Department of biology

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(animal physiology)

Stage (-3-)

LEC- ((7))

Urinary system

By

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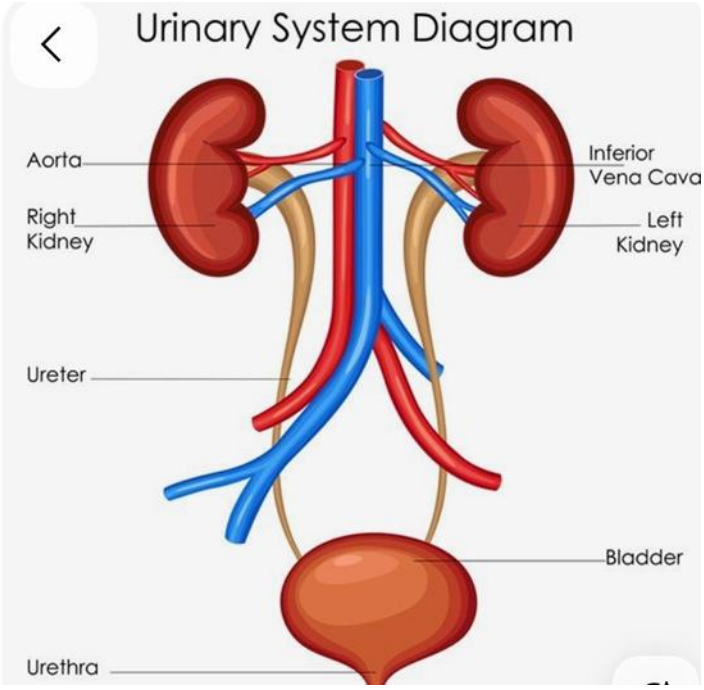
Urinary System

Urinary System is a group of organs in the body concerned with filtering out excess fluid and other substances from the bloodstream.

The substances are filtered out from the body in the form of urine.

Urine is a transparent yellow fluid containing unwanted wastes mostly excess water, salts, and nitrogen compounds (In general 95% water and 5% solutes).



The kidneys are the most important excretory organ; they also accomplish several other functions:

1- Regulation of plasma **ionic composition** such as sodium, potassium, calcium, magnesium, chloride, bicarbonate, and phosphates.
2- Regulation of **plasma volume** by controlling how much water excretes.
3- Regulation of **plasma hydrogen ion concentration (pH)** with the lungs (regulated the acid- base balance) because they control the amount of bicarbonate excreted or held onto.
4- Removal of metabolic **waste products** and foreign substances from the plasma like nitrogenous waste(urea, ammonia, creatinine and uric acid).

5- Secretion of **hormones** like **Renin**, it is needed to stimulate the secretion of aldosterone by the adrenal cortex which promotes the kidneys to reabsorb the (Na+) ions.
6- The kidneys also secrete **erythropoietin** when the blood doesn't have the capacity to carry oxygen; erythropoietin stimulates red blood cell production.
7- **Vitamin D** from the skin is also activated with help from the kidneys. Calcium (Ca+) absorption from the digestive tract is promoted by vitamin D.

Kidneys and Their Structure:-

The kidneys are pair of bean shaped, reddish brown organs they are covered by the renal capsule

There are three major regions of the kidney, renal cortex, renal medulla and the renal pelvis.

The Nephron:- The nephron is the structural and functional unit of the kidney; each kidney contains approximately 1 million nephrons. It is in the nephrons, with their associated blood vessels.

Ureters:

The ureters are two tubes that drain urine from the kidneys to the bladder, each ureter is a muscular tube about (25 cm) long.

Muscles in the walls of the ureters send the urine in small spurts into the bladder. After the urine enters the bladder from the ureters, small folds in the bladder mucosa act like valves preventing backward flow of the urine.

Urinary Bladder:

The urinary bladder is a hollow, muscular and distensible or elastic organ that sits on the pelvic floor. When the bladder fills with urine (about half full), stretch receptors send nerve impulses to the spinal cord, which then sends a reflex nerve impulse back to the sphincter (muscular valve) at the neck of the bladder, causing it to relax and allow the flow of urine into the urethra.

Urethra:

The urethra is a muscular tube that connects the bladder with the outside of the body. The function of the urethra is to remove urine from the body.

Formation of Urine:-

The formation of urine involves three major processes:

The first is **glomerular filtration**, which takes place in the renal corpuscles.

The second and third are **tubular reabsorption and tubular secretion,** which take place in the renal tubules.

The blood cells and larger proteins are too large to be forced out of the glomeruli, so they remain in the blood. Waste products are dissolved in blood plasma, so they pass into the renal filtrate. Useful materials such as nutrients and minerals are also dissolved in plasma and are also present in renal filtrate.

The glomerular filtration rate (GFR):

is the amount of renal filtrate formed by the kidneys in 1 minute, and averages 100 to 125 ml per minute .If blood flow increases, the GFR increases, and more filtrate is formed. If blood flow decreases (as may happen following a severe hemorrhage), the GFR decreases, less filtrate is formed, and urinary output decreases.

Urinary System Tubular Reabsorption:

Tubular reabsorption takes place from the renal tubules into the peritubular capillaries.

In a 24 hour period, the kidneys form 150 to 180 liters of filtrate, and normal urinary output in that time is 1 to 2 liters.

Approximately 99% of the filtrate is reabsorbed back into the blood in the peritubular capillaries.

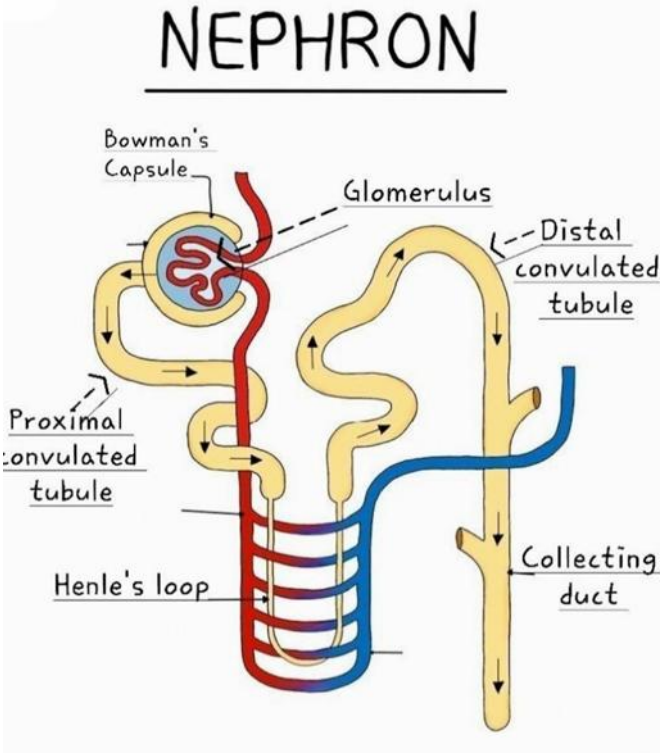
Only about 1% of the filtrate will enter the renal pelvis as urine.

Most reabsorption and secretion (about 65%) take place in the proximal convoluted tubules . **(Water, Na^+, Cl^-, K^+, glucose, amino acid)** are reabsorbed in proximal convoluted tubules whale other does not reabsorb like inulin, creatinine . About 20% of filtered Na^+ and Cl^-, 15% of

filtered water and cations such as K+, Ca2+ and Mg2+ are reabsorbed in the loop of Henle. The distal convoluted tubules and collecting tubules are also important sites for the reabsorption, approximately 7% of the filtered NaCl and about 8-17% of water is reabsorbed.

This reabsorption process allows water (H2O) to pass from the glomerular filtrate back into the circulatory system.

Glucose and various amino acids also are reabsorbed (towards the end of the proximal convoluted tubules) into the circulatory system, these nutrients have carrier molecules that claim the glomerular molecule and release it back into the circulatory system.



reabsorption of Water and Salt

Direct control of water excretion in the kidneys is exercised by the **anti diuretic hormone (ADH)**, released by the posterior lobe of the pituitary gland. ADH allowing water reabsorption to occur. Without ADH, little water is reabsorbed in the collecting ducts and dilute urine is excreted.

Aldosterone is secreted by the **adrenal cortex** in response to a high blood potassium level, to a low blood sodium level, or to a decrease in blood pressure. Aldosterone promotes the excretion of potassium ions and the reabsorption of sodium ions, when aldosterone stimulates the reabsorption of Na+ ions, water follows from

the filtrate back to the blood. This helps maintain normal blood volume and blood pressure.

The release of Aldosterone is initiated by the secretion of renin the enzyme that converts **angiotensinogen** (a large plasma protein produced by the liver) into **Angiotensin I** and eventually into **Angiotensin II** which stimulates the adrenal cortex to produce **aldosterone**.

The antagonist to aldosterone is **atrial natriuretic peptide (ANP),** which is secreted by the atria of the heart when the atrial walls are stretched by high blood pressure or greater blood volume. ANP inhibits the secretion of renin and the secretion of the aldosterone by the adrenal cortex. This promotes the excretion of sodium. When sodium is excreted so is water. This causes blood pressure and volume to decrease.

Acid- Base Balance:-

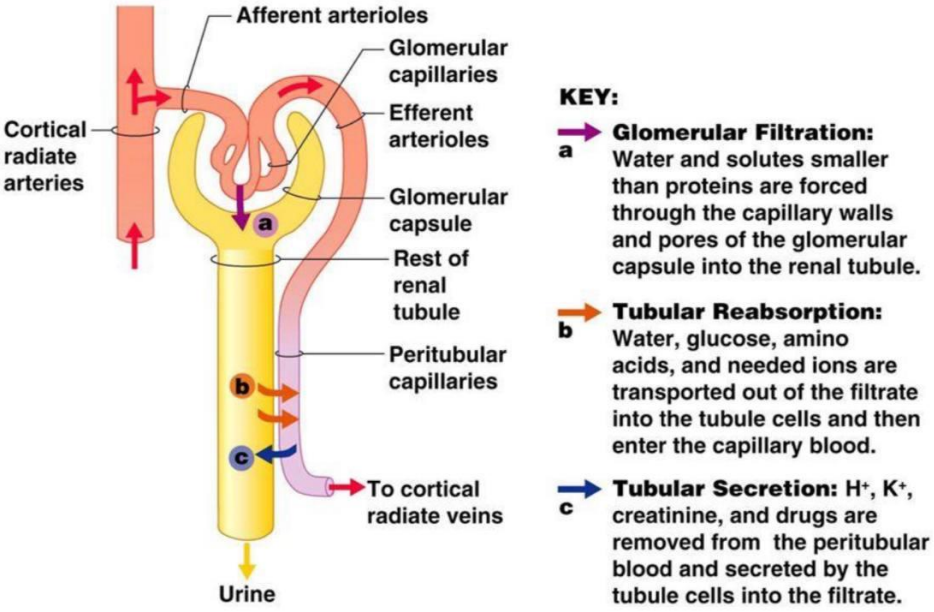
The kidneys are the organs most responsible for maintaining the **pH** of blood **(normal 7.35 - 7.45)** and tissue fluid within normal ranges. They have the greatest ability to compensate for the pH changes that are a normal part of body metabolism or the result of disease, and to make the necessary corrections.

Acid- base balance :

is controlled by renal regulation of **$HCO3^{-}$** and **H+** ions and by pulmonary excretion of **CO2.** If body fluids are becoming **too acidic**, the kidneys will secrete more **H+** ions into the renal filtrate and will return more **$HCO3^{-}$** ions to the blood.

This wills help raise the pH of the blood back to normal. If body fluids are becoming **too alkaline**, the kidneys will return H+ ions to the blood and excrete $HCO3^{-}$ ions in urine. This will help lower the pH of the blood back to normal.

Urine Formation



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