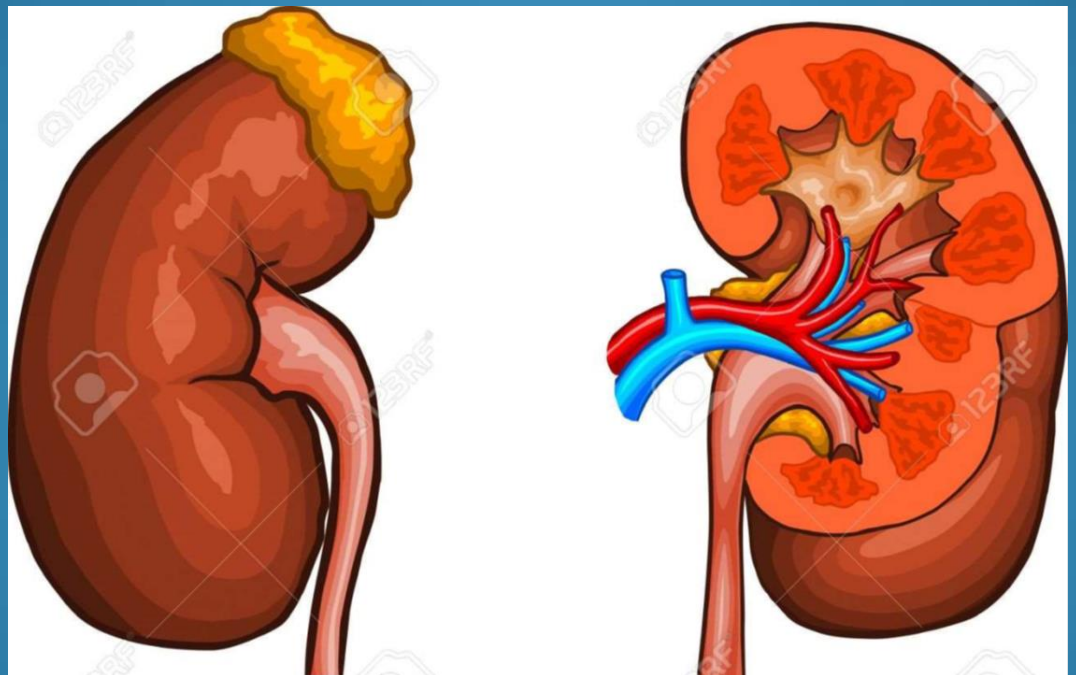
General Histology

Urinary system



Functions of the Urinary System

- Removing waste products from the bloodstream.
- Storage of urine: the urinary bladder is an expandable, muscular sac that can store as much as 1 liter of urine
- Excretion of urine.
- Blood volume regulation: the kidneys control the volume of interstitial fluid and blood under the direction of certain hormones
- Regulation of erythrocyte production:as the kidneys filter the blood, they are also indirectly measuring the oxygen level in the blood
- Erythropoietin (EPO): hormone produced by kidney Released if blood oxygen levels fall
- Stimulates RBC production in red bone marrow

Organs of the Urinary System:

- Primary organs: kidneys

 filter waste products from the bloodstream

 convert the filtrate into urine.

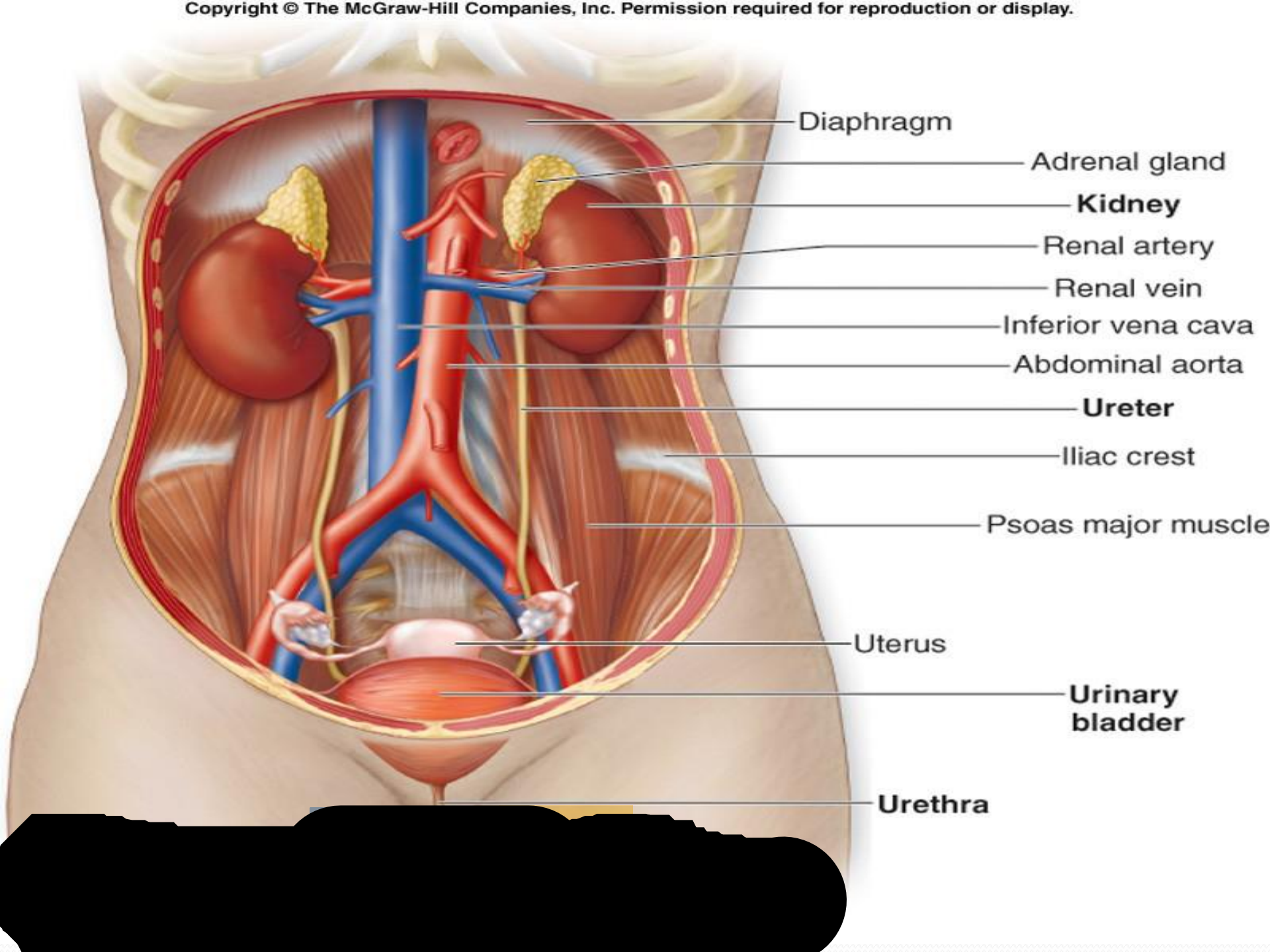
- The Urinary Tract:

 Includes:

 ureters

 urinary bladder

 urethra



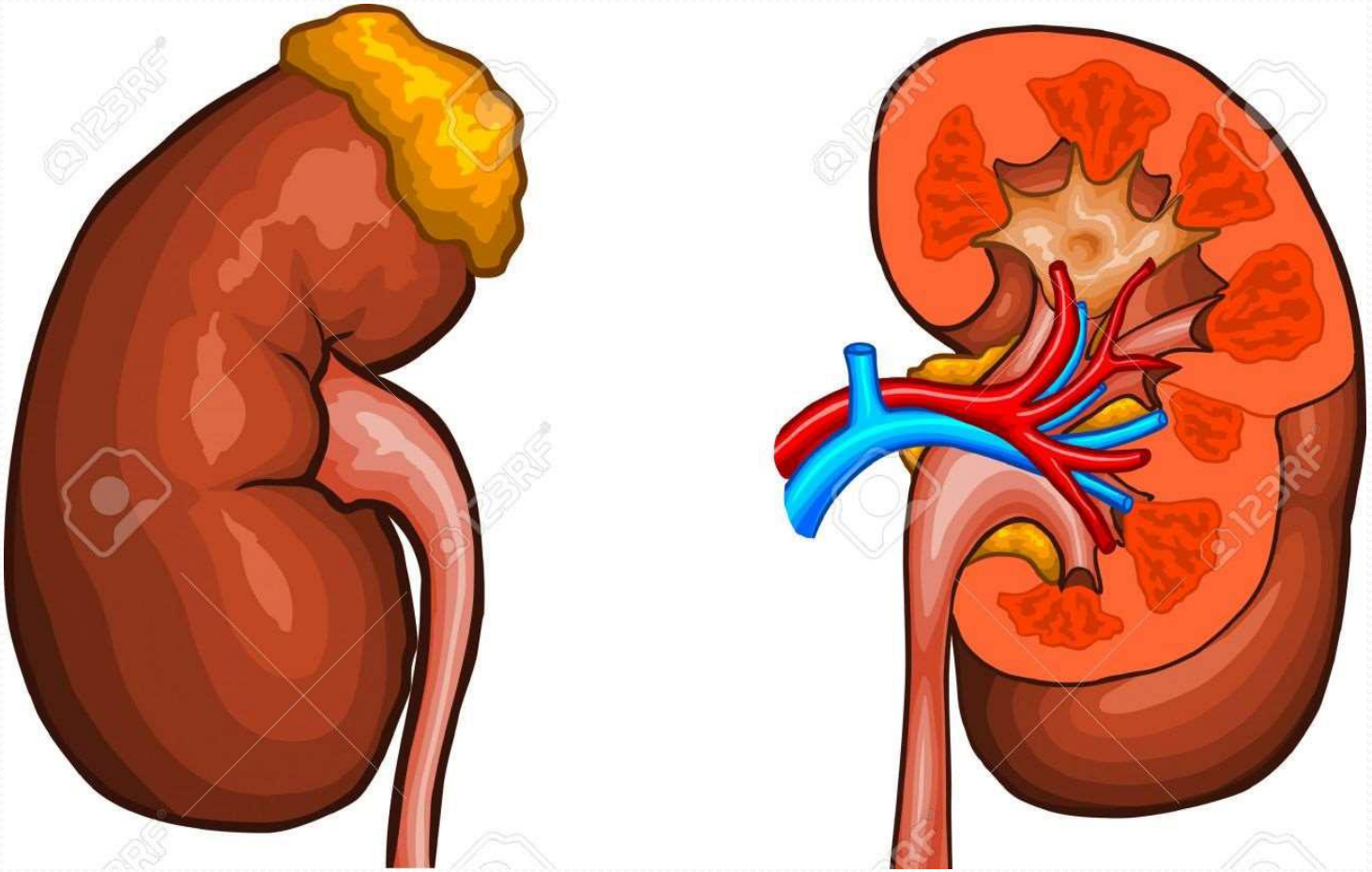
kidneys

- Bean shaped, reddish brown.
- Located between T12 – L3 vertebral level.
- [redacted]
- Weighs around 135-150 grams.
- Highly vascular organ.
- Receives 25 % of cardiac output.
- Kidney produces urine - ultrafiltrate of blood, which is then modified by selective resorption and specific secretion by cells of kidney.

FUNCTIONS OF KIDNEY

- Regulates and maintains composition and volume of extracellular fluid.
- Maintains acid base balance by excreting H+ ions or HCO_3- ions.
- Endocrine organ :

* A) Synthesis of acid protease RENIN
* b) Erythropoietin synthesis



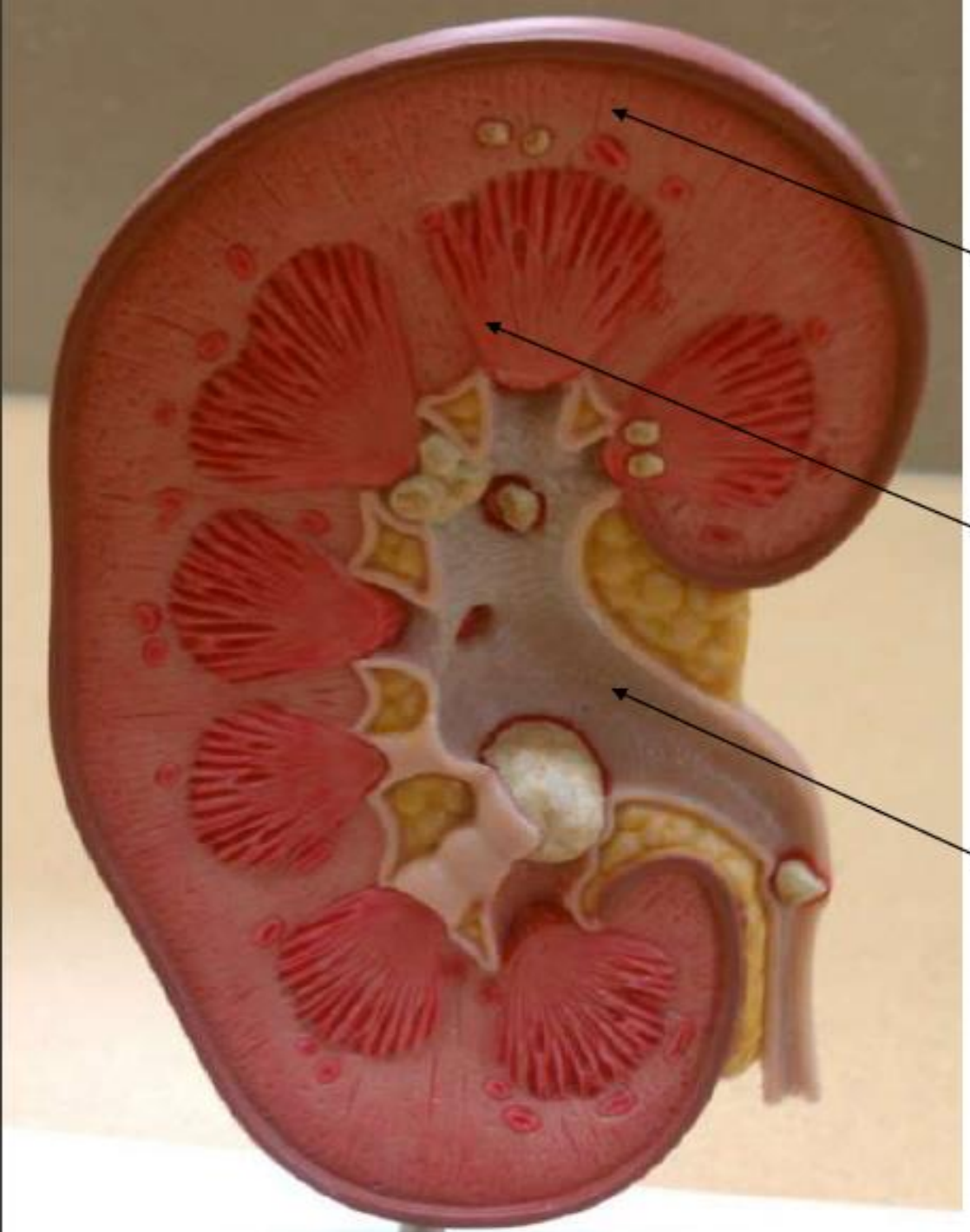
Capsule

- Connective tissue capsule.
- Outer layer – fibroblasts and collagen fibres
- Inner layer – myofibroblasts


outer layer
inner layer

- The kidney is divided into an outer cortex and an inner medulla.
- Renal medulla consists of 10-18 conical or pyramidal structures; the medullary pyramids.
- The tips of pyramids are called renal papillae, where the collecting ducts open into.
- From the base of each medullary pyramids parallel tubules; the medullary rays, penetrate the cortex.

- Kidney lobe consists of medullary pyramid and associated cortical tissue at its base and sides, and they are about 8-18 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.


Cortex
Medulla
- Pyramids
(triangular areas of renal tissue)
Renal pelvis

- Kidney consists of collection of numerous Uriniferous tubules.
- - Uriniferous tubule = Nephron + Collecting Duct.
- *Structural and functional unit of each kidney is*

Nephron. There are 1 million nephrons in each kidney.

- NEPHRON

It is the functional unit of the kidney. There are about 1-4 millions in each kidney. Each nephron consists of a dilated portion; the renal corpuscle, proximal convoluted tubule (PCT), thin and thick limbs of Henle's loop, and distal convoluted tubule (DCT). Some investigators consider the collecting tubules and ducts to be part of the nephron.

- **Bowman's capsule**

Composed of two layers; parietal and visceral, with a space in between called urinary space which receives the fluid filtered through capillary wall.

- **Glomerulus:**

When afferent arteriole enter the renal corpuscle, it will divide into 2-5 primary branches which will further divide into capillaries forming the *glomerulus*. The endothelial cells have thin cytoplasm except around the nucleus. It is of the fenestrated type with 70-90 nm in diameter, with no diaphragm.

- **Proximal convoluted tubules:**

• 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.

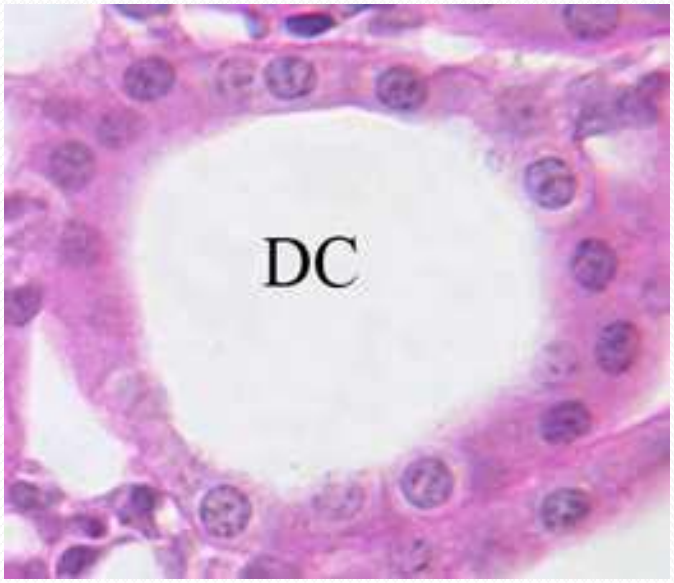
• Cells have microvilli on their luminalsurface (*typical brush border*).

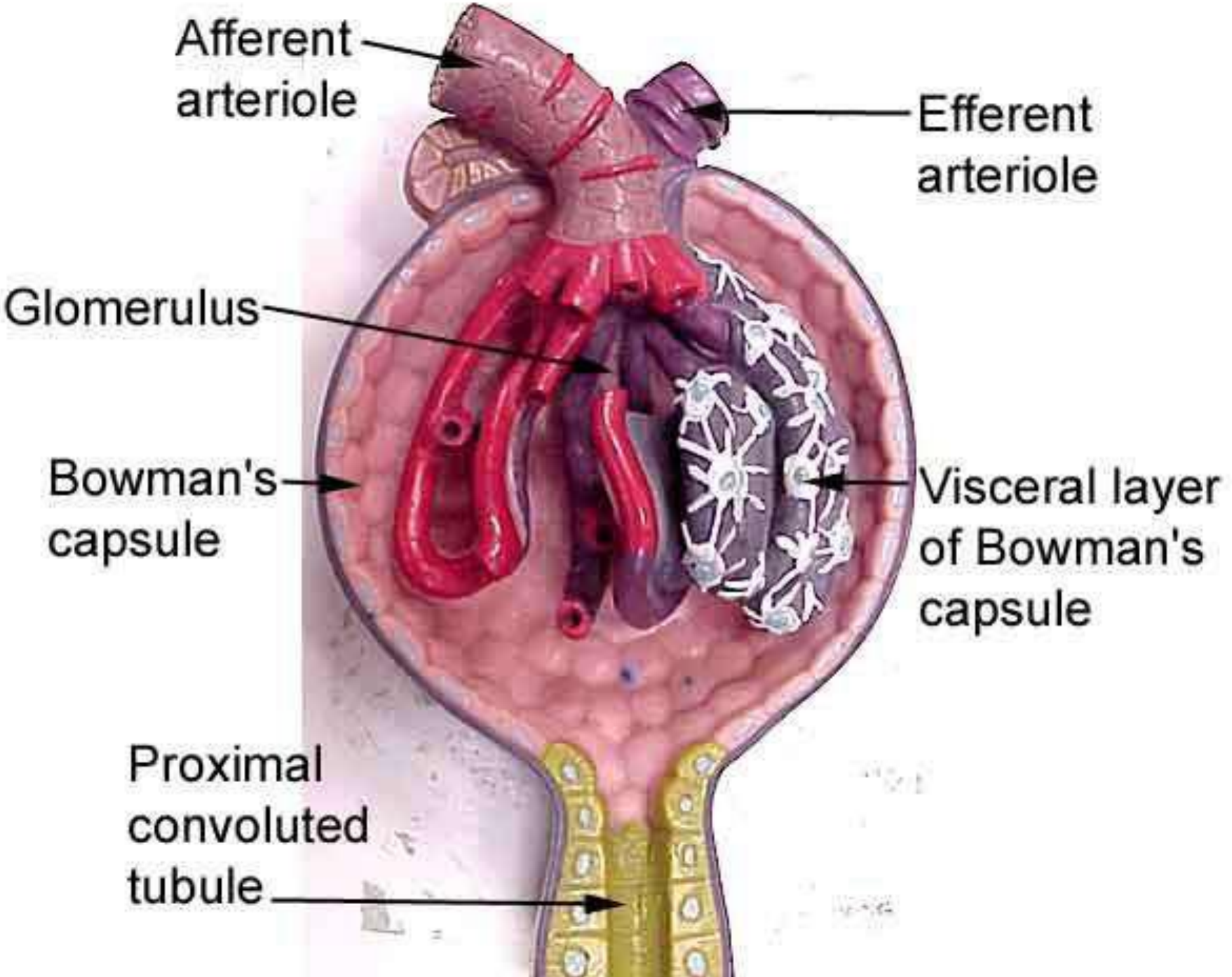
- **HENLE'S LOOP**

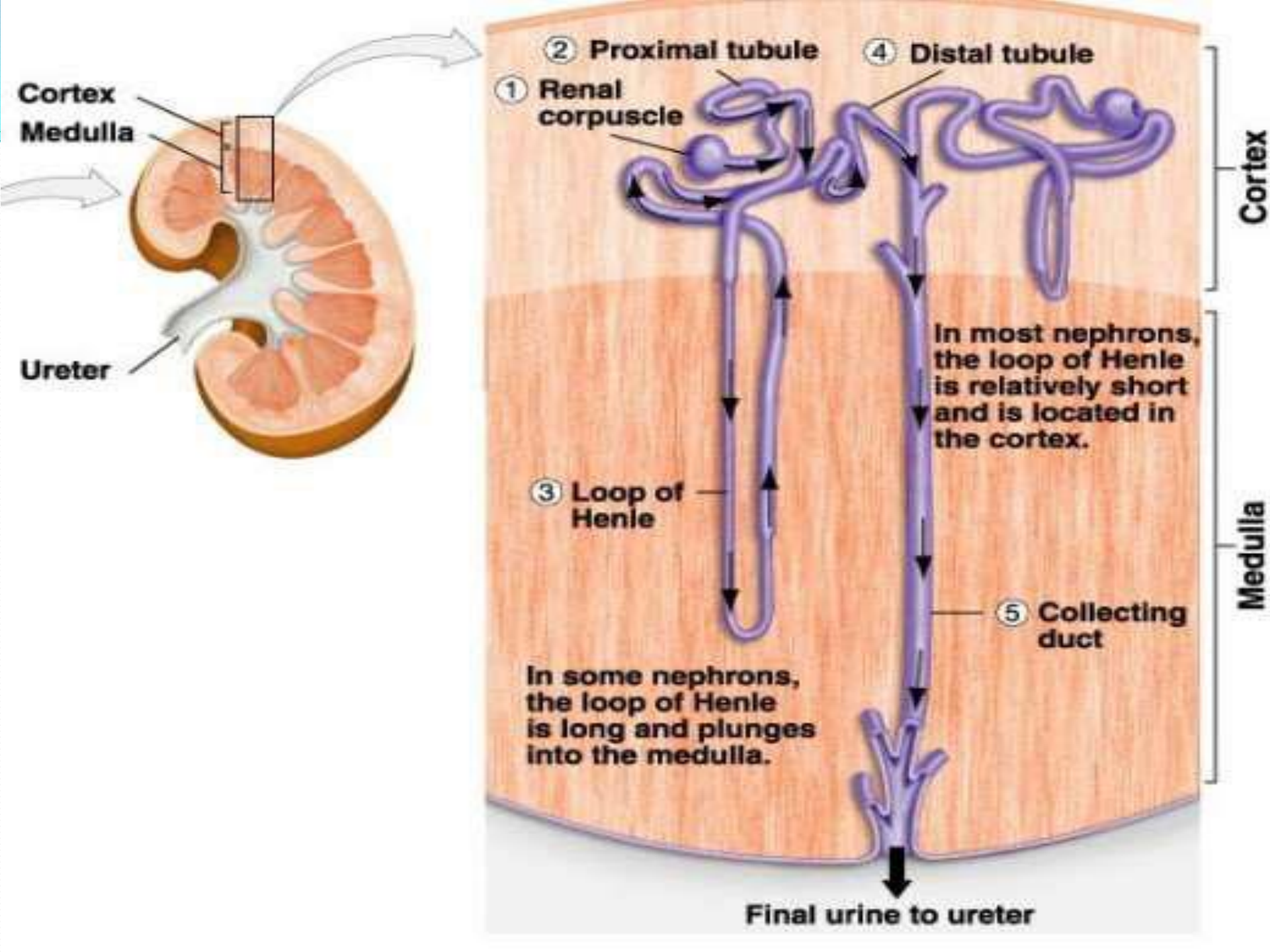
It is a U shaped structure It starts as a thick limb in the outer medulla with a diameter of 60µm, lined by simple cuboidal epith. , then suddenly narrows to about 12µm in diameter as the thin descending limb. This segment has a wide lumen, and lined by simple seq.epith., This segment runs deep into the medulla, then continues upwards as the ascending thin limb, which will suddenly change into simple cuboidal epith. of the thick ascending limb.

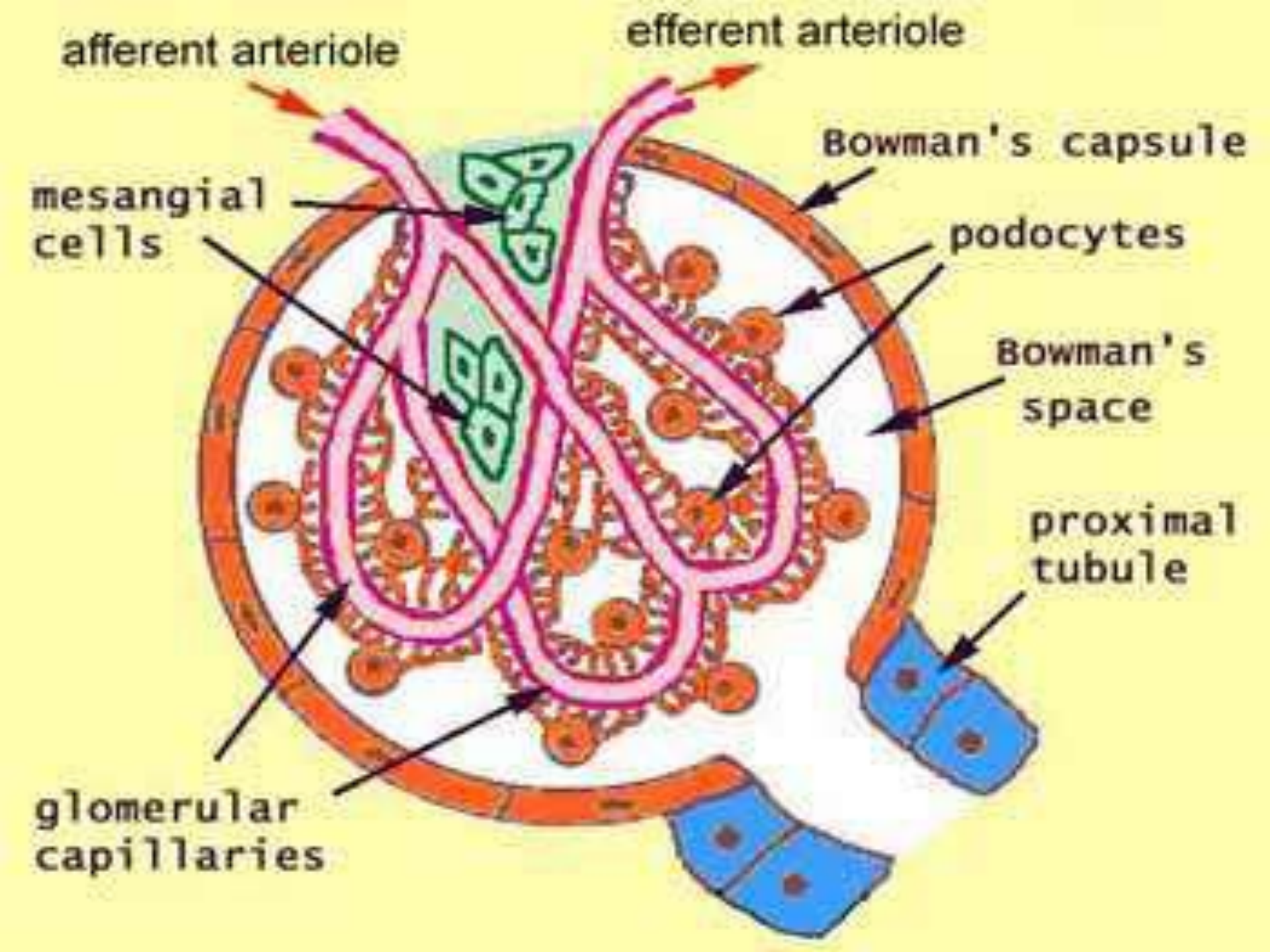
Distal convoluted tubule

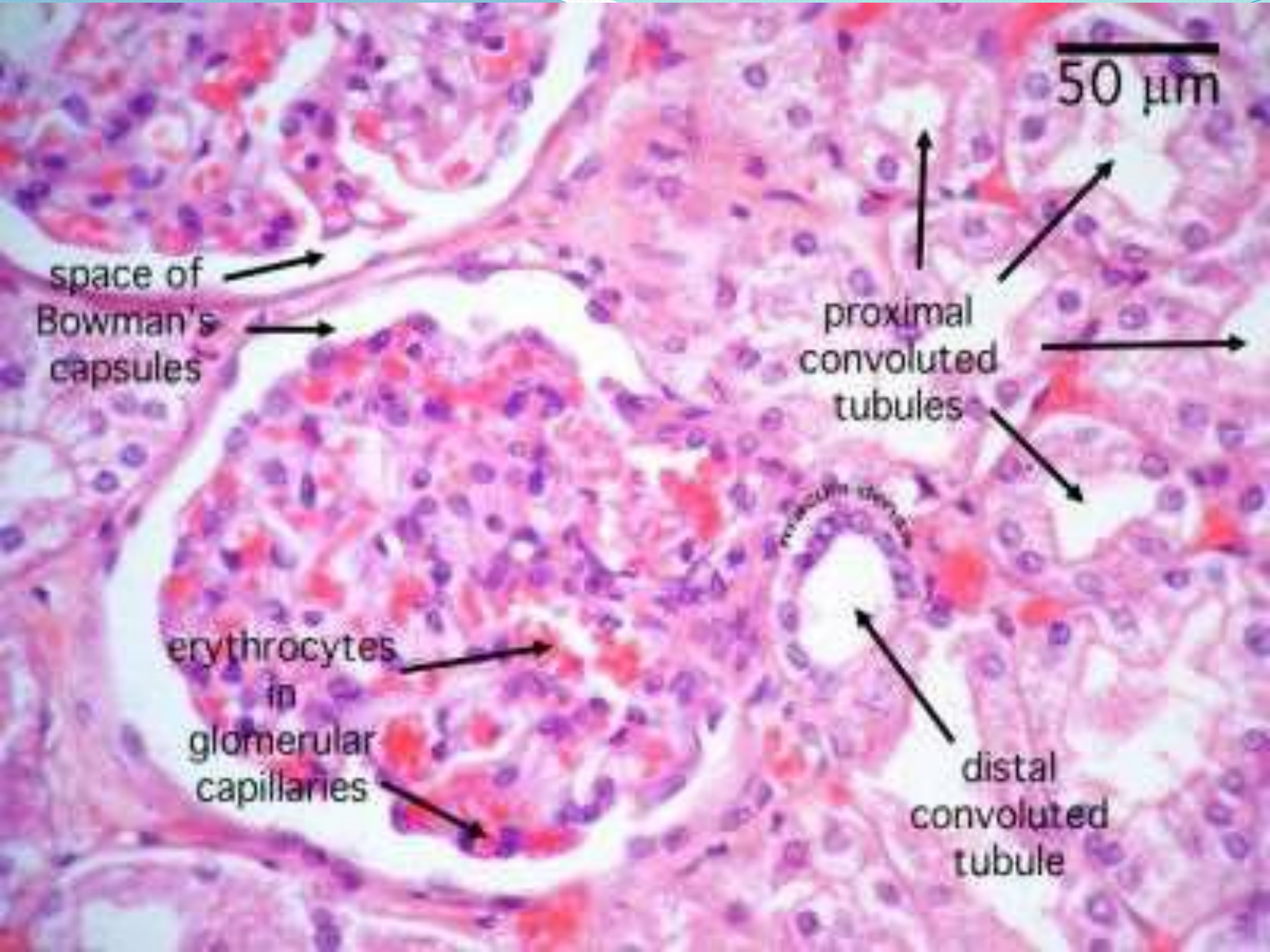
- Shorter in length, therfore are few in number in cortex.
- Have larger lumen.
- Lined by *small, cuboidal cells.*
- Cytoplasm stains less intensely.
- Deep basal and lateral cell membrane infoldings and interdigitations are also present.
- Cells *lack microvilli.*




Afferent arteriole
Efferent arteriole
Glomerulus
Bowman's capsule
Visceral layer of Bowman's capsule
Proximal convoluted tubule


Cortex
Medulla
Ureter
2 Proximal tubule
4 Distal tubule
1 Renal corpuscle
Cortex
In most nephrons, the loop of Henle is relatively short and is located in the cortex.
3 Loop of Henle
5 Collecting duct
Medulla
In some nephrons, the loop of Henle is long and plunges into the medulla.
Final urine to ureter


afferent arteriole
efferent arteriole
Bowman's capsule
mesangial cells
podocytes
Bowman's space
proximal tubule
glomerular capillaries

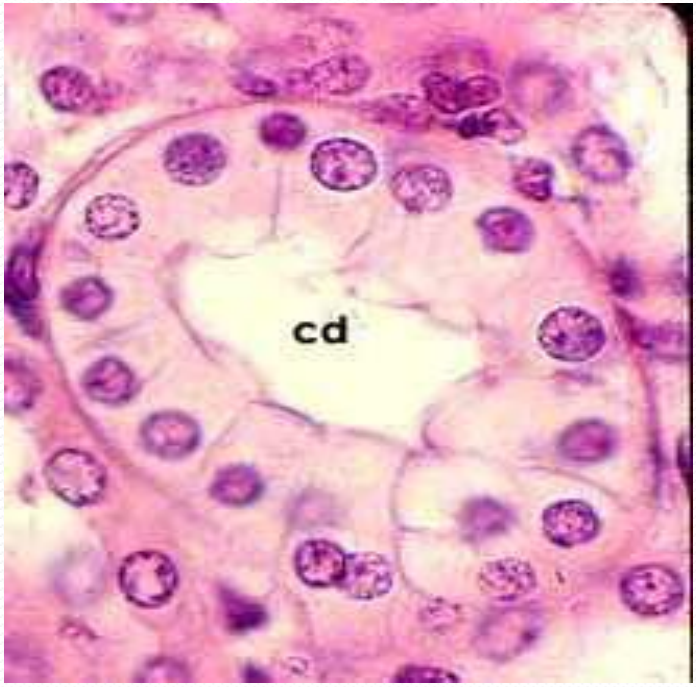

50 µm
space of Bowman's capsules
proximal convoluted tubules
erythrocytes in glomerular capillaries
distal convoluted tubule

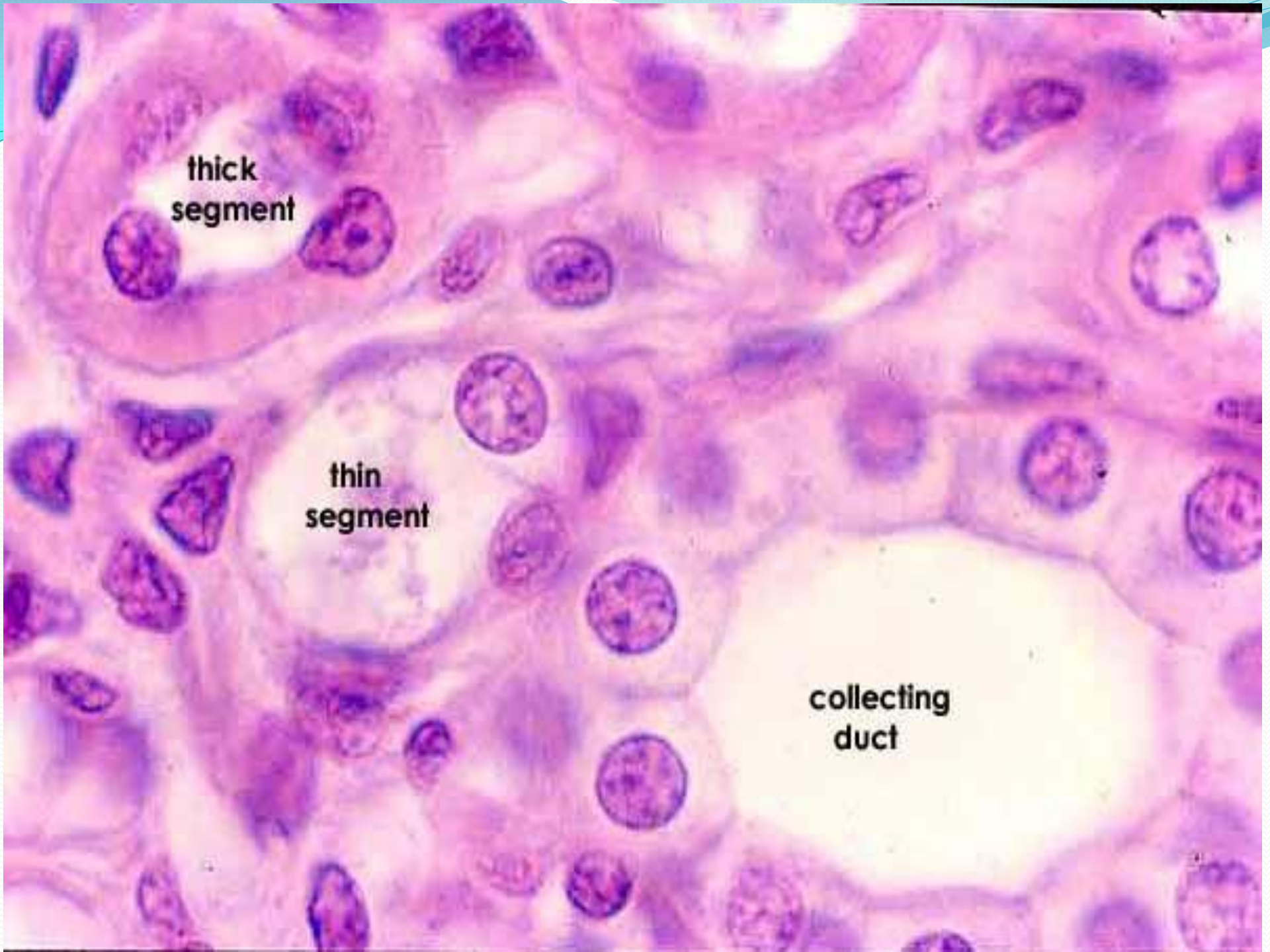
Collecting Tubule and Duct

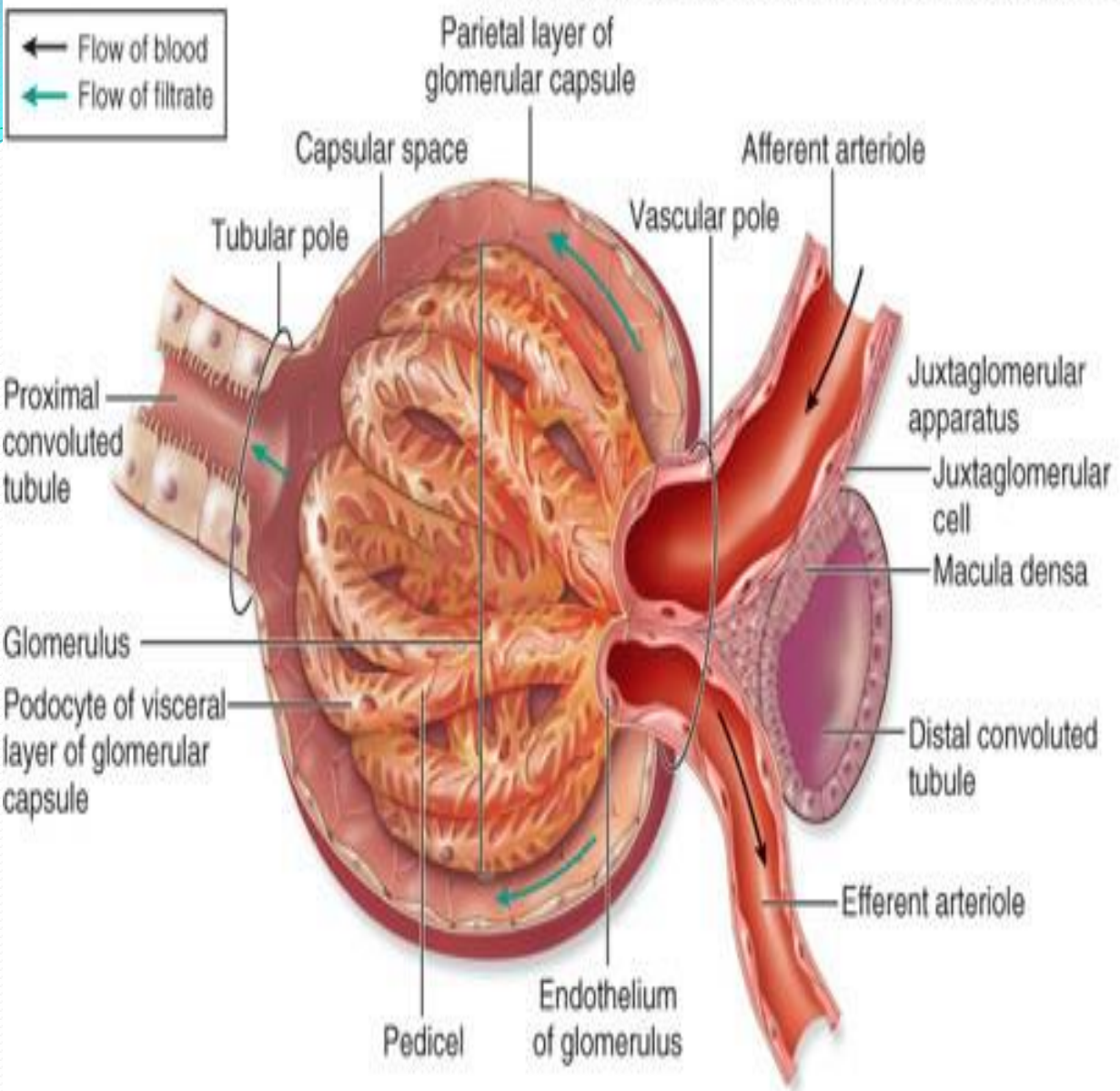
- Drain urine from nephron to renal pelvis.
- Lie on medullary ray within cortex.
- Progressively increase in diameter towards medulla.
- Simple epithelium - *Squamous to cuboidal.*
- Cell boundaries are seen
- Two types of cells in collecting tubule and collecting duct –

1) Light or thin segment

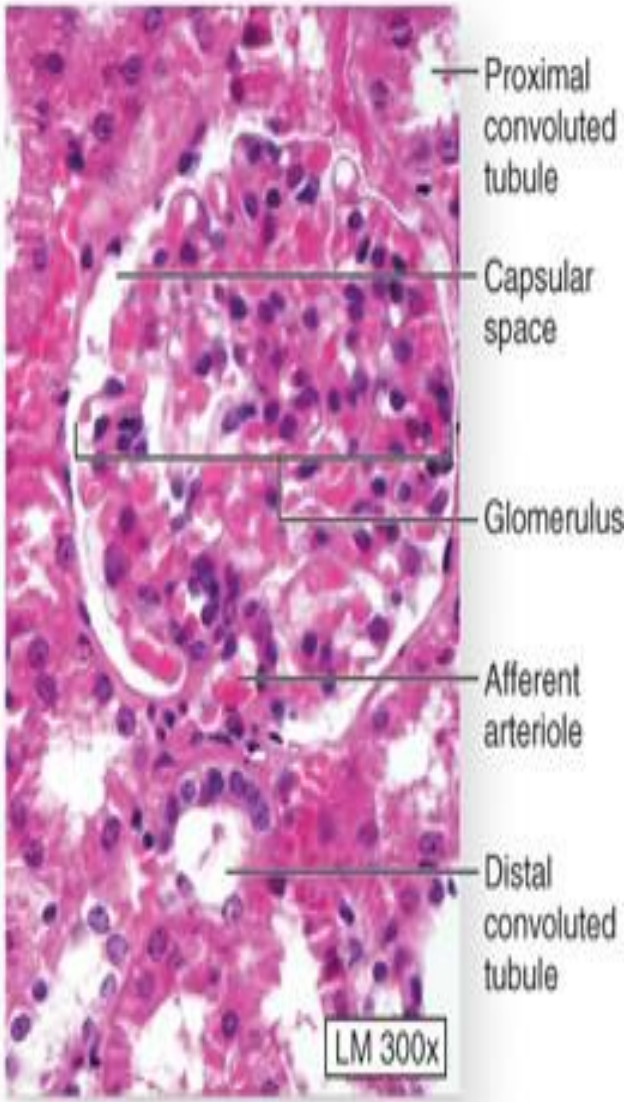
2) Dark or thick segment



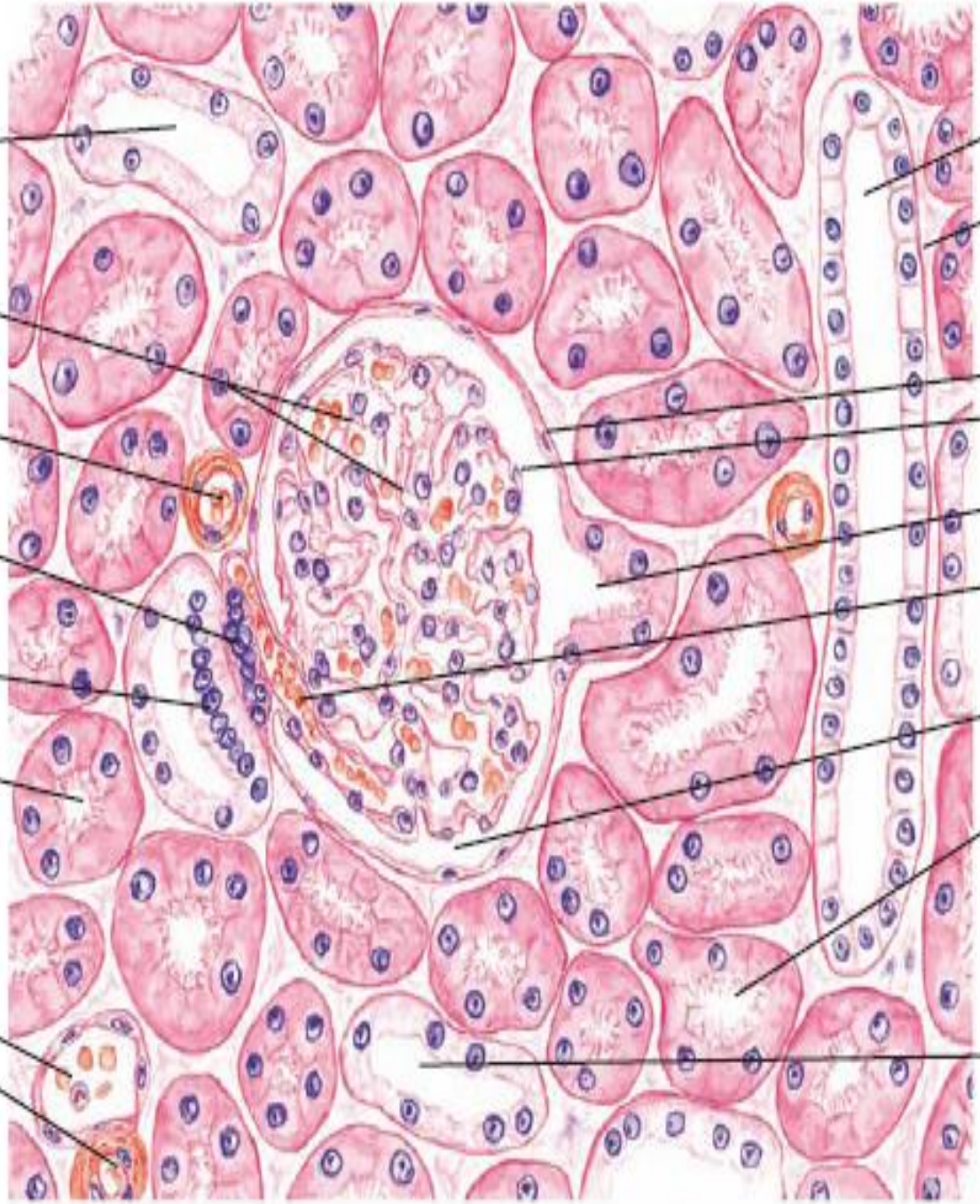

thick
segment
thin
segment
collecting
duct

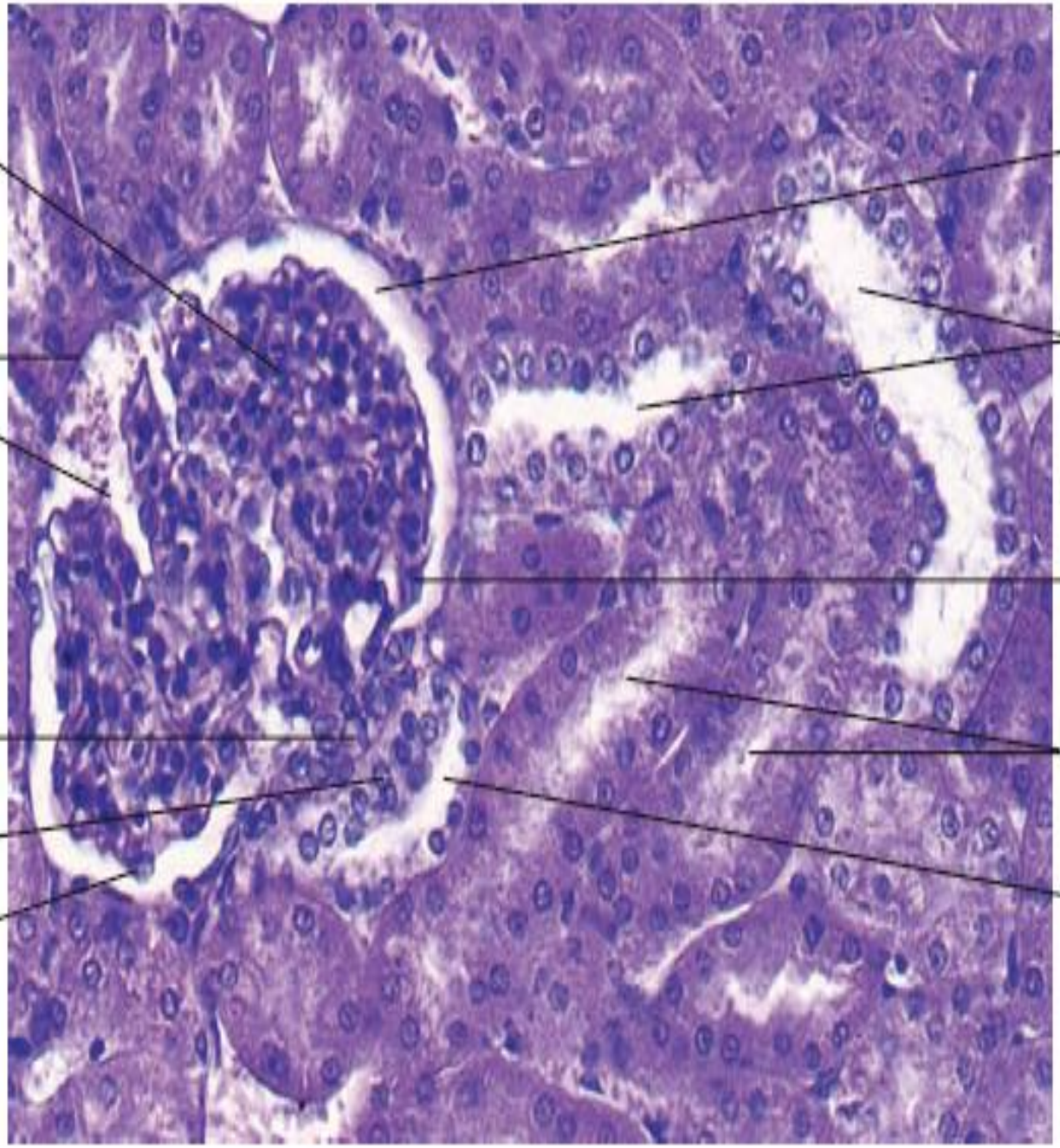


(a) Renal corpuscle



(b)


1 Distal convoluted tubule
2 Glomerular capillaries
3 Glomerular arteriole
4 Juxtaglomerular cells
5 Macula densa
6 Proximal convoluted tubule
7 Interlobular vessels:
a. Venule
b. Arteriole
8 Collecting tubule
9 Basement membrane
10 Glomerular (Bowman's) capsule:
a. Parietal layer
b. Visceral layer
11 Urinary pole
12 Afferent glomerular arteriole
13 Capsular space
14 Proximal convoluted tubule
15 Distal convoluted tubule


1 Glomerulus
2 Glomerular capsule
a. Parietal layer
b. Visceral layer
3 Juxtaglomerular apparatus
a. Juxtaglomerular cells
b. Macula densa
4 Podocyte
5 Capsular space
6 Distal convoluted tubules
7 Podocyte
8 Proximal convoluted tubules
9 Distal convoluted tubule

URETER

- Fibromuscular tube
- exits the urinary bladder through the urethral opening at anteroinferior surface
- conducts urine to the exterior of the body.
- Female Urethra:- Has a single function to transport urine from the urinary bladder to the vestibule, an external space immediately internal to the labia minora
- 3 to 5 centimeters long, and opens to the outside of the body at the external urethral orifice located in the female perineum.
- Male Urethra:- Urinary and reproductive
- functions: passageway for both urine and semen
- Approximately 18 to 20 centimeters long.

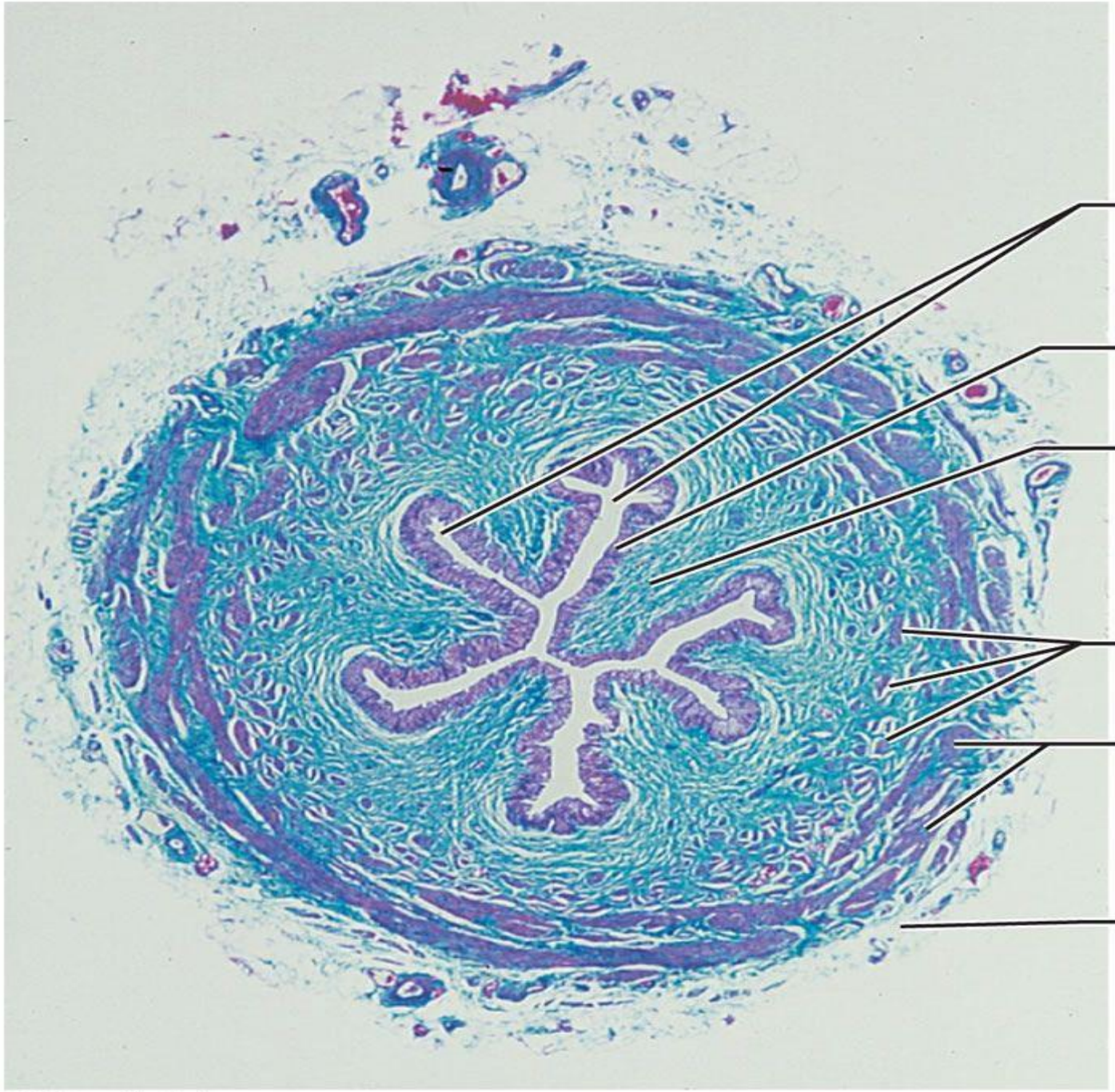
URETER

- **The wall consists of three layers:**

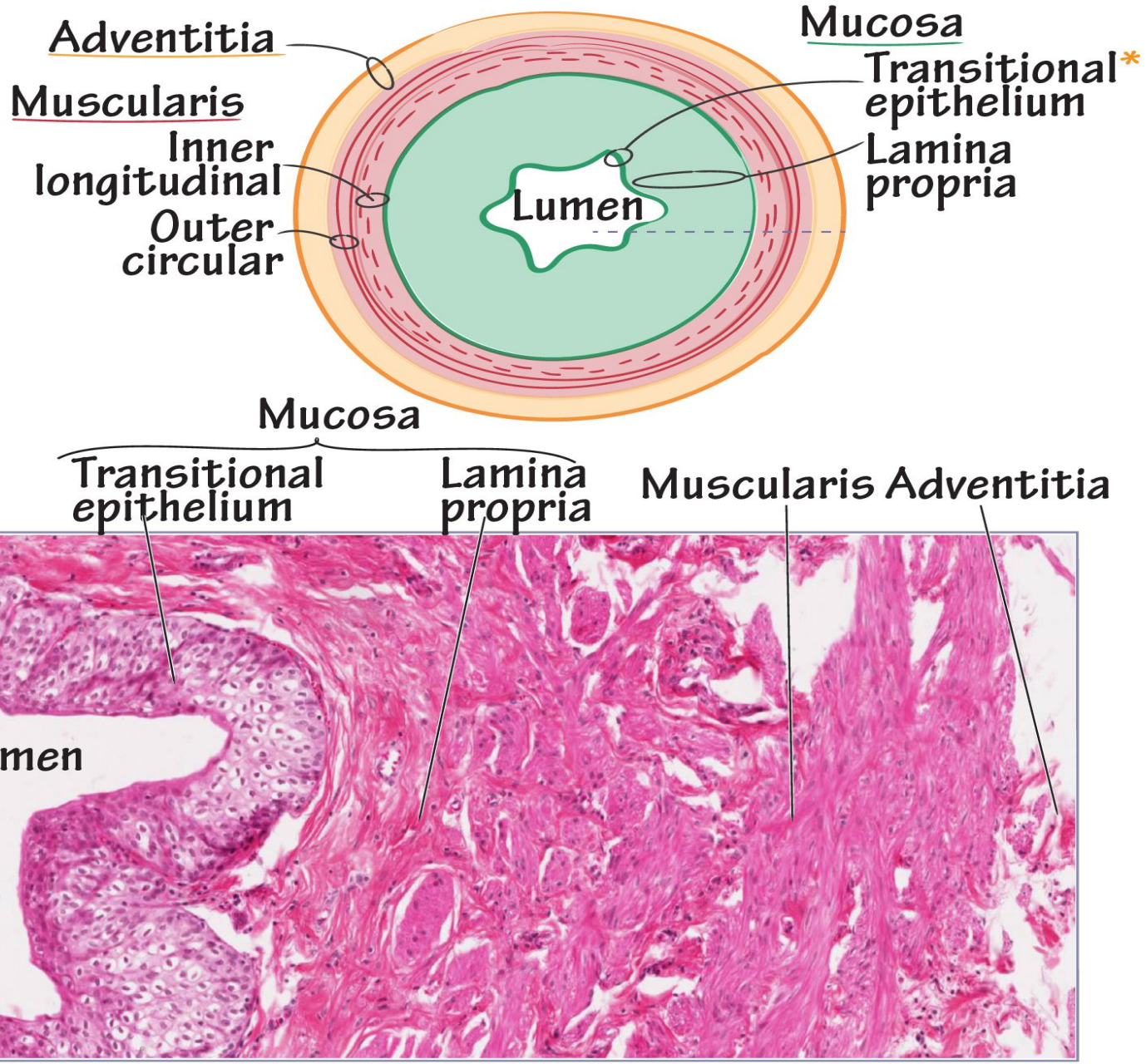
1)Mucosa: similar to that of the urinary bladder.

2)Muscular layer: it has a helical arrangement, then near the bladder, it will become two layers; an inner longitudinal and outer circular. When the ureter pass through the wall of the bladder, the muscles will become longitudinal only. The ureter pass obliquely through the bladder forming a valve to prevent the back-flow of urine. In addition, there is a flap of bladder mucosal membrane act as a valve.

3)Adventitia: loose connective tissue .



Ureter: Cross Section



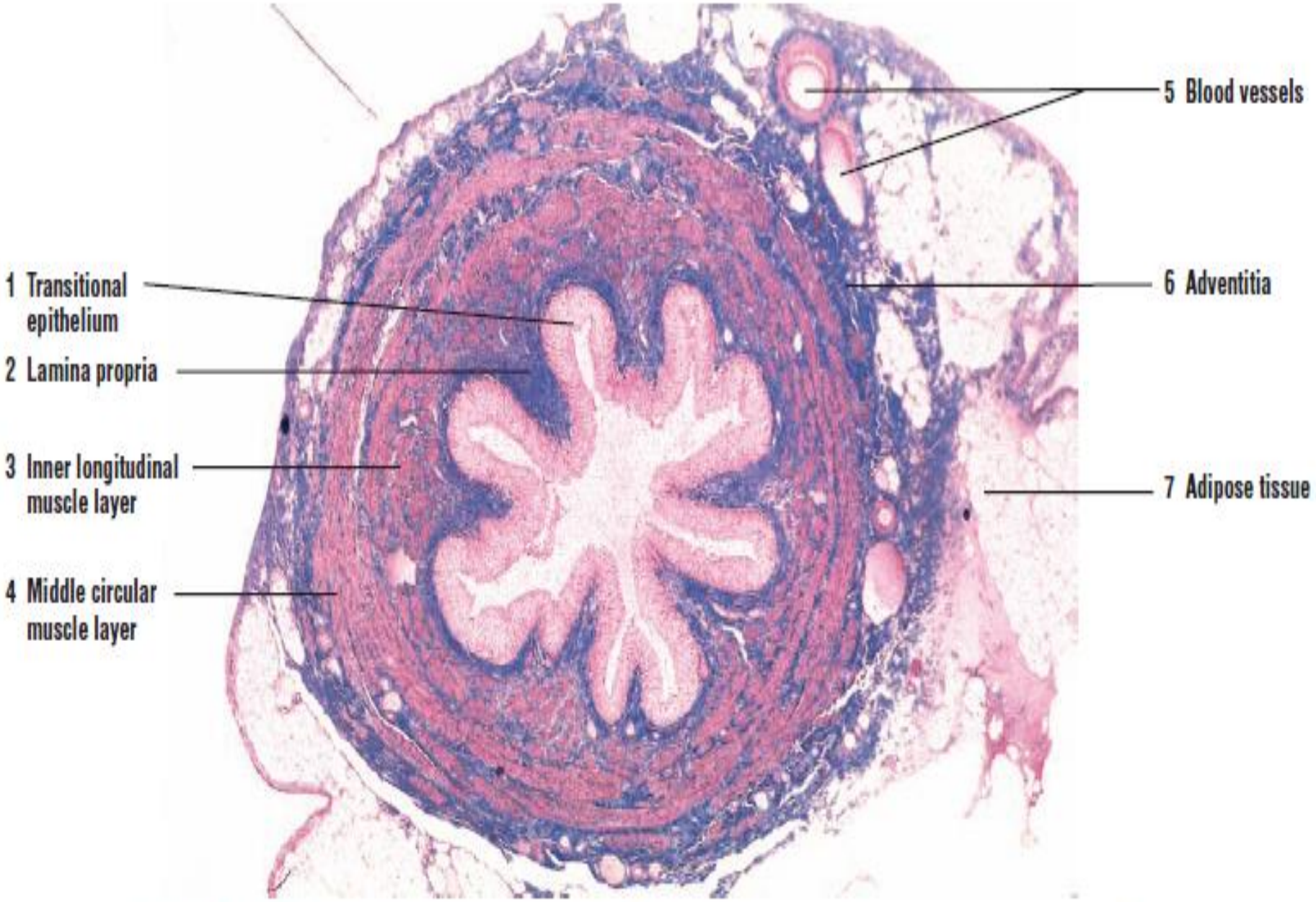


FIGURE 16.12 ■ Ureter (transverse section). Stain: iron hematoxylin and Alcian blue (IHAB). ×10.

URINARY BLADER

- The urinary bladder:

expandable, muscular container serves as a reservoir for urine

- positioned immediately superior and posterior to the pubic symphysis.
- in females: the urinary bladder is in contact with the uterus posterosuperiorly and with the vagina posteroinferiorly.
- in males: it is in contact with the rectum posterosuperiorly and is immediately superior to the prostate gland.
- when empty exhibits an upside-down pyramidal shape.
- Filling with urine distends it superiorly until it assumes an oval shape.

The wall of the bladder consists of three layers:

1-Mucosa: It is the inner layer, composed of ***transitional epith.*** and ***lamina propria.*** In an empty bladder, the transitional epith. is 5-6 cells in thickness, the superficial cells are rounded and bulge into the lumen, and they are usually polypoid or binucleated. When bladder is full of urine, the epith. will stretch and cells will become 3-4 only in thickness and the superficial cells become sequamous.

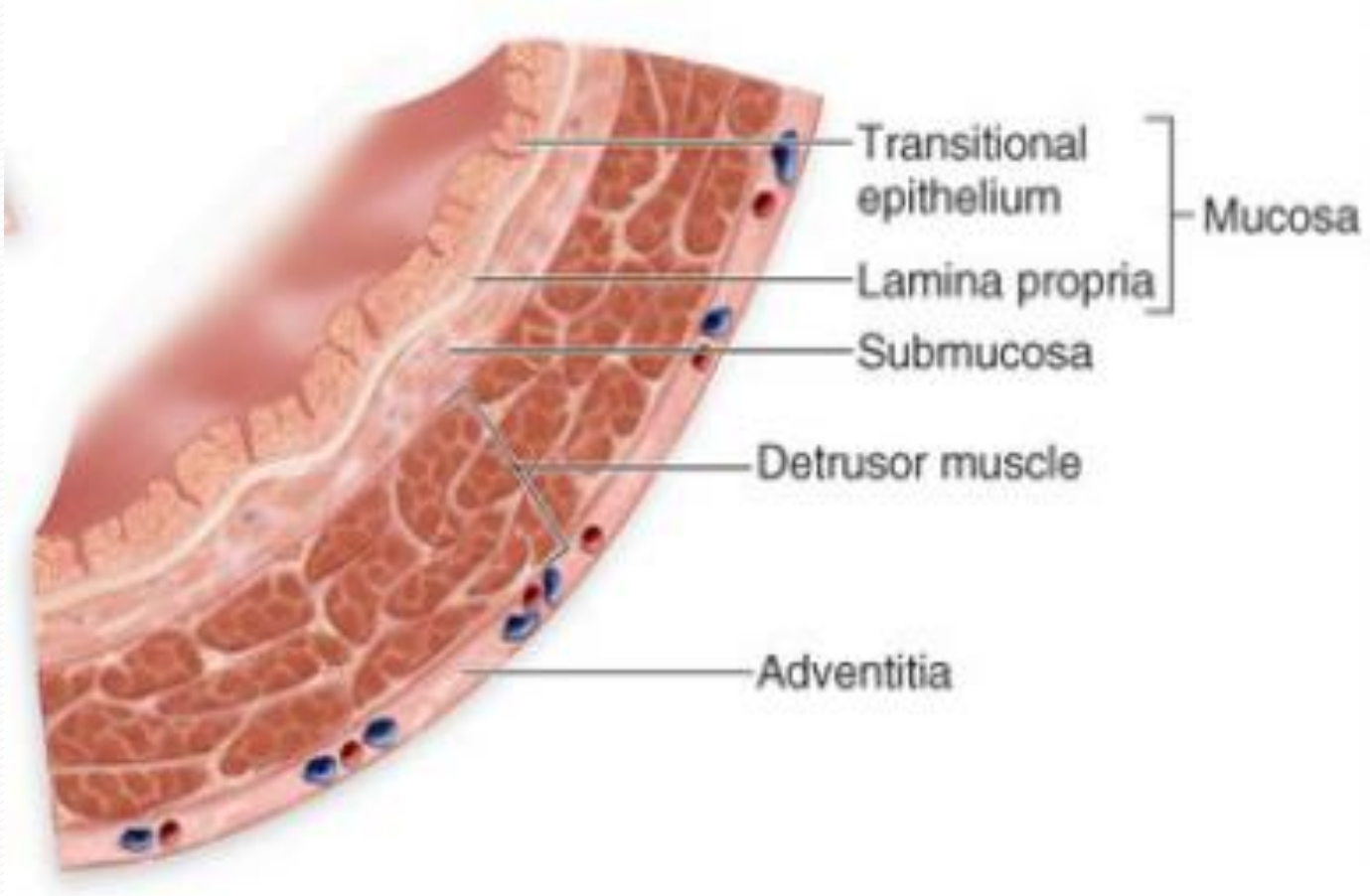
2-Muscular layer: Thick layer that runs in every direction, without distinct orientation. [redacted] urethra), the muscular layer will arrange in three layers:

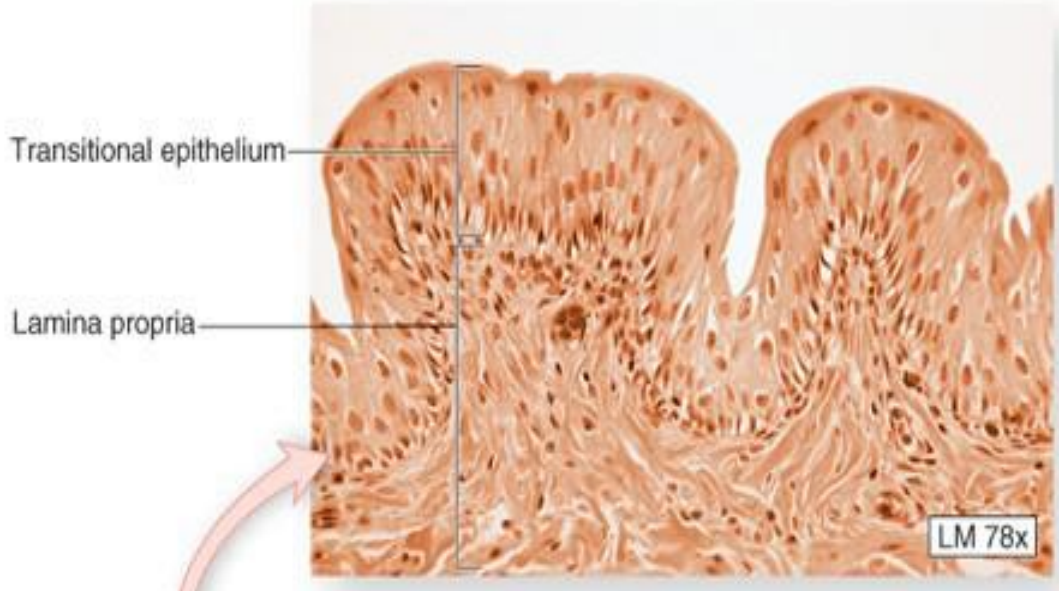
a- Inner longitudinal layer: it will become circular distal to the bladder neck and surrounds the prostatic urethra in the male, and external meatus of the female, forming the true involuntary urethral sphincter.

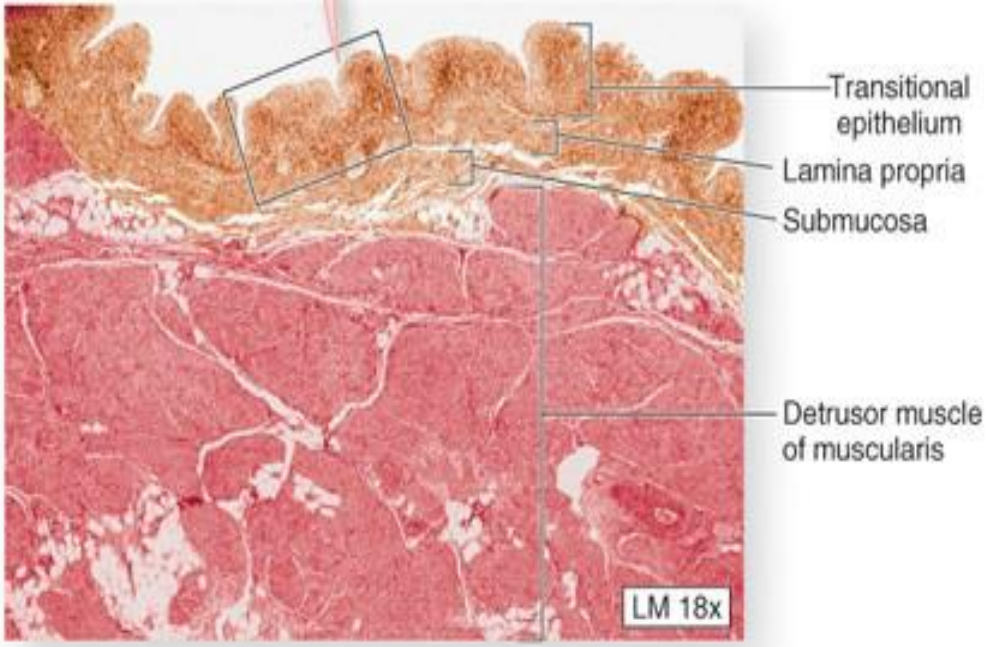
b- Middle circular layer: it ends at the bladder neck.

c- Outer longitudinal layer: continues to the end of the prostate in male, and the external urethral meatus in female.

3 -Adventitia: Loose connective tissue rich in blood vessels, except the upper part of the bladder which is covered by serosa(because it is an intra peritoneal part .







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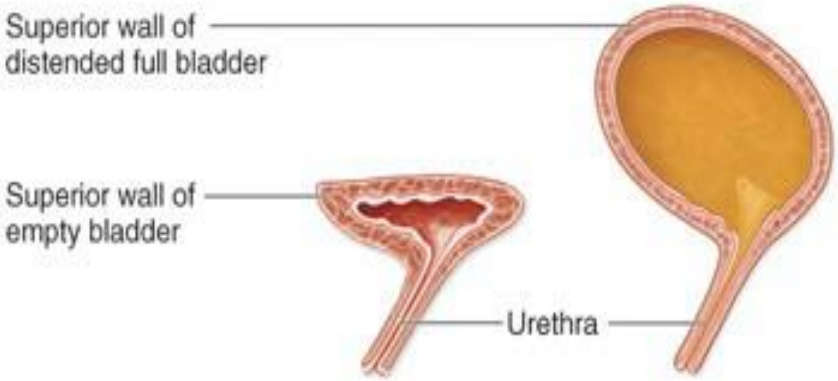
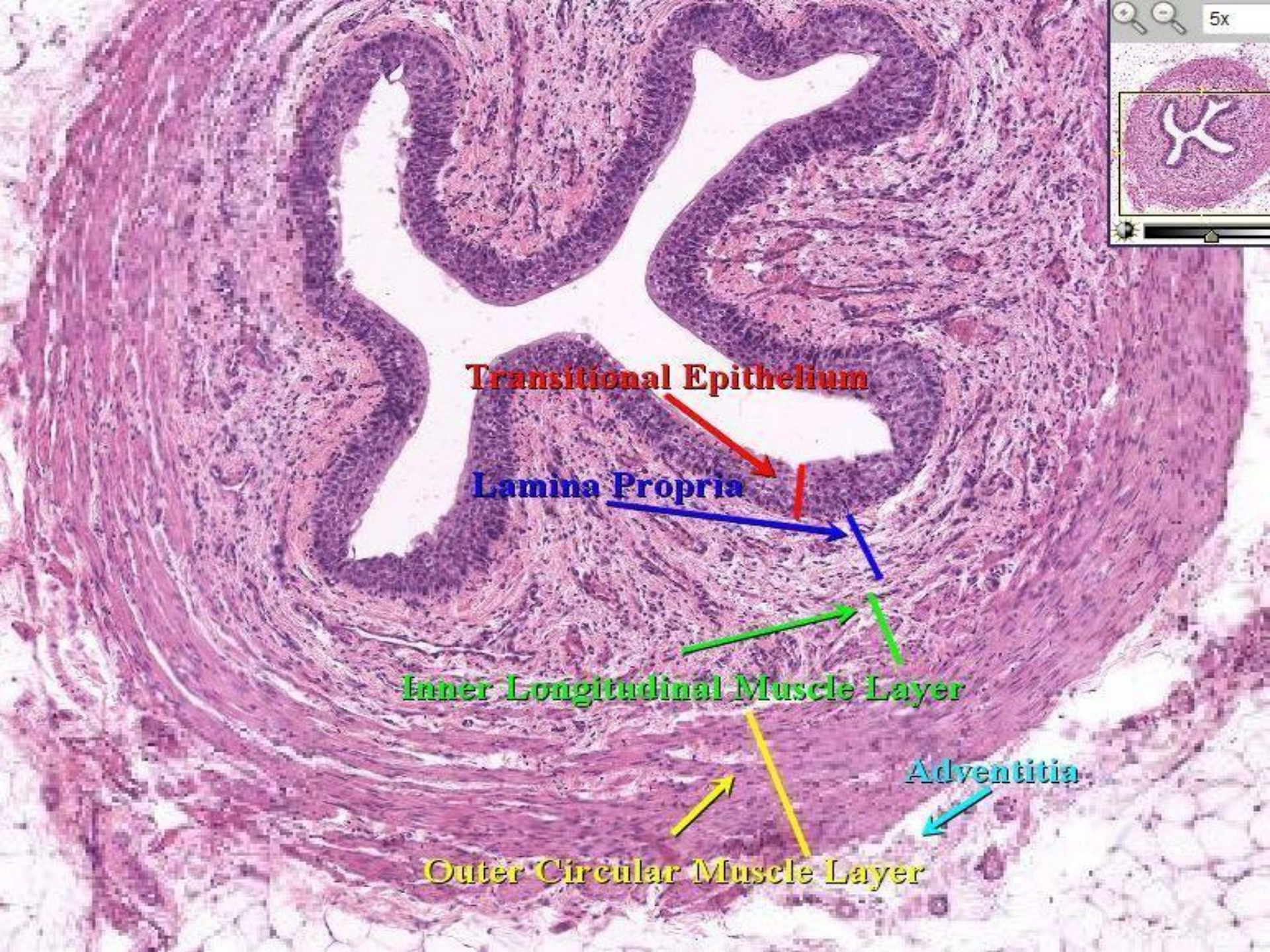
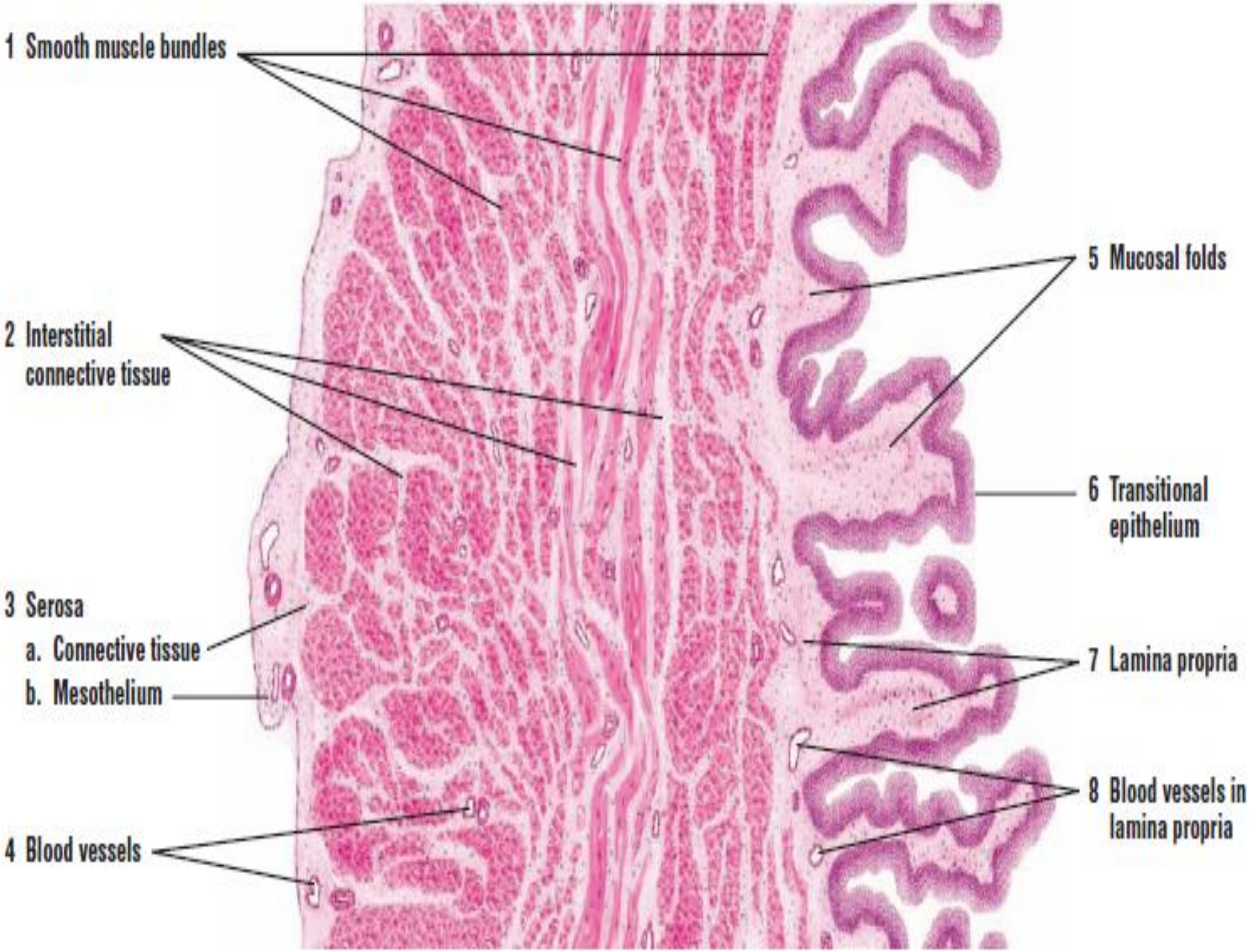


(c)


5x
Transitional Epithelium
Lamina Propria
Inner Longitudinal Muscle Layer
Adventitia
Outer Circular Muscle Layer


1 Smooth muscle bundles
2 Interstitial connective tissue
3 Serosa
a. Connective tissue
b. Mesothelium
4 Blood vessels
5 Mucosal folds
6 Transitional epithelium
7 Lamina propria
8 Blood vessels in lamina propria

Urethra

- Urine leaves the bladder through a tube-like structure called the urethra. The lining of the urethra is epithelium. The wall of the urethra is smooth muscle.
- Urine flow is controlled by two uretheral sphincters: the internal urethral sphincter and the external urethral sphincter. The internal urethral sphincter is at the start of the urethra. This sphincter is composed of smooth muscle. The external urethral sphincter is skeletal muscle.

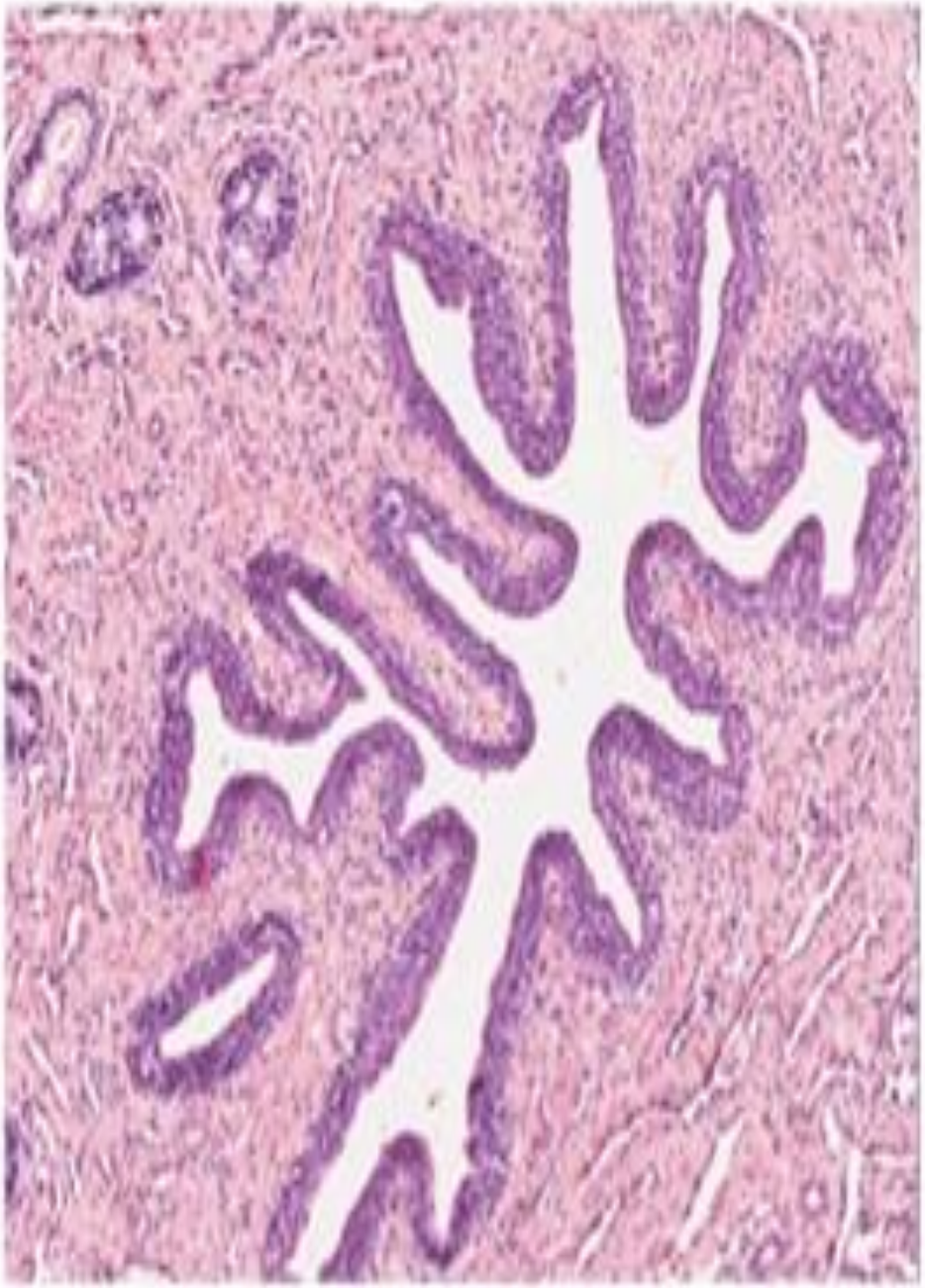
Histology of the Female Urethra

- The urethra in females is short. It is only about about 1.5 inches lengthwise. The lining epithelium of the female urethra is psuedostratified columnar epithelium and stratified sqauamous epithelium.

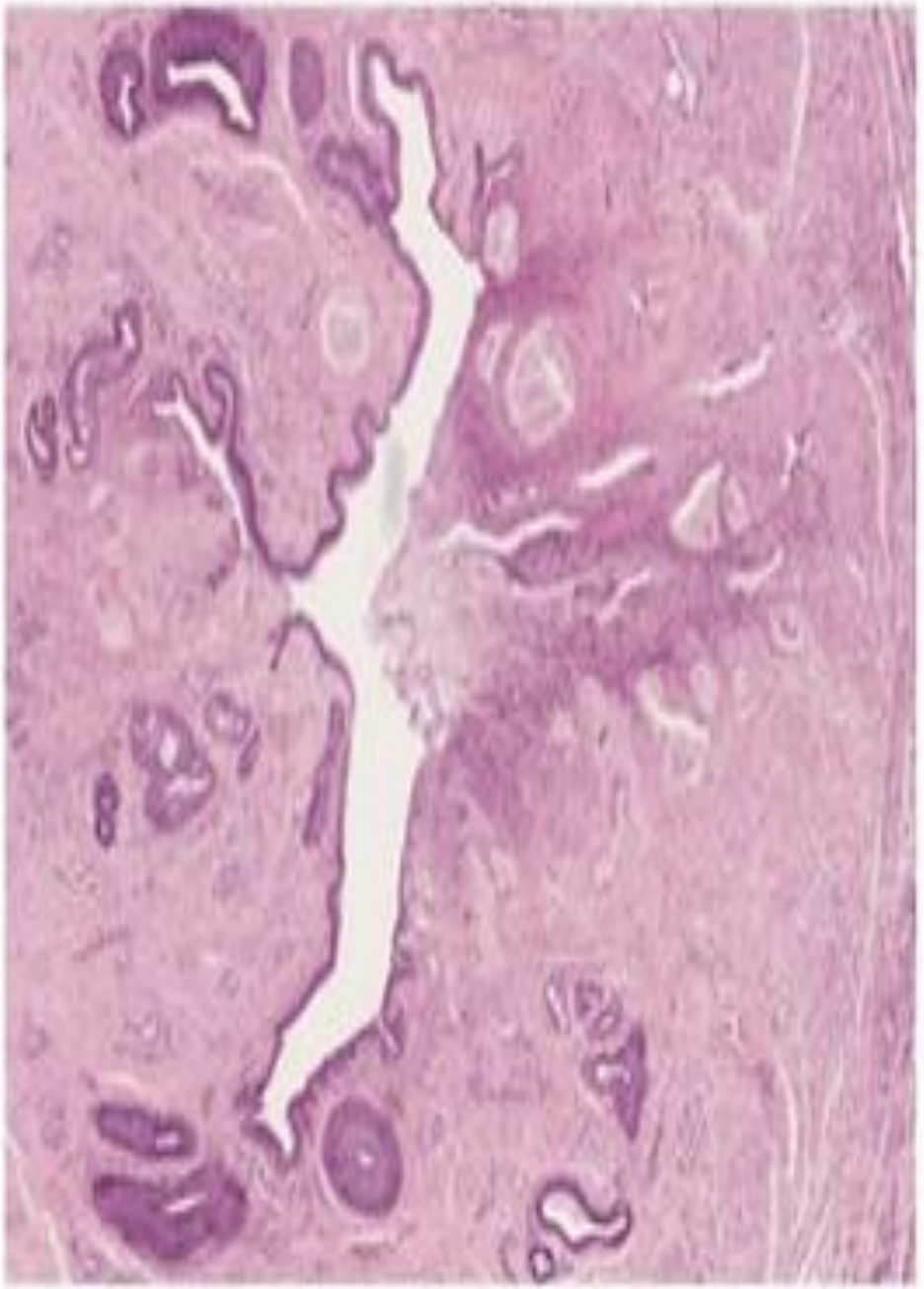
Histology of Male Urethra

- The urethra in the male is longer than the urethra of females. The male urethra is 7 to 8 inches lengthwise. The male urethra fuctions as a conduit for urine and semen. The male urethra is divided into three sections: prostatic urethra, membranous urethra, and spongy (penile) urethra.

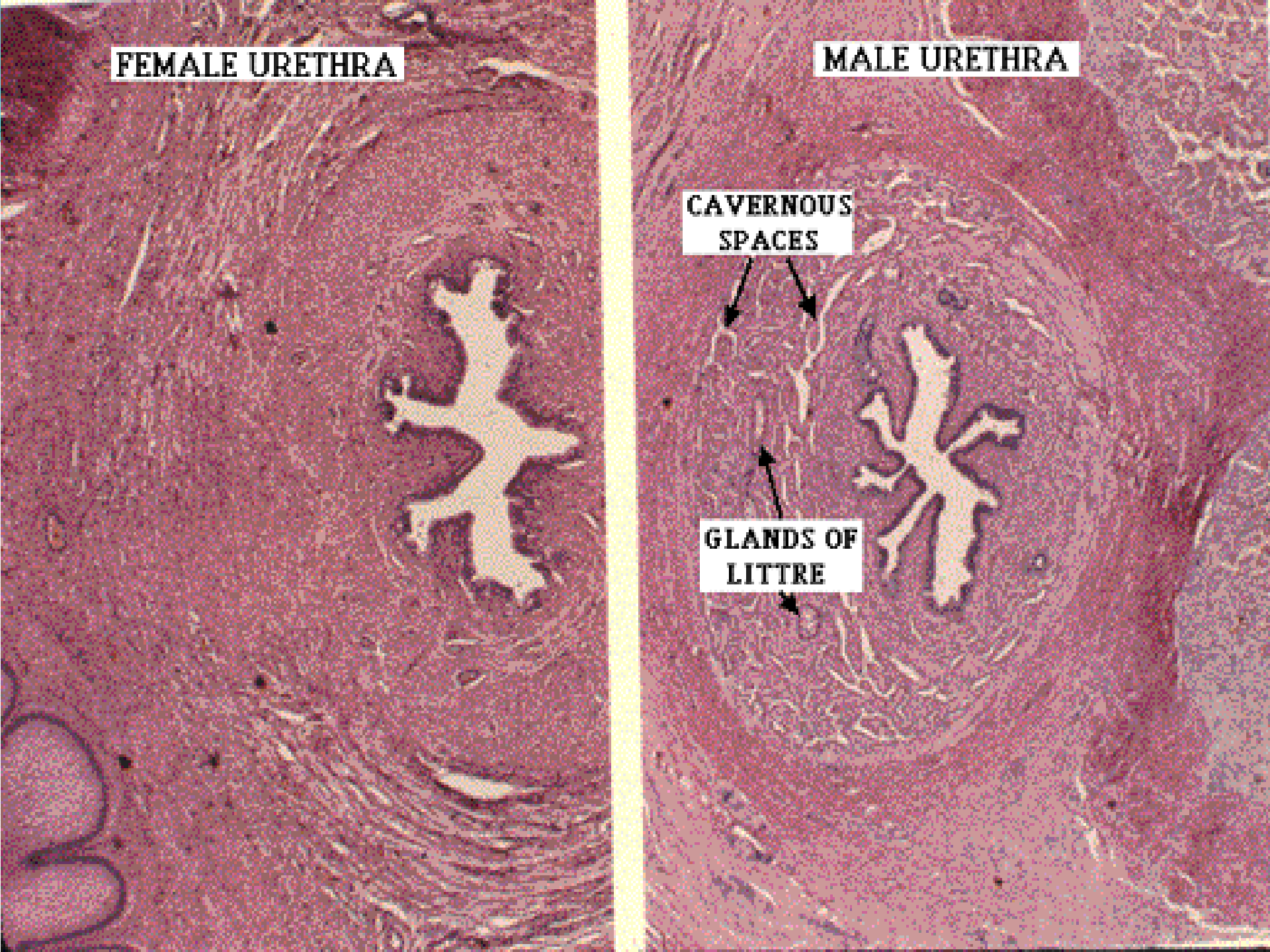
[redacted]



Male urethra



Female urethra


FEMALE URETHRA
MALE URETHRA
CAVERNOUS SPACES
GLANDS OF LITTRE

GOOD LUCK