

# Urinary System

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# Histology of Kidney

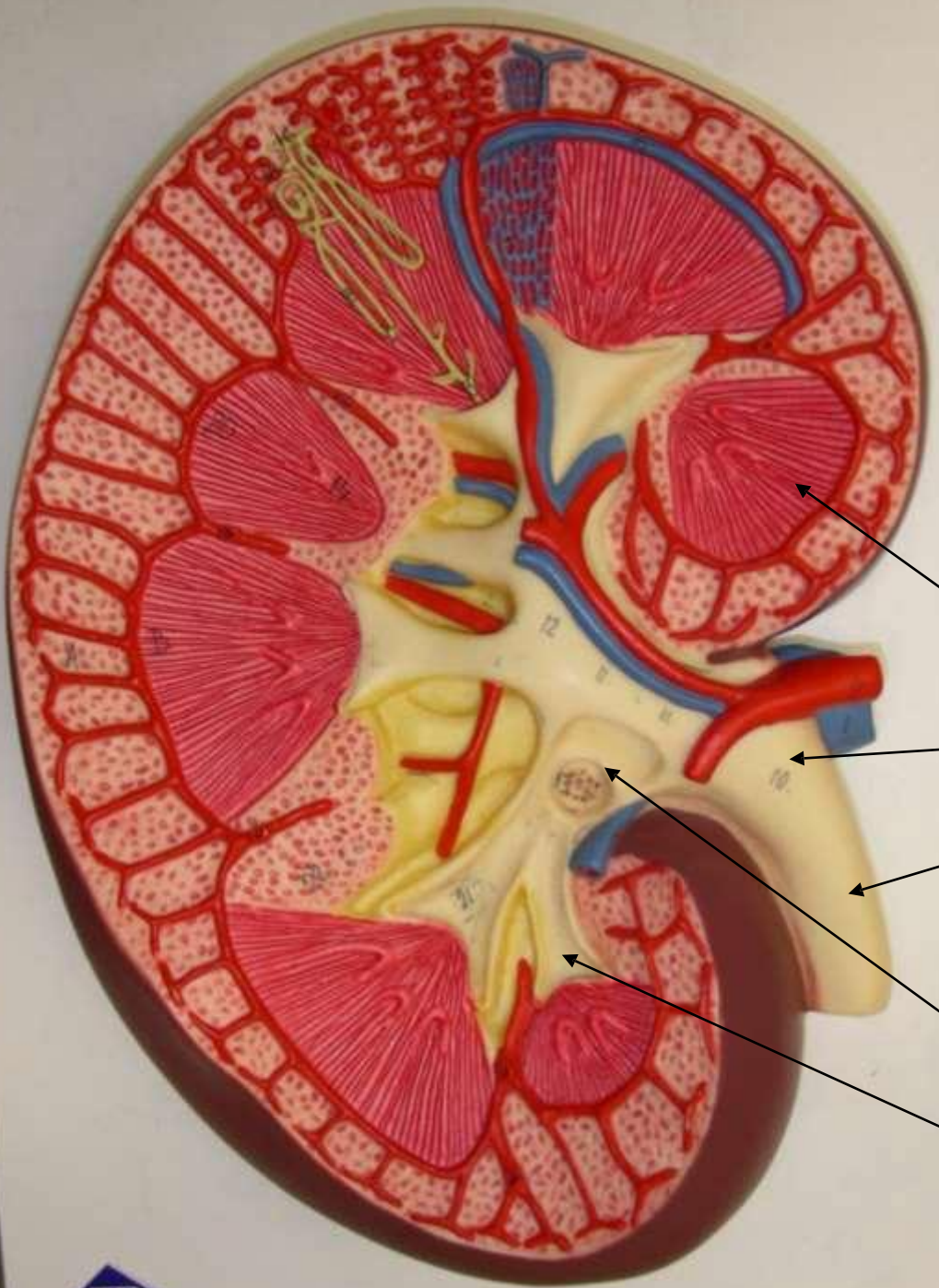
# Urinary system

The urinary system comprises

- A pair of kidney
- A pair of ureters
- Urinary bladder
- Urethra.

# Kidneys

- Each kidney is a large bean shaped organ located retroperitoneally.
- Is covered by a thin capsule of dense irregular connective tissue consisting of collagen fibers, fibroblasts and myofibroblasts.



Pyramids

Hilus

Ureter

Major calyx

Minor calyx

# Capsule

Connective tissue capsule.

**Outer layer:** Fibroblasts and collagen fibres

**Inner layer:** Myofibroblasts





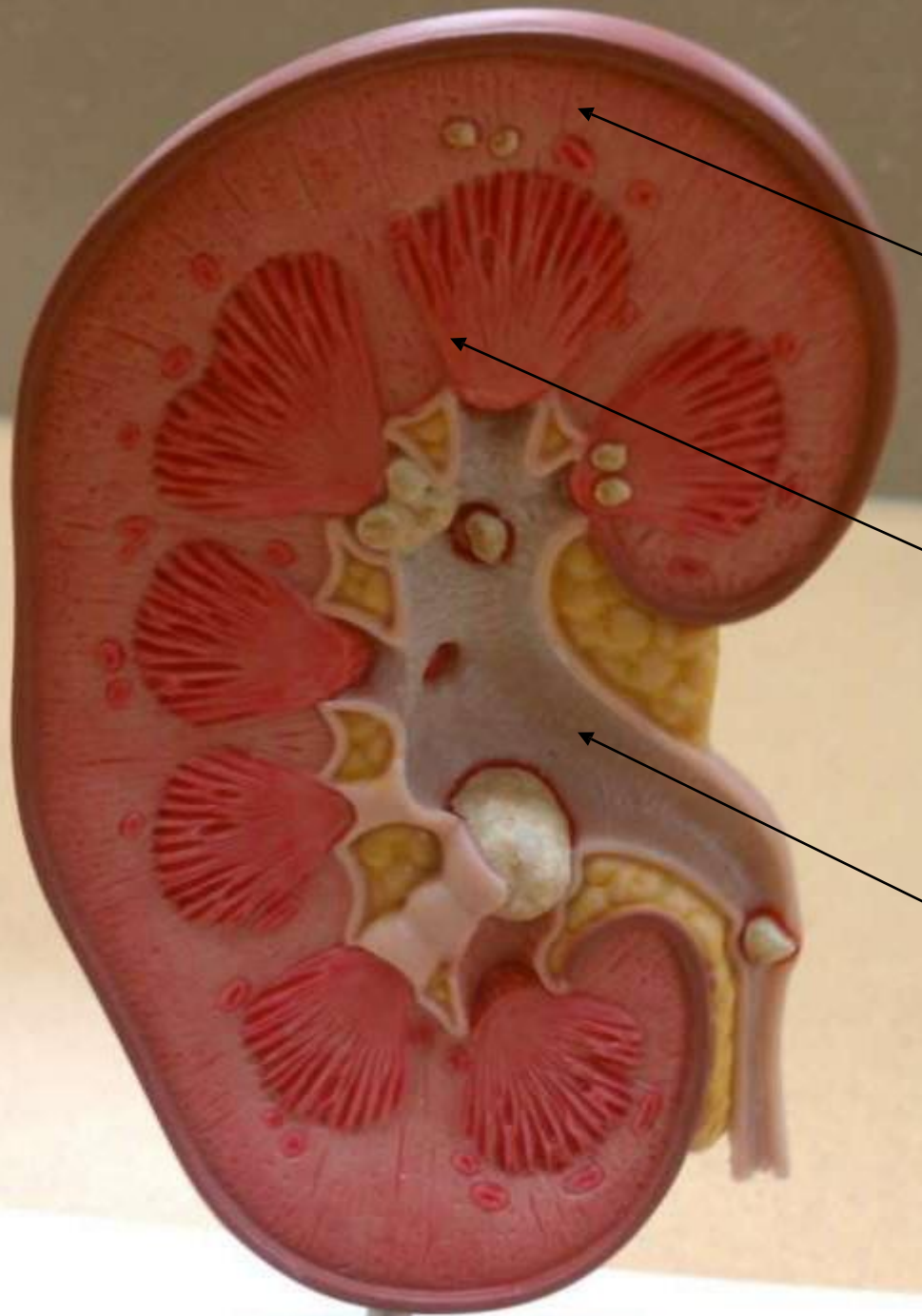
outer layer

inner layer

# Kidneys

- On naked eye, an outer reddish brown granular zone called **cortex** and inner lighter striated zone known as **medulla**.
- The **cortex** appears granular because it contains renal corpuscles and convoluted parts of renal tubules.
- The reddish brown colour is due to that 90% blood passing through cortex.
- The **medulla** gives striated appearance because it contains straight parts of renal tubules and parallelly arranged blood vessels.





**Cortex:**

- Glomerulus
- Proximal and Distal convoluted tubules

**Medulla:**

- Loops of Henle
- Collecting duct
- Pyramids

**Renal pelvis:**

- Hilum
- Major calyces
- Minor calyces

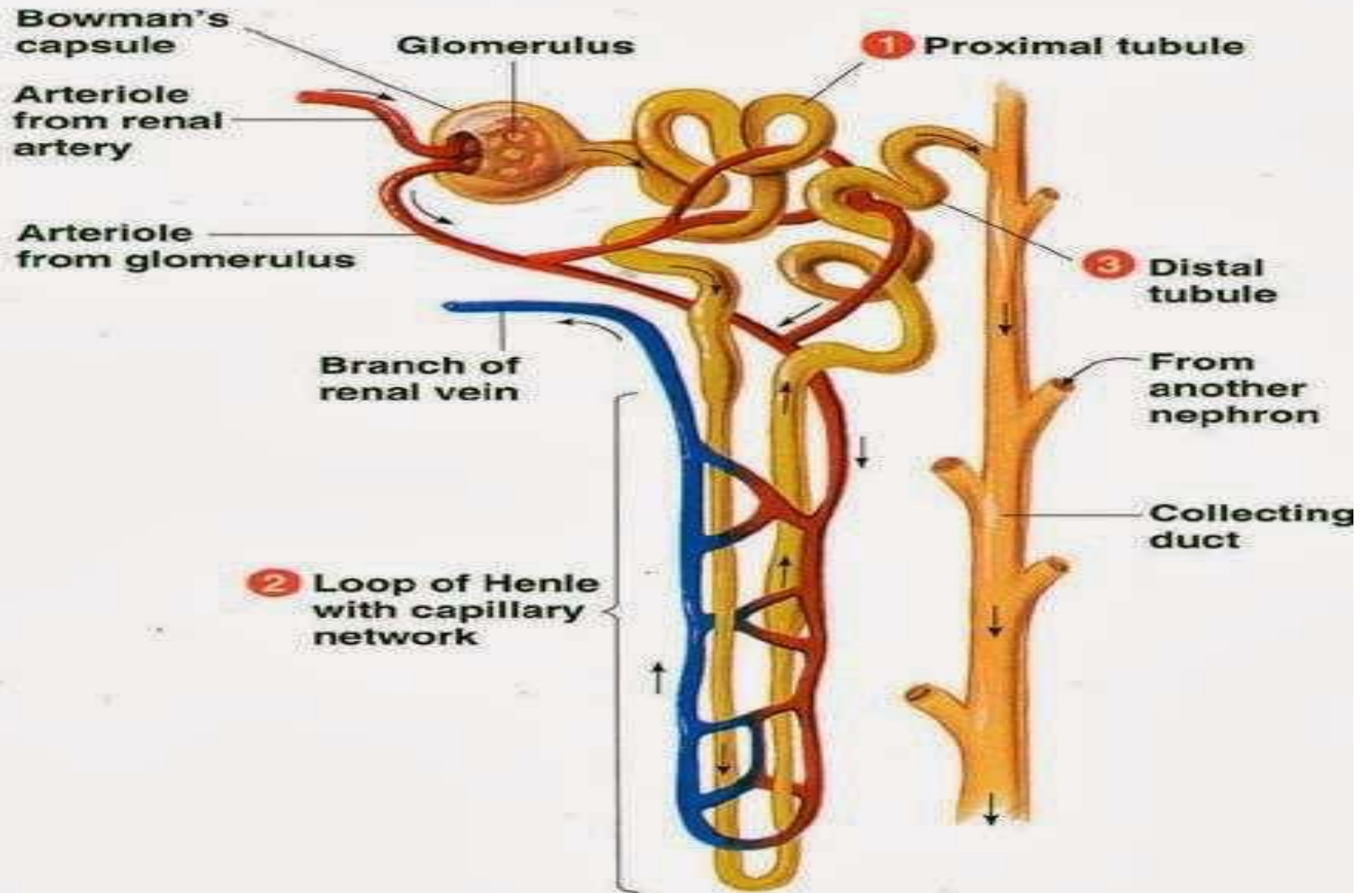
# Urineriferous Tubule

- Parenchyma of kidney consist of a large number of closely packed urineriferous tubes , between which blood vessels and small amount of interstitial connective tissue.
- **Urineriferous tubule** forms the structural and functional unit of kidney and has two parts
  - 1) Nephron
  - 2) Collecting tubule.

# Nephron

- A **nephron** is a long epithelium lined tube which starts blindly and ends by joining a collecting tubule.
- Each nephron begins as a double walled cup shaped dilatation known as **Bowman's capsule** and a tuft of capillaries called **Glomerulus** occupies the concavity of capsule.
- The Bowman's capsule and glomerulus collectively known as ***renal corpuscle***.

## Detailed structure of a nephron



# Types of Nephron

- Depending upon the location of renal corpuscle the nephrons are classified into three types.
  - 1) Superficial cortical nephron
  - 2) Midcortical nephron
  - 3) Juxtamedullary nephron

# Renal corpuscle

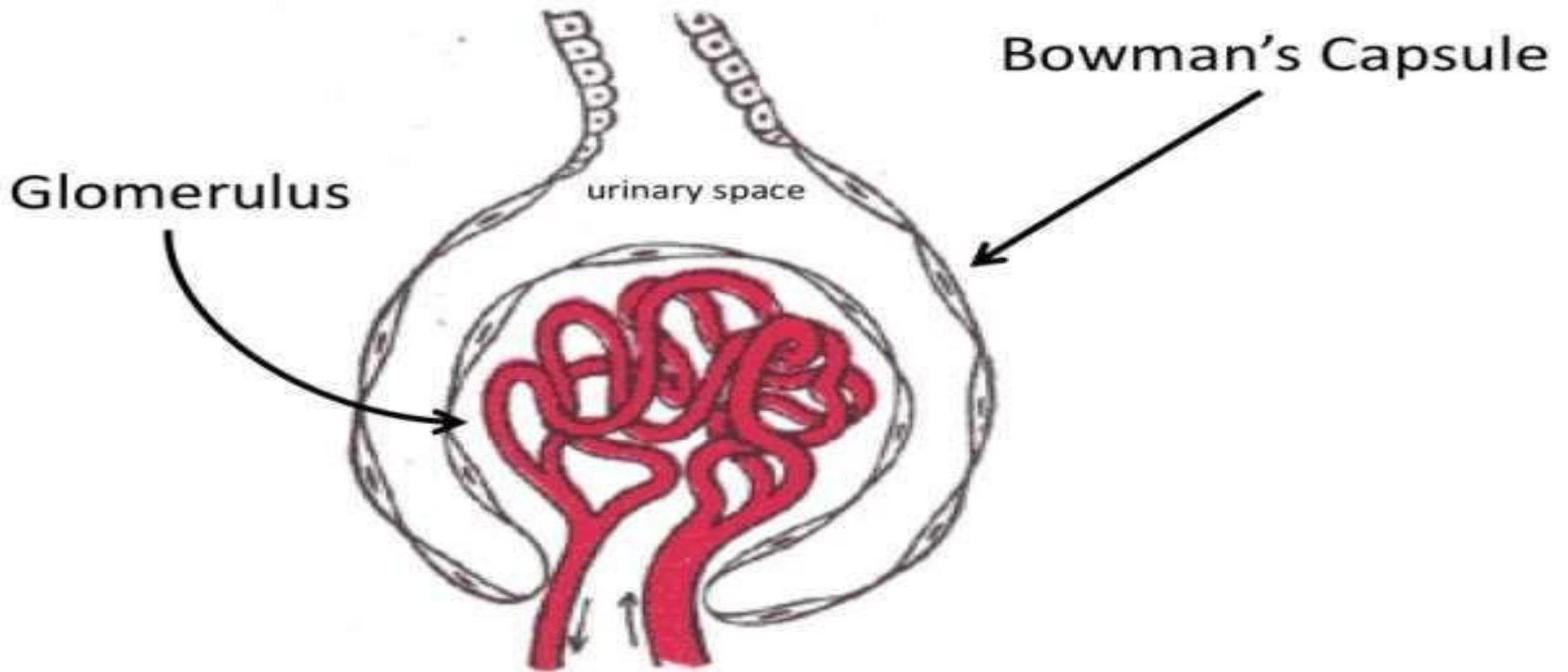
- Are spherical bodies having a **vascular pole** where afferent arteriole enter and efferent arteriole leaves and a **urinary pole** where the proximal convoluted tubule begins.
- Renal corpuscle consist of
  - Bowman's capsule
  - A glomerulus.

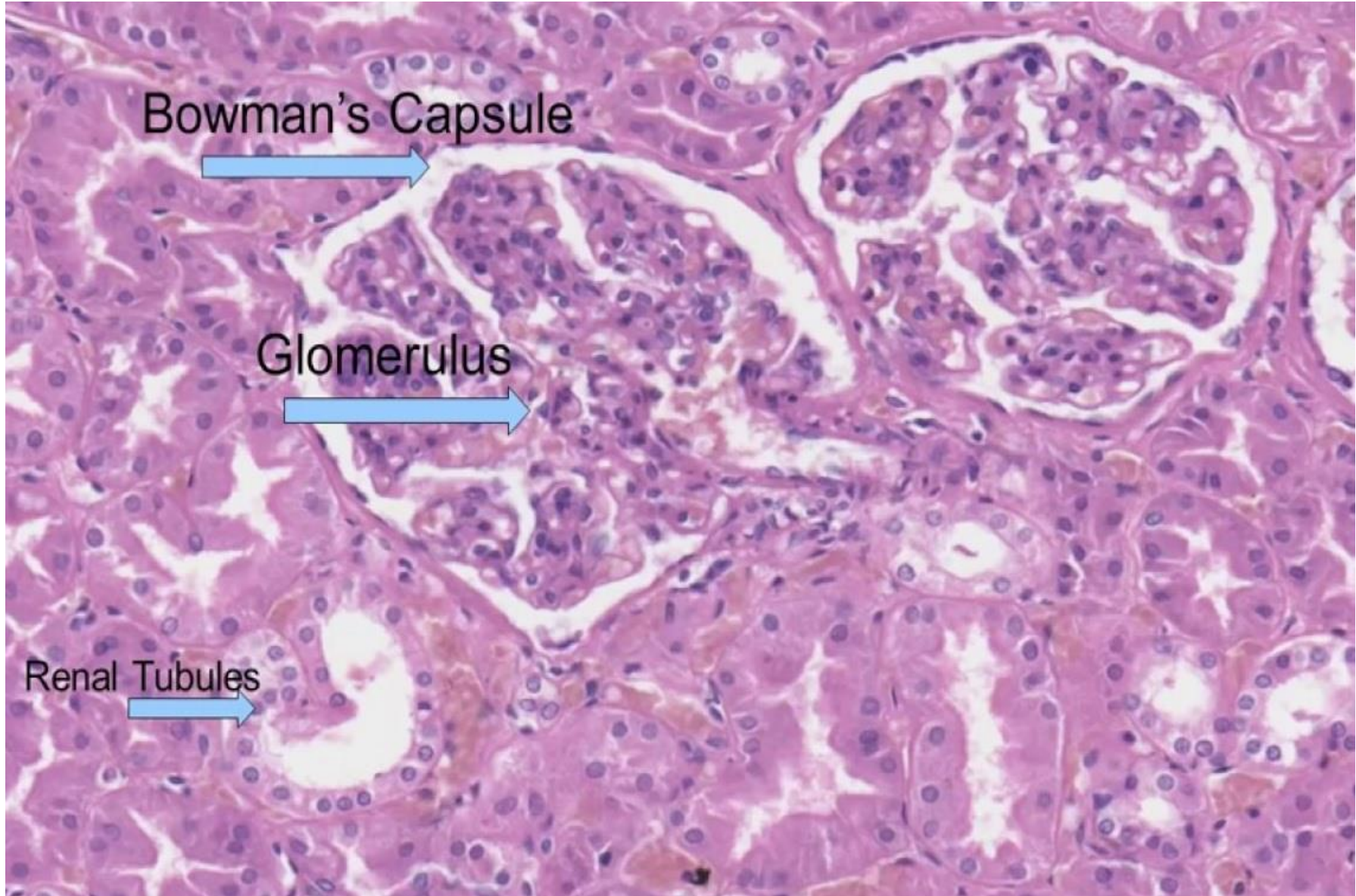


**Glomerulus + Bowman's capsule**

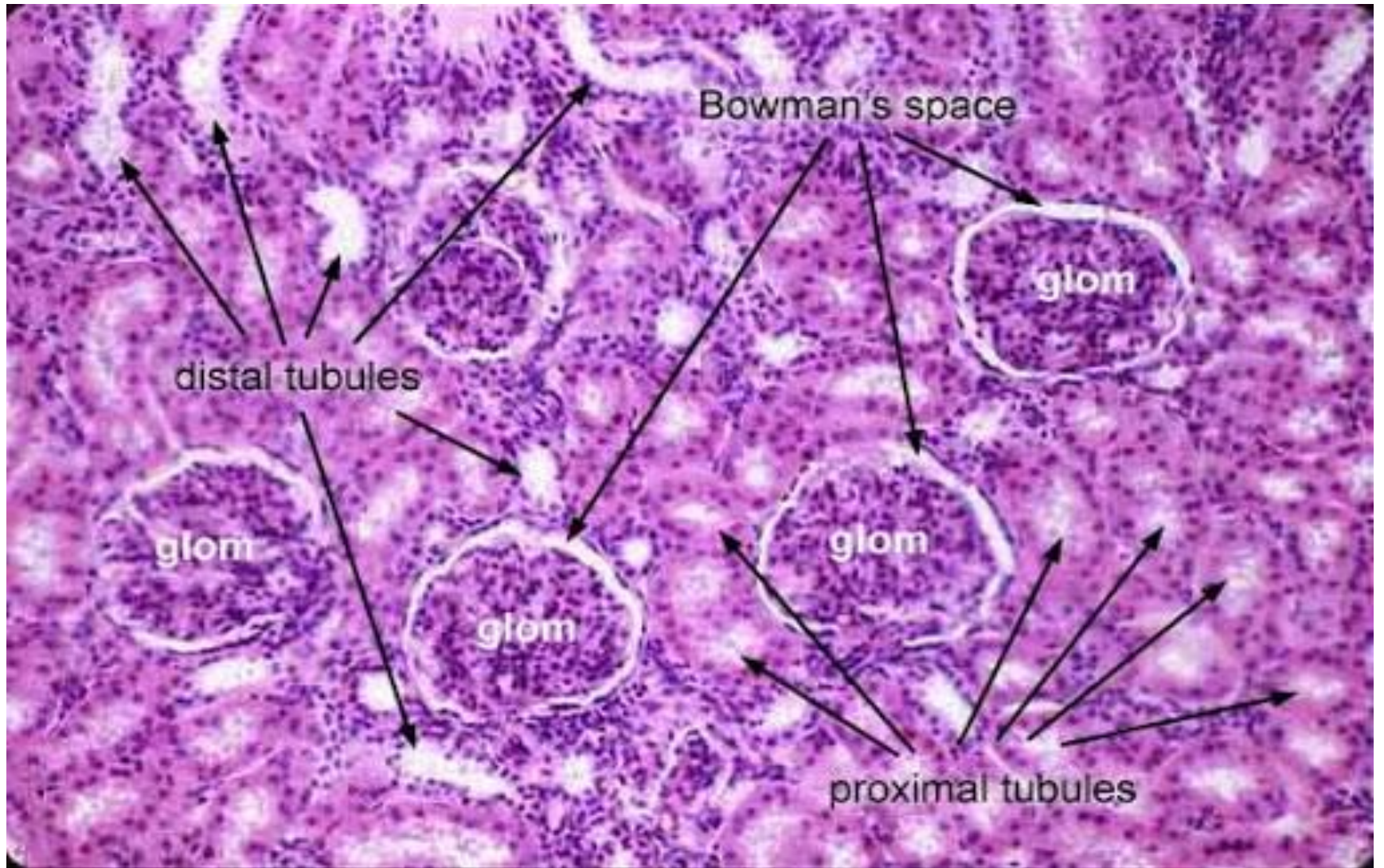


**Renal Corpuscle**









# Bowman's capsule

- Also called glomerular capsule has double wall an outer **parietal** and an inner **visceral layer**.
- In between two layers the capsular space called **urinary space**.

## **Parietal layer:**

- Is made up of a simple squamous epithelium.
- At urinary pole the simple squamous epithelium becomes continuous with simple cuboidal epithelium

# Bowman's capsule

## Visceral layer:

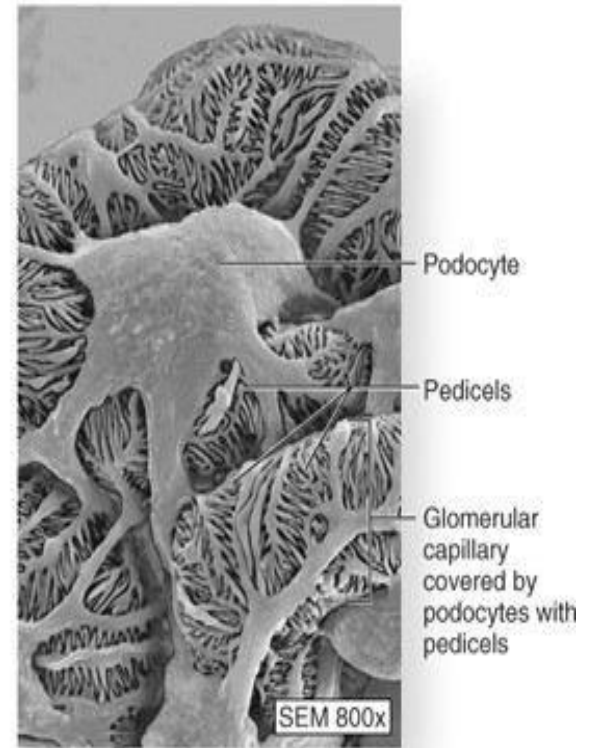
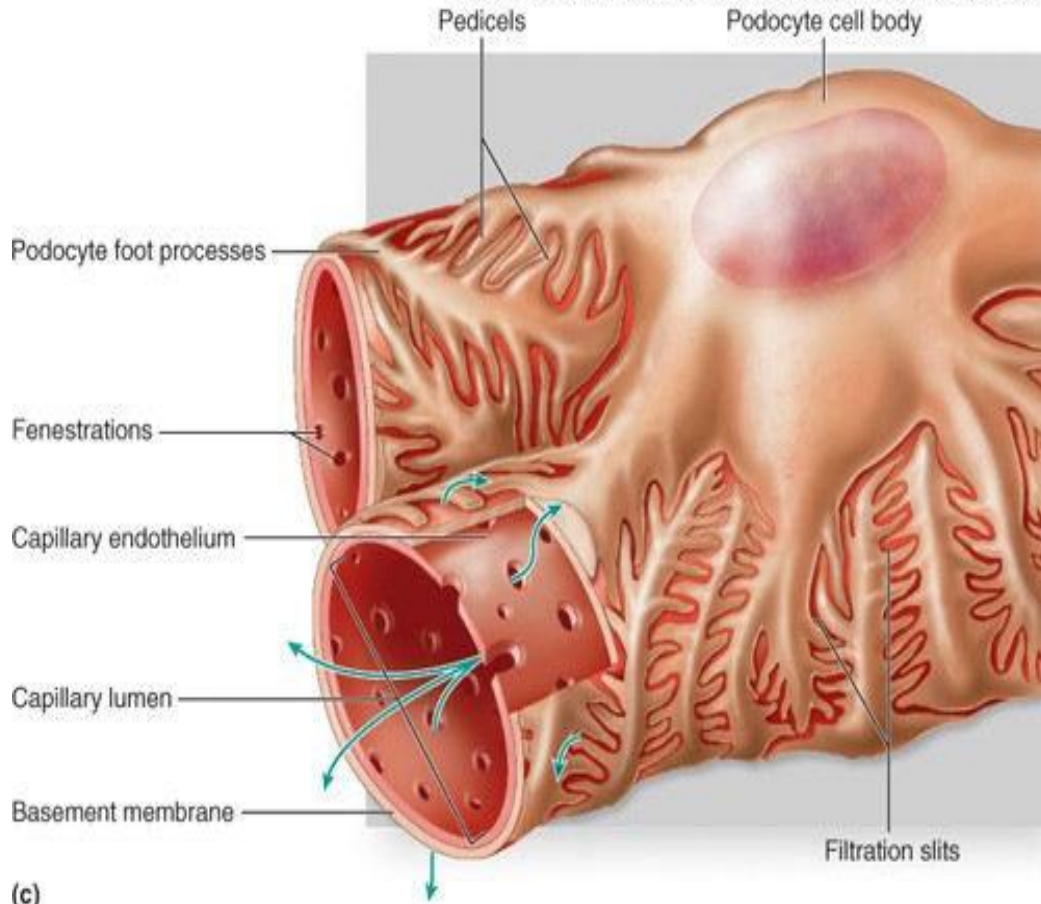
- The visceral layer of Bowman's capsule covers the glomerulus .
- It is composed of a single layer of specialized epithelial cells called **podocytes**.

# Podocyte

- Are large irregularly star shaped cells.
- The podocytes have long processes, called foot processes, foot projections, or pedicels.
- The foot projections wrap around the capillaries and leave slits between them. Blood is filtered through these slits, each known as a **filtration slit** or **slit diaphragm** or **slit pore**.

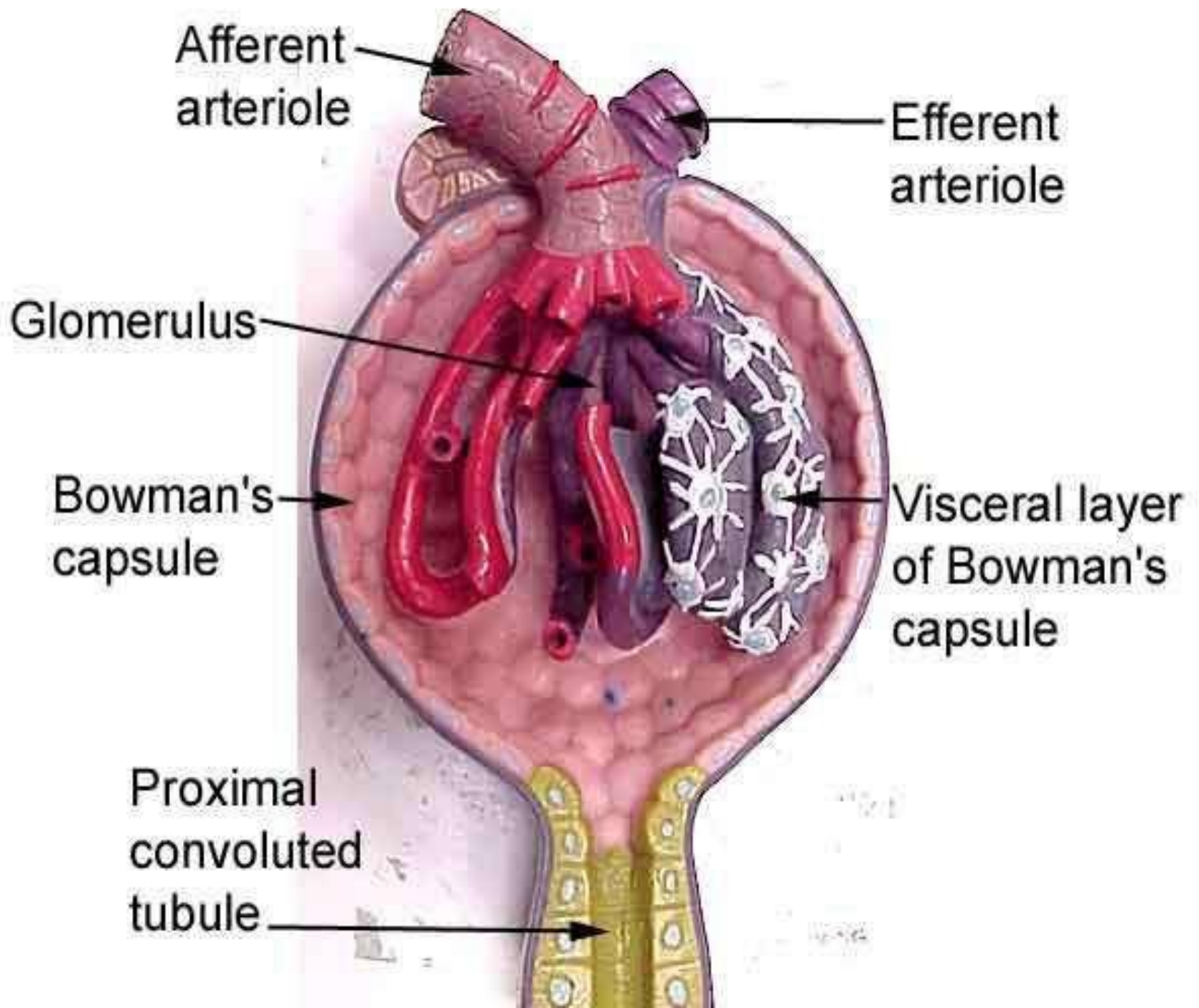


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# Glomerulus

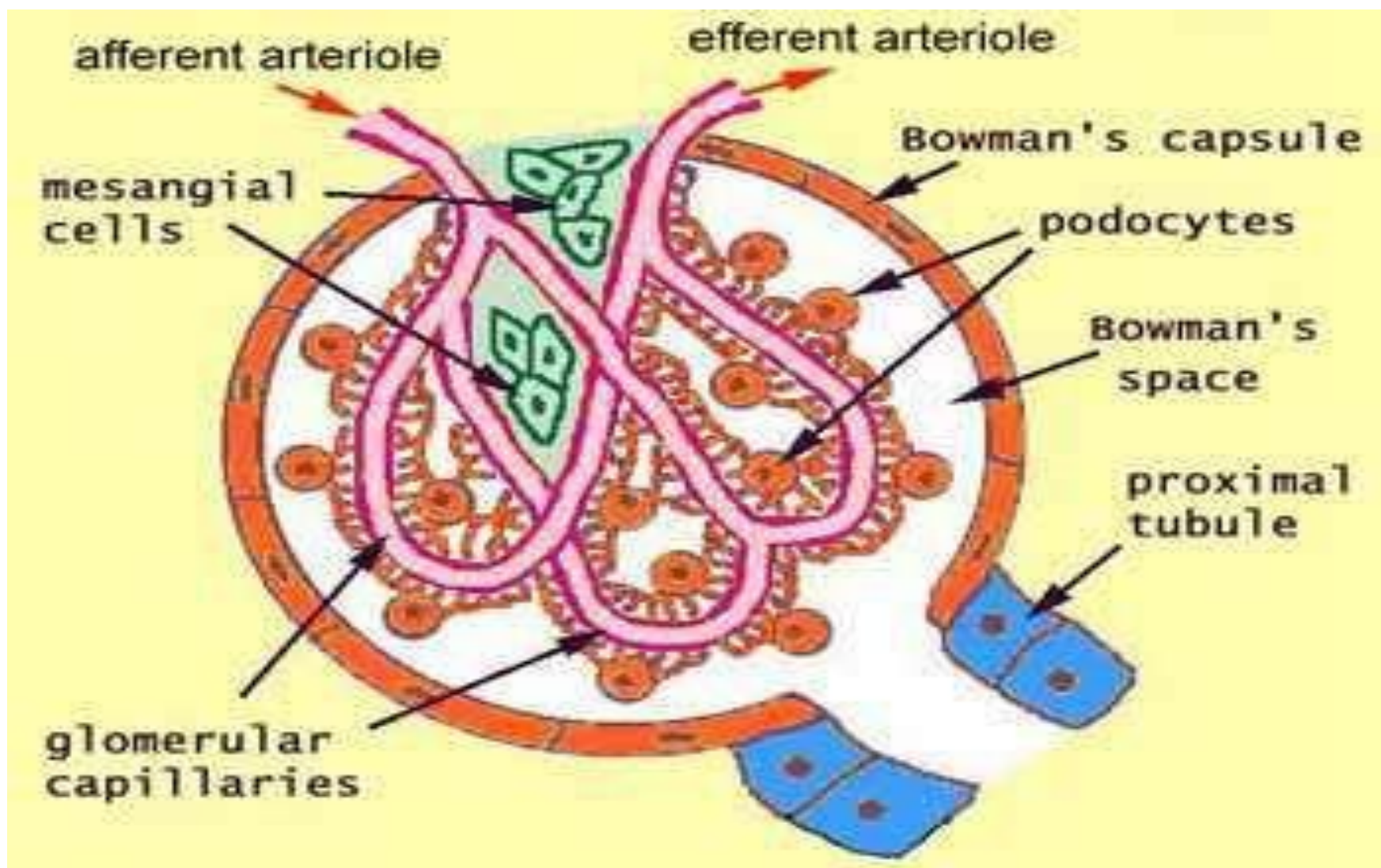
- Is a tuft of fenestrated capillaries connecting an afferent arterioles with an efferent arterioles.
- The fenestrations of the glomerular capillaries are larger in diameter and more numerous.



# Mesangium

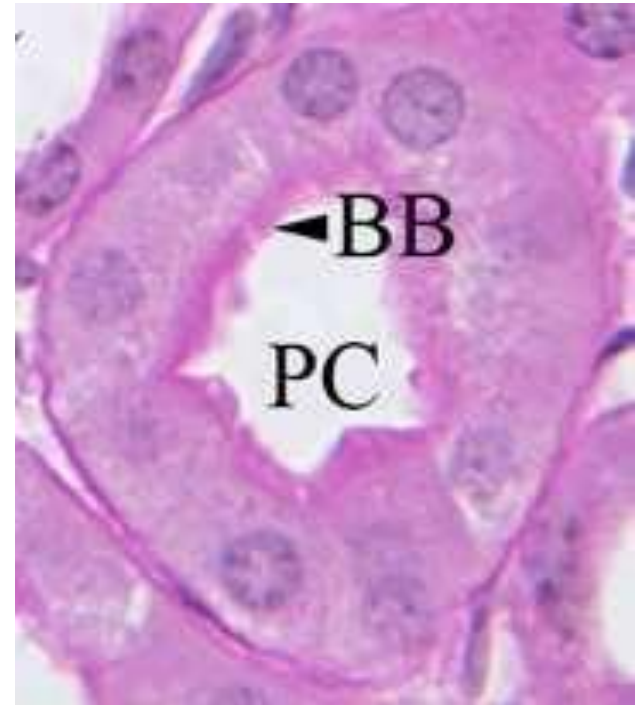
- The space between the glomerulus capillaries is occupied by a special type of connective tissue called **mesangium**.
- It consist of meseangial cells and extracellular matrix.
- EM shows they are irregular in shape and have cytoplasmic processes.
- Mesangial cells contain common cell organelles, in addition bundles of actin and myosin filaments are also present.





# Proximal convoluted tubule

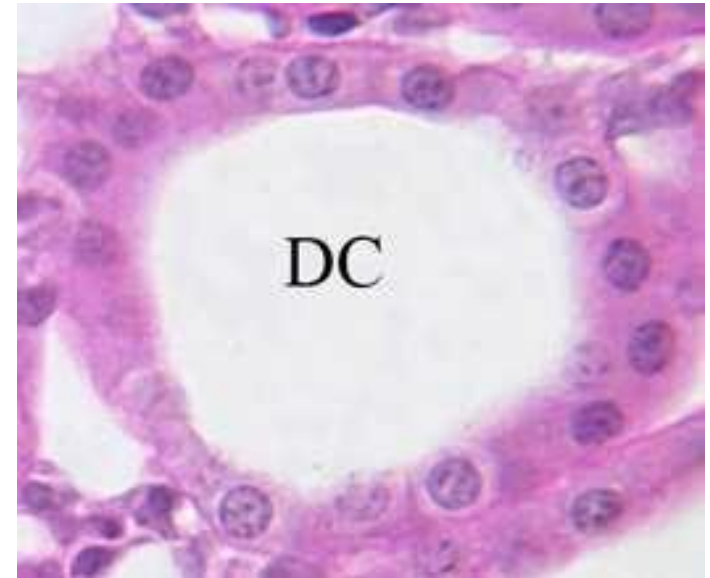
- Longer and hence, are more numerous in cortex.
- Have small and uneven lumen.
- Contains *single layer of cuboidal cells* with eosinophilic granular cytoplasm.
- Cell boundaries are not distinct because of extensive basal and lateral cell membrane *interdigitations* with neighbouring cells.
- Cells have microvilli on their luminal surface ( *typical brush border* ).

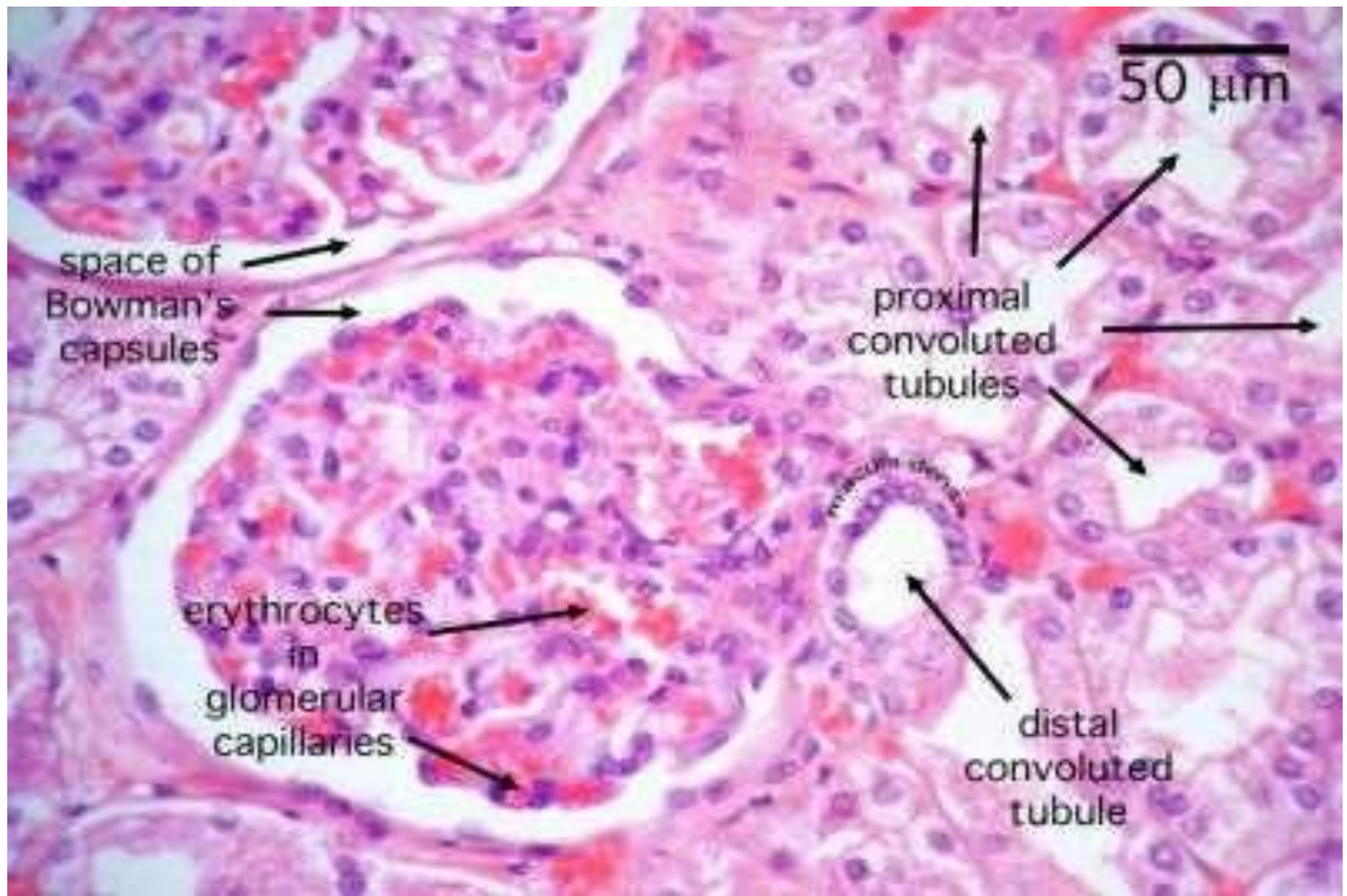




# Distal convoluted tubule

- Shorter in length, therefore are few in number in cortex.
- Have larger lumen.
- Lined by *small, cuboidal cells*.
- Cytoplasm stains less intensely.
- Deep basal and lateral cell membrane infoldings and interdigitations are also present.
- Some cells have *microvilli*.

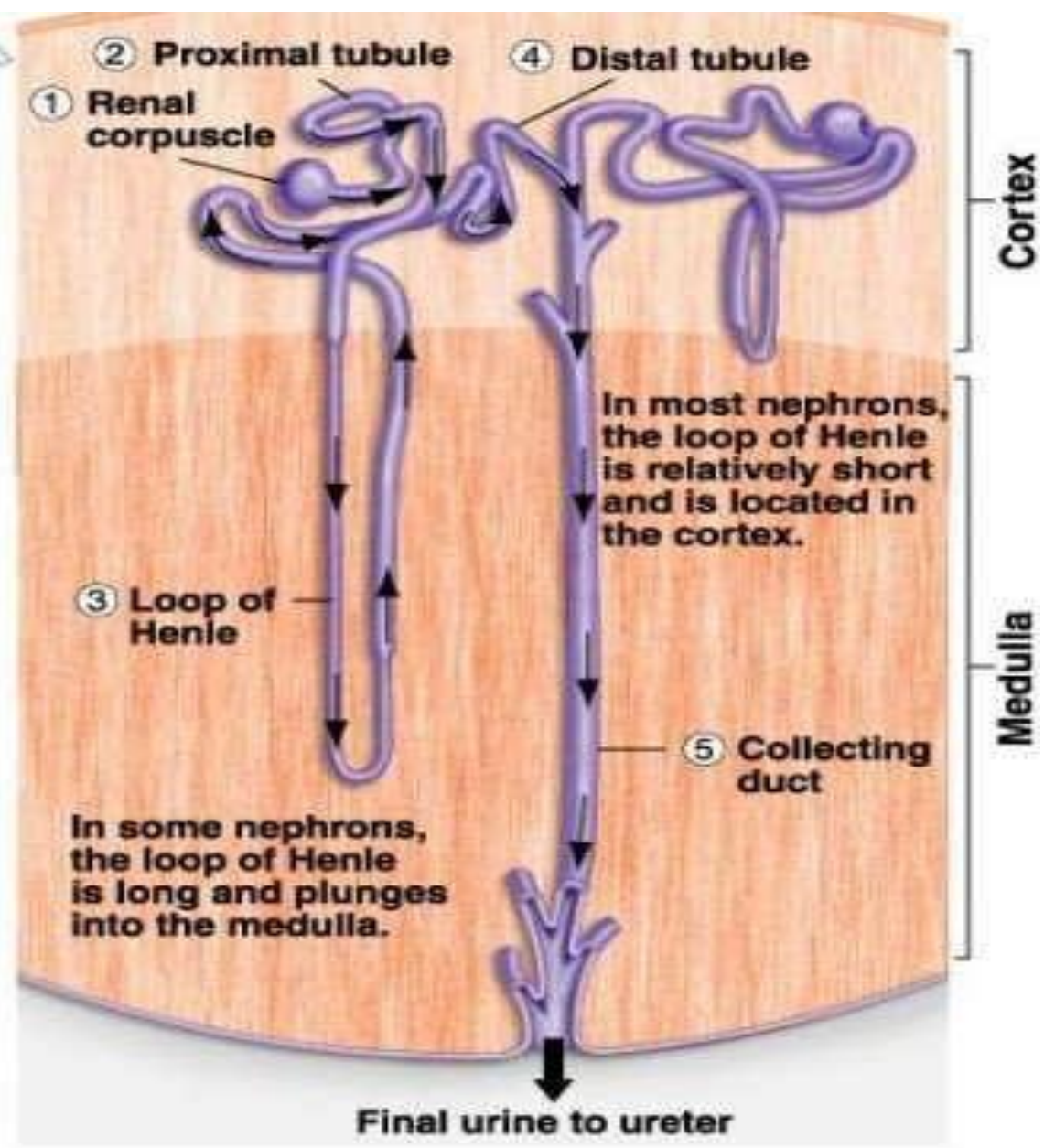
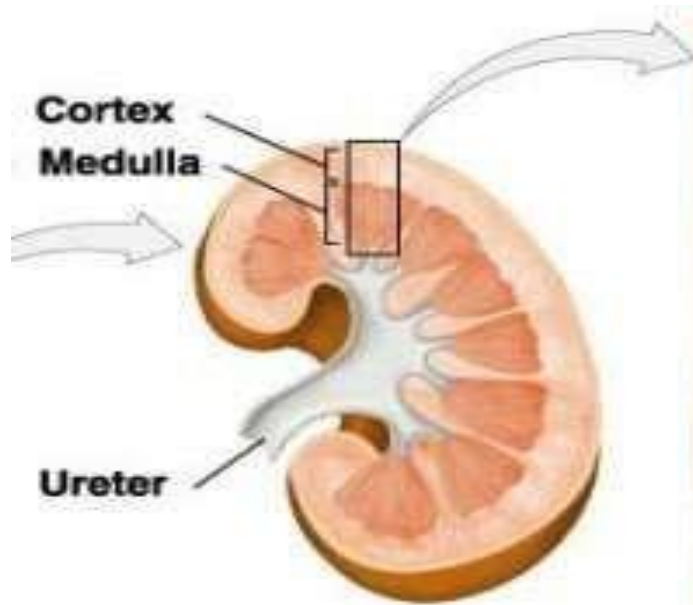


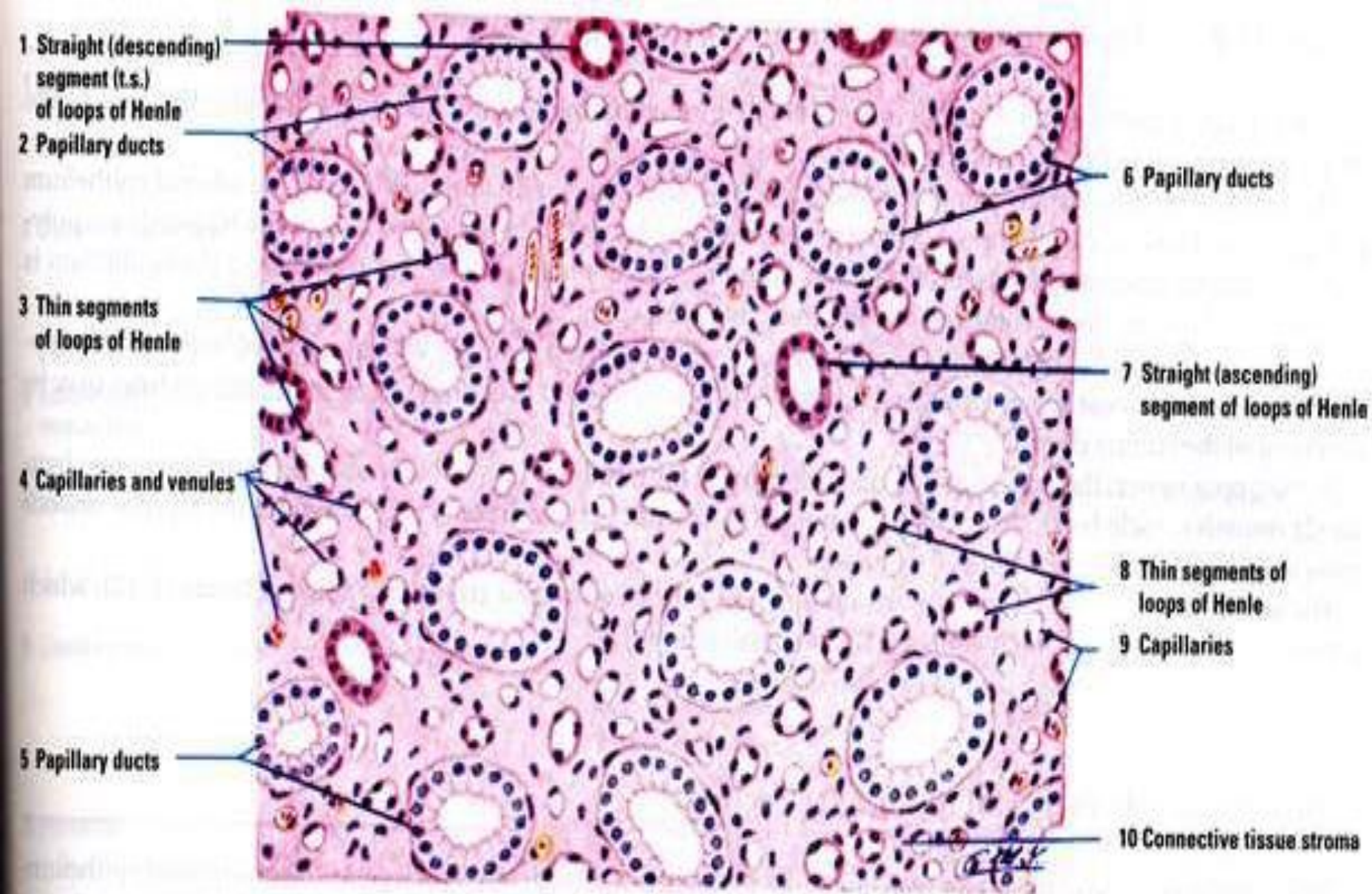


# Loop of Henle

- A typical loop of Henle consist of four parts:
  - 1) Thick descending segment
  - 2) Thin descending segment
  - 3) Thin ascending segment
  - 4) Thick ascending segment
- Thin limbs – *simple squamous epithelium*.
- Thick limbs – *cuboidal epithelium*.
- The luminal surface of cells bear few short microvilli.





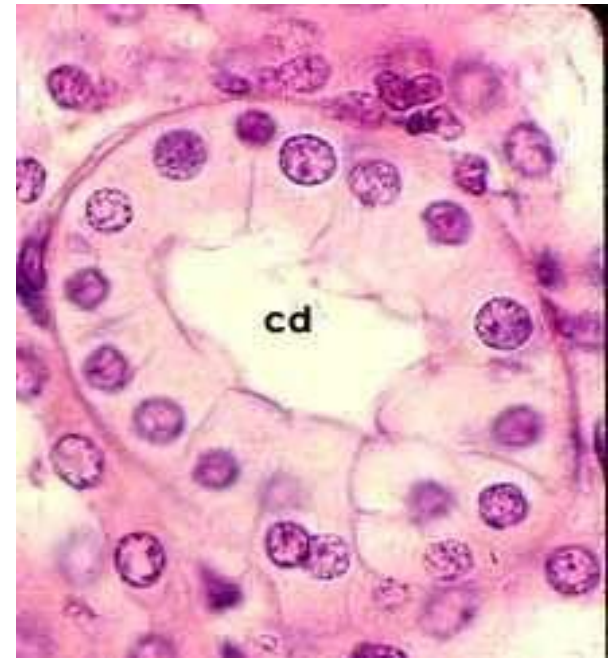


**Fig. 1** Kidney Medulla: Papilla (transverse section). Stain: hematoxylin-eosin. Medium magnification.



# Collecting Tubule and Duct

- Drain urine from nephron to renal pelvis.
- Lie on medullary ray within cortex.
- Progressively increase in diameter towards medulla.
- **Collecting tubules** are lined by simple cuboidal epithelium .
- The **collecting ducts** are lined by simple columnar epithelium.
- The epithelium contains two types of cells
  - 1) **Light cells**
  - 2) **Dark cells**



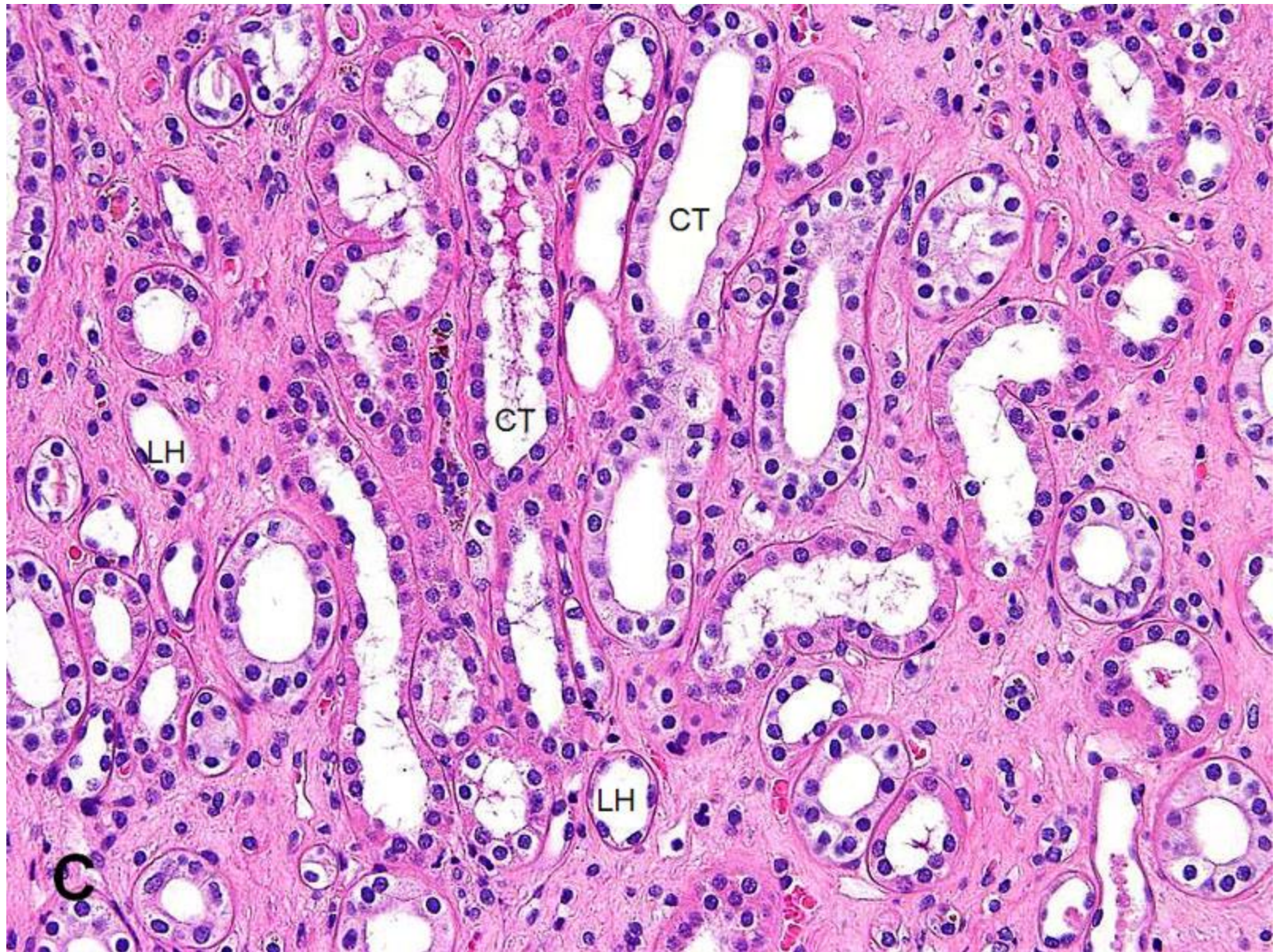
# Light cells

- Also called principal cells .
- Are pale staining cells having oval central nucleus.
- Luminal surface bears few microvilli.
- These cells possess **aquaporin 2** water channels are permeable to water under the influence of antidiuretic hormone.

# Dark cells

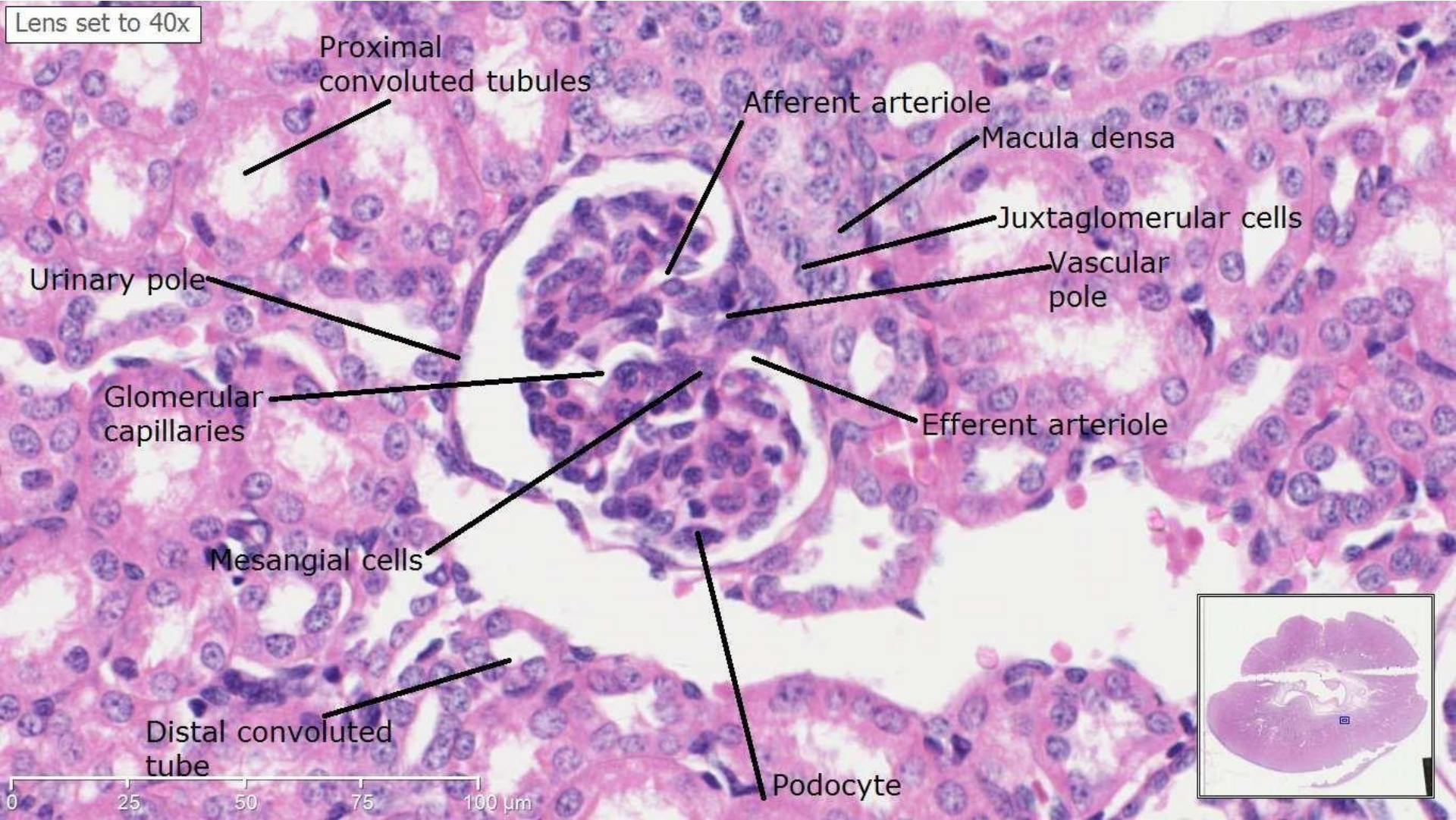
- Also called intercalated cells.
- Much fewer in number and stains darkly.
- The apical surface shows microfolds.
- Dark cells are classified into two types;
- $\alpha$  intercalated cells secrete hydrogen ions
- $\beta$  intercalated cells reabsorb H ion and secrete bicarbonate ion.







Lens set to 40x



Proximal convoluted tubules

Afferent arteriole

Macula densa

Juxtaglomerular cells

Vascular pole

Efferent arteriole

Urinary pole

Glomerular capillaries

Mesangial cells

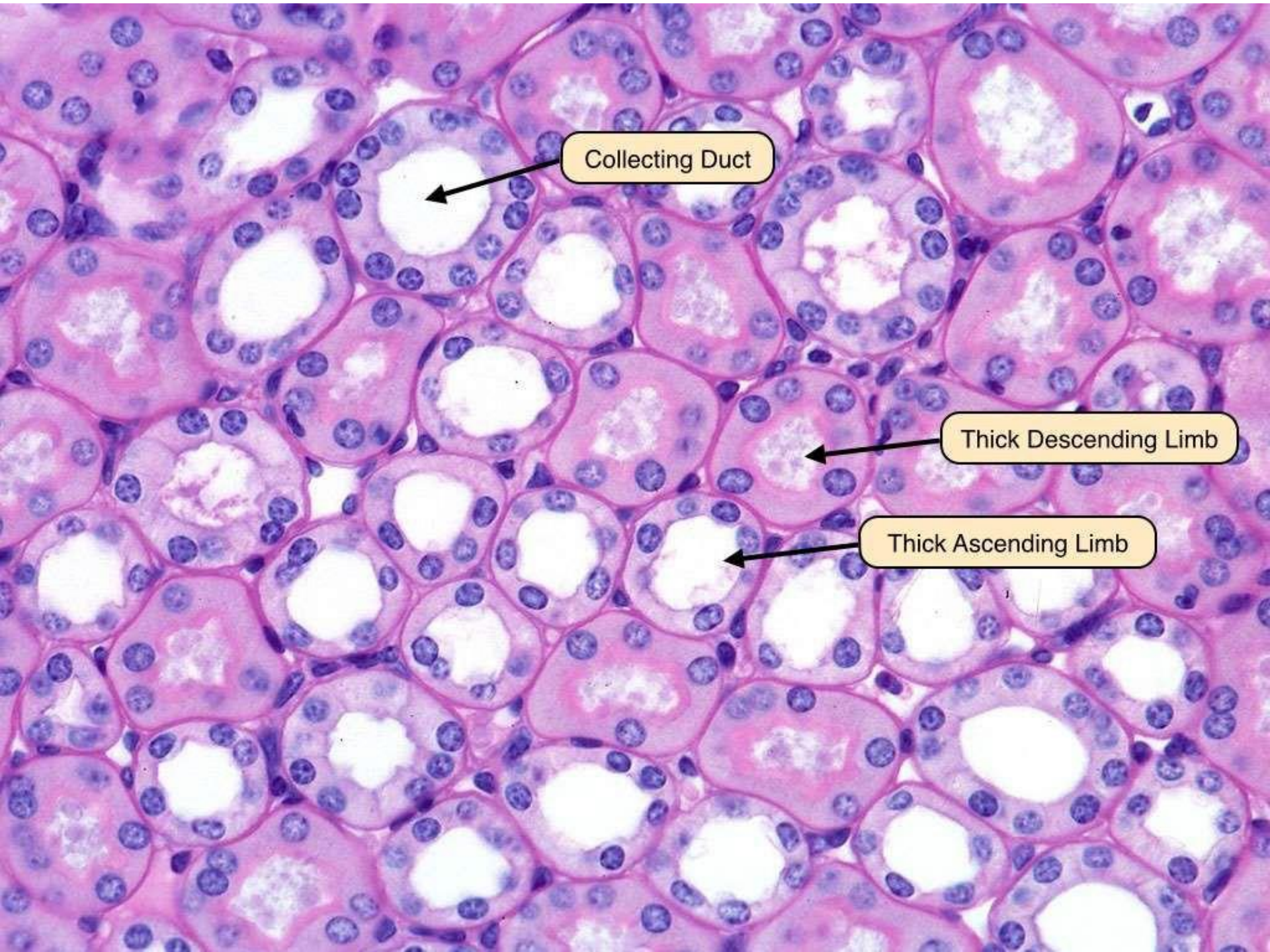
Distal convoluted tube

Podocyte



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Collecting Duct

Thick Descending Limb

Thick Ascending Limb