Body Fluid

A Summary lecture for Medical student.

Any mistake about this lecture I'm here to apologize, because we are humans.

Any ideas or suggestions contact me.

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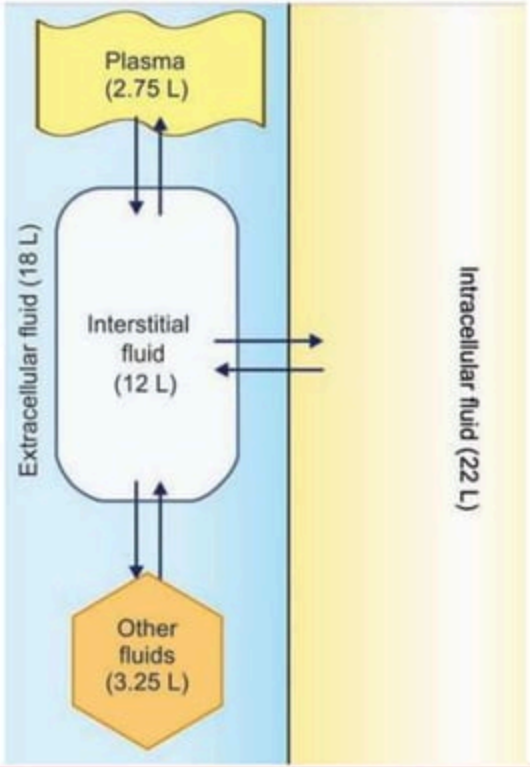
اتمنى لكم التوفيق

- ***Significance or (importance) of body fluids:***

1. **Homeostasis.**
2. **Transport mechanism.**
3. **Metabolic reactions.**
4. **Texture (shape) of tissues.**
5. **Temperature regulation.**

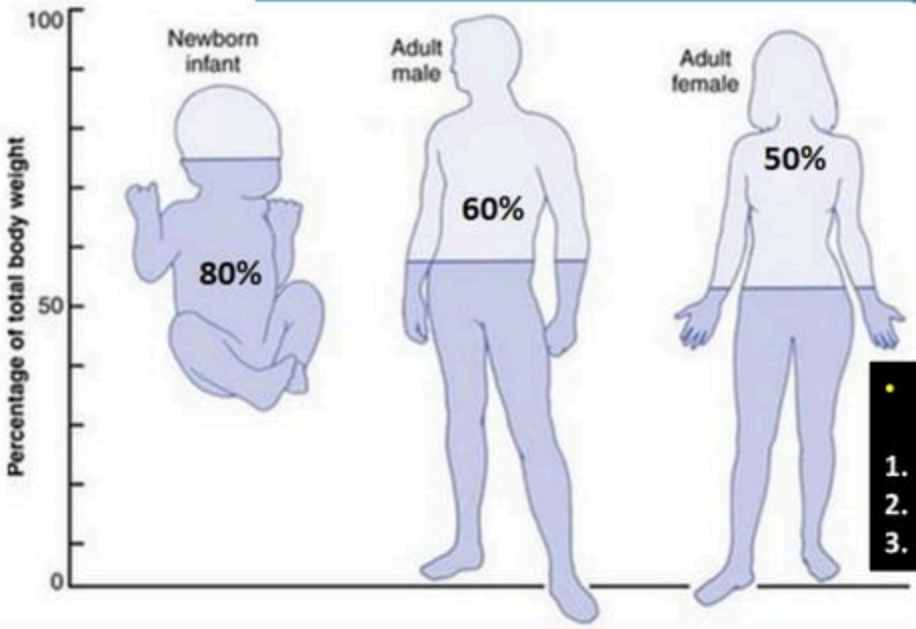
- About 60% of the adult human body **is fluid,** mainly a water solution of ions and other substances.

1. ***Intracellular fluid*: fluid is inside the cells**, 28L, 2/3 of total body fluid.
2. ***Extracellular fluid*: fluid in the spaces outside the cells**, 14L, 1/3 of total body fluid.



The extracellular fluid also known as **"Internal environment or *milieu intérieur*"**

BODY FLUID COMPARTMENTS:



- ***The percentage of fluid depends on:***

1. Age.
2. Gender
3. Degree of obesity.

- The females has **adipose tissue** so the fat cells doesn't absorb water than muscle.
- Dehydration is common and rapid in children because the ***regulatory mechanisms for maintaining ECF volume*** are not well developed in infants and children.

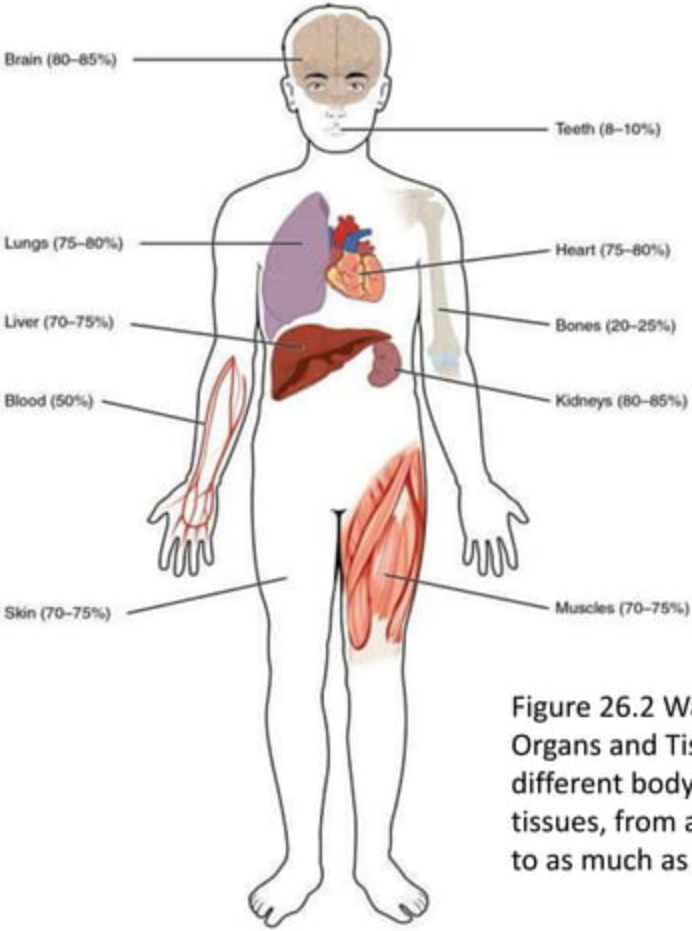
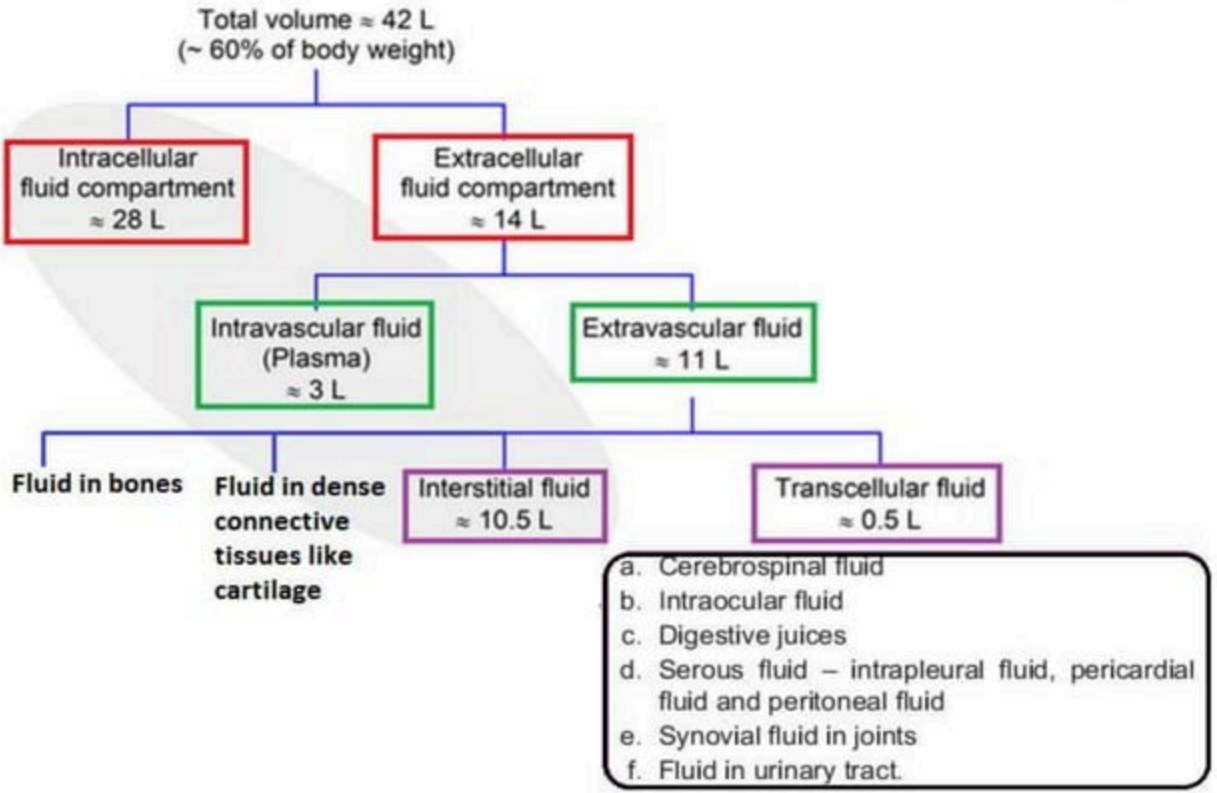
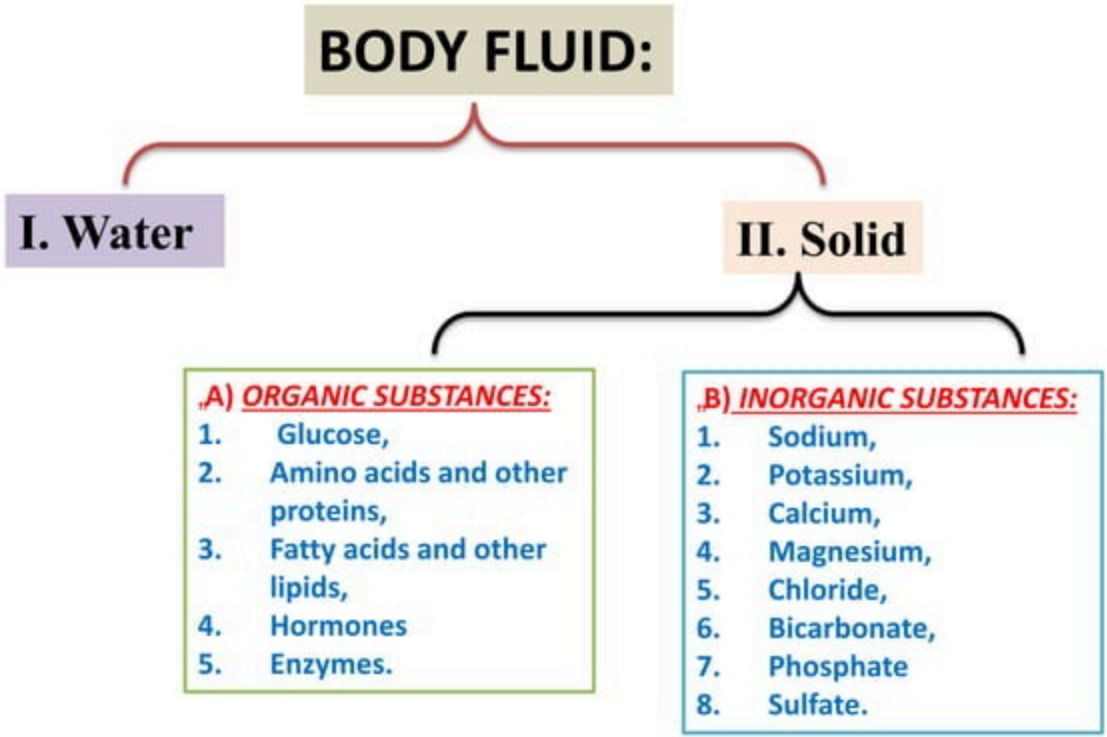


Figure 26.2 Water Content of the Body's Organs and Tissues Water content varies in different body organs and tissues, from as little as 8 percent in the teeth to as much as 85 percent in the brain.

COMPARTMENTS OF BODY FLUIDS – DISTRIBUTION OF BODY FLUIDS



COMPOSITION OF BODY FLUIDS:



Differences Between Extracellular and Intracellular Fluids:

- **The extracellular fluid contains large amounts:**

1. ***Sodium, chloride, and bicarbonate ions*** *plus nutrients* ***(oxygen, glucose, fatty acids, and amino acids).***
2. *Cellular west product* ***carbon dioxide*** *&* ***ammonia.***

- **Intracellular fluid contains large amounts:**

1. ***potassium, magnesium, and phosphate ions.***

Differences between ECF & ICF

ECF

Cations:

Na^+ (142 mmol/L)

K^+ (4.2)

Mg^{2+} (0.8)

Anions:

Cl^- (108)

HCO_3^- (24)

Nutrients:

O_2, glucose, fatty acids, & amino acids.

Wastes:

CO_2, Urea, uric acid, excess water, & ions.

ICF

Cations:

Na^+ (14)

K^+ (140)

Mg^{2+} (20)

Anions:

Cl^- (4)

HCO_3^- (10)

Phosphate ions

Nutrients:

High concentrations of proteins.

- Fluid intake and output are balanced during steady-state conditions.

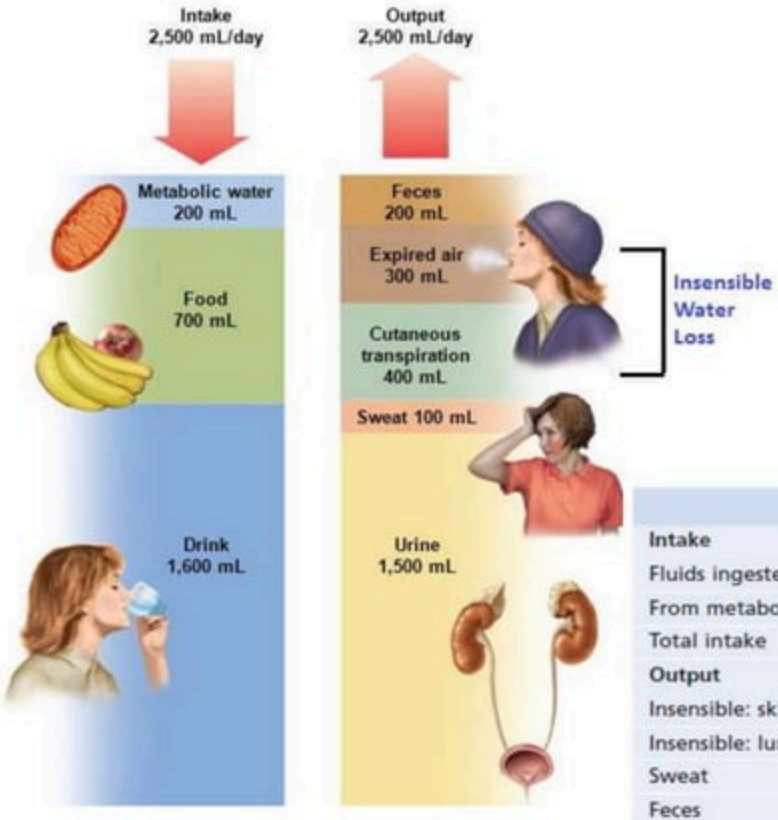
Balance b/w Fluid Intake & Fluid Loss:

DAILY INTAKE OF WATER:

1. It is ingested in the **form of liquids or water in food (2L).**
2. It is synthesized in the **body by oxidation of carbohydrates,** adding about 200 ml/day.

DAILY LOSS OF BODY WATER:

1. **Insensible Water Loss (Skin, Lungs).**
2. **Fluid Loss in Sweat.**
3. **Water Loss in Feces.**
4. **Water Loss by the Kidneys (urine).**



	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

Calculation of body Fluid Compartment:

- **Calculation of Intracellular Volume:**

Intracellular volume = Total body water - Extracellular volume.

- **Calculation of Interstitial Fluid Volume:**

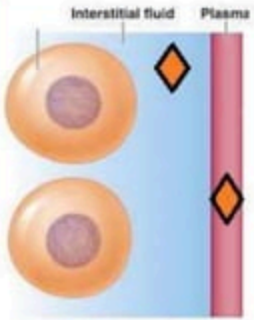
Interstitial fluid volume = Extracellular fluid volume - Plasma volume.

- **Measurement of Blood Volume:**

$$\text{Total blood volume} = \frac{\text{Plasma volume}}{1 - \text{Hematocrit}}$$

Similarity and differentially b/w Interstitial & Plasma.

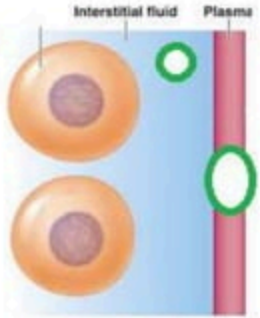
- **The plasma** and **interstitial fluid** their ionic composition is similar.
- But the plasma has a **higher concentration of plasma protein**.



ionic (Na, Ca, K, Cl etc) composition is ***similar*** interstitial & Plasma.

- The distribution of fluid between intracellular and extracellular compartments is determined mainly by the **osmotic effect of the smaller solutes *(sodium, chloride, and other electrolytes)*** acting **across the cell membrane**.
- The cell membranes are **highly permeable to water** but relatively **impermeable to even small ions such as sodium and chloride**.

Plasma proteins is ***more*** in the "plasma" and less in the interstitial



BASIC PRINCIPLES OF OSMOSIS AND OSMOTIC PRESSURE:

- If a solute such as sodium chloride is added to the extracellular fluid, water rapidly diffuses from the cells through the cell membranes into the extracellular fluid until the water concentration on both sides of the membrane becomes equal.
- Conversely, if a solute such as sodium chloride is removed from the extracellular fluid, water diffuses from the extracellular fluid through the cell membranes and into the cells.
- ***Rate of osmosis:*** **is the rate of diffusion of water.**

CONCENTRATION OF BODY FLUIDS:

- Concentration of body fluids is expressed in three ways:

1. Osmolality

2. Osmolarity

3. Tonicity.

1- OSMOLALITY:

- **The number of particles (osmoles) per kilogram of solution (osmoles/kg H_2O).**

2- OSMOLARITY:

- **The number of particles (osmoles) per liter of solution (osmoles/LH_2O).**

- These two terms can be used almost synonymously because the differences are small.
- It is easier to express body fluid quantities in liters of fluid rather than in kilograms of water.

Mole and Osmole

- **Mole (mol):** ***is the molecular weight of a substance in gram.***
- **Osmole (Osm):** ***is the expression of amount of osmotically active particles.***

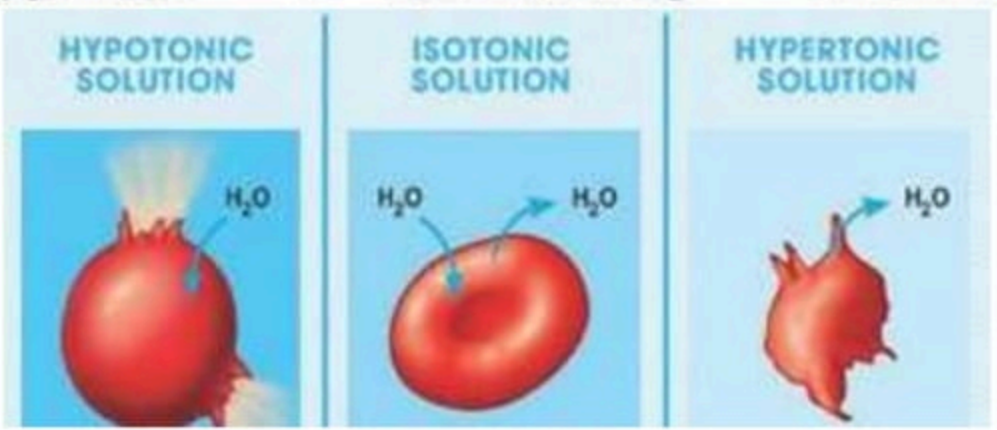
Example of mole & osmoles:

- 1 liter of a solution containing **0.1 mole of glucose** has an **osmolarity of 0.1 osmolar** because **glucose does not dissociate** in solution.
- 1 liter solution containing **0.1 mole of NaCl** has an **osmolarity of 0.2 osmolar** because **NaCl dissociates** in solution to give approximately **0.1 mole** of **sodium ions** and **0.1 mole of chloride ions**, for a total of 0.2 mole of solute particles.

3- TONICITY:

- **Tonicity:** ***is the measure of effective osmolality.***
- Example:
- Small molecules like **urea and alcohol** – cross membrane **very rapidly**, but does not influence water movement so these are called ***" ineffective osmoles "***
- Large molecules like **Sodium and Glucose** – cross membrane **very slowly**, but influence water movement so these are called ***" effective osmoles "***

TONICITY	OSMOLALITY	CELL
Hypotonic	< 270 mOsm/kg	Swelling
Isotonic	275-295 mOsm/kg	Nothing
Hypertonic	> 300 mOsm/kg	Shrinking



- **Some of the different factors that can cause extracellular and intracellular volumes to change markedly are:**

- ***Factors causes excess of water in the body:***

1. Excess ingestion.
2. Renal retention of water.
3. Intravenous infusion of different types of solutions.

- ***Factors causes loss of water in the body:***

1. Dehydration.
2. Loss of large amounts of fluid from the gastrointestinal tract.
3. Loss of abnormal amounts of fluid by sweating or through the kidneys.

- Water moves rapidly across cell membranes.
- Cell membranes are almost completely impermeable to many solutes, such as sodium and chloride.

Imbalance of Body Fluid

- ***DEHYDRATION:***
- **Excessive loss of water from the body.**
- **Causes:**

1. **Diarrhea or vomiting (Isotonic dehydration).**
2. **Fever (Hypertonic dehydration).**
3. **Excess use of diuretics (Hypotonic dehydration)**

- ***OVERHYDRATION:***
- **Condition characterized by great increase in the water content of the body** (also called hyperhydration, Water intoxication or water poisoning).
- **Causes:**

1. **Heart failure.**
2. **Renal disorders.**
3. **Hypersecretion of antidiuretic hormone.**
4. **Intravenous administration of unduly large amount of medications and fluids.**

EDEMA

- **Is the presence of excess fluid in the body tissues.**
- ***Types of edema:***

1. **INTRACELLULAR EDEMA.**
2. **EXTRACELLULAR EDEMA.**

- In most instances, **edema occurs mainly in the extracellular fluid compartment.**

INTRACELLULAR EDEMA:

- ***Is presence of large amount of fluid inside the cell.***
- Three conditions are especially prone to cause intracellular swelling:

(1) Hyponatremia.

(2) Depression of the metabolic systems of the tissues.

(3) Lack of adequate nutrition to the cells.

(4) Inflamed tissues.

- **Pathophysiology:**
- **↓Oxygen & nutrients ⇨ ↓ATP production ⇨ Failure of pumping Na outside the cell ⇨ water moves from low area to high areas ⇨ cell swelling ⇨ cell death.**
- Cell inflamed ↑ cell membrane permiability ⇨ large amount of sodium enter the cell then flow of water ⇨ cell swelling & death.

EXTRACELLULAR EDEMA:

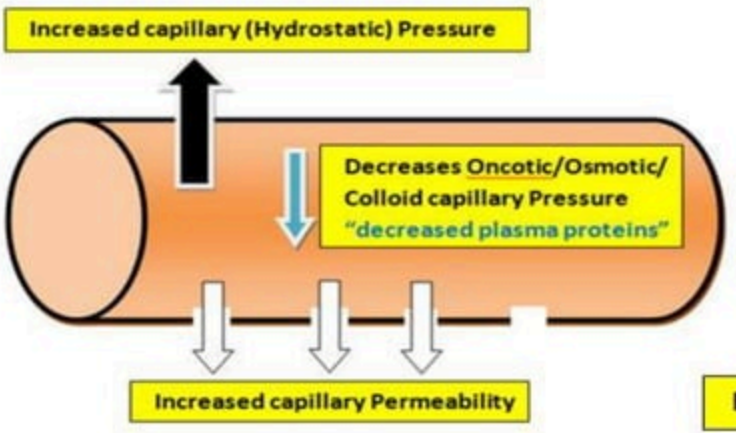
- Is an excess fluid accumulates in the extracellular spaces.
- There are two general causes of extracellular edema:

(1) abnormal leakage of fluid from the plasma to the interstitial spaces across the capillaries.

(2) failure of the lymphatics to return fluid from the interstitium back into the blood.

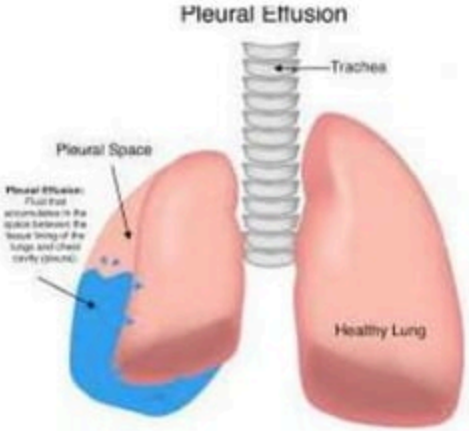
➢Conditions that can cause extracellular edema:

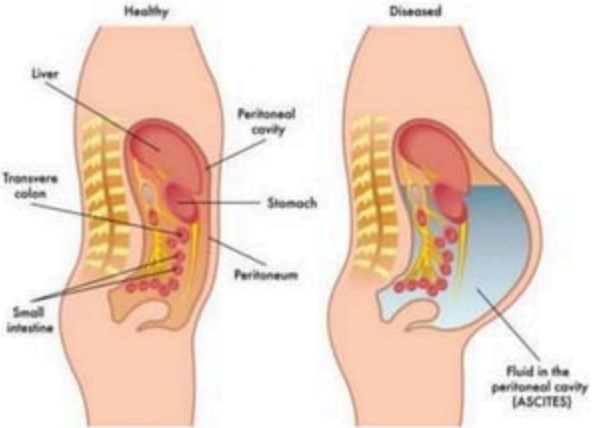
1. Increased capillary Pressure.
2. Increased Capillary permeability.
3. Decreased plasma proteins.
4. Blockage lymph return.

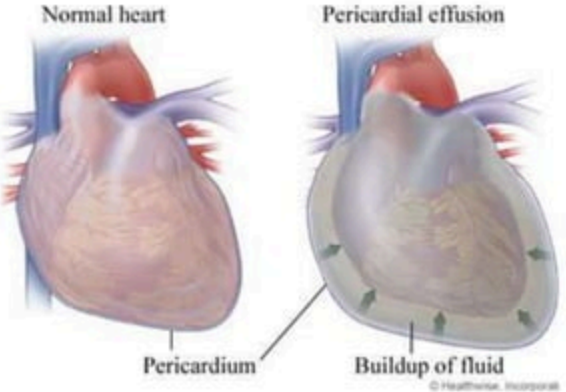


"POTENTIAL SPACES"

- *a space that can occur between two adjacent structures that are normally pressed together.*
- Some examples: **pleural cavity, pericardial cavity, peritoneal cavity, and synovial cavities.**
- Virtually all these potential spaces have surfaces that almost touch each other, **with only a thin layer of fluid in between**, and the surfaces slide over each other.
- To facilitate the sliding, **a viscous proteinaceous fluid lubricates the surfaces.**
- **Edema Fluid in the Potential Spaces Is Called *Effusion.***


Pleural Effusion
Trachea
Pleural Space
Pleural Effusion:
Fluid that accumulates in the space between the tissue lining of the lungs and chest cavity (pleura).
Healthy Lung


Healthy
Diseased
Liver
Peritoneal cavity
Transvere colon
Stomach
Peritoneum
Small intestine
Fluid in the peritoneal cavity (ASCITES)


Normal heart
Pericardial effusion
Pericardium
Buildup of fluid