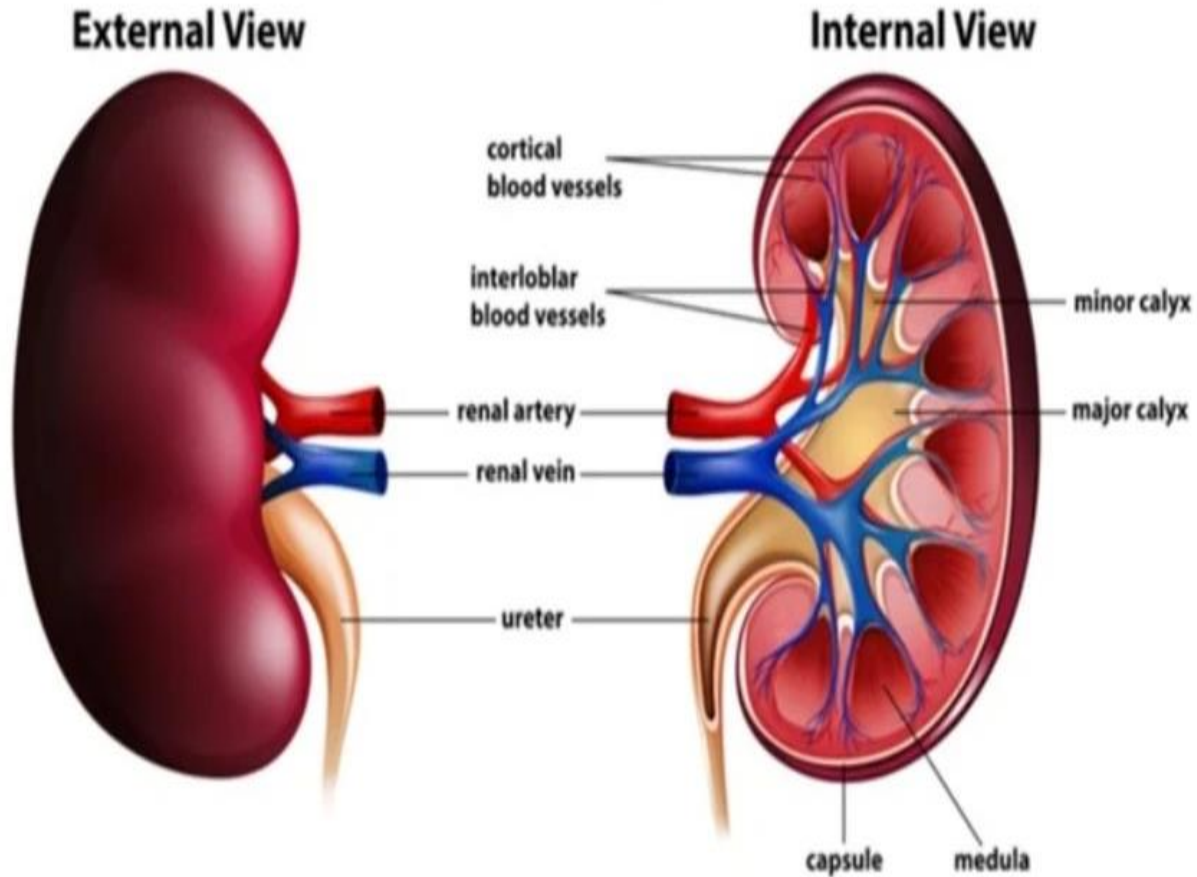




General Histology / Year 2



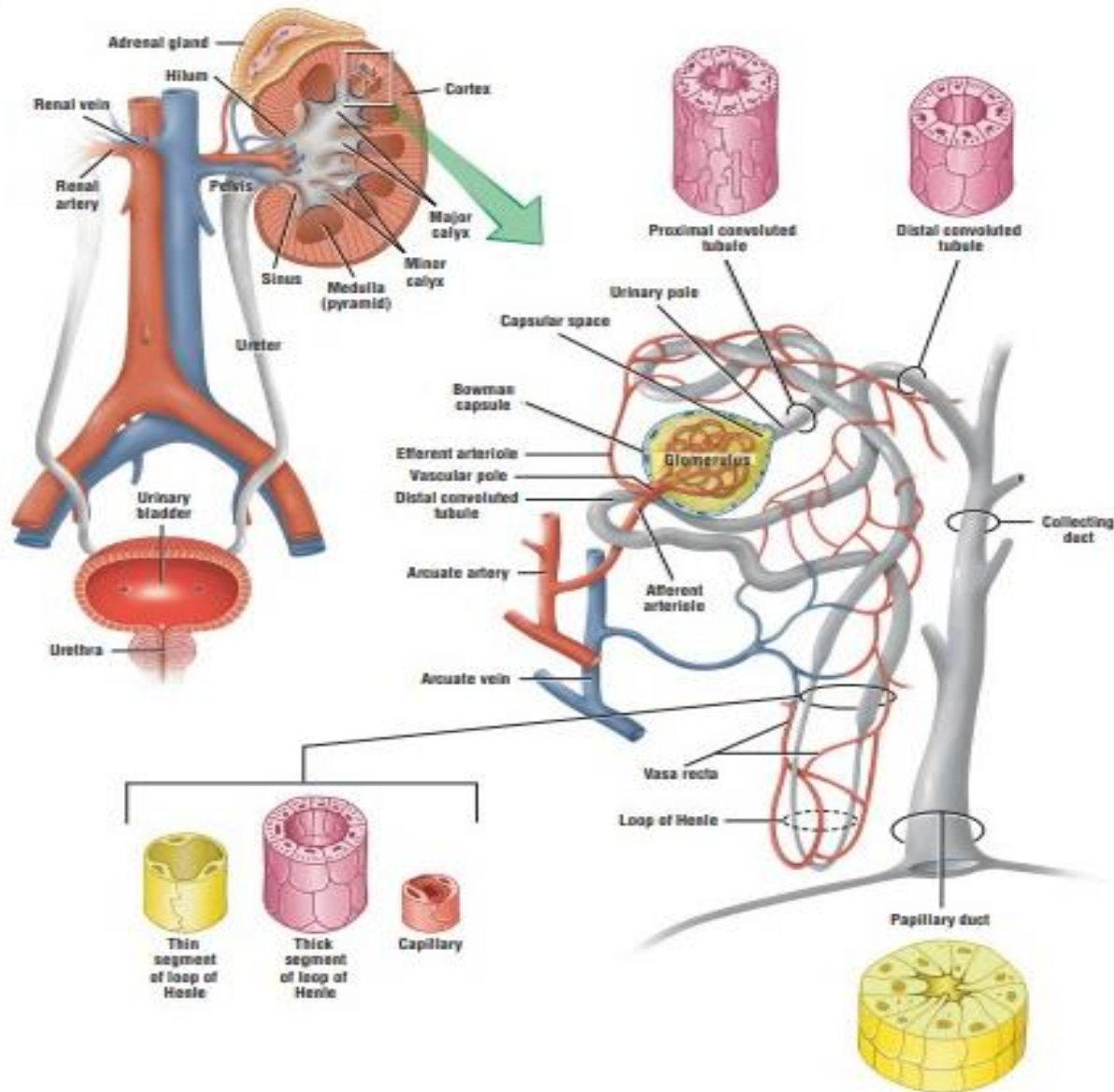
Urinary System **KIDNEY** **Lecture 6**

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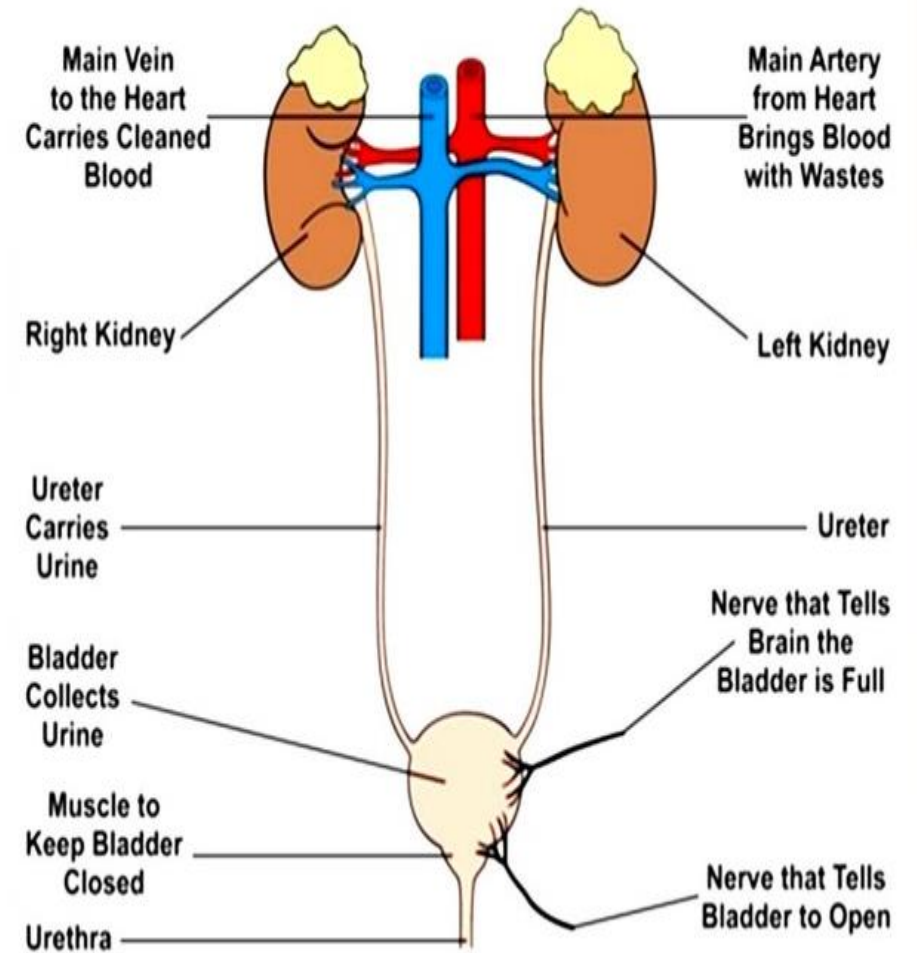
Urinary system

Organs of urinary system

- **Kidneys** – paired organs that produce urine.
- **Urinary tract** – eliminates urine.
- **Ureters** (paired tubes).
- **Urinary bladder** (muscular sac).
- **Urethra** (exit tube).
- **Urination** – process of eliminating urine.
- **Contraction of muscular urinary bladder forces urine through urethra, and out from the body.**
- **Blood is supplied to each kidney by the (renal arteries), which arise from the aorta. One or more (renal veins) drains each kidney to the inferior vena cava.**
- **The total blood volume of the body is circulated through the kidneys about 300 times each day.**



URINARY SYSTEM



Function of urinary system

- 1- Blood filtration, (filtration of cellular wastes from blood).
- 2- Maintenance of fluid homeostasis,(selective reabsorption of water and solutes).
- 3- Regulation of blood pressure,(renin a protease that participates in the regulation of blood pressure).
- 4- Erythrocyte formation, (Erythropoietin a glycoprotein that stimulates the production of erythrocytes).
- 5- Vitamin D conversion to an active form.
- **Functionally, the urinary system is subdivided into the:-**
 - Excretory portion (nephrons), responsible for blood filtration and production of urine.
 - The collecting portion (collecting ducts, calyces, ureter, bladder, and urethra), which receives, transports, and temporarily stores formed urine until excretion.

Kidneys

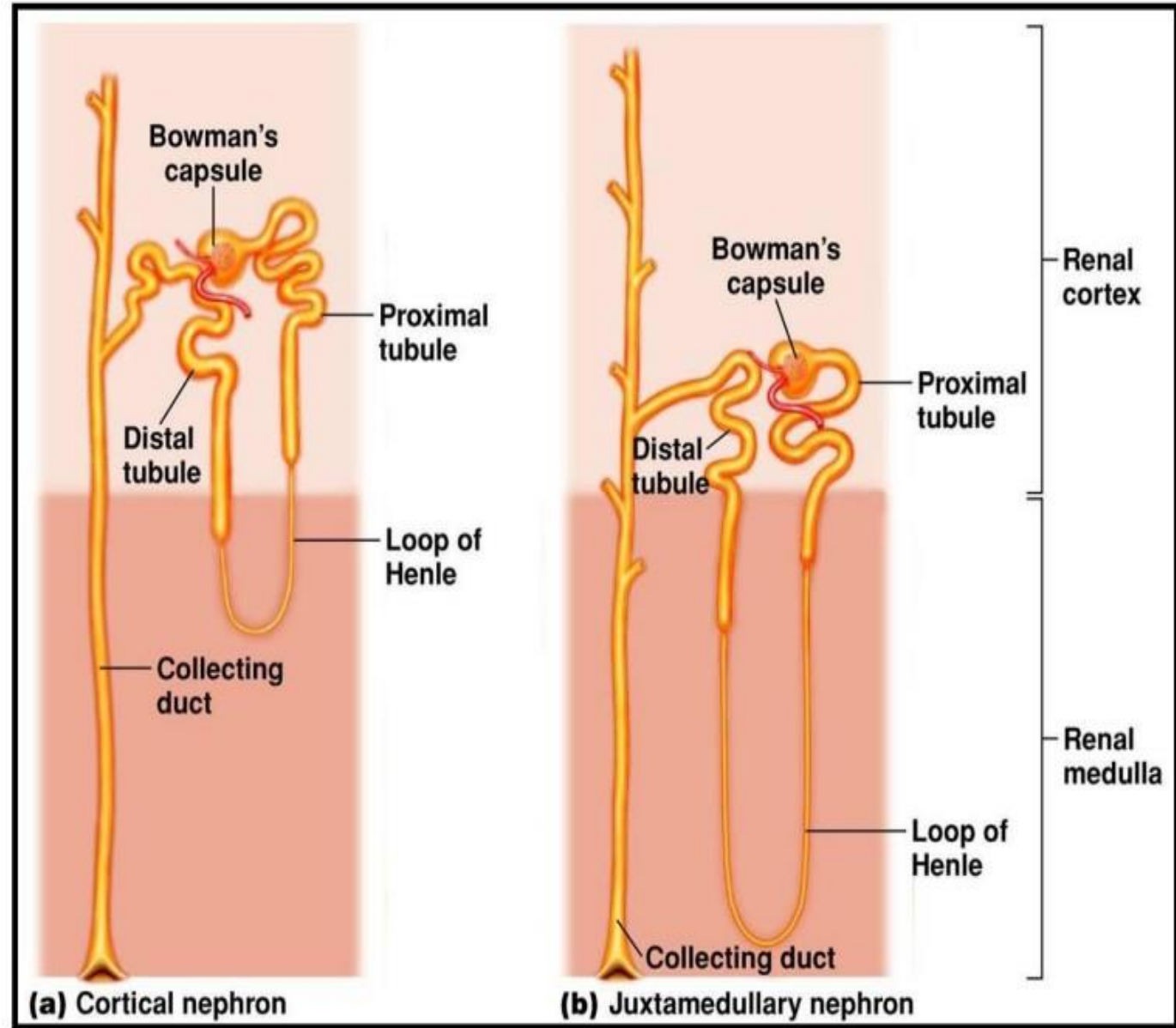
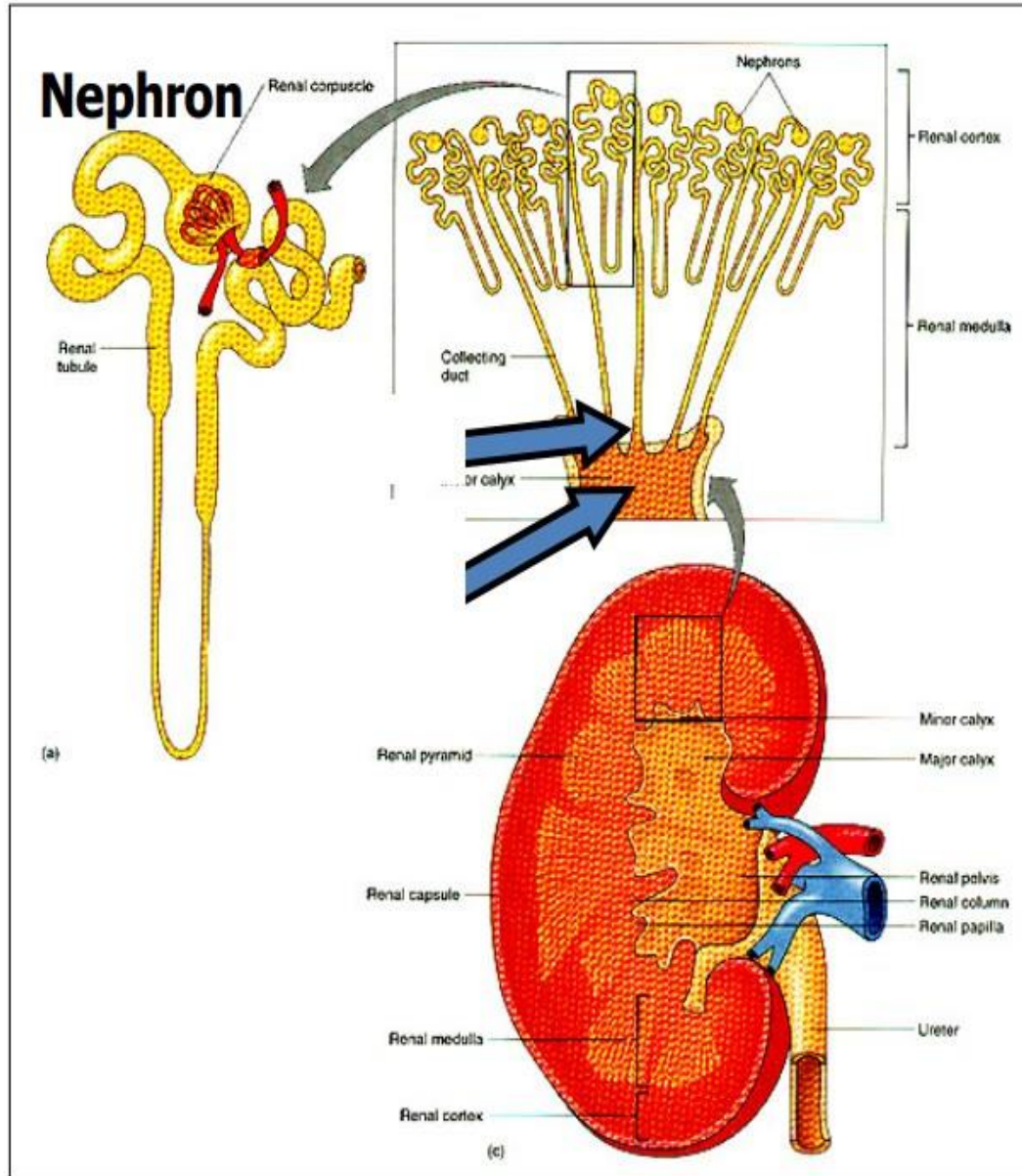
- Kidneys are paired structures functioning filtration of blood, lying in the upper retroperitoneal area and oriented with the (hilum) directed medially. In adults the kidney measures 10 – 12 cm.
- Is bean shaped organ covered by dense irregular collagenous connective tissue capsule contains collagen and fibroblasts.
- Divided into renal **cortex** and **medulla**.
- Has a convex border & a medial concave border have hilum , where the arteries enter, ureter& veins leave the Kidney.
- Kidney lobe consists of medullary pyramid and associated cortical tissue at its base and sides, and they are about 8-15 in each kidney. Renal pelvis is the dilated upper portion of the ureter which is divided into 2-3 major calyces that branch into several smaller minor calyces.

Urineriferous Tubules

- The functional unit of each kidney is the microscopic urineriferous tubule. It consists of a nephron and a collecting duct.
- Millions of nephrons are present in each kidney cortex. The nephron, in turn, is subdivided into two components: a renal corpuscle and renal tubules.
- Each nephron consists of :-
 - 1- Renal corpuscle.
 - 2- Proximal convoluted tubule (PCT).
 - 3- Thin and thick limbs of Henle's loop.
 - 4- Distal convoluted tubule (DCT).
 - 5- Collecting tubules and ducts.

NEPHRON

- Nephrons can be classified:-
- **On the basis of location of their glomeruli:-**
- Superficial (near the capsule).
- Mid cortical (near the medulla/Juxtamedullary).
- **On the basis of the length of the loop of henle:-**
- a- Short looped- generally have superficial or mid cortical glomeruli and the tubules extend only into the outer medulla before it reflects back into the cortex.
- b- Long looped- have juxtamedullary glomeruli and tubules extend into the inner medulla before reflecting back into the cortex.



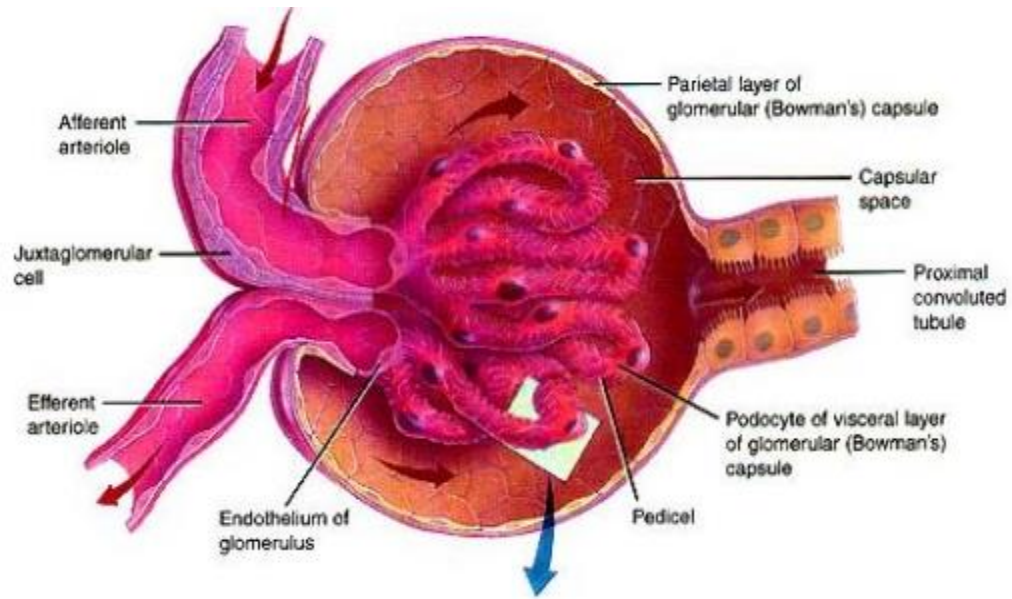
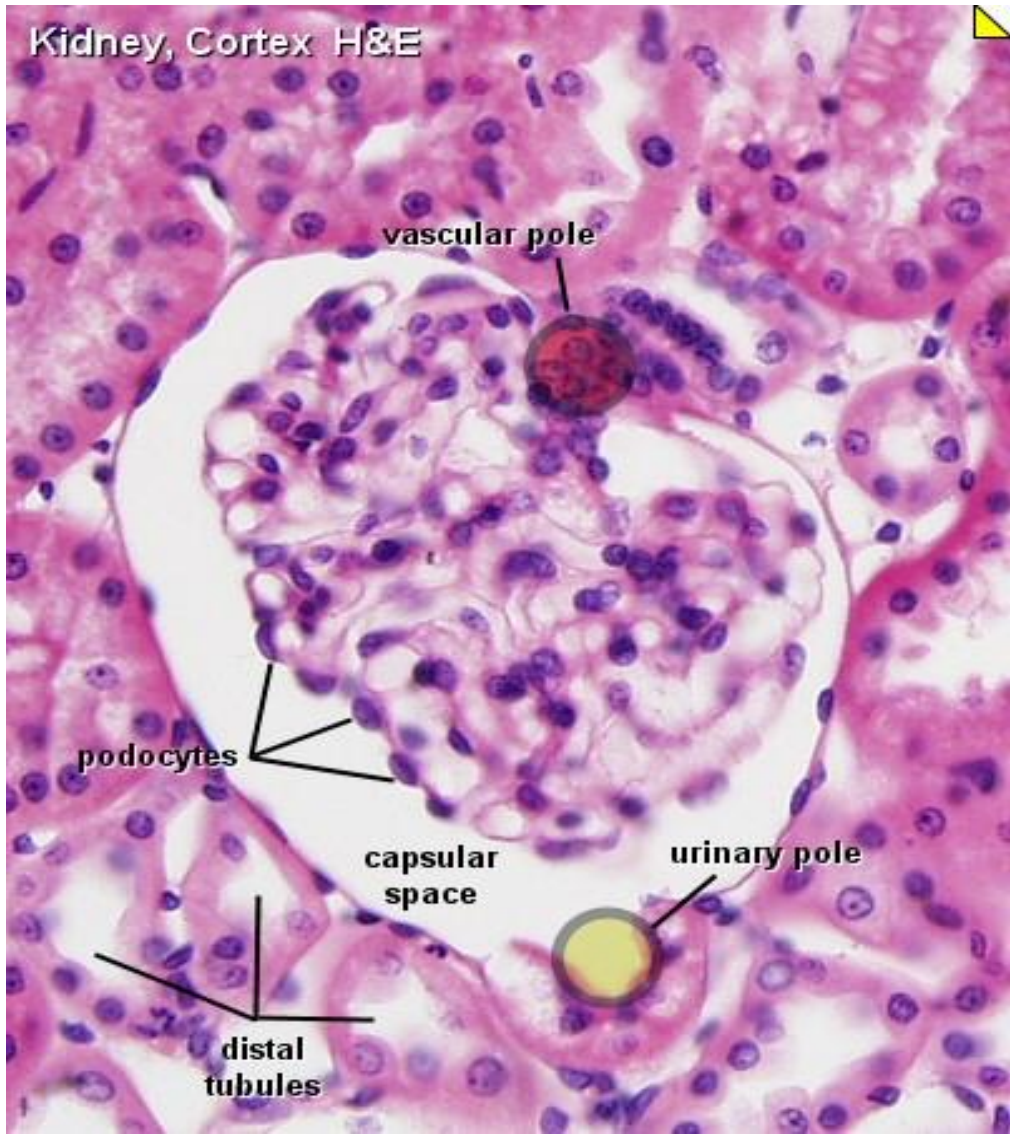
Renal corpuscle

- It is an oval to round structure that has about 200 μm in diameter.
- Composed of:-
 - **A- Glomerulus:** When afferent arteriole enter the renal corpuscle, it will divide into 2-5 primary branches which will further divide into capillaries (of the fenestrated type) forming the glomerulus .
 - **B- Bowman's capsule** Composed of two layers; parietal and visceral, with a space in between called urinary space(Bowman's space) which receives the fluid filtered through capillary wall.
- Parietal layer consists of simple squamous epithelium supported by a basal lamina and a thin reticular fibers. At the urinary pole, this epithelium will change into simple cuboidal epithelium of the Proximal convoluted tubule (PCT).
- Visceral layer is modified during embryonic life and the cells are called Podocytes.

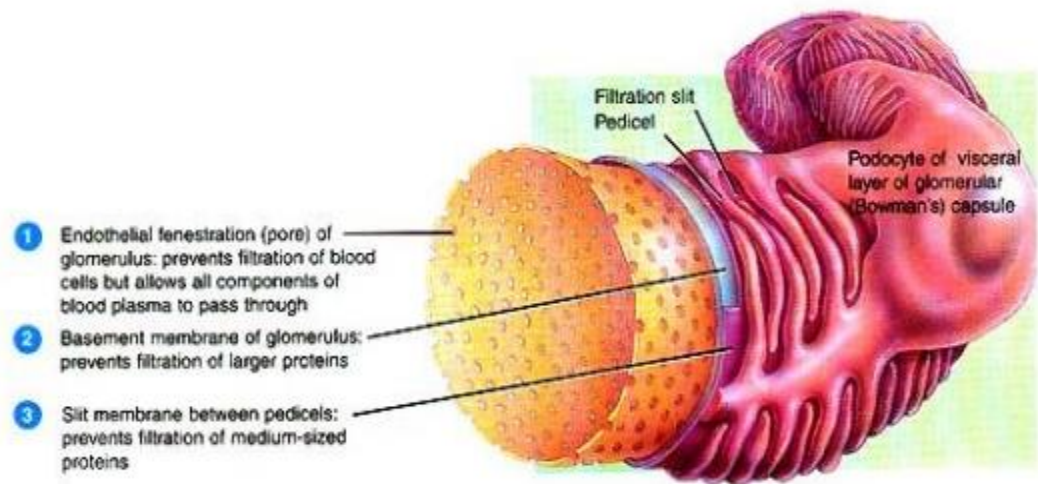
Renal corpuscle

- **Podocytes are modified epithelial cells, perform filtration.**
- **Podocytes have numerous, long, cytoplasmic processes called primary processes that not in contact with capillaries but bear many secondary processes known as pedicels which completely envelop glomerular capillaries.**
- **During filtration of plasma from glomerular capillaries into the renal tubule , the filtrate passes through three layers: capillary endothelium, glomerular basement membrane and the podocyte layer. All contribute to the filtration process.**
- **As blood flows through capillary tuft – filtration occurs.**
- **Water and most dissolved molecules pass into capsular space.**
- **Large proteins and formed elements in the blood do not cross.**

Kidney, Cortex H&E

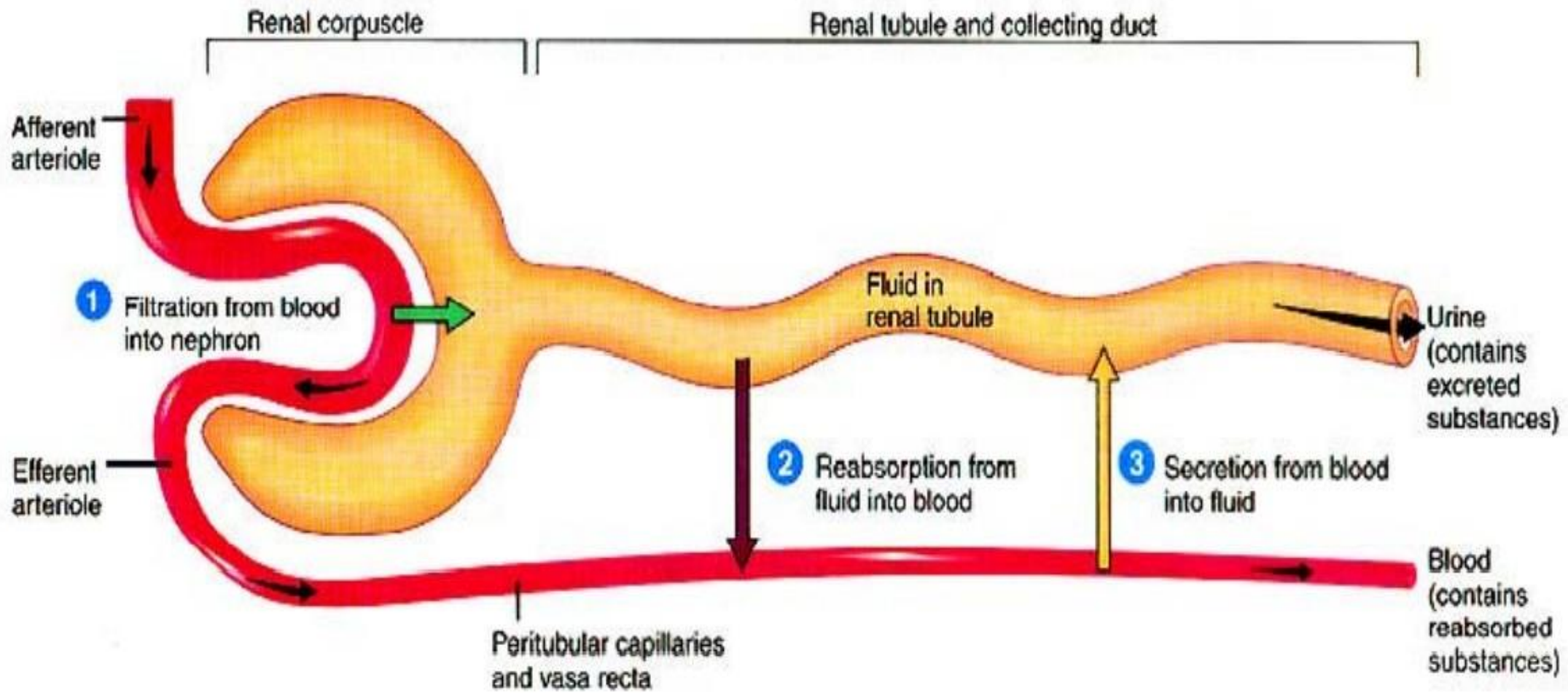


(a) Parts of a renal corpuscle (internal view)



Urineriferous Tubules

- **The functional and structural unit of kidney.**
- **– Three physiological processes: 1) filtration, 2) reabsorption , and 3) secretion.**
- **– These three processes cooperate to achieve the various functions of the kidney.**
- **– Different sites - different primary functions.**
- **(Nephron – Renal tubule) – The renal tubule has a convoluted shape and has four distinct histophysiological zones, each of which has a different role in tubular function.**



Proximal Convoluted Tubule

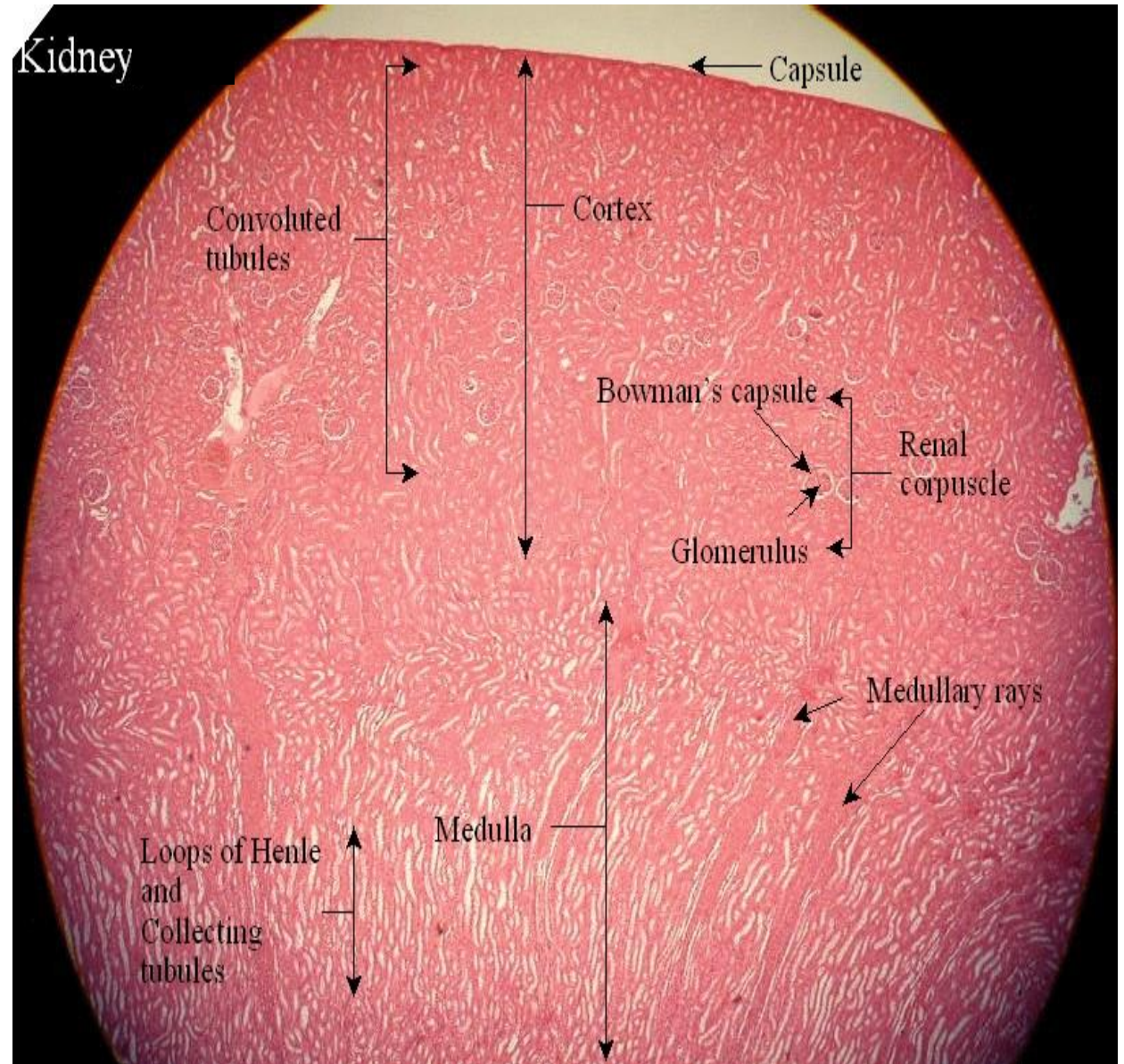
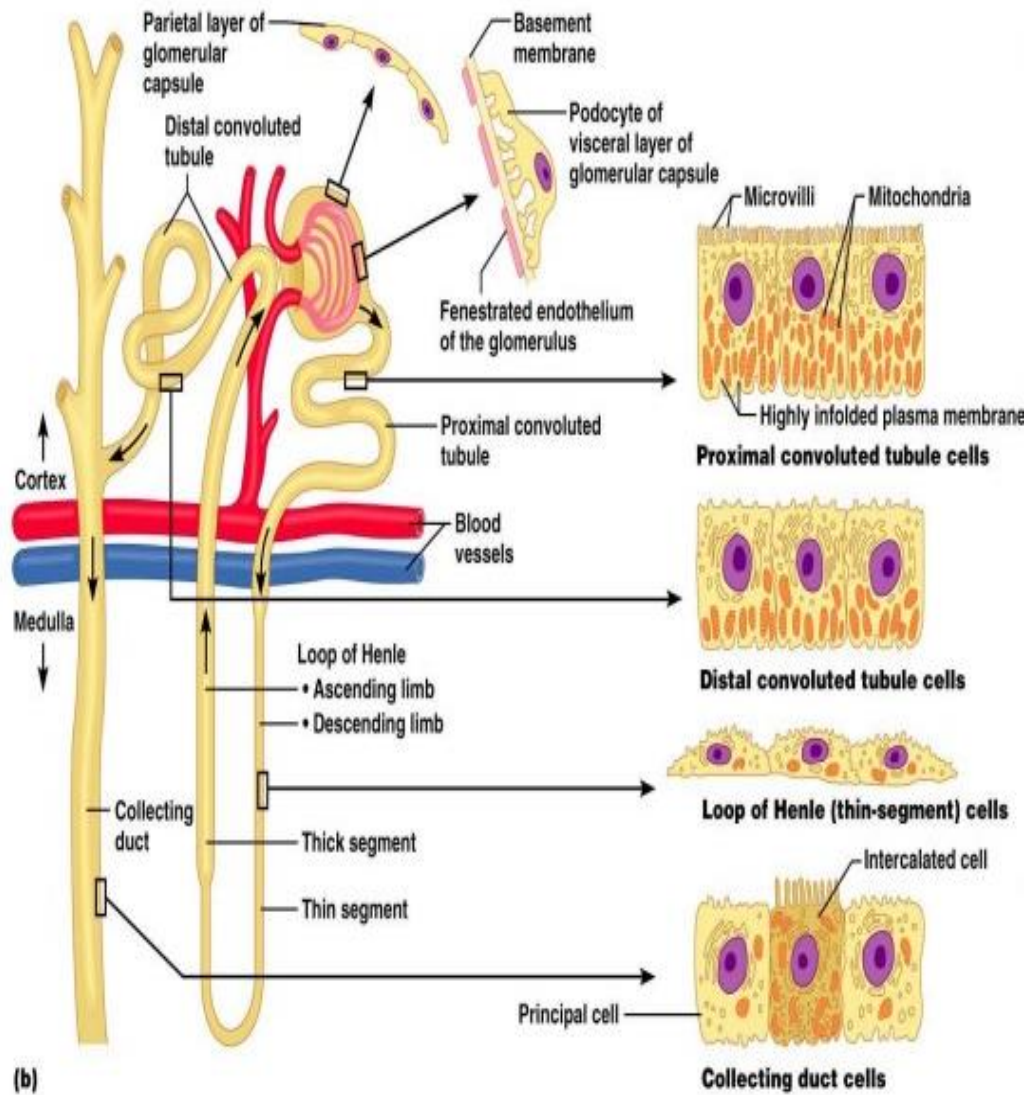
- The proximal tubule is the segment of the [nephron](#) in [kidneys](#) which begins from the renal pole of the [Bowman's capsule](#), it is 14 mm long, and about 50 μm in diameter.
- Longer than distal convoluted tubules and more frequently seen in cortex near renal corpuscles.
- Proximal convoluted tubules lined with brush border and absorb most of filtrate.
- It is lined by simple cuboidal epithelium with spherical nuclei. Acidophilic granular cytoplasm.
- Cell boundaries are not distinct because of extensive basal and lateral cell membrane interdigitations with neighboring cells.
- Basal infoldings of cell membrane contain numerous mitochondria and sodium pumps, Mitochondria supply energy for ionic transport across cell membrane into the interstitium
- Absorb all glucose, proteins, and amino acids, almost all carbohydrates, and 65% to 85% of water.
- Secrete metabolic waste, hydrogen, ammonia, dyes, and drugs into the filtrate for voiding
- **Function:-**
- - Facilitated diffusion glucose, amino acids. - Na pump. - Energy for active transport.

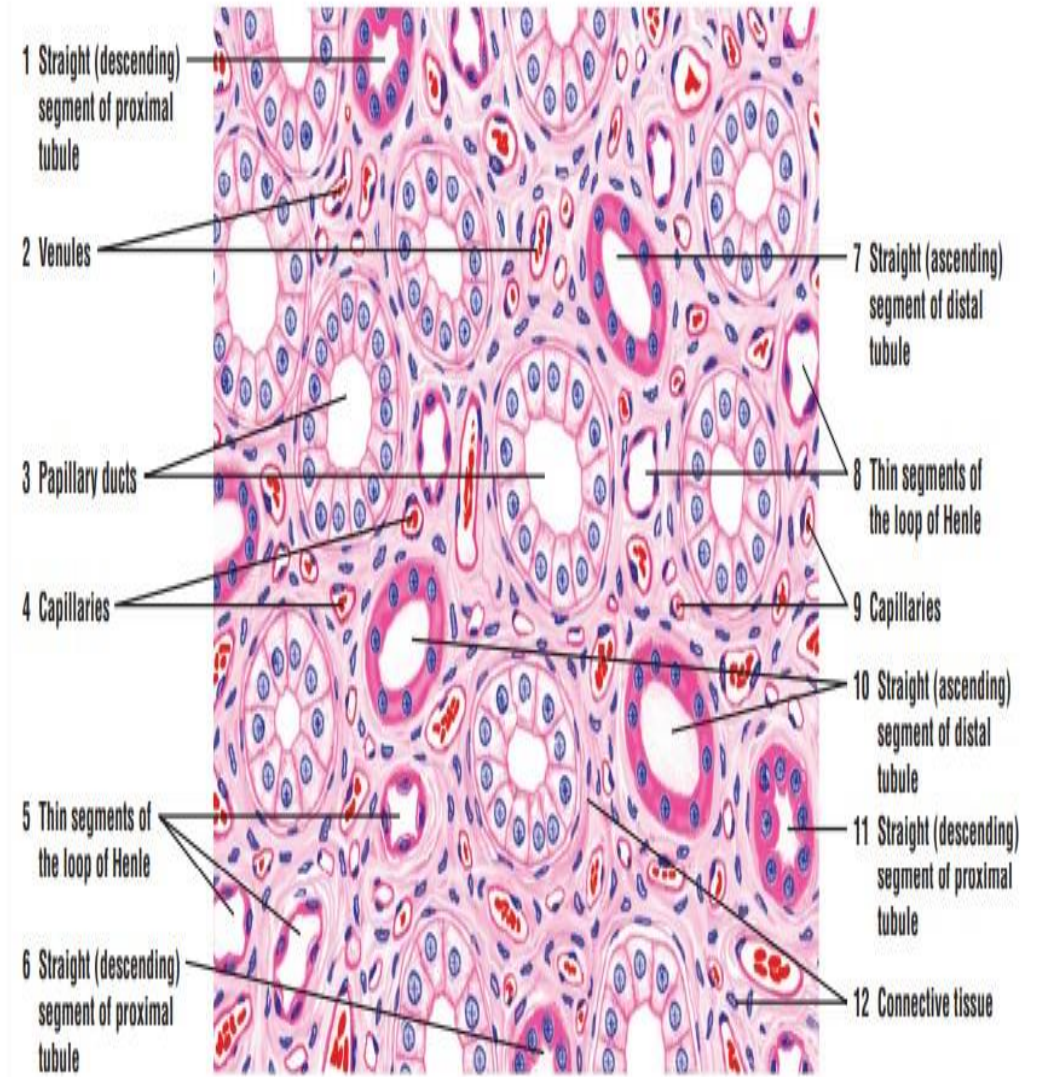
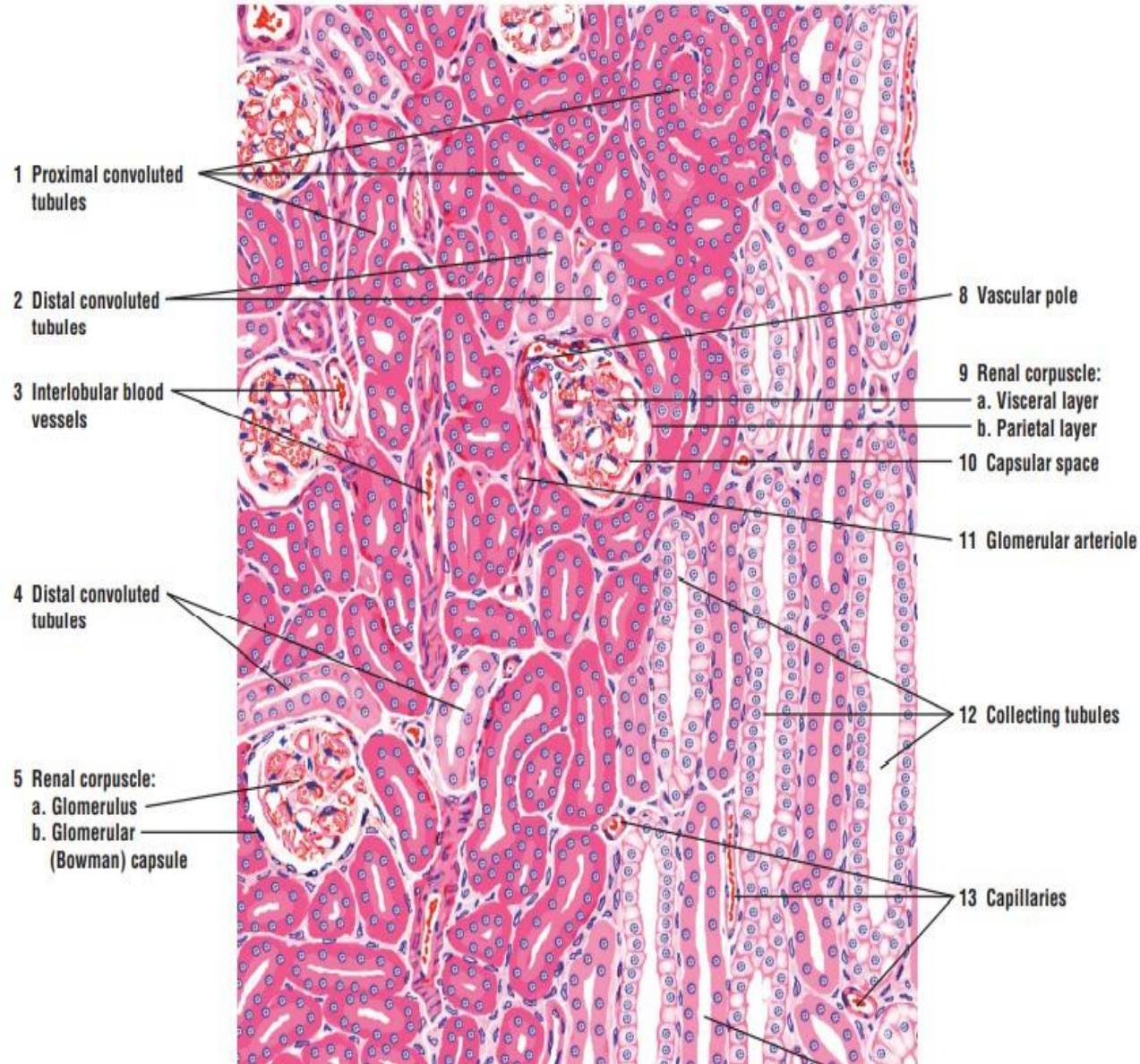
Loop of Henle

- The loop of Henle is made up of four parts:-
- - The (**pars recta**) of the proximal tubule. /- Secretion of organic acids.
- - The (**thin descending limb**). { /- No active transport.
- - The (**thin ascending limb**). { /- Low energy requirement.
- - The (**thick ascending limb**). /- No facilitated diffusion. - Active transport of Na.
- The Thin limb has simple squamous epithelium that gradually changes to low cuboidal at the end of the thin segment.
- Thin limb resemble capillaries in sections.
- The Thick ascending limb has simple cuboidal epithelium.
- Descending thin limb is highly permeable to water and so to urea NaCl and other ions.
- High interstitial osmolarity draws water from the filtrate as it flows through the loop.
- Vasa recta capillaries take up water from interstitial and return it to systemic circulation.

Distal Convoluted Tubule

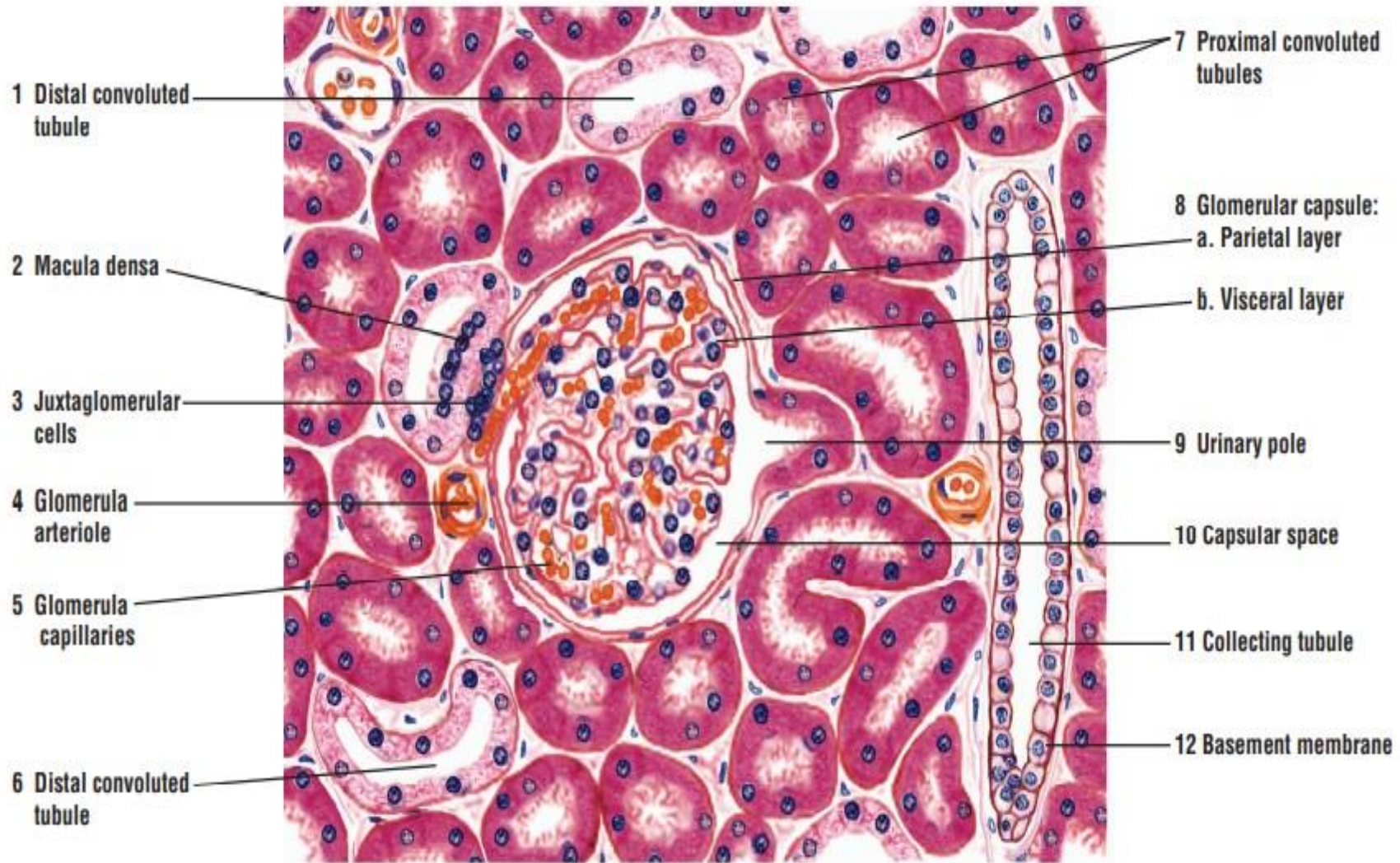
- Distal convoluted tubule has 5 mm long, and 25 – 45 μm in diameter.
- Shorter than proximal convoluted tubules, less frequent in cortex.
- It is lined by simple cuboidal epithelium but paler than PCT cells that has not brush border of microvilli.
- Narrower cells, thus more nuclei in cross sections. Smaller in diameter than PCT, lumen is larger than PCT .
- Under the influence of adrenocortical hormone (aldosterone), sodium ions actively absorbed from the filtrate.
- Peritubular capillaries return ions to systemic circulation to maintain vital acid–base balance.
- **Function:-**
- - Active transport of Na. - Energy for active transport.





Juxtaglomerular Apparatus

- Located adjacent to renal corpuscle and distal convoluted.
- Main function is to maintain proper blood pressure for blood filtration in renal corpuscles.
- Consists of juxtaglomerular cells, macula densa, and extraglomerular mesangial cells.
- Juxtaglomerular cells are modified smooth muscle cells in afferent arteriole before entering glomerular capsule.
- Decreased blood pressure and ionic content causes release of enzyme renin by juxtaglomerular cells.
- Macula densa is a group of modified distal convoluted tubule cells.
- Macula densa responds to changes in sodium chloride concentration in glomerular filtrate.



Collecting Tubules and Ducts

- Glomerular filtrate flows from distal convoluted tubules to collecting tubules and ducts.
- It is 20 mm long, 40 μm in diameter; cuboidal/epithelium; becomes more columnar in distal collecting ducts (up to 200 μm diameter).
- During excessive water loss or dehydration, Antidiuretic hormone (ADH) is released from the pituitary gland.
- ADH causes epithelium of collecting duct to become highly permeable to water.
- **Function:-**
 - - Na reabsorption, ADH- dependent water reabsorption, K secretion.
 - - Acid – base balance, K reabsorption. - Active transport of Na.
- **Cortical collecting duct (Simple columnar) Function:-**
 - - Na reabsorption, ADH – dependent water reabsorption, K secretion. - Acid– base balance, K reabsorption.
- **Medullary collecting duct (Simple columnar) Function:-**
 - - ADH – dependent water reabsorption.

