



# GENITOURINARY SYSTEM

SUBJECT : Anatomy

LEC NO. : 1

DONE BY : Batool ALzubaidi & Hashem Ata

وَقُلْ رَبِّ زِدْنِي عِلْمًا



**GUS..**

**Lecture (1)**

# **Anatomy & Histology of kidney**

***Dr. Amany Allam***

**Assistant professor of Anatomy & Embryology**

# ILOs

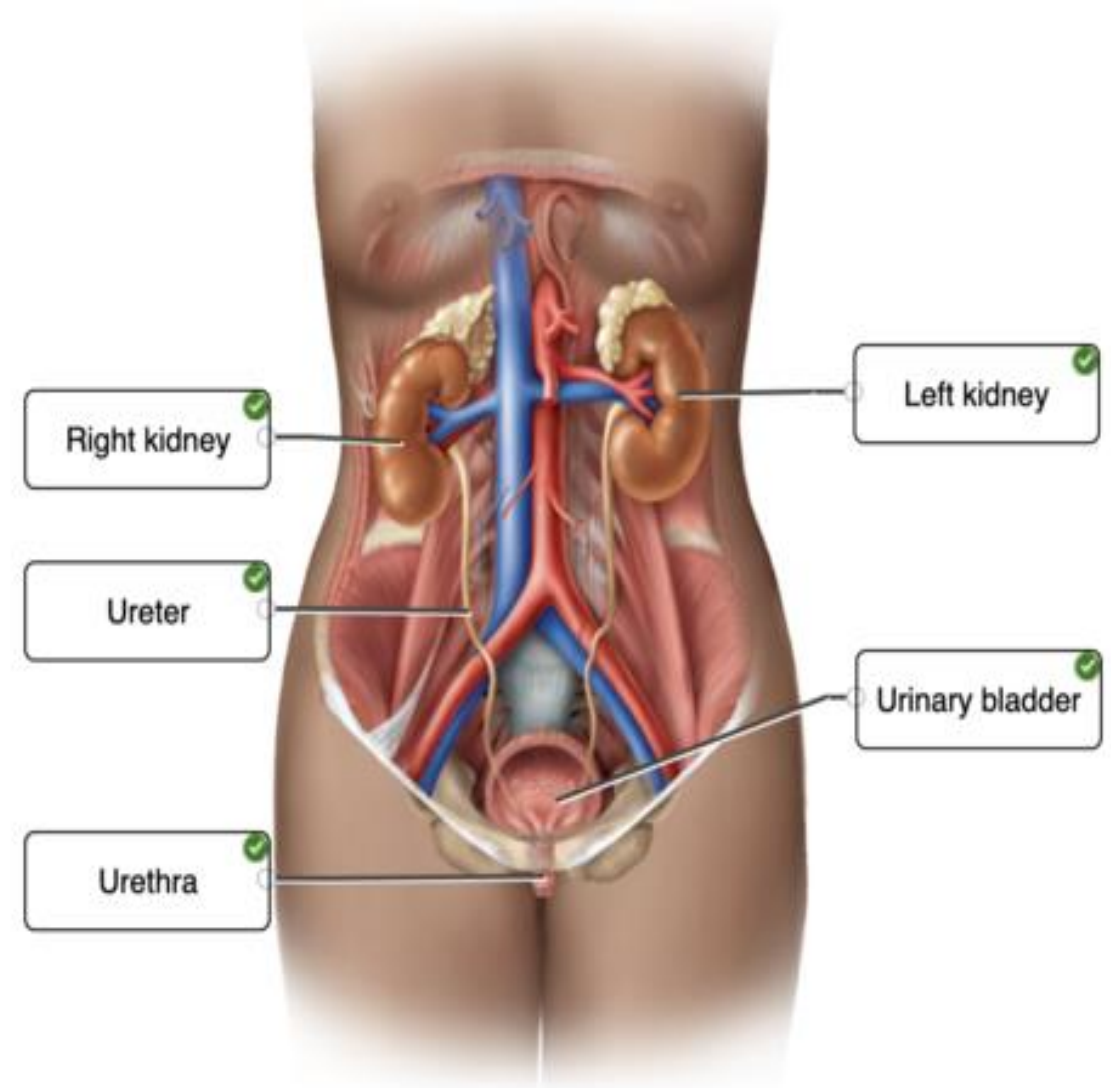
- 1. Describe the shape, function, location, fascial sheaths, gross feature, and relations of kidneys.**
- 2. Understand the gross structure of a sagittal section of kidney.**
- 3. Discuss the blood & nerve supply, and lymphatic drainage of kidneys.**
- 4. Describe the microscopic appearance of kidney.**

# 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  $\frac{1}{2}$  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.



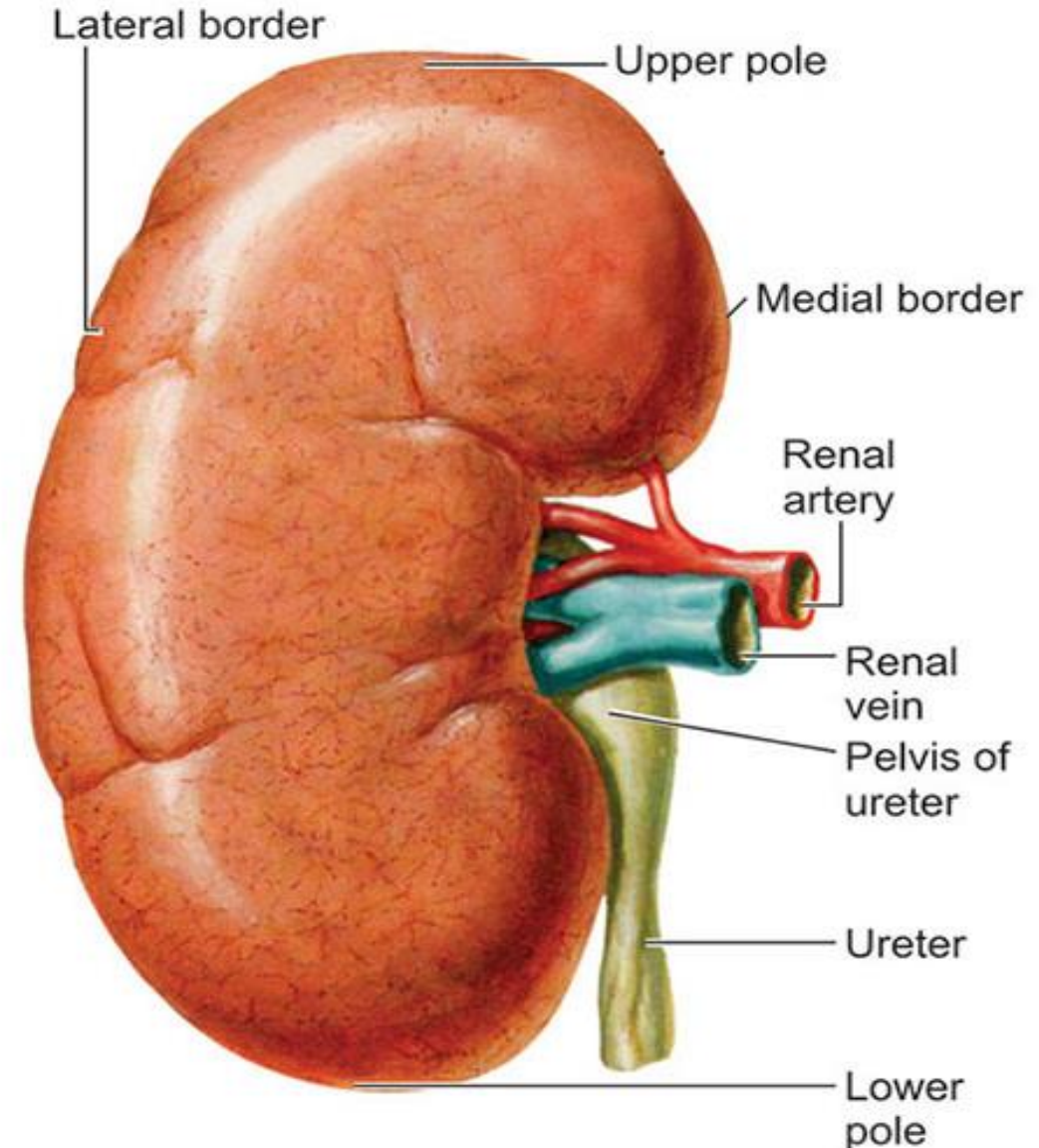


# Shape and Size of kidney

- 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

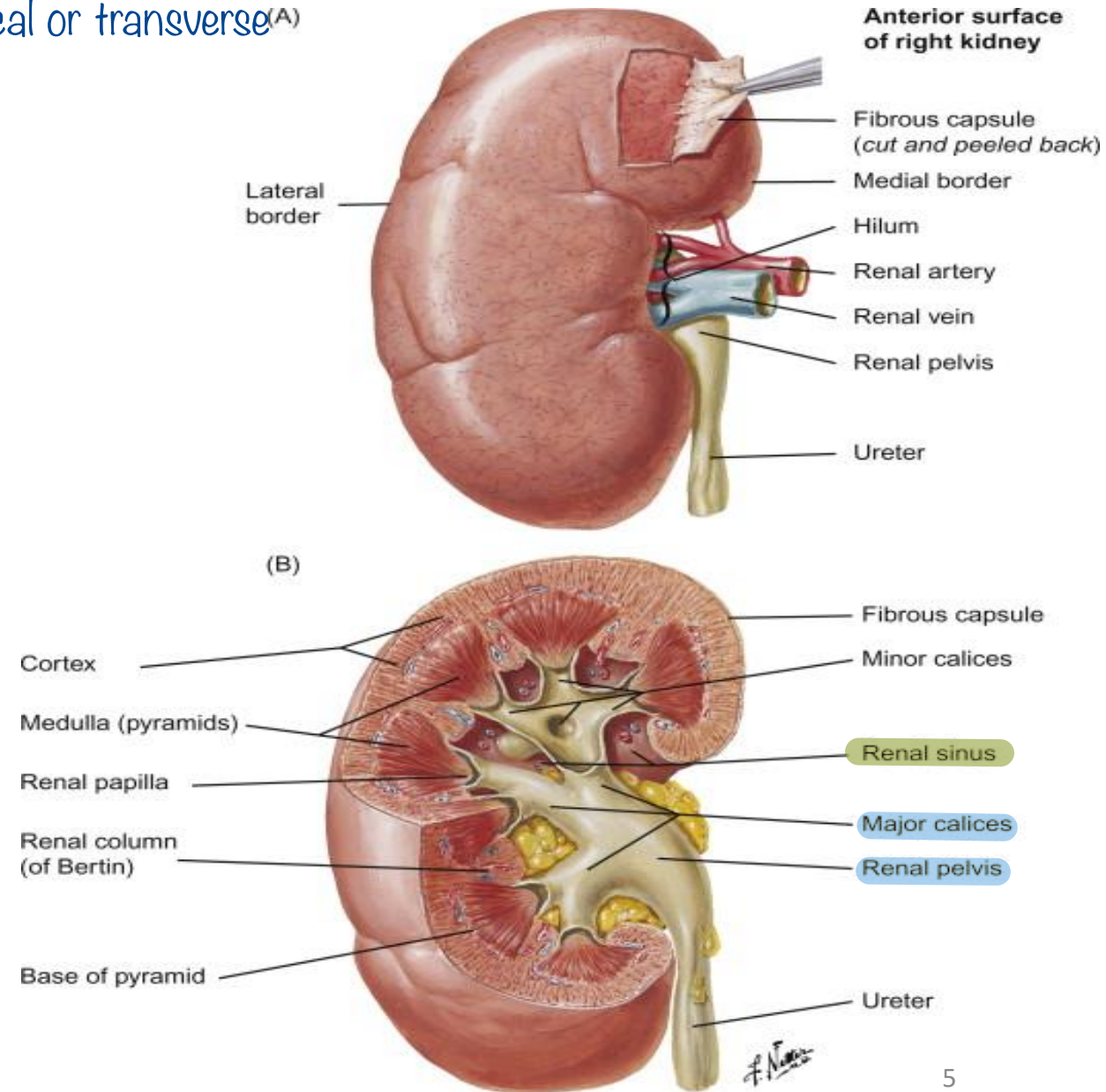
↳ It can be vertical or transverse<sup>(A)</sup>

- 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**.

لو دخلت ايدك بال hilum راح توصل ال sinus

## Renal sinus contains:

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



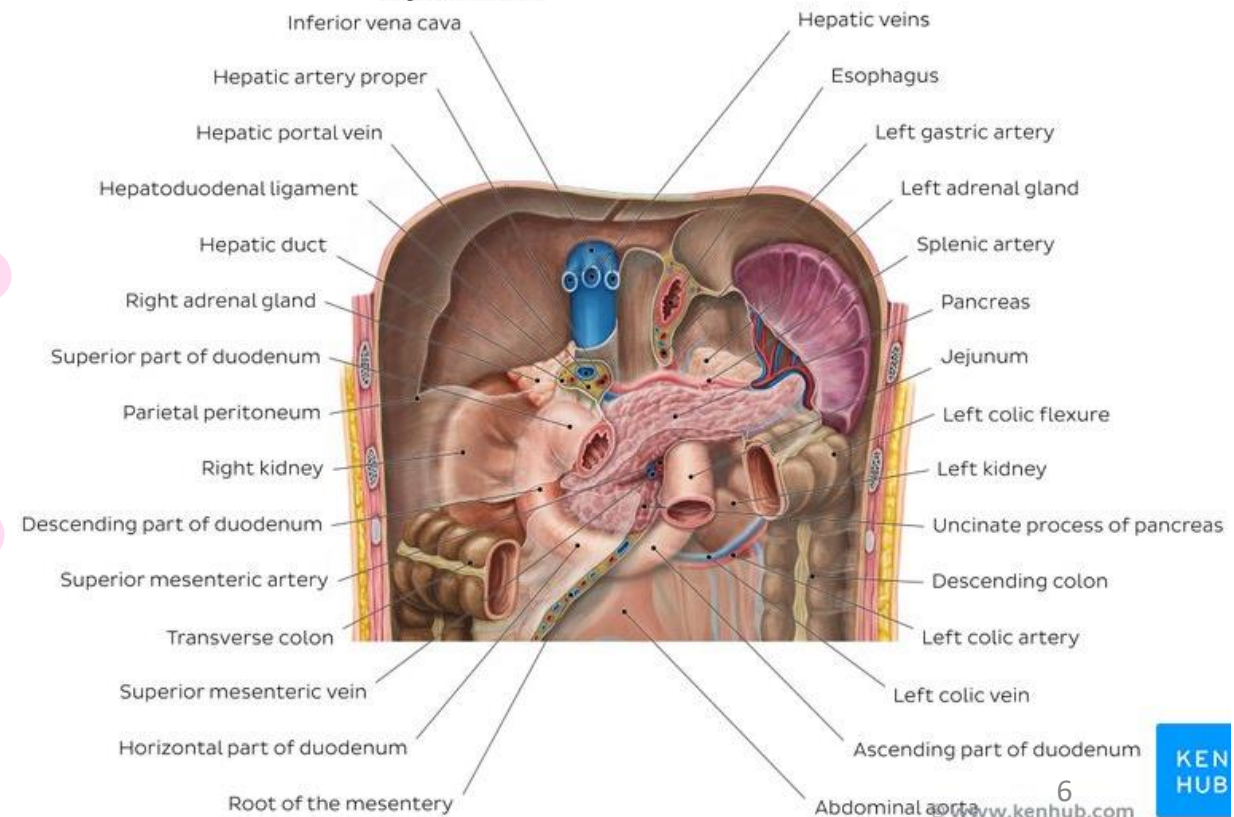
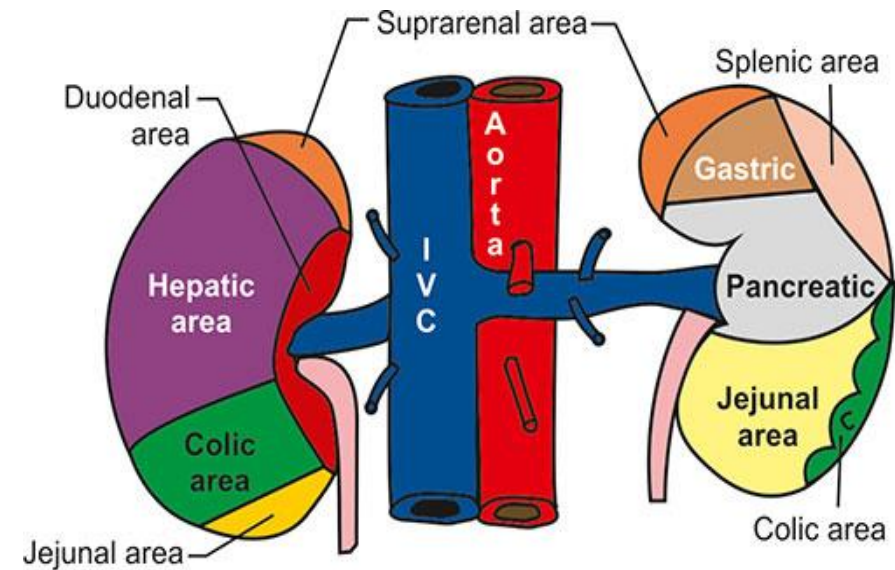
# Relations of Anterior Surface of Kidney (Anterolateral)

Organs make impressions on it's surface

- 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.

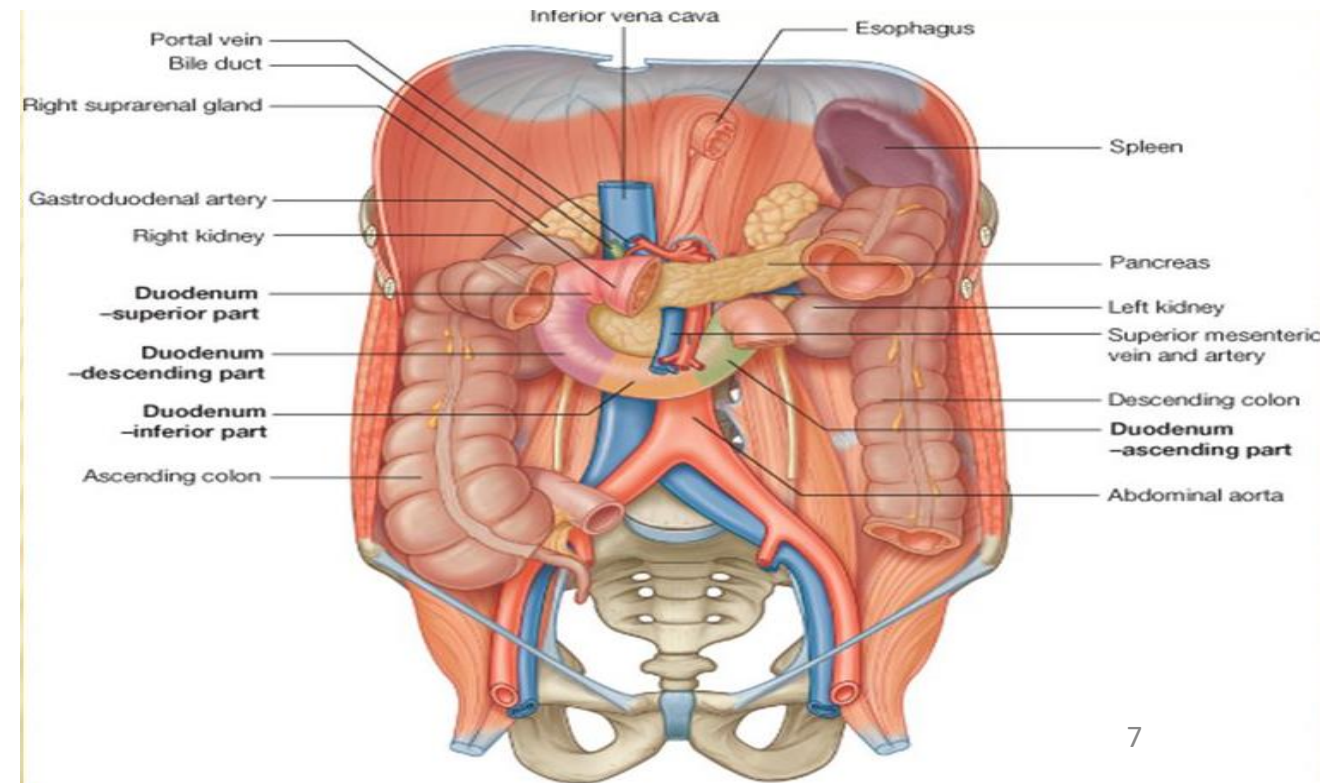
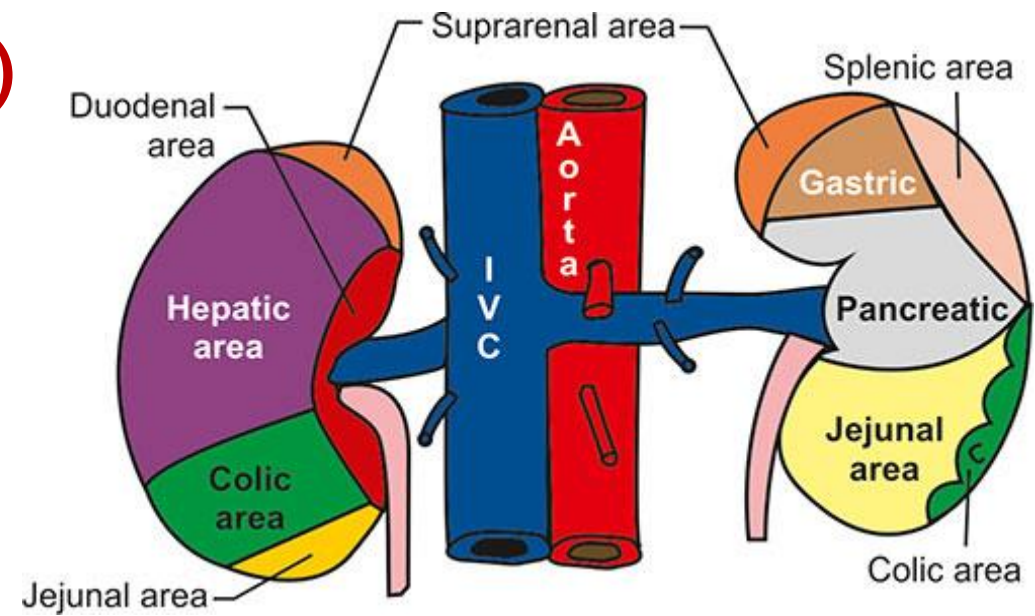




# Relations of Anterior Surface (anterolateral)

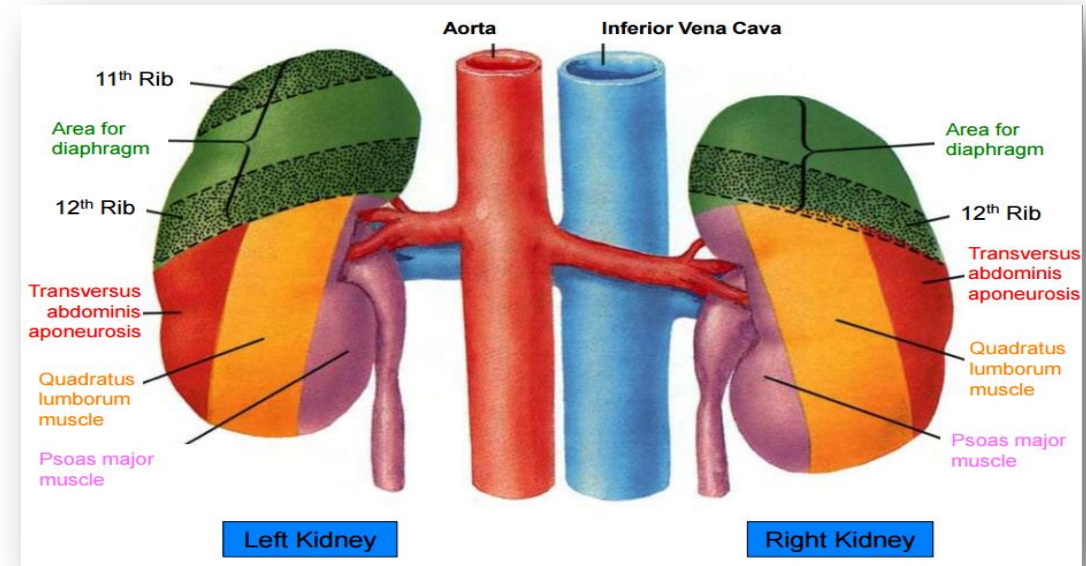
## □ Left kidney is related to:

- 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.

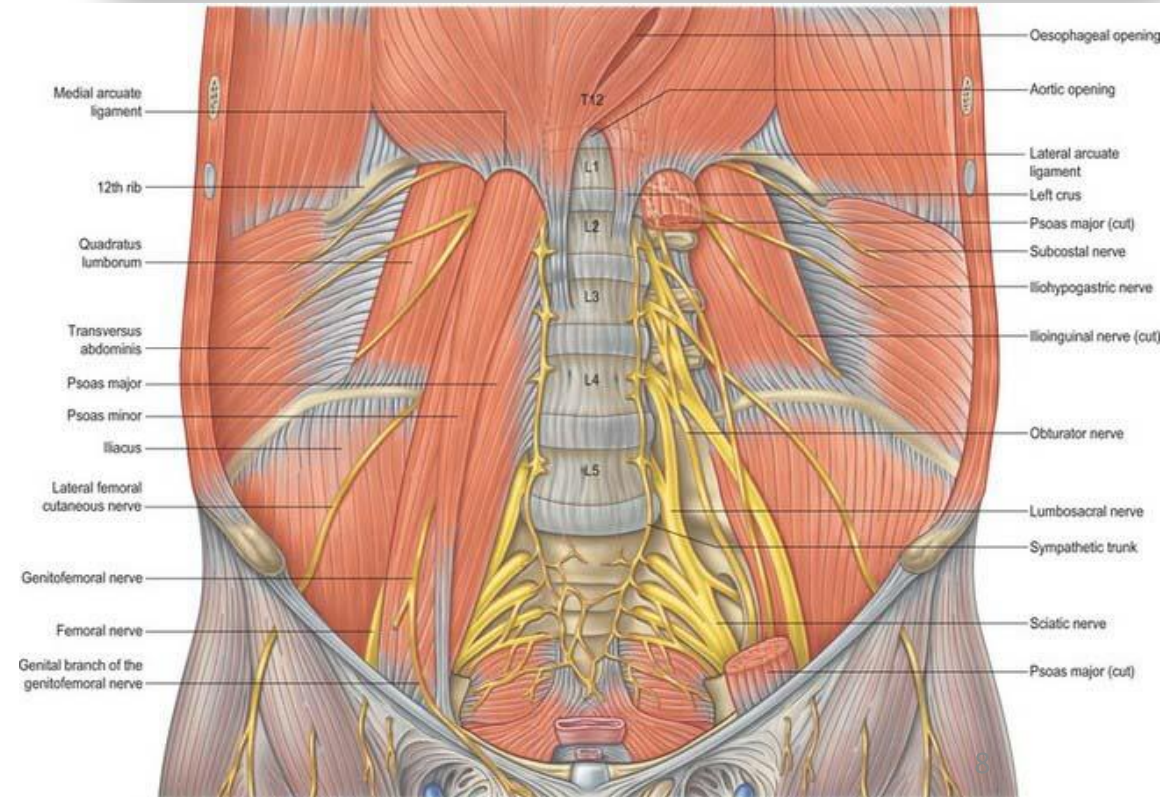


## The muscles:

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

## 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.

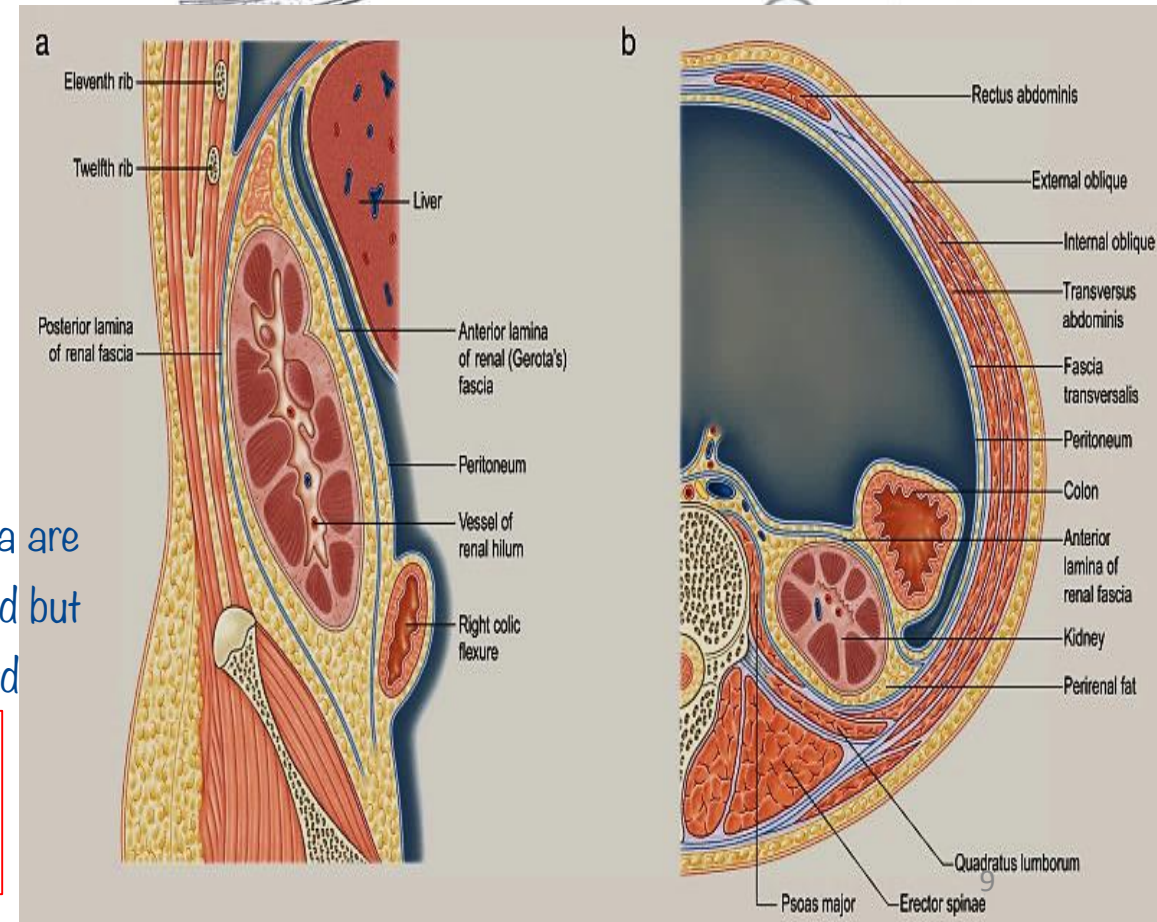
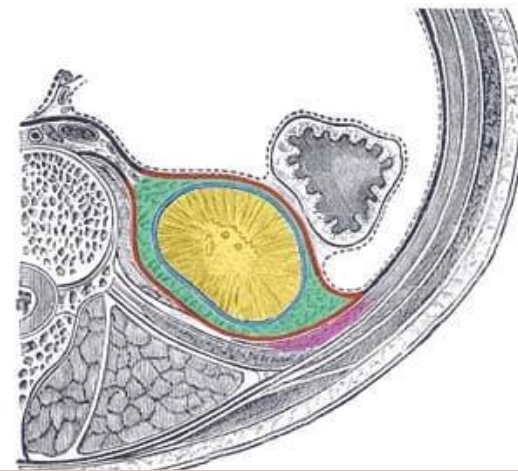
✓ Perirenal fat. → Peritoneal = around the kidney

✓ 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.

\* 2 layers of renal fascia are closed from the upward but opened from downward

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



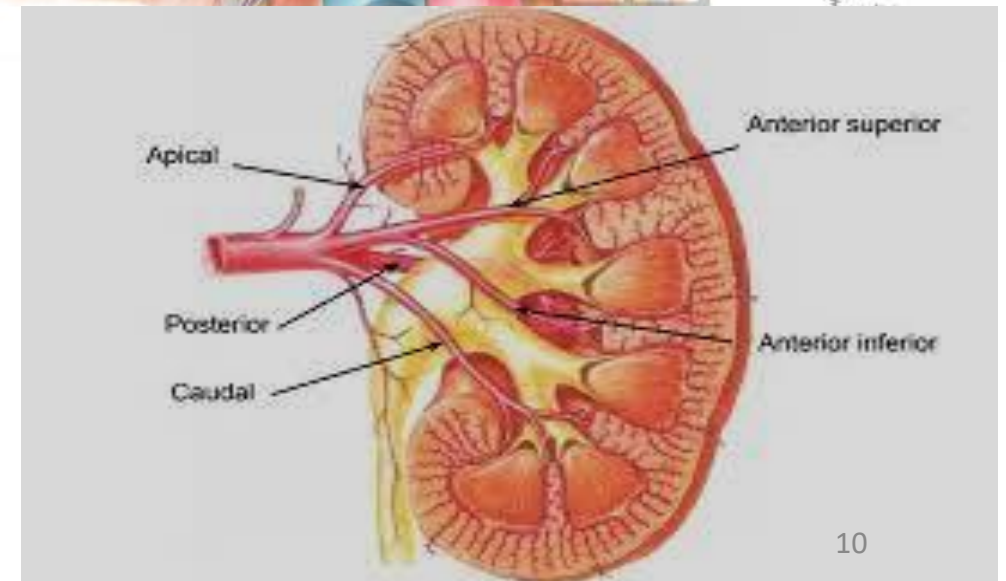
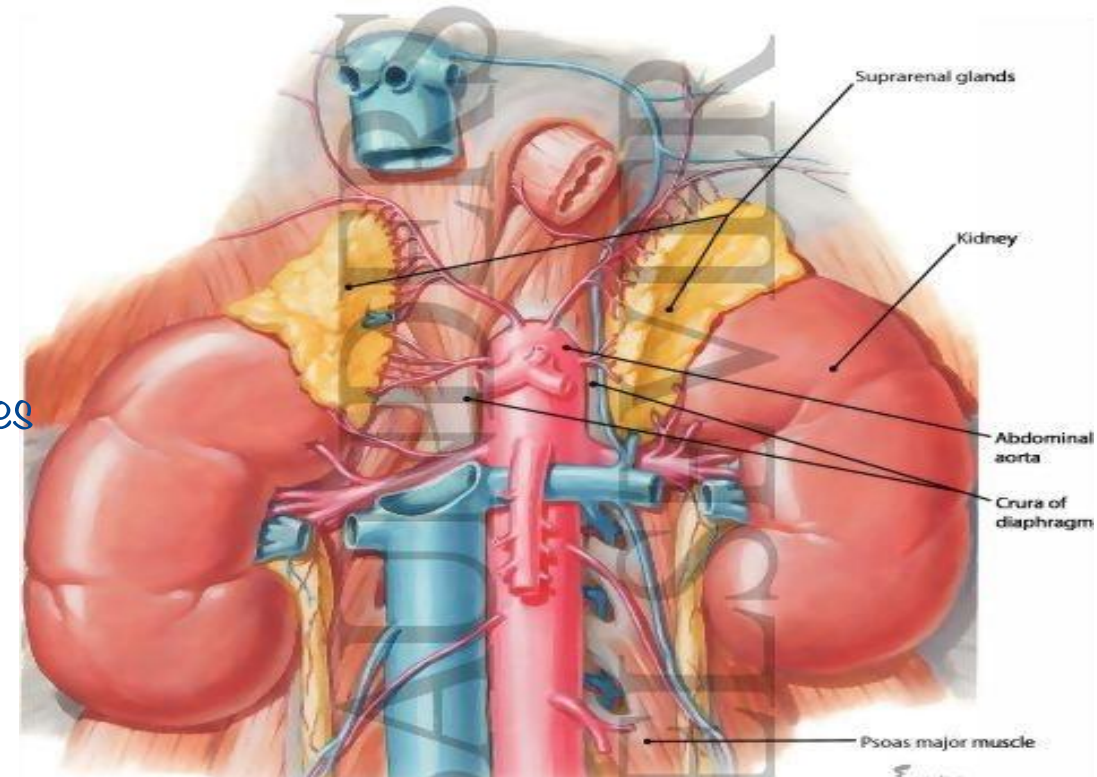
# Arterial Supply of Kidney

## □ Renal artery:

- **Right & Left renal arteries arise from the side of the aorta**
  - ↳ From abdominal artery enters the kidney
- **The renal artery gives:** from the hilum to form segmental branches
  - **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:**

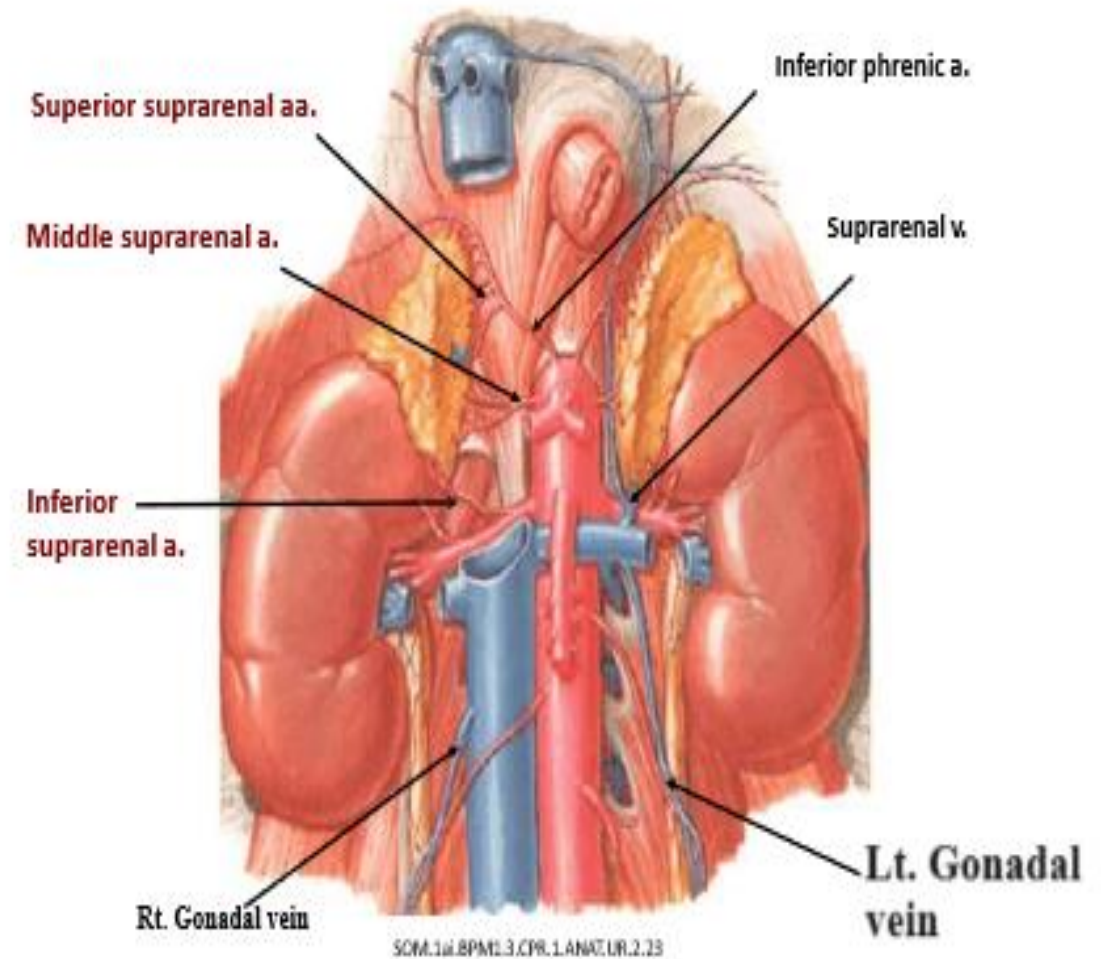
- They **emerge from the hilum** of the corresponding kidney in front of renal artery.
- They **end in I.V.C.**

### Lymphatic drainage:

- **Para-aortic lymph nodes.**  
Around the abdominal aorta

### Nerve supply:

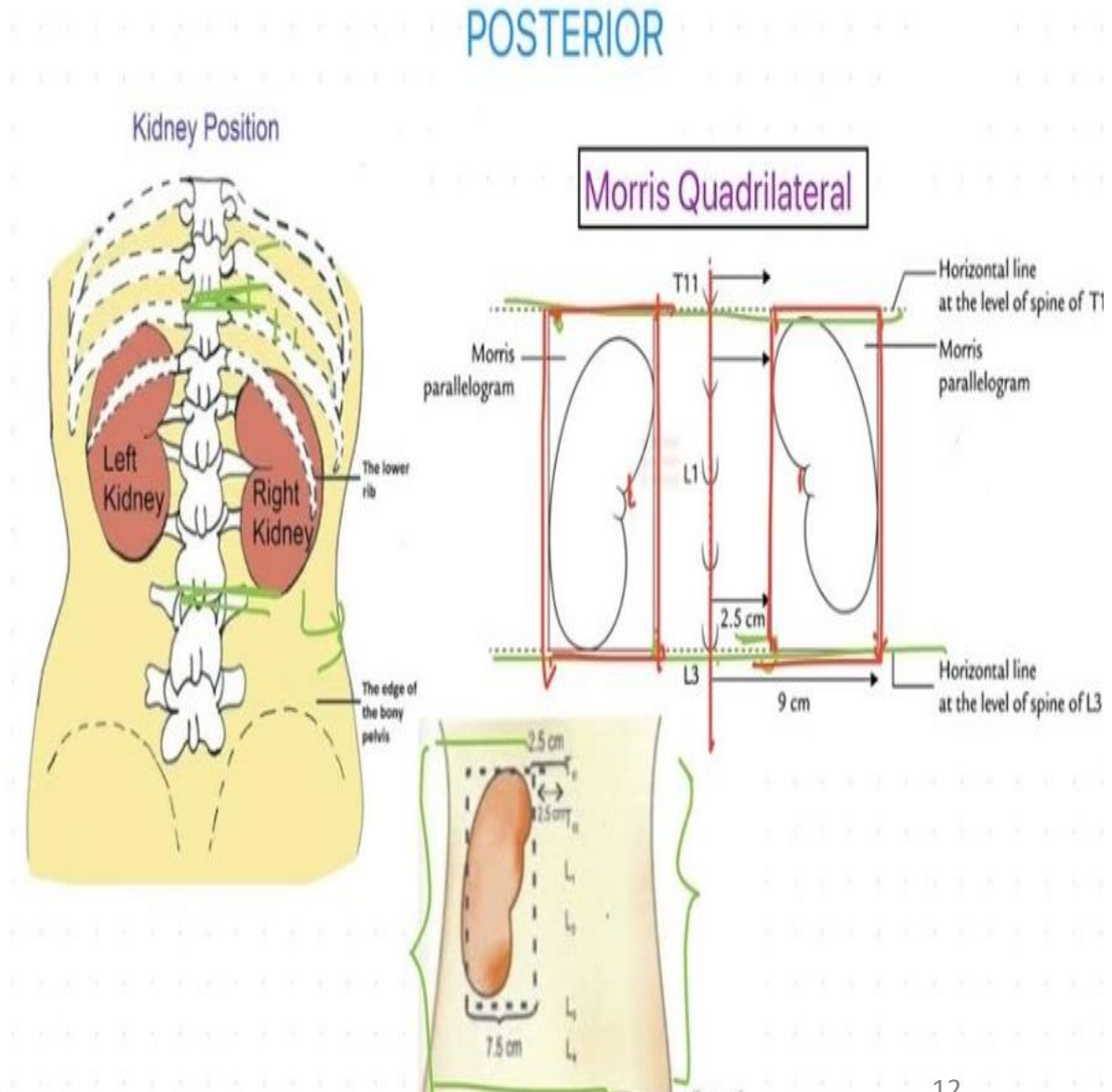
- **Sympathetic fibers from T10 – L1 spinal segments.**



# 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

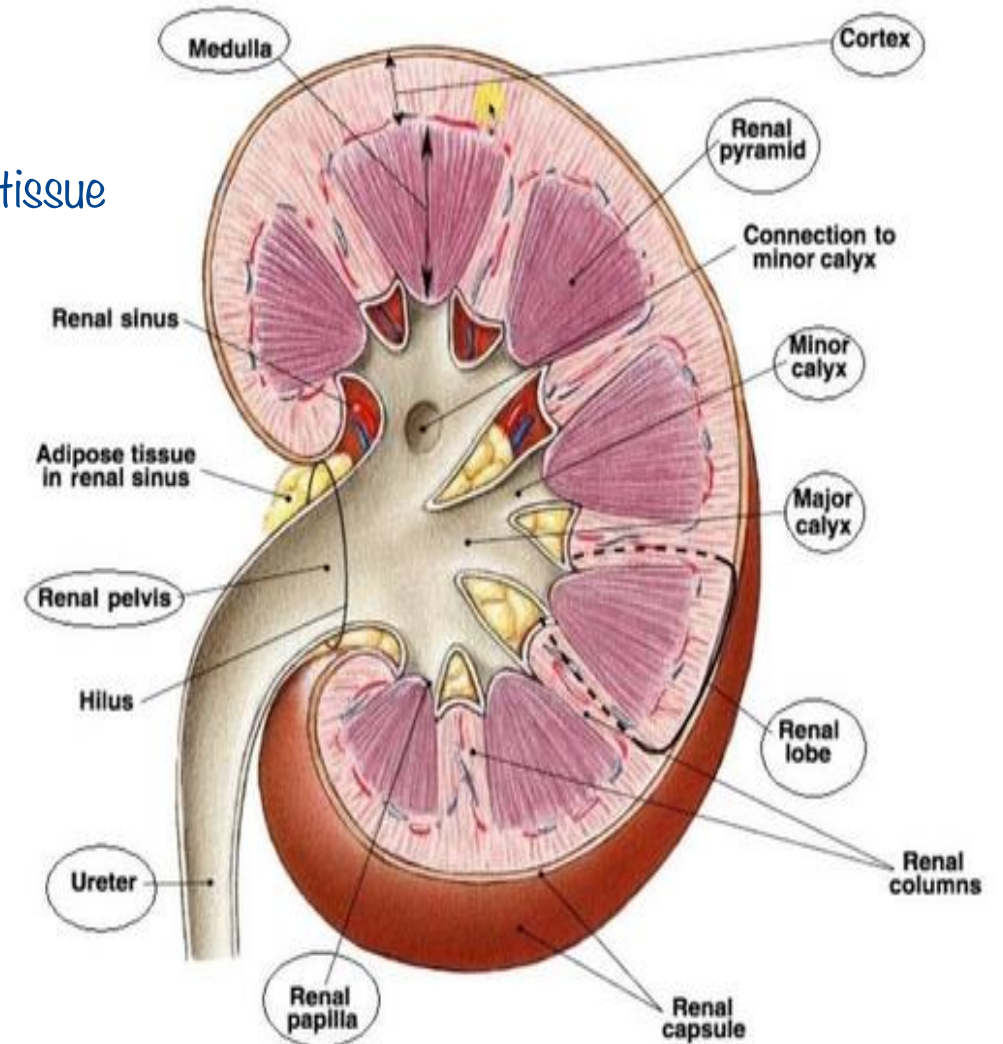
الاشياء التي بقدر اشوفها بعيوني عن طريق اني اخذ longitudinal section و اشوف

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

\* Medullary rays from medulla to the cortex → light rays within cortical tissue

## □ 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. We see medullary rays like lines of light coloured medulla into the darker cortex in the renal column
- The part of cortex close to the medulla is termed **juxtamedullary cortex**.

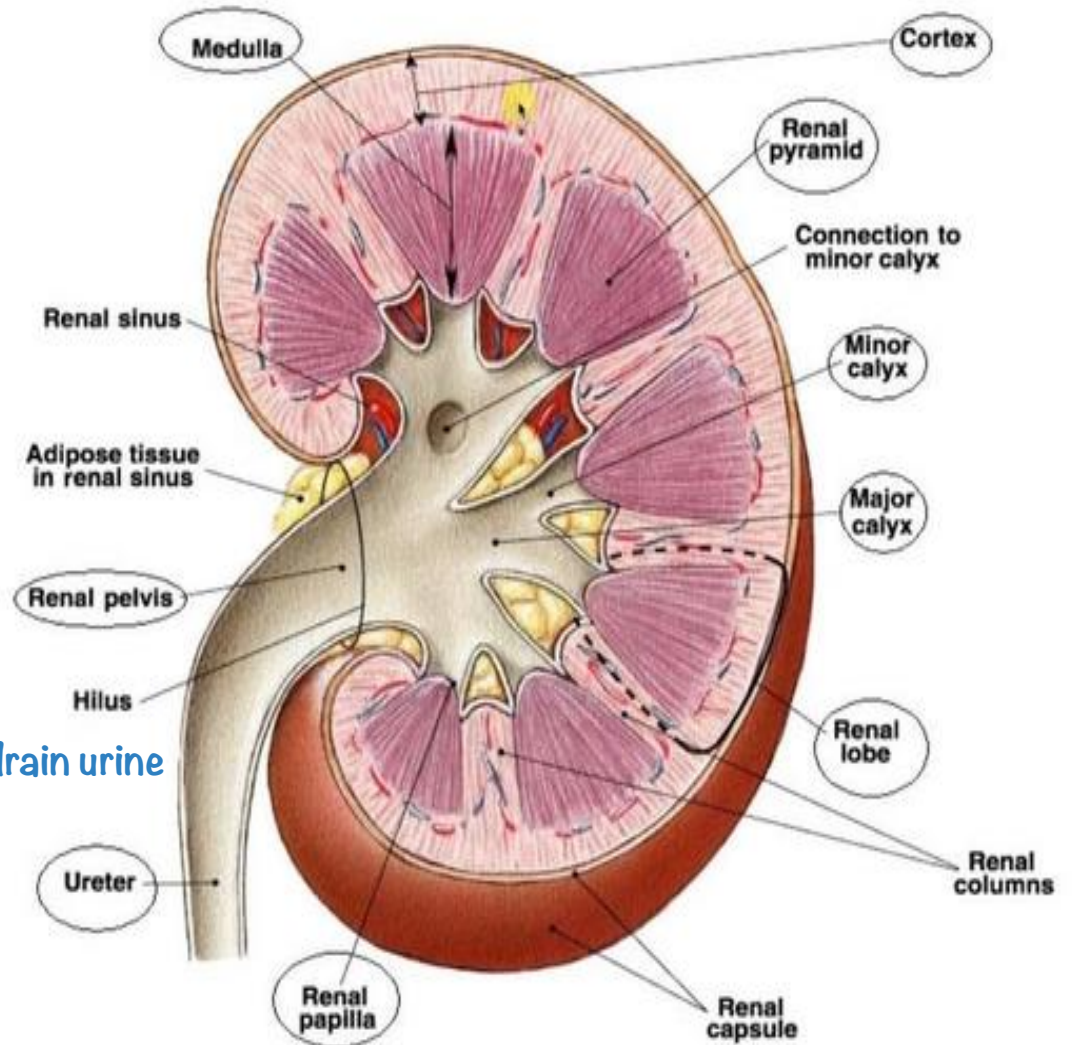




# Internal Macrostructure of Kidney

## □ 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. *It have pores (its perforated) to drain urine*
- Each minor calyx receives from 1-3 papillae.



# Histological Structure of Kidney

## 1-Stroma:

- **Fibrous capsule.**
- **Interstitium** of the cortex and medulla.
  - ↳ Connective tissue

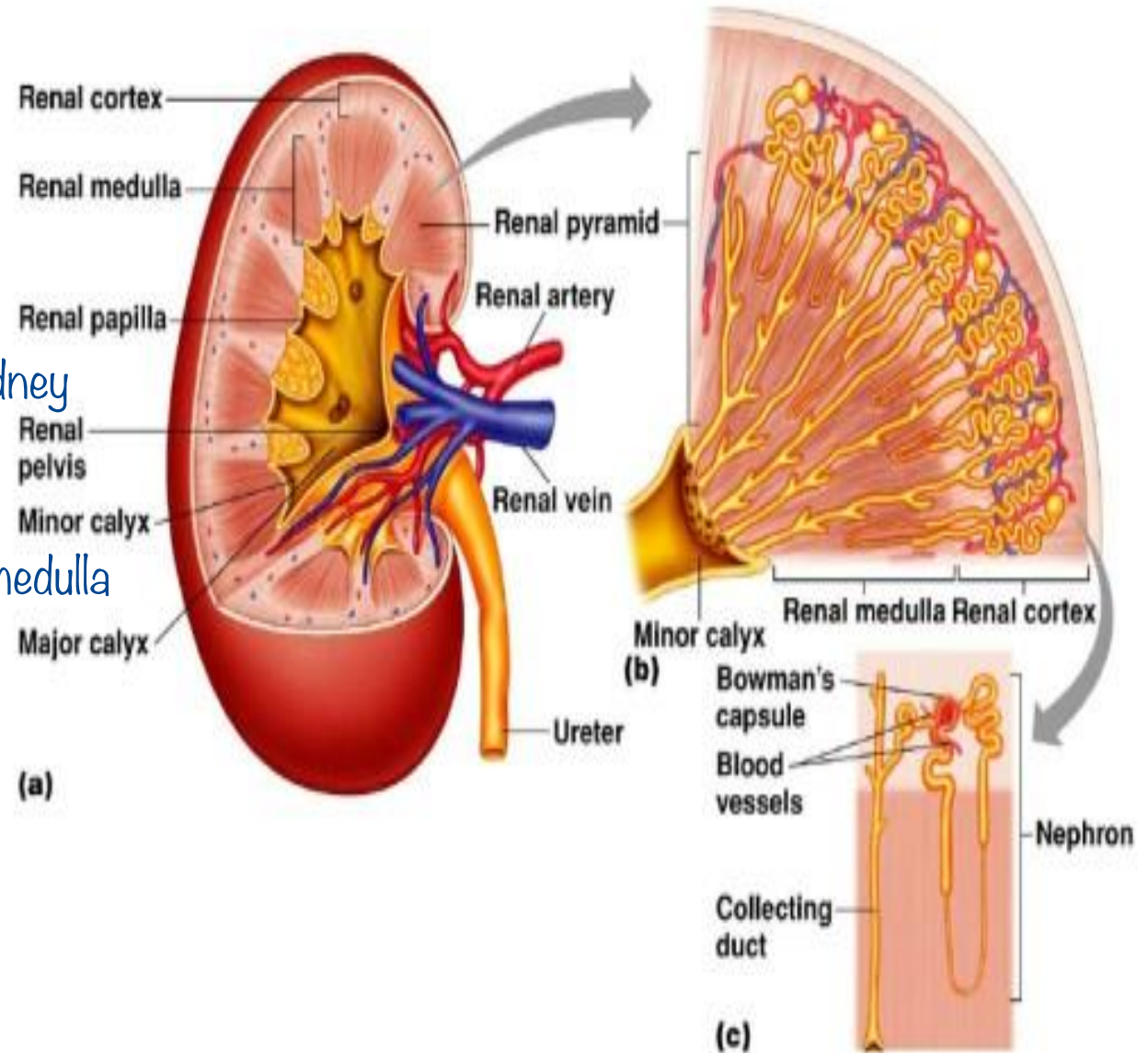
## 2-Parenchyma: \*Structural and functional unit of the kidney

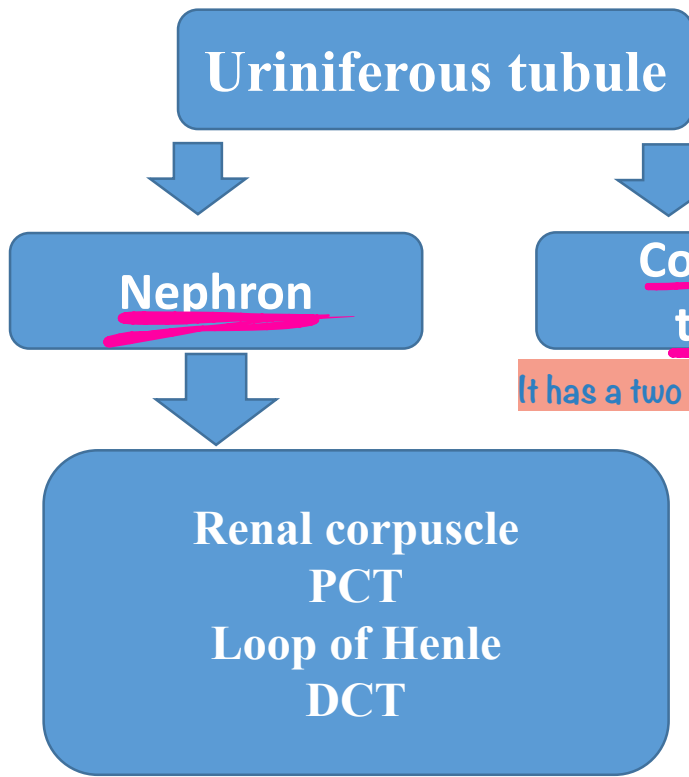
It is formed of the **uriniferous tubules**. Each is formed of:

- The **nephron**.
- The **collecting tubule**.

↳ Parts of tubules in the cortex other in the medulla

\*Parenchyma includes both cortex and medulla

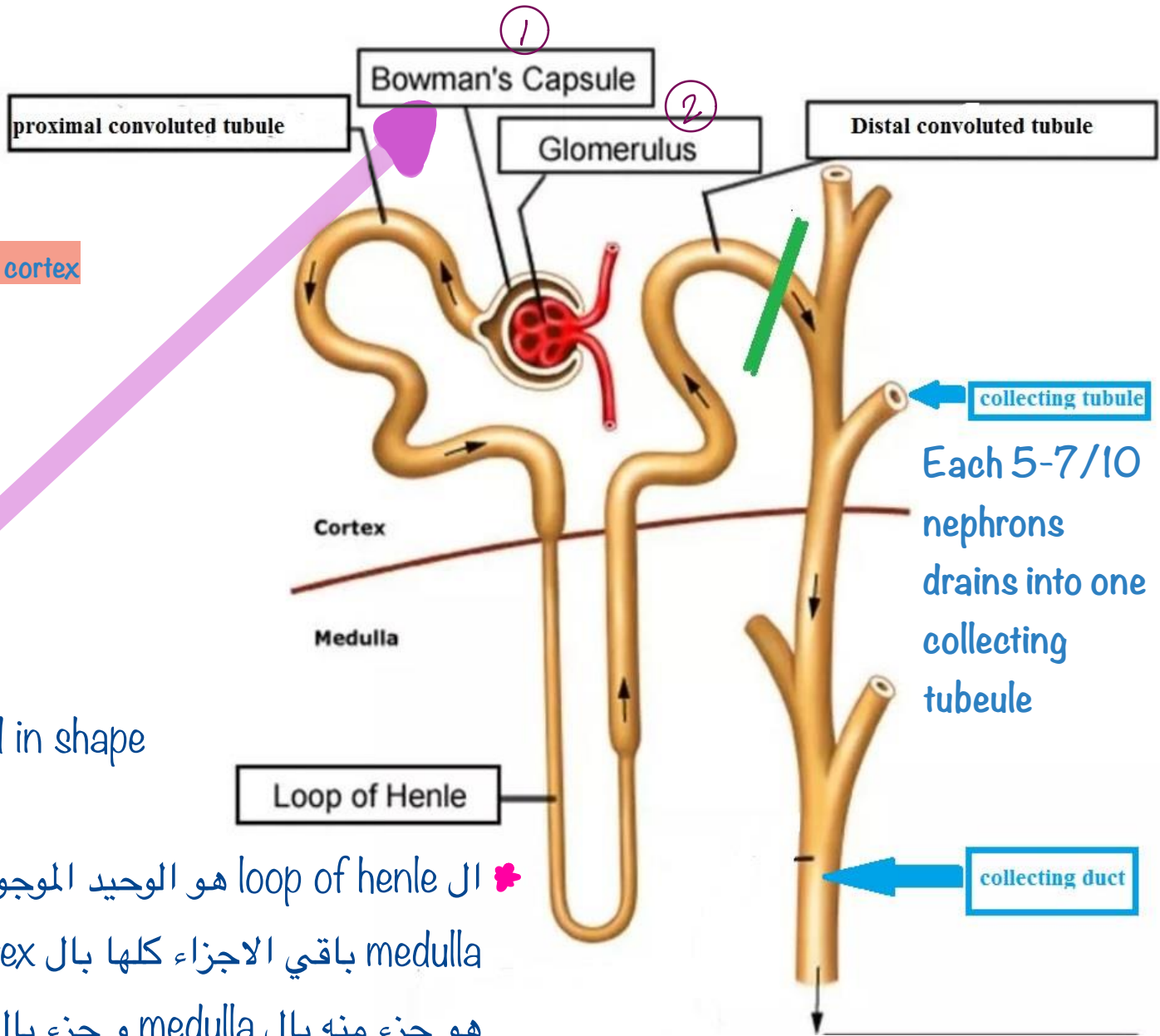




Less in number

Collecting tubule

It has a two parts : in medulla and cortex



**Each nephron consists of;**

- 1- Renal (Malpighian) corpuscle. → Rounded in shape
- 2- Proximal convoluted tubules.
- 3- Loop of Henle. → U shaped tubule
- 4- Distal convoluted tubules.

ال convoluted يعني لافة على حالها

ال loop of henle هو الوحيد الموجود بال medulla باقي الاجزاء كلها بال cortex حاي هو جزء منه بال medulla و جزء بال cortex

Each 5-7/10 nephrons drains into one collecting tubeule

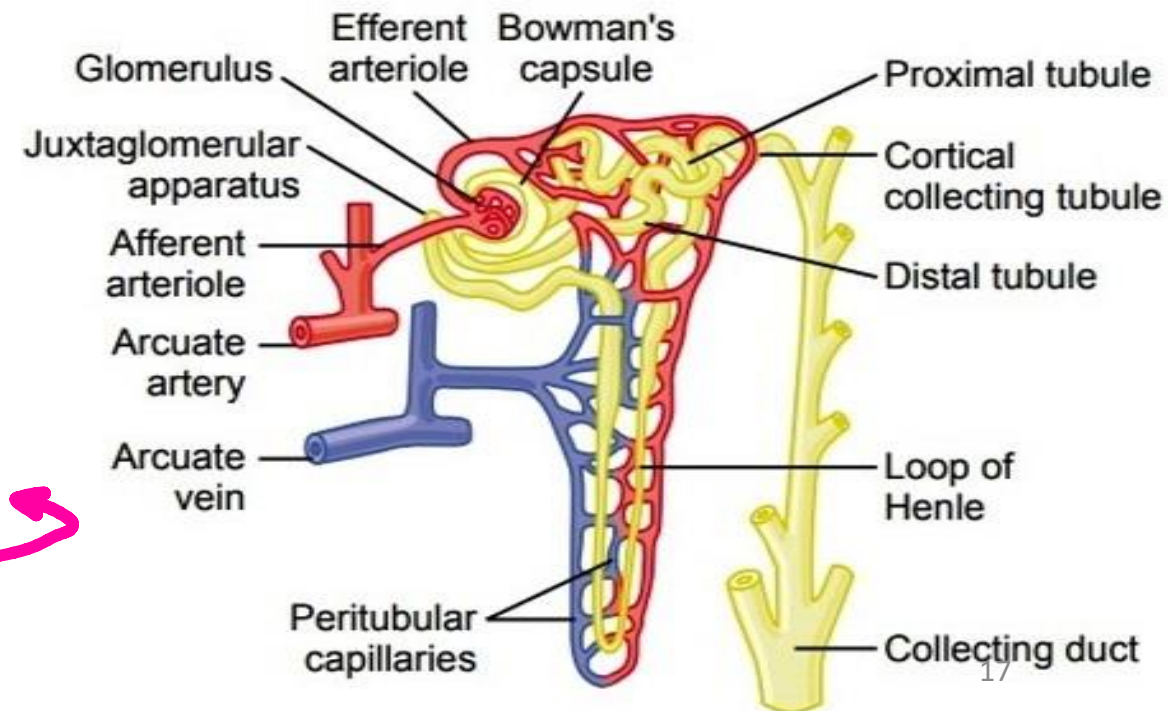
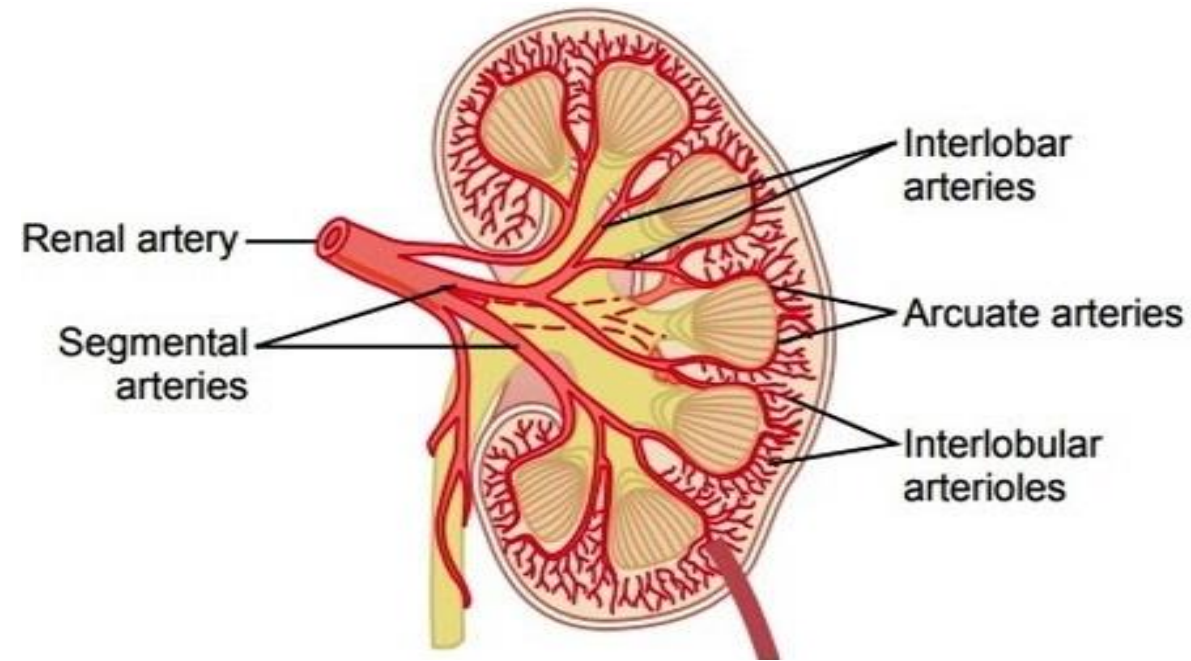


# Distribution of Renal Vessels

↪ 5 branches

- 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**.

Radial in direction in renal cortex

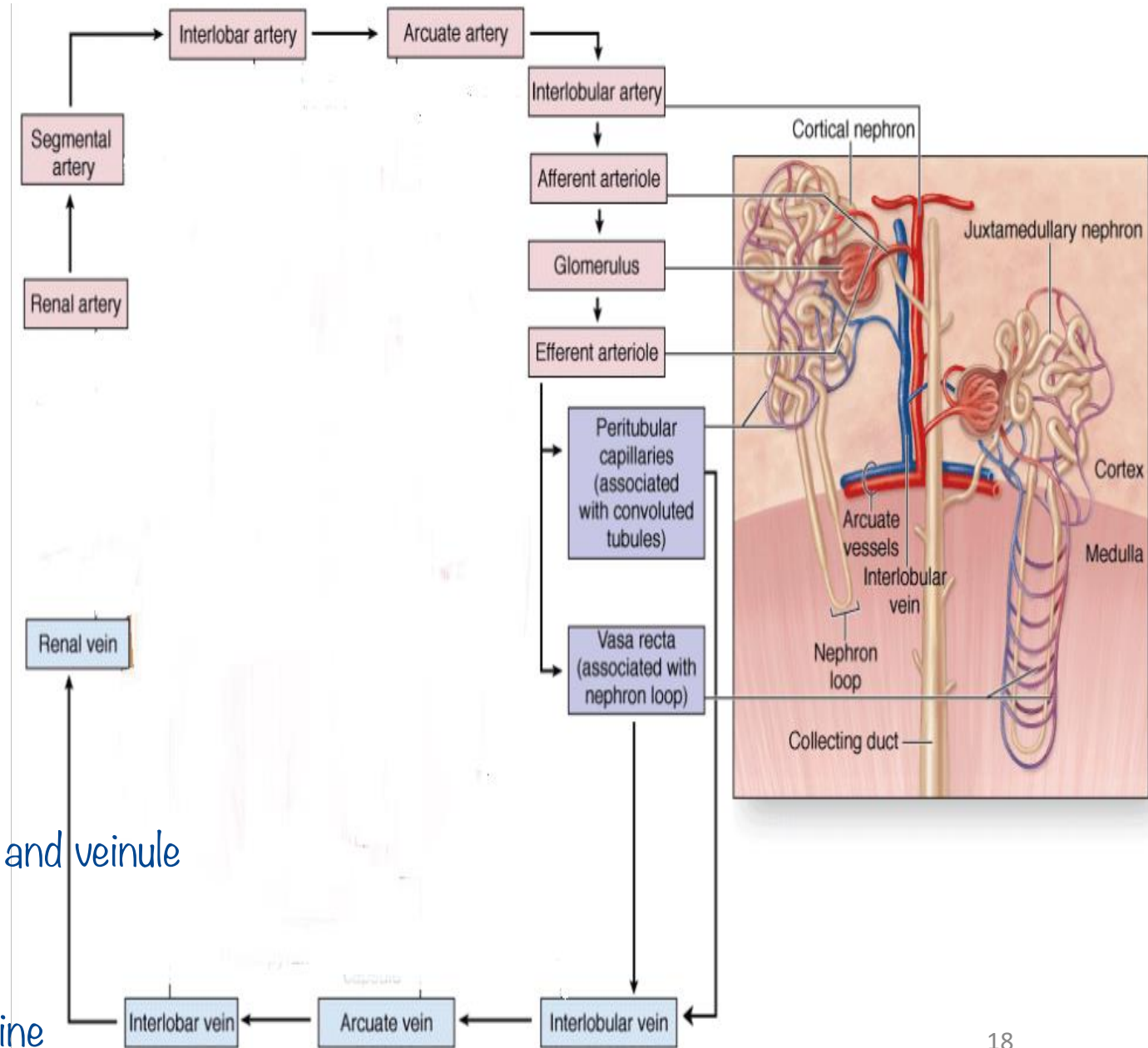




# Distribution of Renal Vessels

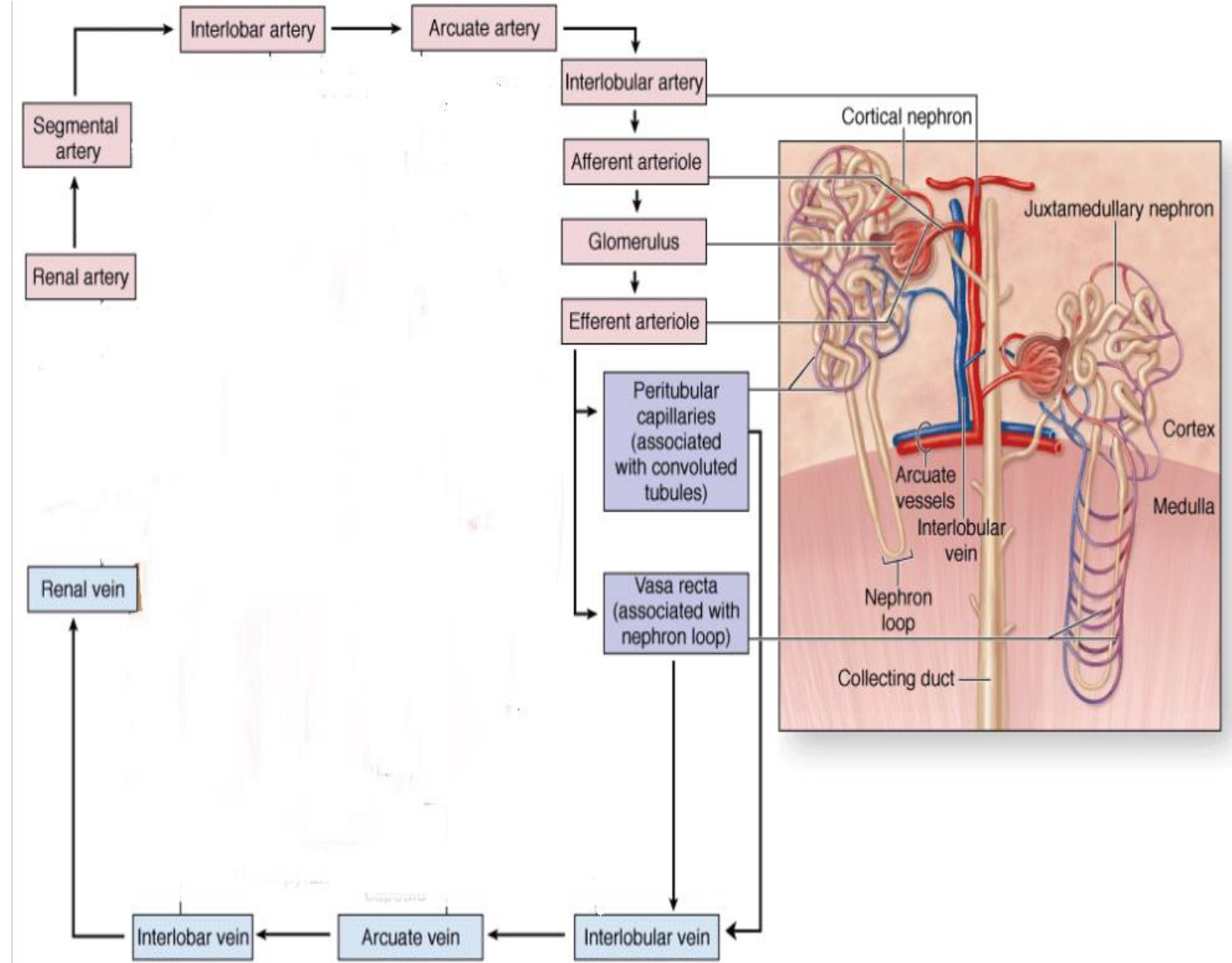
تبعوا على الرسمة ما بتضيعوا بالتقسيم

- **The afferent arterioles** arise as branches of the interlobular arteries.
- **The afferent arterioles** form a capillary network, (**Glomerulus**), where filtration takes place. *↳ Corpuse of nephron*
- The capillaries of glomerulus come together to form the efferent arterioles.
- *✳ For proximal and distal convoluted tubules ↶*
- Efferent arterioles form **peritubular network capillaries** that surround the cortical parts of the nephron. *↳ Straight arterial and veinule*
- **Vasa recta** are straight capillary loops, *↳* lie in renal medulla close to Henle's loop.
- *✳ Related for mechanism responsible for concentration of urine*



# 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.

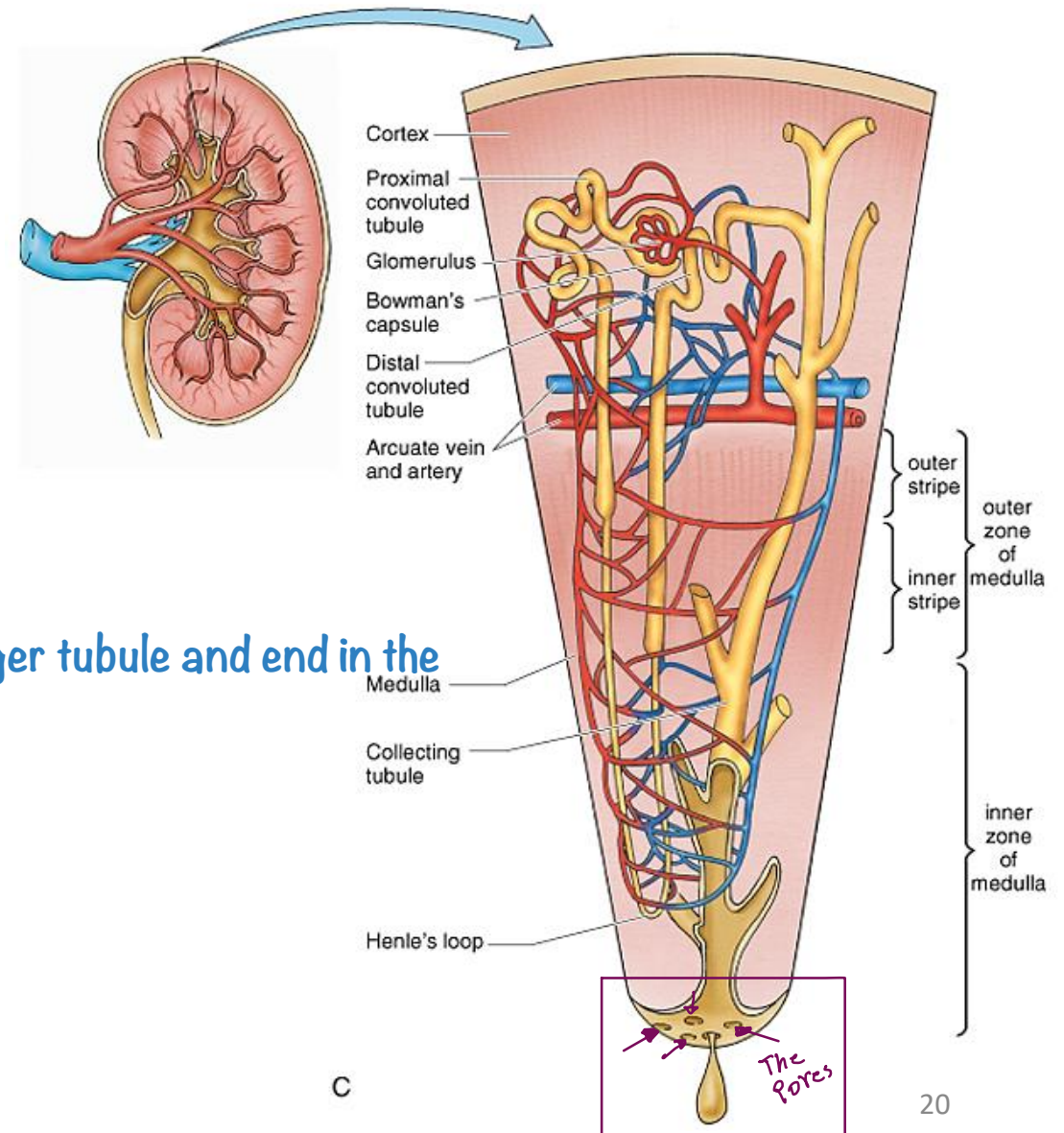


# Urineriferous tubule

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

□ Urineriferous tubule consists of two parts;

- **Nephron.**
- **Collecting tubule.**
- There are approximately 1.3 million nephrons in each kidney. *The collecting tubules join together to form larger tubule and end in the*
- 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):

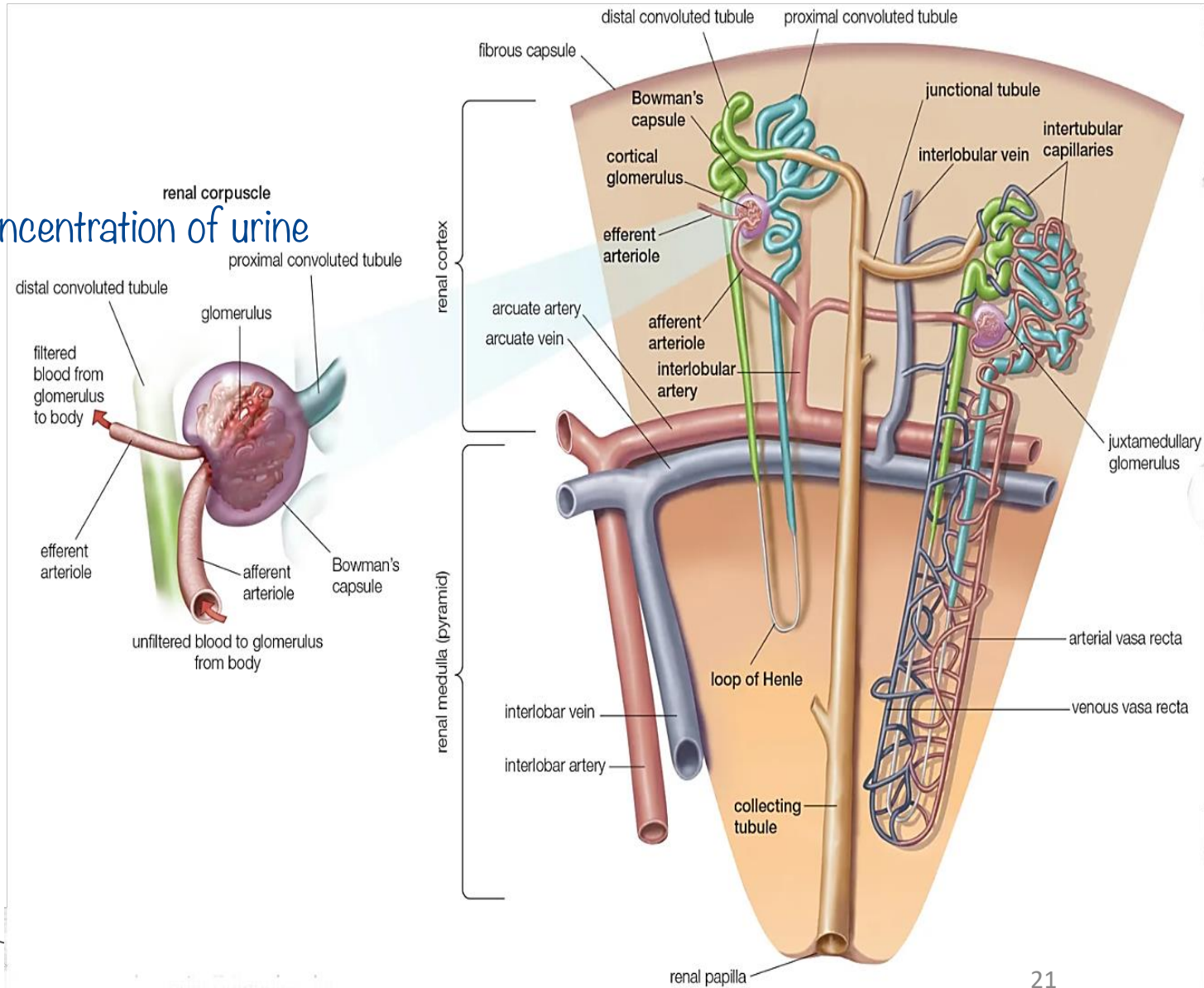
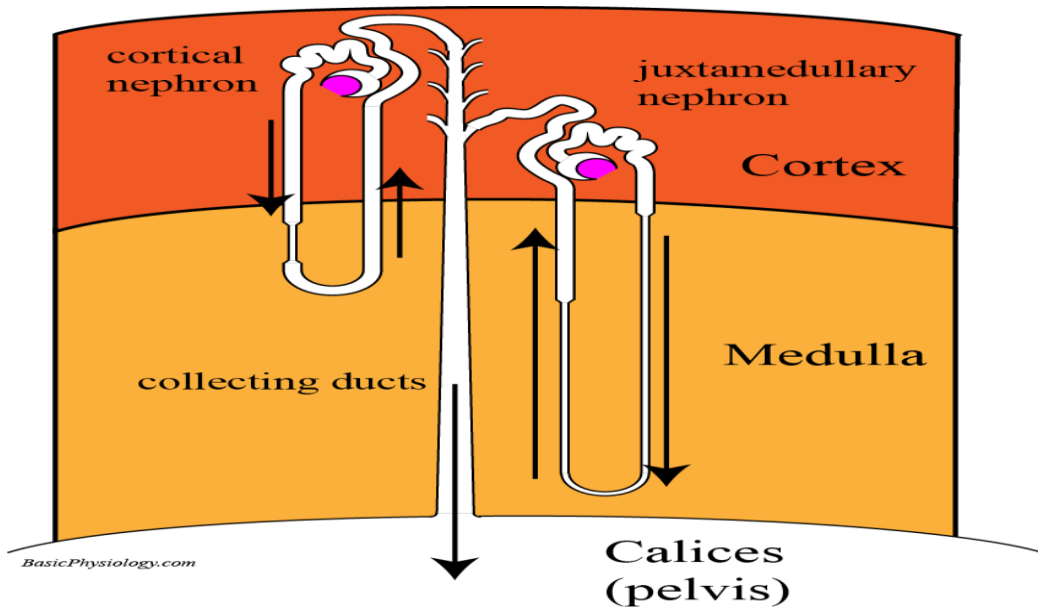
Their renal corpuscles in outer cortex & have short loops of Henle.

Responsible of concentration of urine

### b) Long nephrons (Juxta-medullary nephron):

Their renal corpuscles in deep cortex & have long loops of Henle.

15-20%



# 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.

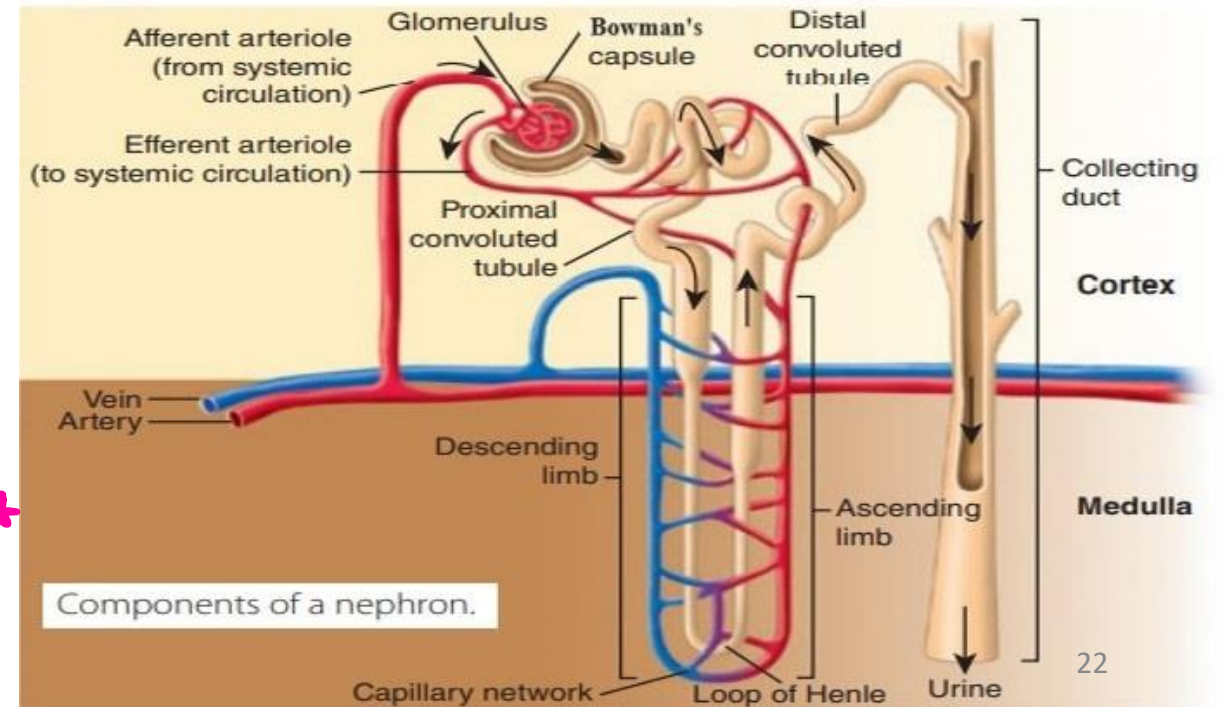
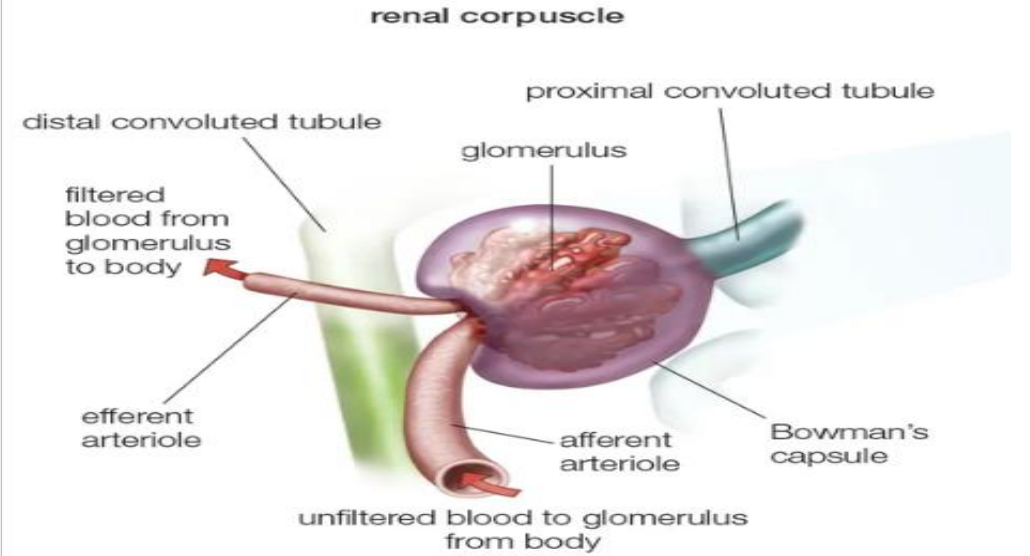
b. **Urinary pole;** where the proximal convoluted tubule begins.

- Each corpuscle consists of:

A. **Bowman's capsule.**

B. **Glomerulus.**

ال Bowman capsule زي البلون الجهة الي انت نفخت منها بتعتبر عن ال vascular pole و الجهة الثانية الي راح تعمل invagination و يكون جواها ال glomerulus و هيك بتصير double layer و بينهم space بتشبه فكرة ال peritonium

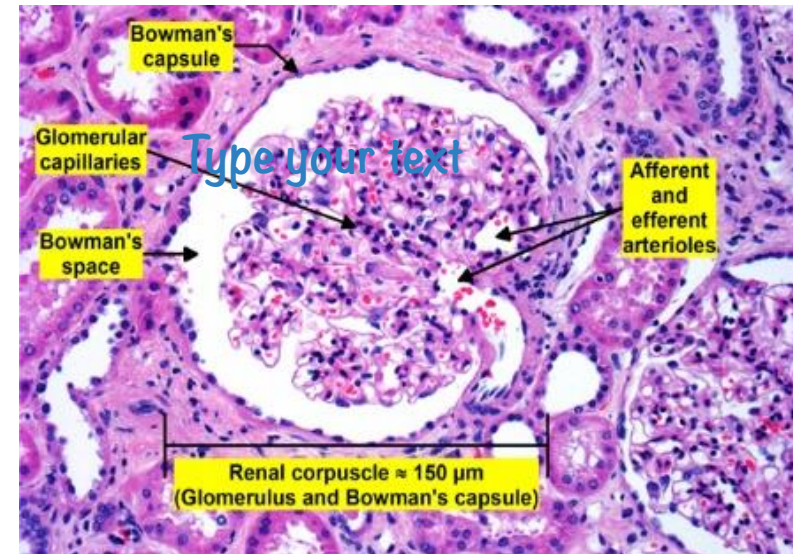
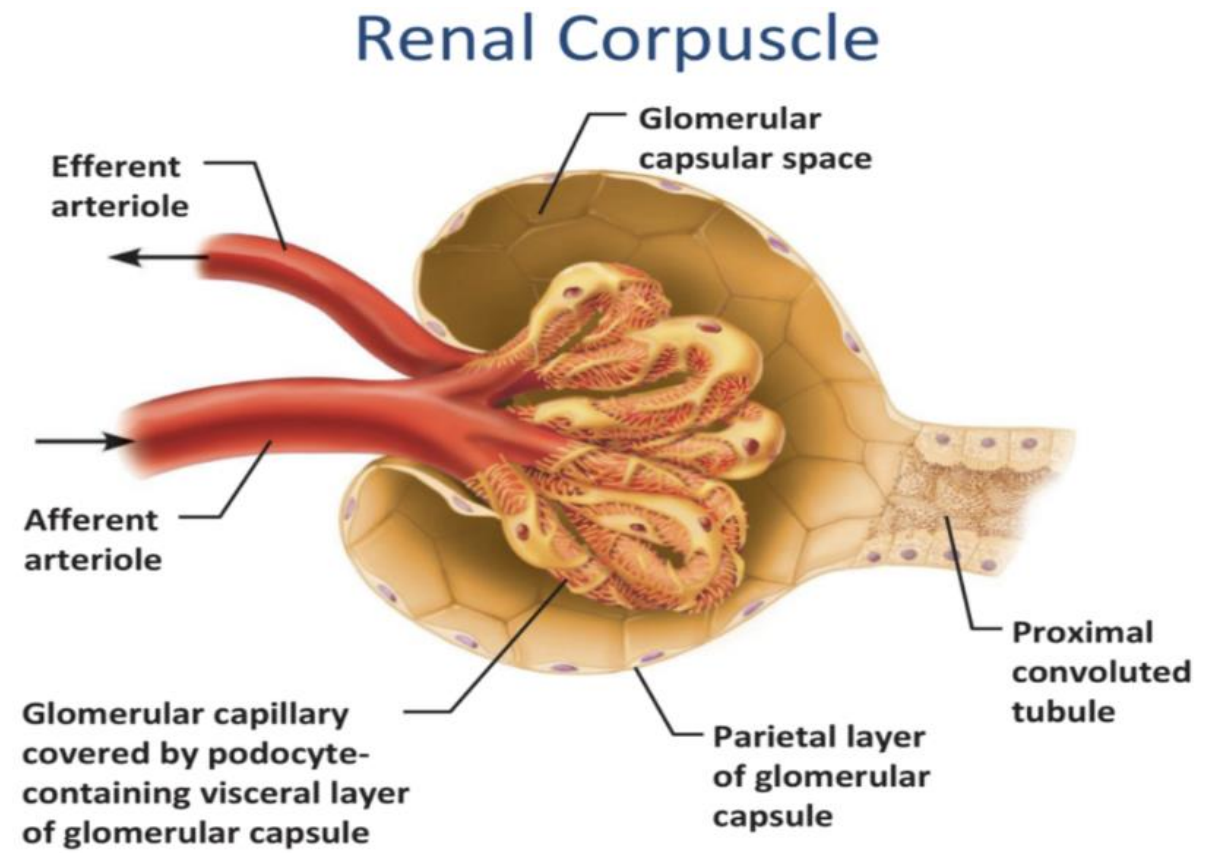




# Renal Corpuscle

## 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.

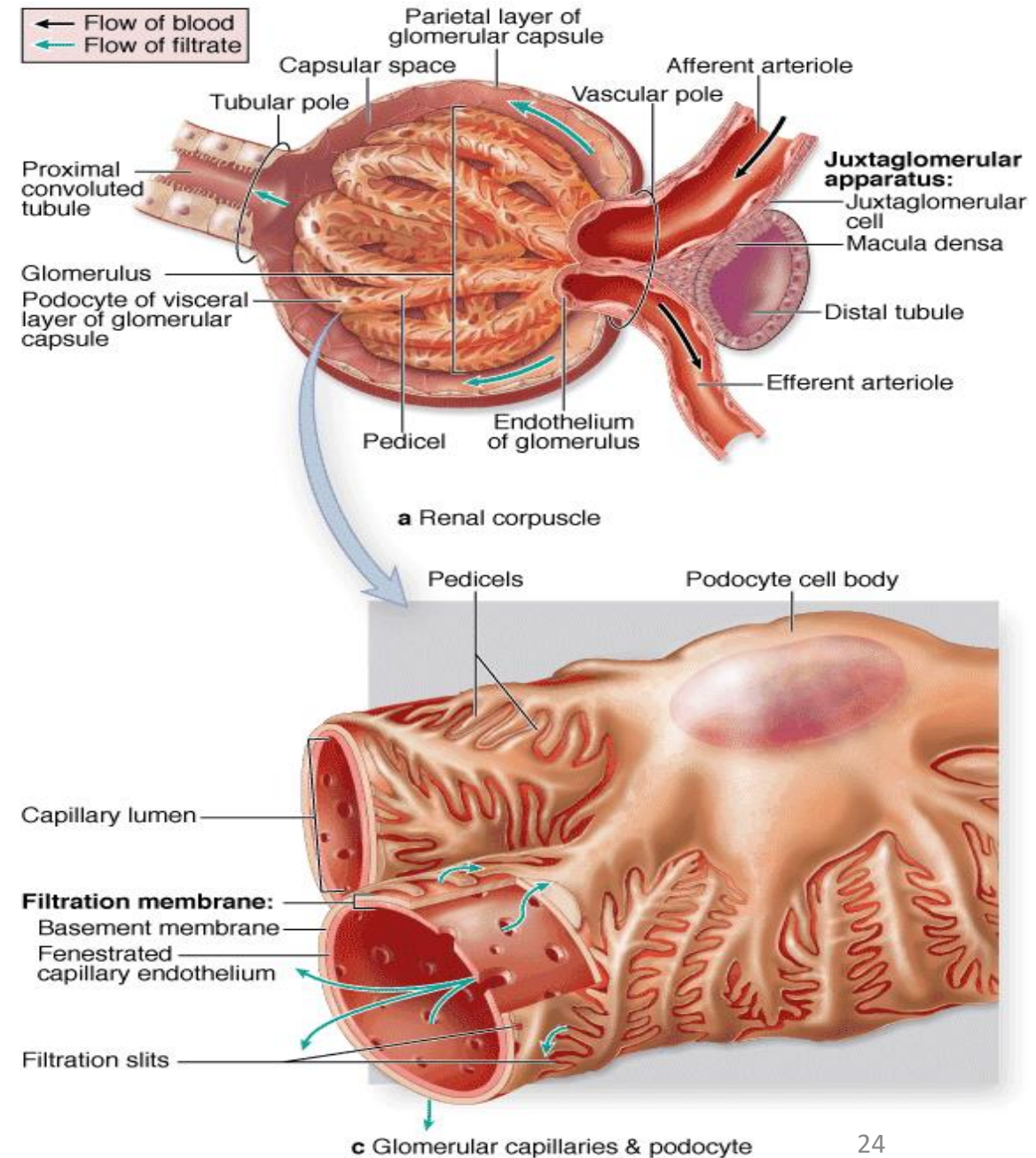


# Podocytes

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

## E/M:

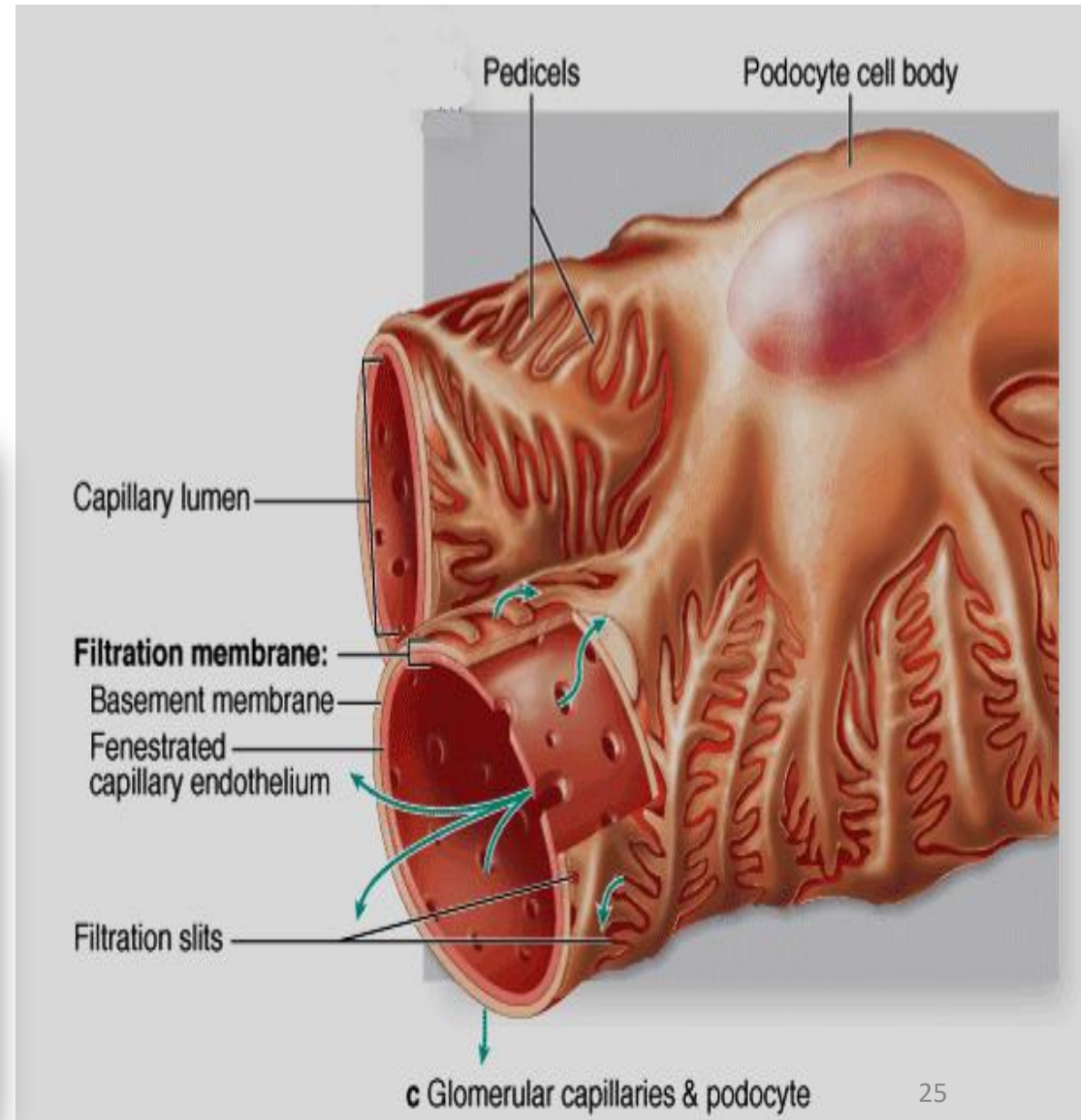
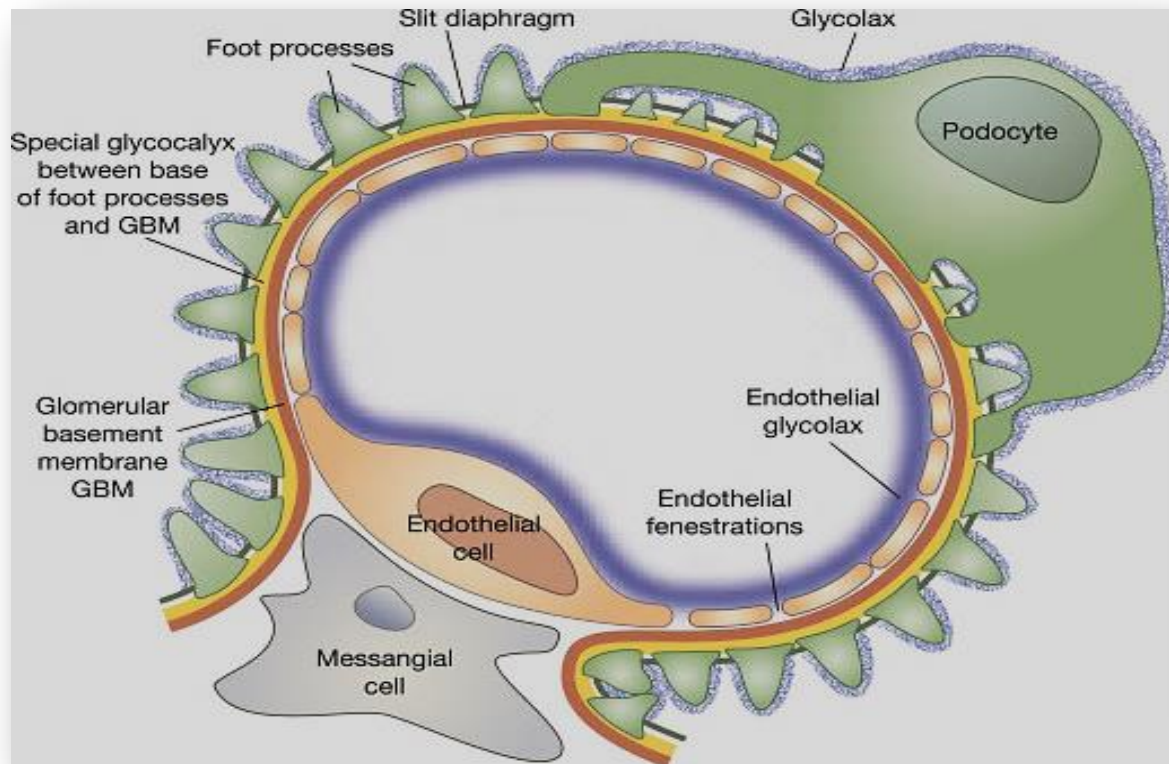
- They are large flattened stellate shaped cells. Each has cell body and several radiating primary processes.
- Primary processes give rise to numerous secondary processes that give foot-processes or pedicels.
- The secondary processes & their feet are closely applied to the basal lamina of the underlying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

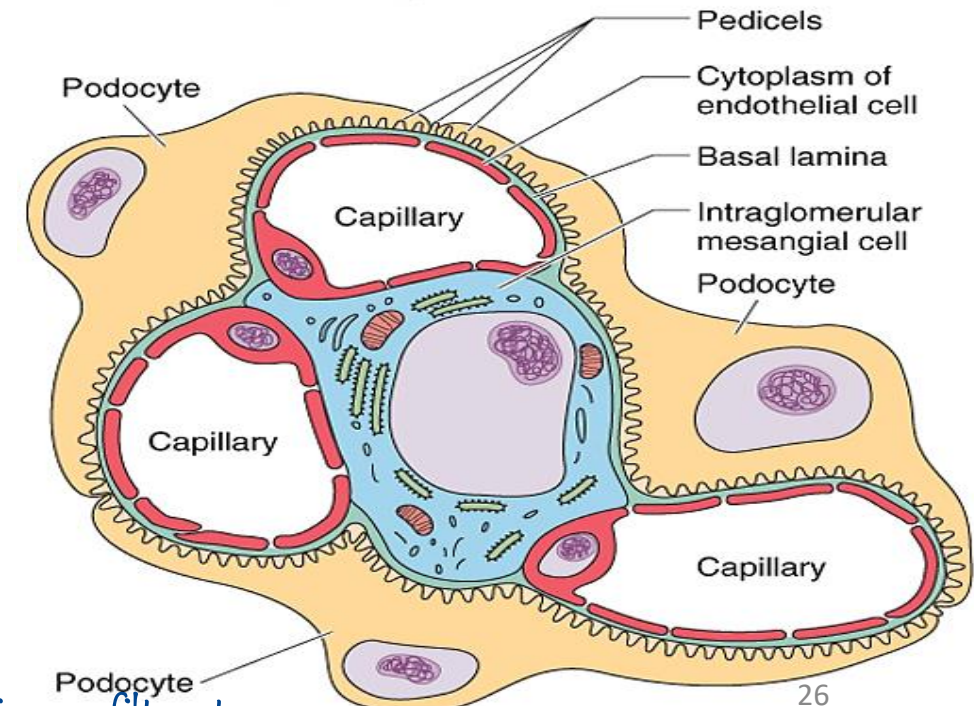
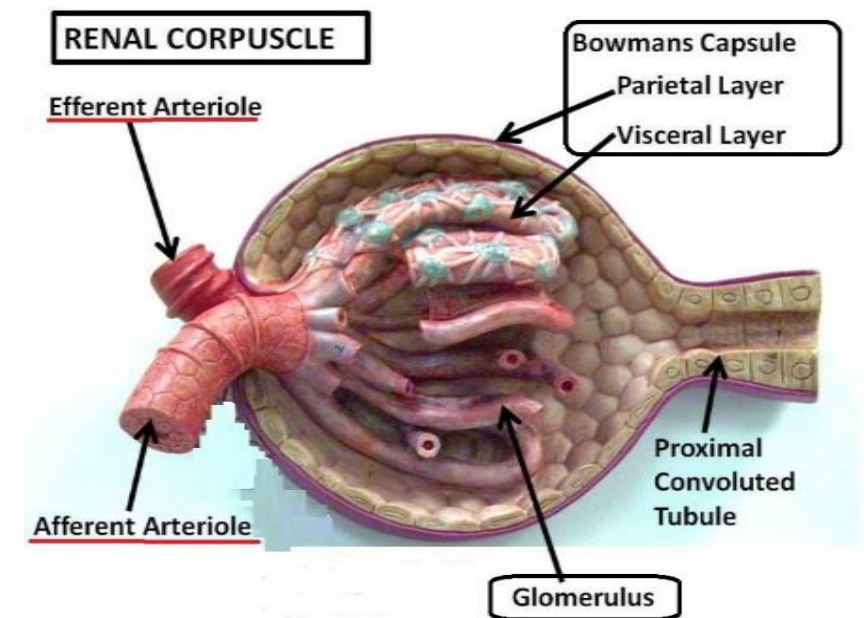
1. **Glomerular capillaries.**
2. **Mesangial cells.** *Connective tissue*

## 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.

↳ Responsible for filtration of blood and forming urinary filtrate

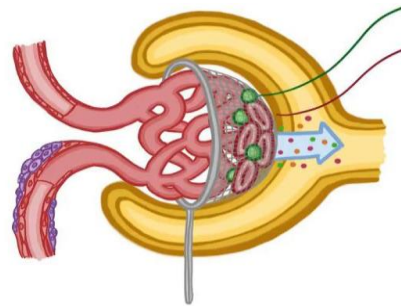




# Glomerulus

## 2-Mesangial cells:

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

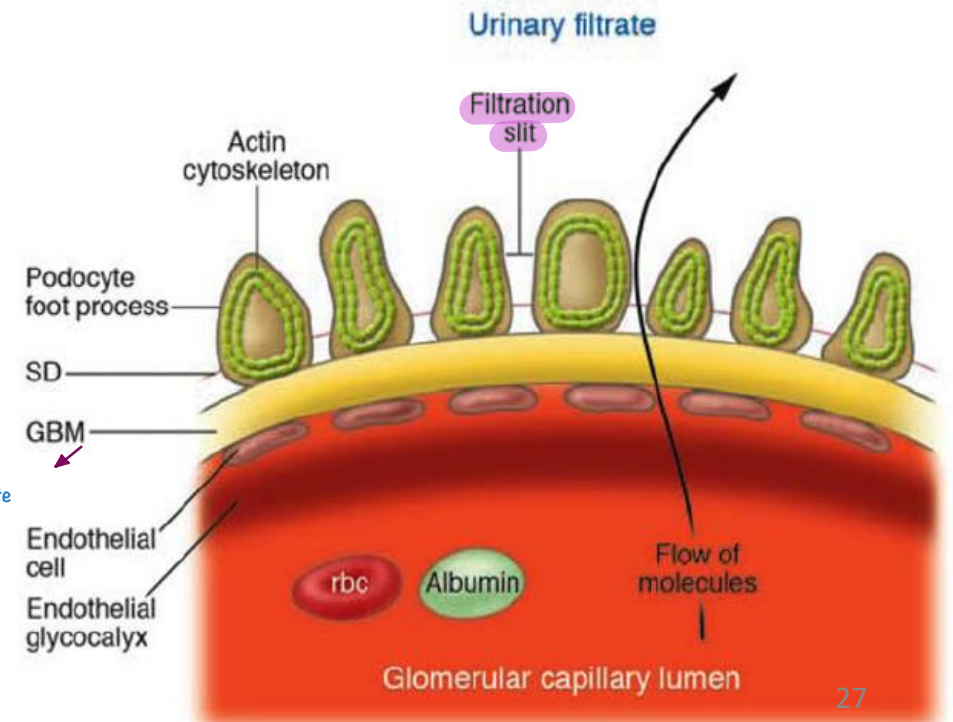
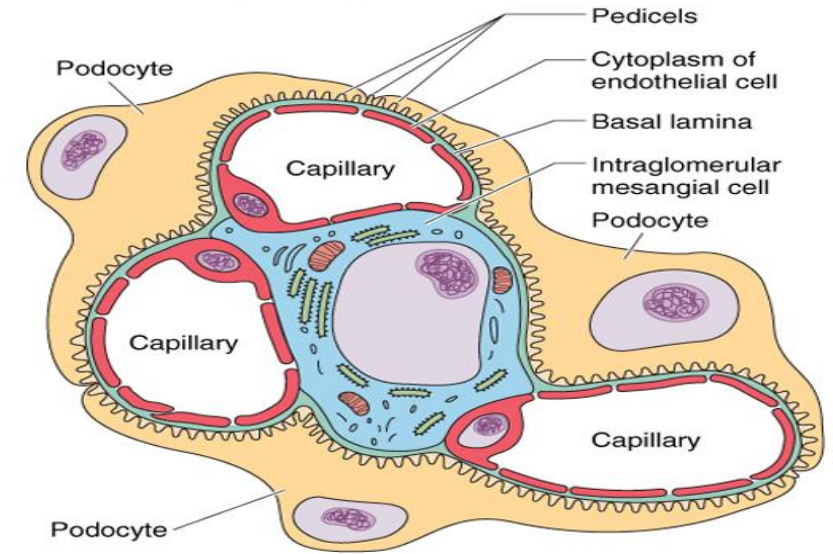


## □ Blood renal barrier:

### 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....

The basment membrane of podocyte and endothelial cells



## Structures of blood renal barrier:

3 layers

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



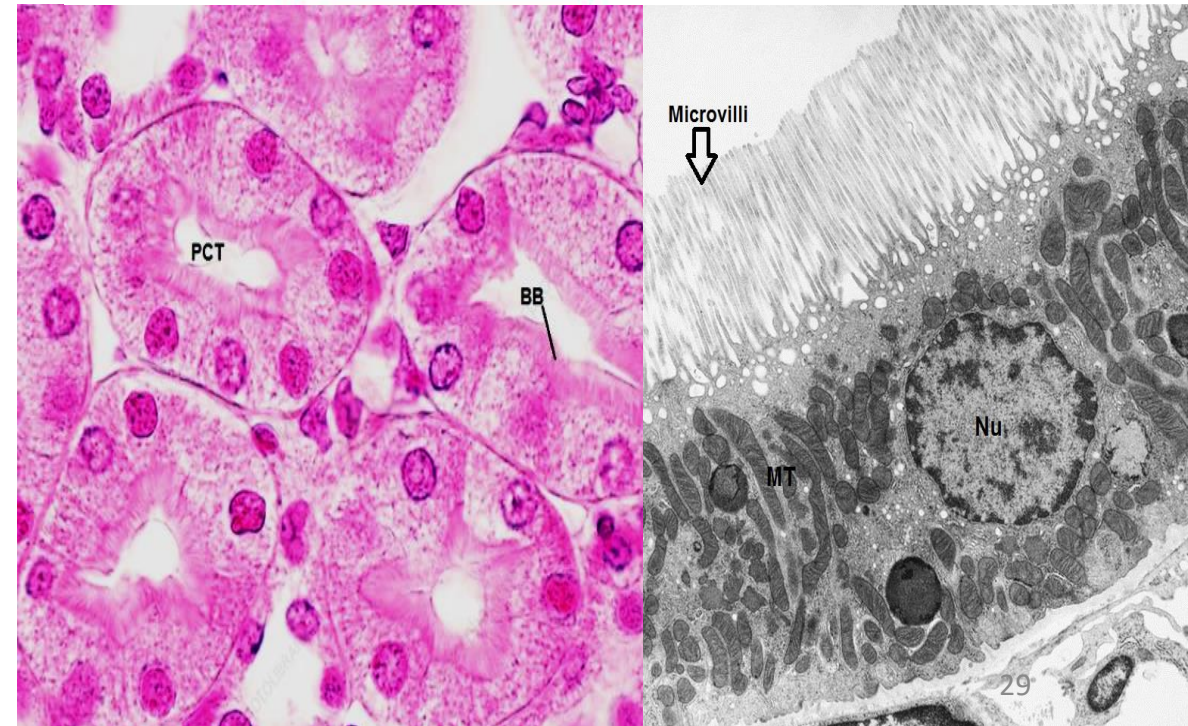
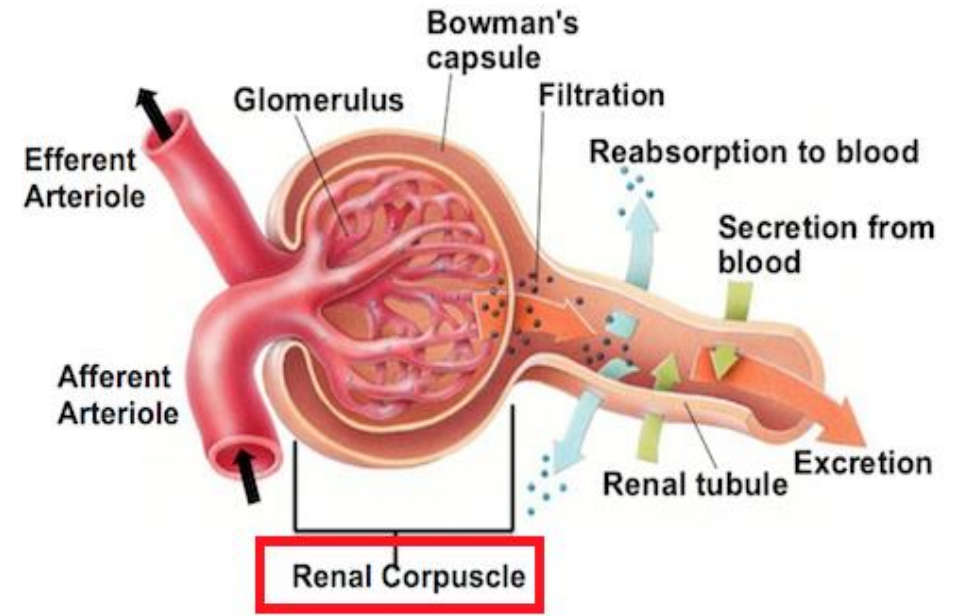
# Proximal Convoluted Tubules

- 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):

مقارنة بال distal

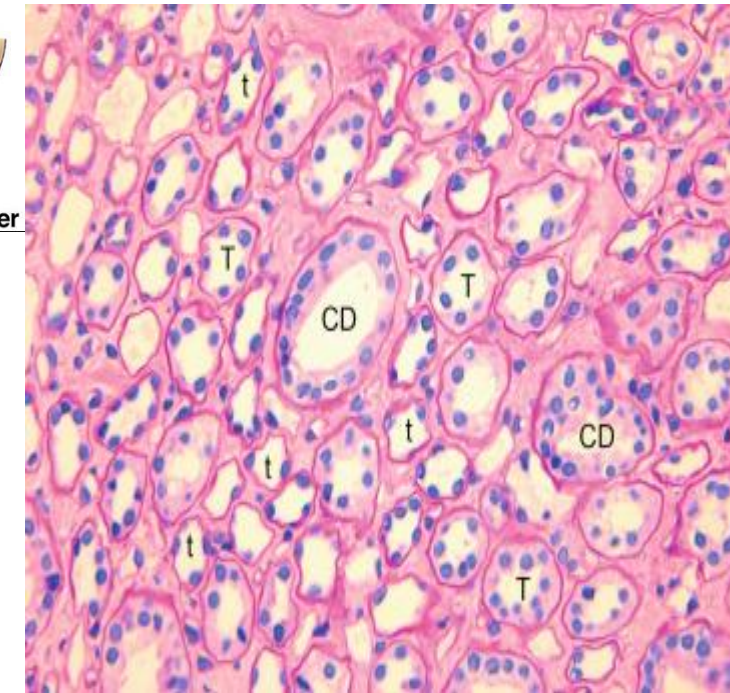
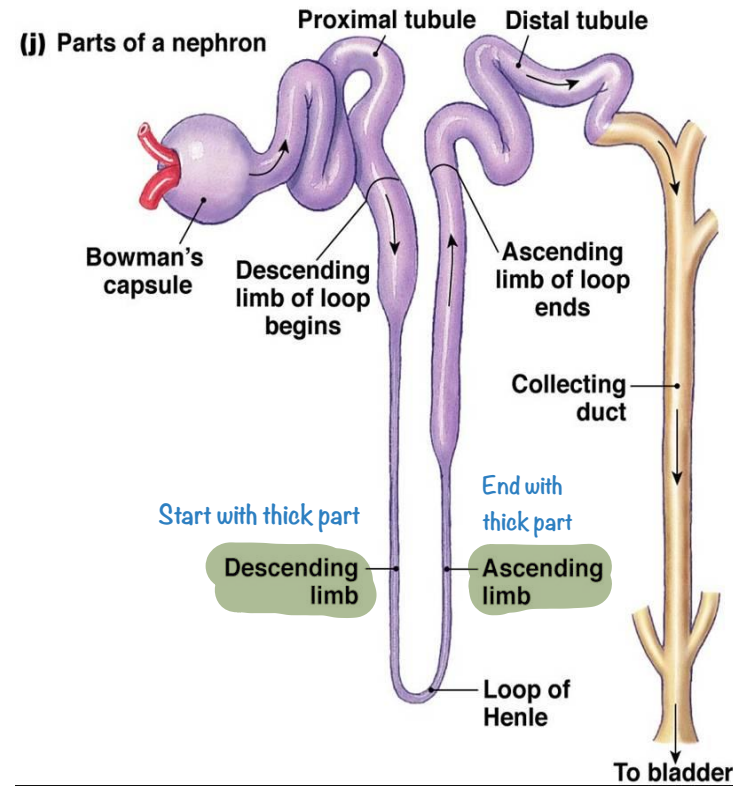
- The lumen is relatively narrow.
- Lined with simple high cuboidal epithelium.
- The luminal surface shows brush border (**Long microvilli**).
- The basal part has striation (**Basal infoldings and many mitochondria**).
- The cell borders are indistinct (**Extensive lateral interdigitation**).
- (**Pinocytotic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



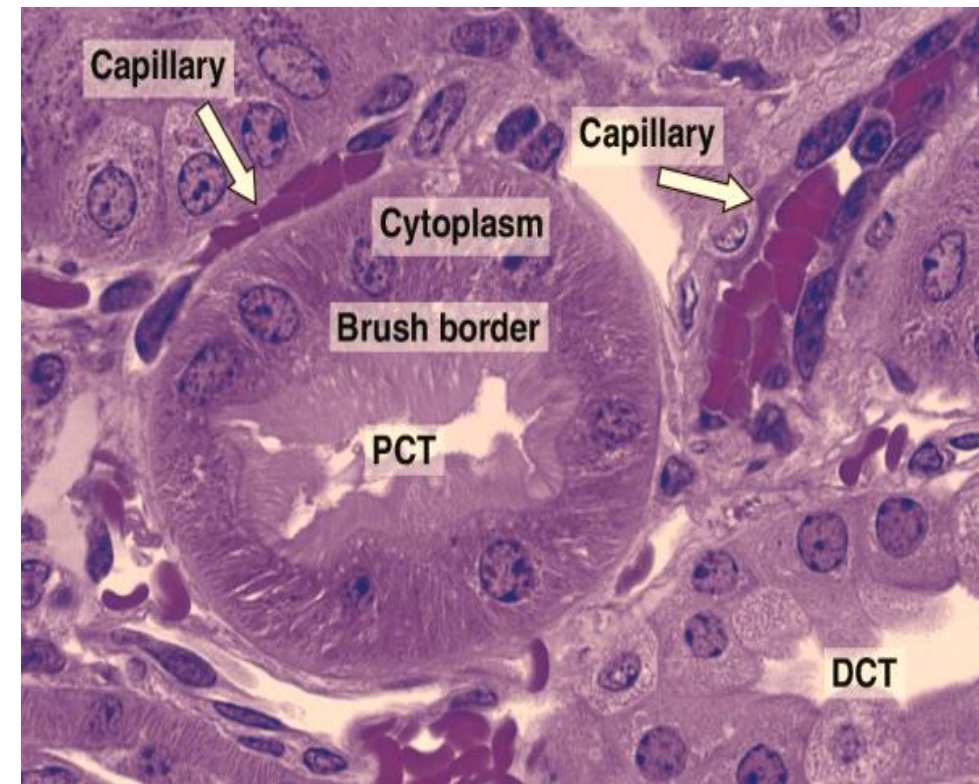
# Distal Convoluted Tubule

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

Facultative reabsorption of water and Na.....

## L/M & (EM):

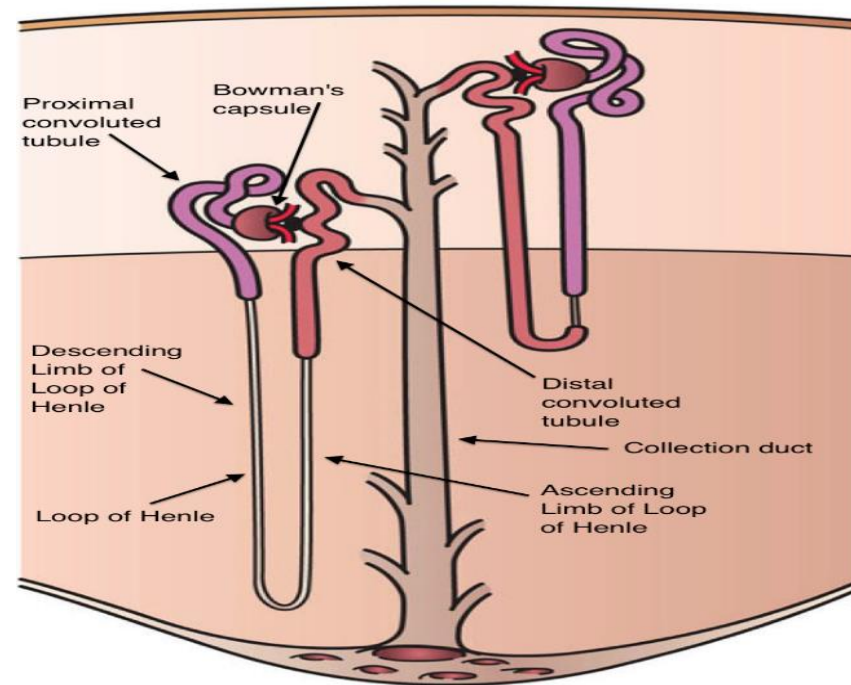
- It is lined with simple cuboidal epithelium.
- The luminal border shows **no brush border (little microvilli)**.  
*Less active than PCT*
- The lumen is **slightly wider** than of the proximal tubules.
- Basal striations (**Basal infolding and mitochondria**).





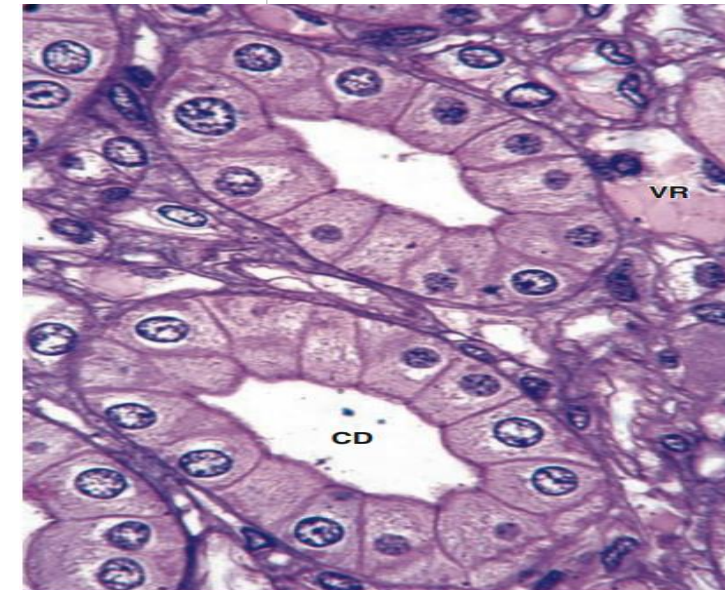
# Collecting Tubules & Ducts

- **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. *bigger one*



## 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>

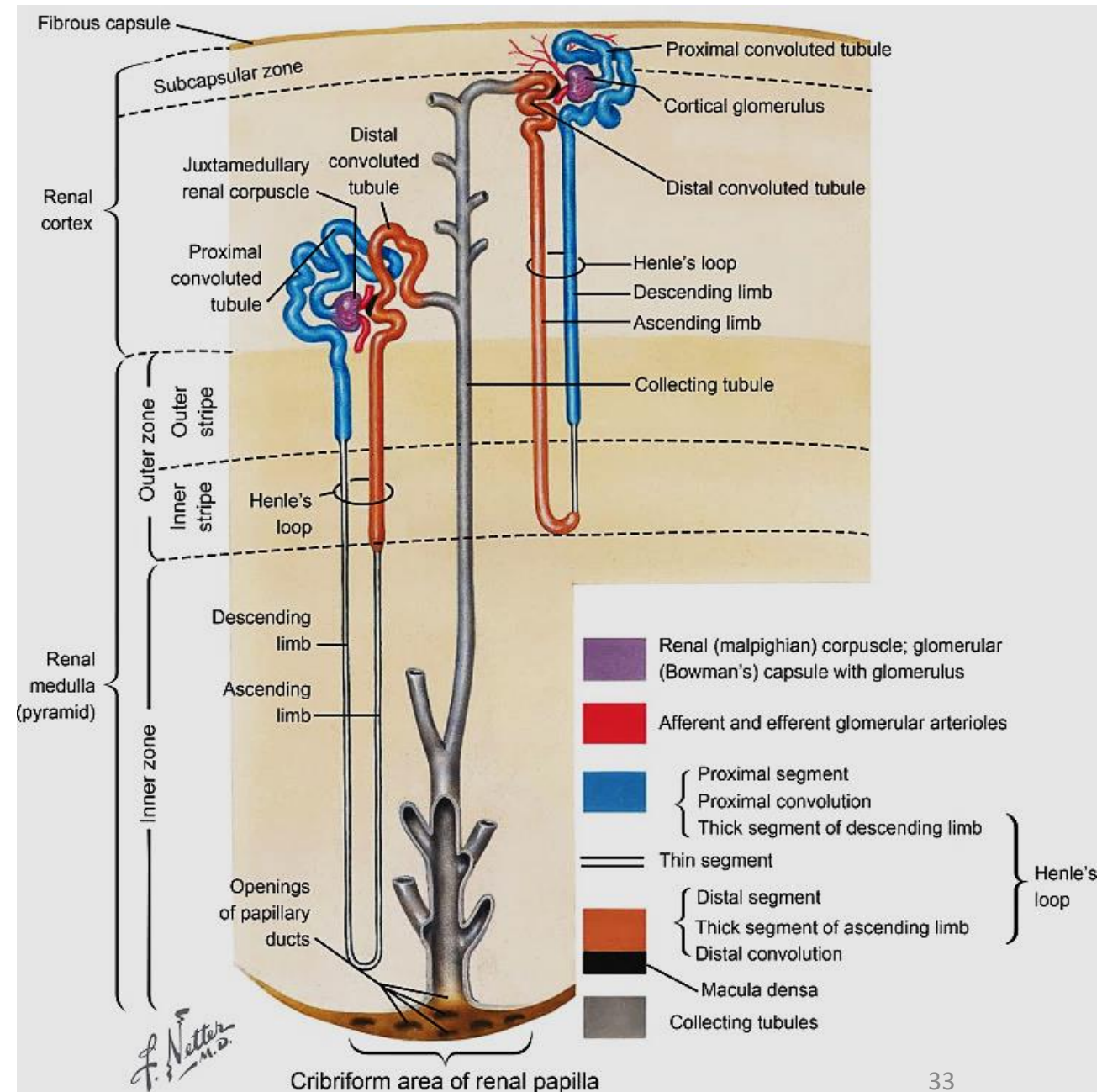
# Collecting Tubules and Ducts

## □ 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.



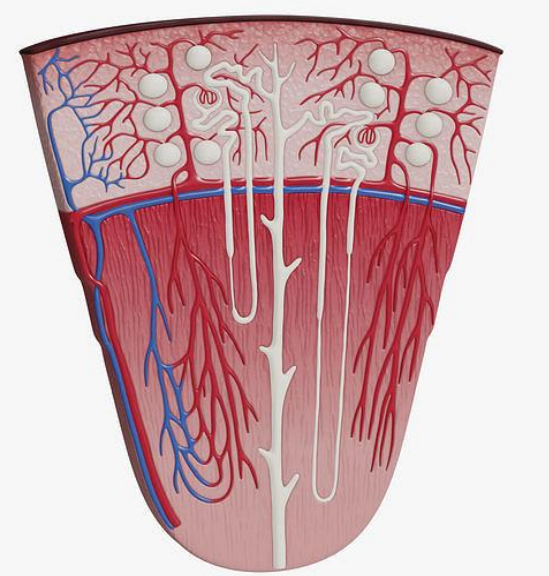
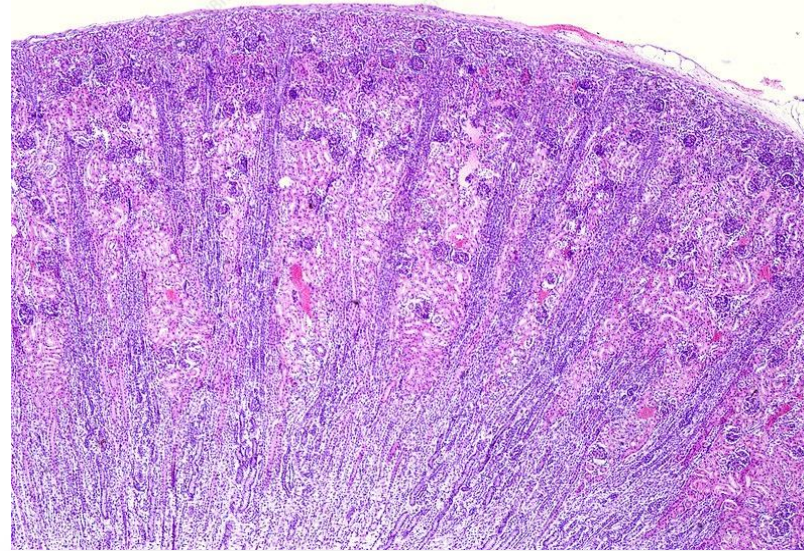


# Histological Structure of Kidney

## □ 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.**

Portion  
of Loop  
of

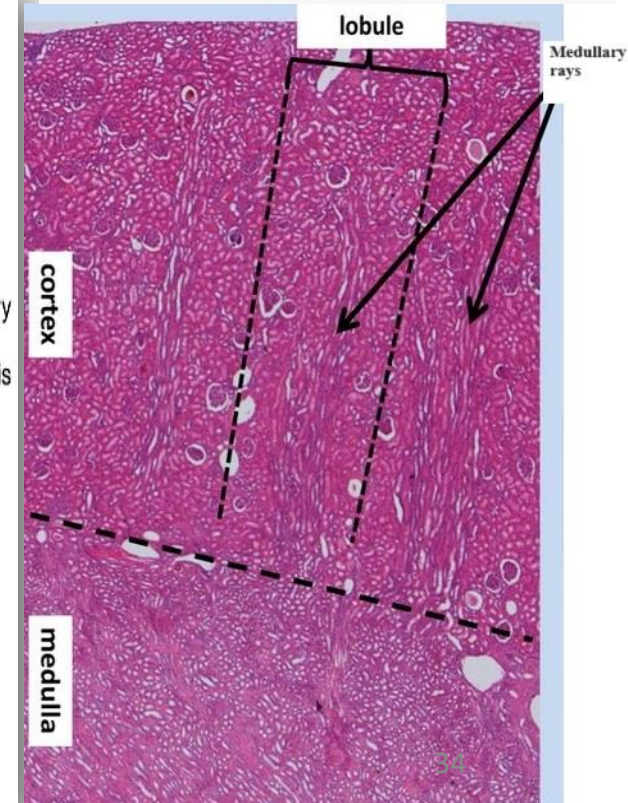
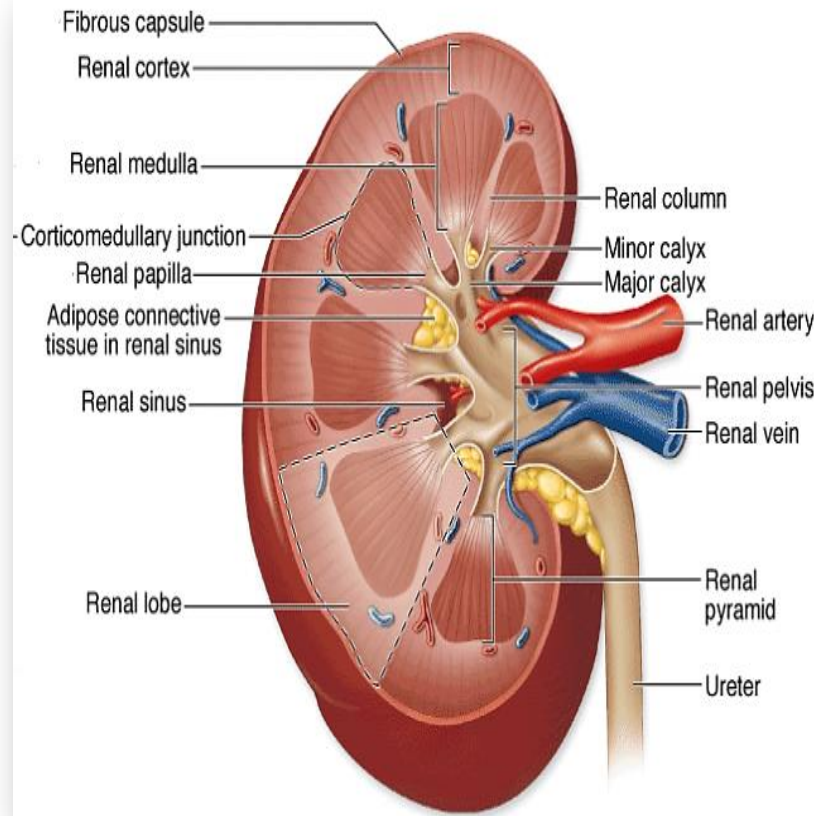


## □ Renal lobe:

- 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

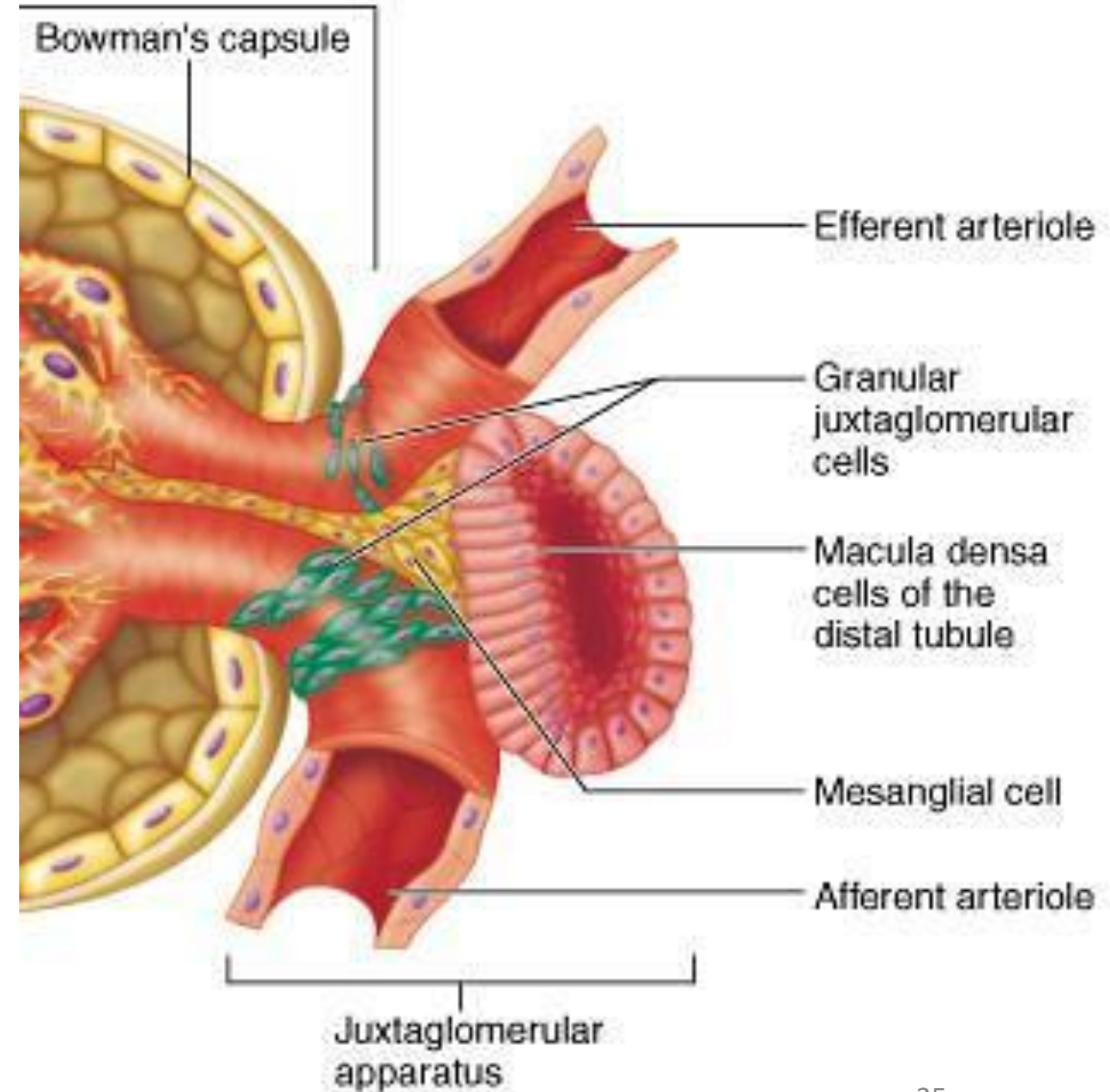
Related to every nephron  
( موجود في الكل )

- 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.

بتكون ال DCT زانقة نفسها ما بين ال

afferent arteriols وهذا ويمثل مكان وجود ال juxta

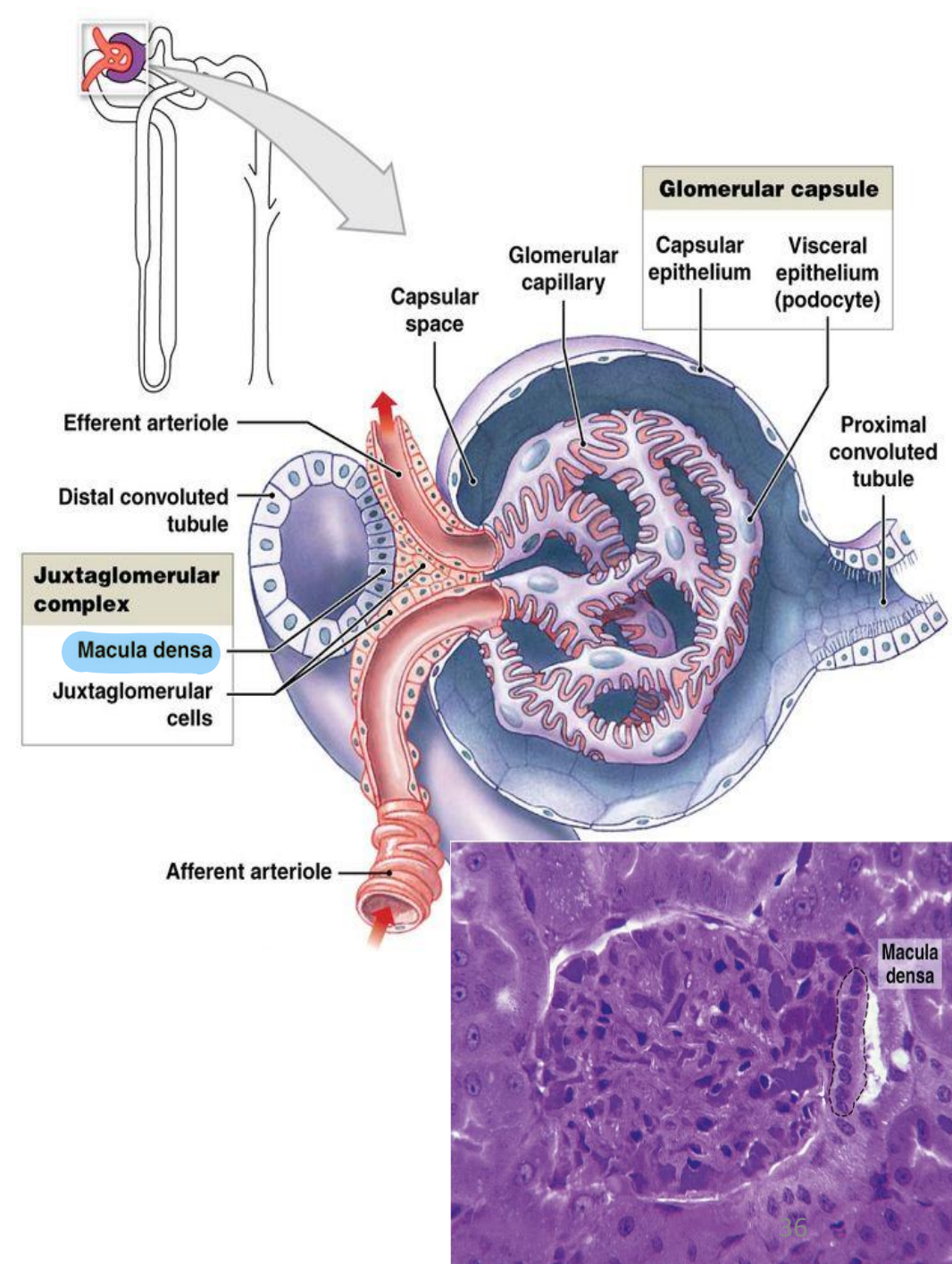
- **It consists of:**
  - A- Macula densa.
  - B- Juxtaglomerular cells.
  - C- Extra glomerular mesangial cells.



## 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.  
“densa”
- They have **thin or absent basement membrane** so the cells of macula densa are in direct contact with JG cells and lacis cells.

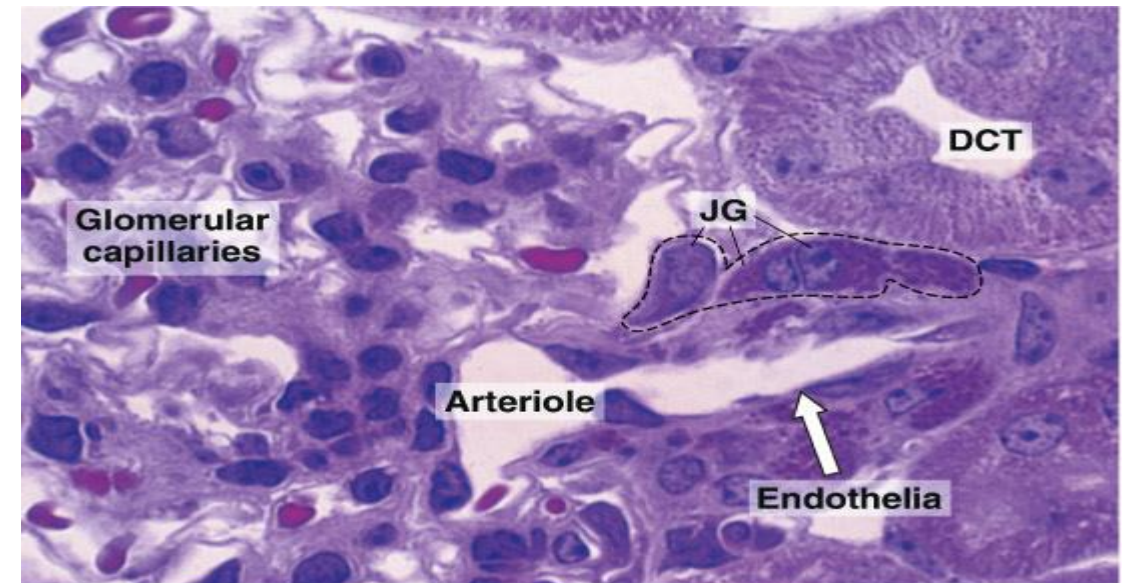
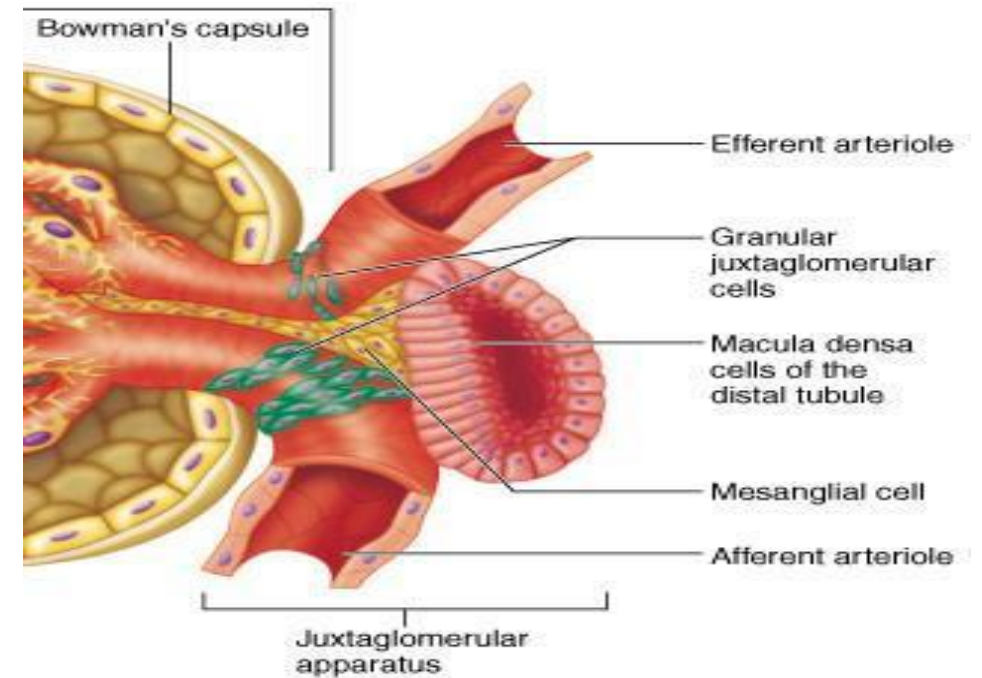
Detect the concentration of Na





## 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.**

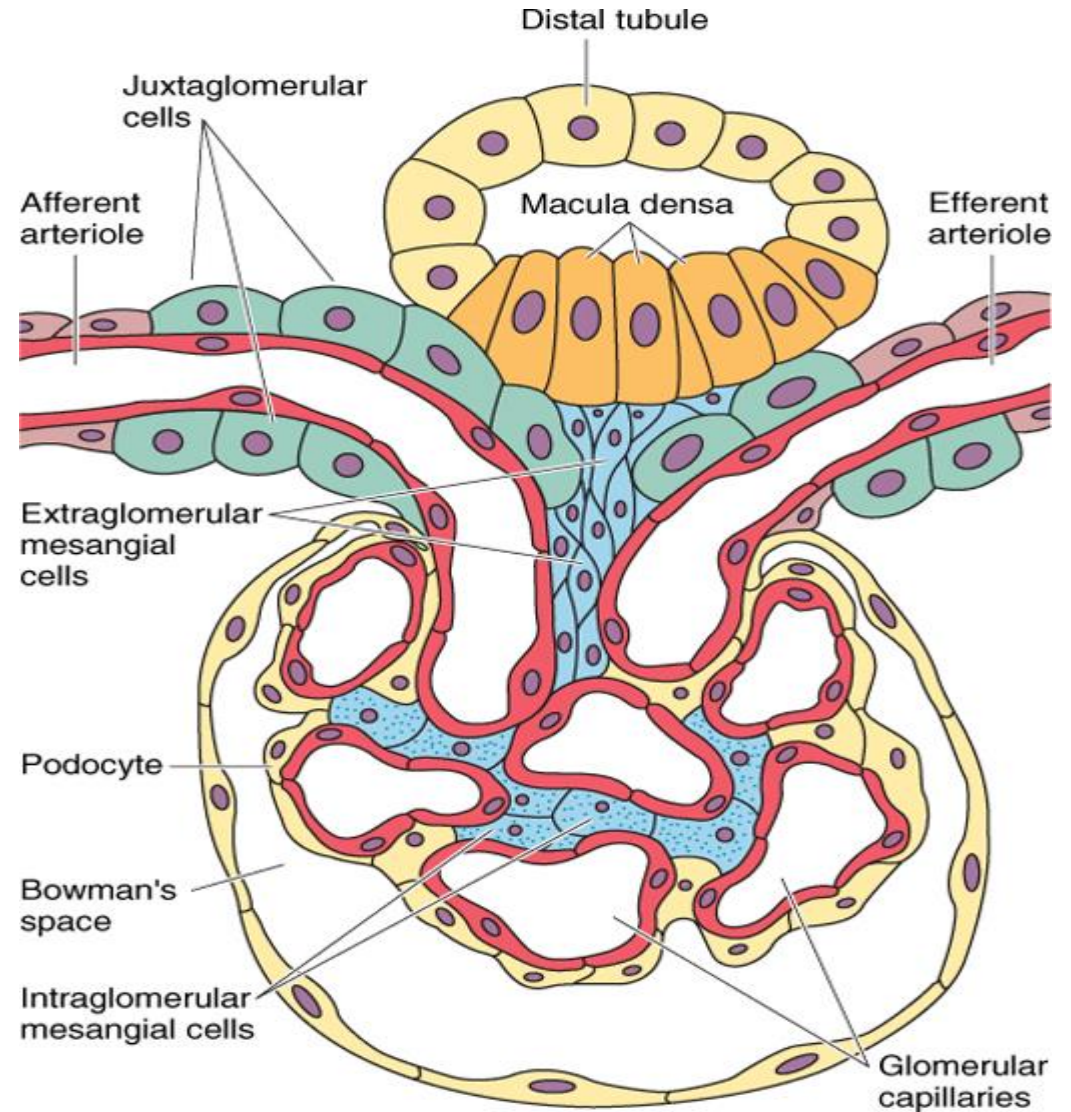


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## C- Extra glomerular mesangial cells (Lacis cells):

- 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!*