

Urinary System

Introduction:

During the nutrient metabolism carried out by cells during physiological processes, protein catabolism leads to the production of toxic nitrogenous wastes such as ammonia and urea, in addition to the accumulation of large amounts of sodium, sulfate, phosphate and hydrogen ions. Therefore, these toxic substances accumulated in the body must be eliminated.

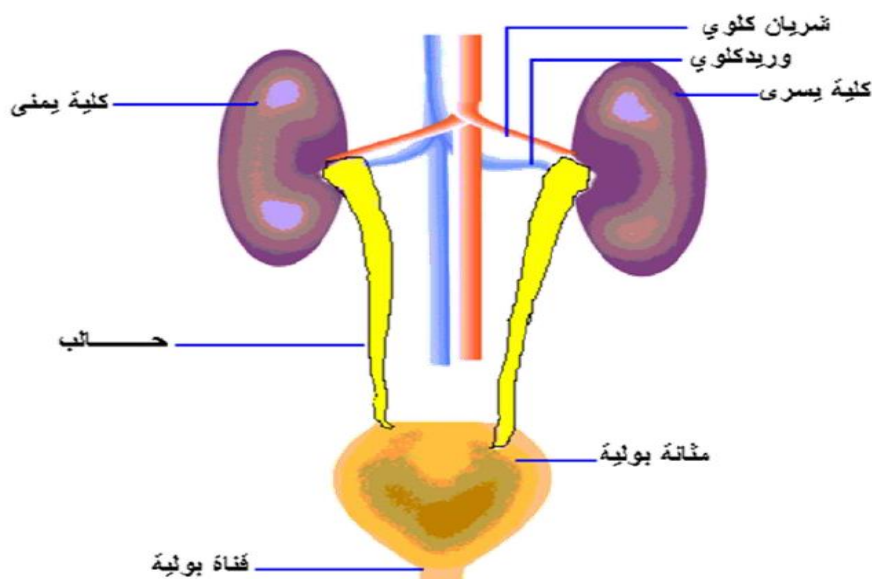
Urinary System: It is the group of organs that manufacture, store and excrete urine.

Urinary System consists of :

- 1- The kidneys.
- 2- Ureters.
- 3- Bladder.
- 4- Urethra.

The main function of the urinary system:

- 1- Maintain the stability of the natural state of the body by controlling the volume.
- 2- Components and pressure of blood.
- 3- This is done by removing and restoring certain amounts of water and salts.





The kidneys:

- The kidney is the main the excretory organs in humans, that participate in the removal of these nitrogenous wastes, water and salts in excess of the body's need, and some heat.
- The kidneys are two dark red glands located in the dorsal side of the body on both sides of the spine, in the back part of the abdominal cavity.
- The left kidney is higher, in position than the right kidney.
- its shape like to a bean.
- the kidney has a convex outer surface and a concave inner surface known as the navel of the kidney.
- connected to each kidney from the navel side and two blood vessels, one of which branches from the aorta, and is known as the renal artery that enters the kidney and branches inside it, and the other is The renal vein, in which the blood from the kidney returns after separating the excretory substances from it, to then flow into the inferior vena cava, which in turn empties into the heart.
- Each kidney is surrounded by a fatty layer that forms a covering around the kidney that protects it from shocks and helps to stabilize it in place
- The ureter exits from the kidney to the urinary bladder, and the urethra, which carries urine out of the body, emerges from the bladder.

Function of Kidney:

1. Excretion of metabolic waste products and foreign.
2. Regulation of water and electrolyte balances.
3. Regulation of body fluid osmolality and electrolyte concentrations.
4. Regulation of arterial pressure.
5. Regulation of acid-base balance.
6. Regulation of erythrocyte production.
7. Secretion, metabolism, and excretion of hormones.
8. Regulation the level of salt concentration in the body.
9. Regulation the level of glucose in the body.

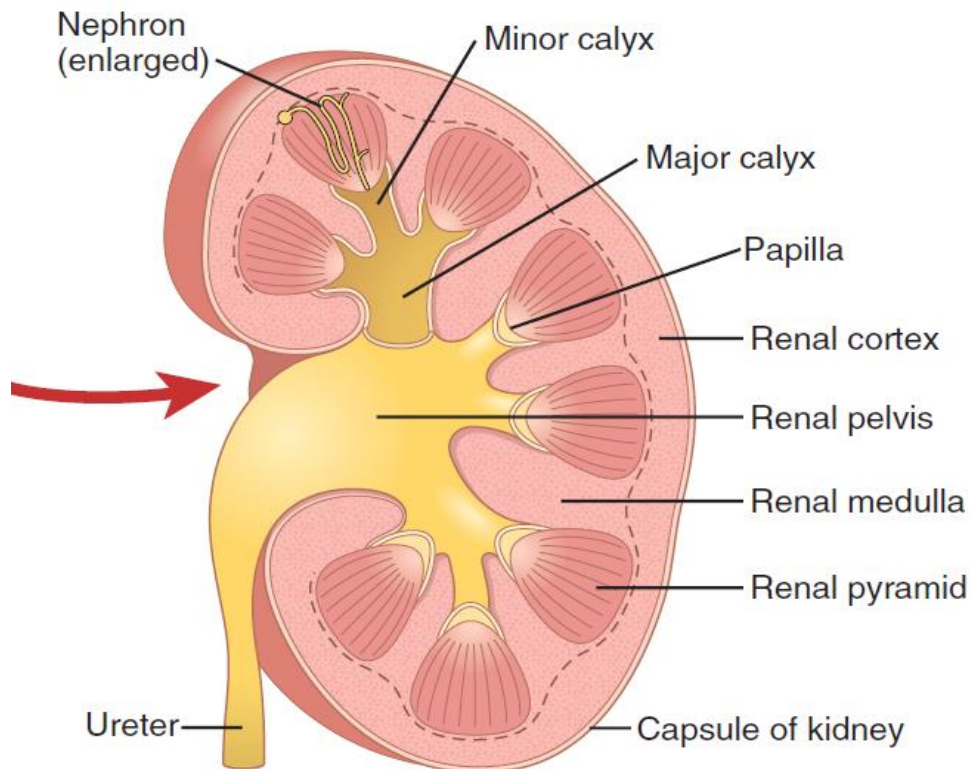


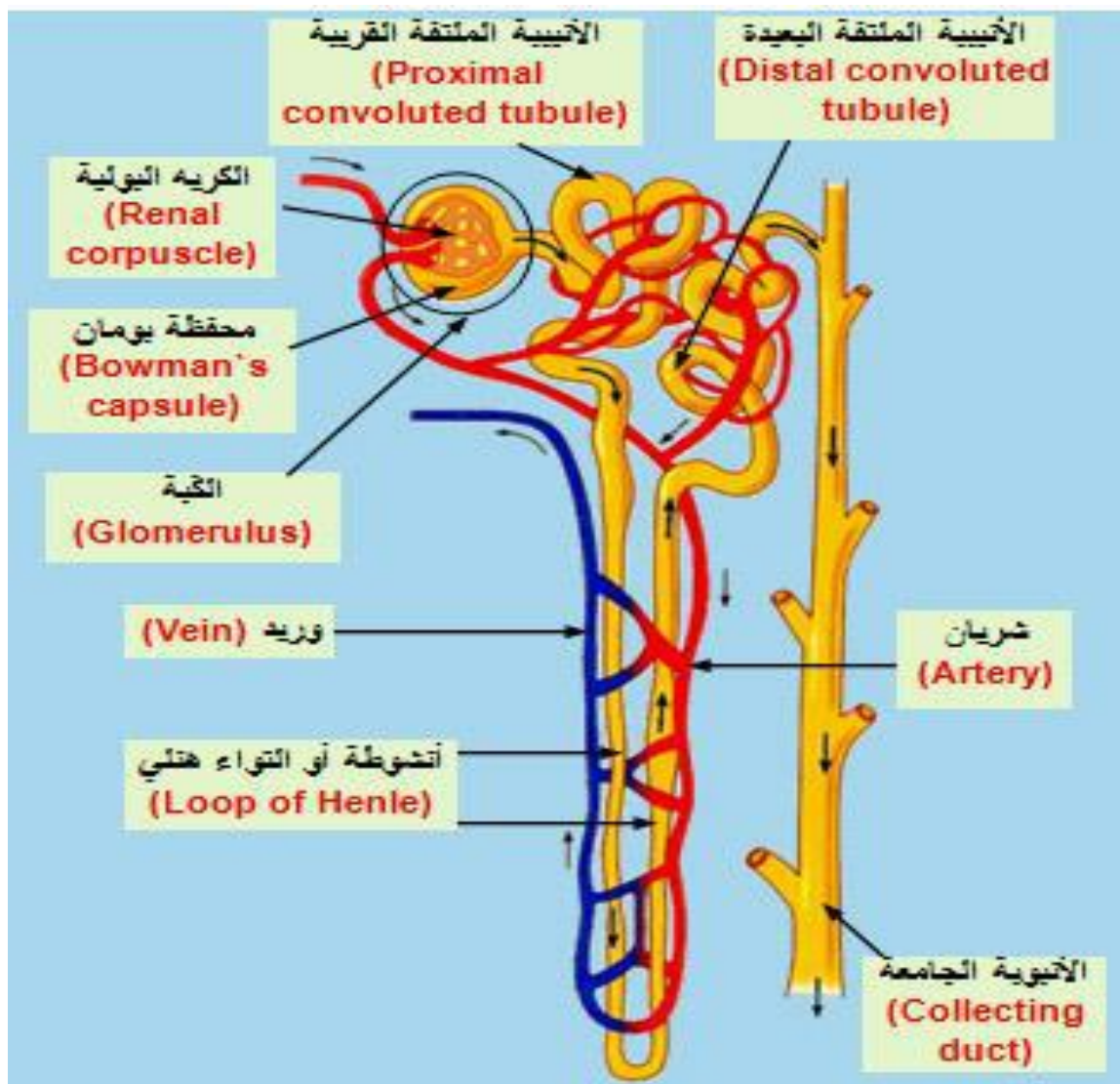
Figure 1. General organization of the kidneys and the urinary system.

The physiological unit in building the kidney

- The human kidney consists of about a million anatomical and functional units called nephrons, and each nephron consists of a urinary tube with blood vessels attached to it.
- The urethral tubes pass from the cortex through the pulp and open into the pelvis.
- The tube begins with a funnel-shaped structure, the Bowman's capsule, within which is a mass of capillary blood vessels called the glomerulus.
- The urinary tube is divided into a number of histologically and functionally distinct regions, such as the proximal bypass tube, the loop of Henle, the distal bypass tube, and finally the collecting tube.



- As for the blood vessels, it contains an afferent artery. It is a branch of the renal artery, which in turn branches off the dorsal aorta.
- The afferent artery branches within Bowman's capsule to form a set of parallel capillaries, the glomerulus, which reunite to form an efferent artery that branches again to form a network of capillaries around the urinary tube.
- The capillary blood vessels surrounding the urinary tubules unite to form a vein, which unites with the other veins of the other nephrons, to form the renal vein, which empties into the inferior cavity.





Renal blood flow

The blood enters the kidneys in large quantities for the purpose of getting rid of waste and estimating the amount of blood

The blood that enters the kidneys is about 25% of the blood that is pumped out of the heart, that is, every 4 or 5 minutes.

This blood flow in the circulatory system passes through the kidneys. Blood vessels Participating in this process are:

- 1- The renal artery, which branches from the abdominal aorta and enters the kidney from the navel area, then branches into small arteries and then into smaller arteries called arterioles, and this branch of the arteries is called the afferent glomerular arteries.
- 2- Afferent glomerular arterioles deliver blood to the glomerular capillaries of Malpighian corpuscle.
- 3- Glomerular capillaries are extensions of the glomerular arterioles Incoming plasma is filtered into Bowman's capsule, called glomerular filtration. Not all of the plasma is filtered, so a portion remains that exits the glomerulus through the efferent glomerular capillaries.
- 4- The efferent glomerular capillaries branch into a network of capillaries that surround the urinary unit and are called peritubular capillaries. These capillaries unite to form veins and unite to form large veins that drain into the renal vein.
- 5- The renal vein leaves the kidney through the umbilicus and connects to the inferior vena cava.

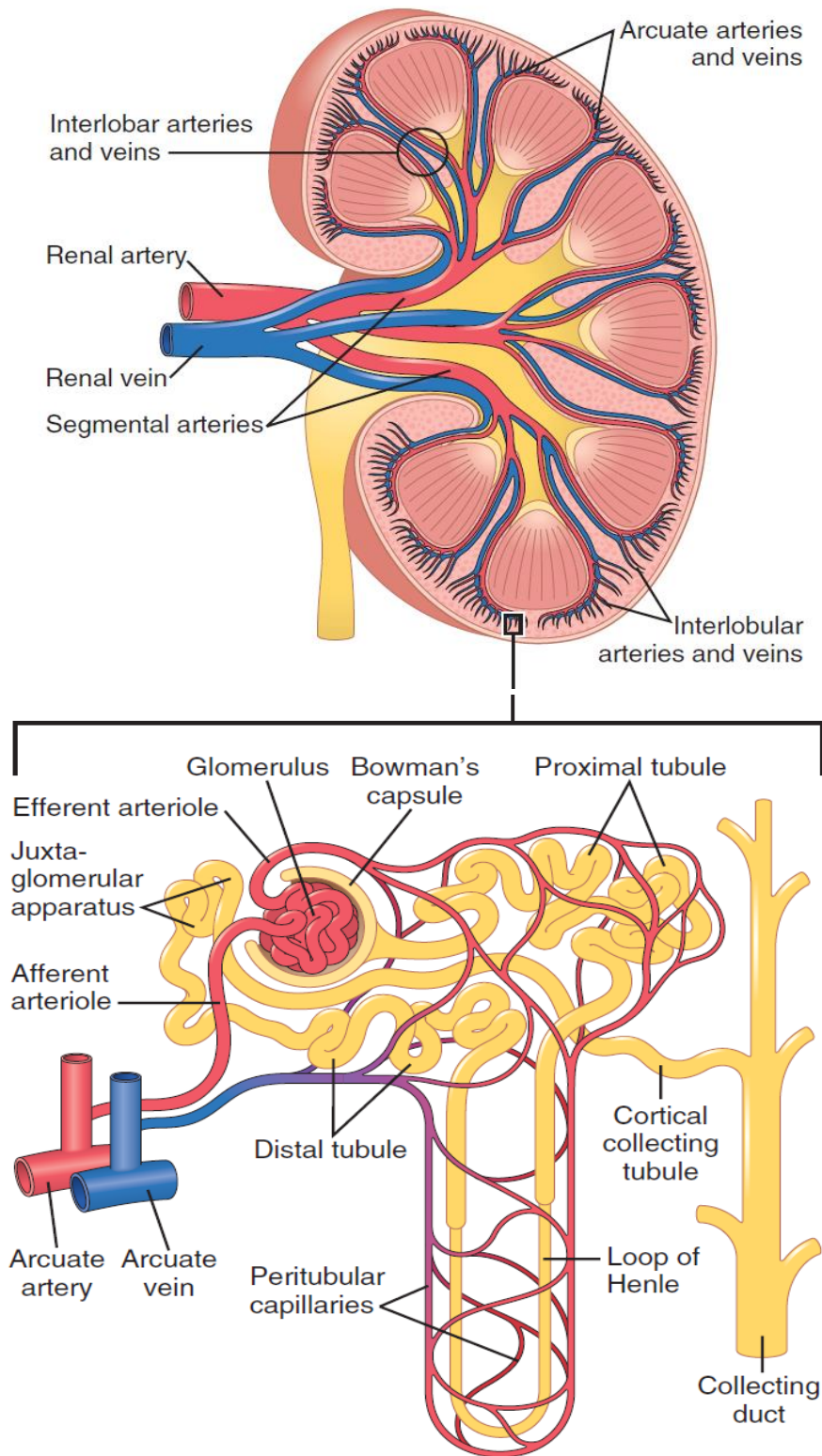


Figure 2. Section of the human kidney showing the major vessels that supply the blood flow to the kidney and schematic of the microcirculation of each nephron.



Innervations of renal vessels

The kidney is an organ rich in sympathetic nerves from the autonomic nervous system, that follow the course of the previous renal arterioles and arterioles, where they innervate the smooth muscles in the walls of those vessels and stimulate their contraction and this regulates blood flow through the capillaries in the glomerulus.

Micturition

Micturition is the process by which the urinary bladder empties when it becomes filled.

This process involves two main steps:

- 1- First, the bladder fills progressively until the tension in its walls rises above a threshold level.
- 2- This tension elicits the second step, which is a nervous reflex called the micturition reflex that empties the bladder or, if this fails, at least causes a conscious desire to urinate.

Although the micturition reflex is an autonomic spinal cord reflex, it can also be inhibited or facilitated by centers in the cerebral cortex or brain stem.

The physiology of urine formation

Urine is formed by the following processes

- 1- Filtration. 2- Reabsorption. 3- Secretion. 4- Synthesis
- 1- Filtration: The filtration takes place in Malpighian bodies by the transfer of materials by diffusion in the blood capillaries to the cavity of Bowman's capsule, and it is noted that the filtrate is similar to blood plasma in its composition, except that it is devoid of proteins.
- 2- Reabsorption: The filtrate is considered a "reduced" solution when compared to the final urine, where the filter volume is 180 liters per day while the urine volume is 1.5 liters per day. The glucose in



the filtrate and a large proportion of mineral salts and other dissolved substances are absorbed. The renal tubules have a limited ability to absorb glucose. If the glucose concentration exceeds this capacity, it appears in the urine.

- 3- Secretion: The kidney expels or excretes excess substances from the body's need, such as sodium, for excretion in the urine. This process is the opposite of re-absorption, but is complementary to it in order to ensure the required balance for the body.
- 4- Synthesis: It is the process of creating new substances that are not present in the filtrate, such as the formation of ammonia from amino acids, so that the body can overcome the increased acidity that it may be exposed to.