



**GUS..**

**Lecture (1)**

# **Anatomy & Histology of kidney**

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# ILOs

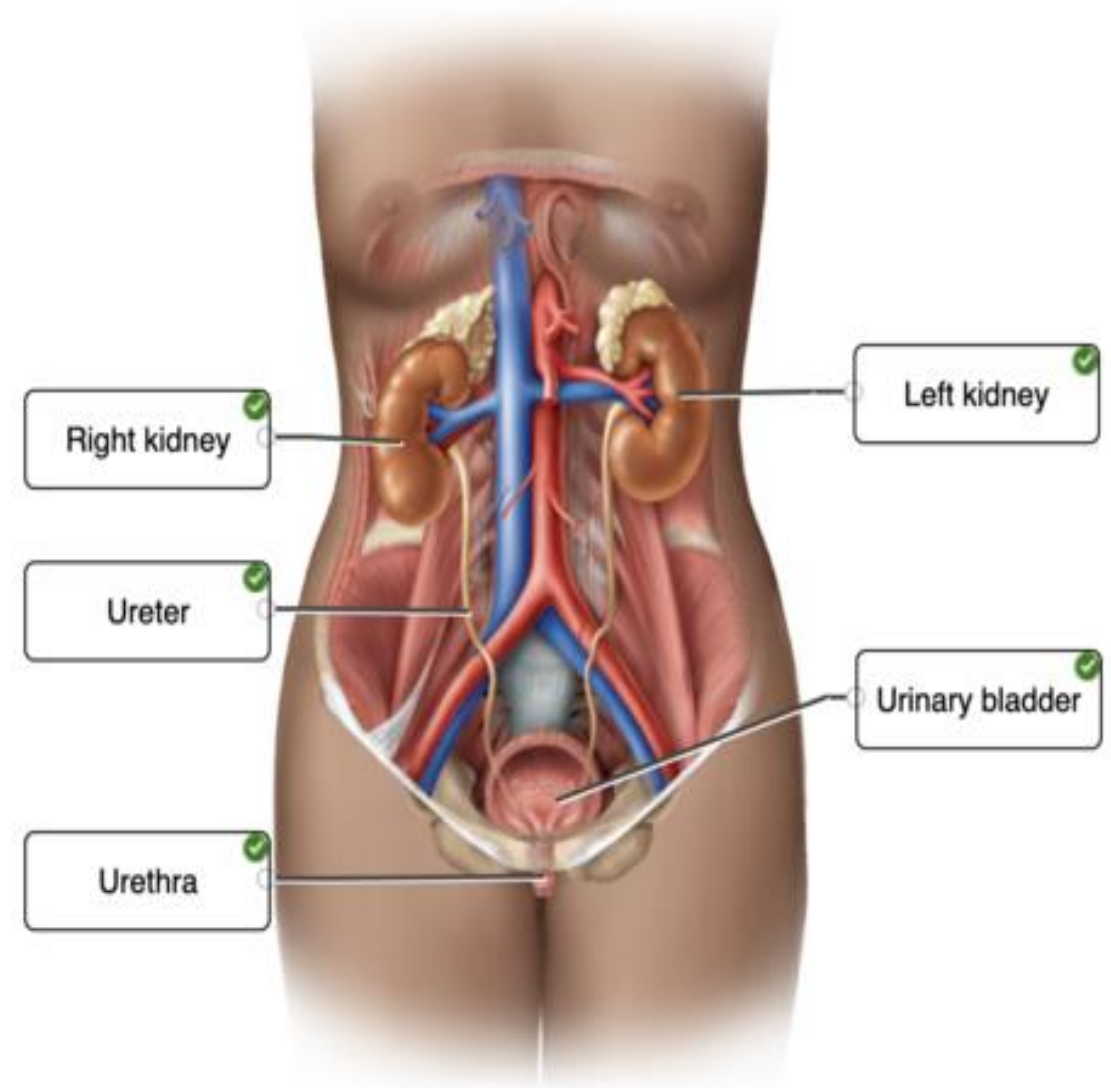
- 1. Describe the shape, function, location, fascial sheaths, gross feature, and relations of kidneys.**
- 2. Understand the gross structure of a sagittal section of kidney.**
- 3. Discuss the blood & nerve supply, and lymphatic drainage of kidneys.**
- 4. Describe the microscopic appearance of kidney.**

# Kidney

- The two kidneys are responsible for excretion of waste products and control the water and electrolyte balance.

## Site:

- They are retroperitoneal organs.
- **Lie on** the upper part of posterior abdominal wall from level of 12<sup>th</sup> thoracic vertebra to 3<sup>rd</sup> lumbar vertebra.
- The right kidney is ½ **inch** lower than the left kidney.
- **The long axis of each kidney** is directed downward and laterally so the upper poles of both kidney lie closer to median plane than the lower poles.

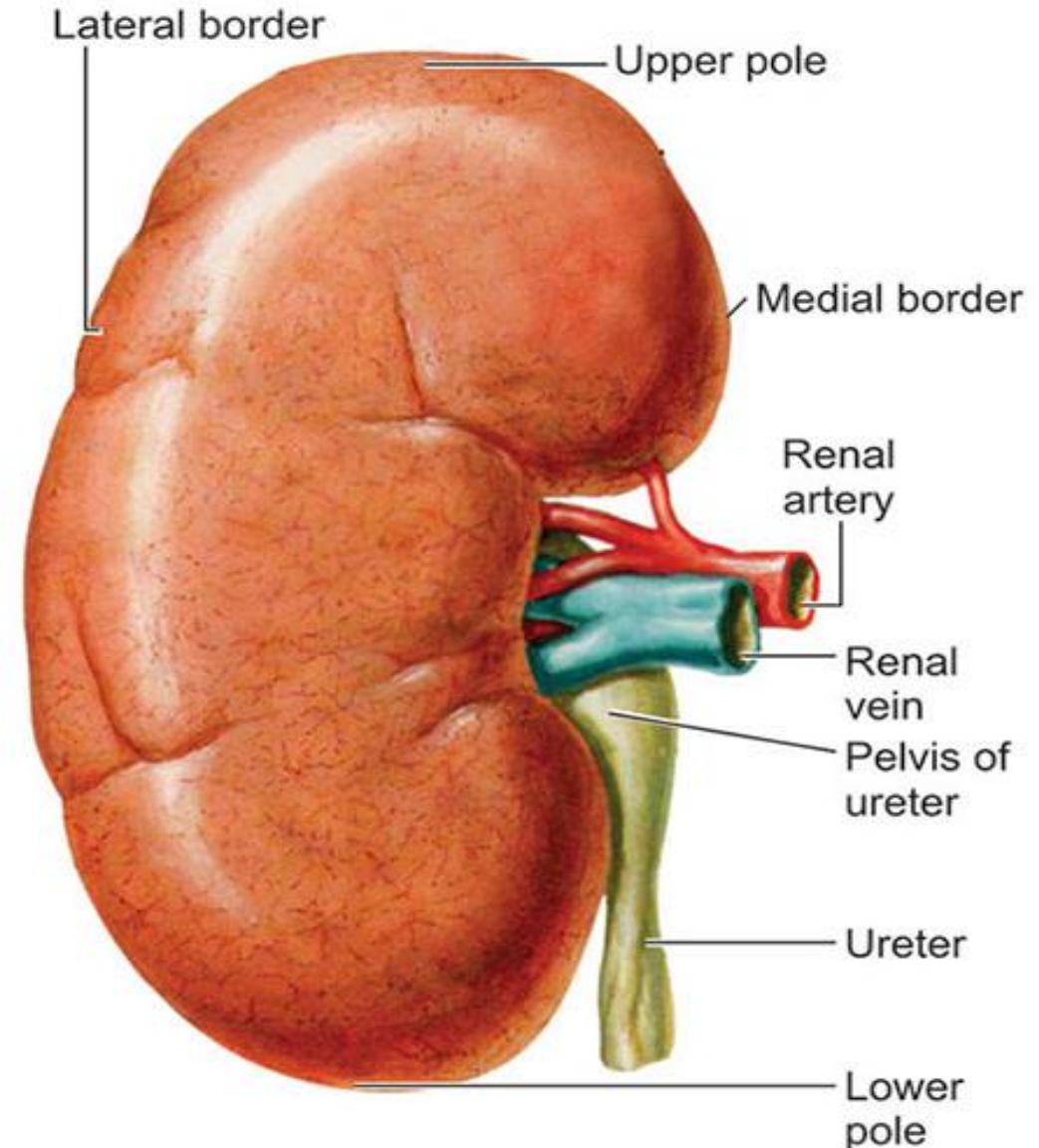


# Shape and Size of kidney

- It is a bean **shaped** organ.
- **Size:** about 3cm thick, 6cm wide& 12cm long.

## Description:

- It has **2 ends:** Upper& Lower poles.
- It has **2 borders:**
  - Lateral border is convex.
  - Medial border is convex adjacent to the poles& concave between them.
- It has **2 surfaces:** Anterior & Posterior surfaces.

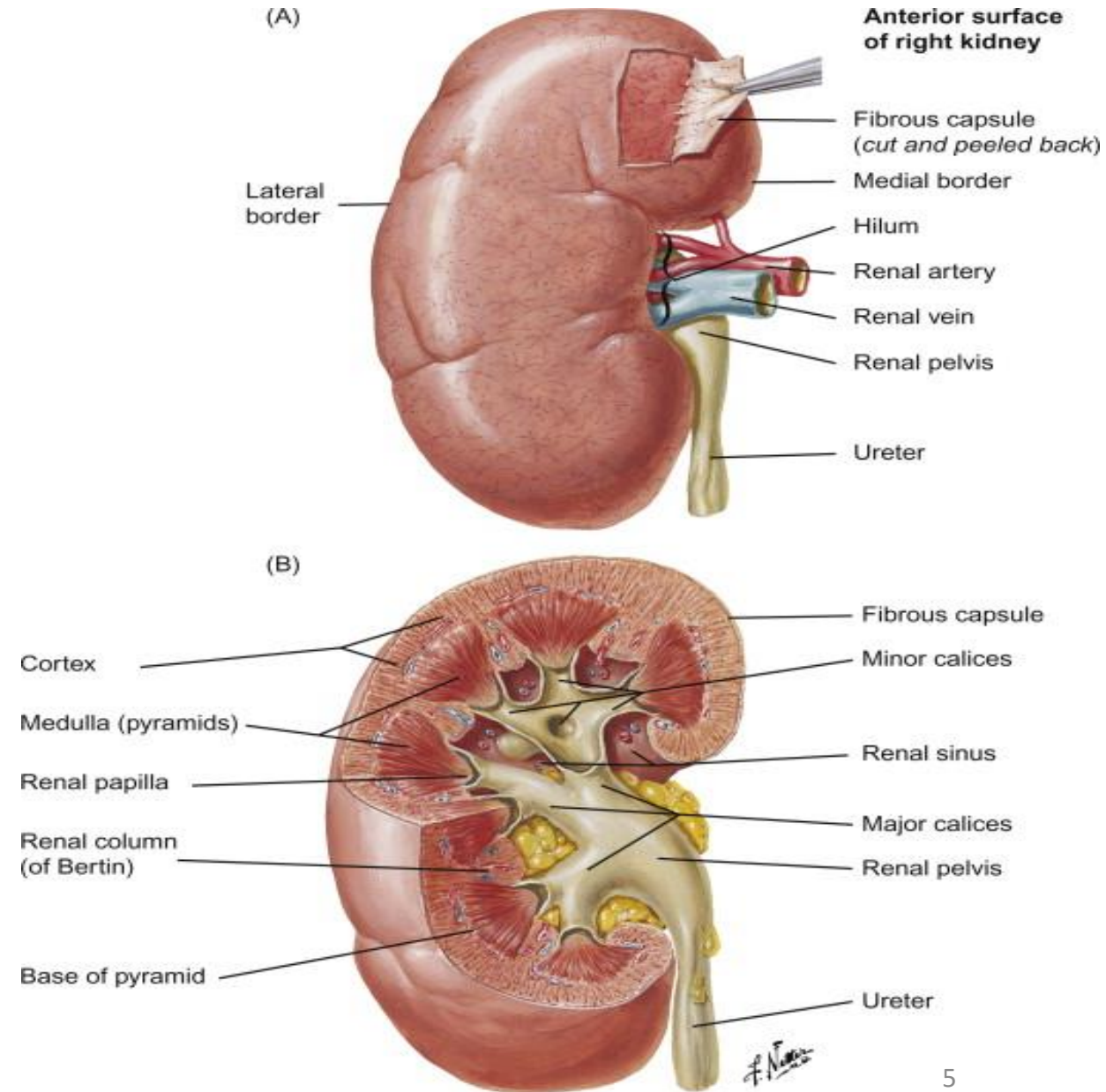


# Hilum of kidney

- The hilum is a **vertical slit** at the medial border of the kidney.
- **It transmits:** Renal vein, Renal artery, Ureter, Lymphatic vessels and autonomic nerve fibers.
- Hilum leads to a space inside the kidney called **Renal sinus**.

## Renal sinus contains:

- 1- Renal pelvis & its calyces.
- 2- Segmental branches of the renal artery and accompanying veins.

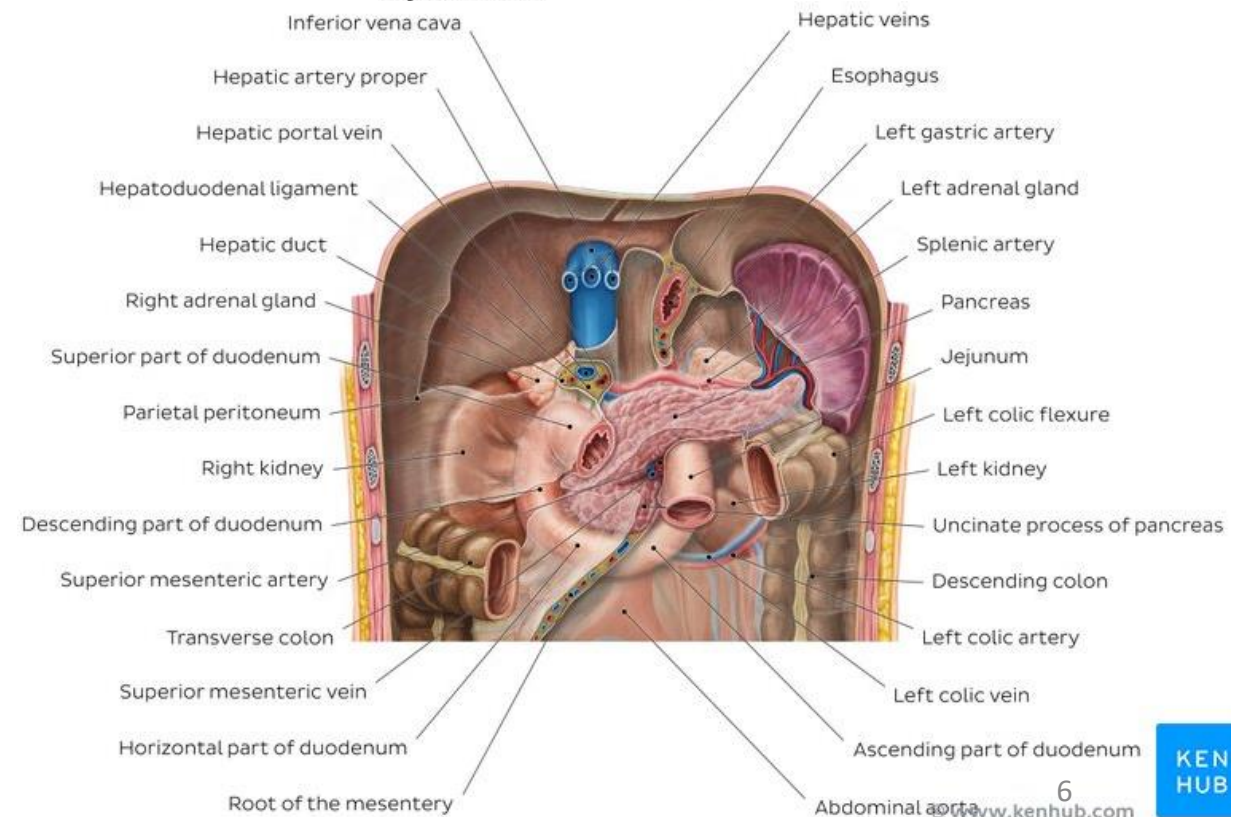
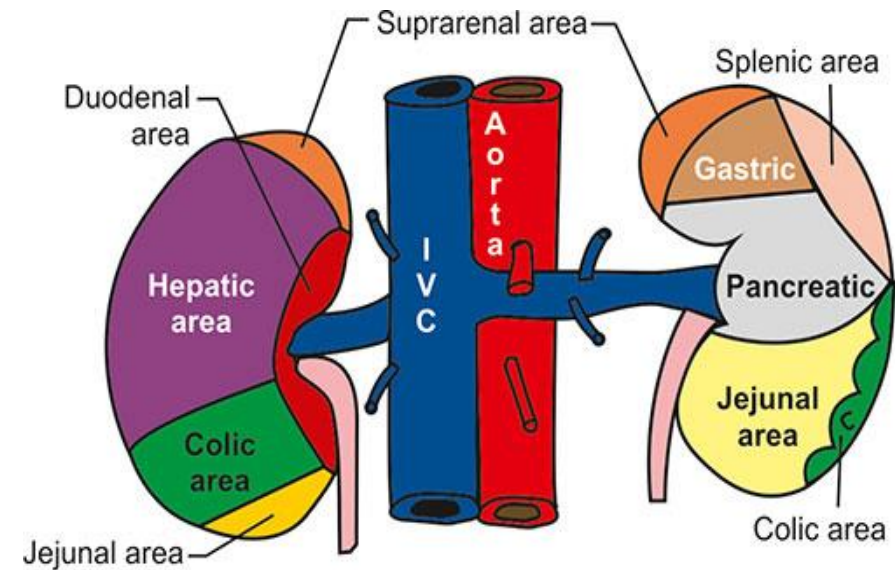


# Relations of Anterior Surface of Kidney (Anterolateral)

- It is irregular and related to abdominal organs.
- Anterior relations of the two kidneys are different.**

## Right kidney is related to:

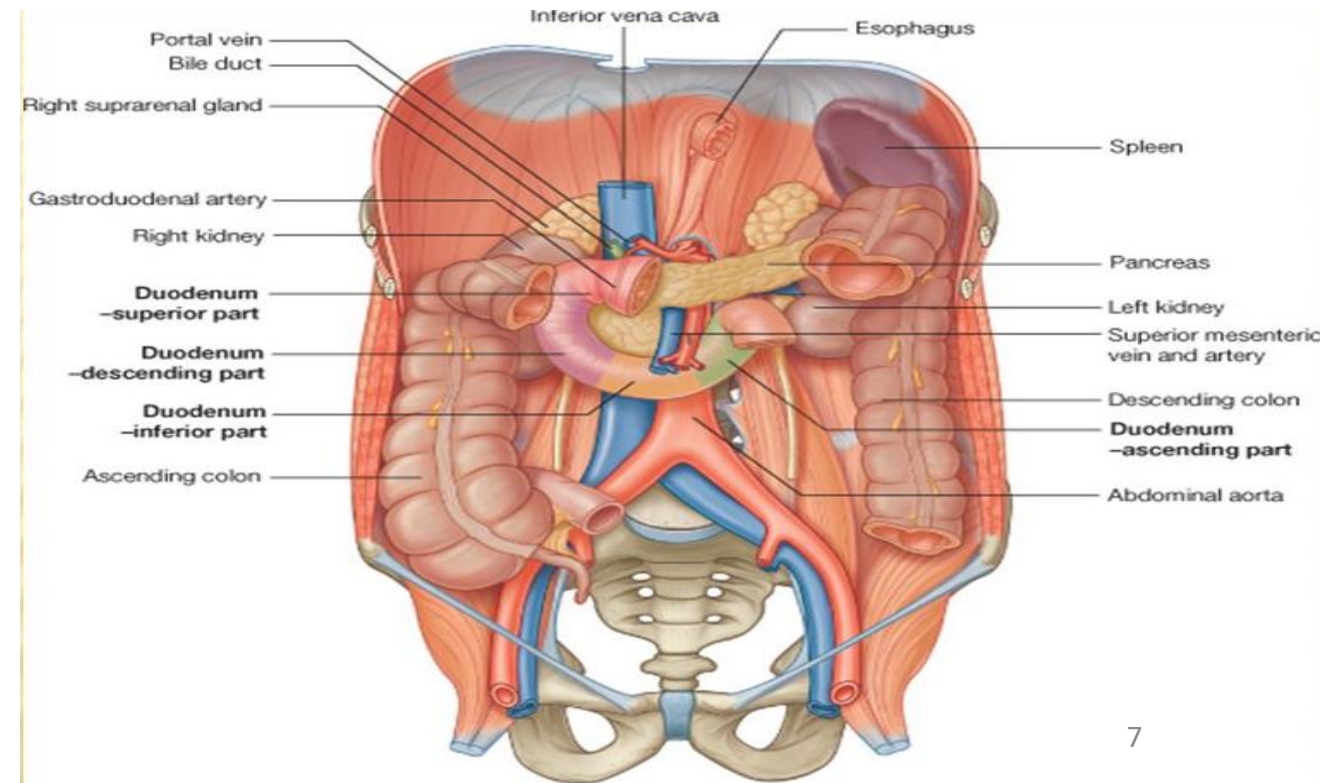
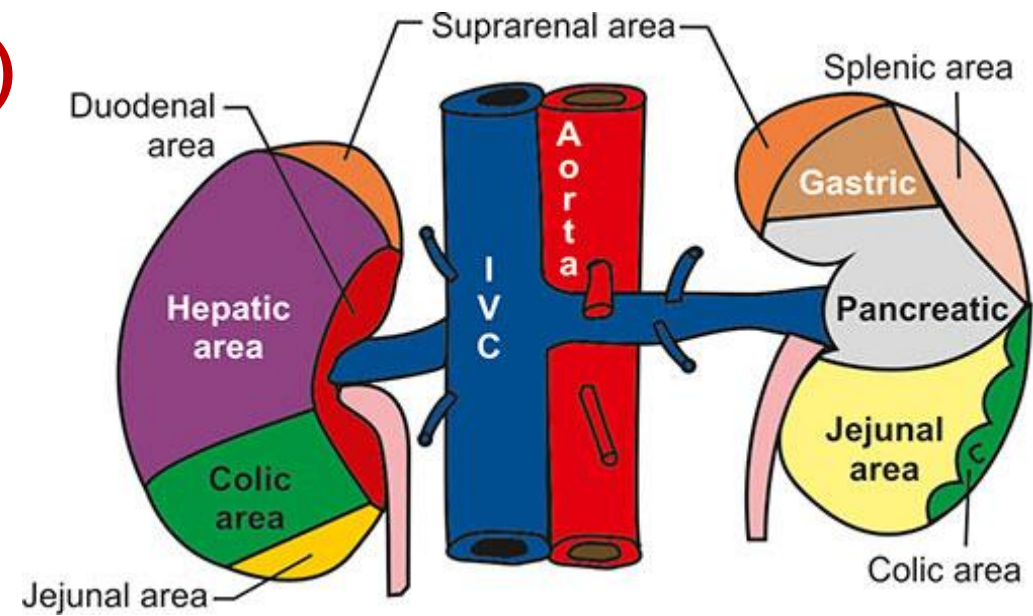
- Right suprarenal gland:** covers the anterior aspect of upper pole.
- Second part of duodenum** covers the part close to the hilum.
- Right lobe of liver** covers the upper part.
- Right colic flexure** covers the lower lateral part.
- Coils of jejunum** covers the lower medial part.



# Relations of Anterior Surface (anterolateral)

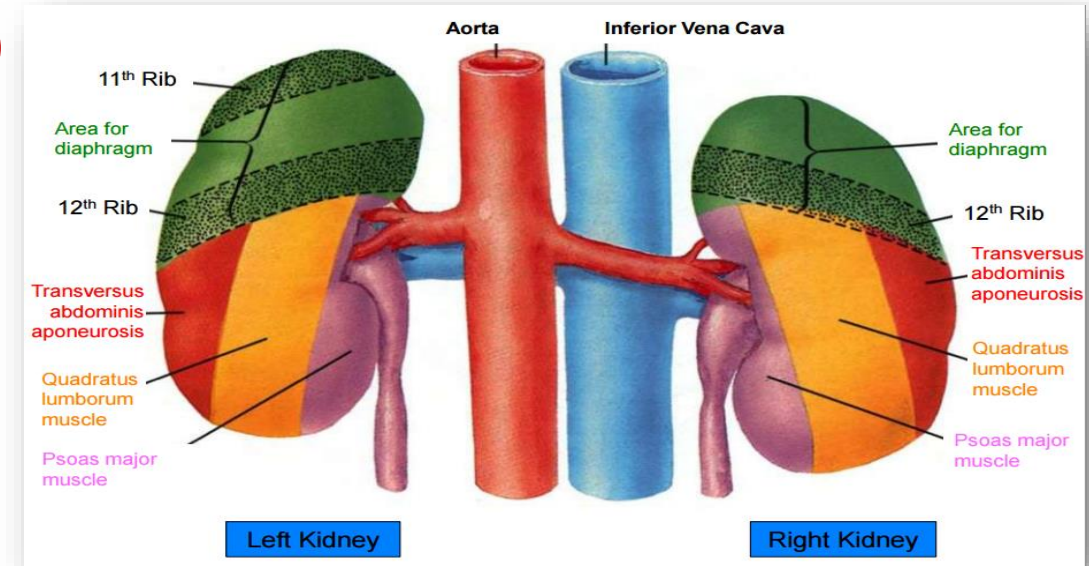
## □ Left kidney is related to:

- **Left suprarenal gland:** covers the anterior aspect of upper pole.
- **Stomach** covers area in its upper part.
- **Spleen** covers its upper lateral part.
- **Body of pancreas & splenic vessels** cover its middle part.
- **Left colic flexure & Descending colon** covers its lower lateral part.
- **Coils of jejunum** covers its lower medial part.



# Relations of Posterior Surface (Posteromedial)

- Posterior surface is flat and **related** to the posterior abdominal wall.
- The posterior relations of 2 kidneys are **similar** and include: **4 muscles and 4 neurovascular structures**.

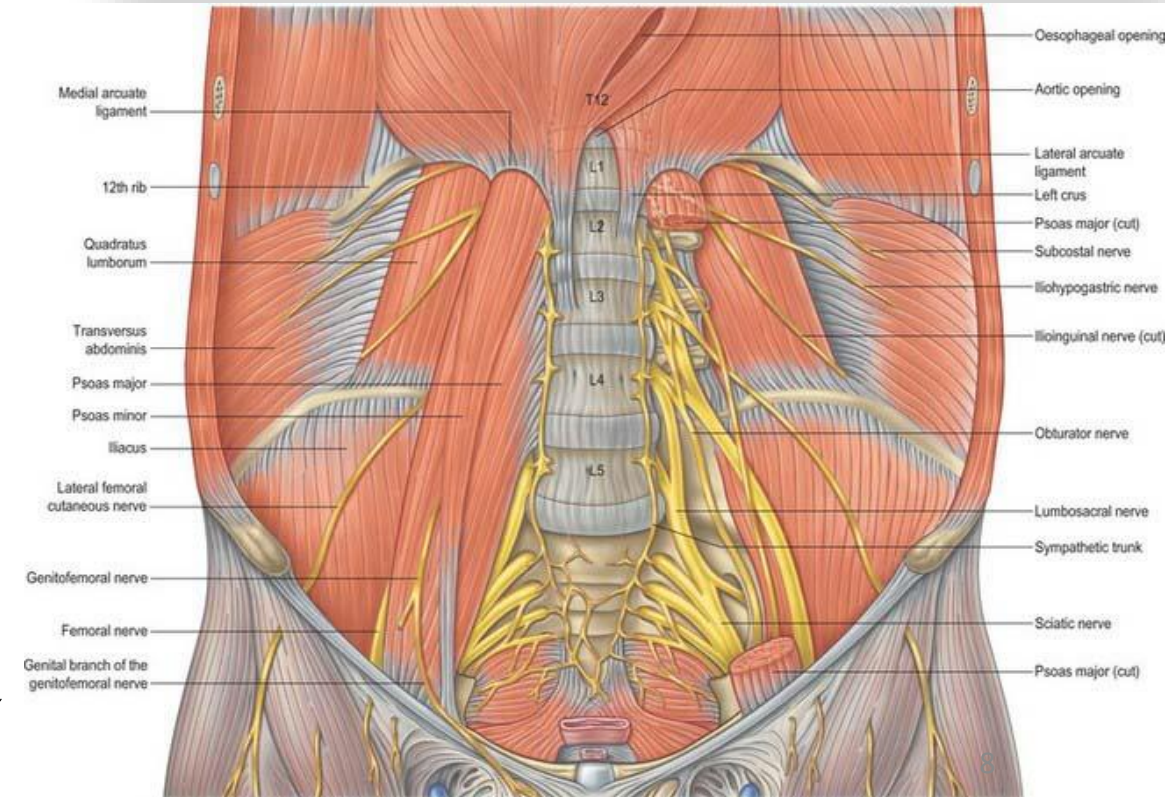


## The muscles:

- Diaphragm.** Related to the upper part.
  - Psoas major.**
  - Quadrates lumborum.**
  - Transversus abdominis.**
- Related to lower part

## Neurovascular structures:

- Leis between the kidney and muscles.
- Include;** Subcostal nerve & vessels, Iliohypogastric & Ilioinguinal nerves.





# Fascial Sheaths of Kidney

- The kidney is encased in four layers of fascia and fat;

- They are arranged as follows (deep to superficial):

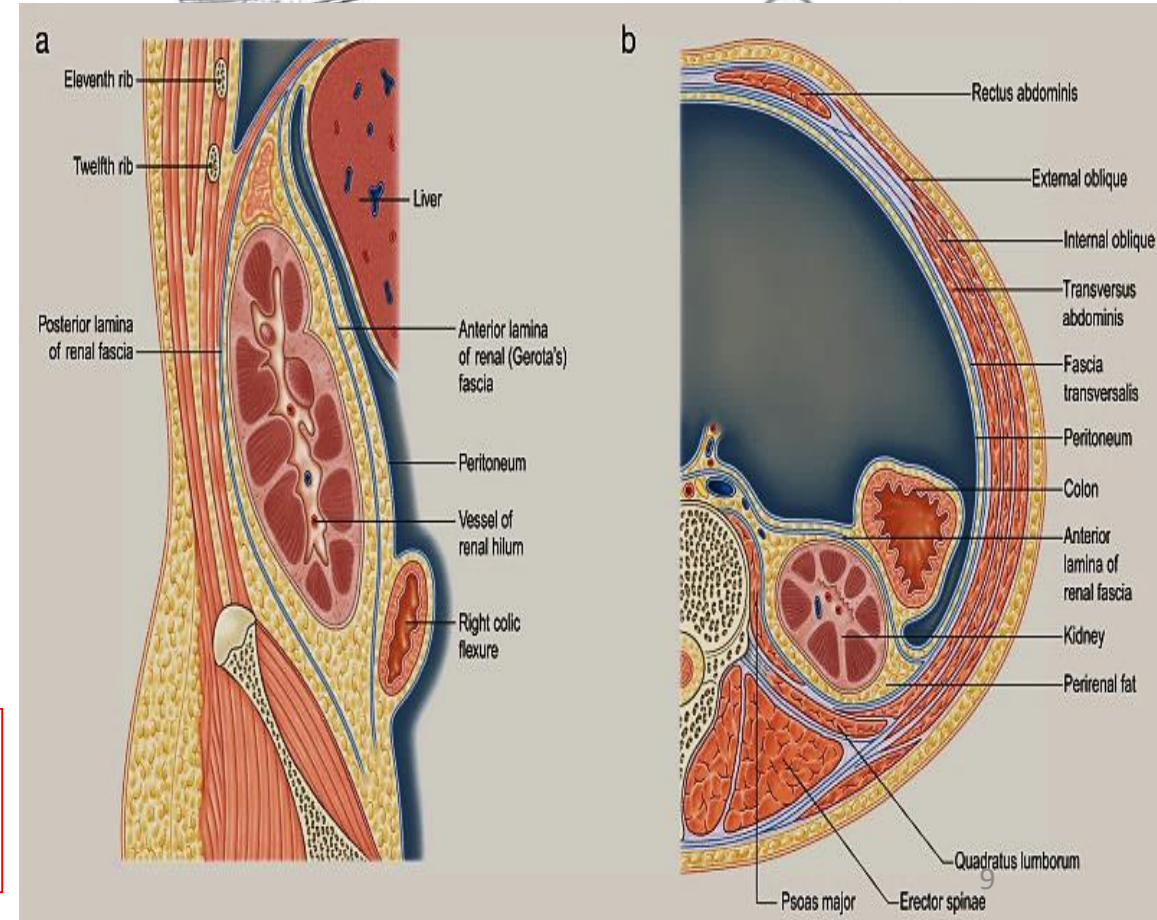
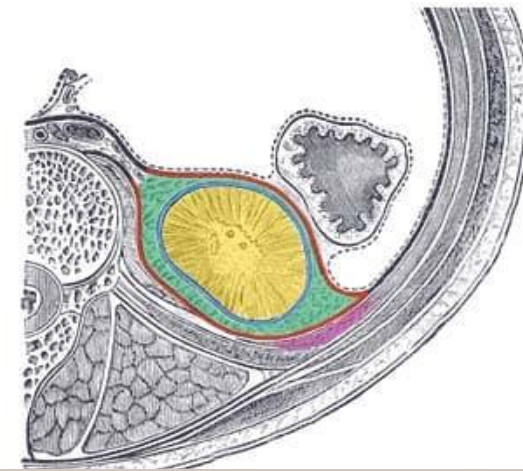
✓ **Renal capsule:** Closely applied to its outer surface.

✓ **Perirenal fat.**

✓ **Renal fascia: (Gerota's fascia):** Consists of anterior & posterior layers. It encloses the kidneys and the suprarenal gland, but the suprarenal gland has separate fascial compartment.

✓ **Pararenal fat.** Mainly posterolateral.

Perinephric abscess spread only downward where the two layers of renal fascia are separate.



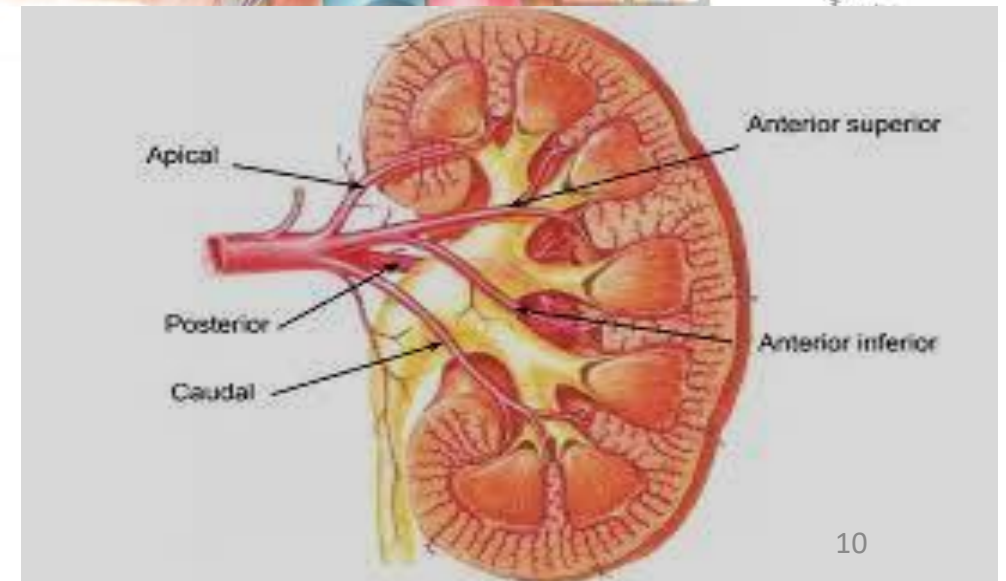
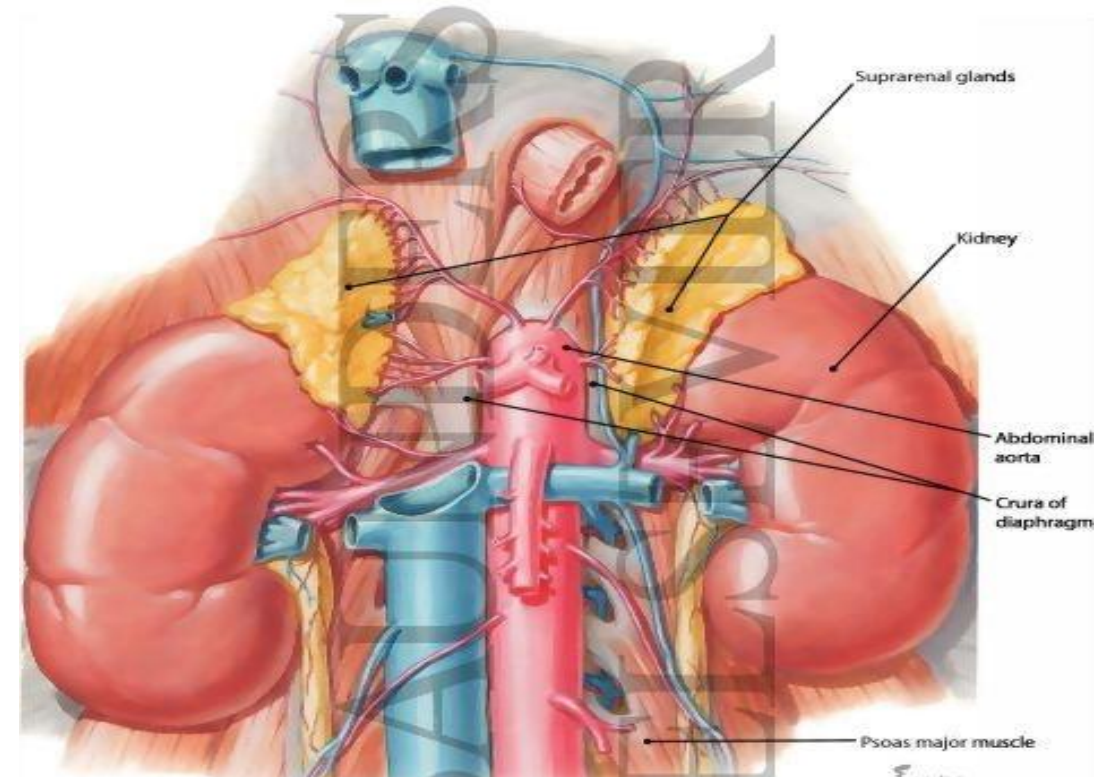
# Arterial Supply of Kidney

## □ Renal artery:

- **Right & Left renal arteries arise from the side of the aorta**
- **The renal artery gives:**
  - **Five segmental branches for kidney.**
  - **Inferior suprarenal artery to the suprarenal gland.**
  - **Branches to the pelvis of the ureter and upper part of ureter.**

## □ Accessory renal artery:

- **It is present in 30% of cases.**
- **It arises from aorta above or below the renal artery.**
- **It enters the kidney either at the hilum or at one of the two poles of the kidney.**



## Venous drainage:

### **Right & left renal veins:**

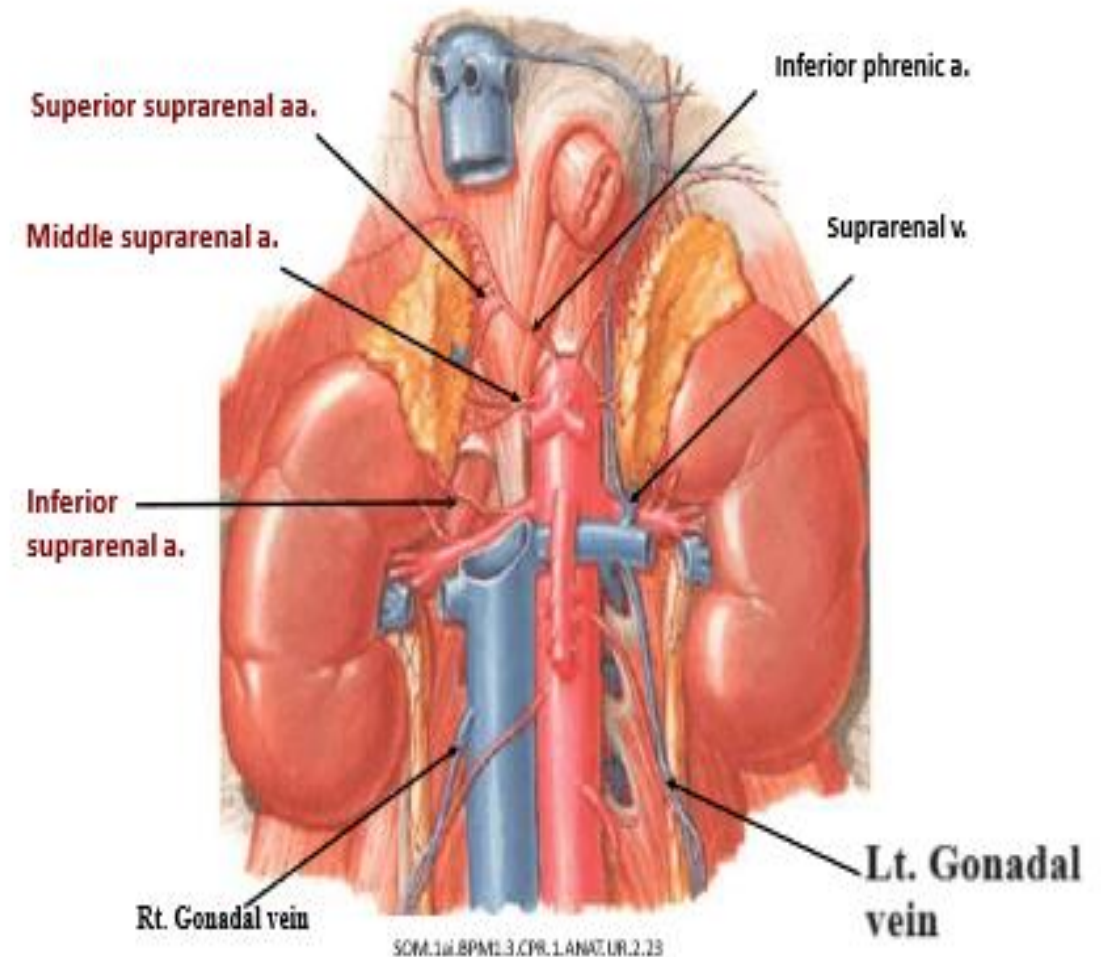
- They **emerge from** the hilum of the corresponding kidney in front of renal artery.
- They end in I.V.C.

### Lymphatic drainage:

- Para-aortic lymph nodes.

### Nerve supply:

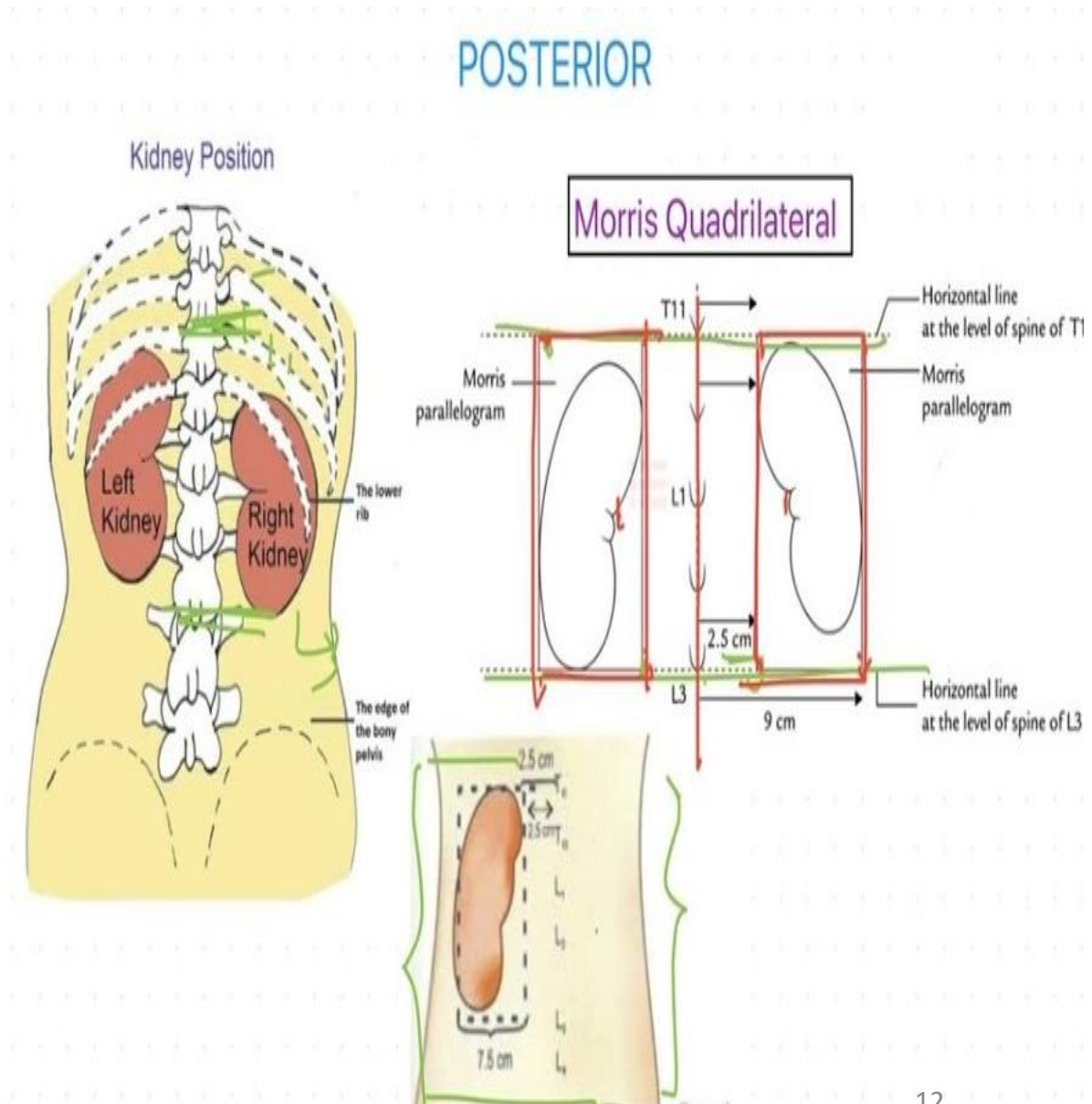
- Sympathetic fibers from T10 – L1 spinal segments.



# Surface Anatomy of the Kidney

## Surface anatomy of the kidney from behind;

- ❑ Kidney lies inside a rectangle called **Morris parallelogram** which is drawn as follows;
- **Two horizontal lines** opposite the 11<sup>th</sup> thoracic spine and 3<sup>rd</sup> lumbar spine.
- **Two vertical lines** opposite 1 inch and 3 inches from the median plane.

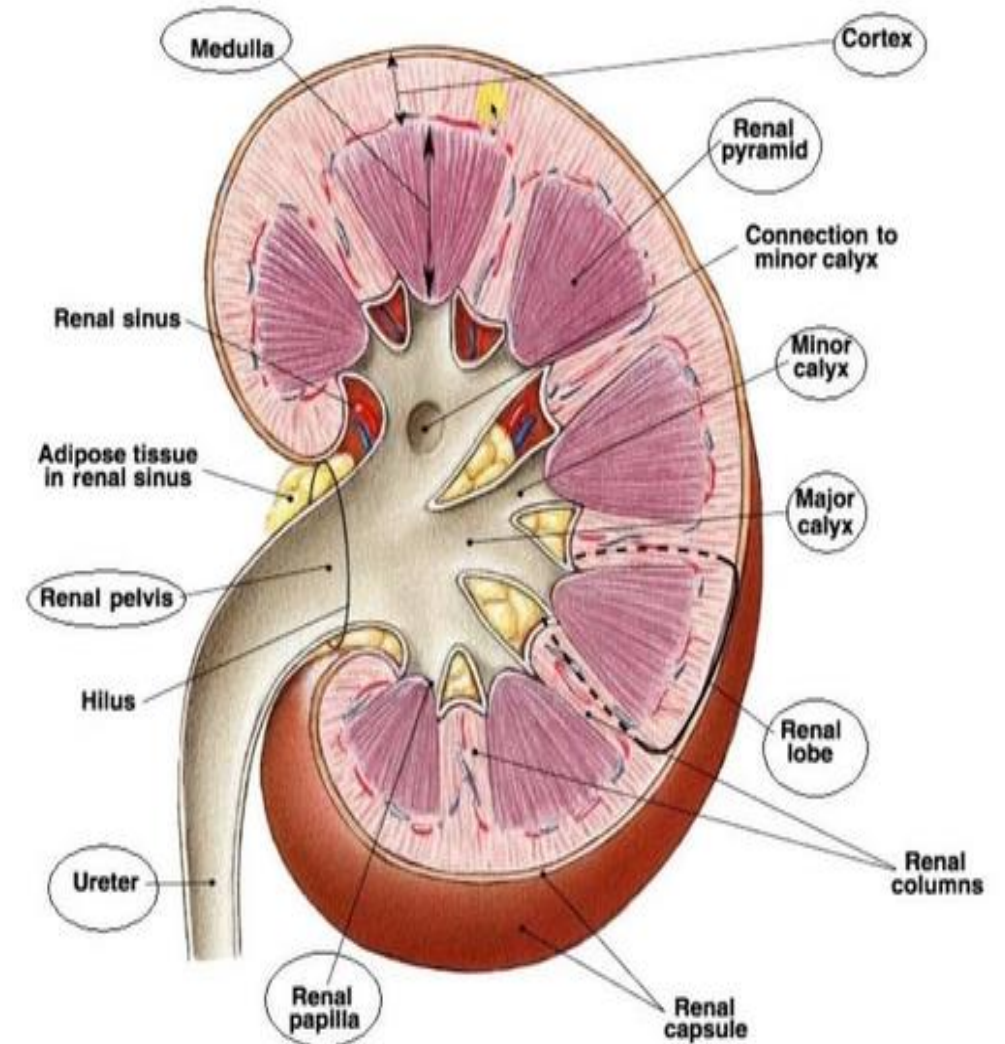


# Internal Macrostructure of Kidney

Longitudinal section of kidney show that the kidney consists of an outer cortex & an inner medulla.

## □ Renal Cortex:

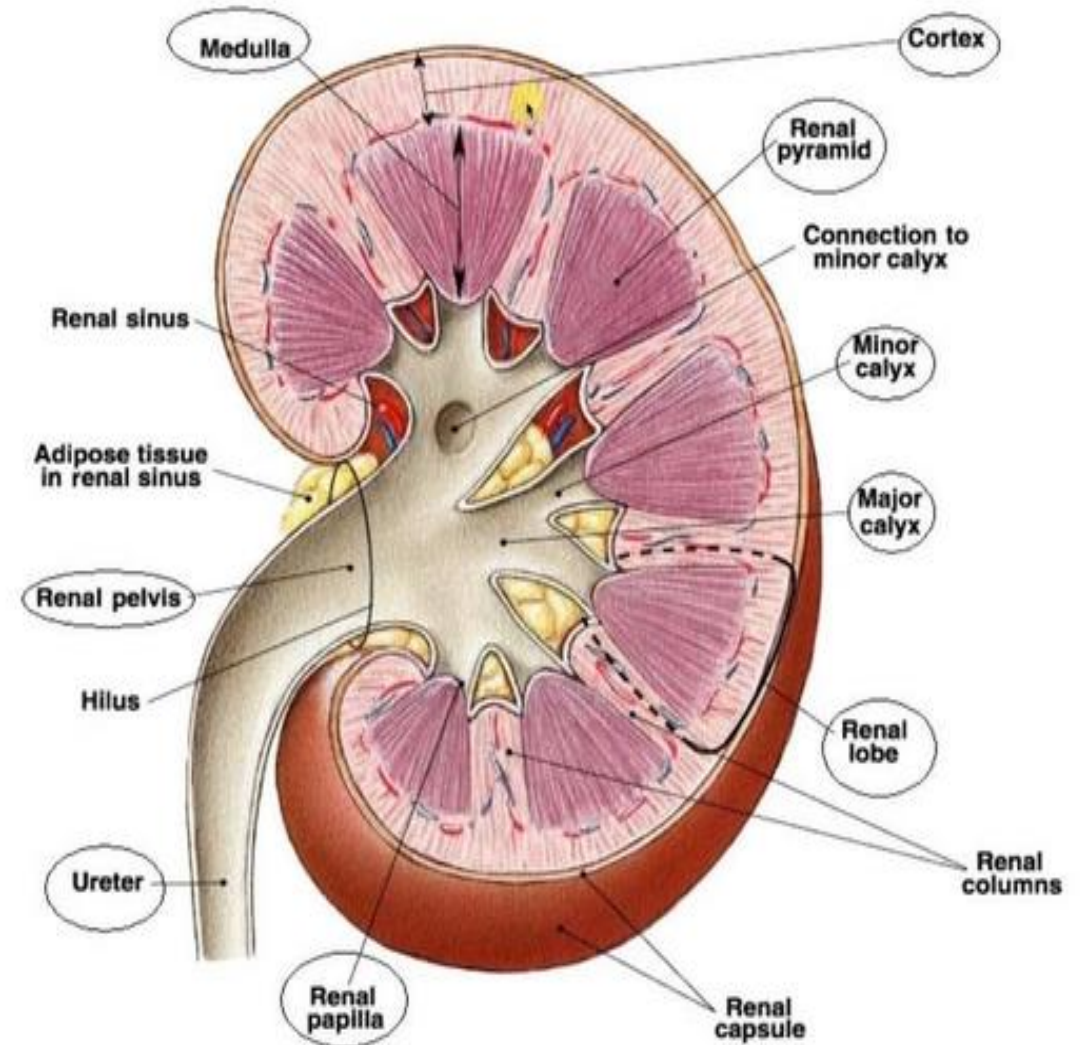
- It is dark, granular reddish region, lies beneath fibrous capsule.
- Cortical tissues extend between pyramids in the form of columns called renal columns (**Cortical columns of Bertin**).
- **It is traversed** by radial, lighter-coloured medullary rays.
- The part of cortex close to the medulla is termed **juxtamedullary cortex**.



# Internal Macrostructure of Kidney

## □ Renal Medulla:

- It is pale striated region.
- It **consists of** conical renal pyramids (10-18 medullary pyramids).
- The bases of renal pyramids are peripheral.
- The apices of renal pyramids converging toward the renal sinus and project into minor calyces as **renal papillae**.
- Each minor calyx receives from 1-3 papillae.



# Histological Structure of Kidney

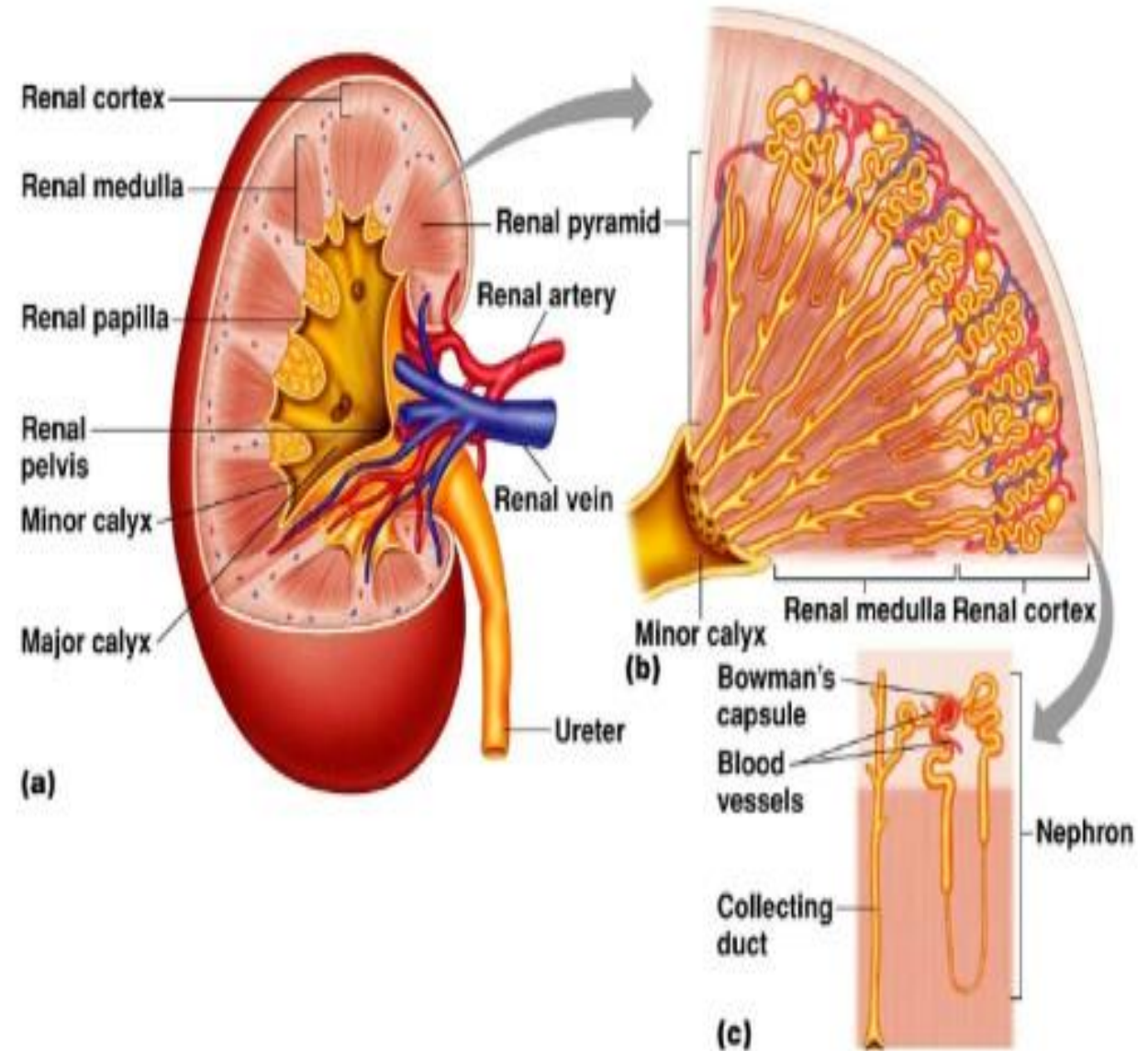
## 1-Stroma:

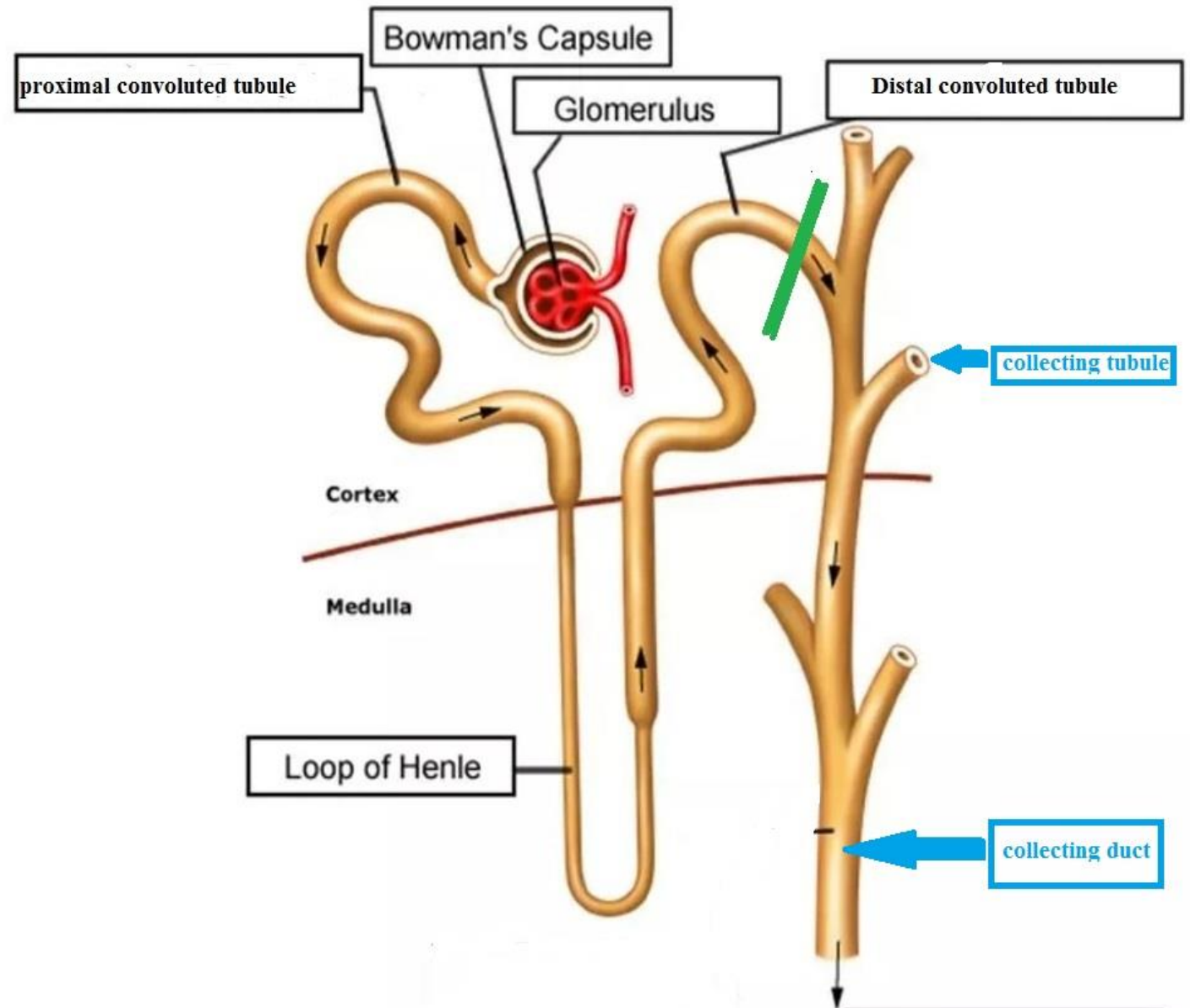
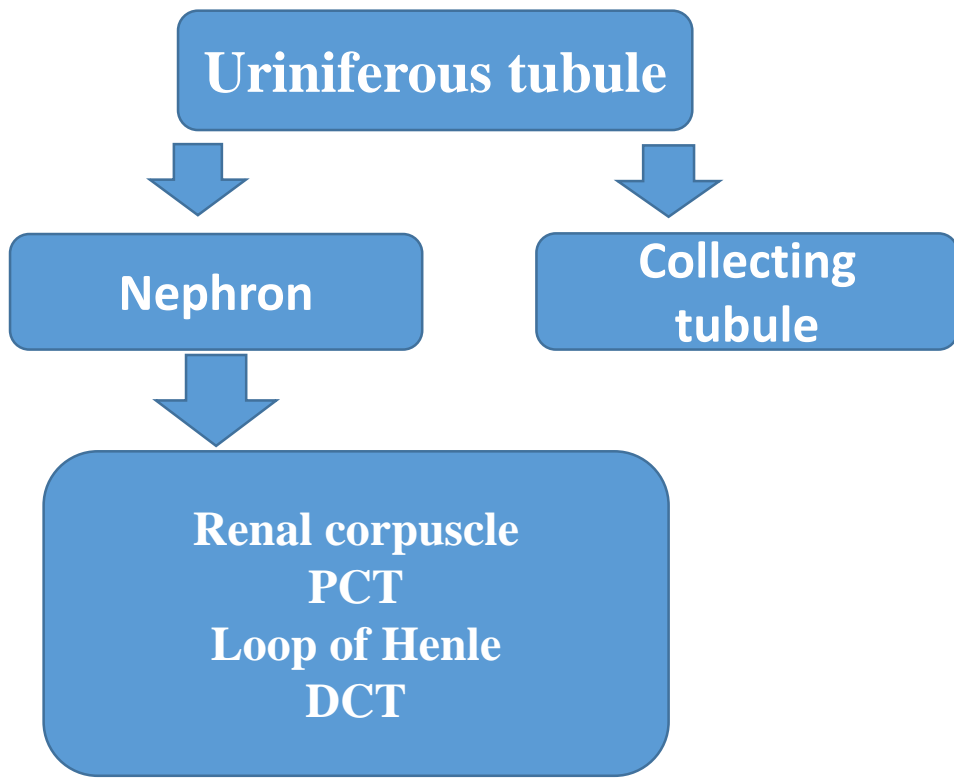
- **Fibrous capsule.**
- **Interstitium** of the cortex and medulla.

## 2-Parenchyma:

It is formed of the **uriniferous tubules**. Each is formed of:

- A. The nephron.
- B. The collecting tubule.





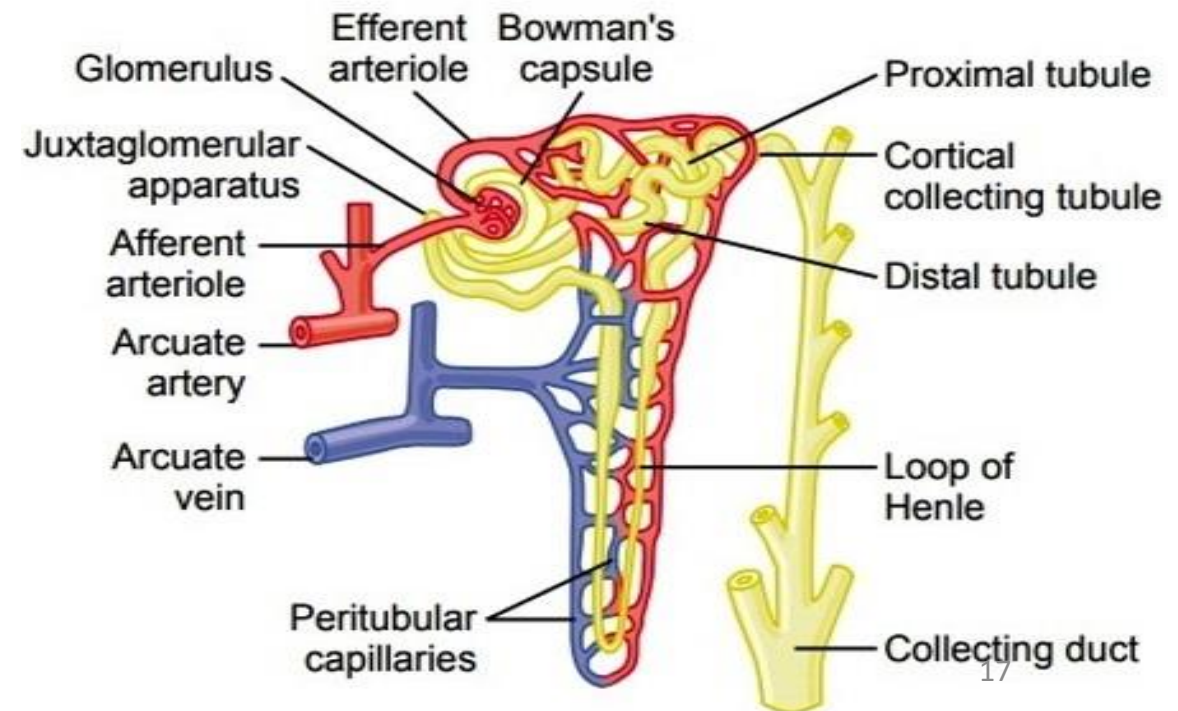
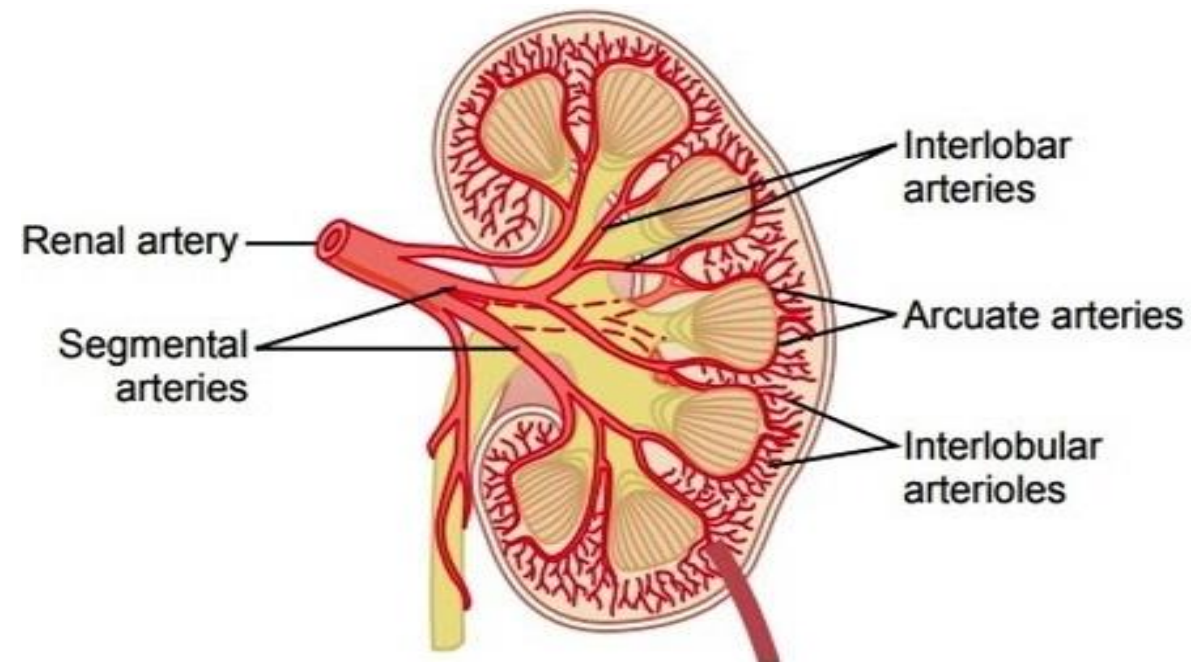
□ Each nephron consists of;

- 1- Renal (Malpighian) corpuscle.
- 2- Proximal convoluted tubules.
- 3- Loop of Henle.
- 4- Distal convoluted tubules.



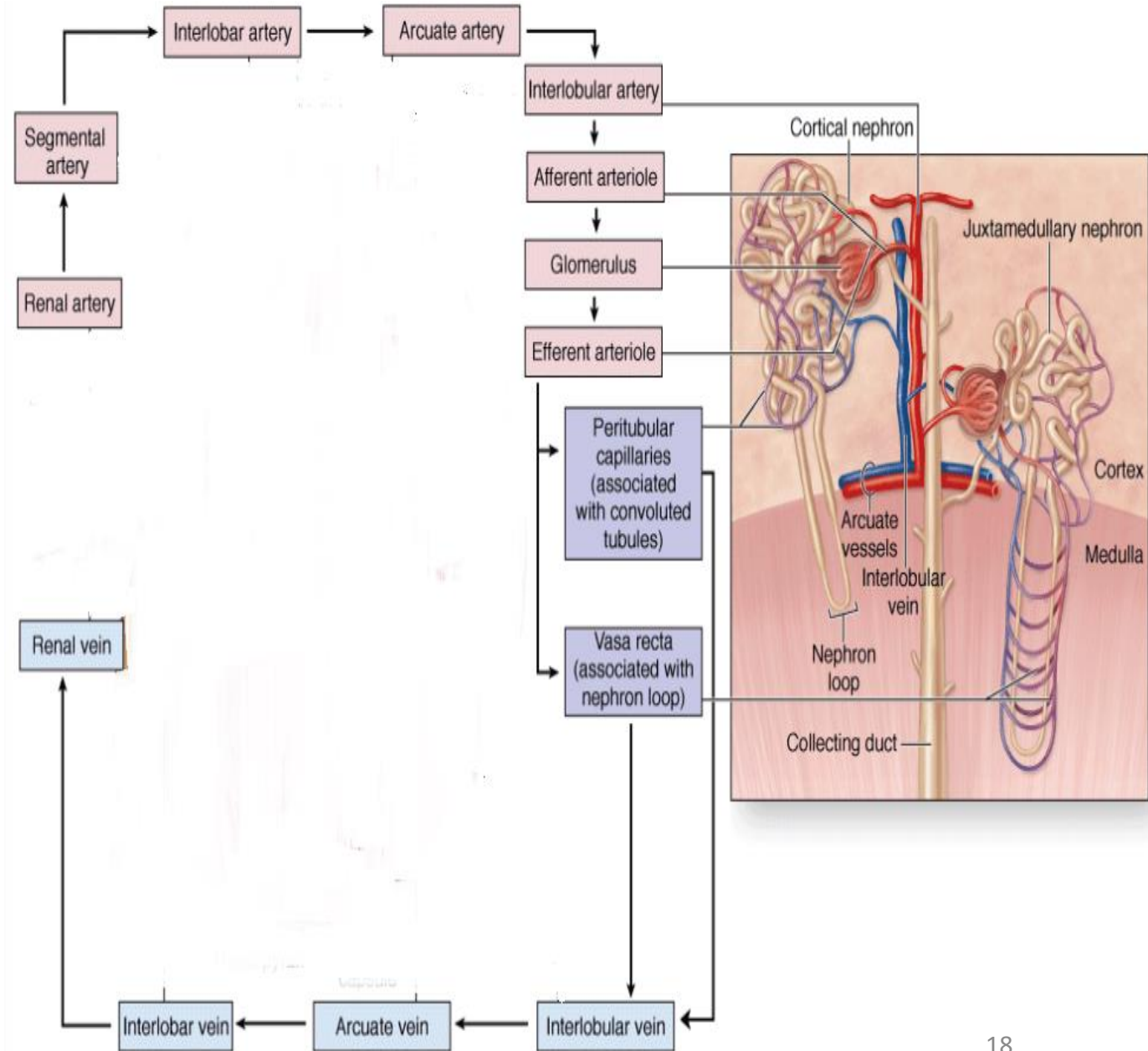
# Distribution of Renal Vessels

- The **segmental branches** of the renal artery undergo further divisions.
- Each segmental artery give rise to **Interlobar arteries**.
- **Interlobar artery** runs toward the cortex, in interval between two adjacent pyramids.
- At the junction of the cortex and the medulla, the interlobar arteries arch over the bases of the pyramids, give off the **arcuate arteries**.
- The arcuate arteries give off several **interlobular arteries** that ascend in the cortex.



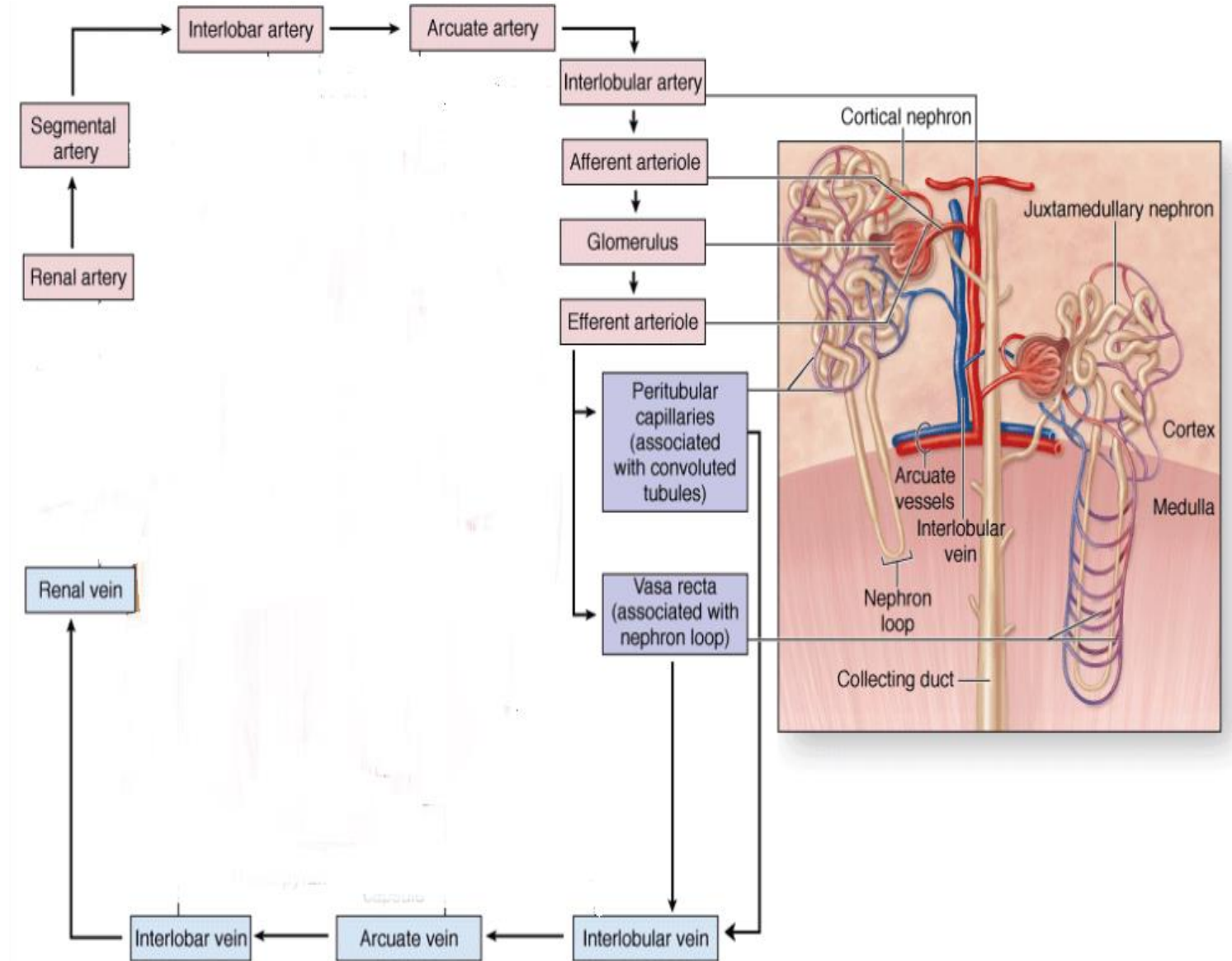
# Distribution of Renal Vessels

- **The afferent arterioles** arise as branches of the interlobular arteries.
- **The afferent arterioles** form a capillary network, (**Glomerulus**), where filtration takes place.
- The capillaries of glomerulus come together to form **the efferent arterioles**.
- Efferent arterioles form **peritubular network capillaries** that surround the cortical parts of the nephron.
- **Vasa recta** are straight capillary loops, lie in renal medulla close to Henle's loop.



# Distribution of Renal Vessels

- Peritubular network drain into the **interlobular veins**.
- Interlobular veins join together to form **interlobar veins** which end in renal vein.
- Vein of the medulla join interlobular veins.

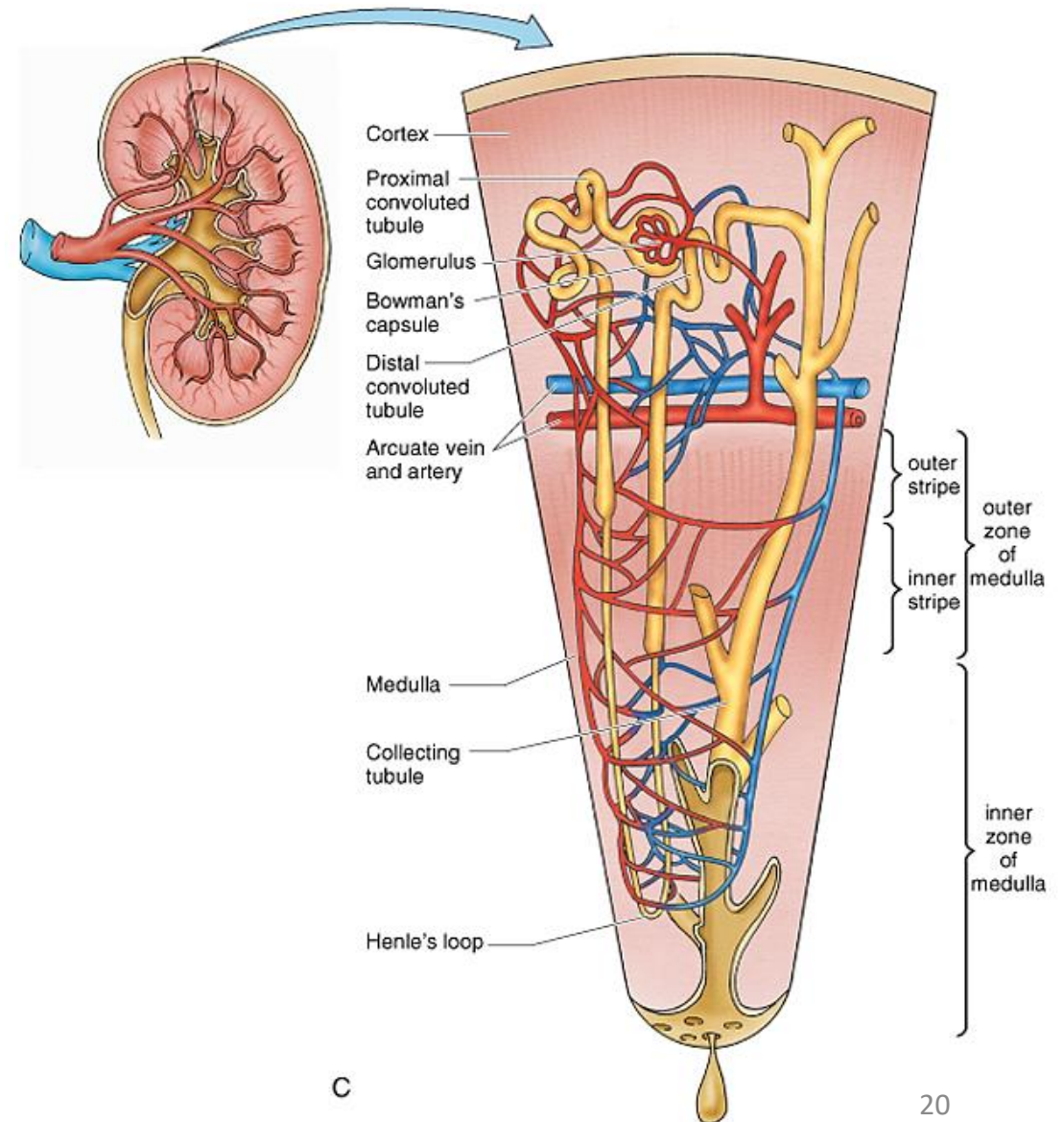


# Uriferous tubule

□ It is the functional unit of the kidney. It is a highly convoluted structure, its final output is the urine.

□ **Uriferous tubule consists of two parts;**

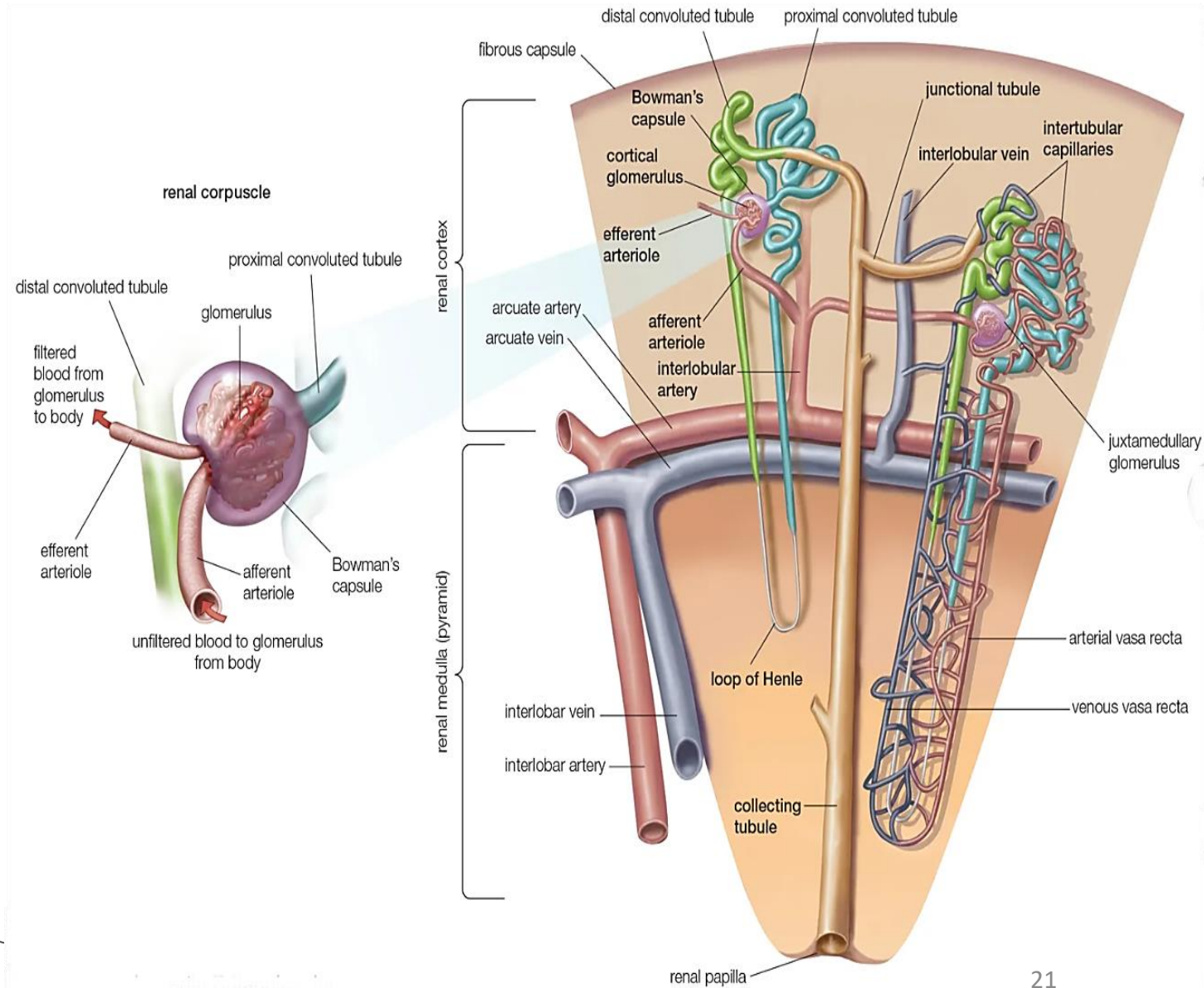
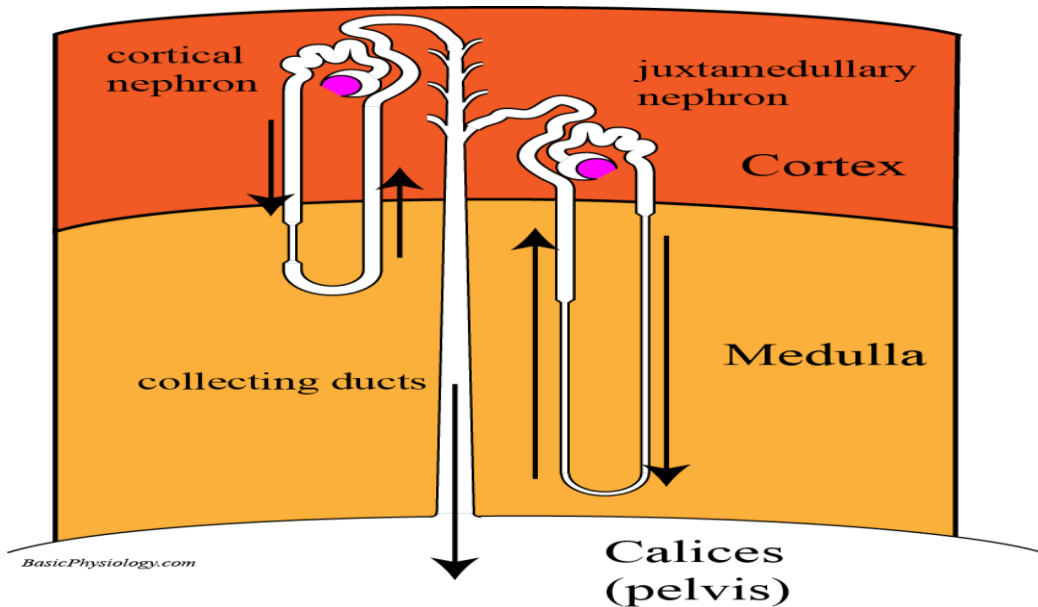
- **Nephron.**
  - **Collecting tubule.**
  - There are approximately 1.3 million nephrons in each kidney.
- Several nephrons are drained by a single collecting tubule, and multiple collecting tubules join in the deeper aspect of the medulla to form larger and larger ducts.



# Nephron

## Types of nephron:

- a) **Short nephrons (Cortical nephron):** Their renal corpuscles in outer cortex & have short loops of Henle.
- b) **Long nephrons (Juxta-medullary nephron):** Their renal corpuscles in deep cortex & have long loops of Henle.



# Renal Corpuscle

- It is rounded structure lying in the renal cortex.
- **Each corpuscle has two poles:**

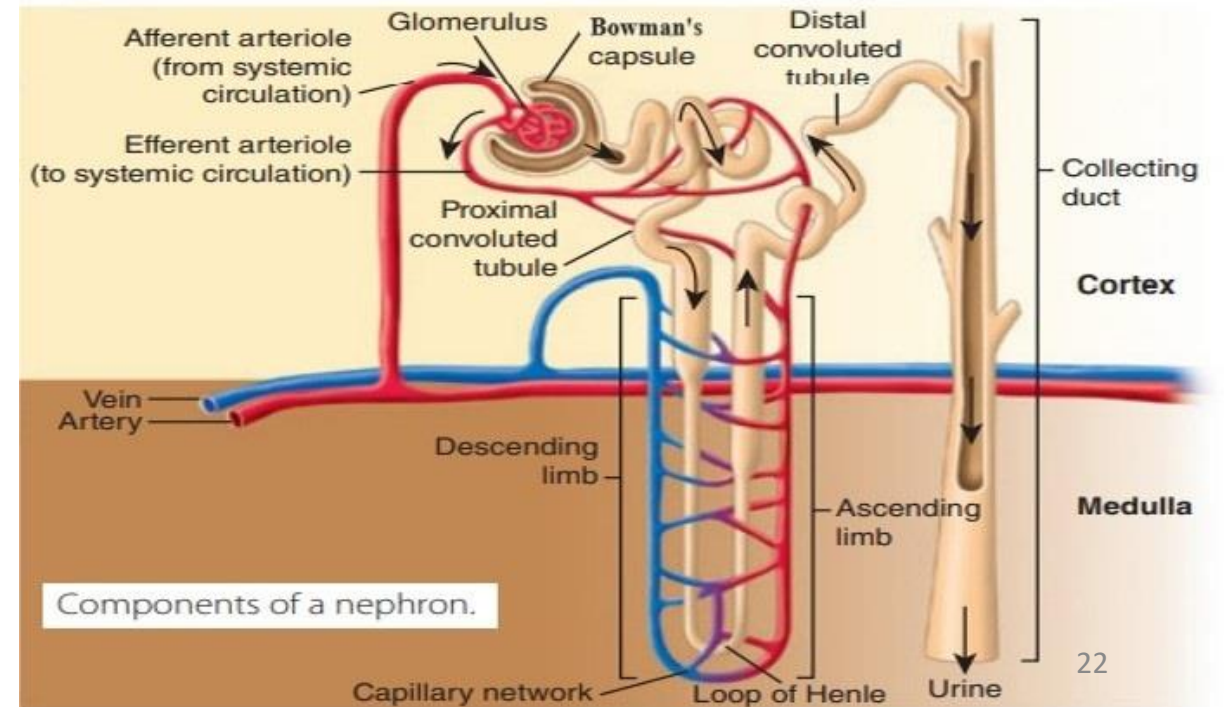
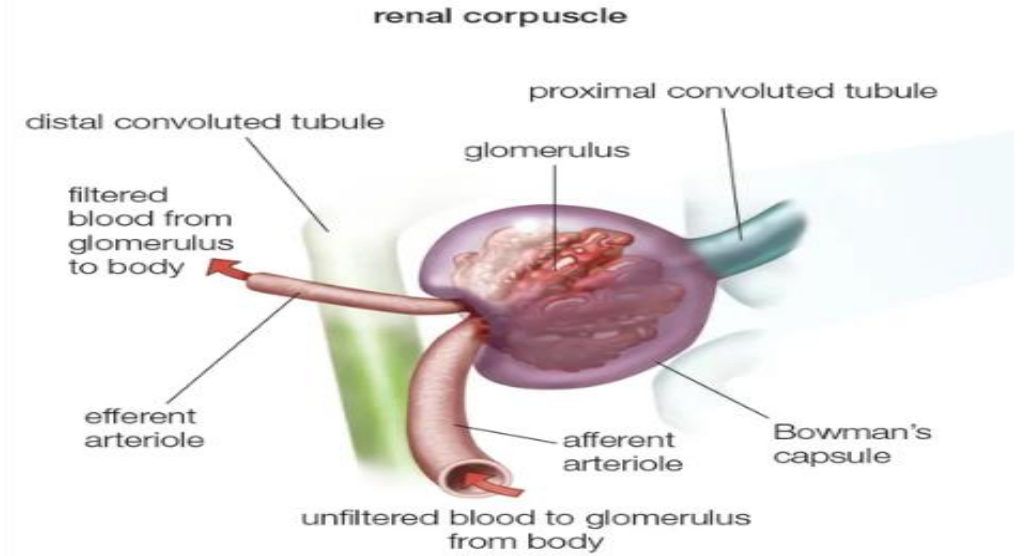
**a. Vascular pole;** where afferent arteriole enters and efferent arteriole leaves the renal corpuscle.

**b. Urinary pole;** where the proximal convoluted tubule begins.

- Each corpuscle consists of:

**A. Bowman's capsule.**

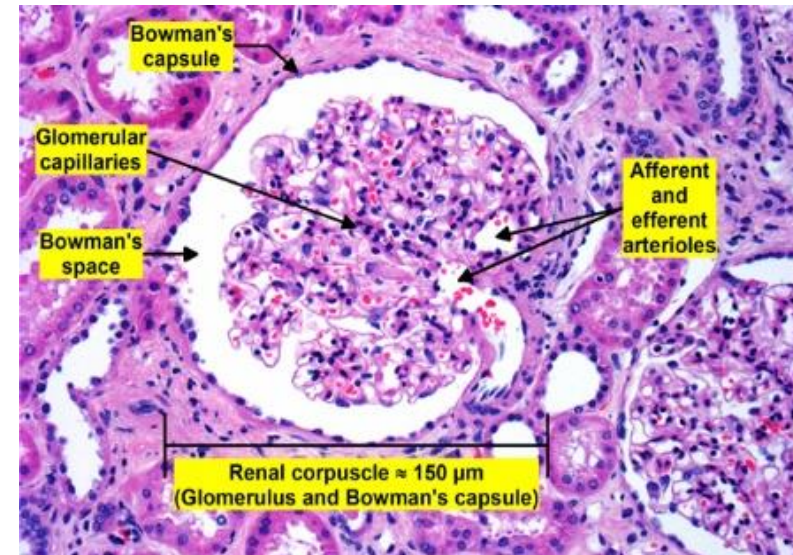
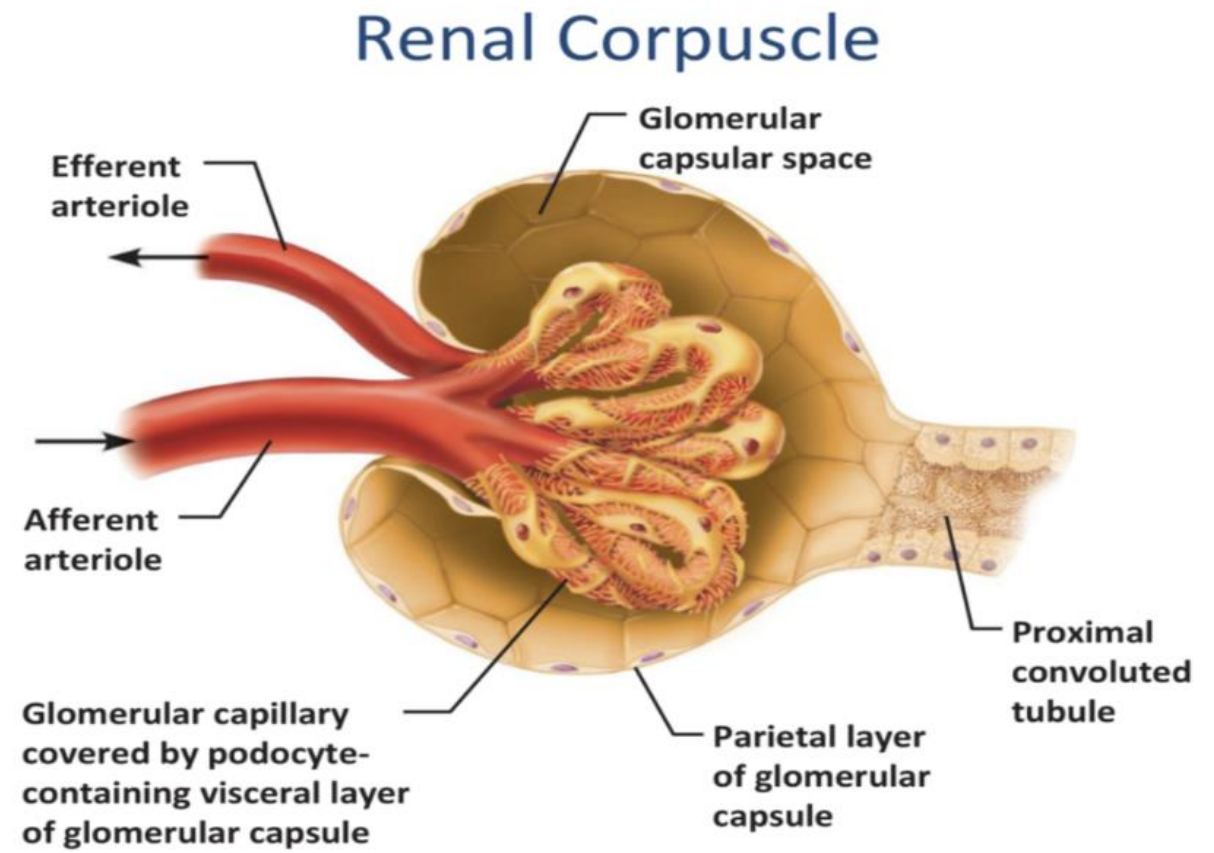
**B. Glomerulus.**



# Renal Corpuscle

## Bowman's capsule;

- It is a double-walled epithelial capsule that surround the glomerulus.
- a. **The outer parietal layer** consists of simple squamous epithelium.
- a. **The inner visceral layer** envelops the capillaries of the glomerulus. it is formed of special cells called **Podocytes**.
- b. Between the 2 layers is the urinary space (**Bowman's space**) that receives the fluid filtered through the capillary wall.

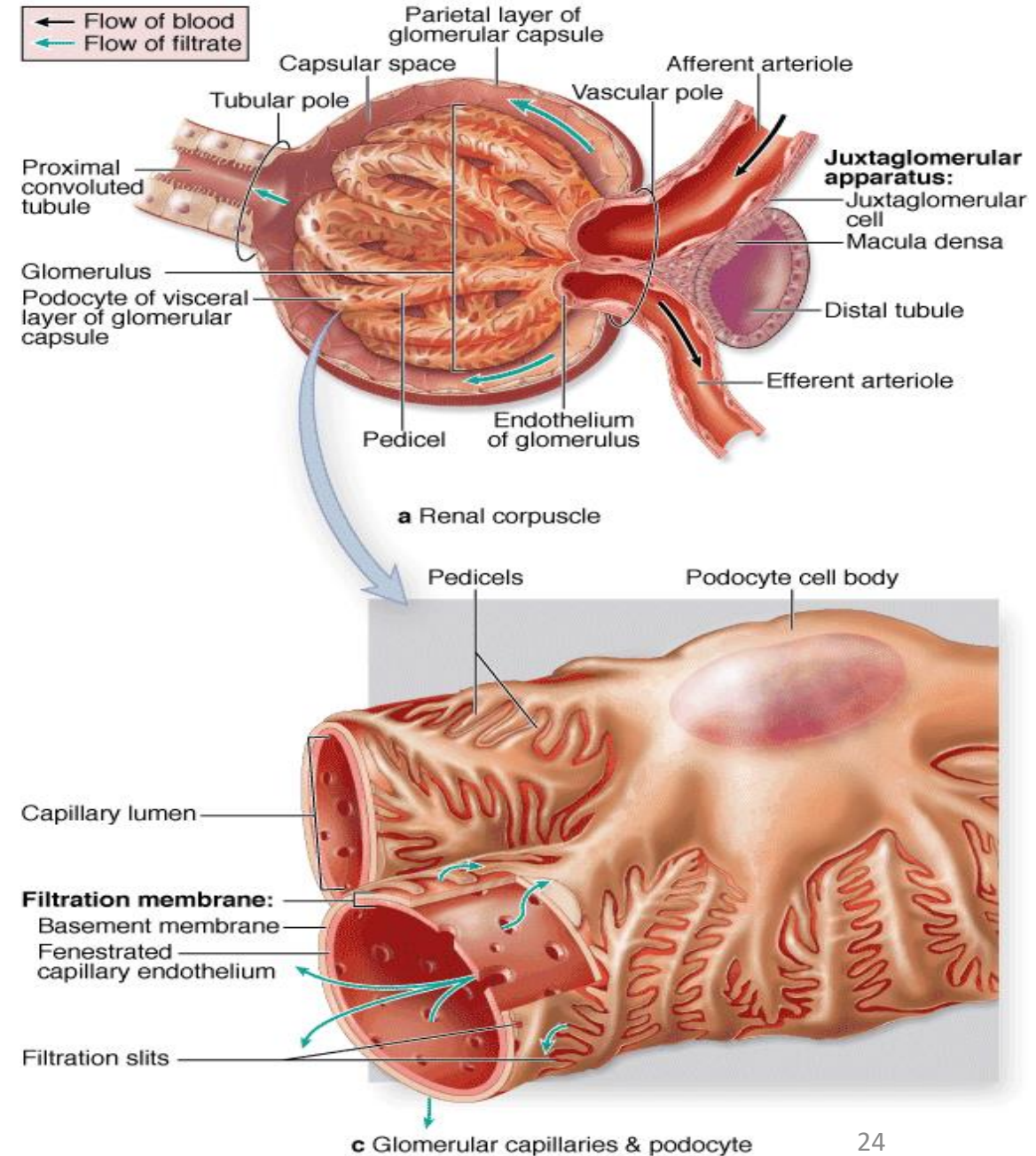


# Podocytes

- They are modified epithelial cells of visceral layer of Bowman's capsule. Share in formation of renal filtration barrier.

## E/M:

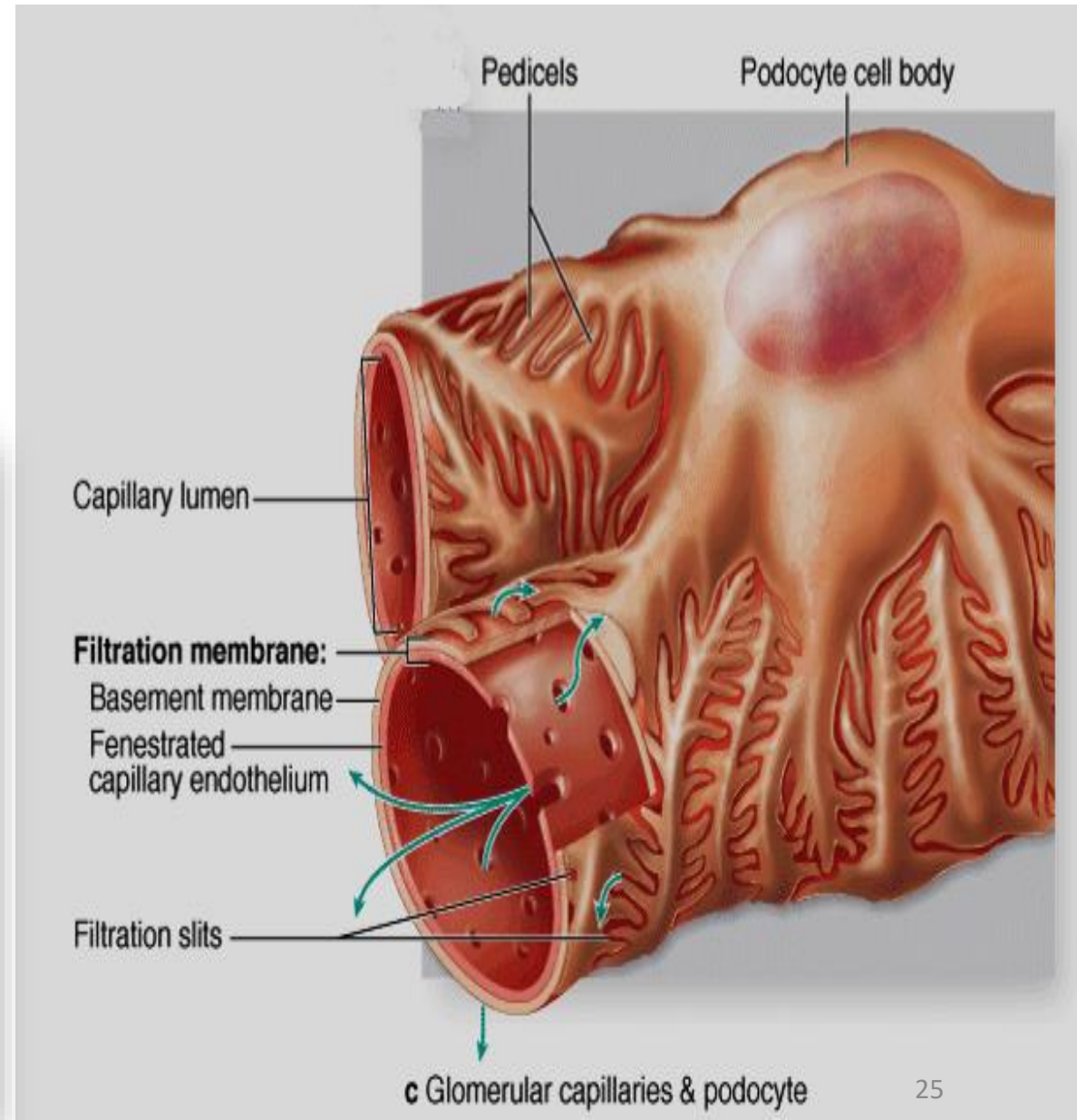
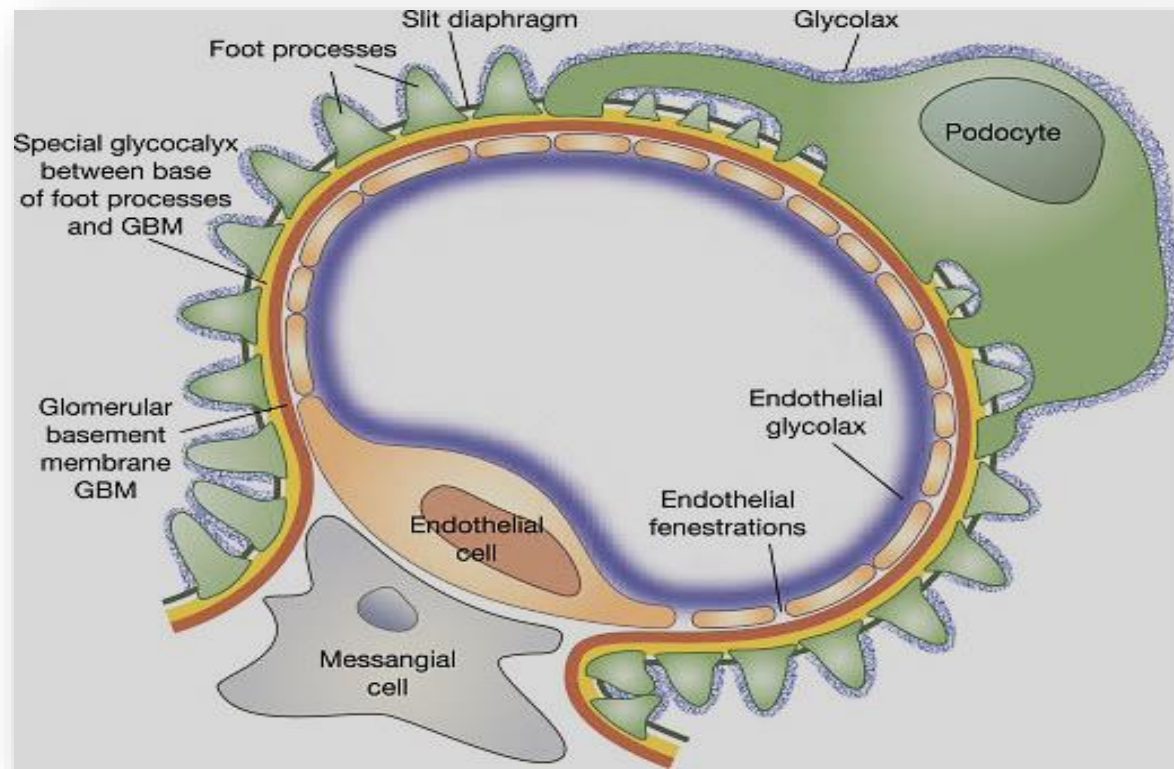
- They are large flattened stellate shaped cells. Each has cell body and several radiating primary processes.
- Primary processes give rise to numerous **secondary processes** that give **foot-processes** or **pedicels**.
- **The secondary processes & their feet** are closely applied to the basal lamina of the underlying capillary.





# Podocytes

- The **pedicels** are separated by **filtration slits**.
- Each slit is covered by a **filtration-slit diaphragm** which acts as molecular sieve, it holds back macromolecules.



# Glomerulus

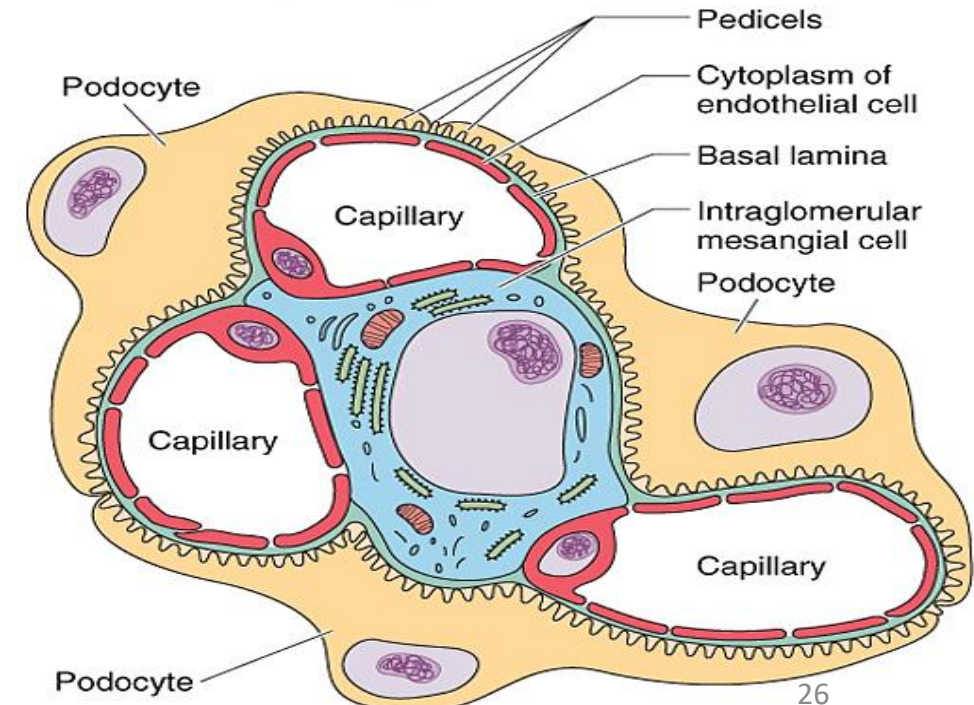
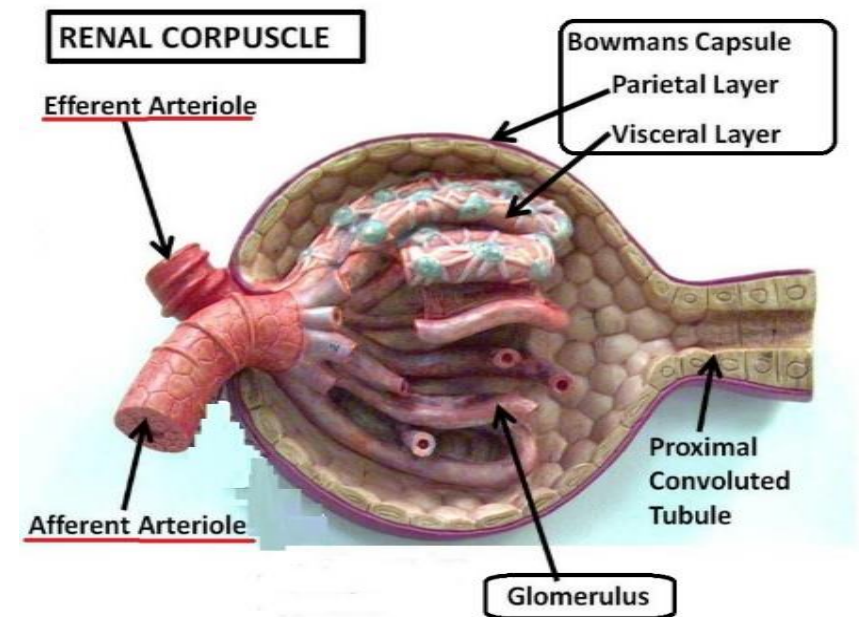
## Glomerulus is formed of:

1. Glomerular capillaries.
2. Mesangial cells.

## 1- Glomerular blood capillaries:

At the vascular pole of each Bowman's capsule;

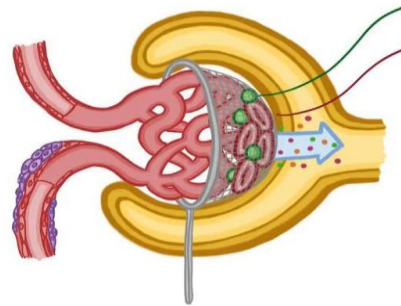
- **An afferent arteriole** give rise to tuft capillaries (glomerular capillaries)
- These capillaries drain into the **efferent arteriole**.
  
- **The endothelium of the glomerular capillaries** is fenestrated simple squamous epithelium. Fenestrae are numerous and large (70 – 90 nm). These fenestrae are not closed by diaphragm.



# Glomerulus

## 2-Mesangial cells:

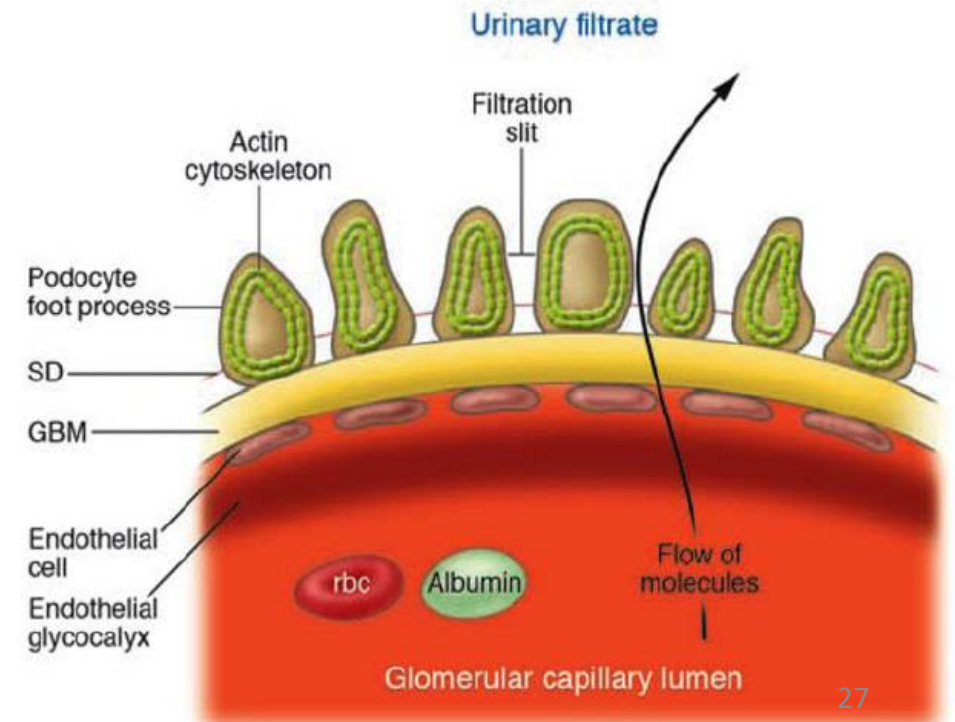
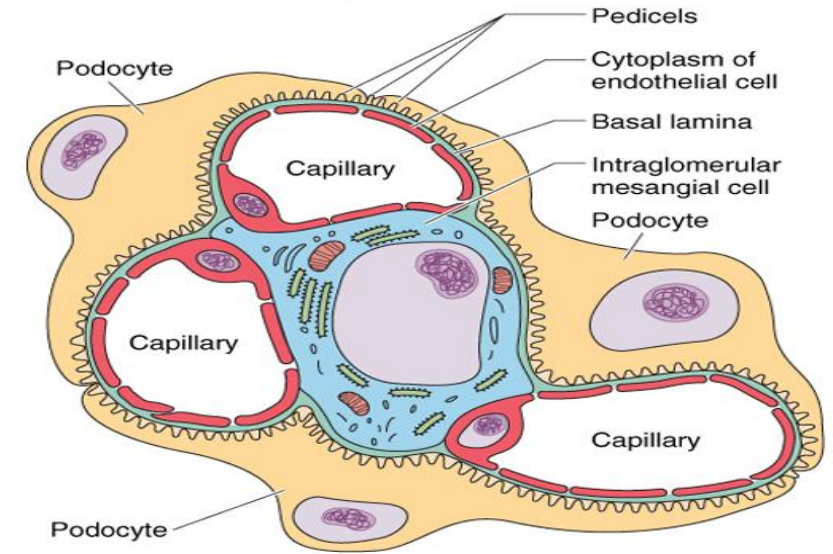
- The spaces between glomerular capillaries is occupied by a C.T consisting of **Intraglomerular Mesangial cells.**



## □ Blood renal barrier:

### Definition:

- It is the structures that separate blood in glomerular capillaries from the filtrate in the Bowman's space.
- It permits the passage of water, ions and small molecules from the blood into Bowman's space.
- It prevents the passage of large molecules as proteins and blood cells....



## Structures of blood renal barrier:

**It is formed of 3 elements:**

- 1. Fenestrated endothelium of blood capillaries;** not closed by diaphragms.
- 2. Glomerular basement membrane:** which is thick, formed of fused of both epithelial (podocytes) and endothelial basement membrane.
- 3. Filtration slits:** Between pedicles of the podocytes. They are closed by slit diaphragms.



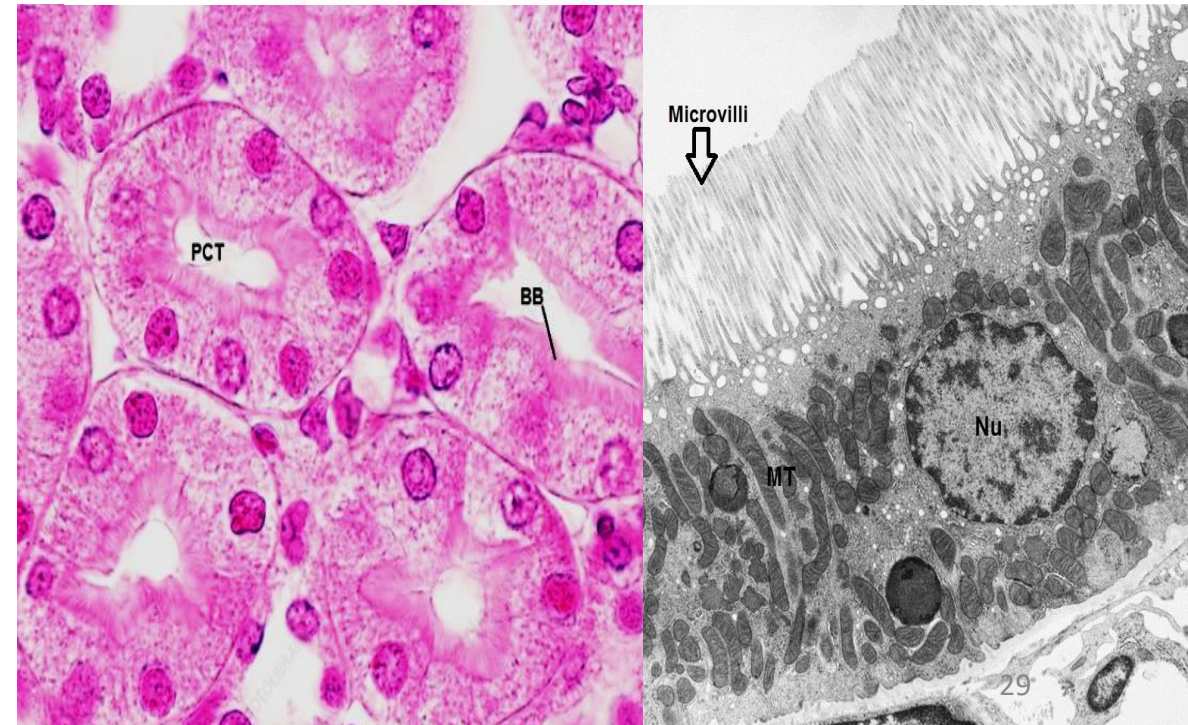
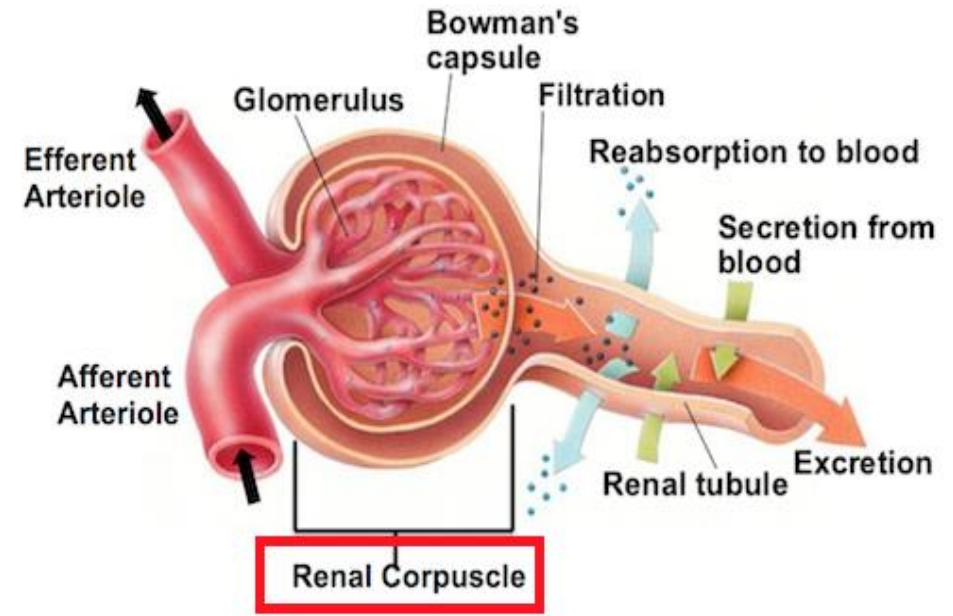
**Electron micrograph of blood renal barrier**

# Proximal Convoluted Tubules

- It has a tortuous course **in the cortex**.
- It is longer than distal convoluted tubule.
- **Function:** Obligatory reabsorption of 65% of filtrate.

## L/M & (EM):

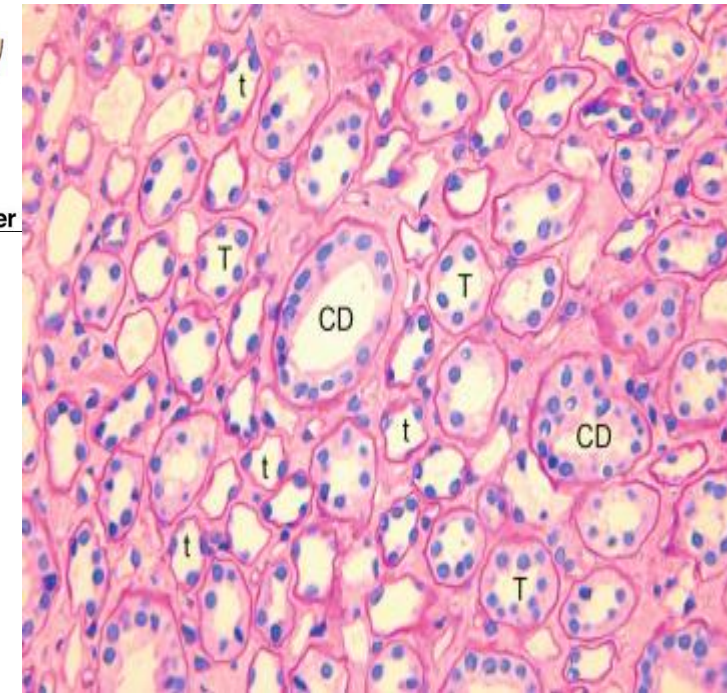
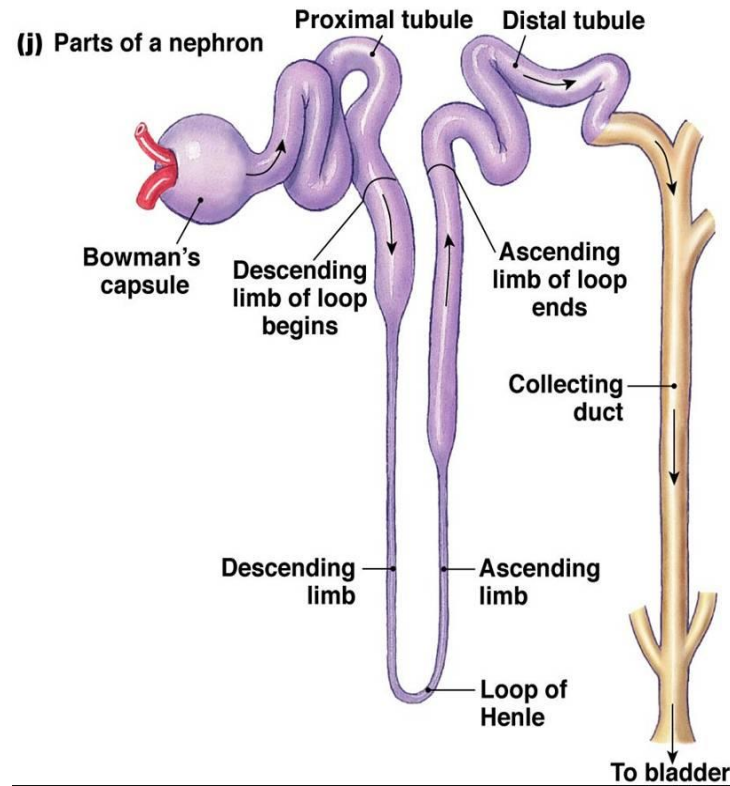
- The lumen is relatively narrow.
- Lined with simple high cuboidal epithelium.
- The luminal surface shows brush border (**Long microvilli**).
- The basal part has striation (**Basal infoldings and many mitochondria**).
- The cell borders are indistinct (**Extensive lateral interdigitation**).
- (**Pinocytotic vesicles** contain macro molecules).



# Loop of Henle

Henle's loop is a U-shaped structure consisting of;

- **A thick descending limb;** which is similar in structure to PCT.
- **A thin descending limb.**
- **A thin ascending limb.**
- **A thick ascending limb;** which is similar in structure to DCT.
- The thin segments is lined with squamous epithelial cells.
- Function of Loop of Henle is to concentrate urine.



Medullary kidney demonstrates cross-sectional profiles of numerous thin limbs of Henle (t), thick ascending limbs (T), and collecting ducts (CD).

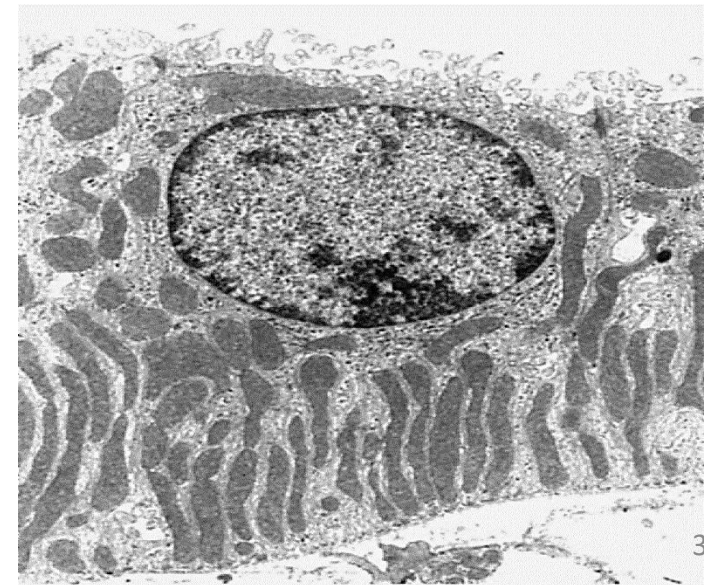
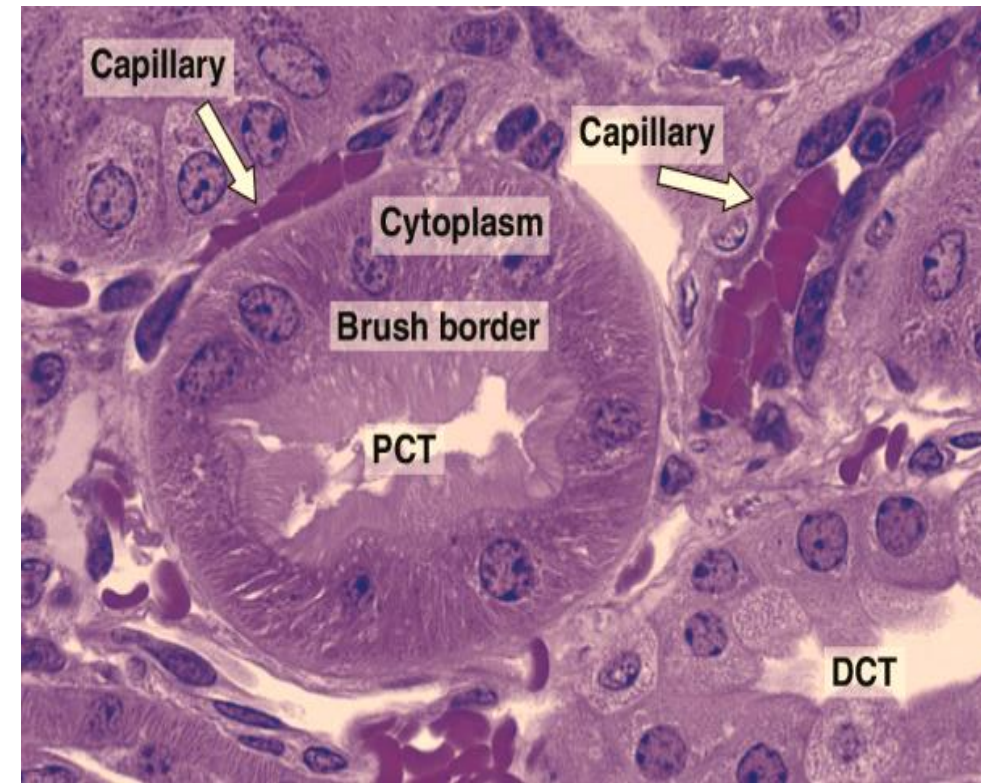
# Distal Convoluted Tubule

- It has a tortuous course **in the cortex**.
- **Function:**

Facultative reabsorption of water and Na.....

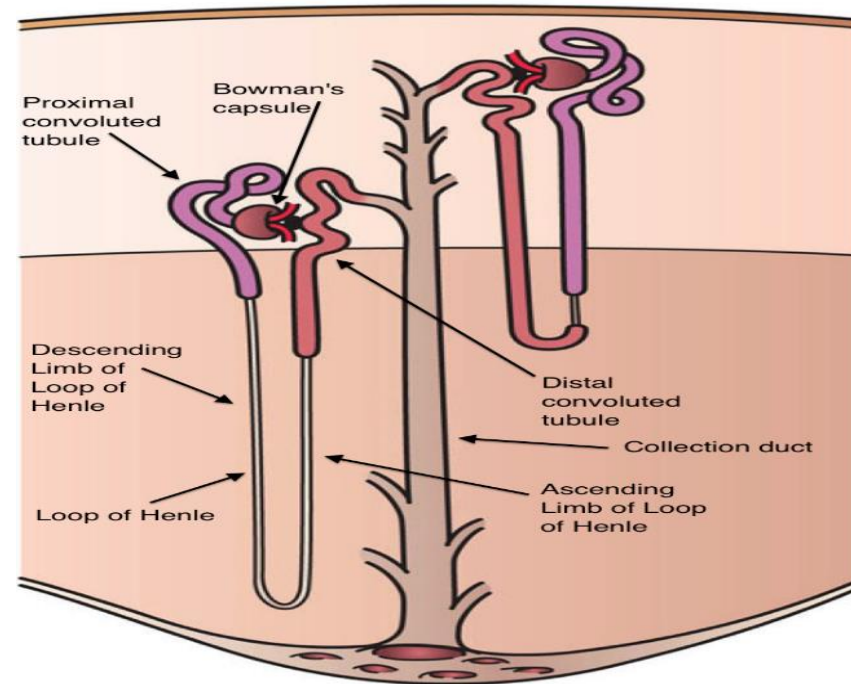
## L/M & (EM):

- It is lined with simple cuboidal epithelium.
- The luminal border shows no brush border (**little microvilli**).
- The lumen is slightly wider than of the proximal tubules.
- Basal striations (**Basal infolding and mitochondria**).



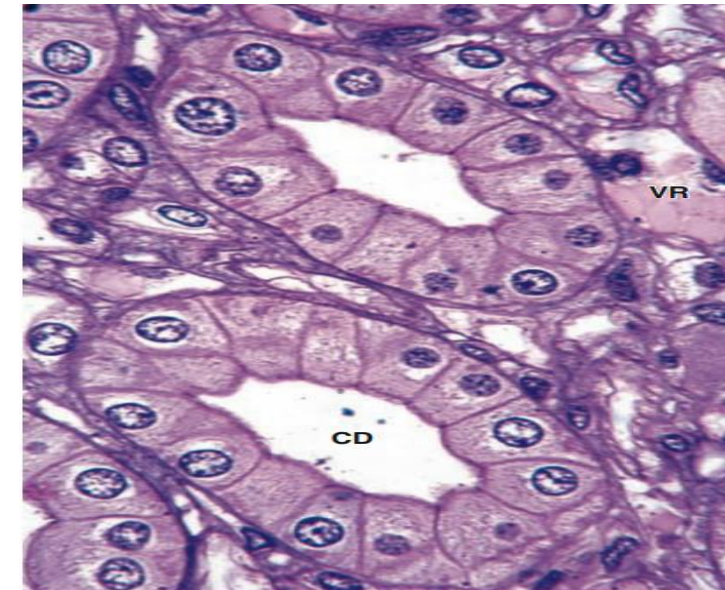
# Collecting Tubules & Ducts

- **Connecting tubules:** They are short segments between DCT and the beginning of cortical collecting tubules.
- **The collecting tubules are of three types:** cortical, medullary and papillary.



## L/M & (EM):

- Each tubule is lined with simple cuboidal epithelium.
- The cytoplasm contains a few organelles.
- The lumen is relatively wide.



- CD; collecting duct.
- VR; vasa recta.<sup>32</sup>



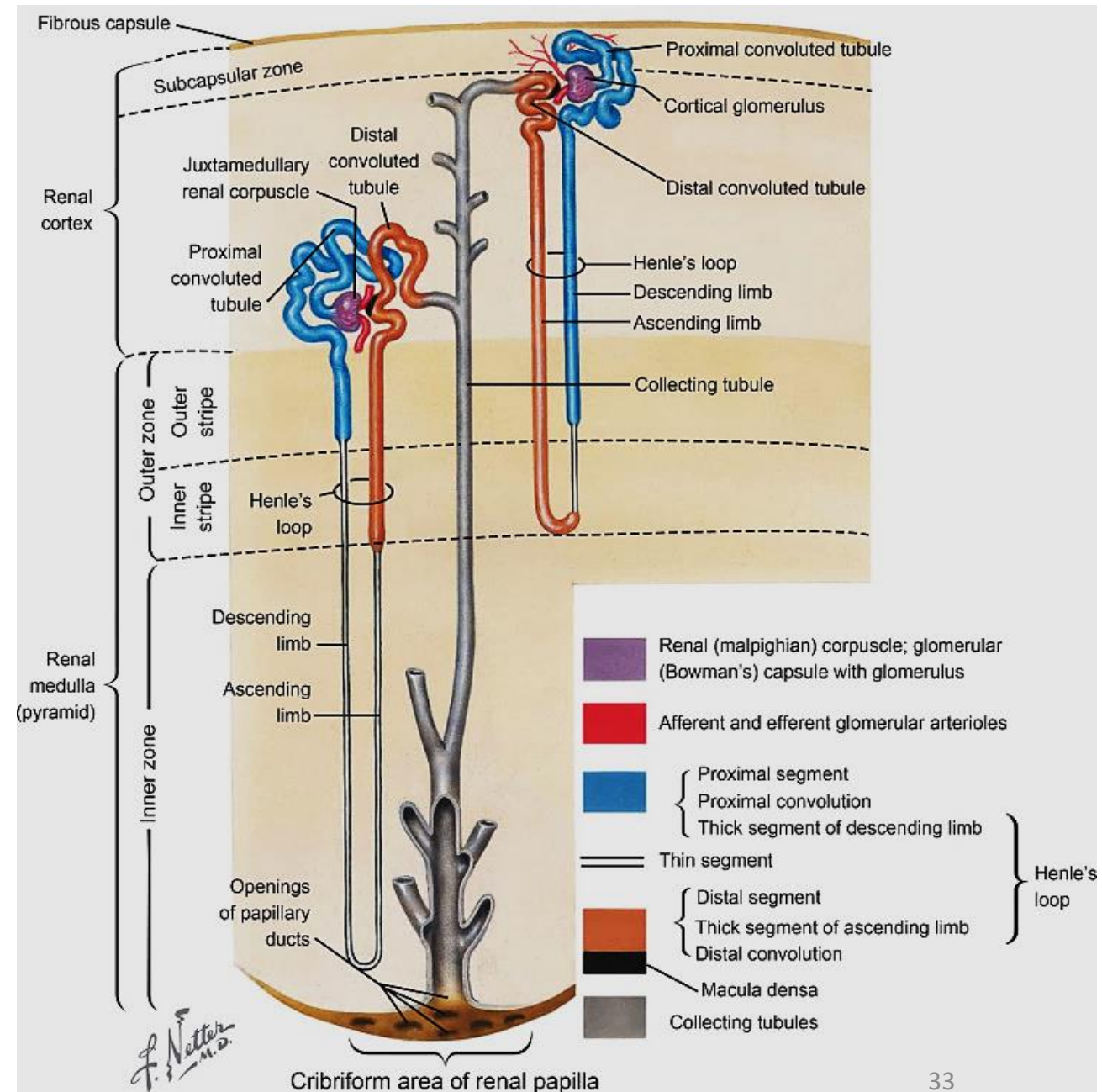
# Collecting Tubules and Ducts

## □ Papillary collecting tubules (Ducts of Bellini):

- They are formed by the union of several medullary collecting tubules.
- They open at the area cribrosa of renal papilla to deliver the urine into the minor calyx.

## □ Function of collecting tubules:

1. They conduct urine.
2. They **concentrate urine.**



# Histological Structure of Kidney

## □ Medullary rays:

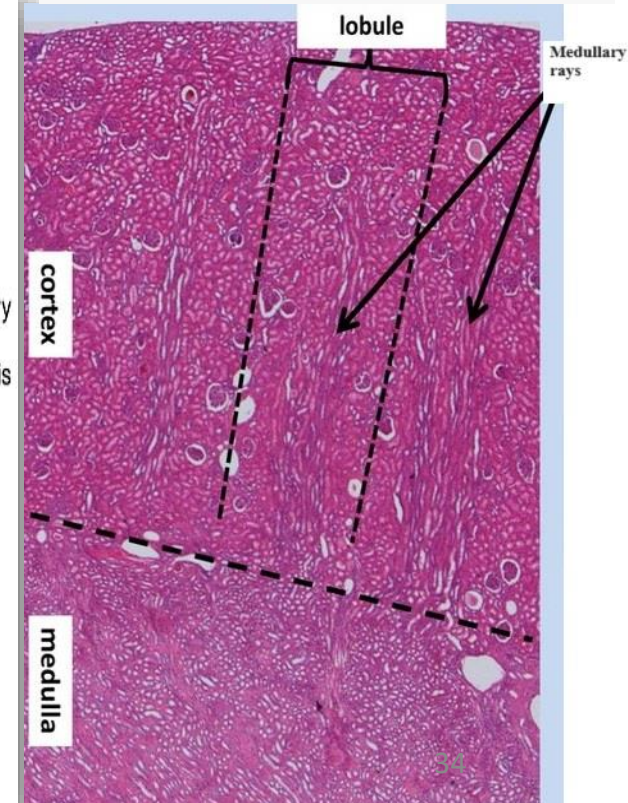
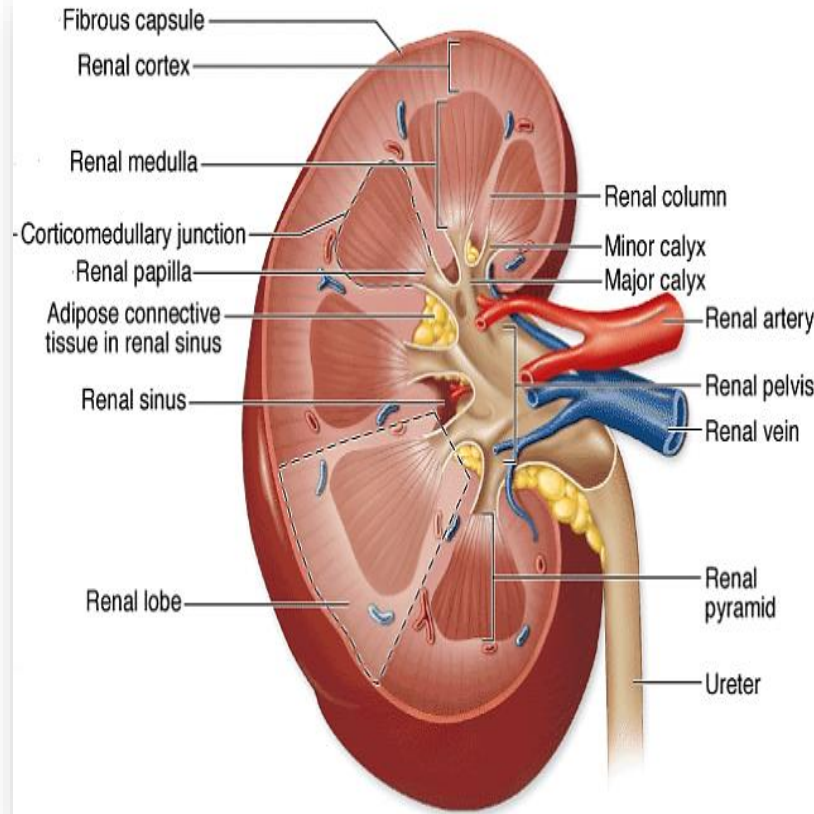
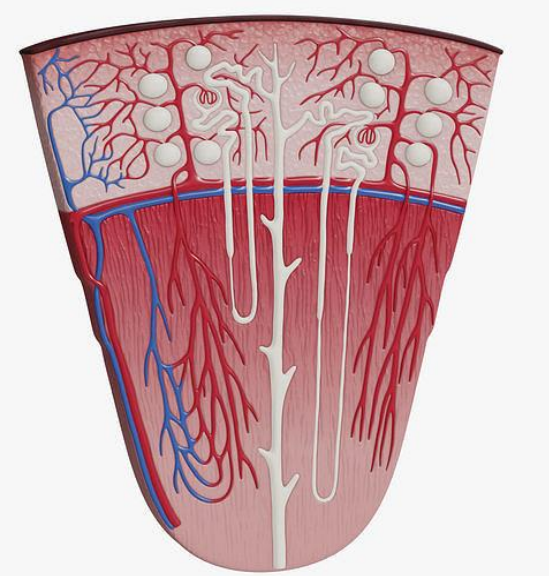
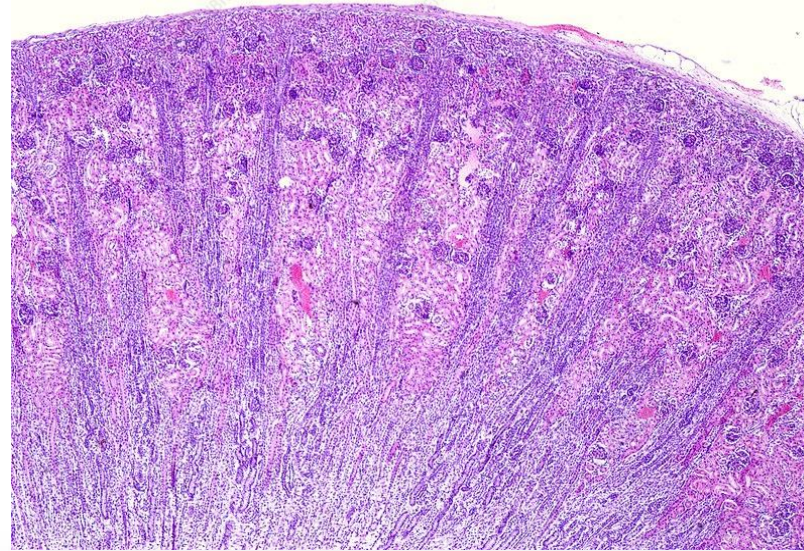
- Medullary projections that enter the cortex.
- Each medullary ray **consists of** a single cortical collecting tubule and the straight portions of several nephrons that drains into it.

## □ Renal lobe:

- Each lobe is formed of a renal pyramid and the corresponding covering of the cortical tissues.

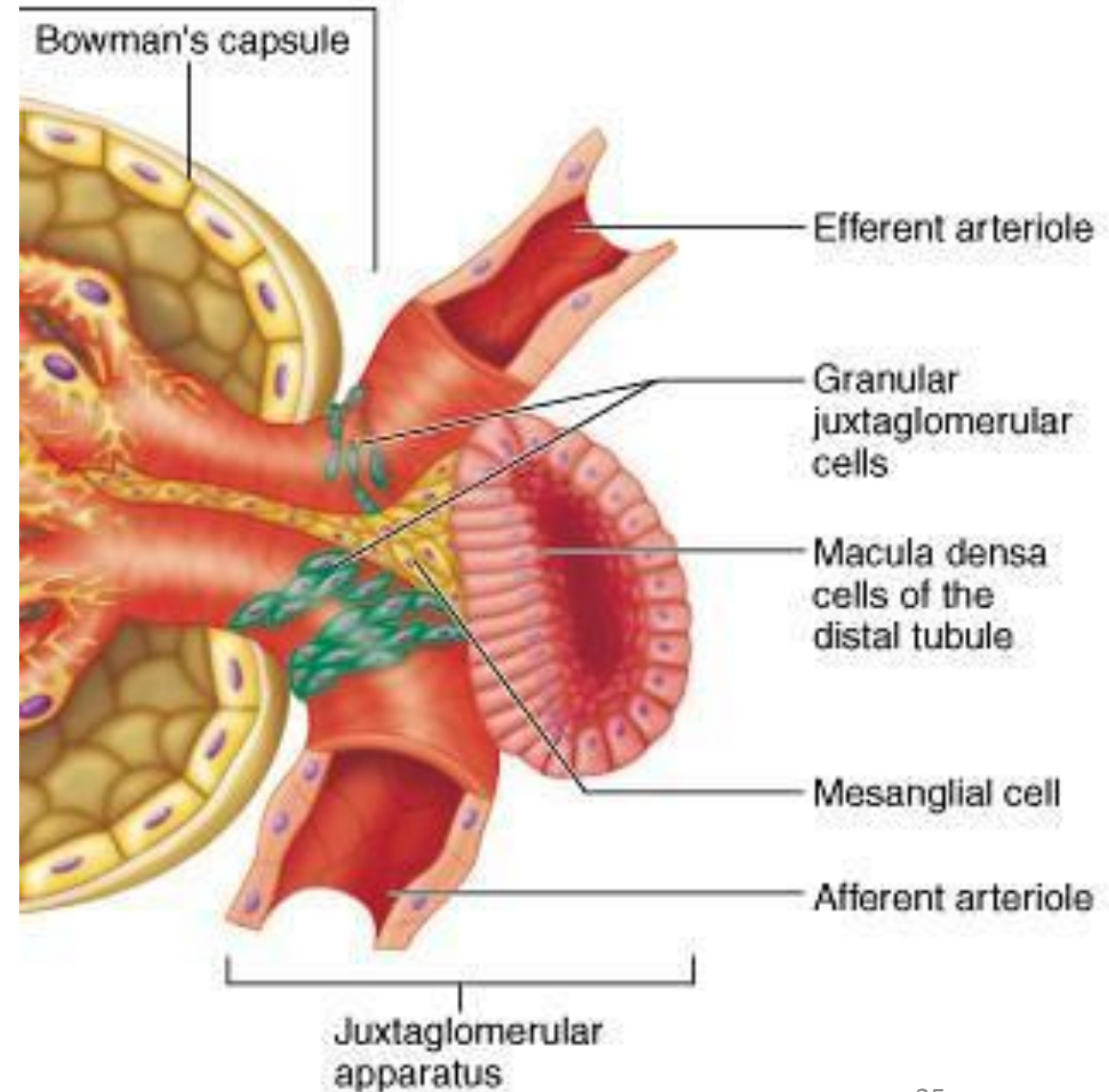
## □ Renal lobule:

- It consists of a medullary ray and the adjacent cortical tissues on either side of it.



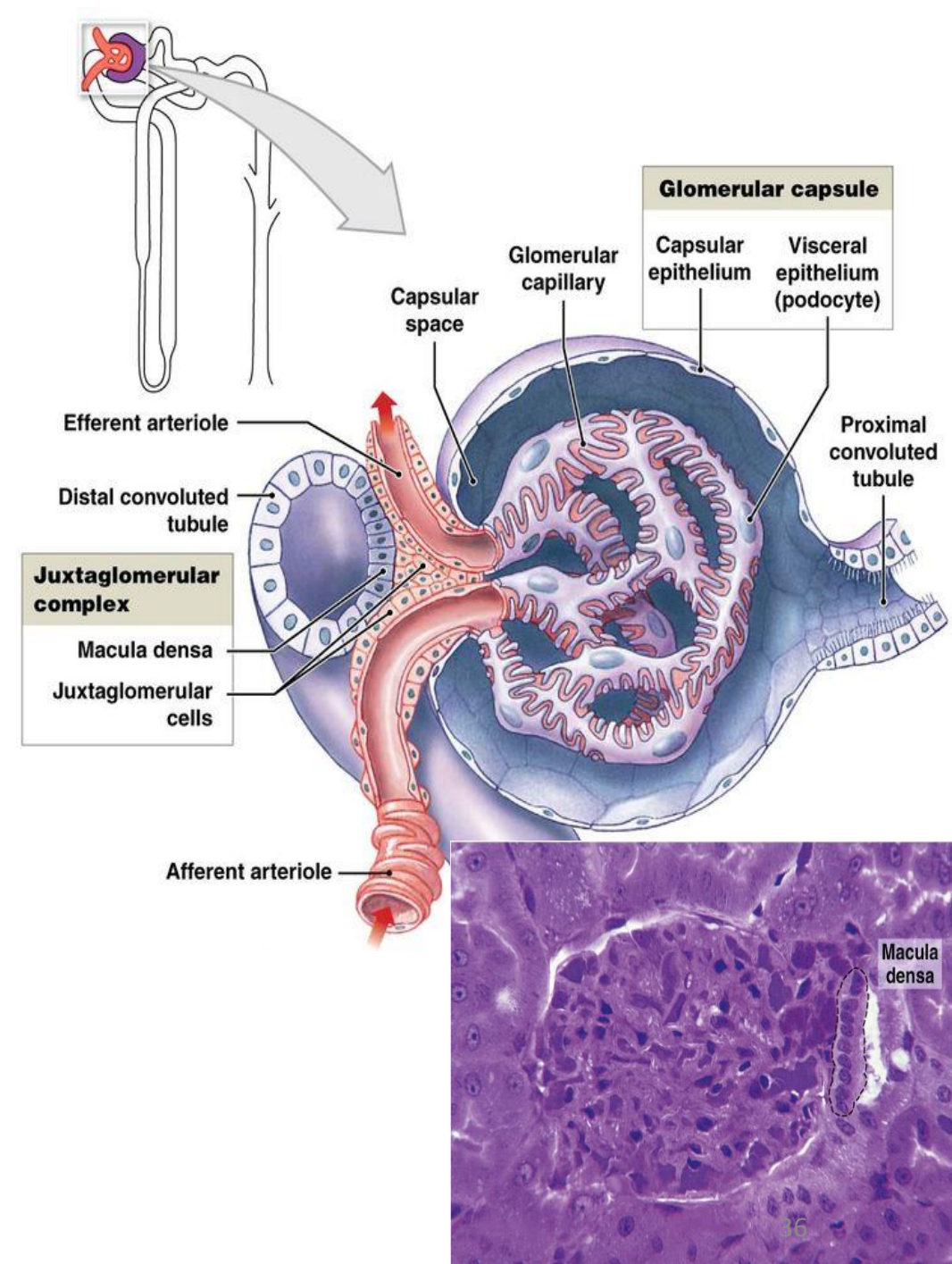
# Juxtaglomerular Complex

- It is a complex of tubular and vascular elements of the nephron.
- **Site:** It presents at the vascular pole of the renal corpuscle at which the distal convoluted tubule fits between the afferent and efferent arterioles.
- **It consists of:**
  - A- Macula densa.
  - B- Juxtaglomerular cells.
  - C- Extra glomerular mesangial cells.



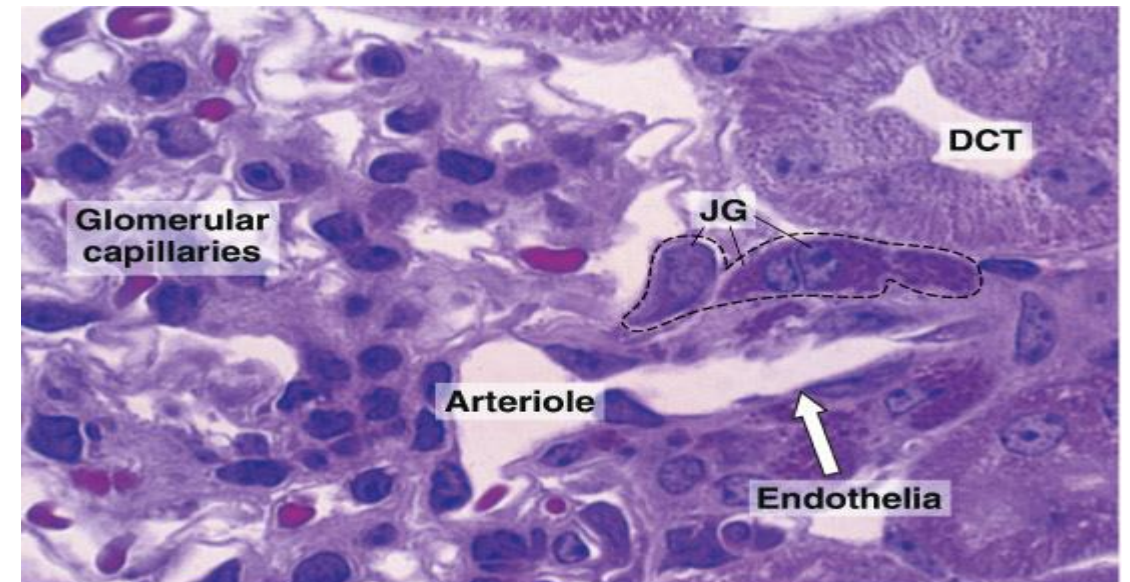
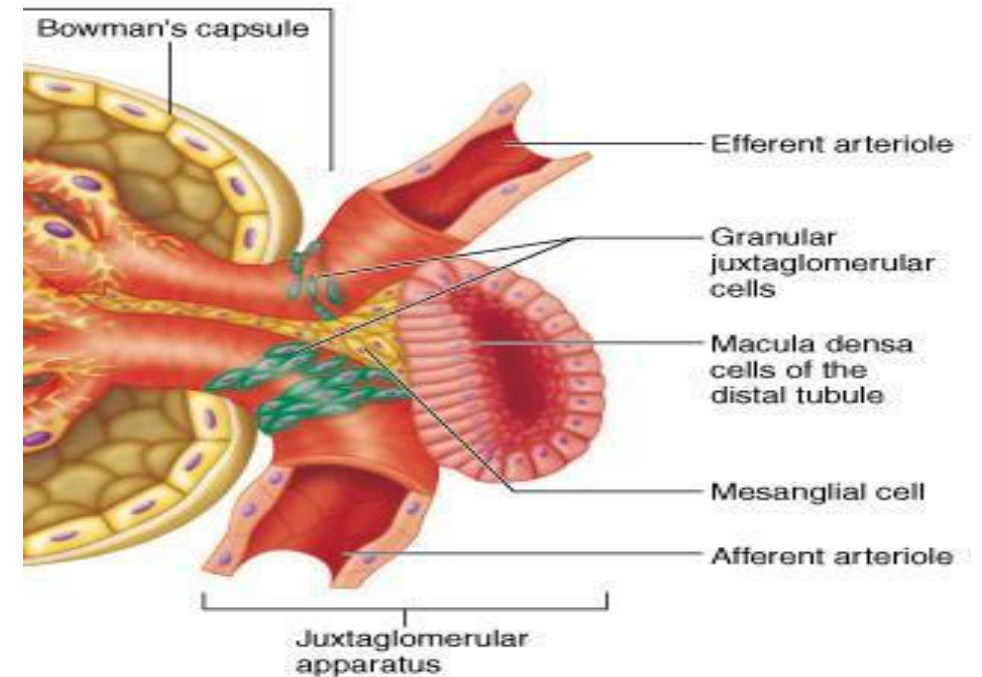
## A- Macula densa:

- It is a special type of cells that line part of a distal convoluted tubule that facing glomerulus.
- It is formed of closely packed columnar cells with deeply stained packed nuclei.
- They have **thin or absent basement membrane** so the cells of macula densa are in direct contact with JG cells and lacis cells.



## B- Juxtaglomerular cells (Renin producing cells):

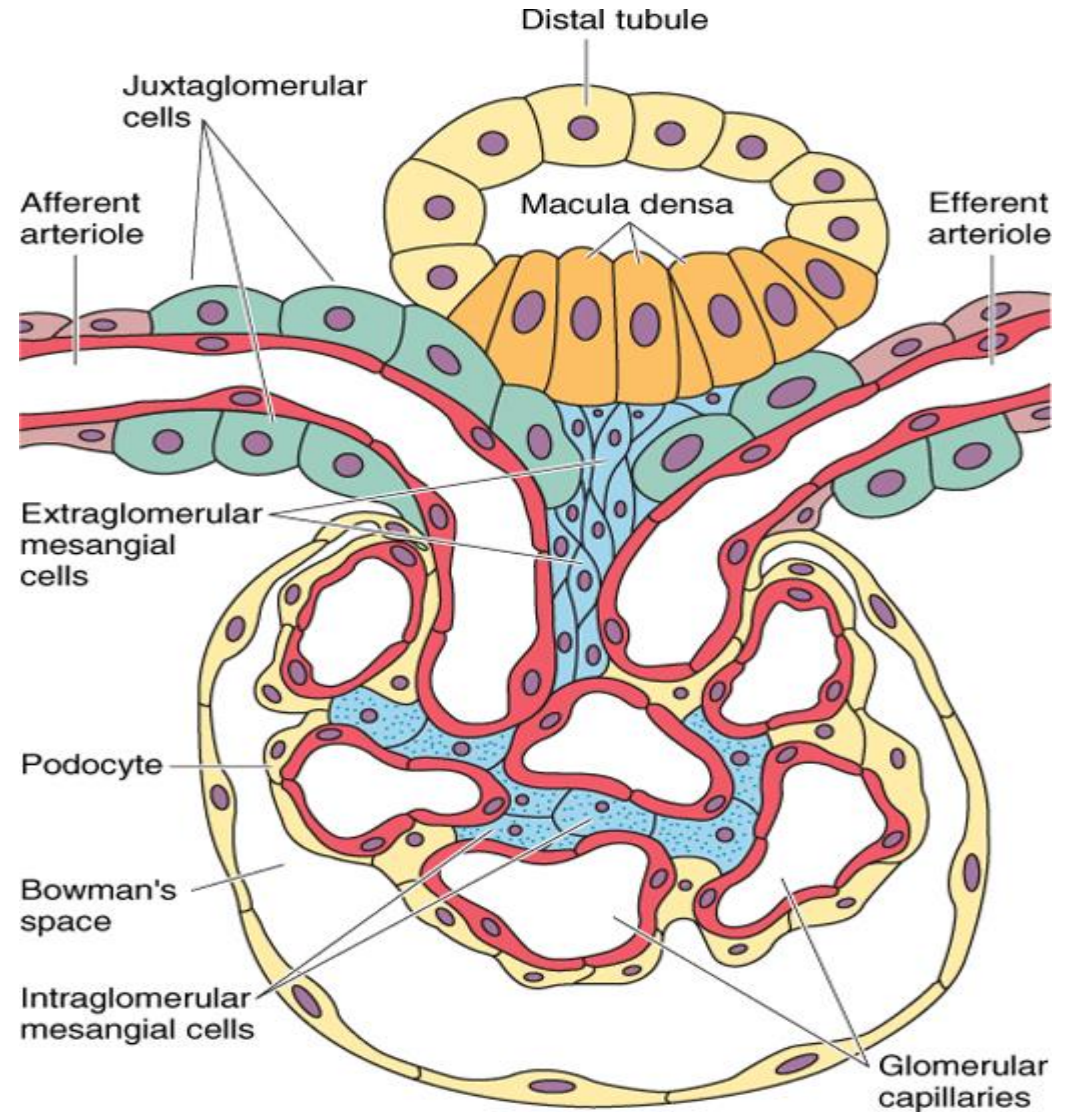
- They are **special modified smooth muscle cells** present in the tunica media of the afferent arteriole (few in efferent arteriole).
- They lie in close contact with the cells of the macula densa.
- The **internal elastic lamina** of the afferent arteriole is missing where juxtaglomerular cells are present.
- Their nuclei are rounded instead of being elongated.
- Their cytoplasm contains numerous **large secretory granules**.
- **Function:** Secretion of renin.



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## C- Extra glomerular mesangial cells (Lacis cells):

- They are group of small cells present in the area between the afferent arteriole, the efferent arteriole and the macula densa.
- They communicate with the intraglomerular mesangial cells.
- **Function:** Support & Coordination.



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*Thank You!*