

Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Bio-Medical Engineering Department



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Lecture Number: 3

Lecture Title: The Renal System

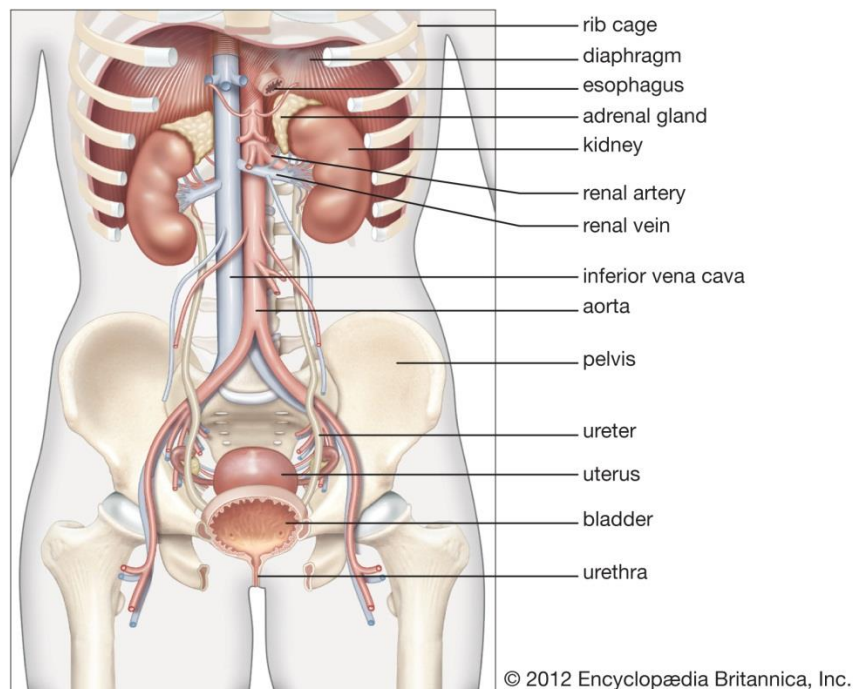
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The Renal System

The renal system , also known as the urinary system or urinary tract, consists of the kidneys, ureters, bladder, and the urethra. The purpose of the urinary system is to eliminate waste from the body, regulate blood volume and blood pressure, control levels of electrolytes and metabolites, and regulate blood pH.

The urinary tract is the body's drainage system for the removal of urine. The kidneys have an extensive blood supply via the renal arteries which leave the kidneys via the renal vein. Each kidney consists of functional units called nephrons. Following filtration of blood and further processing, wastes (in the form of urine) exit the kidney via the ureters, tubes made of smooth muscle fibres that propel urine towards the urinary bladder, where it is stored and subsequently expelled from the body by urination (voiding). The female and male urinary system are very similar, differing only in the length of the urethra.



Urine is formed in the kidneys through a filtration of blood. The urine is then passed through the ureters to the bladder, where it is stored. During urination, the urine is passed from the bladder through the urethra to the outside of the body.

The renal system, also known as the urinary system, consists of:

1. kidneys, which filter the blood to produce urine;
2. ureters, which convey urine to the bladder;
3. urinary bladder, a storage organ for urine until it is eliminated;
4. urethra, which conveys urine to the exterior.

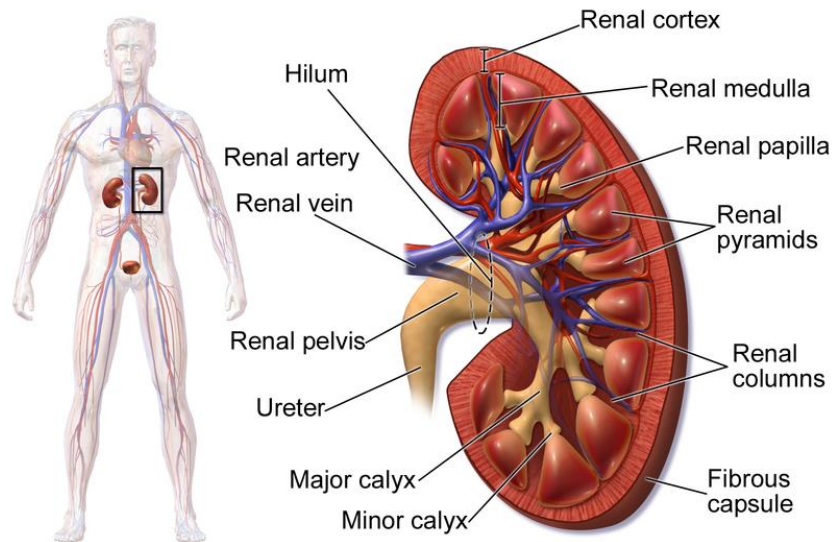
The organs of the renal system ensure that a stable internal environment is maintained for the survival of cells and tissues in the body – homeostasis. The main functions of the urinary system and its components are to:

- Regulate blood volume and composition (e.g. sodium, potassium and calcium)
- Regulate blood pressure.
- Regulate pH homeostasis of the blood.
- Contributes to the production of red blood cells by the kidney.
- Helps synthesize calcitriol (the active form of Vitamin D).
- Stores waste product (mainly urea and uric acid) before it and other products are removed from the body.

Urination, is the ejection of urine from the urinary bladder through the urethra to the outside of the body. In healthy humans, the process of urination is under voluntary control. In infants, some elderly individuals, and those with neurological injury, urination may occur as an involuntary reflex. Physiologically, urination involves coordination between the central, autonomic, and somatic nervous systems. In placental mammals the male ejects urine through the penis, and the female through the vulva.

Kidneys

The kidneys are two reddish-brown bean-shaped organs found in vertebrates. They are located on the left and right in the retroperitoneal space, and in adult humans are about 12 centimetres in length. They receive blood from the paired renal arteries; blood exits into the paired renal veins. Each kidney is attached to a ureter, a tube that carries excreted urine to the bladder.



Kidney Anatomy

Functions of the kidney

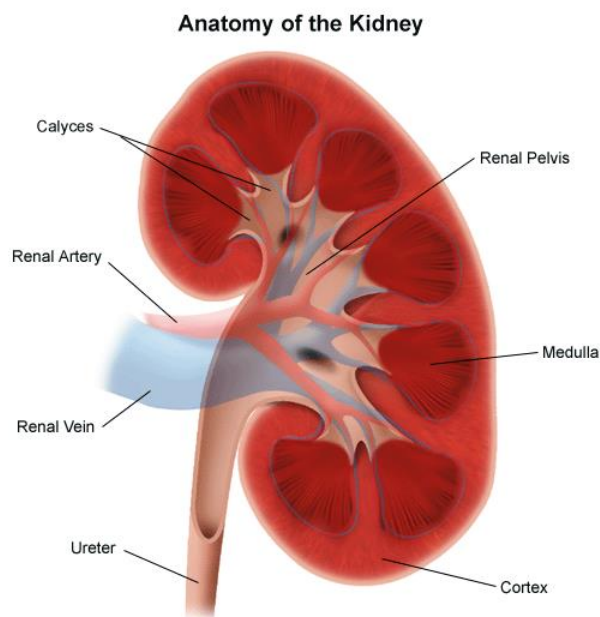
The kidneys maintain fluid balance, electrolyte balance and the acid–base balance of the blood.

1. The kidneys remove wastes and excess water (fluid) collected by, and carried in, the blood as it flows through the body. Approximately 190 L of blood enter the kidneys every day via the renal arteries. Millions of tiny filters, called glomeruli, inside the kidneys separate wastes and water from the blood. Most of these unwanted substances come from what we eat and drink. The kidneys automatically remove the right amount of salt and other minerals from the blood to leave just the quantities the body needs.
2. By removing just the right amount of excess fluid, healthy kidneys maintain what is called the body's fluid balance. In women, fluid content stays at about 55% of total weight. In men, it stays at about 60% of total weight. The kidneys maintain these proportions by balancing the amount of fluid that leaves the body against the amount entering the body. When a large volume of fluid is drunk, healthy kidneys remove the excess fluid and produce a lot of urine. On the other hand, if fluid intake is low, the kidneys retain fluid and the patient does not pass much urine. Fluid also leaves the body through sweat, breath and faeces. If the weather is hot and we lose a lot of fluid by sweating, then the kidneys will not pass much urine.

3. Kidneys synthesis hormones such as renin and angiotensin. These hormones regulate how much sodium (salt) and fluid the body keeps, and how well the blood vessels can expand and contract. This, in turn, helps control blood pressure. Kidneys produce a hormone known as erythropoietin, which is carried in the blood to the bone marrow where it stimulates the production of red blood cells. These cells carry oxygen throughout the body. Without enough healthy red blood cells anaemia develops, a condition that causes weakness, cold, tiredness and shortness of breath.
4. Healthy kidneys keep bones strong by producing the hormone calcitriol. Calcitriol maintains the right levels of calcium and phosphate in the blood and bones. Calcium and phosphate balance are important to keep bones healthy. When the kidneys fail they may not produce enough calcitriol. This leads to abnormal levels of phosphate, calcium and vitamin D, causing renal bone disease. For a summary of the functions of the kidney

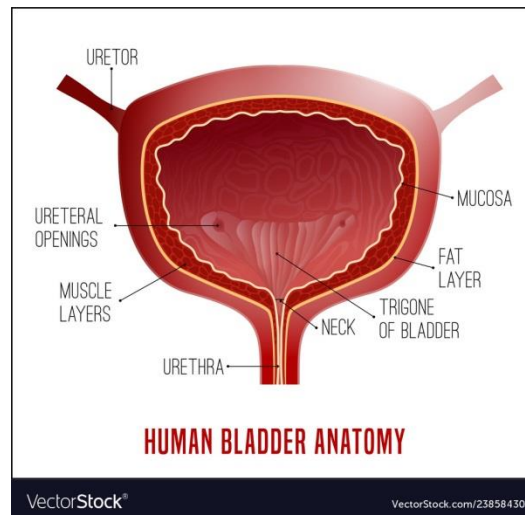
Two ureters

These narrow tubes carry urine from the kidneys to the bladder. Muscles in the ureter walls continually tighten and relax forcing urine downward, away from the kidneys. If urine backs up, or is allowed to stand still, a kidney infection can develop. About every 10 to 15 seconds, small amounts of urine are emptied into the bladder from the ureters.



Bladder

This triangle-shaped, hollow organ is located in the lower abdomen. It is held in place by ligaments that are attached to other organs and the pelvic bones. The bladder's walls relax and expand to store urine, and contract and flatten to empty urine through the urethra. The typical healthy adult bladder can store up to two cups of urine for two to five hours.



Urethra

This tube allows urine to pass outside the body. The brain signals the bladder muscles to tighten, which squeezes urine out of the bladder. At the same time, the brain signals the sphincter muscles to relax to let urine exit the bladder through the urethra. When all the signals occur in the correct order, normal urination occurs.

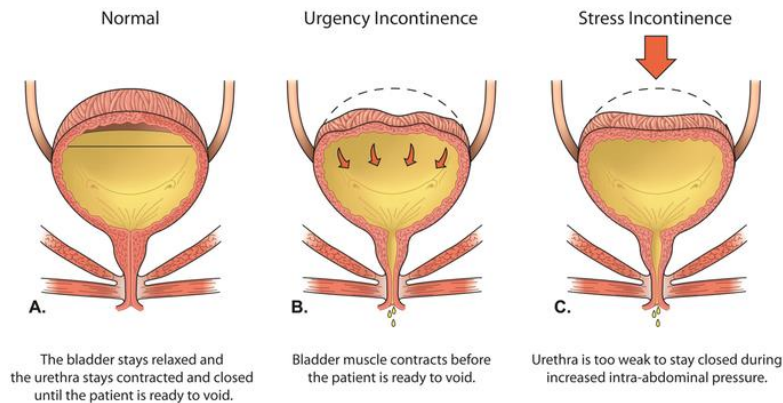
Urinary Tract Diseases

Urologic disease can involve congenital or acquired dysfunction of the urinary system. As an example, urinary tract obstruction is a urologic disease that can cause urinary retention

Diseases of other bodily systems also have a direct effect on urogenital function. For instance, it has been shown that protein released by the kidneys in diabetes mellitus sensitizes the kidney to the damaging effects of hypertension.

Diabetes also can have a direct effect in urination due to peripheral neuropathies, which occur in some individuals with poorly controlled blood sugar levels.

Urinary incontinence can result from a weakening of the pelvic floor muscles caused by factors such as pregnancy, childbirth, aging, and being overweight.

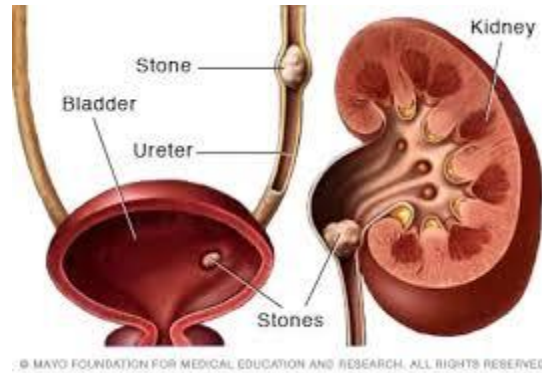


Some cancers also target the urinary system, including bladder cancer, kidney cancer, ureteral cancer, and urethral cancer.



Kidney stones form when your urine contains more crystal-forming substances — such as calcium, oxalate and uric acid — than the fluid in your urine can dilute. At the

same time, your urine may lack substances that prevent crystals from sticking together, creating an ideal environment for kidney stones to form.



Facts about urine

- Normal, healthy urine is a pale straw or transparent yellow color.
- Darker yellow or honey colored urine means you need more water.
- A darker, brownish color may indicate a liver problem or severe dehydration.
- Pinkish or red urine may mean blood in the urine.