

### URINARY SYSTEM

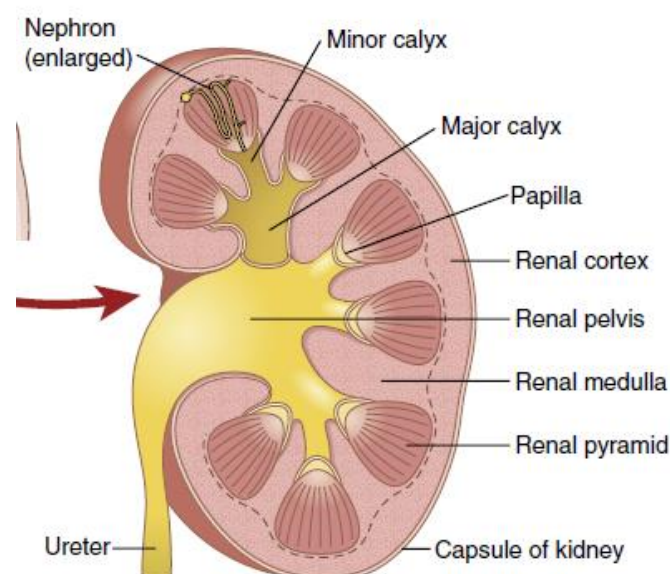
The urinary system consists of those organs which produce urine and eliminate it from the body. These organs comprise two kidneys, two ureters, one bladder and one urethra

#### **Functions of the Kidney:**

1. Excretion of metabolic waste products and foreign chemicals
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. Gluconeogenesis

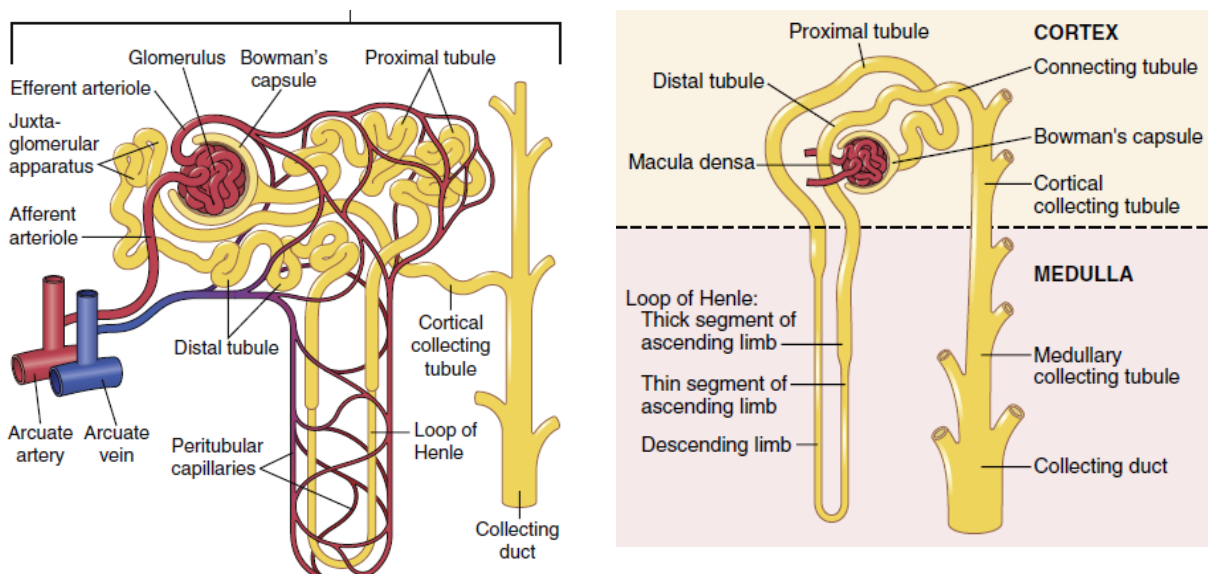
#### **Characteristic Features of the Kidney:**

1. The human kidneys are bean-shaped paired organs situated just behind the vertebral column in the abdomen at the twelfth thoracic to third lumbar segment.
2. An average-sized kidney measures 10 to 12 cm in length, 5 to 6 cm in width and 3 to 4 cm in thickness, each weighing about 150 gm in adult male and about 135 gm in adult female. Usually the right kidney is slightly smaller than the left one.
3. A deep notch or concavity is present at the medial border-the hilus (hilum), and it is through this region the blood vessels-renal artery and vein, ureter and nerves pass.
4. If the kidney is sectioned along its long axis and examined with the naked eye, a dark reddish-brown peripheral region (opposite the hilus), the cortex, and the rest lighter area-the medulla are distinguishable.
5. The medulla is again divided into 10 to 15 conical areas, the renal pyramids having their broad base towards the cortex and the vertex, apex or papilla projected into the lumen of the minor calyx.



## Nephron:

- It is the functional unit of the kidney.
- Each human kidney contains about 1,000,000 *nephrons*, each of which is capable of forming urine.
- The kidney cannot regenerate new nephrons. Therefore, with renal injury, disease, or normal aging, the number of nephrons gradually decreases.
- The nephrons consist of the following parts:
  1. Renal or malpighian corpuscle
  2. Proximal convoluted tubule
  3. Descending limb of loop of Henle
  4. Ascending limb of loop of Henle: The ascending limb of loop of Henle comprises two segments: Thin ascending limb of loop of Henle and thick ascending limb of loop of Henle.
  5. Distal convoluted tubule.



**Malpighian corpuscles (malpighian body or renal corpuscle):** Found only in the cortex of the kidney. The corpuscle consists of two parts:

1. Glomerulus
2. Bowman's capsule

- **Glomerulus:** It is the capillary tuft located at the beginning of the nephron.

The afferent arteriole breaks up into about fifty capillary loops and forms the glomerular tuft which lies within Bowman's capsule, a double-walled epithelial sac. The capillary tuft reunites and forms the efferent arteriole which passes out of the glomerulus.

- **Bowman's capsule:** It is a cup-like sac at the beginning of the tubular component of a nephron. It consists of two layers- parietal and visceral.
- **Juxtaglomerular cells (JG cells)** of the kidneys. The JG cells are modified smooth muscle cells located mainly in the walls of the afferent arterioles immediately proximal to the glomeruli.

The proximal convoluted and distal convoluted tubules are in the cortex and in close proximity to the renal corpuscle.

The loop of Henle extends from the cortex to the variable distance in the medulla according to the position of the corpuscles in the cortex.

Fluid filtered from the glomerular capillaries flows into Bowman's capsule and then into the proximal tubule which lies in the cortex of the kidney.

From the proximal tubule, fluid flows into the loop of Henle which dips into the renal medulla then fluid enters the distal tubule, which, like the proximal tubule, lies in the renal cortex. The distal tubule is followed by the connecting tubule and cortical collecting tubule, which lead to the cortical collecting duct.

The collecting ducts merge to form progressively larger ducts that eventually empty into the renal pelvis through the tips of the renal papillae.

### **The juxtaglomerular apparatus:**

- It is a specialized structure formed by the distal convoluted tubule and the glomerular afferent arteriole.
- It is located near the vascular pole of the glomerulus.
- its main function is to regulate blood pressure and the filtration rate of the glomerulus.
- The **macula densa** is a collection of specialized epithelial cells in the distal convoluted tubule that detect sodium concentration of the fluid in the tubule. In response to elevated sodium, the macula densa cells trigger contraction of the afferent arteriole, reducing flow of blood to the glomerulus and the glomerular filtration rate.
- The juxtaglomerular cells, derived from smooth muscle cells, of the afferent arteriole secrete renin when blood pressure in the arteriole falls. Renin increases blood pressure via the renin-angiotensin-aldosterone system.
- Lacis cells, also called extraglomerular mesangial cells, are flat and elongated cells located near the macula densa. Their function remains unclear.