Human Biology

Urinary System -
Hormone Regulation of Water Balance
Water Homeostasis

Hormones:

1. Antidiuretic Hormone (ADH)
   - Aka. Vassopressin
   Source:
   - Release controlled by Hypothalamus
   - produced in the posterior pituitary gland

2. Aldosterone
   Source:
   - Produced by Adrenal Cortex
ADH

1. Hypothalamus detects variations in osmolarity of blood
   - As [water] in blood changes, the amount of water diffusing in or out of hypothalamus cells changes

2. Change stimulates it to vary the amount of releasing hormone sent to posterior pituitary

3. Target cells for ADH = collecting duct (CD) and Distal Convoluted Tubule (DCT)
   - Cells of CD and DCT become more permeable to water in the presence of ADH

4. Peri-tubular environment is salty (NaCl)
   - Thus, any increase in water permeability causes water to leak through membrane into peri-tubular capillary network
**ADH - Negative Feedback**

- When [water] in blood falls, the body becomes dehydrated
- Posterior Pituitary signaled to release more ADH
- ADH acts on CD and DCT
- As More water is reabsorbed; [water] in blood ↑’s
  - = reduced stimulus to hypothalamus
    - Hypothalamus slows secretion of releasing hormone
      - Balance is restored!

This is **NEGATIVE FEEDBACK** b/c a decrease in [water] in blood stimulates a series of events that reverse the imbalance
Do you know why you often produce a darker urine in the morning?

Because: ADH is primarily released at night!

Thus, we reabsorb much of our water while we sleep!
Aldosterone

- Affects both WATER and SALT reabsorption
  - As a result, its presence causes an ↑ in both blood pressure & volume without changing tonicity (concentration)

- Secretions of RENIN from juxtaglomerular apparatus promote release of aldosterone
Juxtaglomerular Apparatus

- prefix "juxta-"
  - from the Latin preposition meaning near, nearby, close.

- a collective term referring to the cells near the glomerulus in the kidney

- The juxtaglomerular cells are specialized cells that stimulate the secretion of the adrenal hormone aldosterone

- Plays a major role in renal autoregulation
- JGA cells are sensitive to changes in blood pressure
  - When pressure drops, glomerular filtration slows
    - Stimulates secretion of RENIN

- Renin is circulated (via blood) to adrenal cortex
  - Stimulates release of aldosterone

- Aldosterone affects DCT
  - DCT excretes MORE K\(^+\) and reabsorbs more Na\(^+\)
  - As more Na\(^+\) is reabsorbed, more H\(_2\)O is absorbed
    - ↑ in water & salt causes an ↑ in **blood volume** and ↑ in **blood pressure**
**Stimulus:**
- Low blood volume
- Low blood pressure
- Lack of salt
Liver

Angiotensinogen
plasma
protein

cleaved

Renin

Angiotensin I

Angiotensin II

DCT

Juxtaglomerular apparatus (JGA)

**Stimulus:**
Low blood volume
Low blood pressure
and/or
Lack of salt
Liver → Angiotensinogen → Renin → Angiotensin I → Angiotensin II → Adrenal gland (cortex)

Stimulus:
- Low blood volume
- Low blood pressure
- Lack of salt
Liver

Angiotensinogen

Renin

Afferent arteriole

DCT

Juxtaglomerular apparatus (JGA)

Adrenal gland (cortex)

Aldosterone

Stimulus:
Low blood volume
Low blood pressure and/or
Lack of salt
ADH and Aldosterone

Both increase water reabsorption.... but....

1. ADH
   - Response to dehydration (lack of water)
   - Reduced blood volume WITH an increase in osmolarity

2. Aldosterone
   - Response to fluid and salt loss
     - Eg. Loss of blood (wound) or diarrhea
   - Reduced blood volume WITHOUT an increase in osmolarity