Renal Regulation of ECV and osmolality

Dr Sitelbanat Awadalla

Objectives

At the end of this lecture student should be able to describe:

1. **Identify and describe the role of the Sensors and Effectors in the renal regulation of body fluid volume**
2. **Identify and describe the role of the Sensors and Effectors in the renal regulation of body fluid osmolality**
3. **Role of the kidney in volume regulation**
4. **Role of the kidney in ECF osmolality**

Renal regulation of Extra Cellular Volume

Is a reflex mechanism in which variables reflecting total body sodium and ECV are monitor by appropriate sensor (receptors)

Regulation of ECF volume = Regulation of body Na^+ = Regulation BP

Thus, regulation of Na^+ also dependent upon baroreceptors.

Summary of Renal Regulation of ECV

- Changes in ECV, Na and Pressure
- Sensor
  - Carotid sinus
  - Volume receptors (large vein, atria, intrarenal artery)
- Effectors
  - Rennin/angiotensin, aldosterone
  - Renal sympathetic nerve
  - ANF
  - ADH
- Affecting
  - Urinary Na excretion

ECF volume Receptors

1. **Central vascular sensors**
   - **Low pressure receptors (very important)**
     - Cardiac atria
     - Pulmonary vasculature
   - **High pressure receptors (less important)**
     - Carotid sinus
     - Aortic arch
     - Juxtaglomerular apparatus (renal afferent arteriole)
2. **Sensors in the CNS (less important)**
3. **Sensors in the liver (less important)**

1. Renin-angiotensin Aldsterone

- Renin is released into plasma when plasma Na ↓
- Renin → angiotensinogen → Angiotensin I
- Angiotensin I →ACE → angiotensin II
- angiotensin II act on adrenal cortex → aldosterone secretion→ ↑ Na reabsorption in distal & collecting duct of nephron

2. Renal Sympathetic

- ↓ ECV → ↑ renal sympathetic activity → stimulate Na absorption by direct tubular effect mediated through α-receptors on renal tubules (mainly PCT) to correct for low ECV

3. ATRIAL NATRIURETIC PEPTIDE (ANP)

- ↑ ECV→ Stretch of Atria → release ANP →inhibit aldosterone release → ↓ sodium reabsorption by collecting duct
- ↑ sodium excretion and water → correcting for the increase in ECV
- ANP can also inhibit Renin secretion

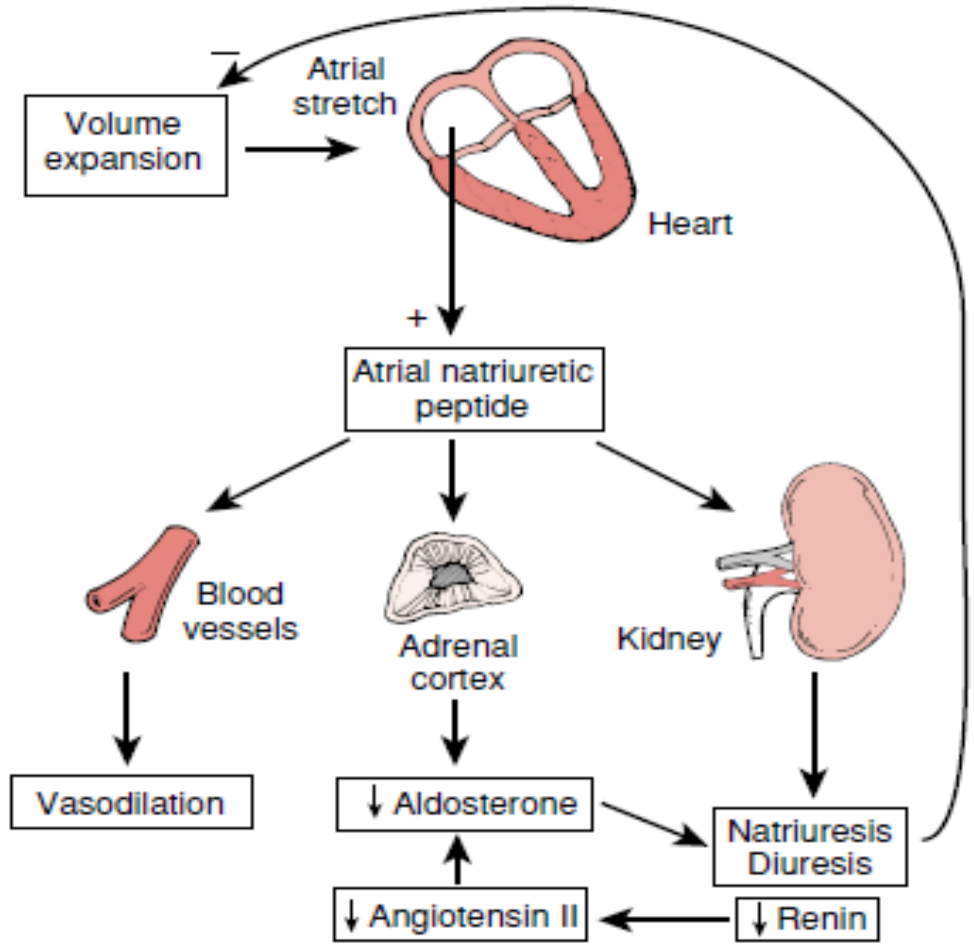


FIGURE 24.10 **Atrial natriuretic peptide and its actions.** ANP release from the cardiac atria is stimulated by blood volume expansion, which stretches the atria. ANP produces effects that bring blood volume back toward normal, such as increased Na^+ excretion.

4. Antidiuretic hormone

- **Increase of plasma osmolality → osmoreceptor → trigger the release of ADH.**
- **ADH → ↑ permeability of collecting duct to H_2O → ↑ H_2O reabsorption → correction of hyperosmolality of blood.**

ADH release stimulated by

- **↑Osmolarity**
- **↓ Blood volume**
- **↓ Blood pressure**
- **Drugs: Morphine; Nicotine; cyclophosphamide**

ECV and Urinary Sodium Excretion

- Regulation of urinary sodium excretion → regulation EC volume
- ↑ ECV or Sodium is corrected by ↑ urinary sodium excretion and water by:
  - **Renin – aldsterone**
  - **ANP**
  - **Sympathetic**
  - **ADH**

Renal Regulation of ECF osmolality

Summary of Renal regulation of body fluid osmolality

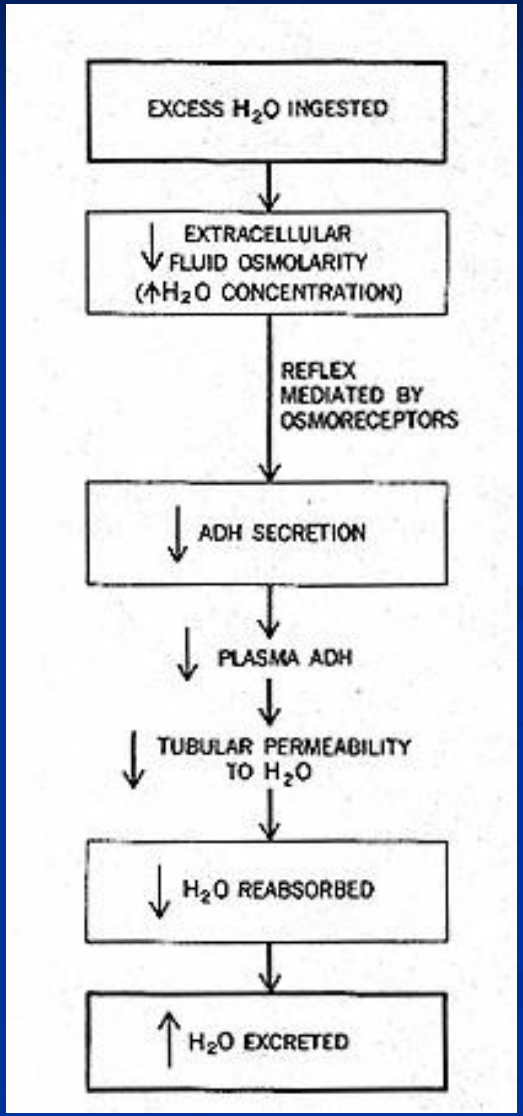
- Changes in ECF osmolarity
- Sensors
  - Hypothalamic osmoreceptors
- Effectors
  - ADH
  - thirst
- Affecting
  - Urine osmolaity
  - Water intake

Renal regulation of Extra Cellular Osmolality

Is a reflex mechanism in which a chang in plasma osmolality is monitor by appropriate sensor (osmoreceptors)

hypothalmus osmoreceptor

1. Osmoreceptor ADH Feedback System



2. Role of Thirst in Controlling Extracellular Fluid Osmolarity

Thirst sensation stimulated by:

1. ↑Osmolarity
2. ↓ Blood volume
3. ↓ Blood pressure
4. ↑ Angiotensin
5. Dryness of mouth

2. Thirst

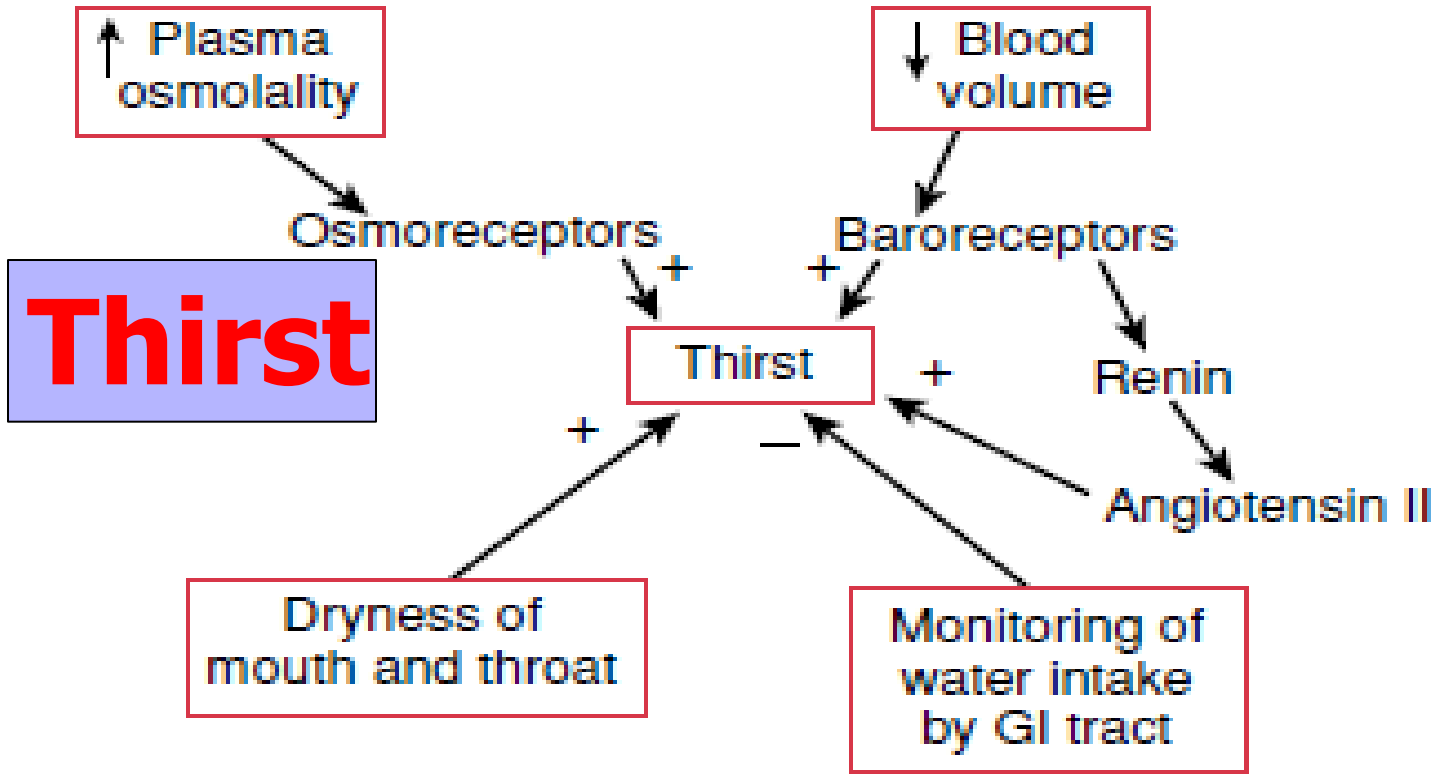


FIGURE 24.7 **Factors affecting the thirst sensation.** A plus sign indicates stimulation of thirst, the minus sign indicates an inhibitory influence.

High water intake

- **Drop** in plasma osmolality
- inhibit ADH secretion
- Collecting impermeable to water
- excretion of large volume of urine
- **increases** plasma osmolality back to normal.

Low water intake

1. **Increases** plasma osmolality
2. Stimulate ADH secretion
3. Making Collecting duct permeable to water
4. Excretion of small volume of urine
5. Diluting plasma and a **drop** in osmolality back to normal.
6. Accompanied by thirst sensation.

Urine Osmolarity Regulation: Collecting Duct

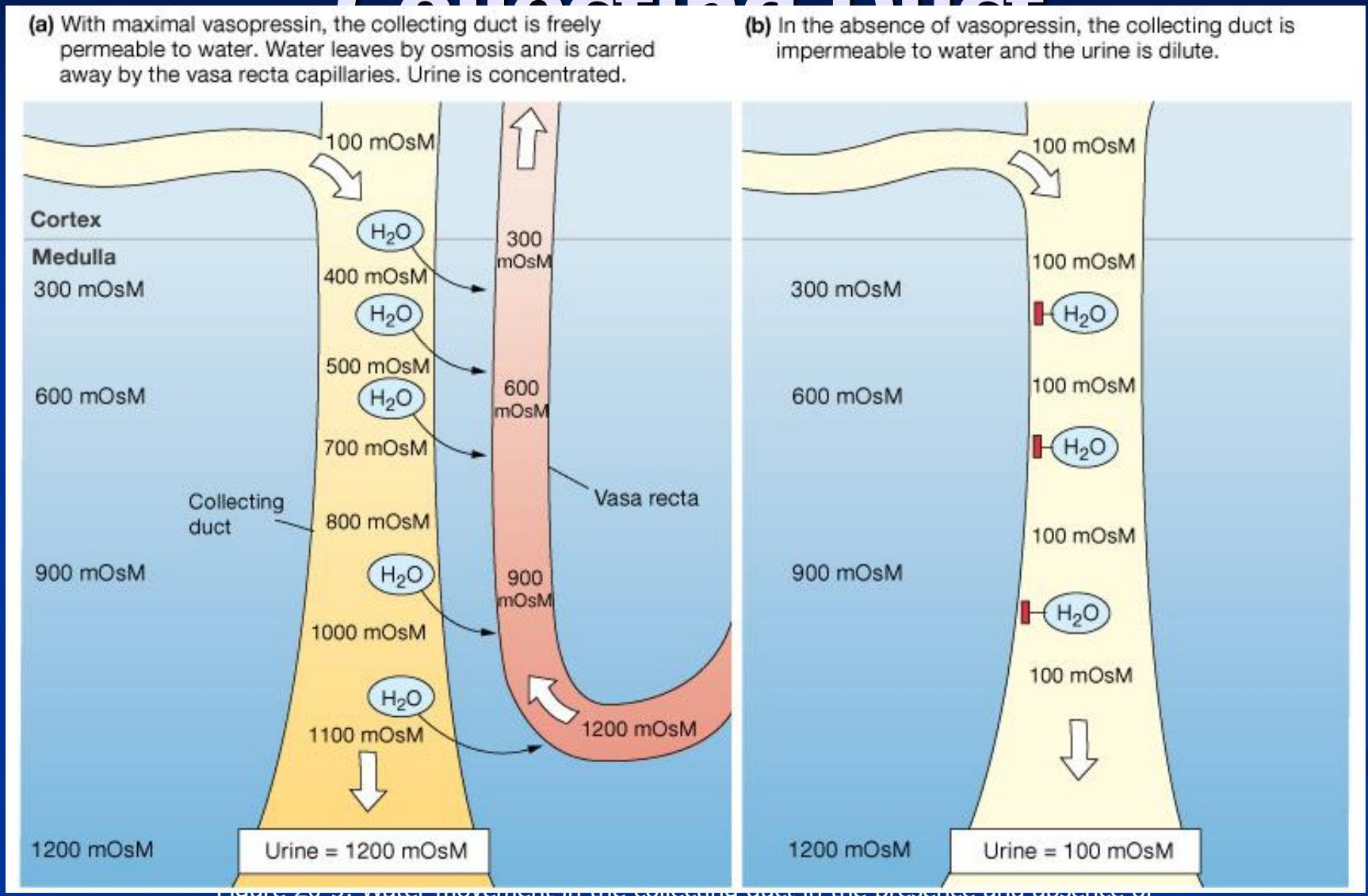


Figure 26-9: Water movement in the collecting duct in the presence and absence of vasopressin.