



University of Basra  
College of medicine

# The Urinary System

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## Proximal convoluted tubules(PCT)

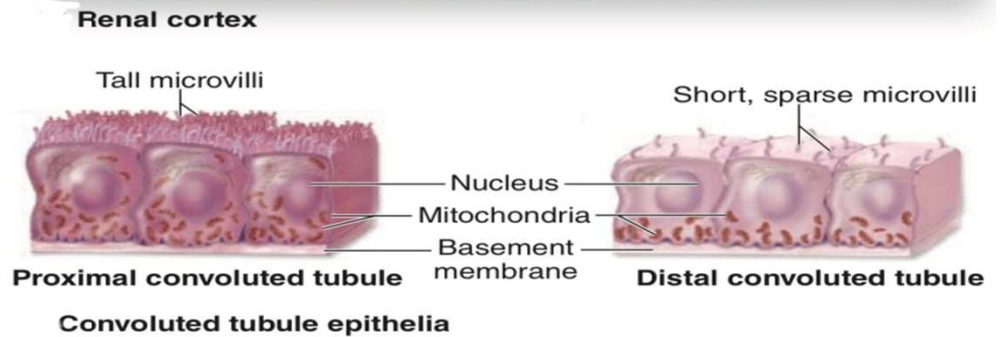
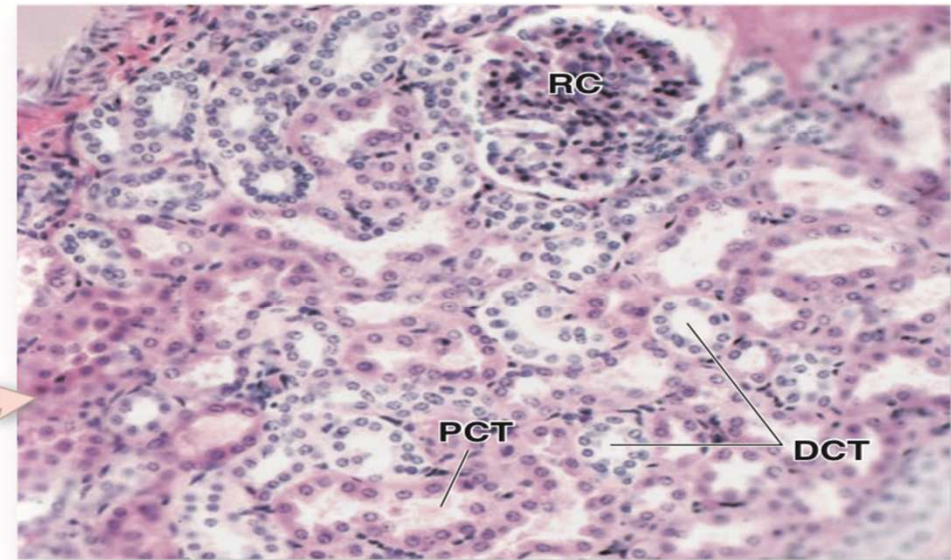
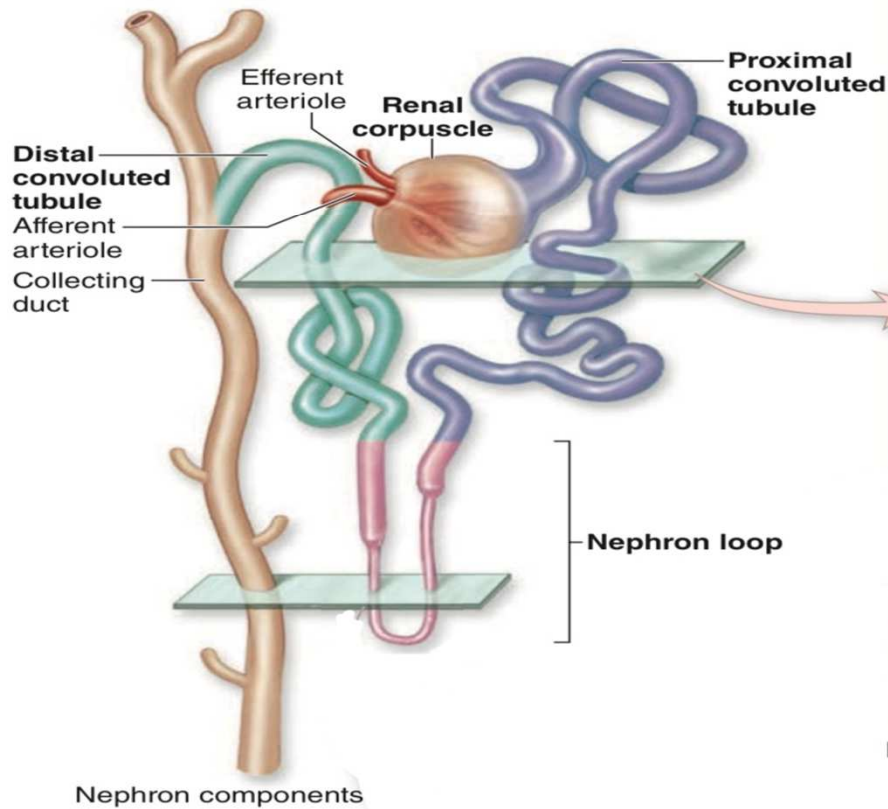
.They are long , tortuous tubules fill most of the cortex, PCT cells are specialized for **reabsorption** and **secretion**.

. Over half of the **water and electrolytes** , and all of the **organic nutrients** ( glucose , amino acids , vitamins , etc. ) that are filtered from plasma in the renal corpuscle are normally **reabsorbed** in the PCT.

.**Organic anions and cations** not filtered in the corpuscle may be released in the peritubular capillaries , taken up by PCT cells and **secreted** into the filtrate.

.In addition, the PCT cells also perform hydroxylation and release of **vitamin D** to the capillaries.

The PCT cells are **simple cuboidal** epithelium with central nucleus and a very acidophilic cytoplasm, the apex has long microvilli to form the prominent brush border in the lumen that facilitate reabsorption.

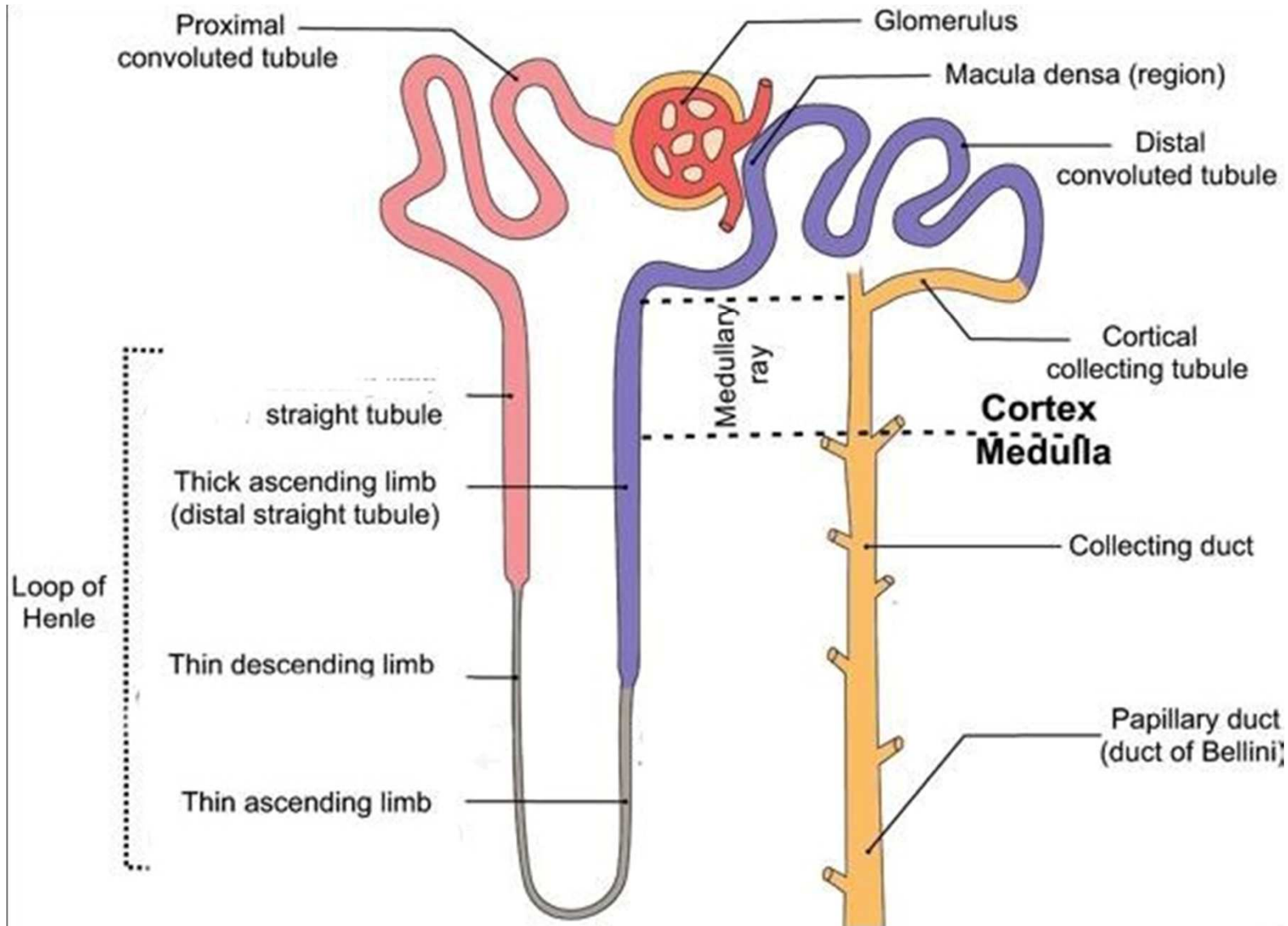


## Loop of henle

The PCT continues with the much shorter proximal **straight tubule**, which enters the medulla and continues as the loop of henle , which is a U shaped structure with a **thin descending limb** and a **thin ascending limb** both of which are lined by **simple squamous** epithelium (consist of only squamous cells with few organelles indicating a **passive** role in transport).

The thin ascending limb becomes the **thick ascending limb (TAL)** with **simple cuboidal** epithelium and many mitochondria, it extend as far as macula densa near the glomerulus. The TAL is involved in **active** reabsorption of various electrolytes.

# Nephron components



## Distal convoluted tubule and juxtaglomerular apparatus

.The ascending limb of the nephron enters the cortex and forms the macula densa , then becomes tortuous as the distal convoluted tubule ( DCT), much less tubular reabsorption occur here than PCT.

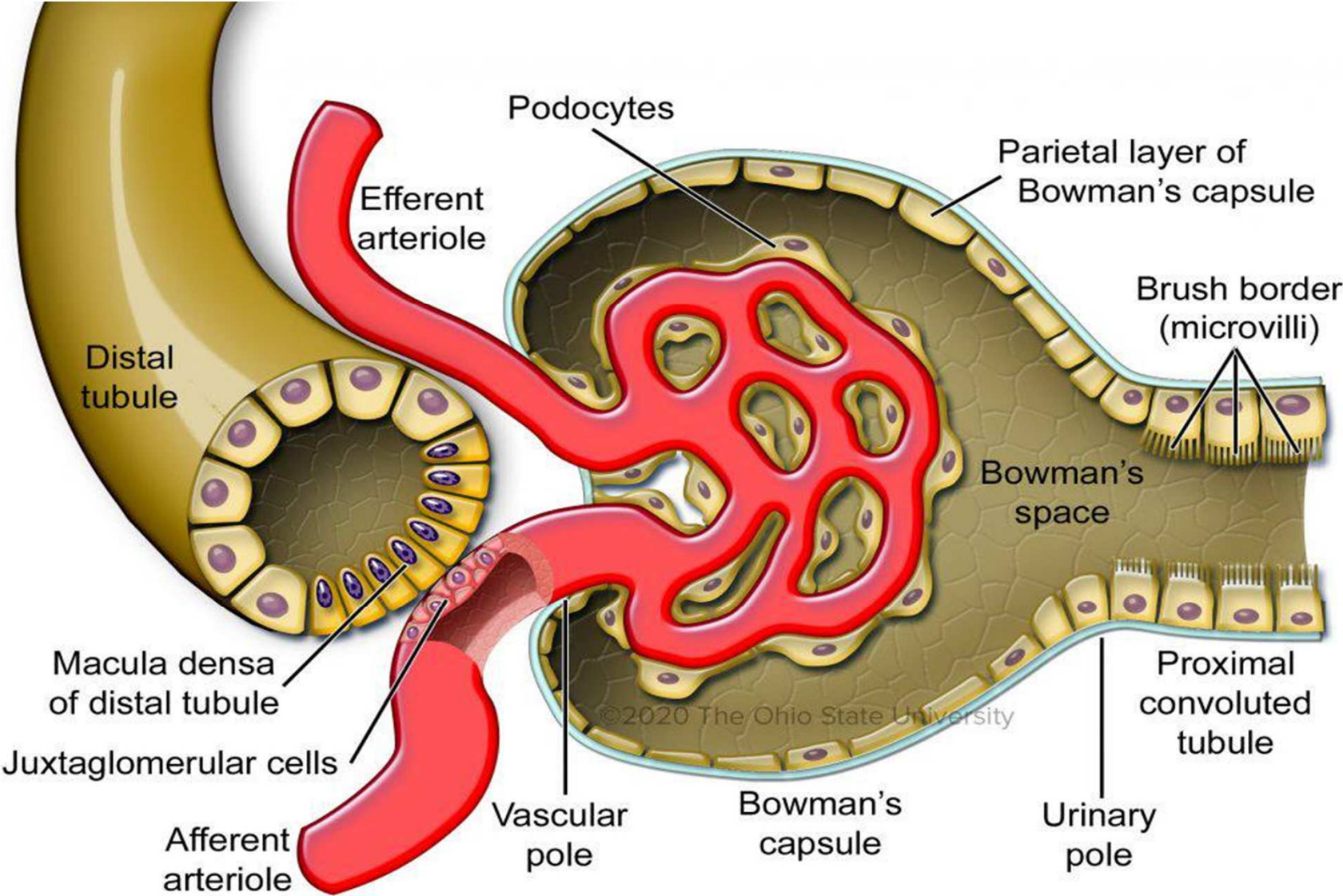
.The **simple cuboidal** cells of DCT differ from that of PCT by being **smaller** with **no brush border** and an **empty lumens**, the cells also have fewer mitochondria , hence the **less acidophilic** staining.

The rate of sodium absorption here is controlled by **aldosterone** from the adrenal gland.

Where the initial part of DCT contacts the arterioles at the vascular pole of the renal corpuscle , the cells become more columnar and closely packed forming the **macula densa**, which is a part of a sensory structure called the **juxtaglomerular apparatus ( JGA)** that utilizes a feedback mechanism to **regulate the glomerular blood flow**.

Cells of macula densa have apical nuclei and basal golgi complexes. Adjacent to macula densa , tunica media of the afferent arterioles has a modified smooth muscle cells with secretory phenotype called the **juxtaglomerular (JG) cells** capable of **renin** secretion.

# Juxtaglomerular apparatus





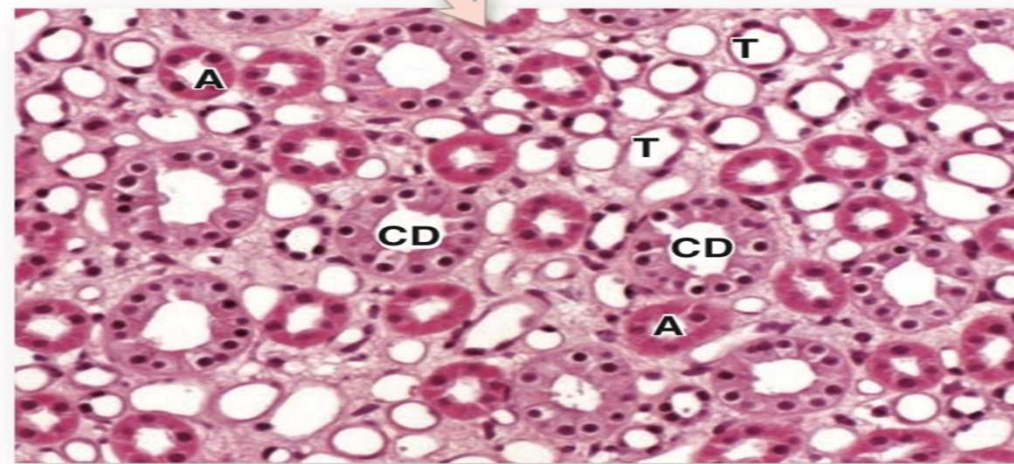
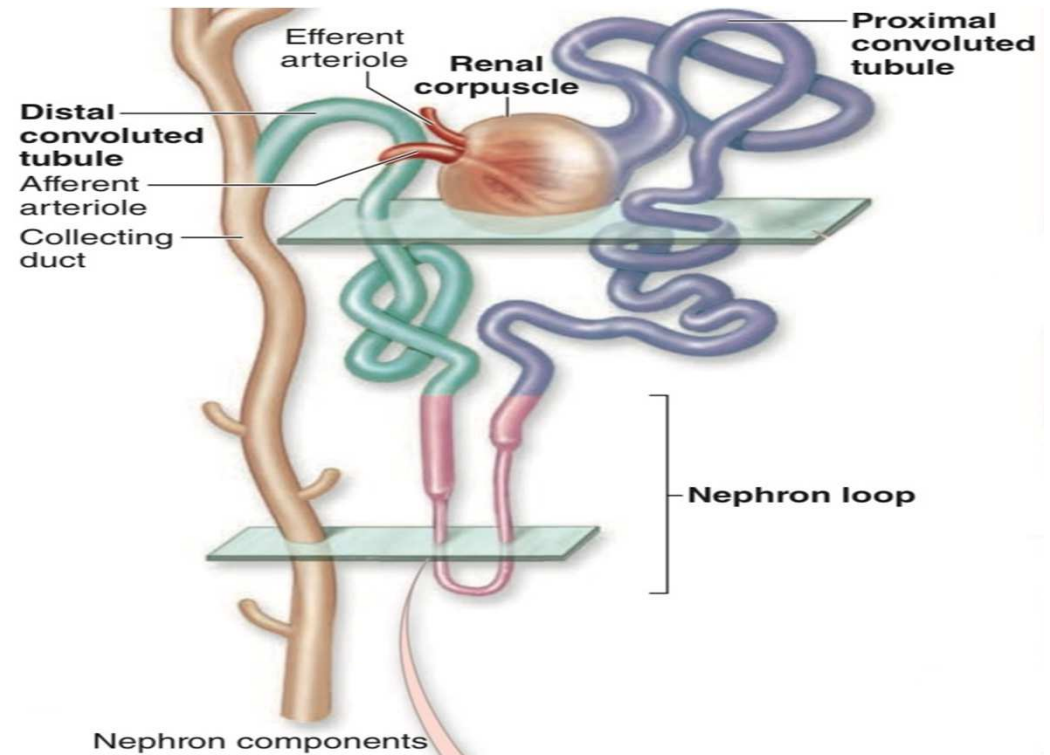
## Collecting ducts

. The last part of each nephron , the **connecting tubule** , carries the filtrate into the collecting system that transport it into the minor calyx where more water is absorbed if needed. Connecting tubules from several nephrons join together to form **collecting ducts**, which are lined by simple cuboidal epithelium.

.In the medulla , the collecting ducts merge further forming larger and straighter collecting ducts with more columnar lining , approaching the apex of each renal pyramid ,several collecting ducts merge to form each **papillary duct** , Which deliver urine into minor calyx.

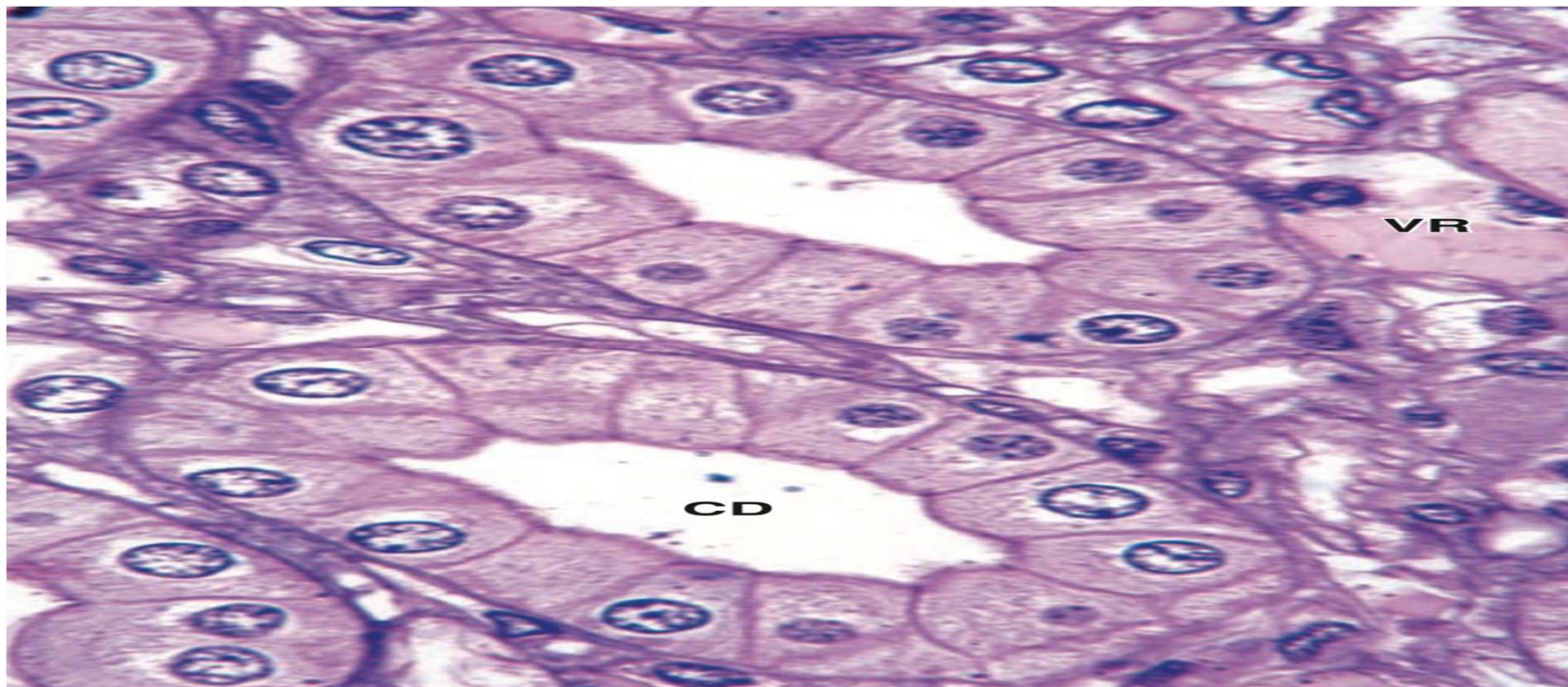
Collecting ducts play a role in the final concentration of urine

- \*A: thick ascending duct
- \*T : thin ascending and descending ducts
- \*CD: collecting ducts



Cross section of renal medulla

.Collecting ducts and tubules are composed mainly of pale staining cuboidal –columnar **principle cells** which act on regulation of water and electrolytes reabsorption and secretion of potassium ( under the influence of ADH from the posterior pituitary gland), with a fewer darker staining **intercalated cells** that act on maintaining acid – base balance by reabsorption of potassium



## Ureters , bladder and urethra:

. Urine is transported by the ureters from the renal pelvis to the urinary bladder, where it is stored until emptying by micturition by the urethra.

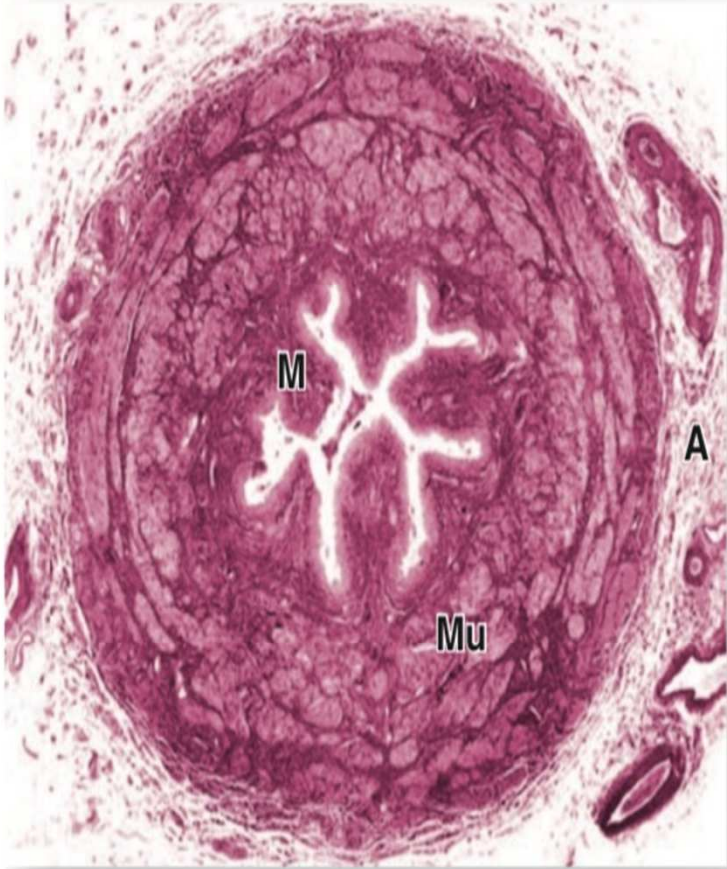
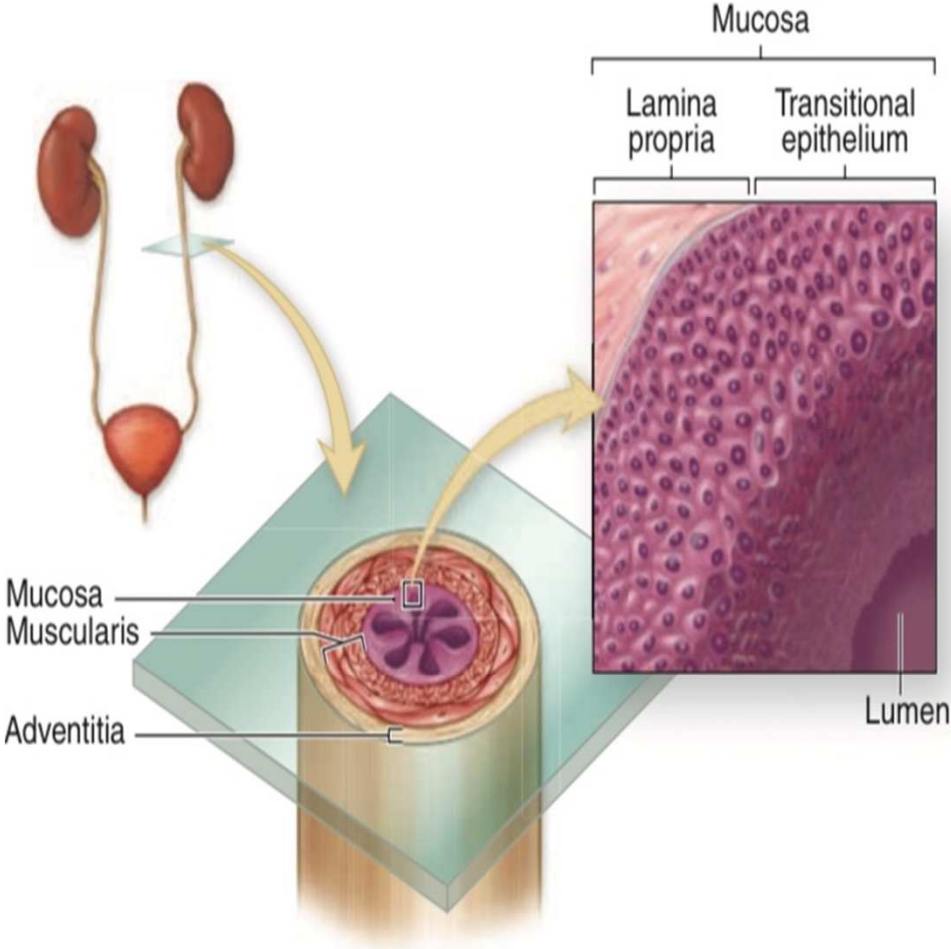
.The walls of **ureters** are similar to that of the calyces and renal pelvis , with mucosal , muscular and adventitial layers that become gradually thicker near the urinary bladder.

.The mucosa of these organs ( calyces , renal pelvis , ureters and bladder ) is lined by the uniquely stratified **urothelium** or transitional epithelium.

**Urothelium** is organized into 3 layers:

1. Single layer of small **basal** cells resting on a very thin basement membrane
2. **Intermediate** region containing one to several layers of cuboidal - low columnar cells
3. Superficial layer of large bulbous or elliptical **umbrella cells**, that are highly differentiated to protect the underlying cells from the cytotoxic effects of the urine.

.The thick muscularis of the ureters move urine toward the bladder and produce prominent mucosal folds when the lumen is empty.



Ureter cross section

.The umbrella cells are especially well developed in the **bladder** with extensive intercellular complexes , apical membranes having hinged regions with dense plaques of **uroplakin** proteins that protect the cytoplasm.

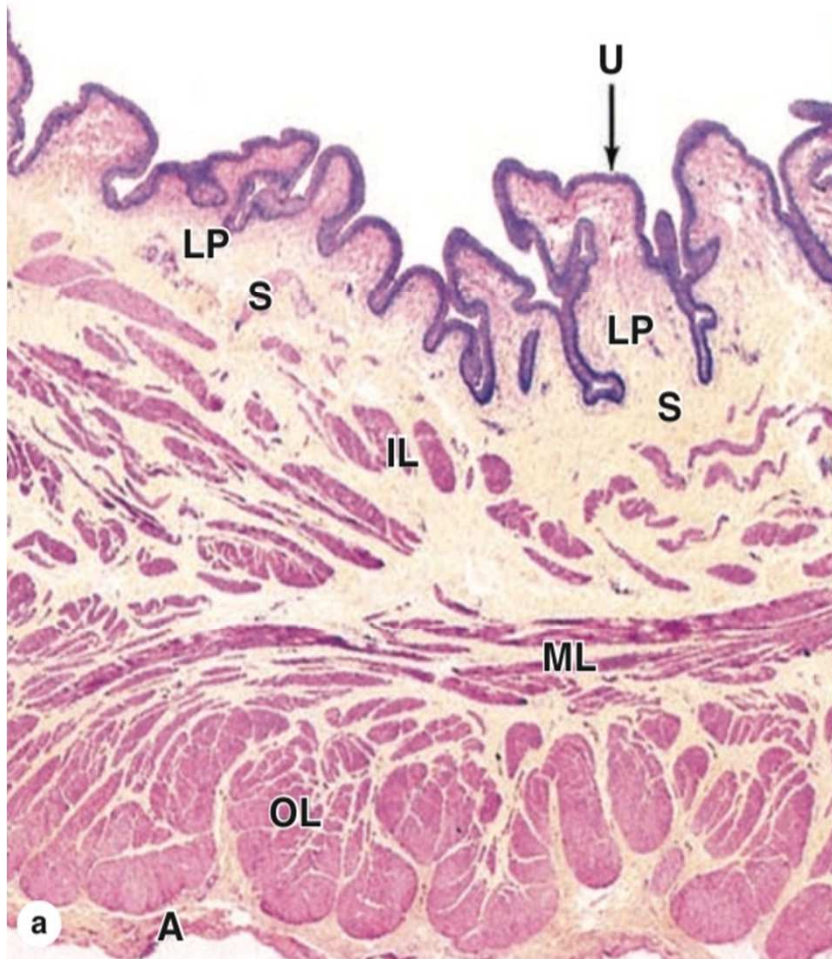
When bladder is emptied , the mucosa folds extensively and the individual umbrella cells decrease their apical surface by folding the membrane at the hinged regions and internalizing the plaques.

.Urothelium is surrounded by folded lamina propria and submucosa( highly vascularized) followed by dense interwoven smooth muscle layers ( 3 poorly delineated layers called the **detrusor** muscle) and adventitia.

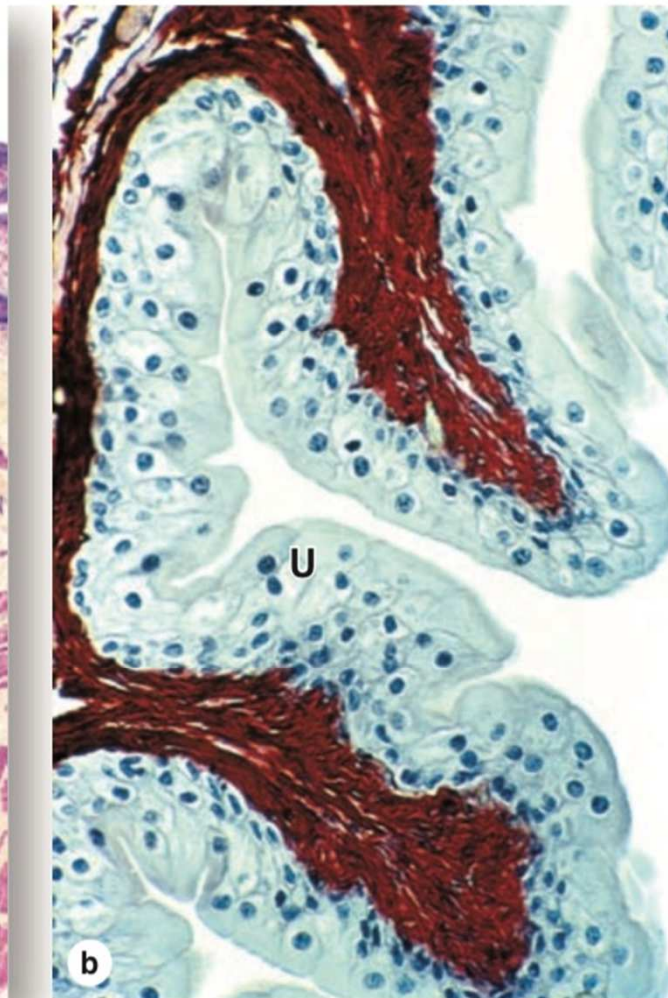


# Bladder wall and urothelium

**A: wall of bladder**



**B: empty bladder**



**C: full bladder**



\*U: urothelium \* LP: lamina propria \* S : submucosa \* IL, ML, OL: inner , middle and outer layer of muscularis \* A; adventitia

# Urethra

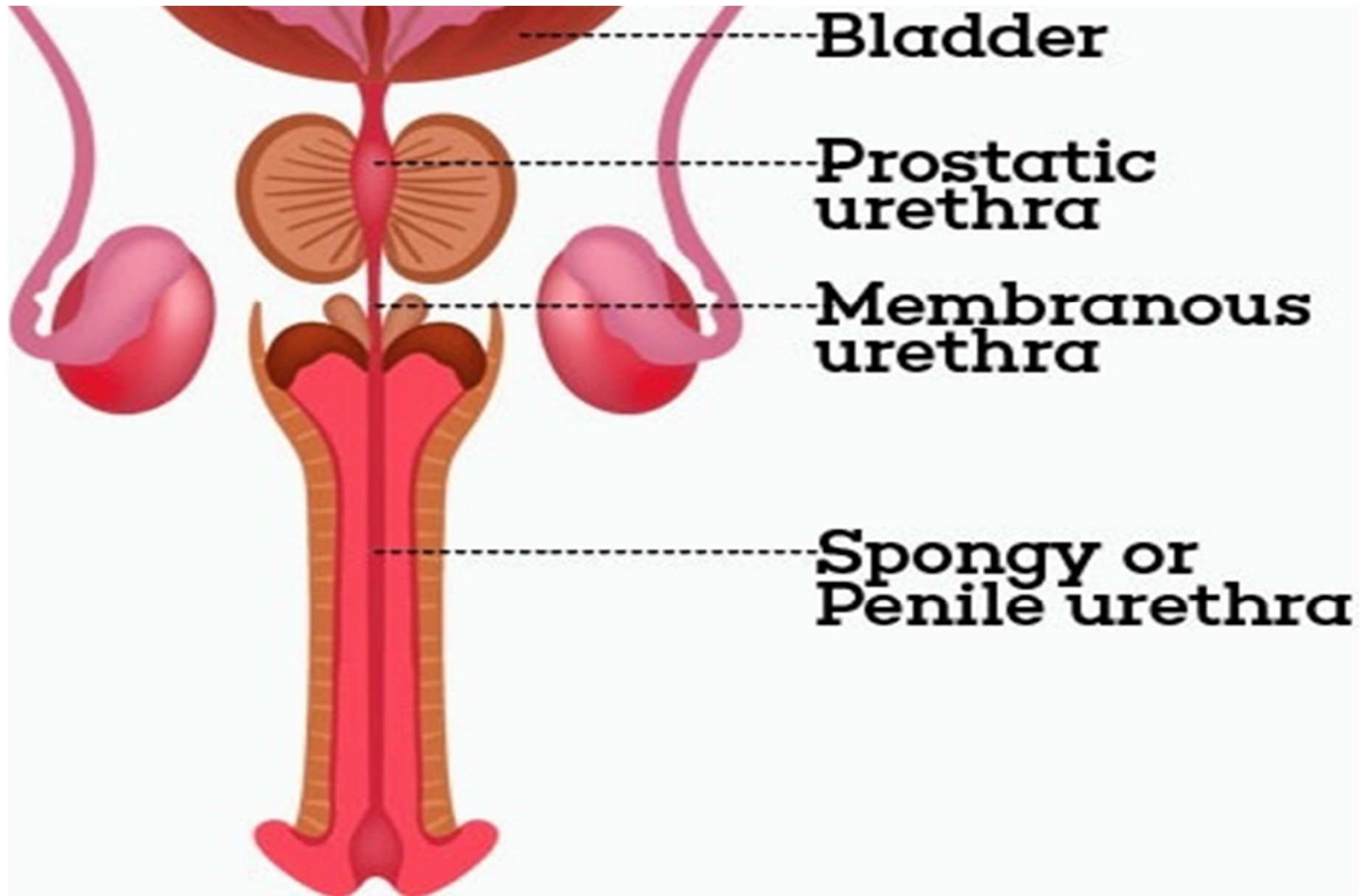
.It is a tube that carries the urine from the bladder to the exterior .The urethral mucosa has prominent longitudinal folds.

.In men, the ejaculation ducts join the urethra at the prostate gland .

The **male** urethra is longer and has three segments:

- 1. Prostatic urethra:** 3-4 cm , extend through the prostate gland and lined by urothelium.
- 2. Membranous urethra:** short segment, pass through an external sphincter of striated muscles, and lined by stratified columnar and pseudostratified columnar epithelium.
- 3. Spongy urethra:** 15 cm long , enclosed within the erectile tissue of the penis and lined by stratified columnar and pseudostratified columnar epithelium with stratified squamous epithelium distally.

## Male urethra



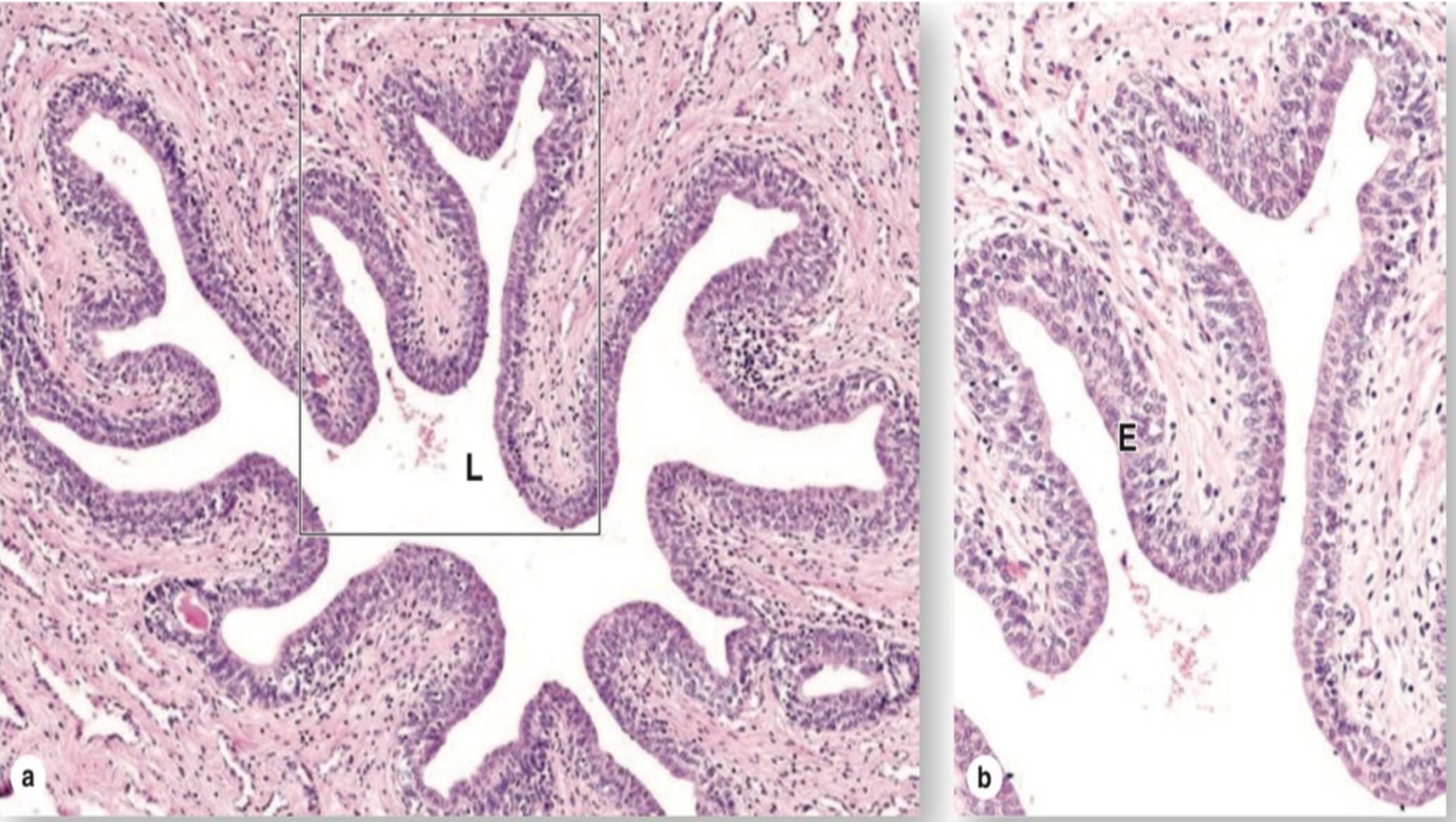
In **women**, the urethra is exclusively a urinary organ, it is 3-5 cm long , lined initially by transitional epithelium which then transit to non keratinized stratified squamous epithelium continuous with that of the skin of labia minora.

.The middle part of the urethra in both sexes is surrounded by the external striated muscle sphincter.

# Urethra

A: transverse section show longitudinal folds around the lumen (L)

b: higher magnification show the urothelial mucosa with the thick epithelial lining ( E )



*Thank you*