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## 46 How do hormones affect kidney function?

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### LEARNING OBJECTIVES

To fully appreciate this tutorial, you should be familiar with the processes of:

- Salt reabsorption in the loops of Henle
- Urine production by filtration, reabsorption, and secretion

After this tutorial, you will be able to:

- Describe the interactions of the four major hormones on the control of kidney function.

Hormones are important signaling molecules controlling the kidneys in the regulatory processes of osmoregulation and excretion.

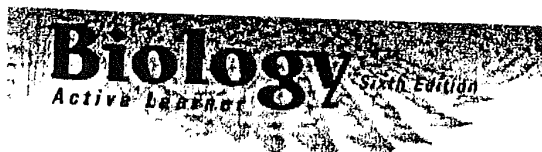
**Osmoregulation** keeps body fluids from becoming too diluted or too concentrated.

**Excretion** is the process of ridding the body of excess metabolic wastes, including water.

Four major hormones help to maintain homeostasis in concentration and amount of urine excreted. They are:

- 1) Antidiuretic hormone (ADH)
- 2) Aldosterone
- 3) Angiotensin II
- 4) Atrial natriuretic peptide (ANP)

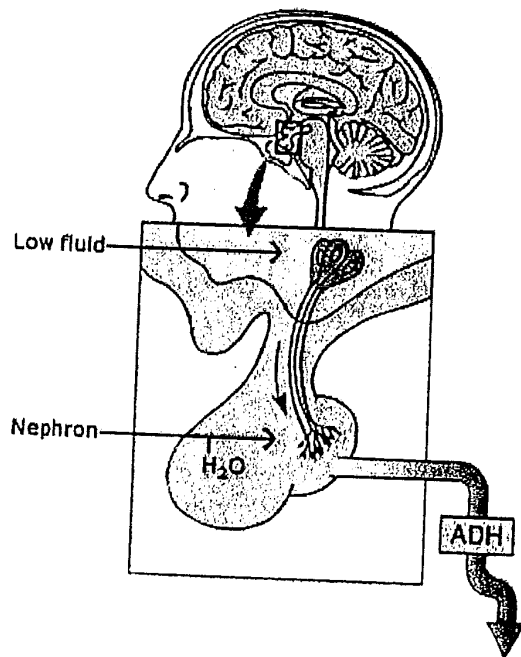
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### ANTIDIURETIC HORMONE (ADH)

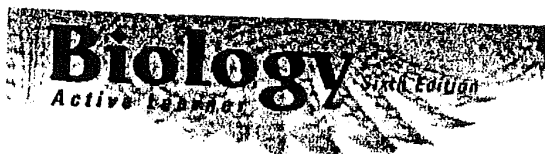
Produced in the hypothalamus and released by the posterior pituitary, **antidiuretic hormone (ADH)** controls the permeability of the collecting ducts to water. Increased levels of ADH result in greater water reabsorption and decreased water excretion.

When blood volume is reduced as a result of decreased fluid intake, the body can become dehydrated. Concentration of salts in the blood increases, causing a rise in osmotic pressure. Receptors in the hypothalamus react to the shift in osmotic pressure and signal the posterior pituitary to activate more ADH. At the same time, the hypothalamus responds by stimulating a feeling of thirst.

Conversely, when an abundance of water is consumed, the blood becomes less concentrated and osmotic pressure decreases. The hypothalamus compensates by reducing ADH release, causing the amount of water reabsorbed from the collecting ducts to decrease. The kidneys then produce an increased volume of dilute urine.

A condition called *diabetes insipidus* results when the pituitary does not produce enough ADH, or from an acquired insensitivity to ADH. Water is inadequately reabsorbed from the collecting ducts, and a large quantity of urine is produced. *Diabetes insipidus* is often treated clinically by ADH injections or by ADH nasal spray treatment.

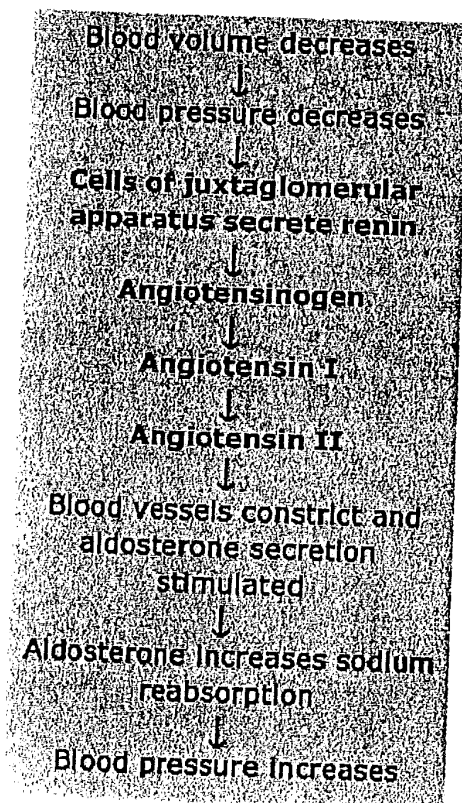
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### ANGIOTENSIN II

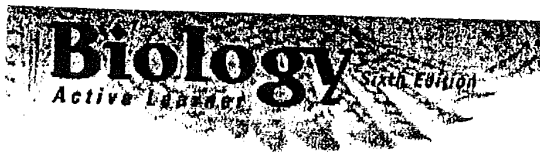
As blood pressure decreases, the cells of the **juxtaglomerular apparatus** secrete the enzyme **renin** and activate the **renin-angiotensin-aldosterone system**. The juxtaglomerular apparatus is a small group of cells situated in the renal tubule links up with the **afferent** and **efferent arterioles**. Renin converts angiotensinogen into angiotensin I. Angiotensin converting enzyme converts angiotensin I into **angiotensin II**, a peptide hormone in its active form. Angiotensin II has the following effects:

- Increases the synthesis and release of aldosterone
- Raises blood pressure directly by constricting blood vessels
- Stimulates sodium reabsorption by the proximal convoluted tubule
- May stimulate the posterior pituitary to release ADH

These changes assist in restoring extracellular fluid volume and in raising blood pressure.

*ACE Inhibitors* are sometimes administered to block the production of angiotensin II in people with elevated blood pressure.

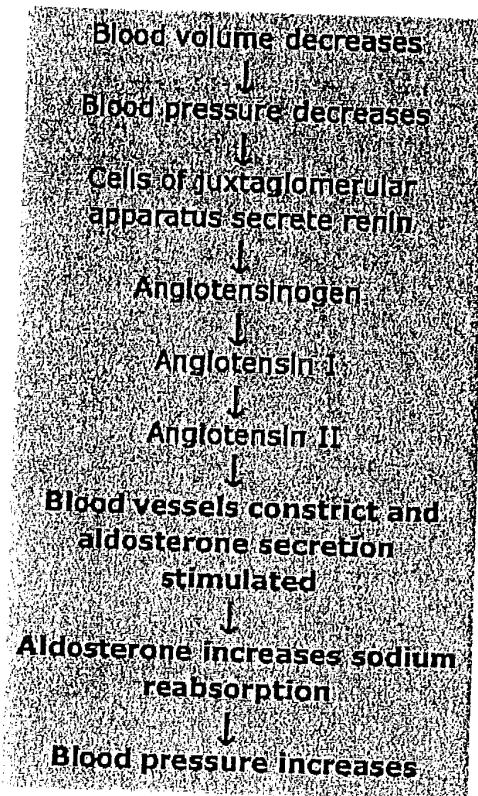
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### ALDOSTERONE

**Aldosterone** causes the distal tubule and collecting ducts to reabsorb levels of sodium. Aldosterone is produced in the cortex of the adrenal glands. In experimental animals where the adrenal glands are removed, too much sodium is excreted, leading to serious depletion of the extracellular fluid.

Decreased blood volume and interstitial fluid level, resulting in decreased pressure, trigger aldosterone secretion.

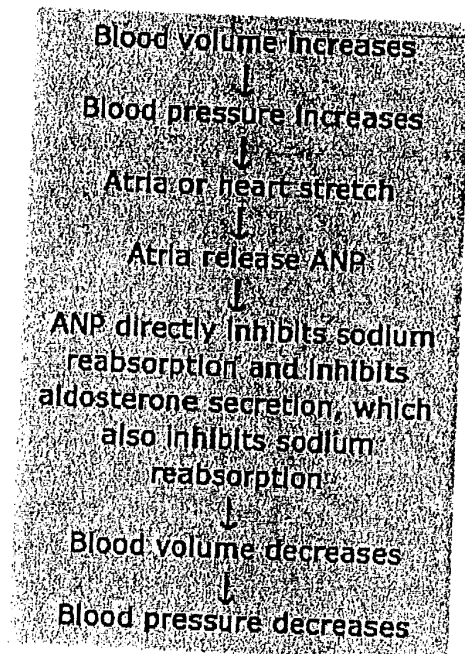
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### ATRIAL NATRIURETIC PEPTIDE (ANP)

A hormone produced by the heart, **atrial natriuretic peptide (ANP)** increases sodium excretion and decreases blood pressure and blood volume.

ANP is released into the bloodstream in response to stretching of the atria by increased blood volume.

ANP has the following physiological effects:

- Increases **glomerular filtration rate** by dilating afferent arterioles
- Inhibits the collecting ducts from reabsorbing sodium, both directly and indirectly (by inhibiting aldosterone secretion)
- Inhibits release of renin

The renin-angiotensin system and ANP function antagonistically in fluid/electrolyte balance and blood pressure.

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#### SUMMARY

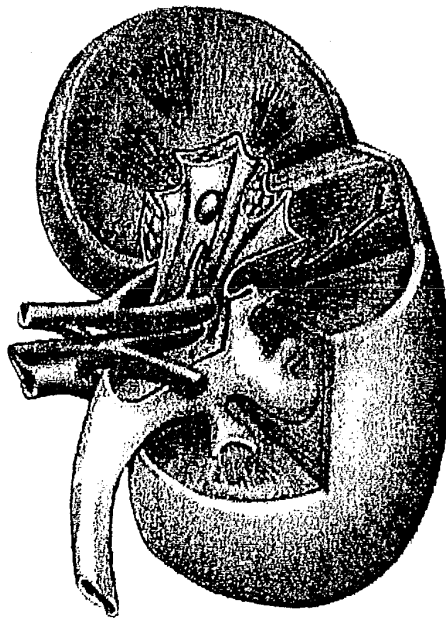
Several hormones regulate the effect of the kidney on urine volume concentration. A main factor in determining the amount of urine is the body's need to retain or rid itself of water. We have studied four

- Antidiuretic hormone (ADH)
- Angiotensin II
- Aldosterone
- Atrial natriuretic peptide (ANP)

These work simultaneously in controlling the body's level of water, maintaining homeostasis.

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