The Urinary System

The **urinary system** consists of the kidneys and the structures that carry the urine from the kidneys to the outside for elimination from the body . The kidneys are a pair of bean-shaped organs about 4 to 5 inches long that lie behind the abdominal cavity , one on each side of the vertebral column, slightly above the waistline.

Each kidney is supplied by a **renal artery** and a **renal vein** leaves the kidney.

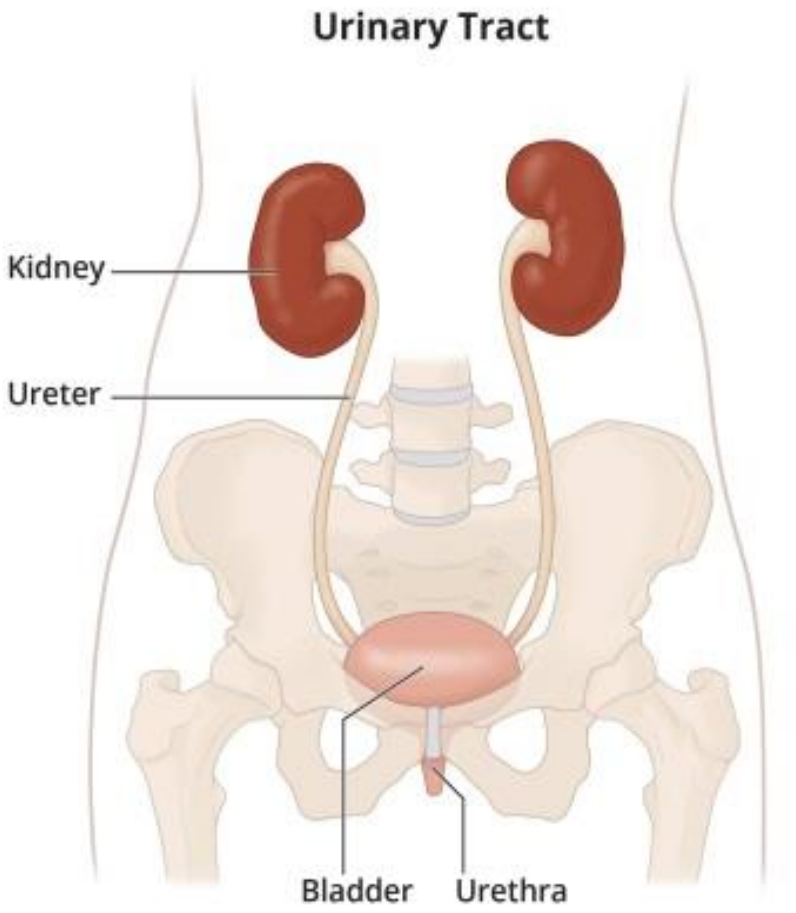
The kidney acts on the plasma flowing through it to produce urine, conserving materials to be retained in the body and eliminating unwanted materials into the urine.

After urine is formed, it drains into a central collecting cavity, the **renal pelvis**, located at the medial inner core of each kidney.

From there urine is channeled into the **ureter**, a duct that exits at the medial border close to the renal artery and vein. There are two ureters, one carrying urine from each kidney to the single urinary bladder.

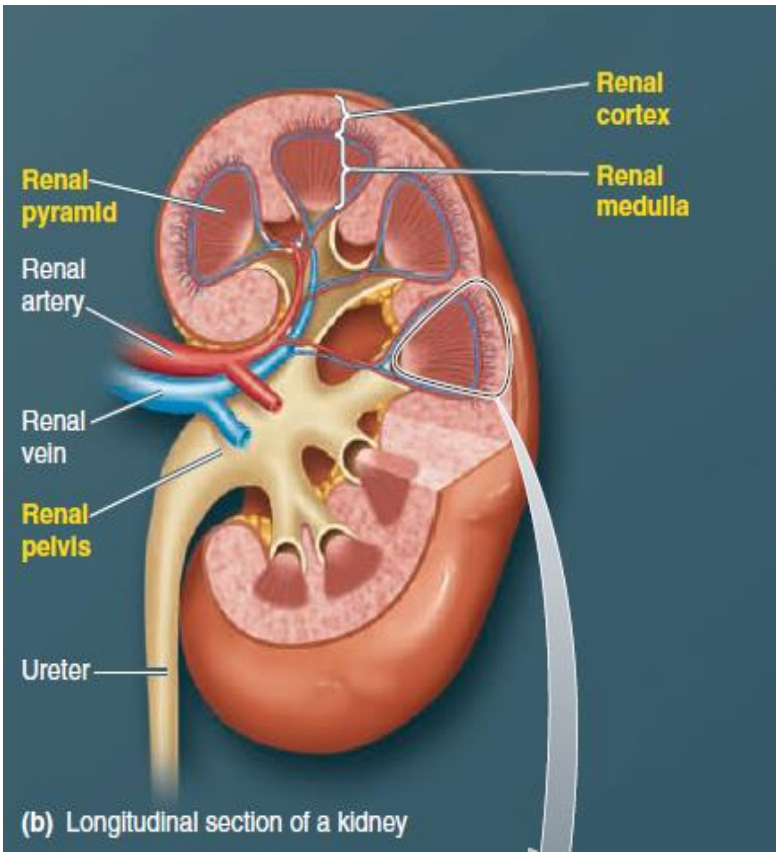
The **urinary bladder**, which temporarily stores urine, is a hollow, distensible, smooth muscle–walled sac. Periodically, urine is emptied from the bladder to the outside through another tube, the **urethra**, as a result of bladder contraction.

The urethra passing directly from the neck of the bladder to the outside.



Kidney Functions:

1. *Maintaining water (H2O) balance in the body.*
2. *Regulating the quantity and concentration of most ECF ions,* including sodium (Na1), chloride (Cl2), potassium (K1), calcium (Ca21), hydrogen ion (H1), bicarbonate (HCO3), phosphate(PO4), sulfate (SO4), and magnesium (Mg21).
3. *Maintaining proper plasma volume,* which is important in the long-term regulation of arterial blood pressure. This function is accomplished through the kidneys' regulatory role in salt (NaCl) and H2O balance.
4. *Helping maintain the proper acid–base balance* of the body by adjusting urinary output of H1 and HCO3
6. *Excreting (eliminating) the end products (wastes) of body metabolism,* such as urea (from proteins), uric acid (from nucleic acids), creatinine (from muscle creatine), bilirubin (from hemoglobin), and hormone metabolites. If allowed to accumulate, many of these wastes are toxic, especially to the brain.
7. *Excreting many foreign compounds,* such as drugs.
8. *Producing renin,* an enzymatic hormone that triggers a chain reaction important in salt conservation by the kidneys.
9. *Producing erythropoietin,* a hormone that stimulates red blood cell production.
10. *Converting vitamin D into its active form.*

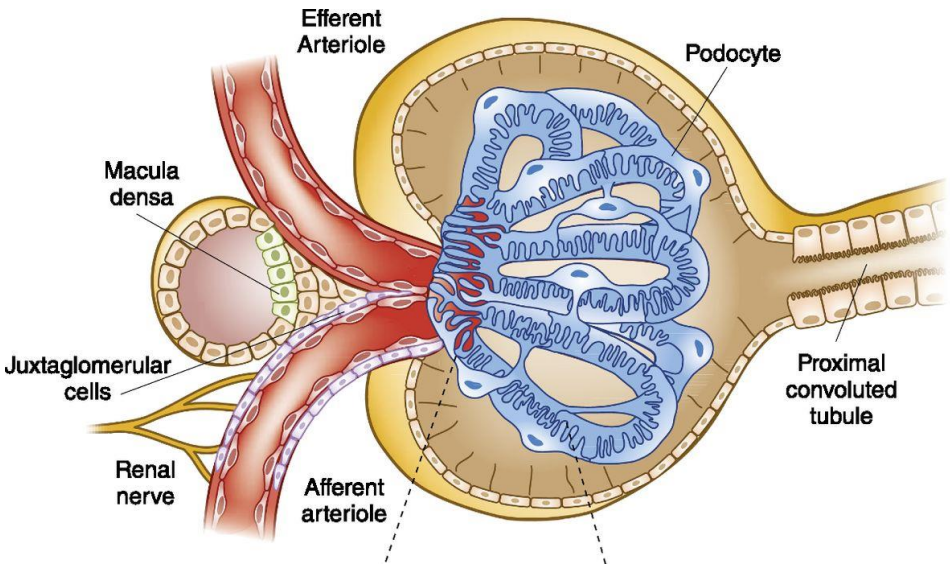


The nephron is the functional unit of the kidney.

Each kidney consists of about 1 million microscopic functional units known as **nephrons**. a nephron is the smallest unit capable of forming urine.
The arrangement of nephrons within the kidneys gives rise to two distinct regions : an outer region called the **renal cortex**, which looks granular, and an inner region, the **renal medulla**, which is made up of striated triangles, the **renal pyramids** .

Vascular Component of the Nephron

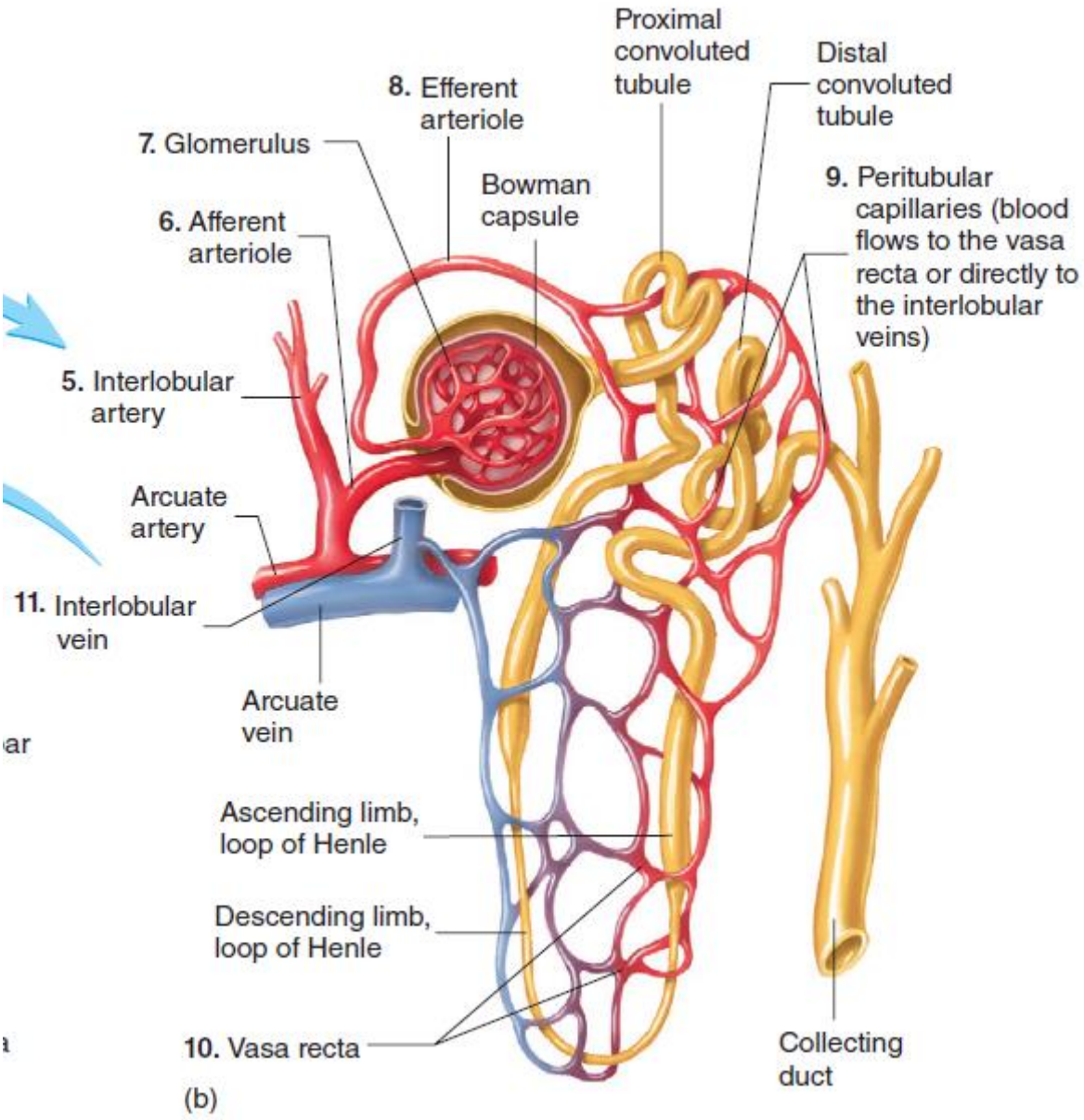
The dominant part of the nephron's vascular component is the **glomerulus**, a ball-like tuft of capillaries through which part of the water and solutes is filtered from blood passing through . On entering the kidney, the renal artery subdivides to ultimately form many small vessels known as **afferent arterioles**, which delivers blood to the glomerulus. The glomerular capillaries rejoin to form the **efferent arteriole**,
The efferent arteriole subdivides into a second set of capillaries, the **peritubular capillaries**, which supply the renal tissue with blood and are important in exchanges between the tubular system and blood during conversion of the filtered fluid into urine. The peritubular capillaries rejoin to form venules that ultimately drain into the renal vein, by which blood leaves the kidney.



Tubular Component of the Nephron

The tubular component begins with **Bowman's capsule**, an expanded, double-walled "cup" that surrounds the glomerulus to collect fluid filtered from the glomerular capillaries.
From Bowman's capsule, the filtered fluid passes into the **proximal tubule**, which lies within the cortex and is highly coiled or convoluted throughout much of its course. The next segment, the **loop of Henle**, forms a sharp U-shaped that dips into the renal medulla. The *descending limb* of the loop of Henle plunges from the cortex into the

medulla; the *ascending limb* traverses back up into the cortex. The ascending limb returns to the glomerular region of the same nephron, where it passes through the fork formed by the afferent and efferent arterioles. Both the tubular and the vascular cells at this point are specialized to form the **juxtaglomerular apparatus**, a structure that lies next to the glomerulus. This specialized region plays an important role in regulating kidney function. Beyond the juxtaglomerular apparatus, the tubule again coils tightly to form the **distal tubule**, which also lies entirely within the cortex. The distal tubule empties into a **collecting duct** or **tubule**, with each collecting duct draining fluid from up to eight separate nephrons. Each collecting duct plunges down through the medulla to empty its fluid contents (now converted into urine) into the renal pelvis.



The three basic renal processes:

Three basic processes are involved in forming urine: *glomerular filtration, tubular reabsorption,* and *tubular secretion.*

Glomerular Filtration As blood flows through the glomerulus, protein-free plasma filters through the glomerular capillaries into Bowman's capsule. Normally, about 20% of the plasma that enters the glomerulus is filtered. This process, known as **glomerular filtration**, is the first step in urine formation. On average, 125 mL of glomerular filtrate (filtered fluid) are formed collectively through all the glomeruli each minute. This amounts to 180 liters each day. Considering that the average plasma volume in an adult is 2.75 liters, this means that the kidneys filter the entire plasma volume about 65 times per day.

Tubular Reabsorption This selective movement of substances from inside the tubule (the tubular lumen) into the blood is called **tubular reabsorption**. Reabsorbed substances are not lost from the body in the urine but instead are carried by the peritubular capillaries to the venous system and then to the heart to be recirculated. Of the 180 liters of plasma filtered per day, 178.5 liters, are reabsorbed. The remaining 1.5 liters of filtered fluid left in the tubules pass into the renal pelvis to be eliminated as urine. In general, substances the body needs to conserve are selectively reabsorbed, whereas unwanted substances that must be eliminated stay in the tubular fluid, which becomes urine after tubular modification is complete.

Tubular Secretion The third renal process, **tubular secretion**, is the selective transfer of substances from the peritubular capillary blood into the tubular lumen.

Urine is stored in the bladder, from which it is emptied by micturition.

Once urine has been formed by the kidneys, it is transmitted through the ureters to the urinary bladder. The bladder can accommodate large fluctuations in urine volume.
The bladder in an adult can accommodate 250 to 400 mL of urine before the tension within its walls begins to rise sufficiently to activate the stretch receptors