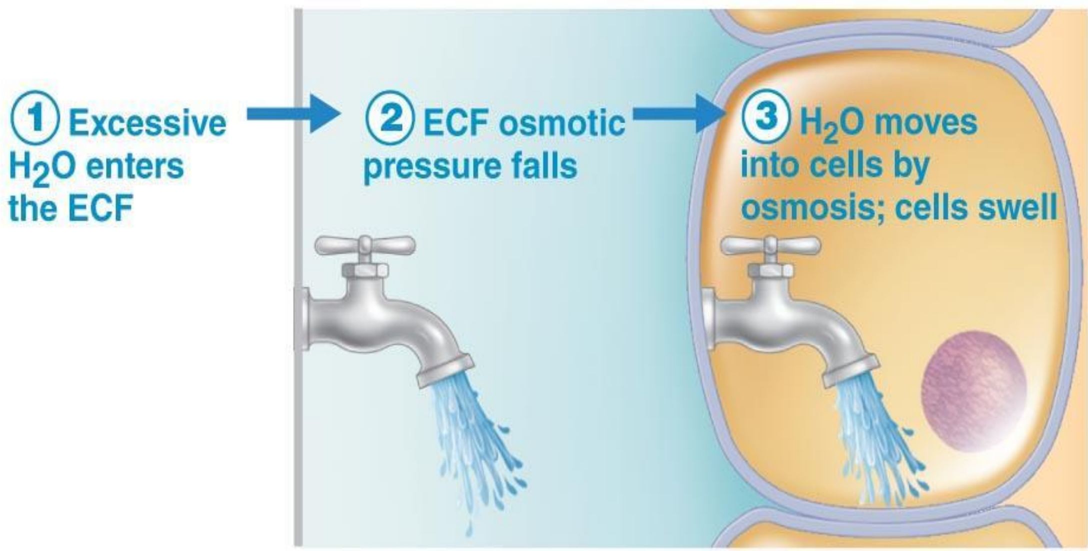

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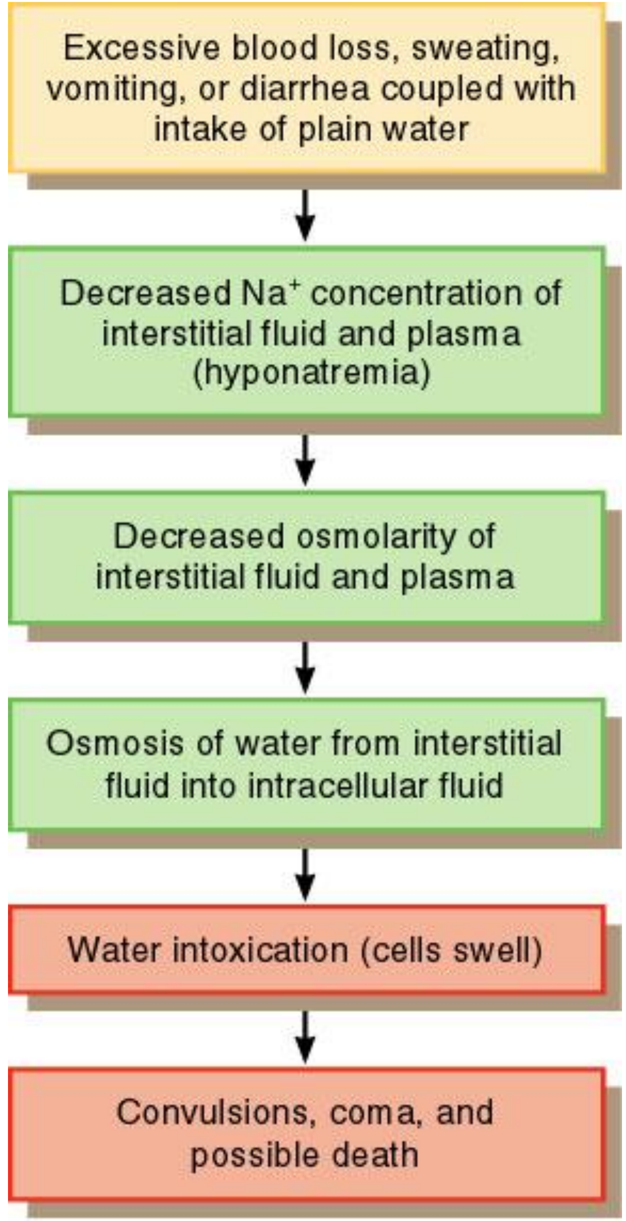
Fig. 27.05



27.05

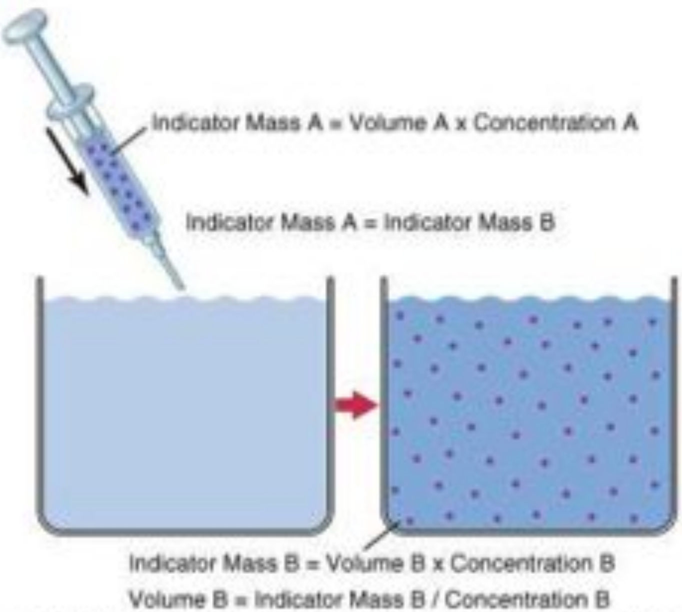
Measurements of Body Fluids

Measuring Body Fluids

Dilution Principle

Dilution method for calculating fluid volume

25-4



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

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,

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

Properties of tracers used for calculation of volumes

- Properties of an Ideal Tracer The tracer should:
- be nontoxic
- be rapidly and evenly distributed throughout the nominated compartment not enter any other compartment.
- not be metabolized.
- 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 (^3H_2O, T_2O, Tritium) or heavy water (^2H_2O, D_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

Measurement of ECF volumes

- $^{22}Na^+$, (Sodium Space)
- ^{125}I-iothalamate,
- Thiosulfate,
- Inulin (Inulin Space)

(Measured in 30-60 minutes)

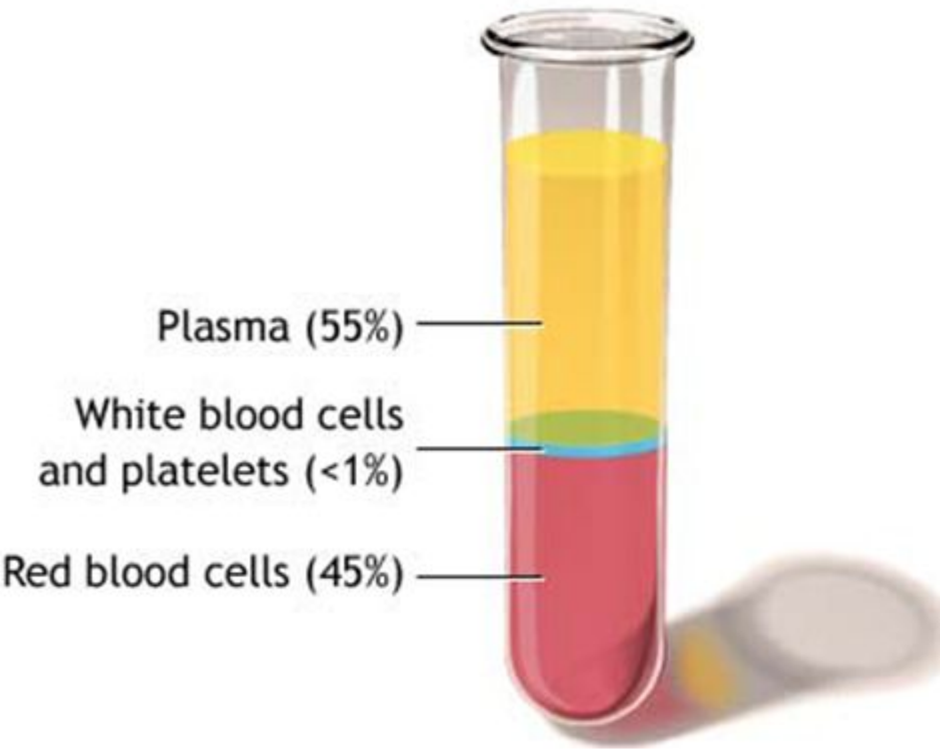
Calculation of ICF
(Intra- Cellular Volume)

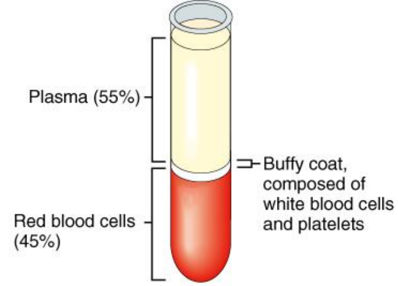
ICF= Total Body water - ECF

Measurement of Plasma volumes

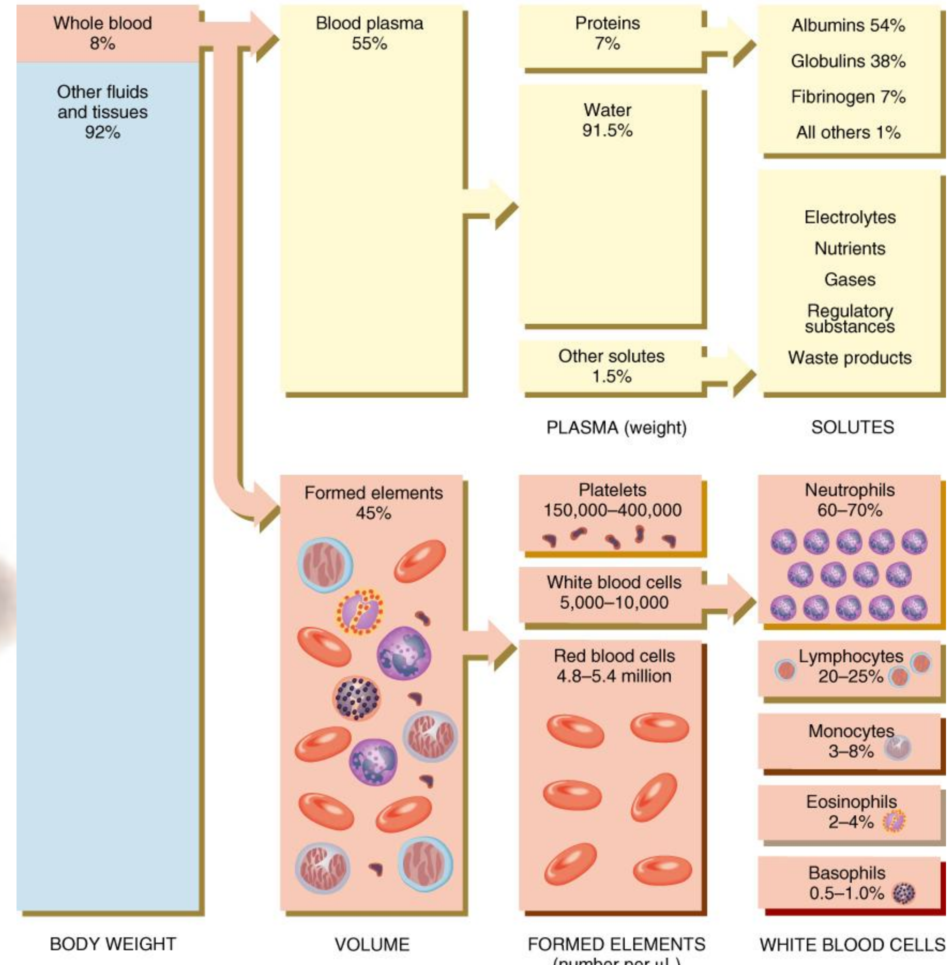
Measurement of Total Blood Volume

Fig.19.01





(a) Appearance of centrifuged blood



(b) Components of blood

19.01

Plasma Composition

- **Water**: > 90%
- **Small molecule**: 2%, it is electrolytes, nutriment, metabolic products, hormone, enzymes, etc.
- **Protein**: 60-80 g/L, plasma protein include albumin (40-50 g/L)(54%), globulins (20-30 g/L,α_1-, α_2, β-, γ-)(38%)and fibrinogen (7%). Most of albumin and globulin made from liver.

Measurement of Plasma volumes

* ^{125}I-Albumin (RISA),

* Evans Blue (Dye (T1824))

Measurement of Total Blood Volume

* ^{51}Cr-labeled Red Blood Cells

* **Calculated** As = $\frac{\text{Plasma Volume}}{\text{1-Hematocrit}}$

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