Al-Mustaqbal University College

Pathophysiology 3rd stage

Disorders of Renal System

Part 1

Dr. Hasanain Owadh

Contents:

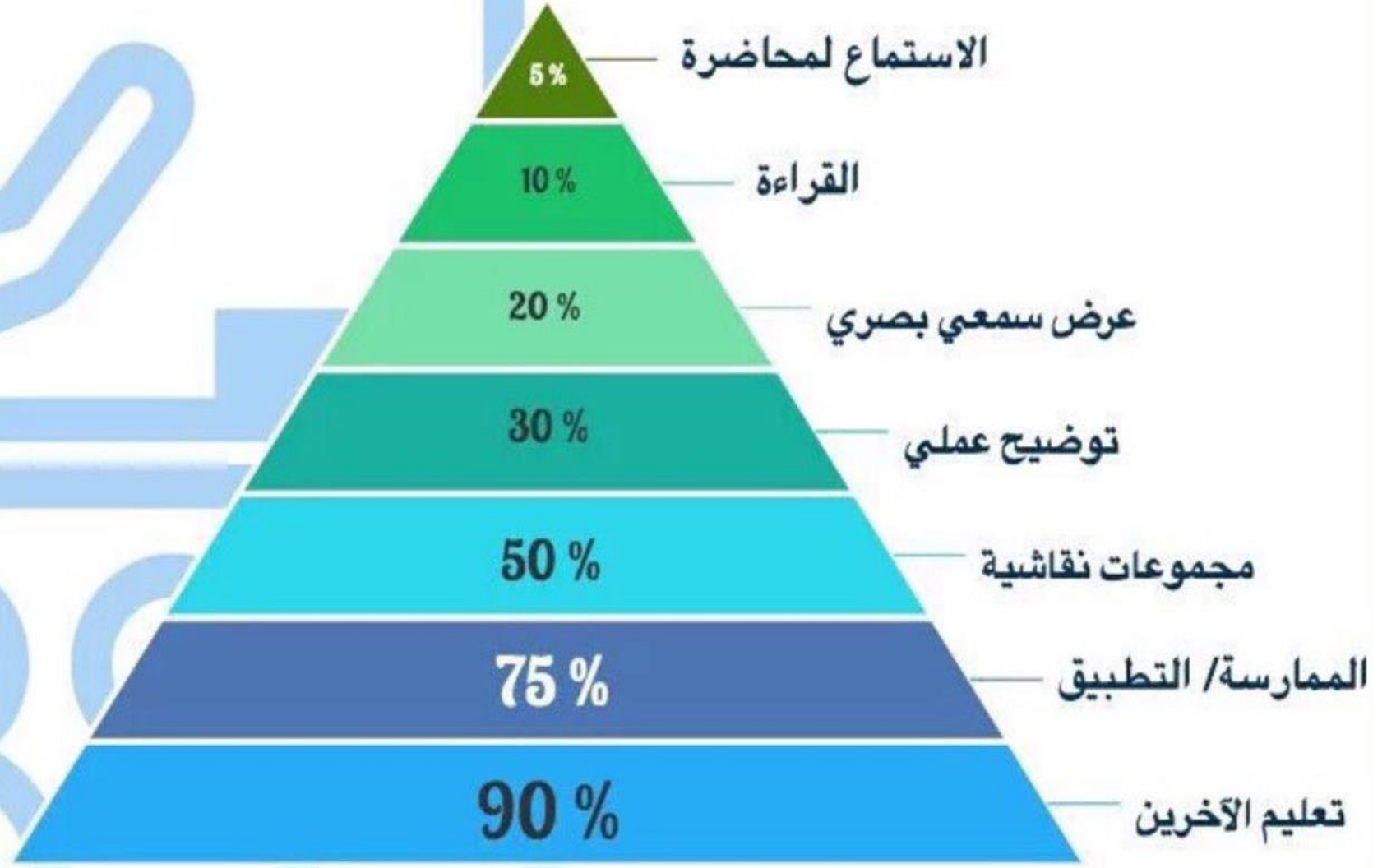
- Physiologic Concepts
- Disorders Of Glomerular Function
- Acute Glomerulonephritis
- Chronic Glomerulonephritis
- Acute Renal Failure
- Chronic Renal Failure
- Nephrotic Syndrom
- Drugs Induced Kidney Disease

General Learning Objectives

Upon completion of the lecture, students will be able to:

- Know normal kidney functions.
- Understand the pathophysiology of renal system disorders.
- Know the complication of renal system disorders..

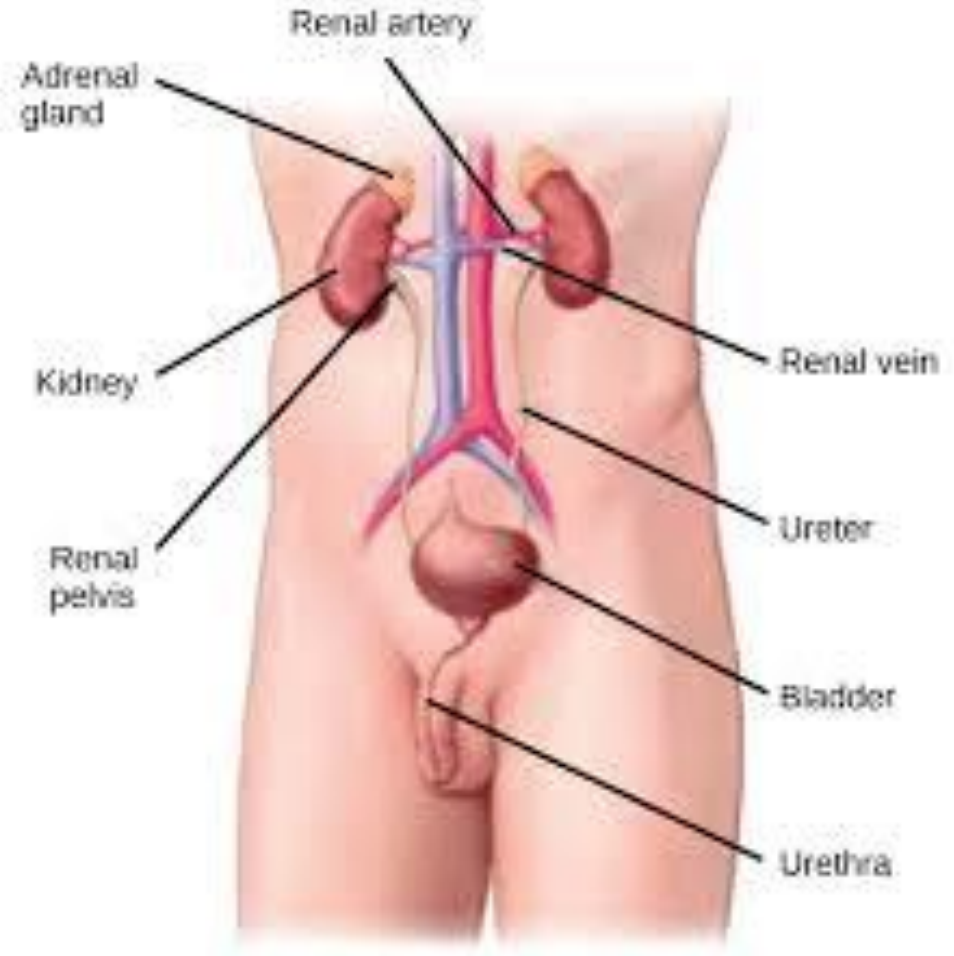
هرم التعلُّم: نسبة الإحتفاظ بالمعلومة عند استخدام طرق التعليم المختلفة



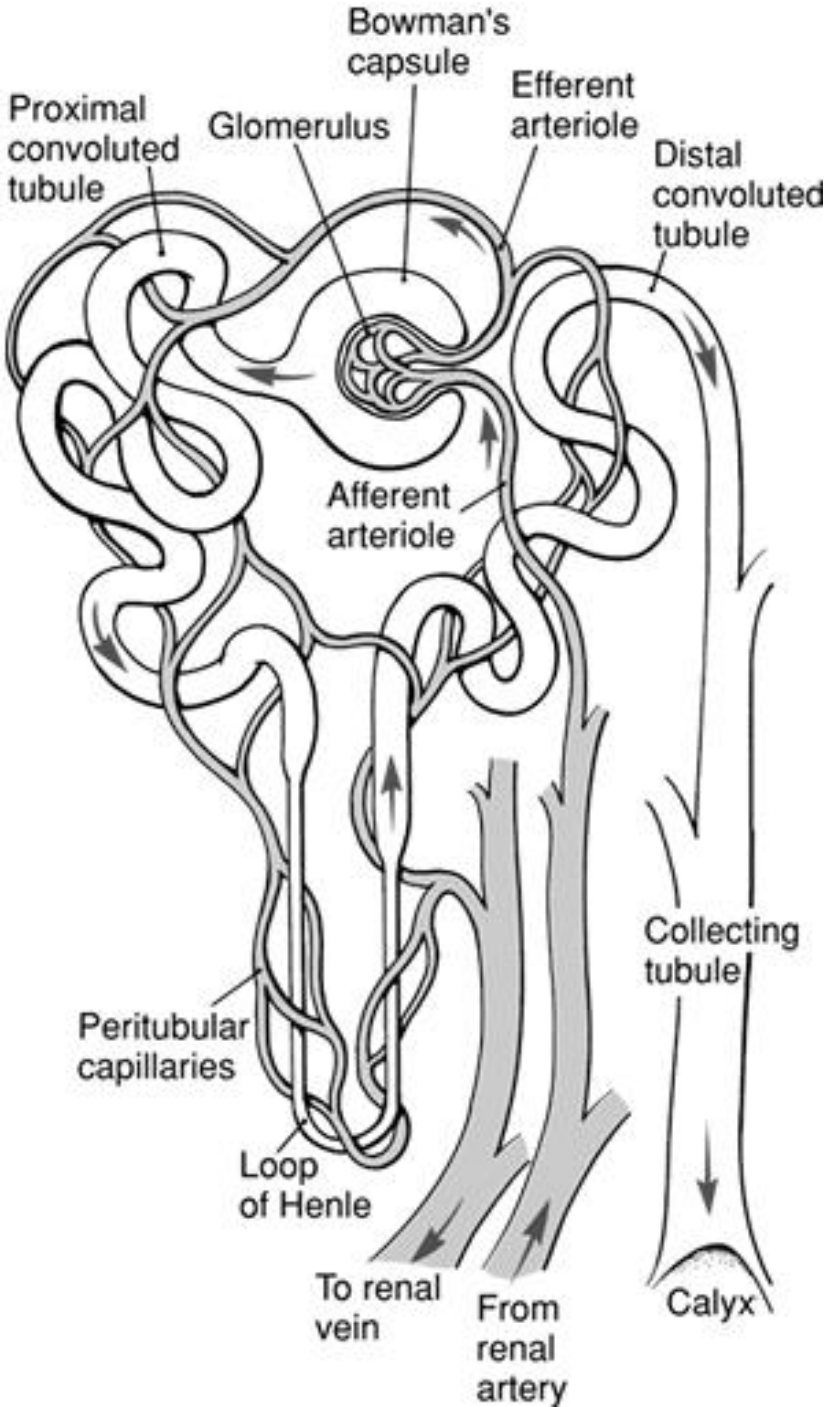
Physiologic Concepts

Structure: The kidneys lie outside the peritoneal cavity in the upper posterior portion of the abdominal wall, one on each side of the body.

Each kidney is made up of approximately one million functional units, each of which is called a nephron.



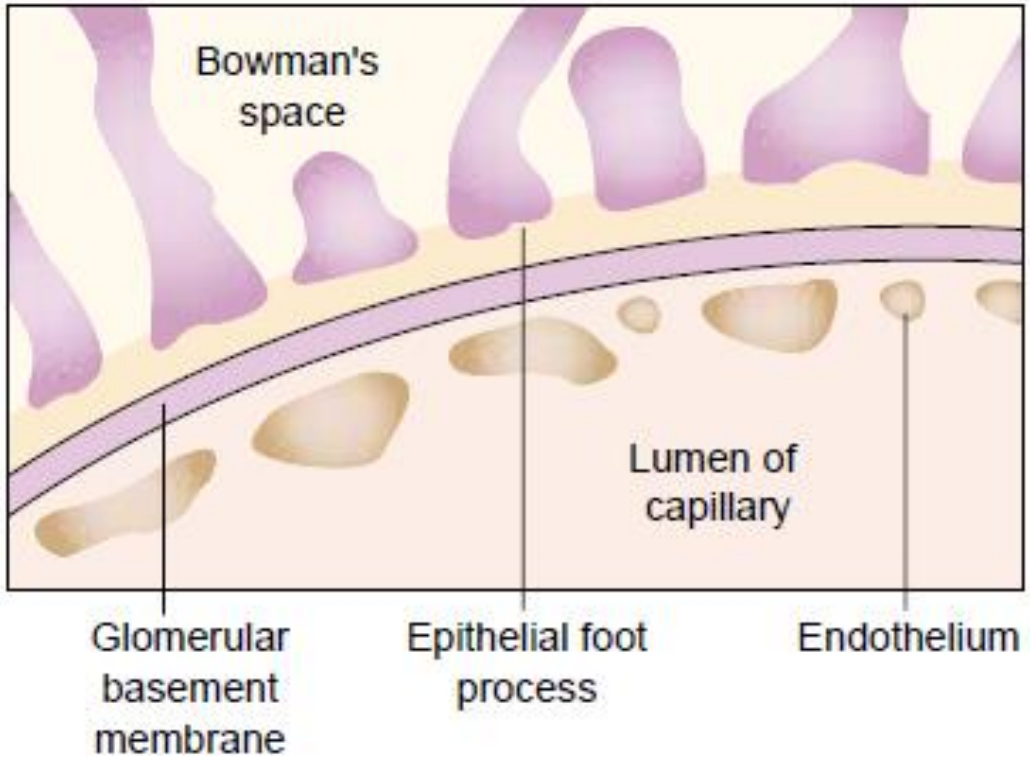
As shown in right figure the nephron begins as a capillary tuft, called the glomerulus. Plasma is filtered across the glomerulus by the process of bulk flow and enters the twisting, looping tubule of the nephron.



Glomerular Filtration

Glomerular filtration is the process by which approximately 20% of the plasma entering the glomerular capillary moves across the capillary into the interstitial space and from there into Bowman's capsule.

Neither red blood cells nor plasma proteins are more than minimally filtered in healthy kidneys.

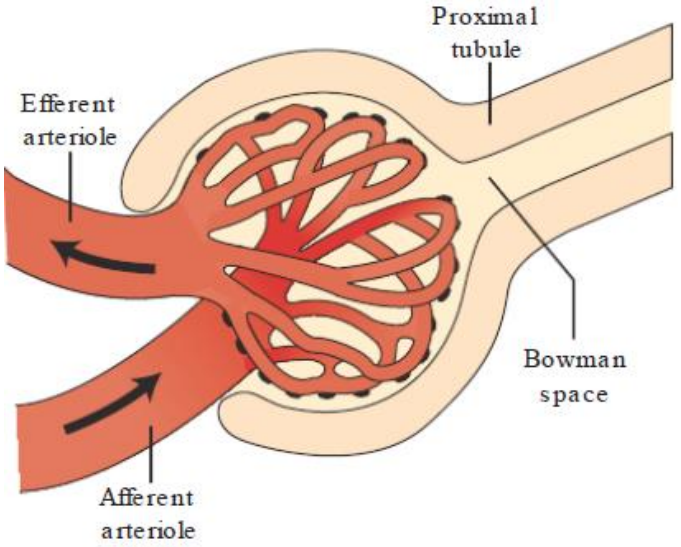


Glomerular Filtration Rate

The glomerular filtration rate (GFR) is defined as the volume of filtrate entering Bowman's capsule per unit of time.
GFR is nearly constant and gives a good indication of the health of the kidneys.

GFR depends on the four forces determining filtration and reabsorption (capillary pressure, interstitial fluid pressure, plasma colloid osmotic pressure, and interstitial fluid colloid osmotic pressure).

Therefore, any change in these forces can alter GFR.



Likewise, GFR depends on the available surface area of the glomerulus for filtration. Therefore, a loss of glomerular surface area decreases GFR.

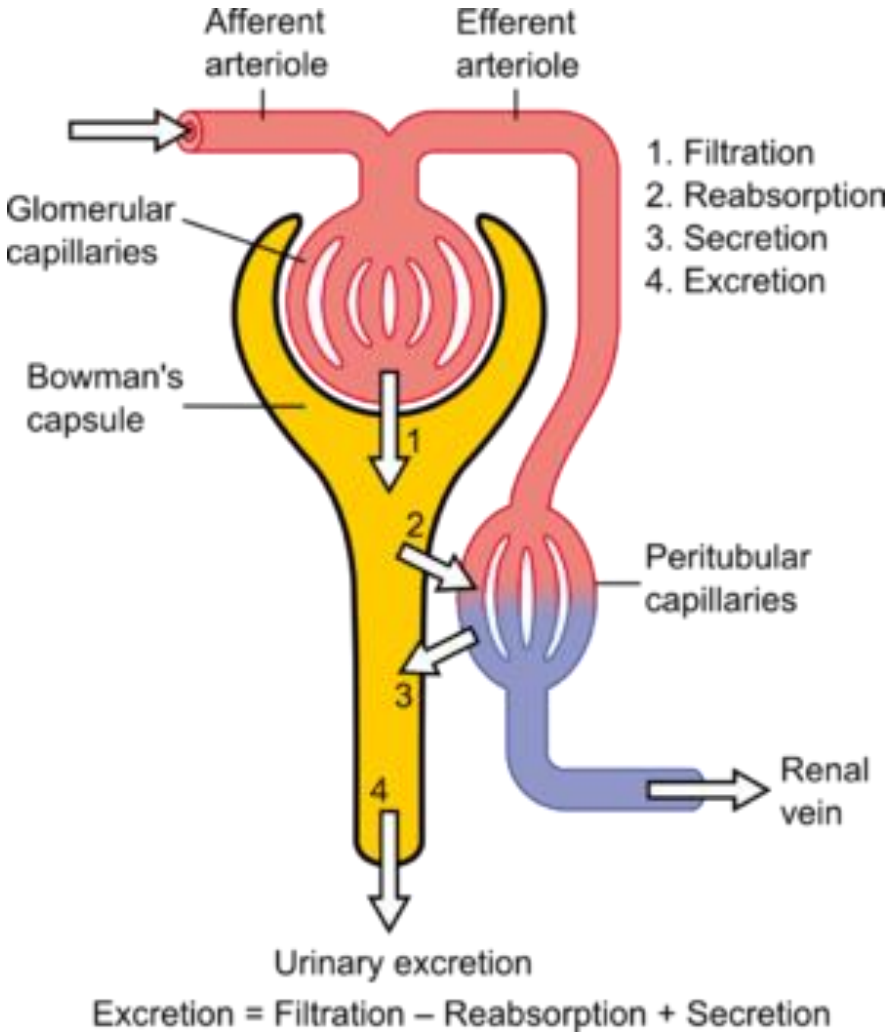
Geriatric Consideration

GFR declines with age due to a 30 to 50% loss of functional nephrons and reduced renal blood flow.

Such a decline means that when drugs normally cleared by the kidneys are given to an elderly individual, their dosage should be adjusted to reflect declining renal function.

Renal Clearance

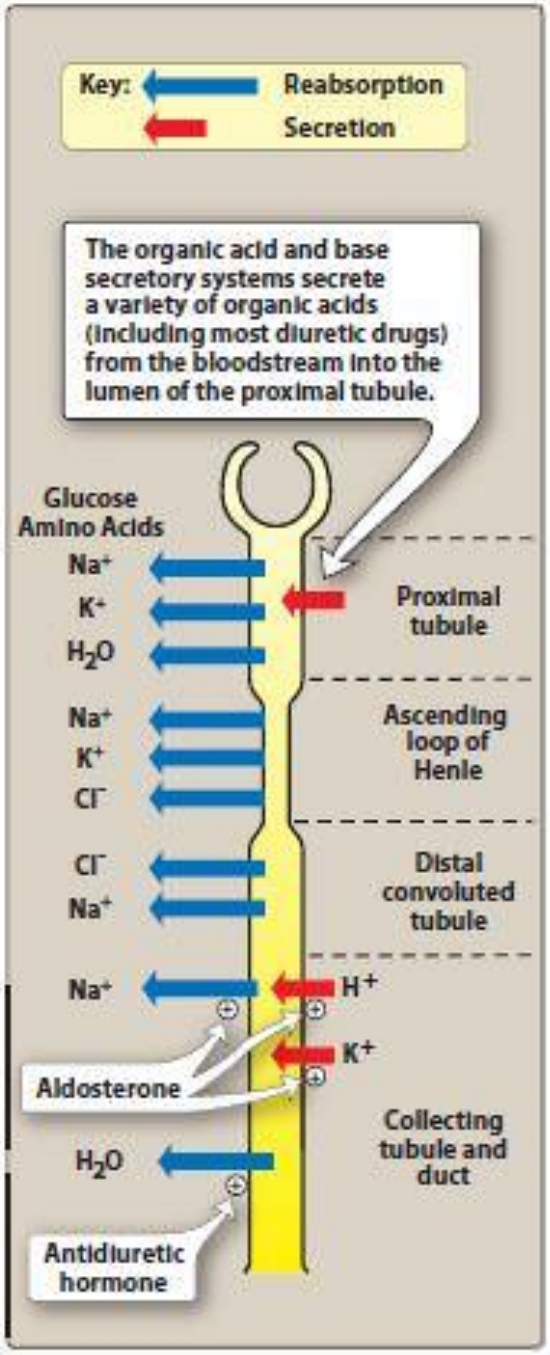
The concentration of a substance totally cleared from the blood into the urine over time is known as the renal clearance.



Tubular Reabsorption and Secretion

From Bowman's capsule, the glomerular filtrate moves into the tubular segments of the nephron.

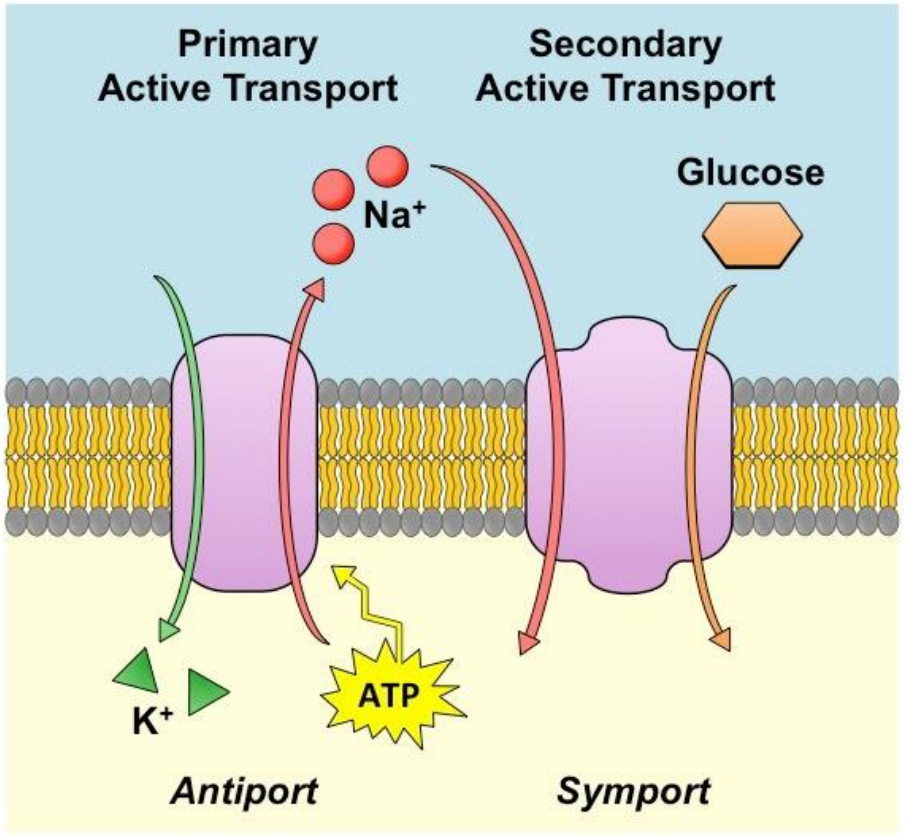
In its movement through the lumen of the tubular segments, the reabsorption of substances from the tubular fluid into the blood or secretion of substances from the blood into the tubular fluid have occurred.



Water and urea are passively absorbed along concentration gradients.

Sodium, potassium, chloride, calcium, and phosphate ions, as well as urate, glucose, and amino acids are reabsorbed using primary or secondary active transport mechanisms to move across the tubular membrane.

Some substances, such as hydrogen, potassium, and urate ions, are secreted into the tubular fluids.

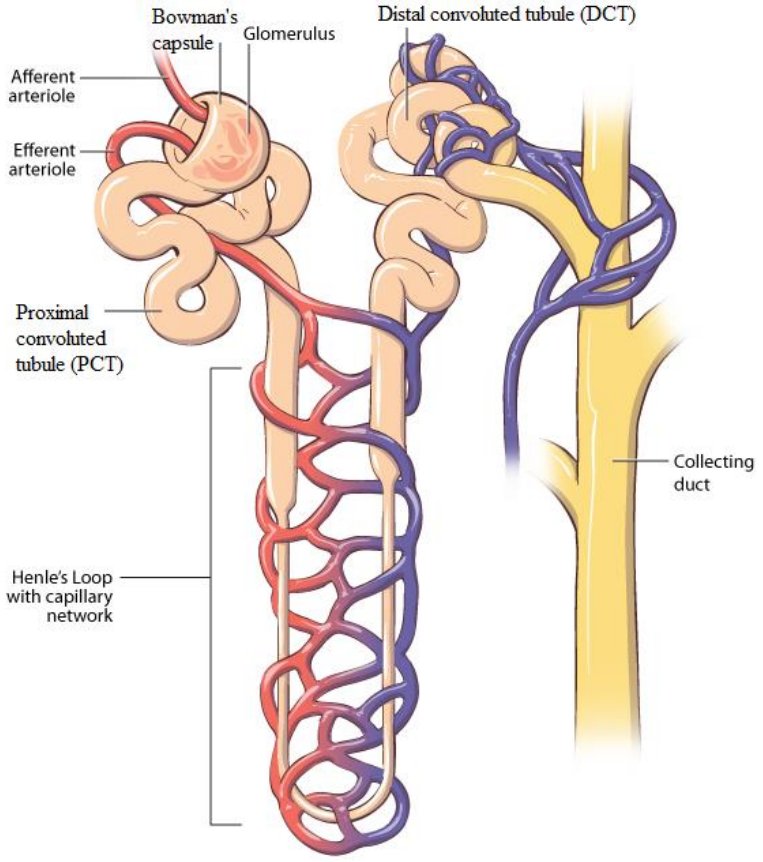


Proximal Tubule.

Approximately 65% of all reabsorptive and secretory processes that occur in the tubular system take place in the proximal tubule.

There is almost complete reabsorption of nutritionally important substances, such as glucose, amino acids, lactate, and water-soluble vitamins.

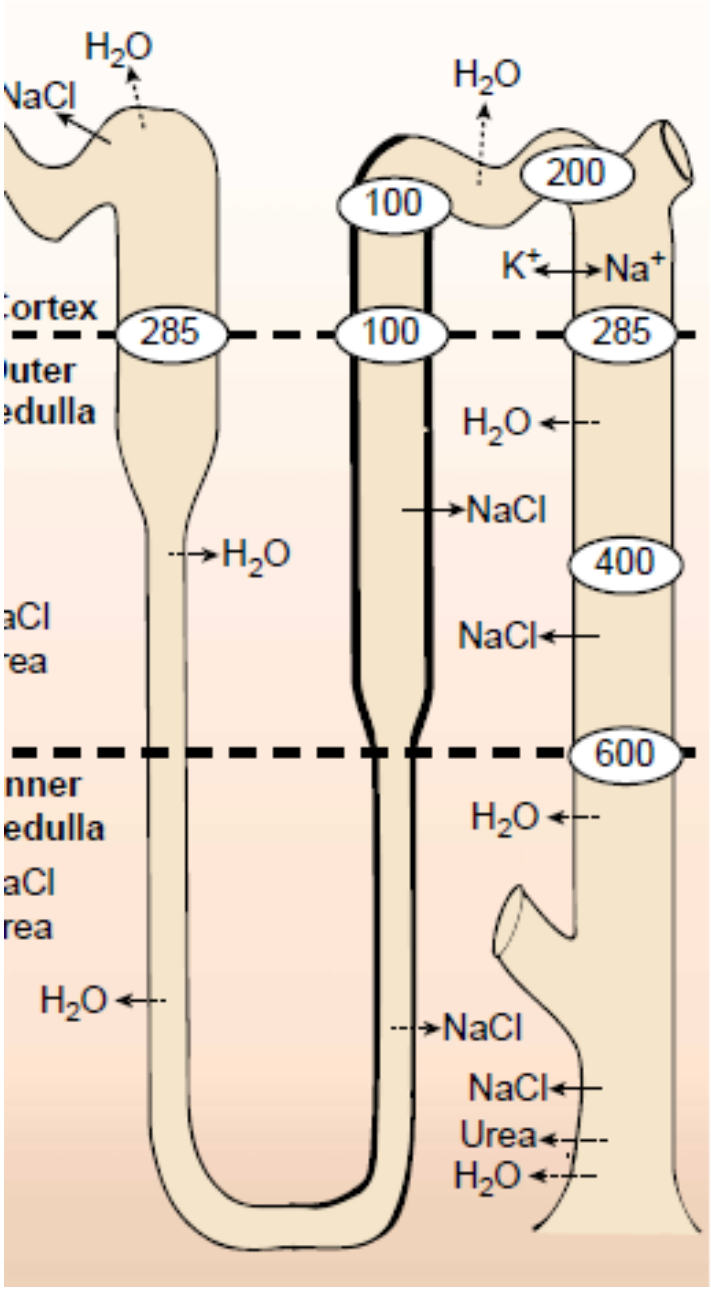
Electrolytes, such as sodium, potassium, chloride, and bicarbonate, are 65% to 80% reabsorbed.



The Loop of Henle.

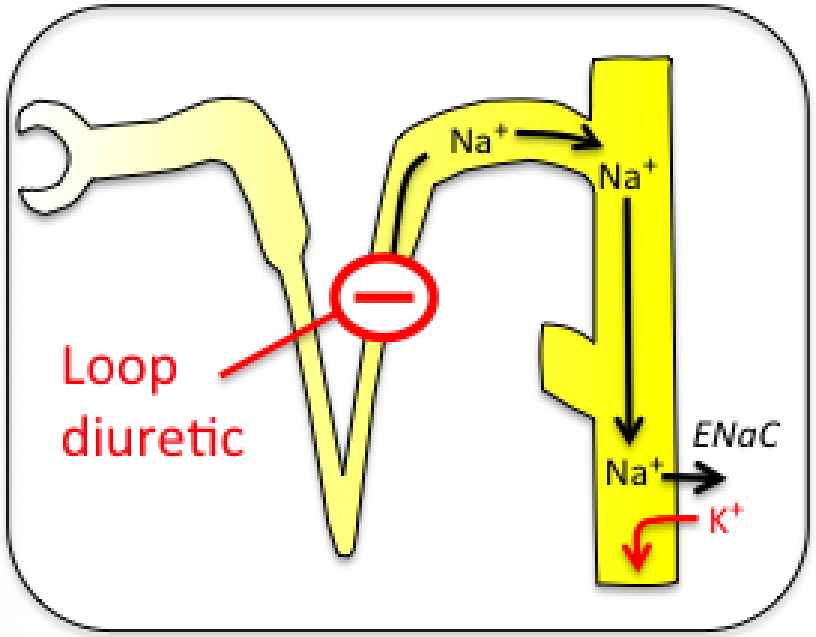
The loop of Henle is divided into three segments:
the thin descending segment,
the thin ascending segment, and
thick ascending segment.

The thin descending limb is highly permeable to water and moderately permeable to urea, sodium, and other ions.



Approximately 20% to 25% of the filtered load of sodium, potassium, and chloride is reabsorbed in the thick loop of Henle.

This transport system is selectively blocked by diuretic agents known as loop diuretics.



Enhanced Na^+ delivery results in K^+ loss in the collecting duct

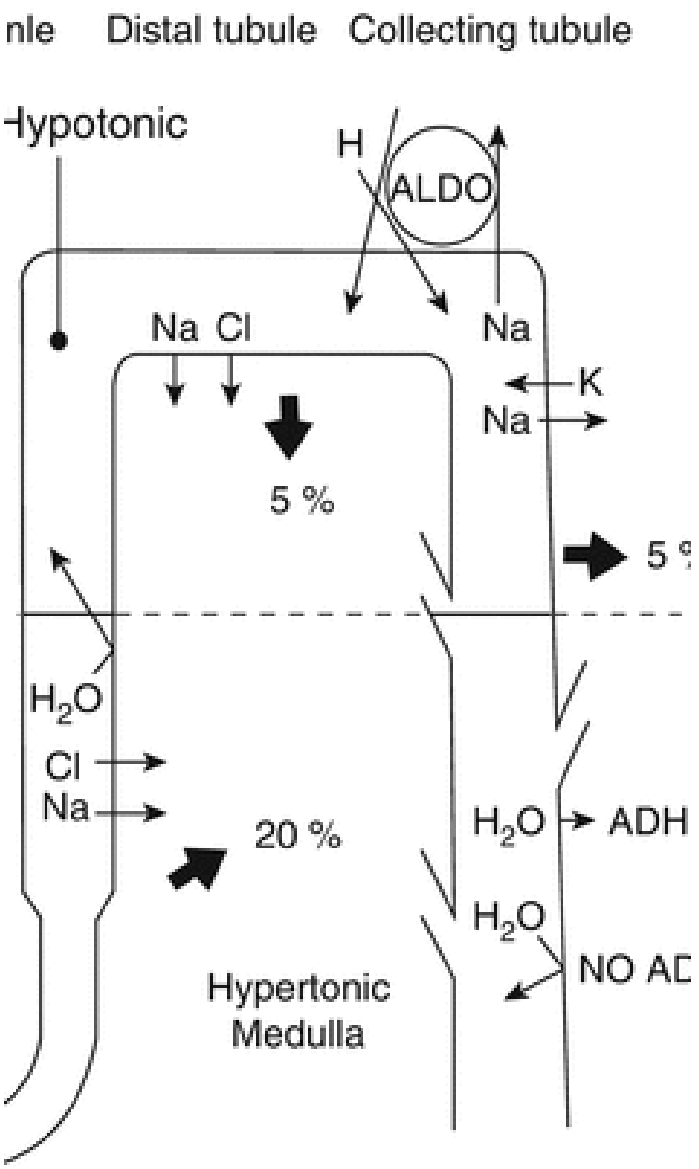
25% of filtered Na is normally reabsorbed in the loop of Henle

Distal Convoluted Tubule.

Approximately 10% of filtered sodium chloride is reabsorbed in this section of the tubule.

Calcium ions are actively reabsorbed in a process that is largely regulated by parathyroid hormone and possibly by vitamin D.

The thiazide diuretics exert their action by inhibiting sodium chloride reabsorption in this segment of the renal tubules.

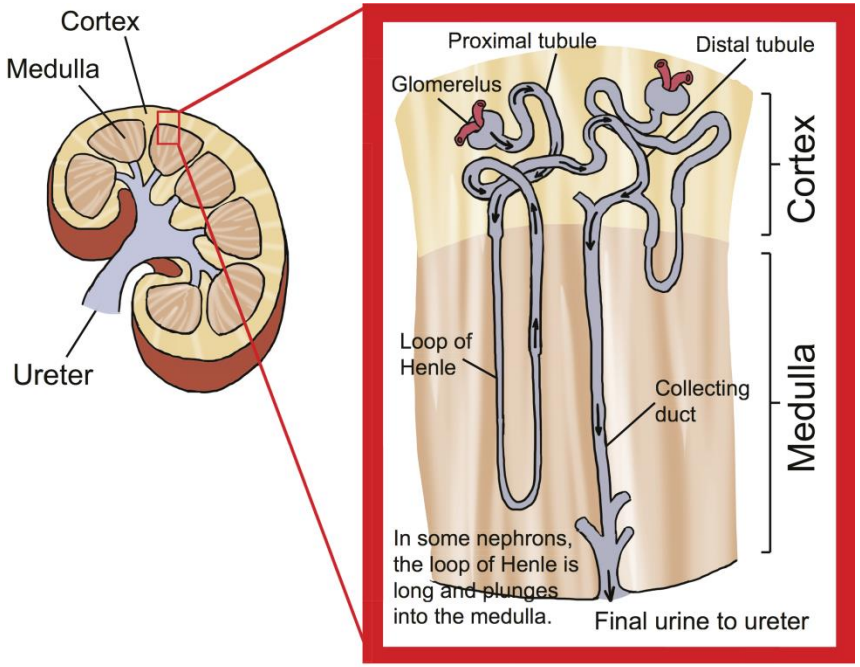


Distal Tubule and Cortical Collecting Tubule.

The late distal tubule and the cortical collecting tubule constitute the site where aldosterone exerts its action on sodium and potassium reabsorption.

Under the influence of aldosterone, sodium moves from the urine filtrate into principal cells; from there it moves into the surrounding interstitial fluid and peritubular capillaries.

Potassium moves from the peritubular capillaries into the principal cells and then into the urine filtrate.



Medullary Collecting Duct.

The epithelium of the inner medullary collecting duct is well designed to resist extreme changes in the osmotic or pH characteristics of tubular fluid, and it is here that the urine becomes highly concentrated, highly diluted, highly alkaline, or highly acidic.

During periods of water excess or dehydration, the kidneys play a major role in maintaining water balance.

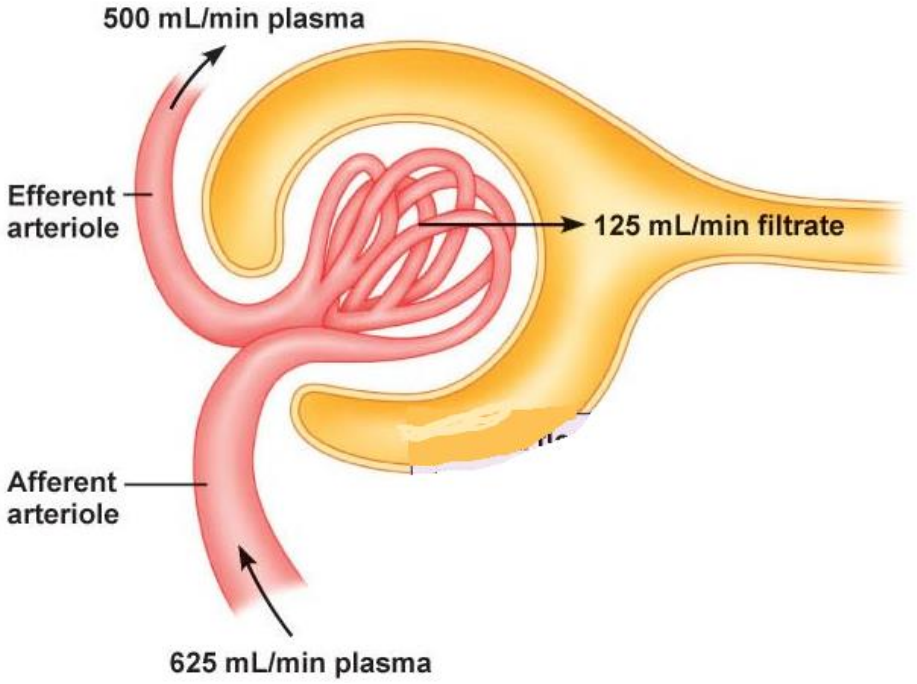
ADH exerts its effect in the medullary collecting ducts. ADH maintains extracellular volume by returning water to the vascular compartment and leads to the production of a concentrated urine by removing water from the tubular filtrate.

Sympathetic Nervous System

Sympathetic nerves innervate both the afferent and the efferent arterioles of the kidney and can override autoregulation when stimulated.

As is true in most arterioles, stimulation of the sympathetic nerves causes constriction of the afferent arterioles, leading to increased resistance to flow.

As a result, blood flow through the glomerulus decreases, causing a decrease both in capillary hydrostatic pressure and in GFR.



Simultaneous sympathetic stimulation of the efferent arterioles, however, and their subsequent constriction, causes blood flow to back up in the glomerulus.

This backup can actually increase capillary hydrostatic pressure and glomerular filtration.

The net result of sympathetic stimulation to the kidneys is a significant decrease in renal blood flow (because blood going both in and out is reduced) but a lesser decrease in GFR.

Q-The sympathetic nervous system is stimulated when there is a decrease in systemic blood pressure. **Why?**

A- Decreased renal blood flow in response to decreased systemic blood pressure is adaptive and helps the organism survive a hypotensive crisis.

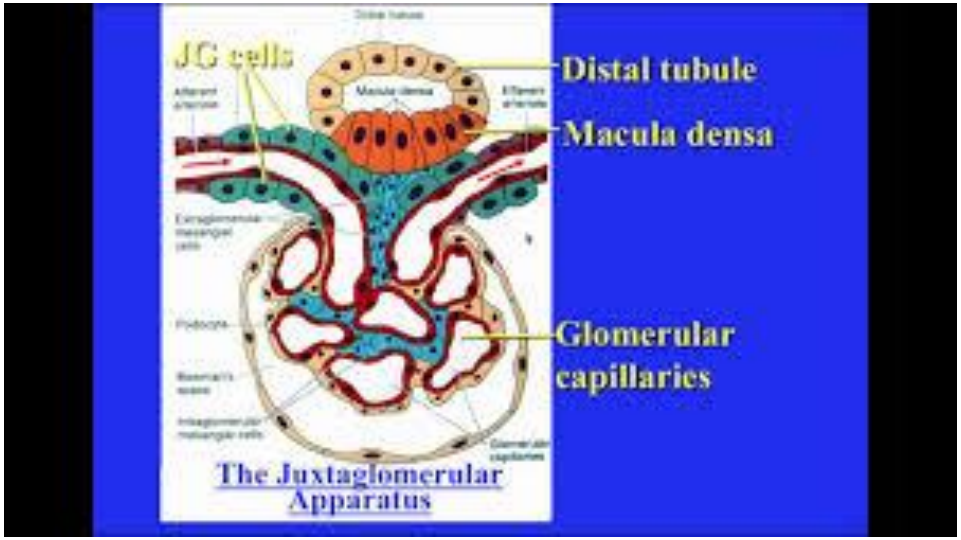
With hypotension, less water and salt are filtered at the glomerulus, causing less to be lost in the urine.

This helps to increase blood volume and restore blood pressure.

Renin

Renin is a hormone released from the kidney in response to either a decrease in blood pressure or a decrease in plasma sodium concentration.

Cells that synthesize and secrete renin and control its release are a particular group of cells of the nephron called the juxtaglomerular (JG) apparatus.

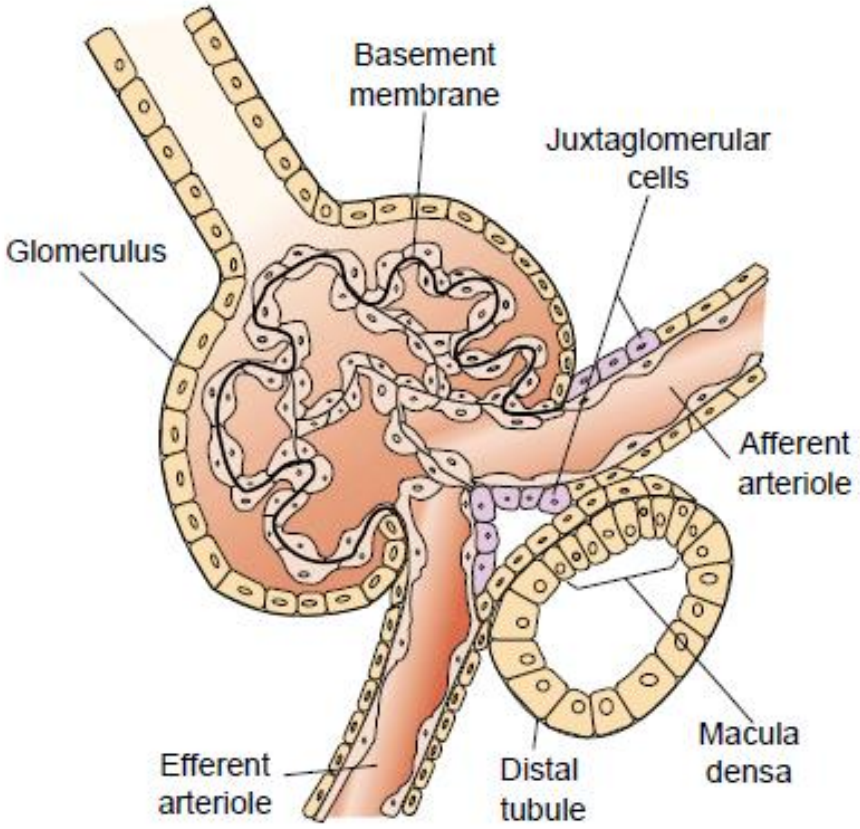


This group of cells includes smooth muscle cells of the afferent arteriole and cells of the macula densa.

The smooth muscle cells synthesize renin and act as baroreceptors monitoring blood pressure.

Macula densa cells are part of the thick ascending limb of the nephron.

These cells sense plasma Sodium concentration.



When the macula densa cells sense a change in plasma sodium, they pass that message on to the renin-secreting cells.

When blood pressure falls, the smooth muscle cells increase renin release.

When blood pressure increases, the smooth muscle cells decrease their release of renin. If plasma sodium levels decrease, macula densa cells signal the renin-producing cells to increase their activity. If plasma sodium levels increase, macula densa cells signal the smooth muscle cells to decrease renin release.

Angiotensin II

AII is a potent vasoconstrictor that acts throughout the vascular system to increase smooth muscle contraction, thereby decreasing vessel diameter and increasing total peripheral resistance (TPR).

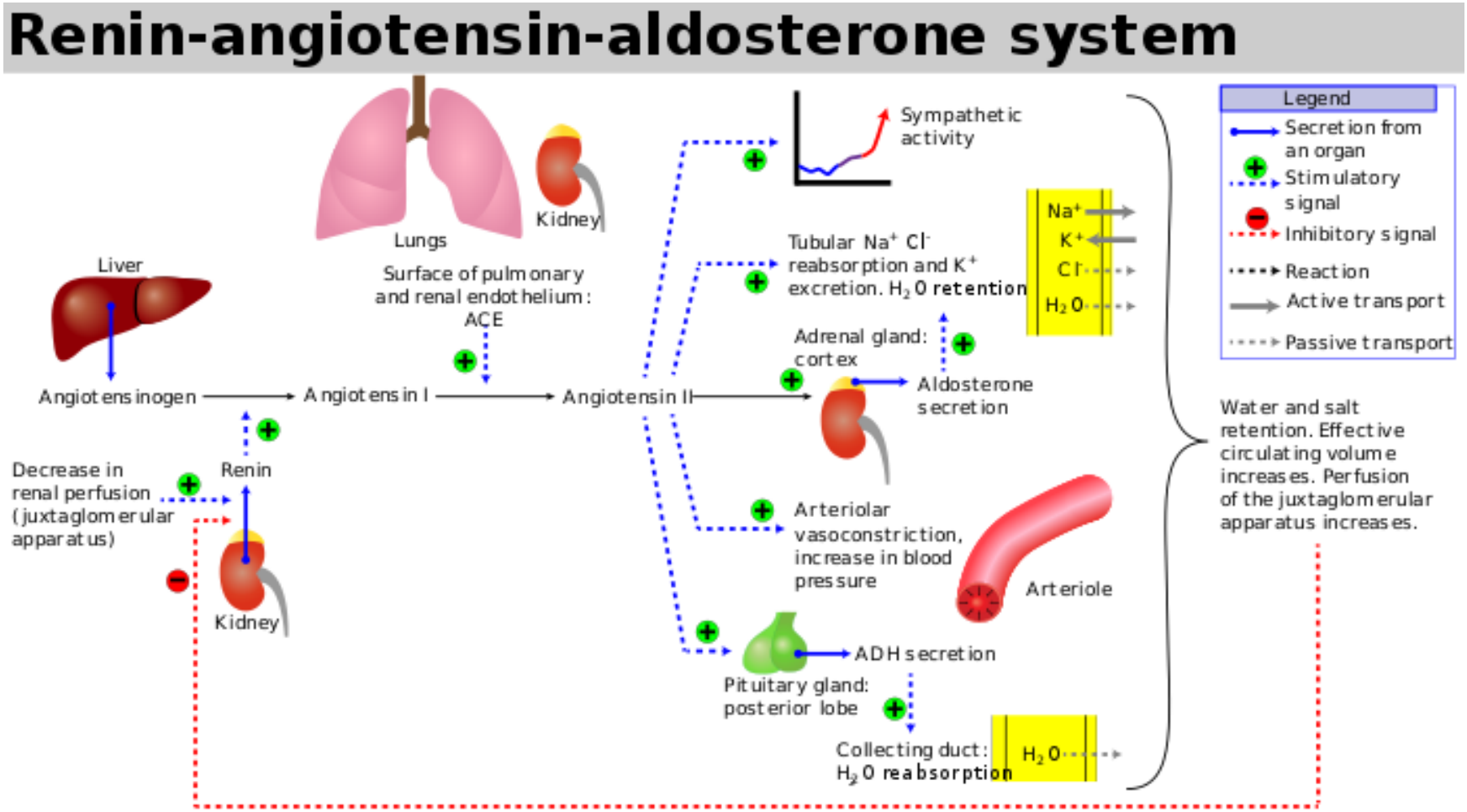
An increase in TPR directly increases systemic blood pressure.

AII is also a potent hormone that circulates in the blood to the adrenal glands, causing the synthesis of the mineralocorticoid hormone aldosterone.

Aldosterone

Aldosterone circulates in the blood and binds to cells of the cortical collecting duct. causing sodium to return into the peritubular capillaries. and water follows sodium movement.

Renin-Angiotensin-Aldosterone Response to Decreased Sodium



Endocrine Functions of the Kidney

❖ Long-term regulation of blood pressure is facilitated through the kidney's activation of the reninangiotensin system and regulation of sodium and water balance.

❖ The activation of vitamin D, which is important for intestinal absorption of calcium, occurs in the kidney.

❖ The kidney synthesizes erythropoietin, which stimulates bone marrow production of red blood cells.

Reference: Corwin , Pathophysiology, 3rd Edition