

Urinary system

The urinary system consists of all the organs involved in the formation and release of urine. It includes the kidneys, ureters, bladder and urethra.

Excretion is the process by which the unwanted substances and metabolic wastes are eliminated from the body. A large amount of waste materials and carbon dioxide are produced in the tissues during metabolic process. In addition, residue of undigested food, heavy metals, drugs, toxic substances and pathogenic organisms like bacteria are also present in the body. All these substances must be removed to keep the body in healthy condition. Various systems/organs in the body are involved in performing the excretory function, like

1. Digestive system excretes food residues in the form of feces. Some bacteria and toxic substances also are excreted through feces
2. Lungs remove carbon dioxide and water vapor
3. Skin excretes water, salts and some wastes. It also removes heat from the body
4. Liver excretes many substances like bile pigments, heavy metals, drugs, toxins, bacteria, etc. through bile.

Although various organs are involved in removal of wastes from the body, their excretory capacity is limited. But renal system or urinary system has maximum excretory capacity and so it plays a major role in homeostasis.

„ **Functions of kidney**

The kidneys maintain the homeostasis of several important internal conditions by controlling the excretion of substances out of the body, and it have many function like the following :-

1- regulation of

•**Ions.** The kidney can control the excretion of potassium, sodium, calcium, magnesium, phosphate, and chloride ions into urine. In cases where these ions reach a higher than normal concentration, the kidneys can increase their excretion out of the body to return them to a normal level. Conversely, the kidneys can conserve these ions when they are present in lower than normal levels by allowing the ions to be reabsorbed into the blood during filtration.

•**pH.** The kidneys monitor and regulate the levels of hydrogen ions (H^+) and bicarbonate ions in the blood to control blood pH. H^+ ions are produced as a natural by product of the metabolism of dietary proteins and accumulate in the blood over time. The kidneys excrete excess H^+ ions into urine for elimination from the body. The kidneys also conserve bicarbonate ions, which act as important pH buffers in the blood.

•**Osmolarity.** The cells of the body need to grow in an isotonic environment in order to maintain their fluid and electrolyte balance. The kidneys maintain the body's osmotic balance by controlling the amount of water that is filtered out of the blood and excreted into urine. When a person consumes a large amount of water, the kidneys reduce their reabsorption of water to allow the excess water to be excreted in urine. This results in the production of dilute, watery urine. In the case of the body being dehydrated, the kidneys reabsorb as much water as possible

back into the blood to produce highly concentrated urine full of excreted ions and wastes. The changes in excretion of water are controlled by antidiuretic hormone (ADH). ADH is produced in the hypothalamus and released by the posterior pituitary gland to help the body retain water.

•**Blood Pressure.** The kidneys monitor the body's blood pressure to help maintain homeostasis. When blood pressure is elevated, the kidneys can help to reduce blood pressure by reducing the volume of blood in the body. The kidneys are able to reduce blood volume by reducing the reabsorption of water into the blood and producing watery, dilute urine. When blood pressure becomes too low, the kidneys can produce the enzyme renin to constrict blood vessels and produce concentrated urine, which allows more water to remain in the blood.

2- Production of Hormones

The kidneys produce and interact with several hormones that are involved in the control of systems outside of the urinary system.

•**Calcitriol.** Calcitriol is the active form of vitamin D in the human body. It is produced by the kidneys from precursor molecules produced by UV radiation striking the skin. Calcitriol works together with parathyroid hormone (PTH) to regulate the level of calcium ions in the bloodstream.

•**Erythropoietin.** Erythropoietin, also known as EPO, is a hormone that is produced by the kidneys to stimulate the production of red blood cells. The kidneys monitor the condition of the blood that passes through their capillaries, including the oxygen-carrying capacity of the blood. When the blood becomes hypoxic, meaning that it is carrying deficient levels of oxygen, cells lining the capillaries begin producing EPO and release it into the bloodstream. EPO travels through the blood to the red bone

marrow, where it stimulates hematopoietic cells to increase their rate of red blood cell production. Red blood cells contain hemoglobin, which greatly increases the blood's oxygen-carrying capacity and effectively ends the hypoxic conditions.

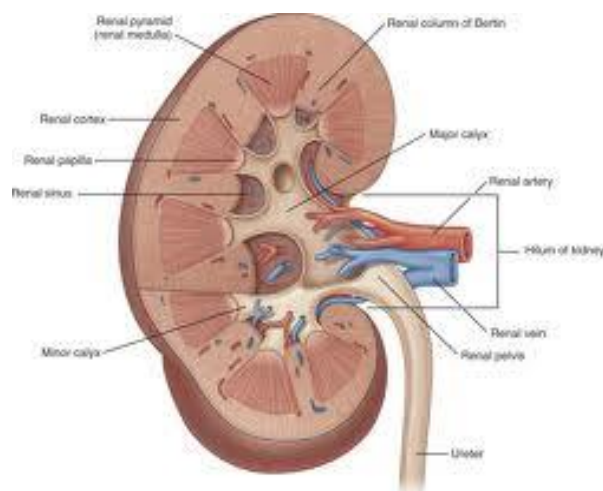
•**Renin.** Renin is not a hormone itself, but an enzyme that the kidneys produce to start the renin-angiotensin system (RAS). The RAS increases blood volume and blood pressure in response to low blood pressure, blood loss, or dehydration.

Components of the urinary system

Kidneys

The kidneys are large, bean-shaped organs found along the posterior wall of the abdominal cavity. The left kidney is located slightly higher than the right kidney because the right side of the liver is much larger than the left side. The kidneys, unlike the other organs of the abdominal cavity, are located posterior to the peritoneum and touch the muscles of the back. The kidneys are surrounded by a layer of adipose that holds them in place and protects them from physical damage. It is composed of several layers and is covered with a fibrous capsule, the **renal capsule**. The outer layer of the kidney is the **cortex**. It contains the major (upper) portion of the **nephrons**. The middle layer of the kidney is the **medulla**. It is composed of the triangular shaped **pyramids** and the renal columns. The pyramids contain the collecting tubules and loops of Henle, the lower portion of the nephrons. These tubules run nearly parallel to one another and give the pyramids a grain which leads to their points or papillae. The renal columns are regions between the pyramids in which blood vessels run to and from the cortex. The papilla of each pyramid projects into a

funnel-shaped area known as the calyx. collect the urine released from the papillae and allow it to drain into a large area known as the renal pelvis and then into the ureter.



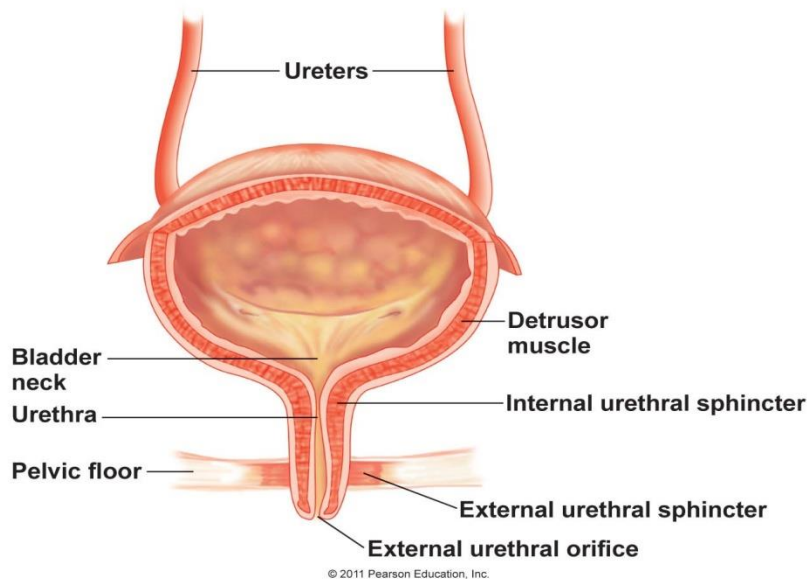
Ureters

The **ureters** are a pair of tubes that carry urine from the kidneys to the urinary bladder. The ureters are about 10 to 12 inches long and run on the left and right sides of the body parallel to the vertebral column. Gravity and peristalsis of smooth muscle tissue in the walls of the ureters move urine toward the urinary bladder. The ends of the ureters extend slightly into the urinary bladder and are sealed at the point of entry to the bladder by the uretero vesical valves. These valves prevent urine from flowing back towards the kidneys.

Urinary Bladder

The **urinary bladder** is a sac-like hollow organ used for the storage of urine. The urinary bladder is located along the body's midline at the inferior end of the **pelvis**. Urine entering the urinary bladder from the ureters slowly fills the hollow space of the bladder and stretches its elastic

walls. The walls of the bladder allow it to stretch to hold anywhere from 600 to 800 milliliters of urine.



Urethra

The **urethra** is the tube through which urine passes from the bladder to the exterior of the body. The female urethra is around 2 inches long and ends inferior to the **clitoris** and superior to the vaginal opening. In males, the urethra is around 8 to 10 inches long and ends at the tip of the **penis**. The urethra is also an organ of the male reproductive system as it carries sperm out of the body through the penis.

The flow of urine through the urethra is controlled by the internal and external urethral sphincter muscles. The internal urethral sphincter is made of smooth muscle and opens involuntarily when the bladder reaches a certain set level of distention. The opening of the internal sphincter results in the sensation of needing to urinate. The external urethral sphincter is made of skeletal muscle and may be opened to allow urine to pass through the urethra or may be held closed to delay urination.