

# BIOLOGY

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## 01. Kidneys

Human kidneys are mesodermal in origin. They are situated in the abdominal cavity on either side of the levels of last thoracic and third lumbar vertebra. Human kidneys are present outside the coelomic cavity and only their ventral surface is covered by visceral peritoneum.

This arrangement is called **retroperitoneal**. Last two pairs of ribs, i.e. floating ribs protect the kidneys from backside.

## 02. External Structure

Human kidneys are bean-shaped, reddish-brown, paired structures. An average sized kidney is about 10-12 cm in length, 5-7 cm in width and 3-4 cm in thickness. Their weight is about 150 gm in males and about 135 gm in females.

Usually, the right kidney is smaller than the left one and positioned a bit lower as compared to the left kidney. Such a difference is seen because most of the portion of right side of the body is occupied by liver.

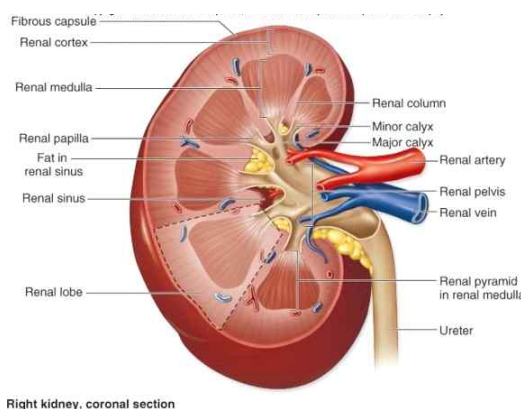
Towards the centre of the inner concave surface of the kidney is a notch called as **hilus renalis** or **hilum**. It is the region through which the blood vessels and nerves pass. Hilum leads to a funnel-shaped space called **renal pelvis**. The projection of renal pelvis are called **calyces**.

## 03. Internal Structure

Mammalian kidney is surrounded by three protective layers from inside to outside. *These are*

### (i) Renal capsule

It is the innermost tough covering of fibrous connective tissues, with few elastic fibres and few muscles.



### (ii) Adipose capsule

It is the middle cover invading adipose tissue, which acts as shock absorber.

### (iii) Renal fascia

It is the outermost fibrous cover linking it with the abdominal wall.

Inside the kidney, there are two zones, an outer cortex and an inner medulla.

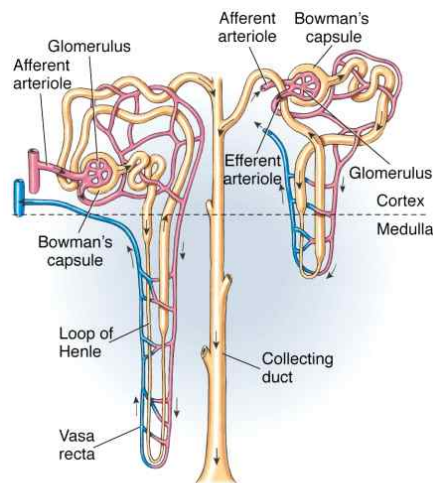
The medulla is further divided into few (8-12 in human) pyramid-shaped masses projecting into the calyces (sing. calyx). These are called as **medullary pyramids**. The extended region of cortex in between the medullary or renal pyramids form renal columns called **columns of Bertini**.

Each medullary pyramid consists of millions of tubular structures called nephron arranged in a radiating fashion. Each medullary (renal) pyramid have a broad base towards the cortex and a narrow end called **renal papilla** towards the pelvis.

Each renal papilla opens into a two to three minor calyx, which joins to form a major calyx. The major calyx open into renal pelvis, which further leads into ureter. The area having apex or papilla with minor calyx is called **area cribrosa**.

## 04. Nephrons

A human kidney contains about one million thin, long, much convoluted tubular units called nephrons or **uriniferous tubules**. These are the structural and functional unit of kidney.



Nephron Structure

*A nephron consists of following parts*

### (i) Malpighian Body (Renal Corpuscle)

It is found in the cortex part of the kidney. It was first observed and described by **Marcello Malpighi** in 1666. It is about 200 microns in diameter. It performs the function of ultrafiltration of blood during urine formation.

*It further consists of following parts*

(a) **Bowman's** : (Glomerular) **capsule** It is a closed cup-shaped double-walled structure containing a network of thin capillaries called **glomerulus**.

It consists of two layers, i.e. parietal (outer) layer and visceral (inner) layer.

The parietal layer consists of single squamous epithelium. The visceral layer, consists of extensively modified cells called **podocytes** or **glomerular epithelial cells**. A podocyte has a number of interdigitated evagination called **pedicels** or **feet**. The pedicels rest over basement membrane. They enclose slit pores or filtration slits.

(b) **Glomerulus** : It is the capillary tuft present inside the Bowman's capsule. These capillaries are formed when afferent arteriole breaks up into about 20-50 fine tubes. All the capillaries reunite and give efferent arteriole, which passes out from the glomerulus. The afferent arteriole is short and wide, while the efferent arteriole is narrow and long. This arrangement facilitates the process of ultrafiltration here.

(ii) **Tubules**

*The tubules consist of the following four main regions*

(a) **Proximal Convoluted Tubule (PCT) or Pars convoluta** : It consists of numerous tubular called invaginations. It is lined by a single layer of brush-bordered cuboidal epithelial cells. These cells help to increase the surface area for reabsorption. Nearly all essential nutrients, 70-80% of electrolytes and water are reabsorbed by this segment.

(b) **Henle's loop or Pars recta** : It is a U-shaped tube which plays a significant role in maintaining high osmolarity of medullary interstitial fluid

*Pars recta is divisible into following three regions*

- **Descending limb** : This limb is lined by flat cells, i.e. simple squamous epithelium. It is permeable to water and impermeable to electrolytes. Due to this the filtrate moving down through the limb becomes concentrated.
- **Ascending limb** : It is made up of two parts. First, is thin ascending limb lined by squamous epithelium and second is thick ascending limb lined by cuboidal epithelium. Ascending limb is impermeable to water, but allows the transport of electrolytes and makes the filtrate dilute.
- **Main loop** : This region is also lined by the flat cells, but their length is highly decreased. It is highly permeable to water and concentrate the filtrate to its maximum. Each limb of Henle's loop in juxtamedullary nephron is surrounded by blood capillaries called **vasa recta**.

(iii) **Distal Convoluted Tubule (DCT)** : It is situated in the cortex region of kidney. It is about 4.5-5.5 mm long. It is lined by cuboidal epithelium. The diameter of the DCT lumen is more as compared to the diameter of PCT. Conditional reabsorption of  $\text{Na}^+$ , water and  $\text{HCO}_3^-$  takes place in this segment.

(iv) **Collecting Duct** : The DCT continues to form a short, straight collecting tubule or duct. It is about 20 mm long and lined by cuboidal epithelial cells. The collecting ducts of different nephrons joins to form **duct of Bellini**, which further open into renal papilla.