Body fluids (2)

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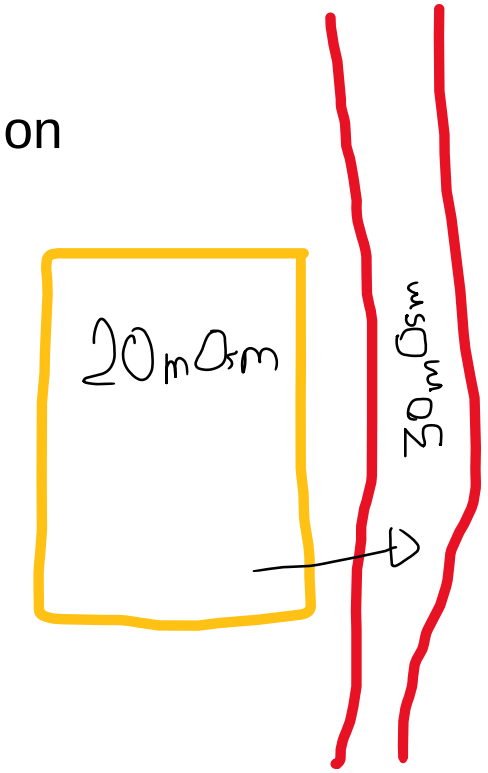
Topics

- 1- Remember
- 2- Osmoregulation
- 3- Regulation of water intake and output
- 4- Disorders of water volume
- 5- Disorders of Osmolality
- 6- Oedema
- 7 to10 – Causes of Oedema
- 11- Safety factors for preventing oedema

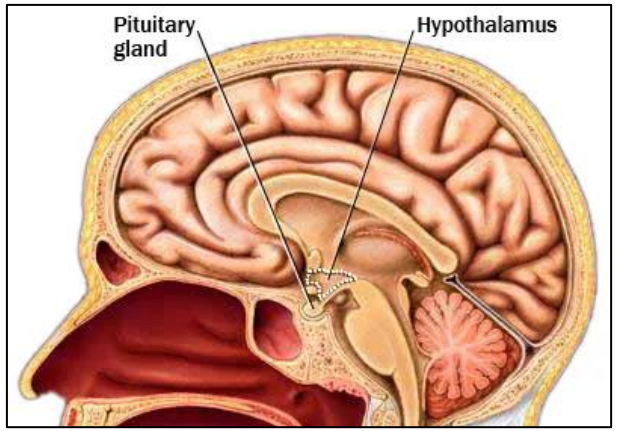
1- Remember

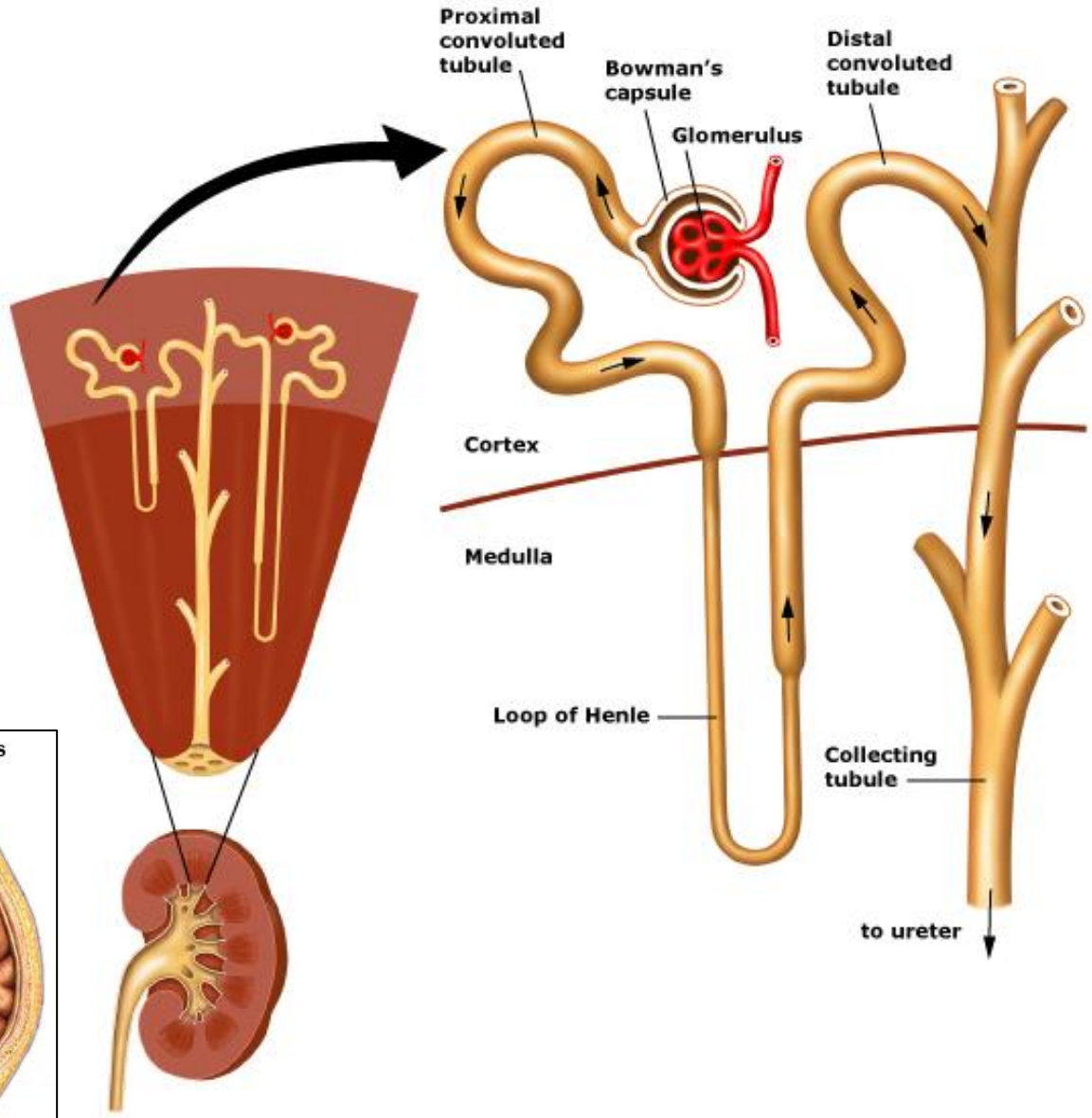
- Osmotic pressure: Pressure exerted by Concentration of solutes in the water
- Osmolarity: Concentration of ions per liter of solution
- Osmolality: Concentration of ion per kilogram of solution



2- Osmoregulation

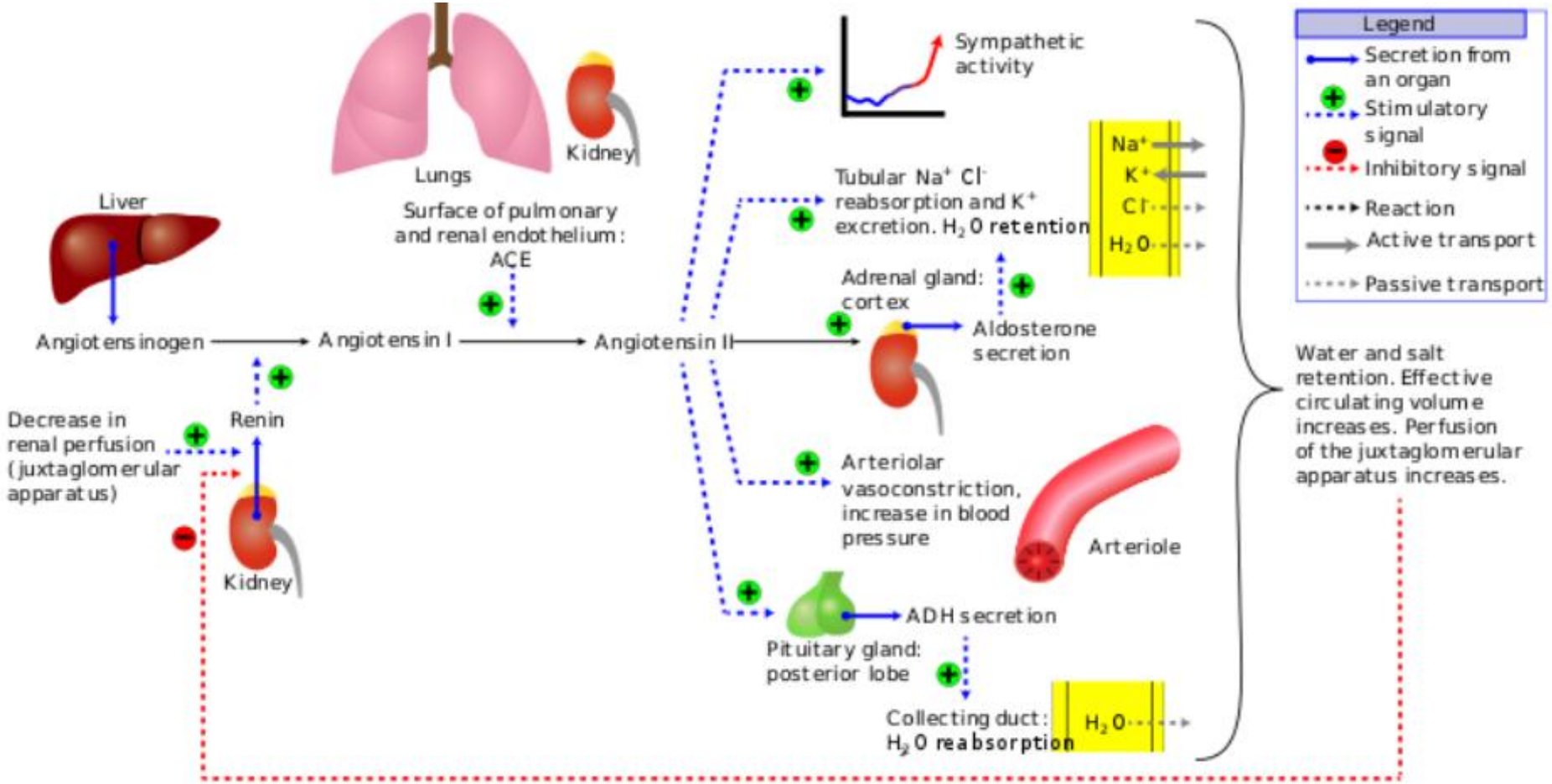
- Osmoregulation: process of regulation of concentration of sodium and water
- Involves regulation of:
  1- Osmolality
  2- Volume of ECF
  → different regulations with many overlapping mechanisms.
- 1- Osmolality:
  Most of the osmolality in our body is caused by: sodium and chloride ions extracellularly, and potassium intracellularly
- How osmolality regulation is achieved?
  - Increased osmolality → stimulate osmoreceptors in hypothalamus → stimulate thirst receptors in the hypothalamus →Increase water intake → Decrease osmolality (negative feedback)
  - Increased osmolality → stimulates release of ADH → acts on renal collecting ducts → increased water reabsorption (Decrease water output)





2- Osmoregulation

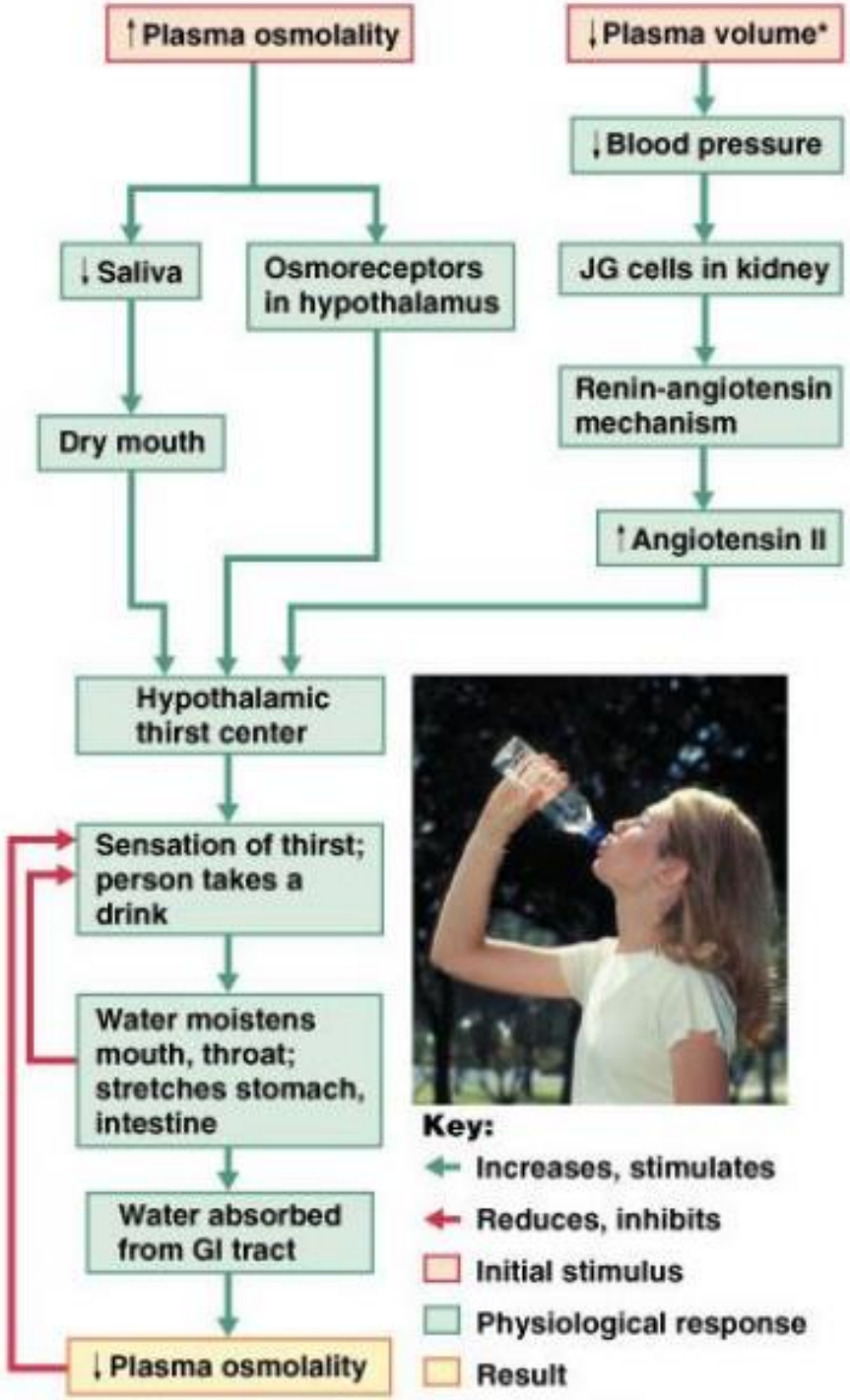
- 2- Volume of ECF:
  - Depends on Na+ excretion in urine, when sodium secretion decreases, water secretion decreases also
  - Controlled by renin-angiotensin aldosterone system, by the following:
  Juxtaglomerular Cells (Kidney) release Renin → Converts angiotensinogen into Angiotensin I → converted into Angiotensin II by the Lung → have many effects including the induce of Aldosterone secretion



3- Regulation of water intake and output

- 1) Water intake

- hypothalamic thirst centers are activated by dry mouth. So the first way to increase water intake: Increased osmolarity reduces salivation, so the mouth will be dry and this activates thirst centers
- The second way is through osmoreceptors in hypothalamus (They sense an increase in the osmolarity and send signals to thirst centers)
- The third way: Decreased plasma volume means decreased BP (blood pressure) and this will activate JG (juxtaglomerular) cells in the kidney to activate a system known as “Renin-angiotensin-aldosterone” and this system activates thirst centers in hypothalamus through angiotensin II –we will study this system with more details



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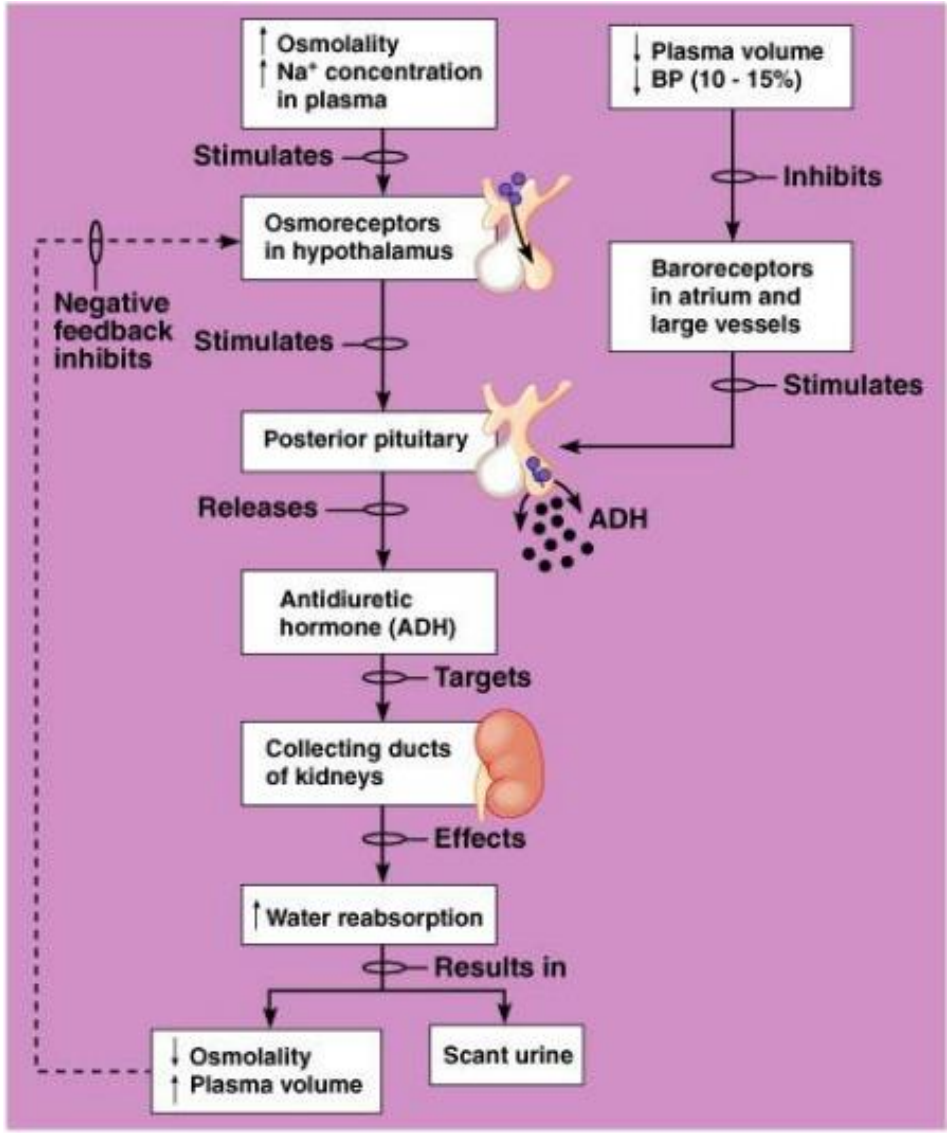

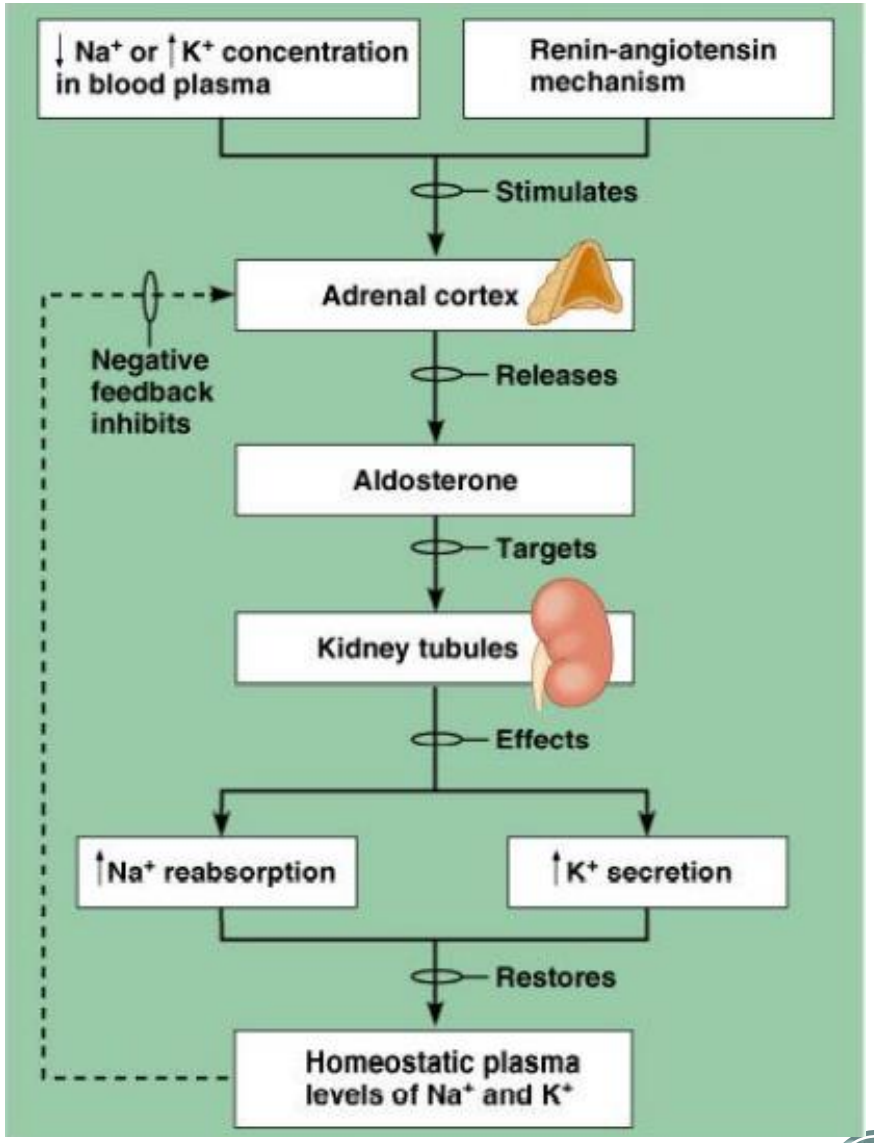

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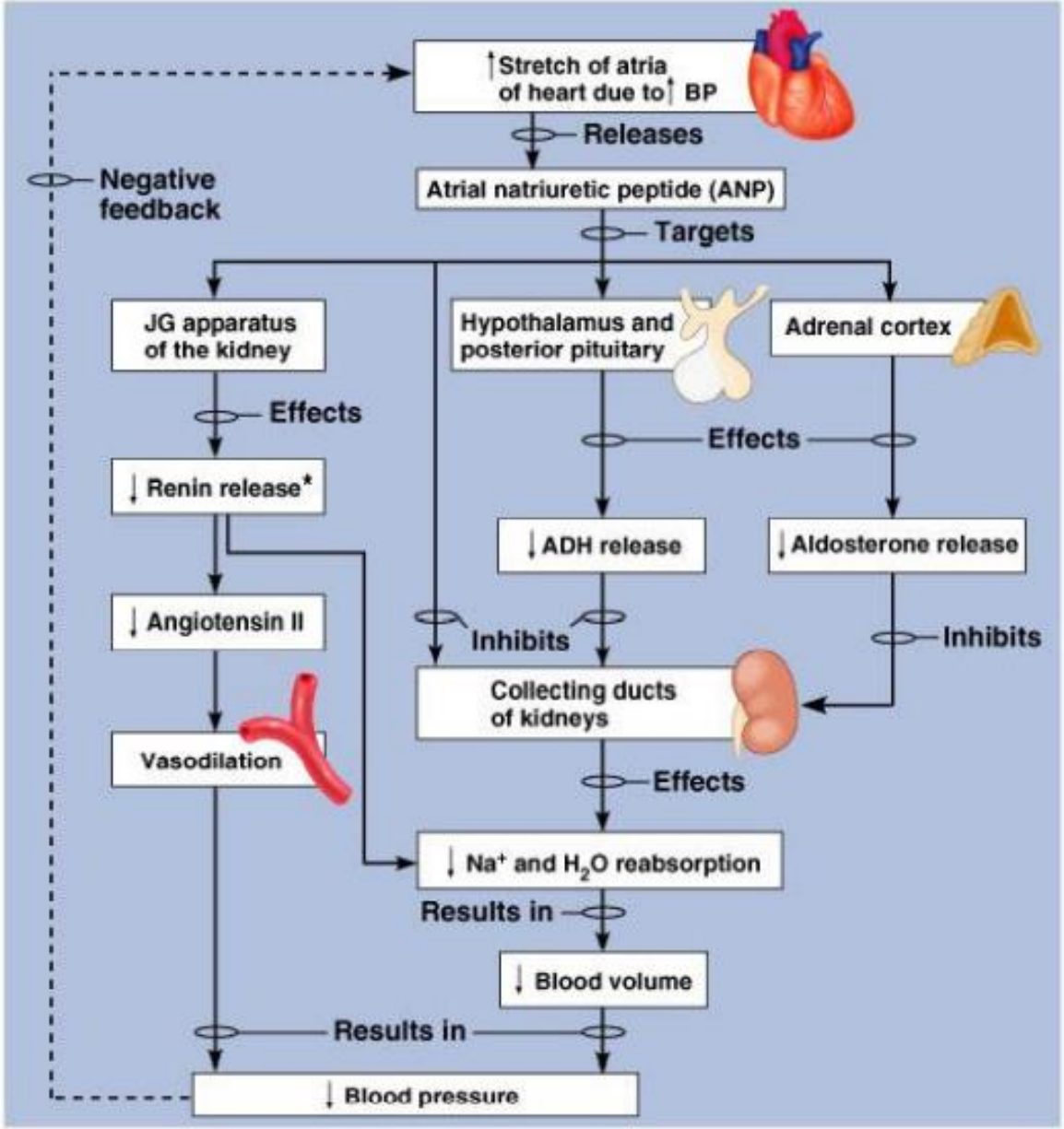


4- Disorders of water volume

- There are many different factors that can cause extracellular and intracellular volumes to change
- Some important principles before we proceed:
  1) Water moves rapidly across cell membranes
  2) Cell membranes are almost completely impermeable to many solutes, so osmotic pressure inside and outside cells generally remains constant unless solutes are added to or lost from the extracellular compartment
- Disorders of volumes :
  1) Hypovolemia
  2) Hypervolemia

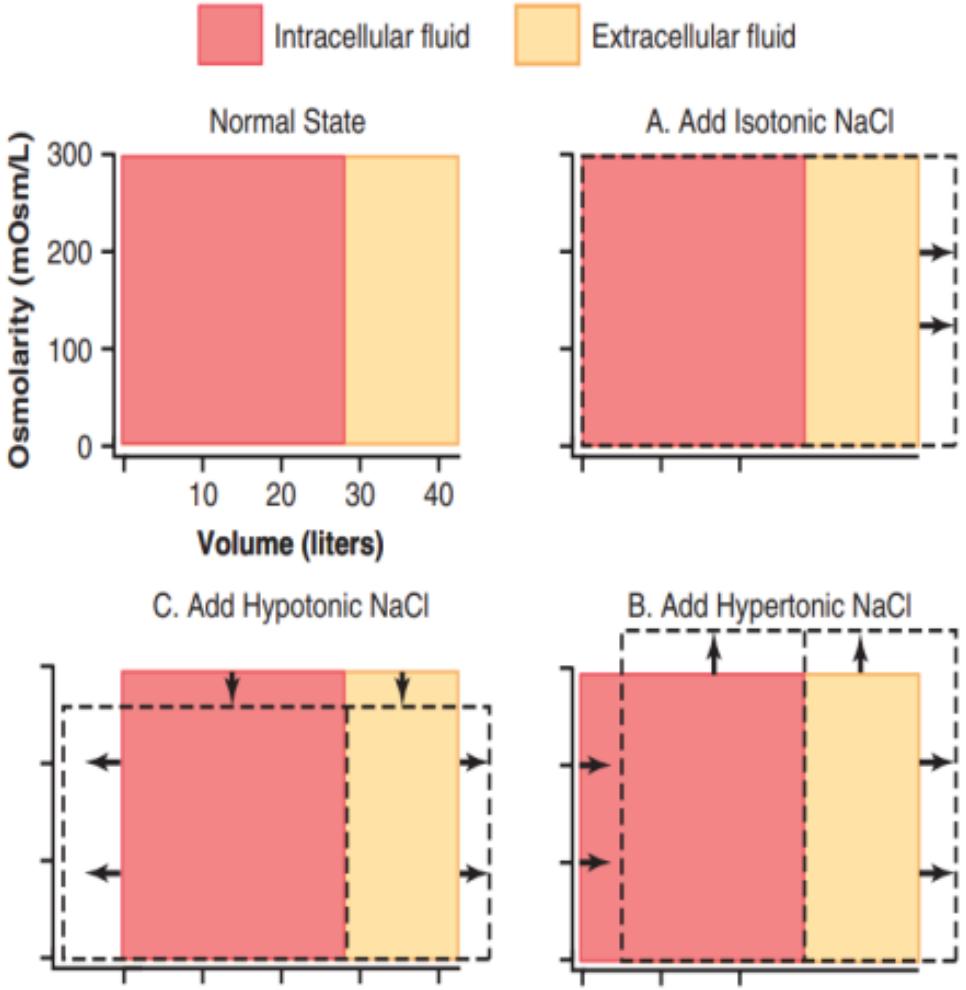
4- Disorders of water volume

- Hypovolemia (decreased water volume)
  → Results by excessive loss of fluids.
  → Caused by diarrhea, vomiting, decreased ADH release (diabetes insipidus) and blood loss.
- Hypervolemia (increased water volume): Results by excessive intake or administration of fluids

5- Disorders of Osmolality

- mainly determined by sodium
- 1) Hyponatremia (decreased osmolality): Results by excessive loss of Na+ or administration of hypotonic fluids/ Can be caused by excessive intake of potable water
- 2) Hypernatremia (increased osmolality): Results by excessive intake of Na+ or administration of hypertonic fluids/ Can be caused by ingesting high amount of sodium (like salts)

5- Disorders of Osmolality



isotonic

A. No change in ICF volume.
ECF volume ↑
No change in osmolality.

Hypertonic

B. ECF volume ↑
ECF osmolality ↑
ICF volume ↓
ICF osmolality ↑

Hypotonic

C. ECF volume ↑
ECF osmolality ↓
ICF volume ↑
ICF osmolality ↓

5- Combination of disorders

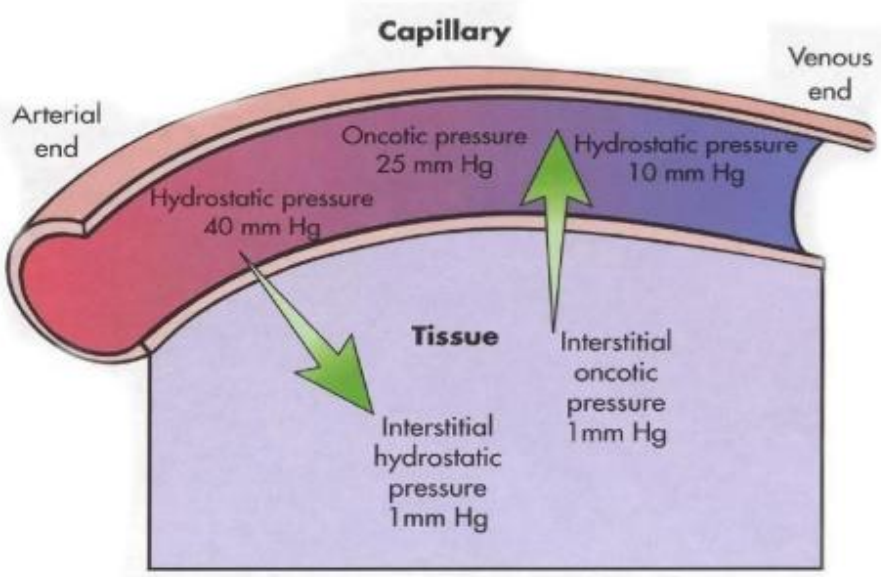
- There can be a combination of disorders of volumes and osmolality:
- 1) Hyponatremia & dehydration: High loss of water (diarrhea, vomiting or blood loss) and solids
- 2) Hyponatremia with overhydration :High retention of water (administration) or Increased ADH.
- 3) Hypernatremia with dehydration
- 4) Hypernatremia with overhydration: caused by hyperaldosteronism

6- Oedema

- Localized retention of fluids at the interstitial compartment
- **Causes of oedema :**

- increasing capillary filtration
- Decreased oncotic pressure
- Increase capillary permeability
- Decreased lymph drainage

	Arteriole	Venule
Hydrostatic pressure	40	10
Oncotic pressure	25	25
Resultant	15 outside with nutrients	15 inside with wastes



7- increasing capillary filtration

→ Caused by:

- **Increased capillary hydrostatic pressure:**

  - Kidney causes: more retention of water and salts *increased inside capillaries* (Renal failure)

  - Excess of Mineralocorticoids (aldosterone) → Increasing Na+ and water.

- **High venous pressure:** (in normal conditions it is very low)

  Heart failure, decrease of Venous return (obstruction, decreased venous pump activity)

- **Decreased arteriolar resistance:**

  Vasodilation → More blood flow → More filtration

Vasodilation can be caused by 1- excessive body heat
2- insufficiency of SNS
3- vasodilators

8- Decreased oncotic pressure

- Caused by:

* **Increased loss of proteins:**

– **From Kidney in nephrotic syndrome**
Proteins are lost in urine. (خلل في عملية الارتشاح)

– **from skin in burns and severe wounds**

* **Decreased production of proteins :**

– **Liver diseases** (mostly the production of albumin)

– **Decreased intake of proteins in malnutrition**

9- Increase capillary permeability

- Caused by:
  - During immune reactions by release of histamine
  - Toxins
  - Infections
  - Vitamin C deficiency
  - Ischemia
  - Burns

10 -Decreased lymph drainage

- Caused by:
  - Cancer
  - Infections
  - Surgery
  - Absence or abnormality of lymphatic vessels

11- Safety factors for preventing oedema

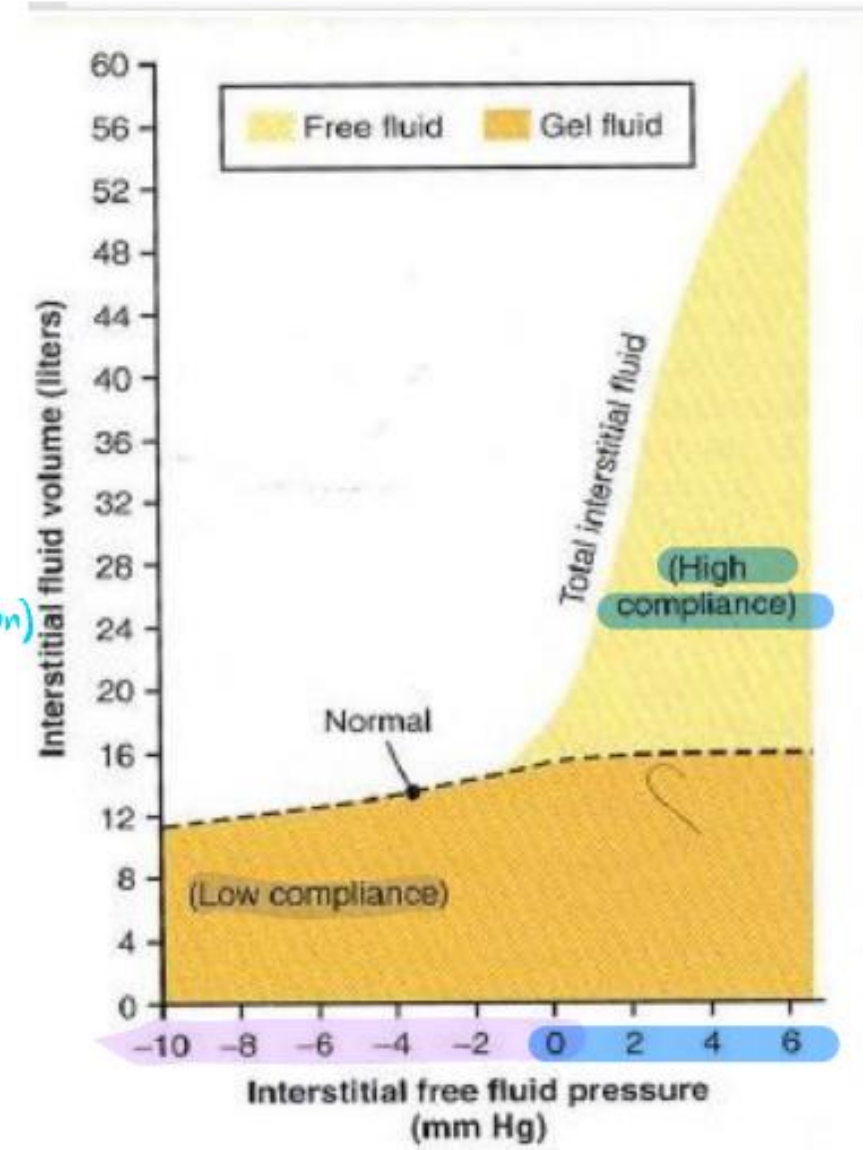
- 1. Low tissue compliance
- 2. Increased lymph flow
- 3. Increased protein wash-down from interstitial fluids

11- Safety factors for preventing oedema

Low tissue compliance

In negative pressure ranges LOW compliance by presence of gel fluids results in relative increase in hydrostatic pressure to small changes in volume → Prevents capillary filtration.

In positive pressure ranges HIGH compliance (more fluid retention) by accumulation of free fluids results in smaller increase in hydrostatic pressure to high changes in volume → Pitting oedema.



11- Safety factors for preventing oedema

Increased lymph flow

Lymph flow can increase up to 10-50 folds → Carry away large amounts of fluids → prevents interstitial pressure from rising into POSITIVE ranges (where we have high compliance)

Increased protein wash-down from interstitial fluids

Increased lymph flow
→ Carry away large amounts of proteins (Protein washed out from interstitial fluids)
→ decrease Colloid osmotic pressure in interstitial fluid
→ Lowering net filtration forces
→ Prevents accumulation of fluids