Regulation of Renal Output and Cardio-vascular Volume Control

Hormonal Control of Renal Output and Cardiovascular Pressure

Three main systems:

• Renin-Angiotension System
• Aldosterone
• Antidiuretic Hormone
Juxtaglomerular Apparatus

Renin Secretion

Chemical Signal from Macula densa to Juxtaglomerular apparatus

Low glomerular filtration rate, excess in Na+ and Cl- reabsorption, decreased ion concentration in the filtrate.

Renin-angiotensin system

Blood

Angiotensinogen

Angiotensin I

Angiotensin II

Increased aldosterone secretion

Decreased plasma volume

Sodium and water retention

Adrenal cortex

Increased aldosterone secretion

Increased water and sodium retention

Increased renin secretion

Decreased plasma volume

Increased renin secretion

Increased aldosterone secretion

Increased water and sodium retention

Sodium and water retention
Renin-Angiotension System:

• Act on vascular system (directly) to increase total peripheral resistance

• Act on the Kidney tubule system to increase retention of salts and water. (vasoconstriction of afferent arteriole and peritubular capillaries)

• Stimulation of Aldosterone System.
Antidiuretic Hormone
Regulation of Urine Secretion
and Body Fluids

↑ extracellular fluid osmolarity - ↑ ADH Secretion
Induce thirst
ADH effects on the body

- Vasoconstriction
- Stimulate reabsorption of Water from the Distal Convoluted Tubule and Collecting Ducts
- Binds to receptors on the basolateral membrane of the epithelial cells.
- Initiates a second (intracellular) messenger (cAMP)
- Cause the fusion of vesicles (containing pores) to the luminal membrane.
- Water rushes from the lumen into the cell and into the interstitium.
Metabolic Acidosis and Alkalosis

Abnormalities of Acid-Base balance besides those caused by excess or insufficient carbon dioxide in the body fluids
Effects of: **Metabolic Acidosis**

**Signs or Symptoms** -
- Depression of the Central Nervous System (< pH 7.0)
- Increased respiratory rate and depth. (H+)

**Causes** -
- Diarrhea - excess loss of sodium bicarbonate
- Uremia - failure of kidney filtration of H+
- Diabetes Mellitus - excess production of glucose based acids (acetoacetic acid)

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Effects of: **Metabolic Alkalosis**

**Signs or Symptoms** -
- Overexcitability of the Central Nervous System (muscle tetany)

**Causes** -
- Excessive Ingestion of Alkaline Drugs
- Excessive Vomiting (loss of Cl-)
- Excess Aldosterone (reabsorption of Na+, release of H+)

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**Hydrogen Ion Regulation**

**Hydrogen Ion buffer system**

\[
\text{CO}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3 \leftrightarrow \text{HCO}_3^- + \text{H}^+
\]

\[\text{Carbonic Anhydrase}\]
Take home message

• Kidneys are homeostatic regulators of the body’s Hydrogen Ion concentration (pH)
• Kidneys maintain balance by regulating plasma bicarbonate concentration

Kidneys and the Renal System are important for both short and long-term control of body fluid levels. By regulating these fluid levels the Renal system will work in conjunction with the Cardiovascular system to maintain blood pressure.
Urea Secretion

~ 30 grams daily

Factors determining excretion:
- Concentration in Plasma
- Glomerular Filtration Rate

Micturition

Control of the bladder