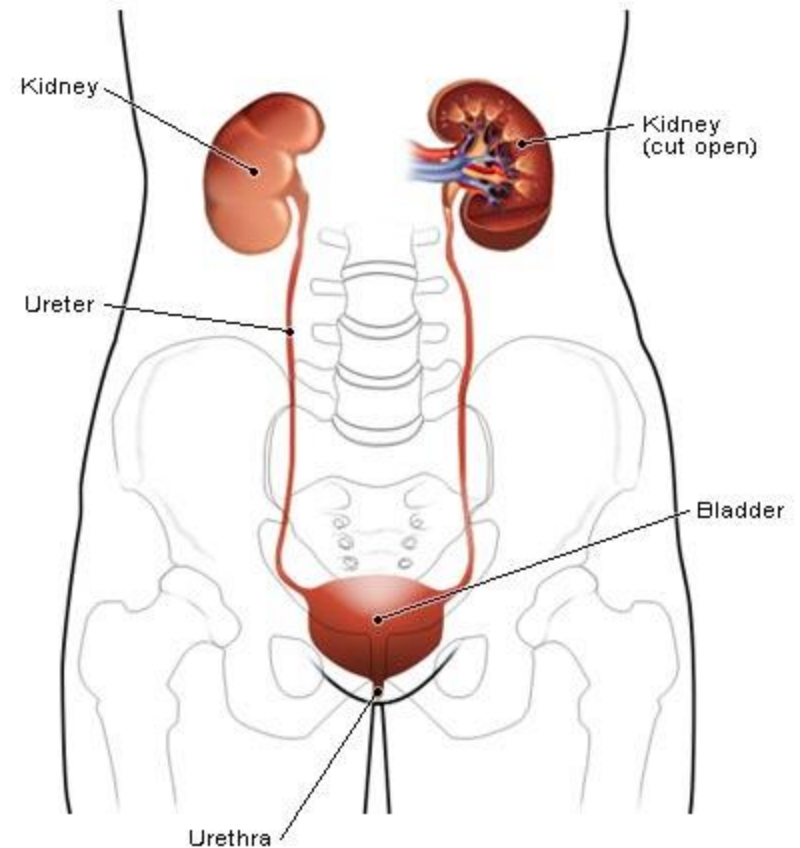


URINARY SYSTEM

Components include

- **Kidneys,**
- **Ureters,**
- **Urinary Bladder,**
- **Urethra**

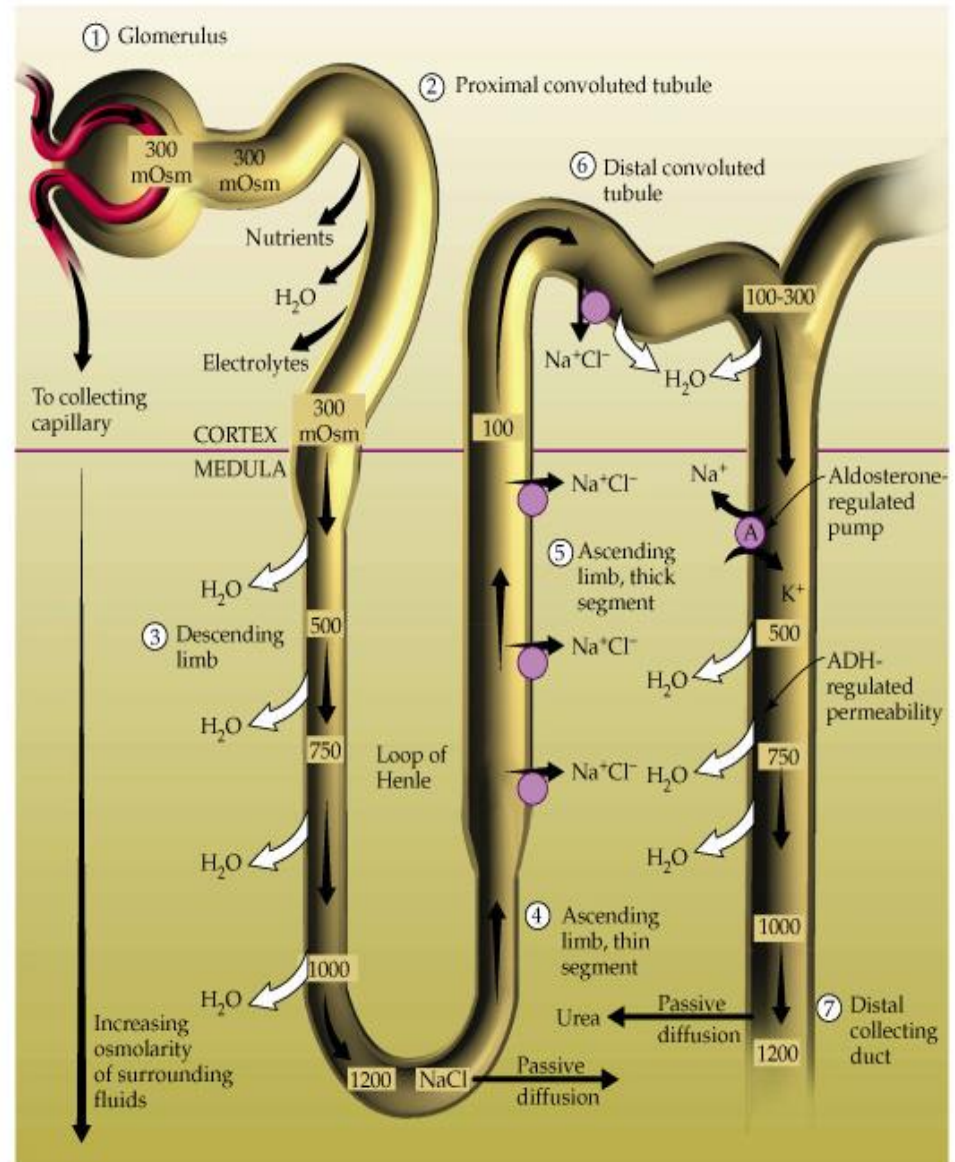


Function

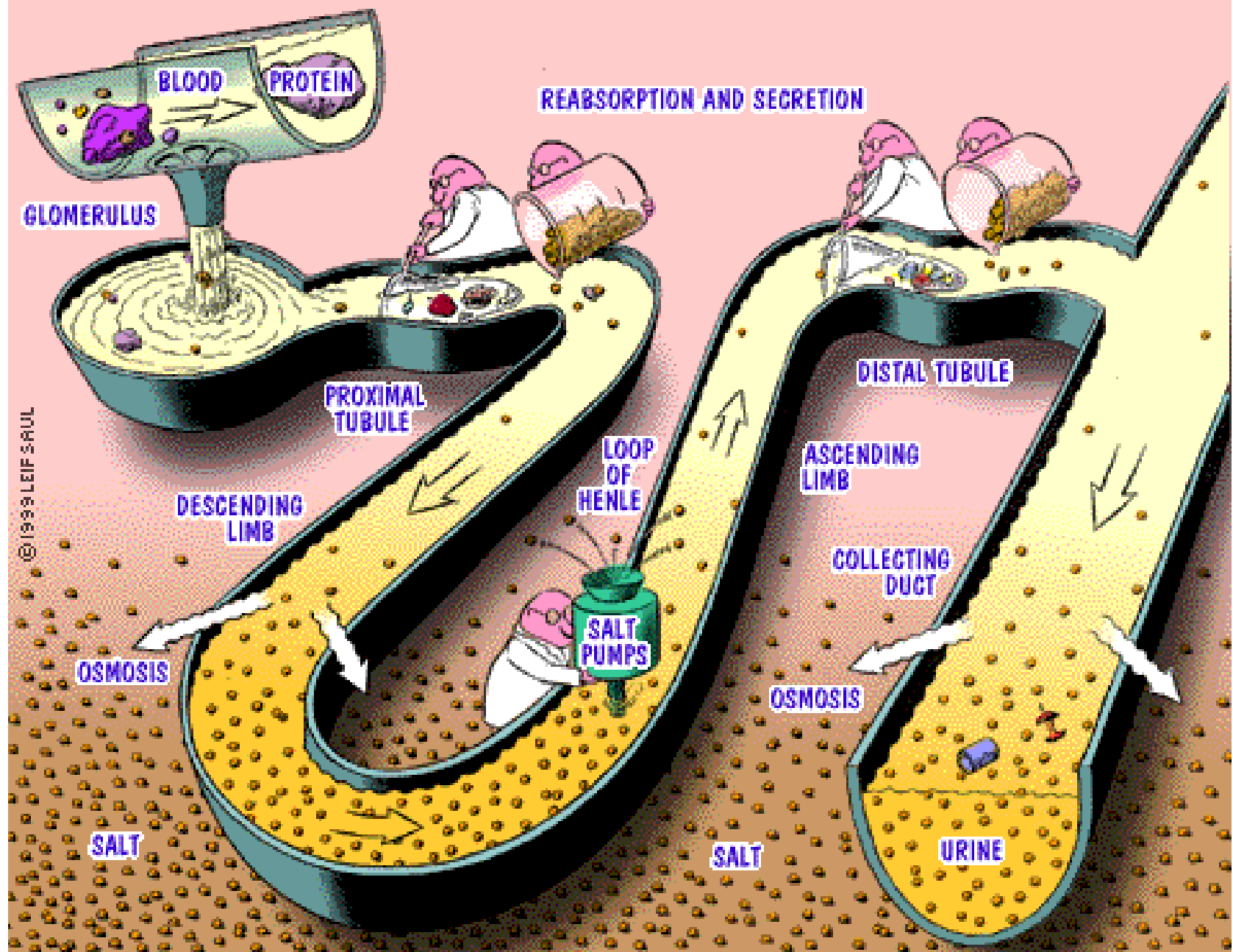
- elimination of nitrogenous wastes produced by protein catabolism
- maintenance of ionic and osmotic balance w/in body

Mechanism

- **ultrafiltration** of blood plasma followed by **reabsorption** of most water and small molecules (e.g., glucose) and **secretion** of certain ions (mostly divalents)



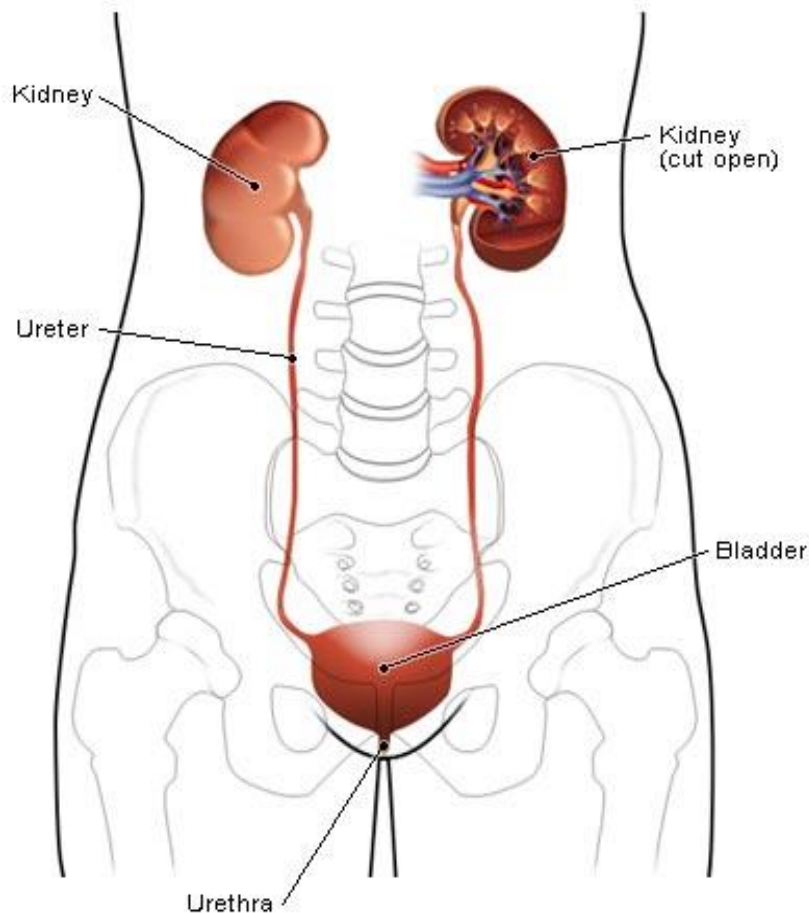
REABSORPTION AND SECRETION



ACCESSORY FUNCTION

- erythropoietin release; this is a hormone which stimulates RBC production

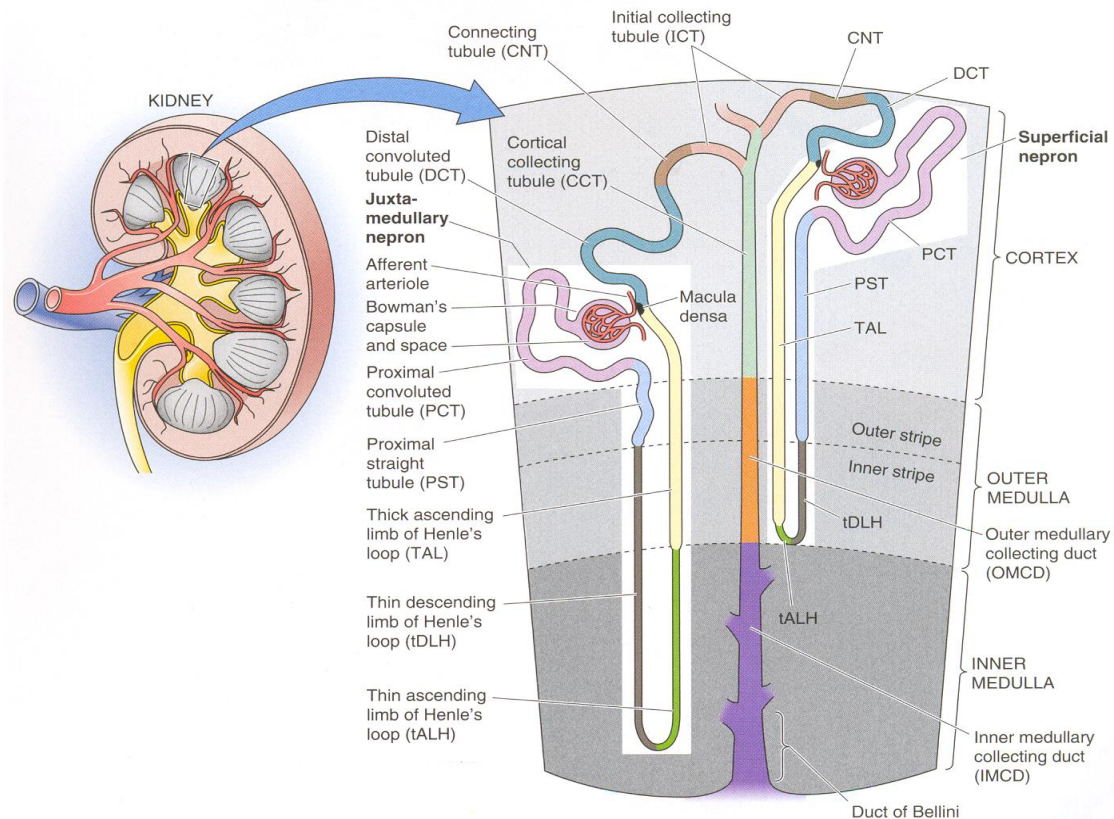
SEQUENCE



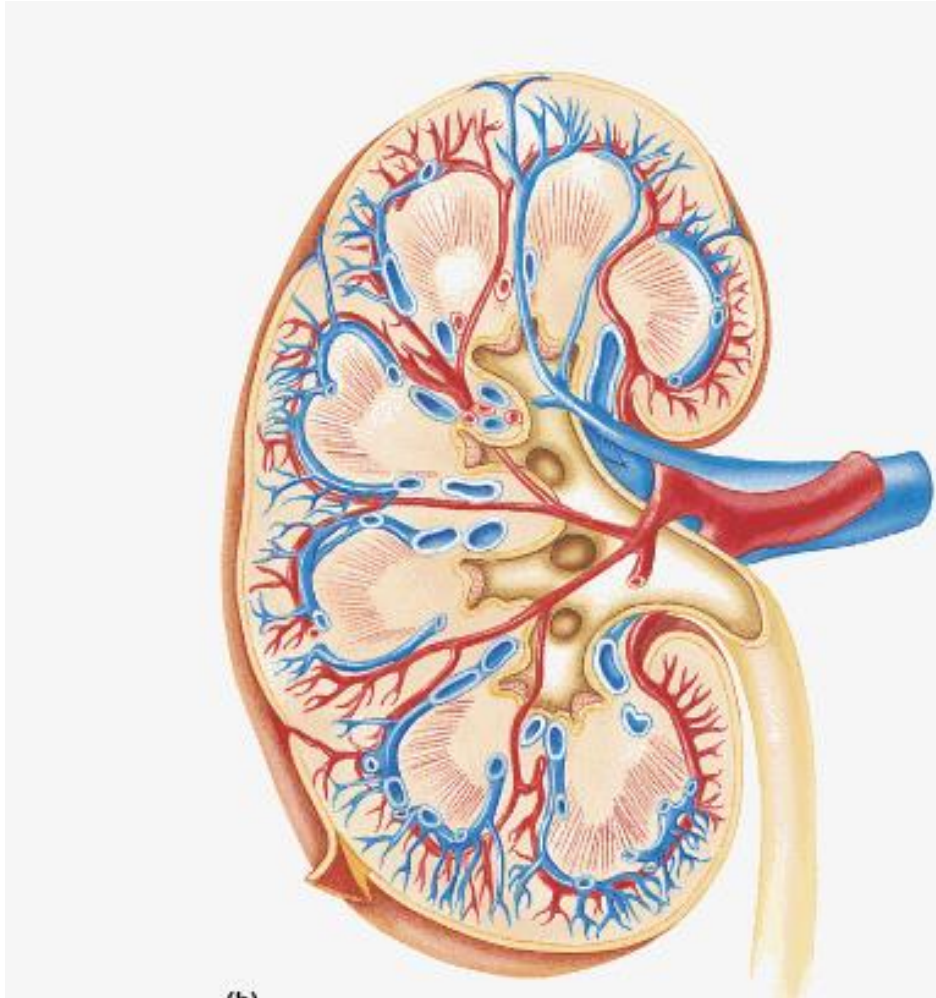
- Urine produced in kidneys,
- drains toward hilum ("dent" in kidney bean shape),
- entering renal pelvis where it leaves the kidneys.
- Upon exiting kidney, urine enters ureters which carry it to the urinary bladder (muscular-walled sac serving as reservoir for urine storage).
- Urethra drains urinary bladder to exterior.

KIDNEY

- Basic structural unit = nephron (Renal Corpuscle + renal tubule)



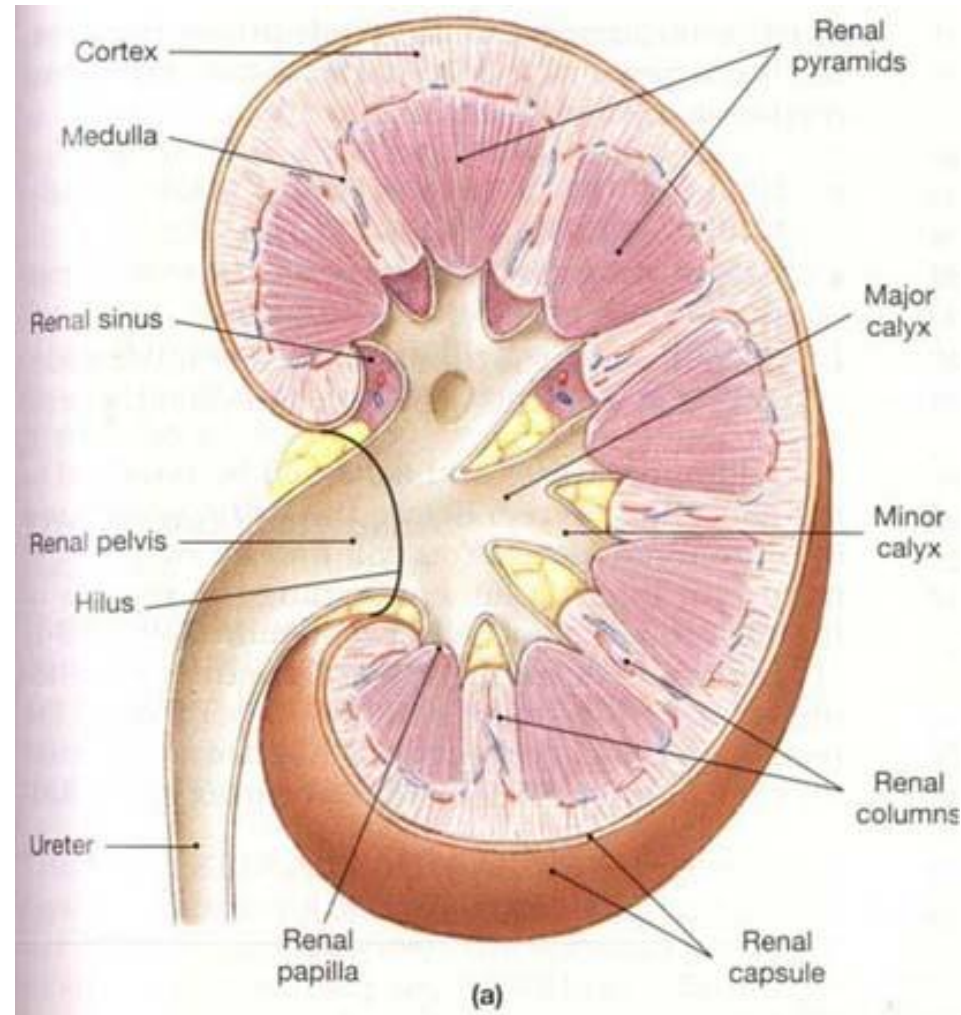
KIDNEY



- **Hilum** = depression thru which urine exits and blood vessels enter the kidney

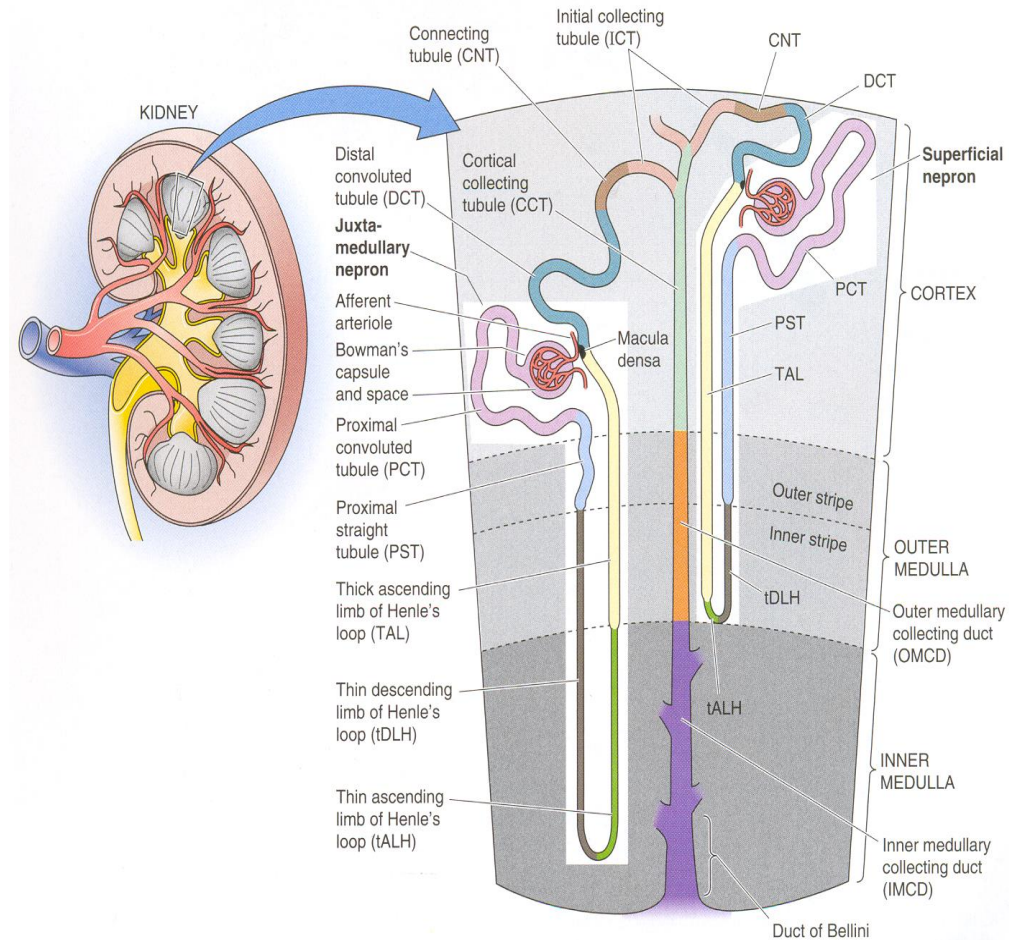
KIDNEY

- **Renal Pelvis** = expansion of upper part of ureter within the hilum, divided into large and small cups (major and minor **calyces**).



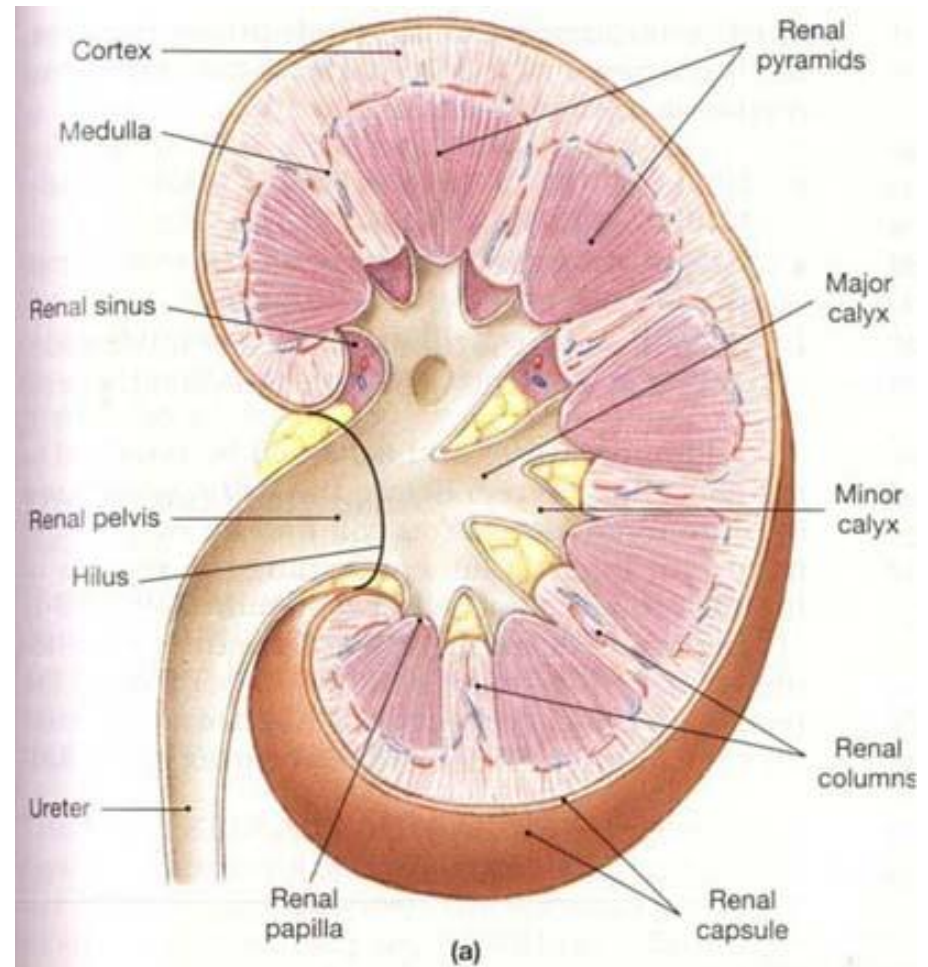
KIDNEY

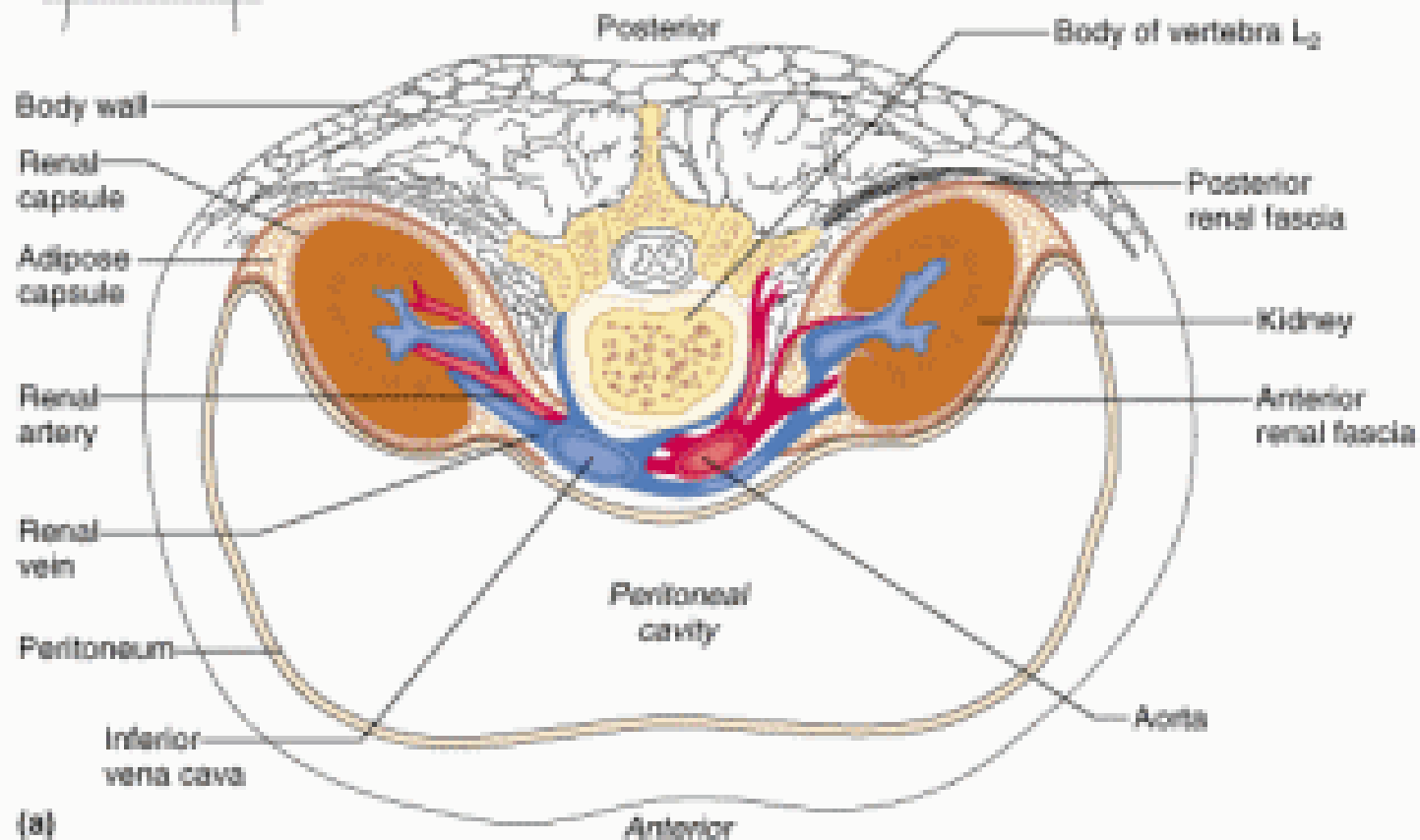
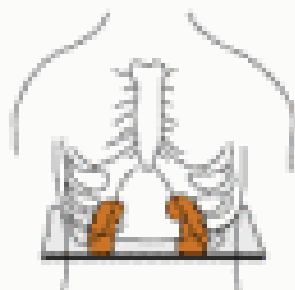
- **Collecting Ducts** = empty into calyces, these are structures into which renal tubules drain



KIDNEY

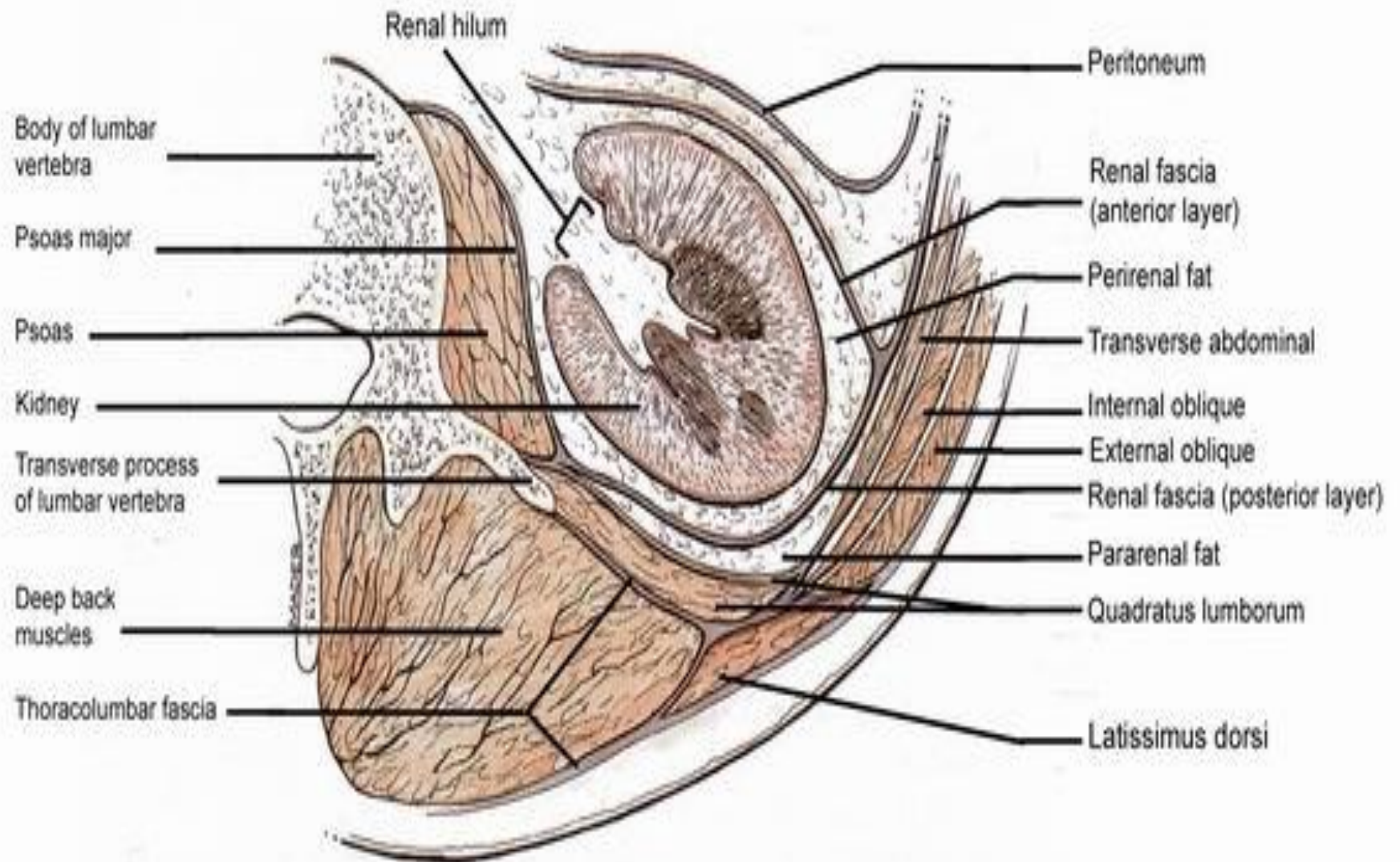
- As a gross structure, the kidney is surrounded by a dense CT capsule which gives off trabeculae extending toward the interior that produce a lobular organization.





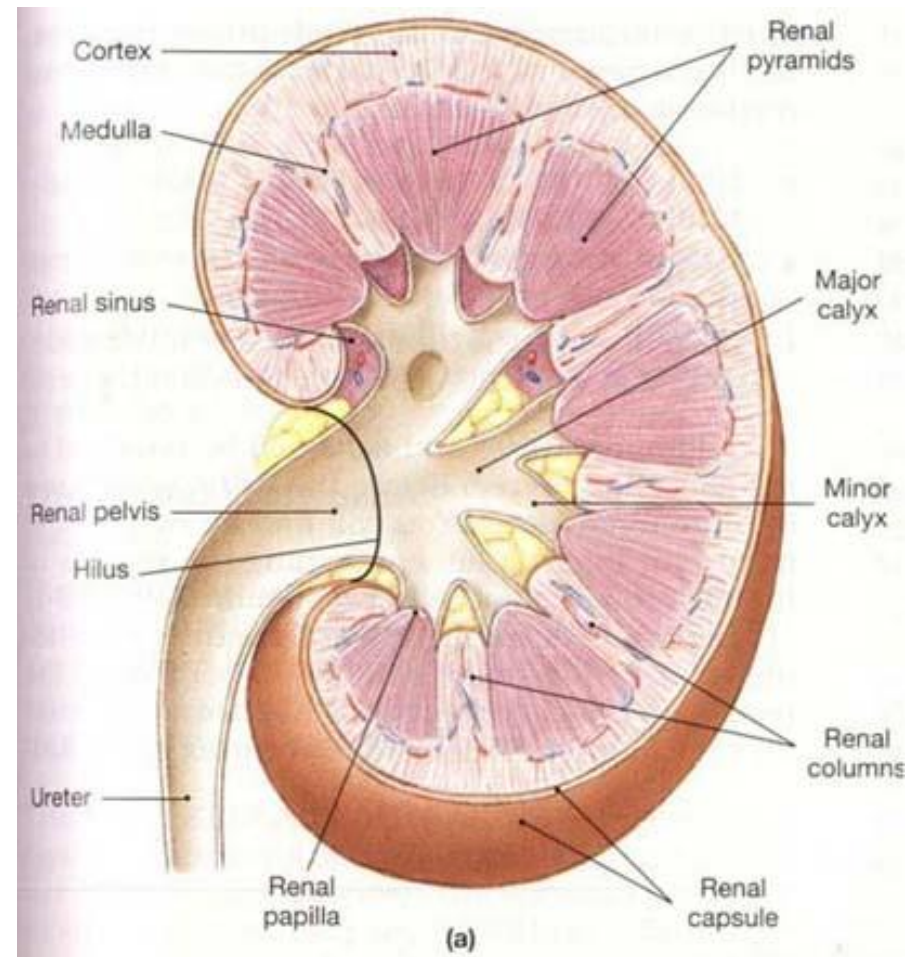
(a)

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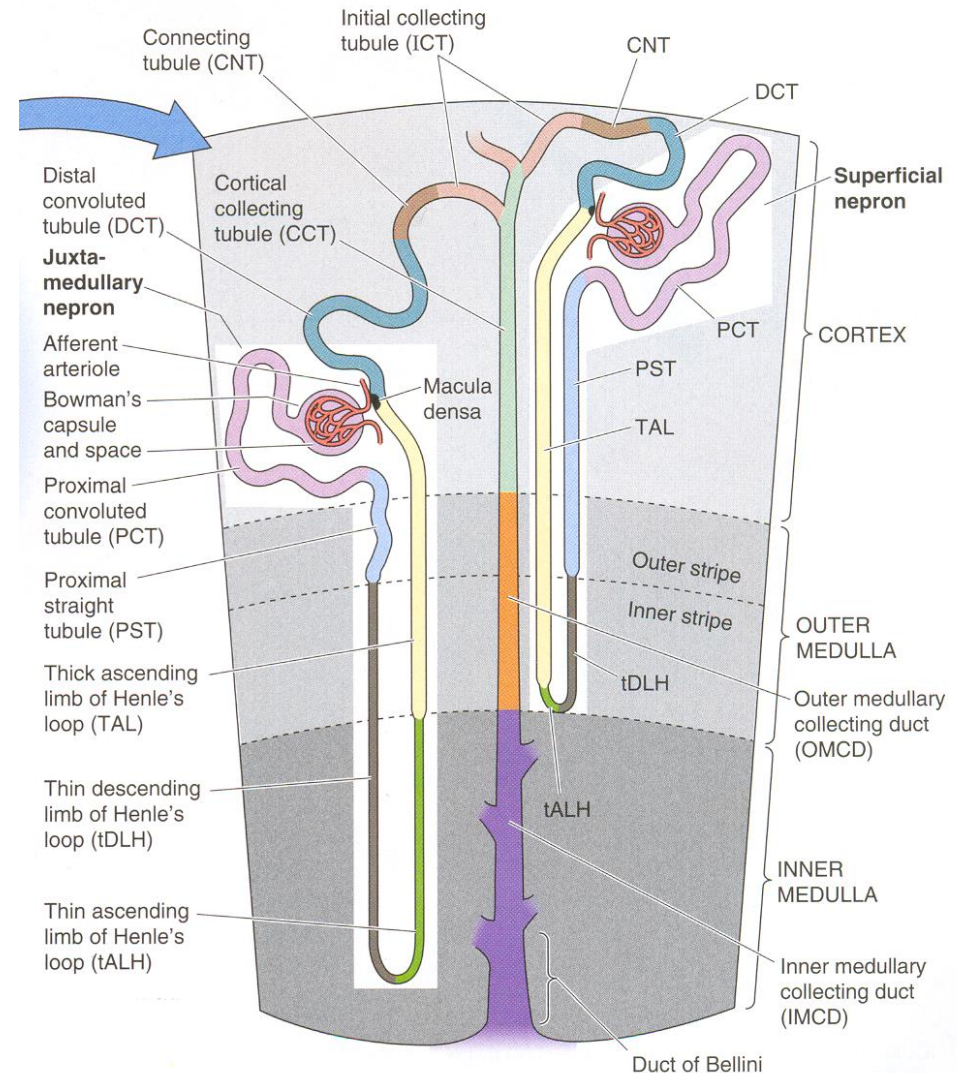
KIDNEY

- The kidney is divided into an outer **cortex** and an inner **medulla**.
- The medulla contains the **loops of Henle** (found only in mammals and some birds) and the collecting ducts.
- **Medullary rays** extend into cortex



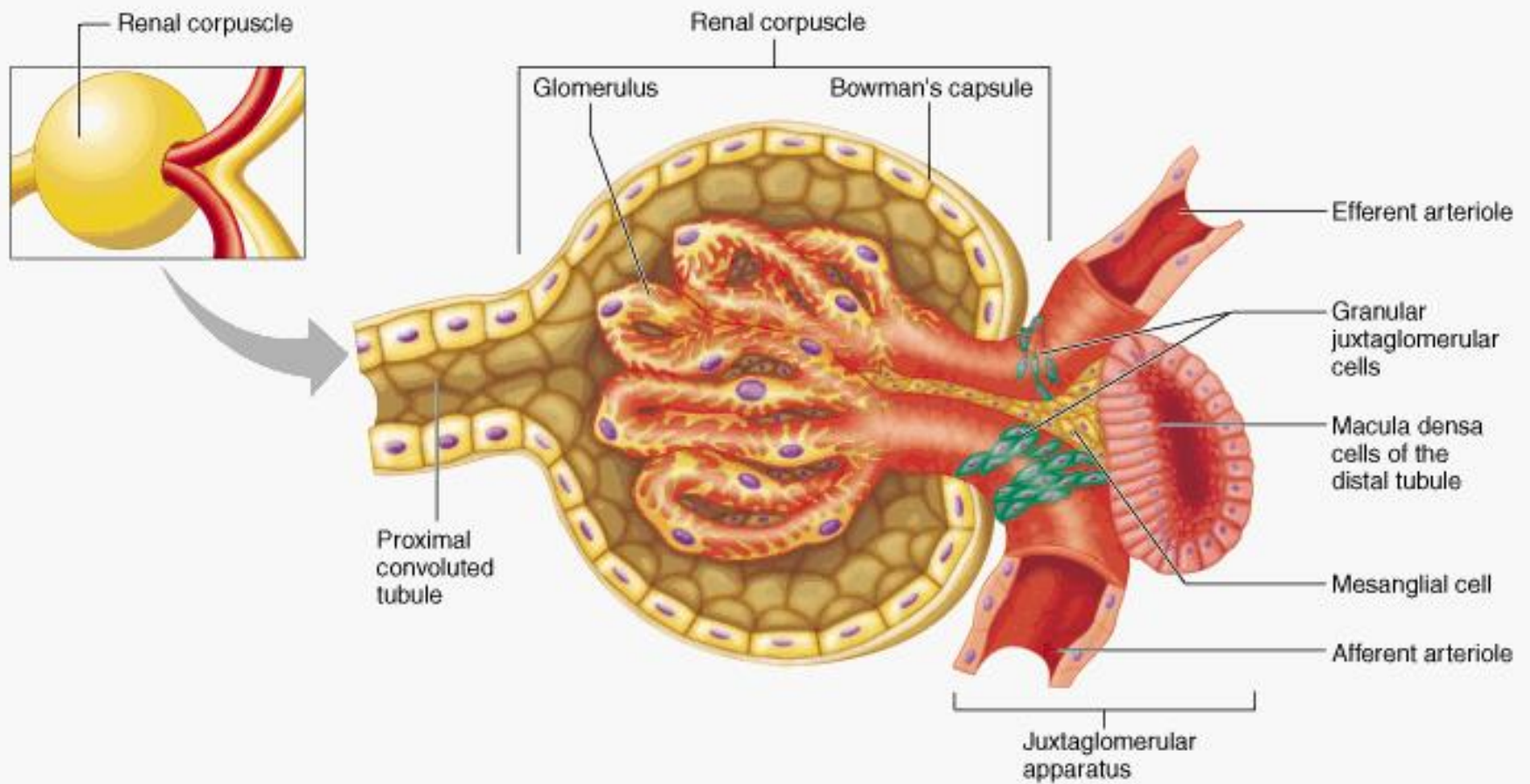
NEPHRON STRUCTURE

- Renal Corpuscle
- Proximal Convoluted Tubule
- Loop of Henle
- Distal Convoluted Tubule



Renal Corpuscle

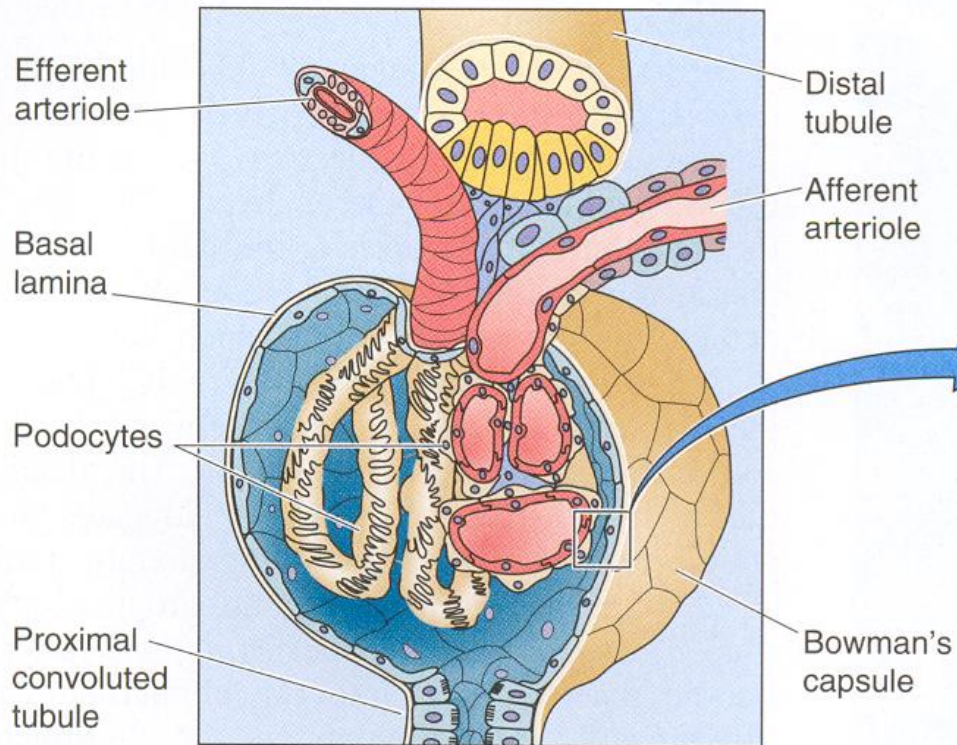
- blind end of nephron;
- consists of a thin capsule of epithelial tissue (**Bowman's Capsule**) surrounding a ball of capillaries (**glomerulus**).
- Blood plasma filters from glomerular capillaries into Bowman's capsule, thereby entering the renal tubule



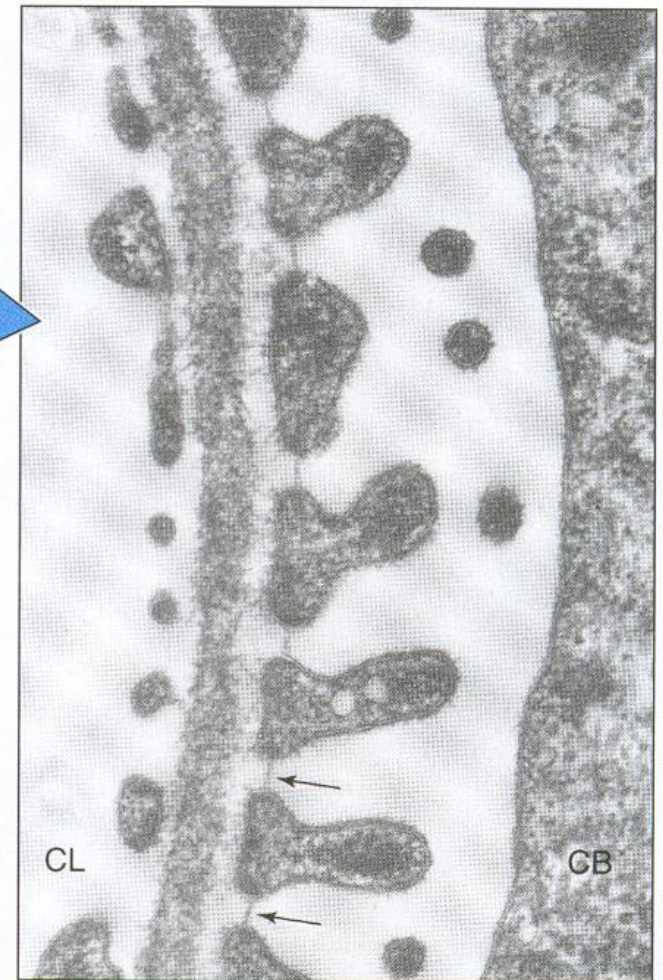
Filtration Barrier

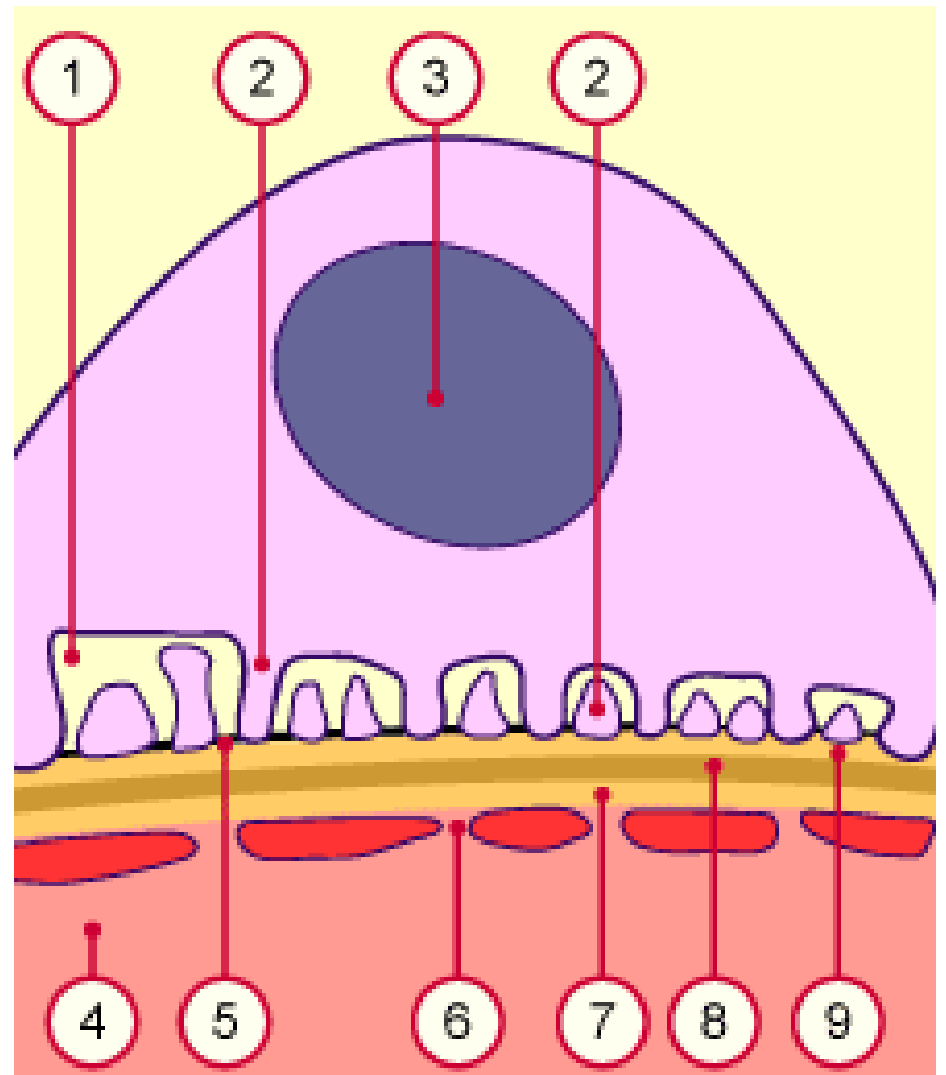
- capillary endothelium (fenestrated)
- +
- relatively thick glomerular basement membrane (functions in support of capillary network)
- +
- Bowman's Capsule epithelium (simple squamous cells = **podocytes**).

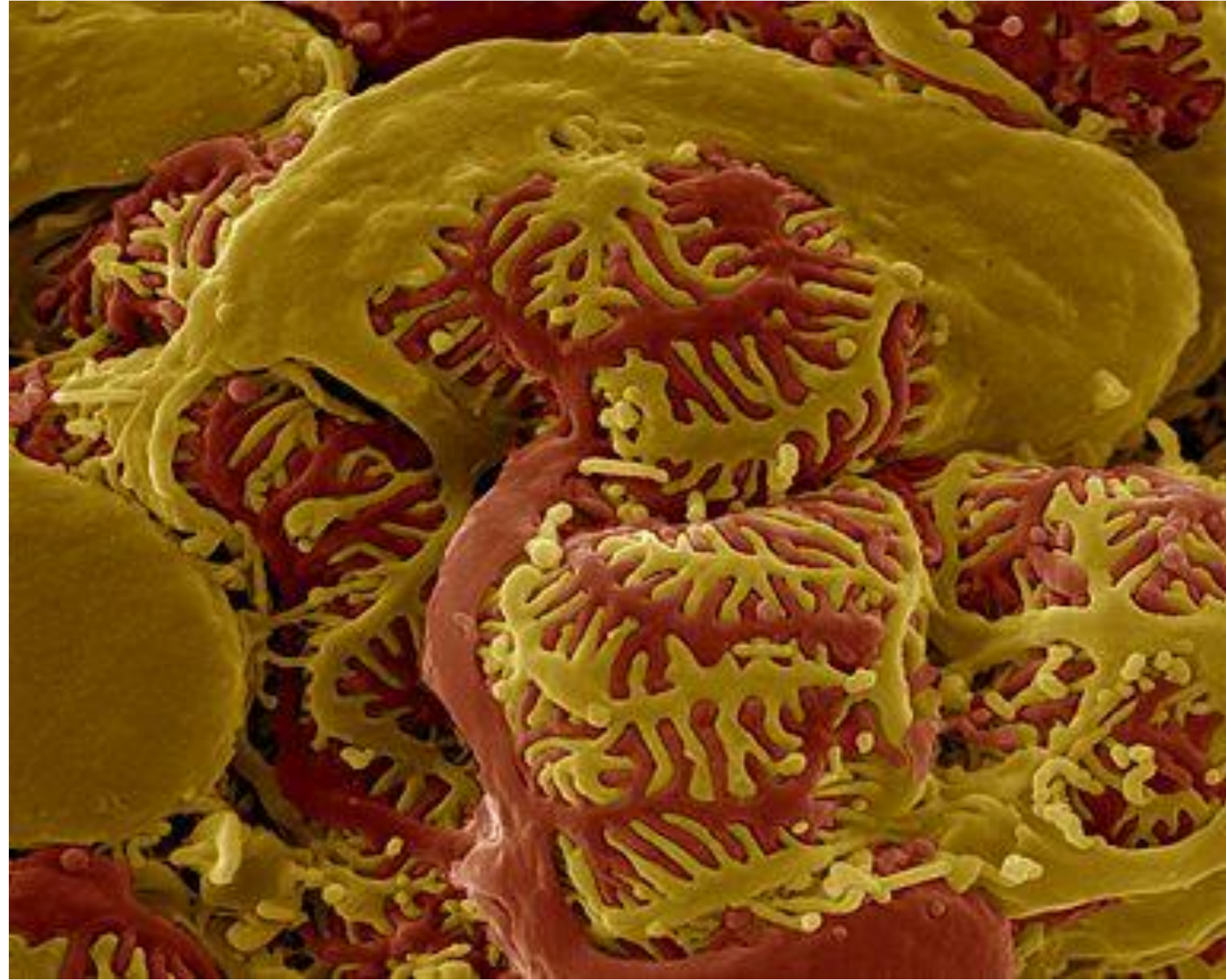
A GLOMERULUS AND BOWMAN'S CAPSULE



B COMPONENTS OF FILTRATION BARRIER

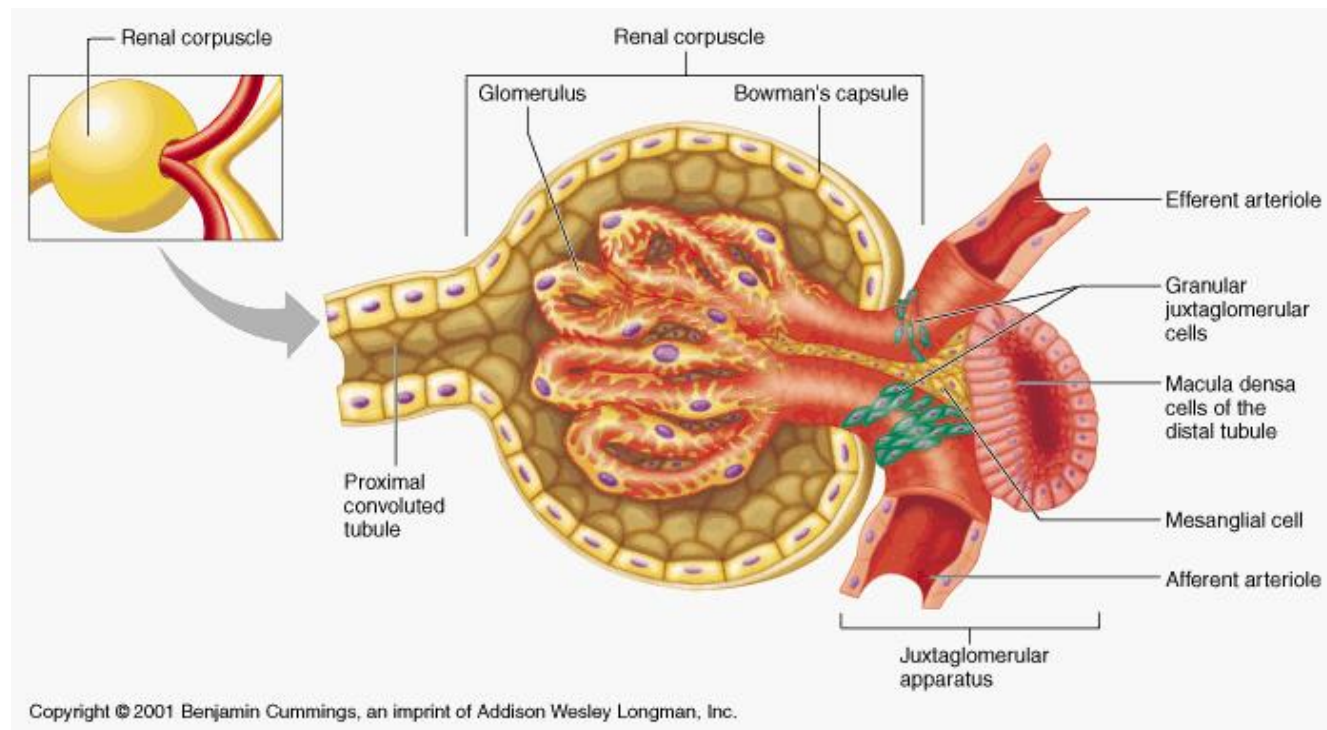






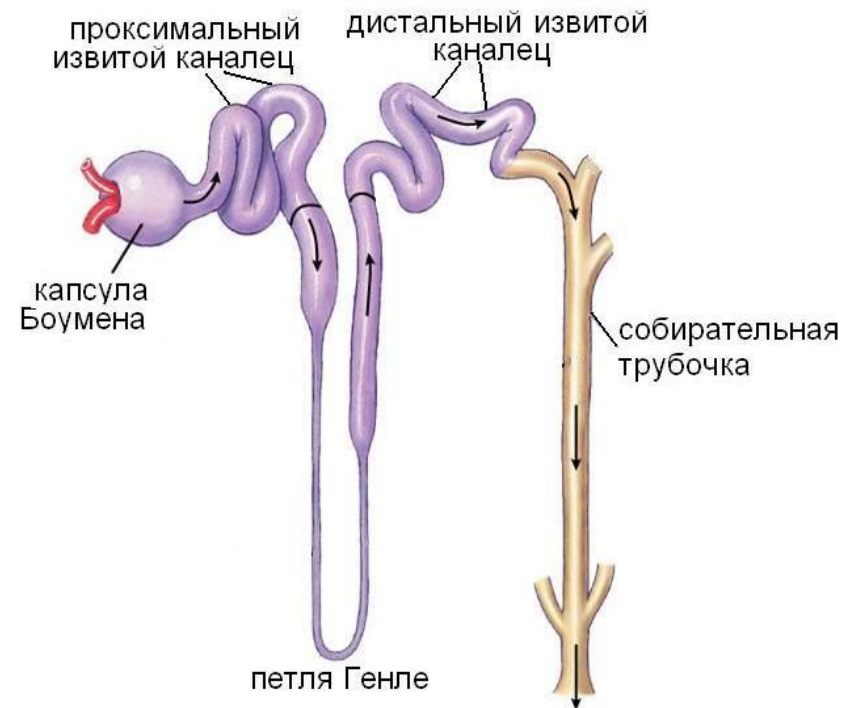
Mesangial Cells

- lie in extracellular matrix between glomerular capillaries, serve a phagocytic function



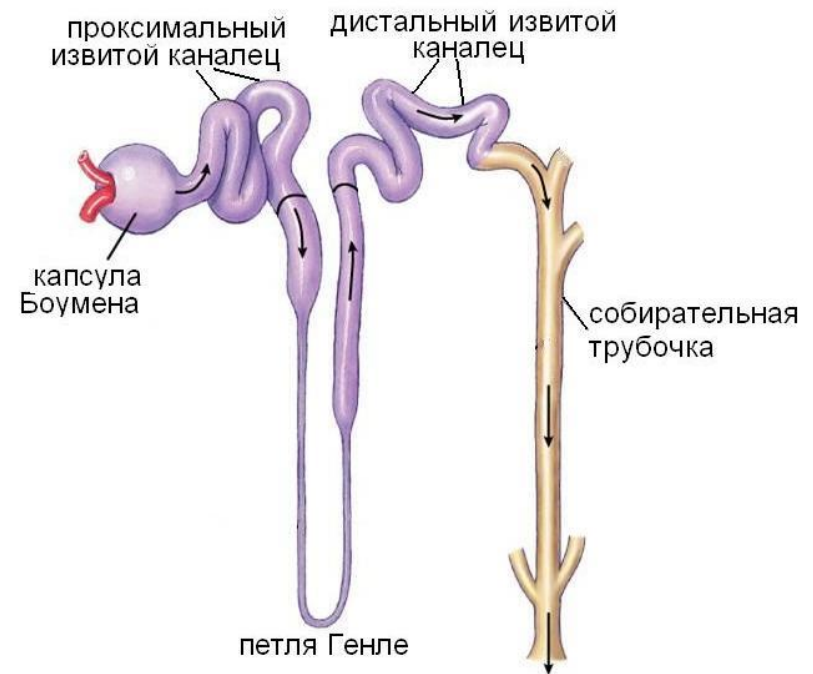
Proximal Convoluted Tubule

- takes a winding path thru the cortex;
- leads from Bowman's capsule to descending loop of Henle
- ***Proximal tubule is active in reabsorption of water, NaCl, glucose, amino acids, vitamins, etc***



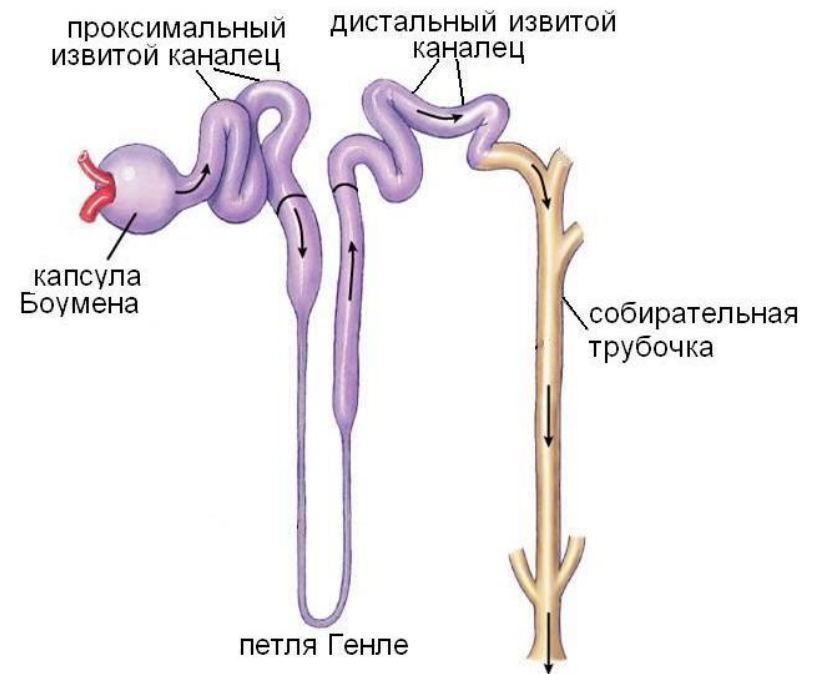
Loop of Henle

- Functions to concentrate urine by removing water and NaCl



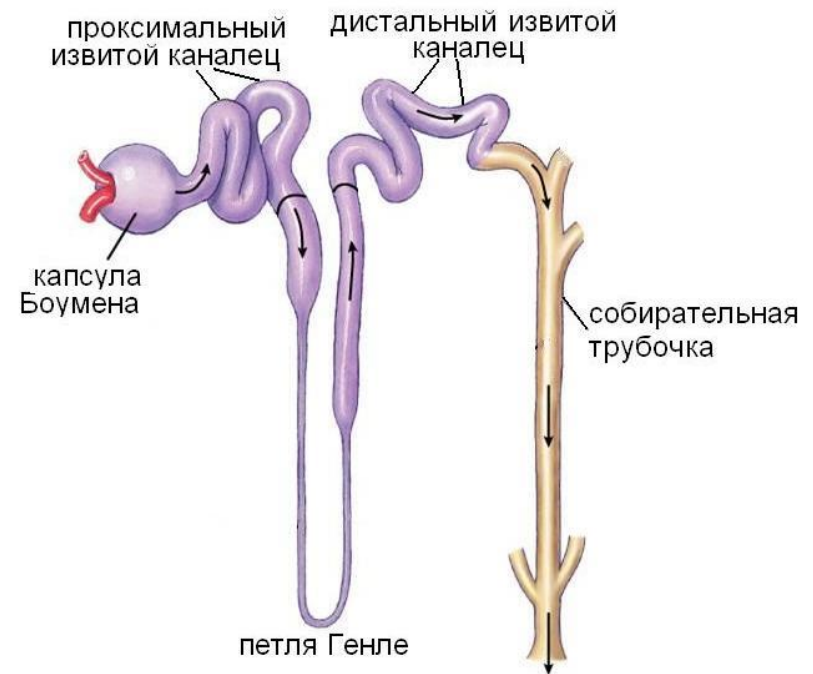
Distal Convoluted Tubule

- takes a winding path to empty into collecting duct.
- **Functions in sodium reabsorption**



Collecting Ducts

- lie mainly within medulla and medullary rays extending into cortex
- **main function is to reabsorb water**

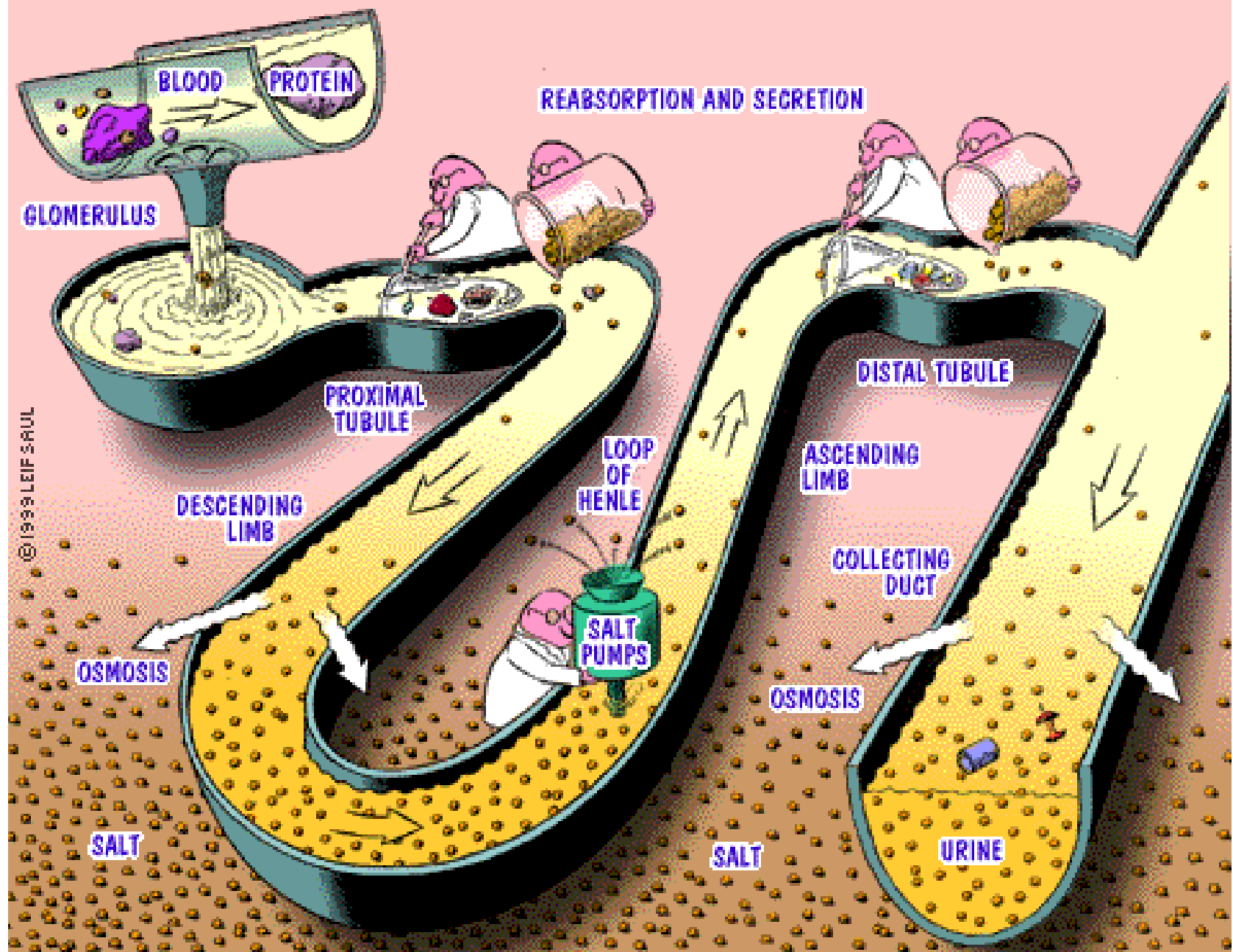


MECHANISM OF FILTRATE CONCENTRATION

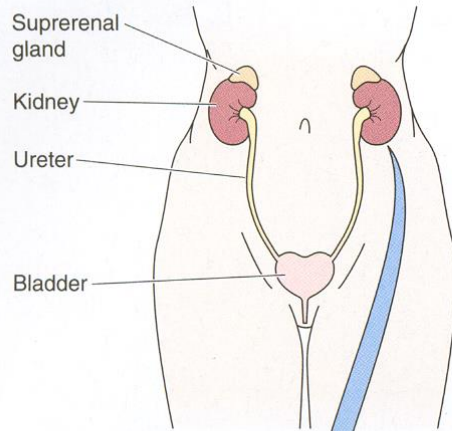
- **Countercurrent Multiplier System**

- Each region has a special permeability for water, ions, and/or urea
- Interstitial spaces accumulate ions and urea to build up a concentration gradient that increases with depth into the medulla
- Parallel to nephrons lies a capillary network (vasa recta) which has freely permeable walls, these capillaries passively participate in maintenance of the concentration gradient in the interstitium by removal of reabsorbed water and NaCl

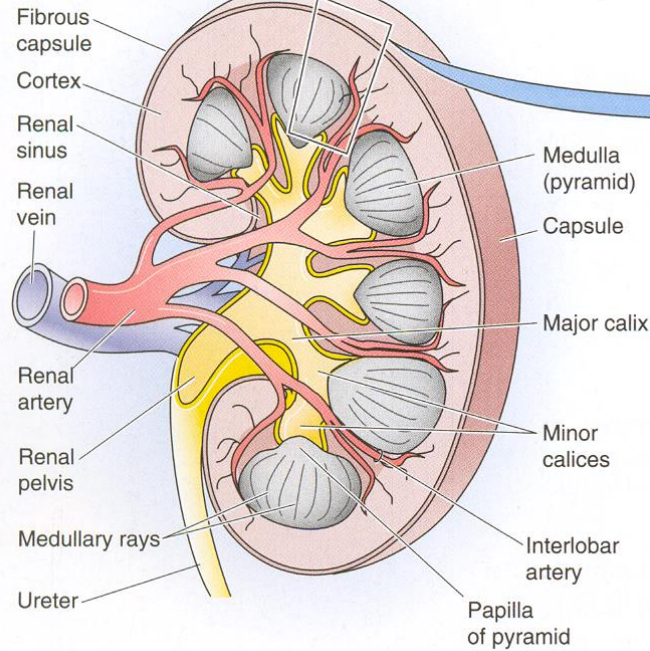
REABSORPTION AND SECRETION



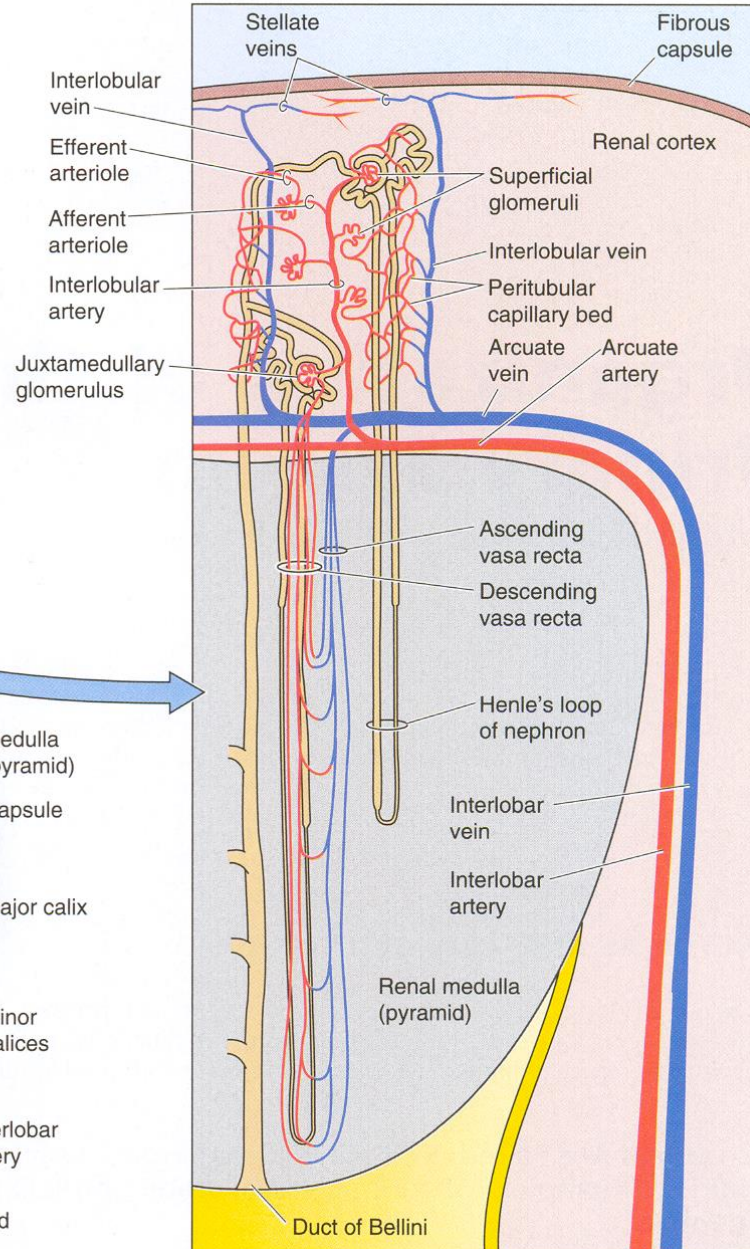
A URINARY SYSTEM



B KIDNEY

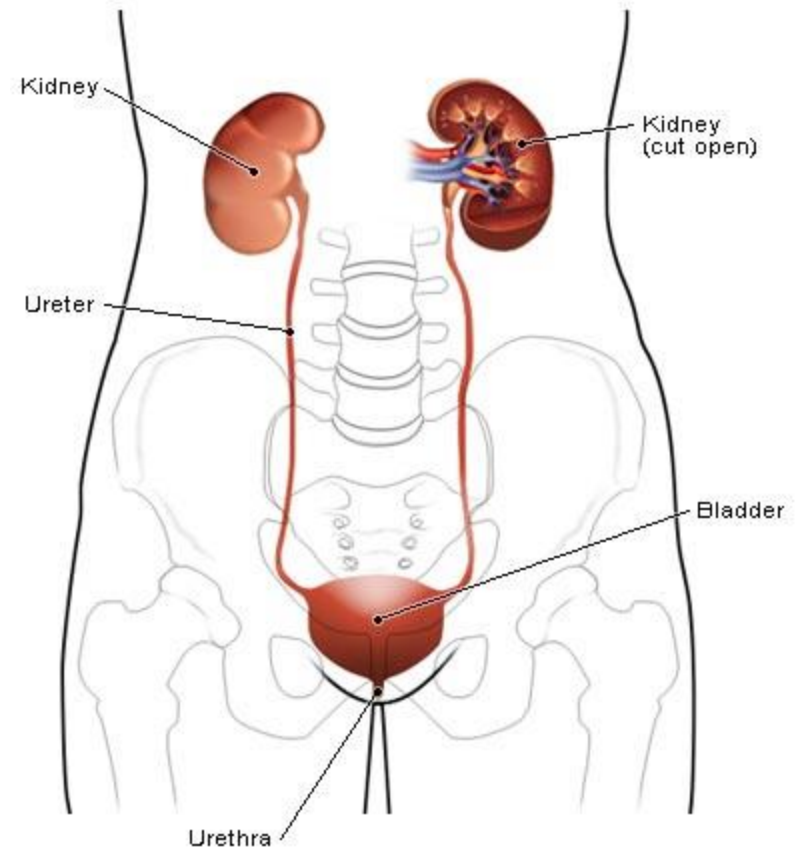


C MAJOR BLOOD VESSELS IN KIDNEY



URETER

- tube extending from renal pelvis to urinary bladder



Mucosa

- transitional epithelium + lamina propria of elastic areolar CT; longitudinal folds are present in mucosa; no submucosa is present

Muscularis

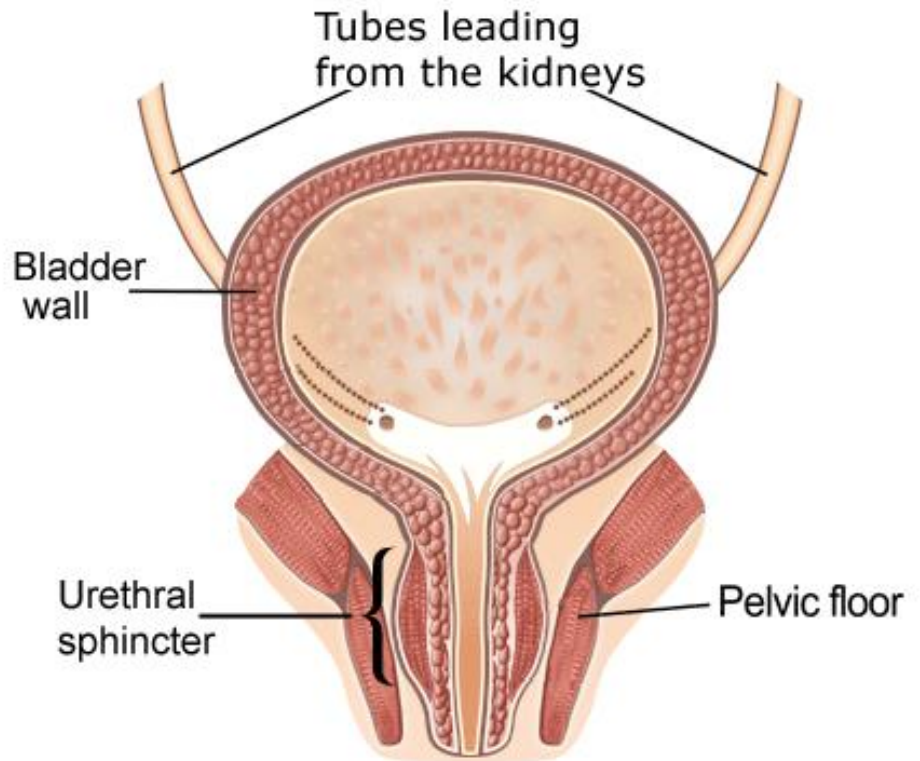
- bundles of smooth muscle fibers with interspersed CT;
- Smooth muscle arrangement is inner longitudinal,
- outer circular,
- Peristaltic contractions of the Muscularis move urine into bladder

Adventitia

- Fibroelastic CT with blood vessels, lymphatics, nerves

URINARY BLADDER

- sac-like structure with wall structure similar to ureter

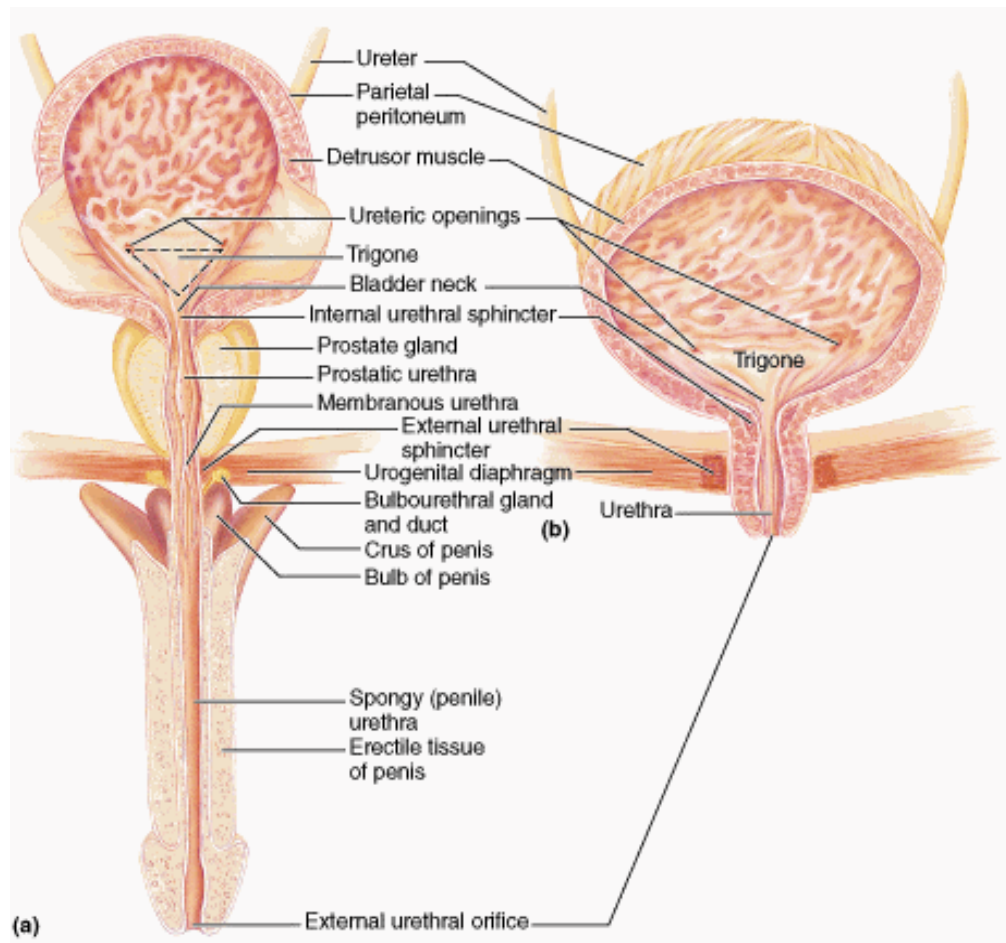


differences include:

- thicker transitional epithelium
- thick muscularis (3 poorly defined layers); at neck of bladder there is a smooth muscle coat that forms an involuntary **internal sphincter**
- adventitia is covered by mesothelium = serosa

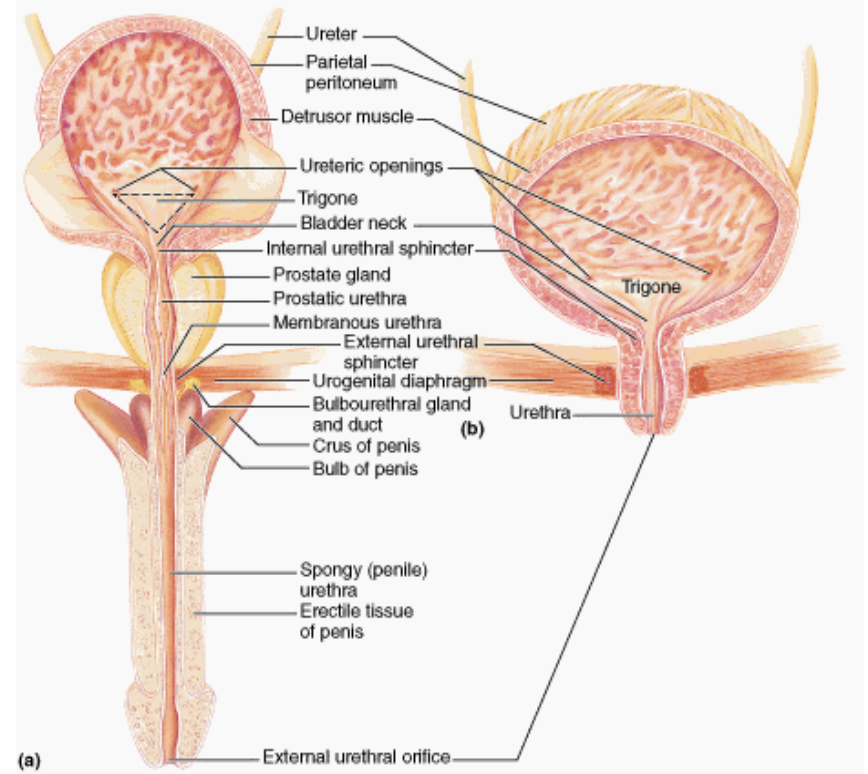
URETHRA

- tube emptying bladder to exterior



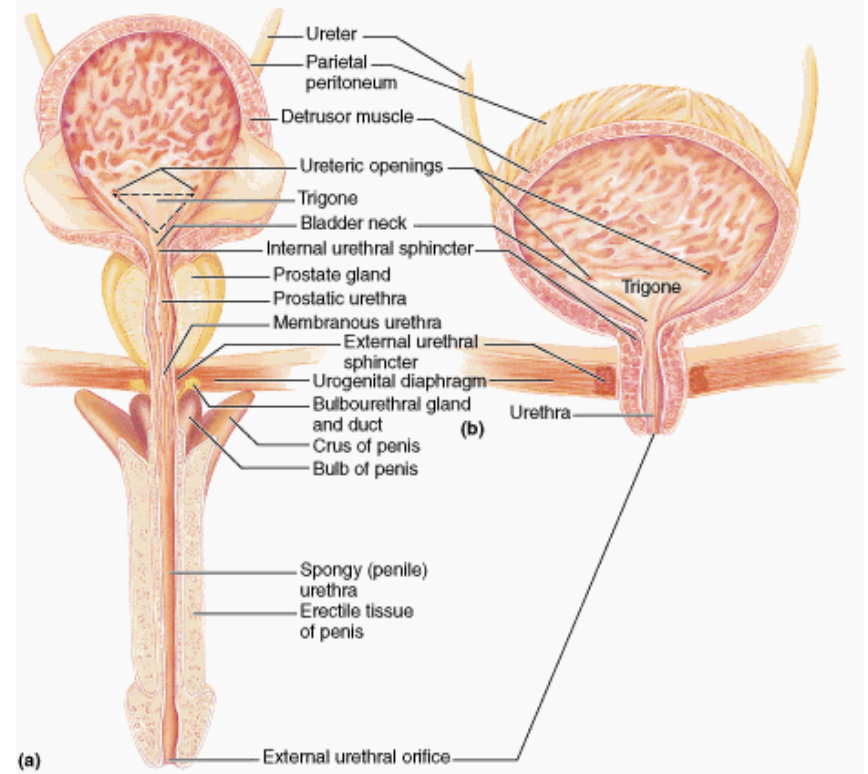
Male

- relatively lengthy tube,
- shared with reproductive tract;
- lumen has an irregular border - pits = **Glands of Littre** which produce mucus;
- surrounded at base of penis by striated muscle = **external sphincter**



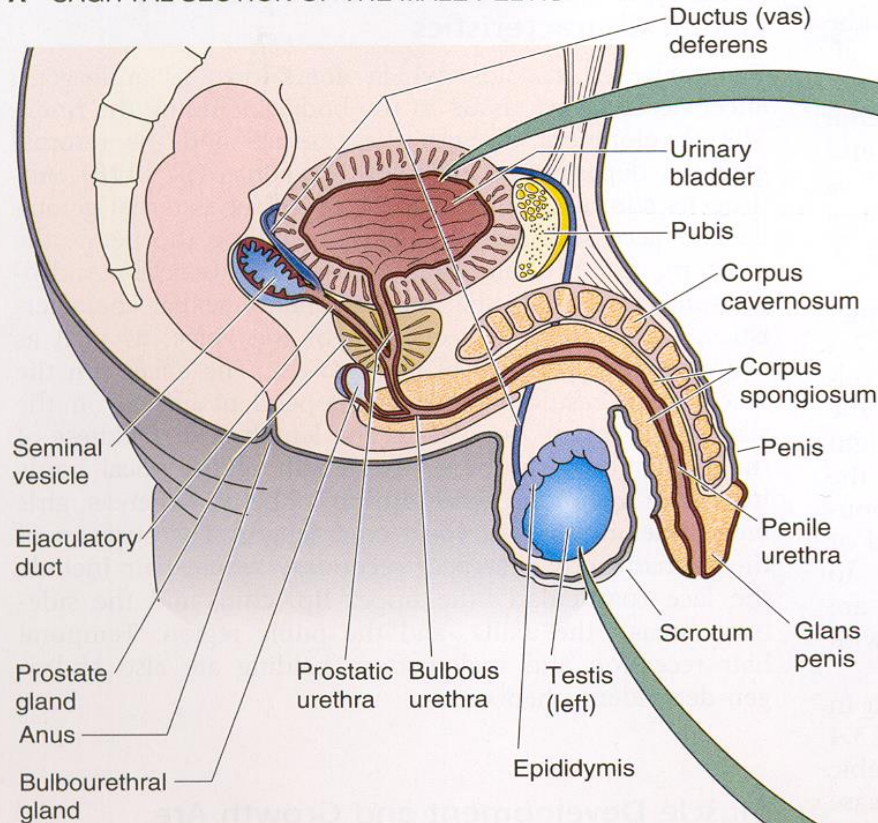
Female

- much shorter tube,
- separate from reproductive tract;
- external sphincter of skeletal muscle surrounds external urethral orifice

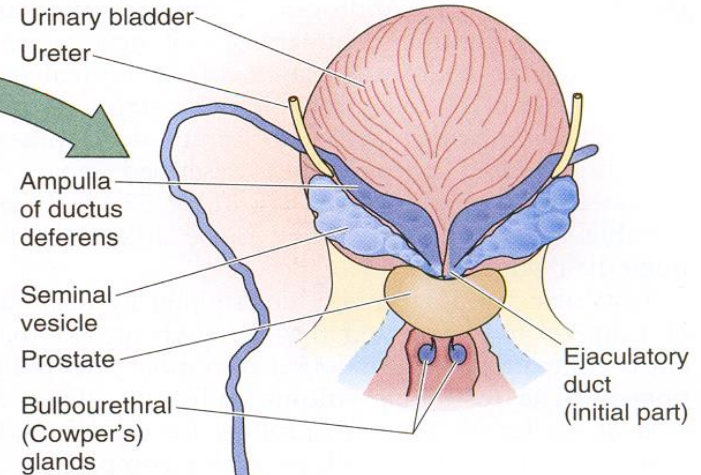


Male Reproductive System

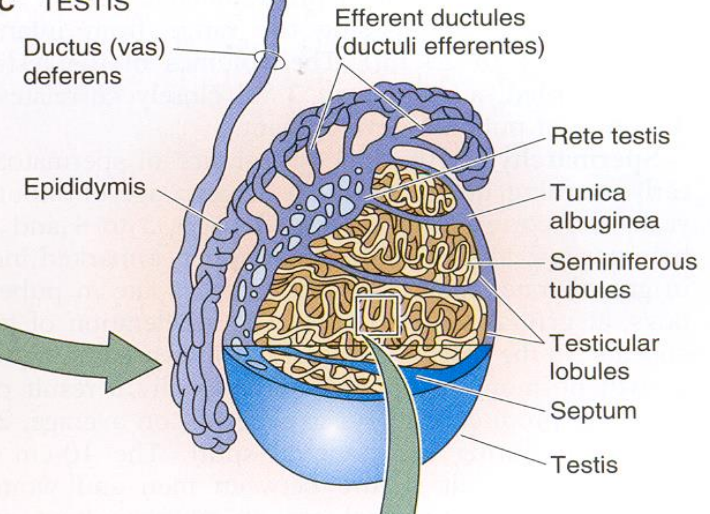
A SAGITTAL SECTION OF THE MALE PELVIS



B URINARY BLADDER (DORSAL VIEW)



C TESTIS

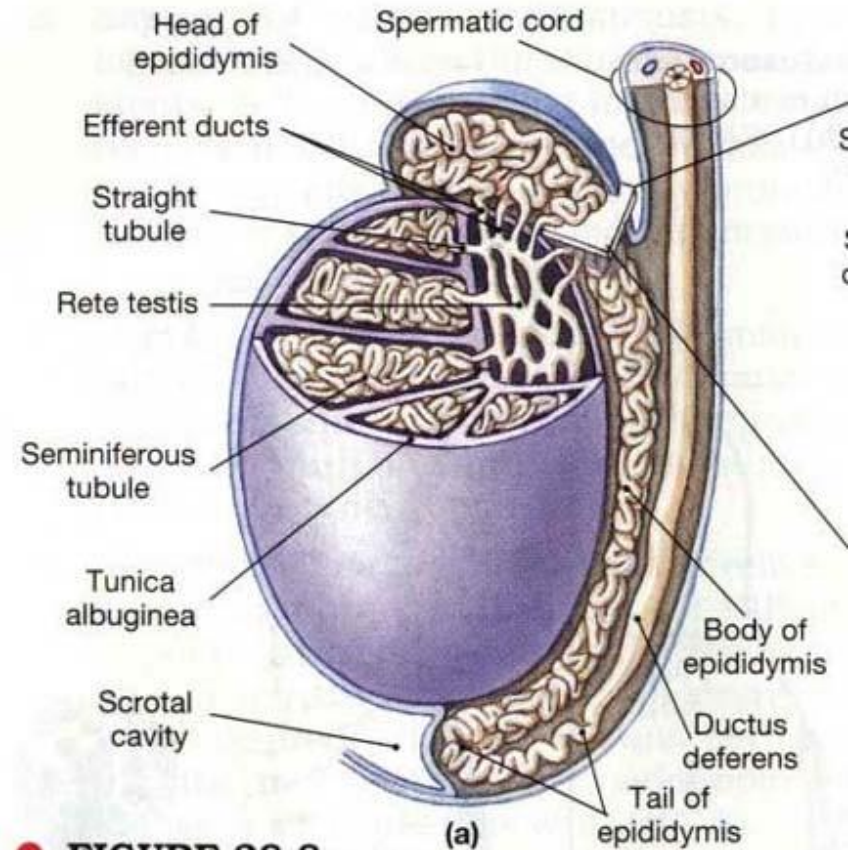


Functions

- ***secretion of sex hormones***
- ***production of sperm - spermatogenesis:***
entire process leading to **spermatozoa** (male gametes)
- ***transport of sperm from male to female.***
Semen (*Latin: liquid seed*): product of ejaculation; spermatozoa, seminal fluid (principally from **seminal vesicle** and **prostate gland**) & desquamated cells from tract; fructose and citrate metabolites

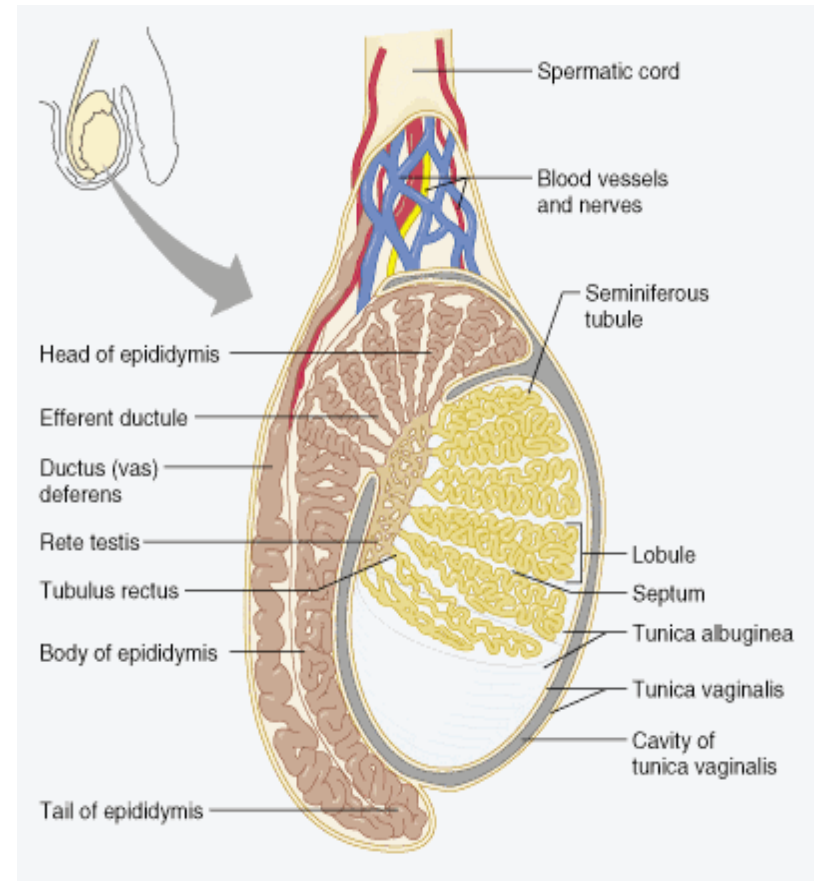
Primary sex organ - testes

- **Tunica albuginea** (white tunic): capsule of dense fibrous tissue; delicate collagenous septa divide testis into about 250 testicular lobules
- **Mediastinum testis** (thickening of **tunica albuginea** at hilum)
- **Seminiferous tubules** : 250 to 1000 per testis; 1 to 4 per testicular lobule;
- **Interstitial tissue** (Leydig cells singly or in groups within ct; secrete androgens).
- **Rete testis** (net): collecting tubules for seminiferous tubules; contained in **mediastinum testis**



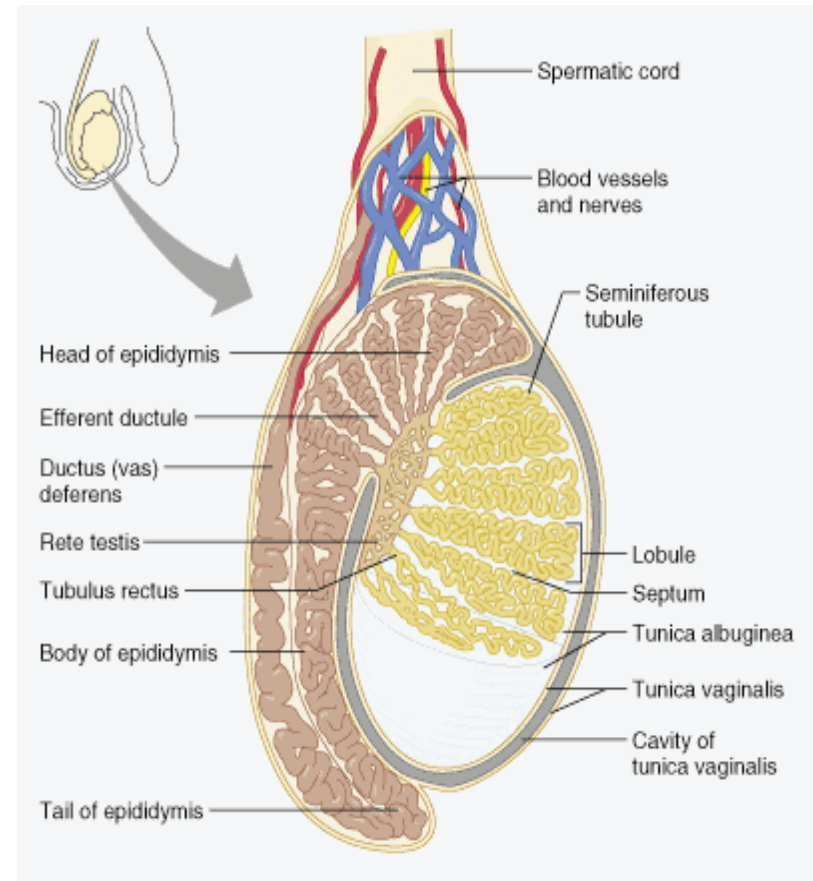
Protective supporting structures for the testes

- **Scrotum**
 - thermosensor
 - radiator
 - protective sac
- **Tunica vaginalis**
serosal lining; both
parietal and visceral
layers;



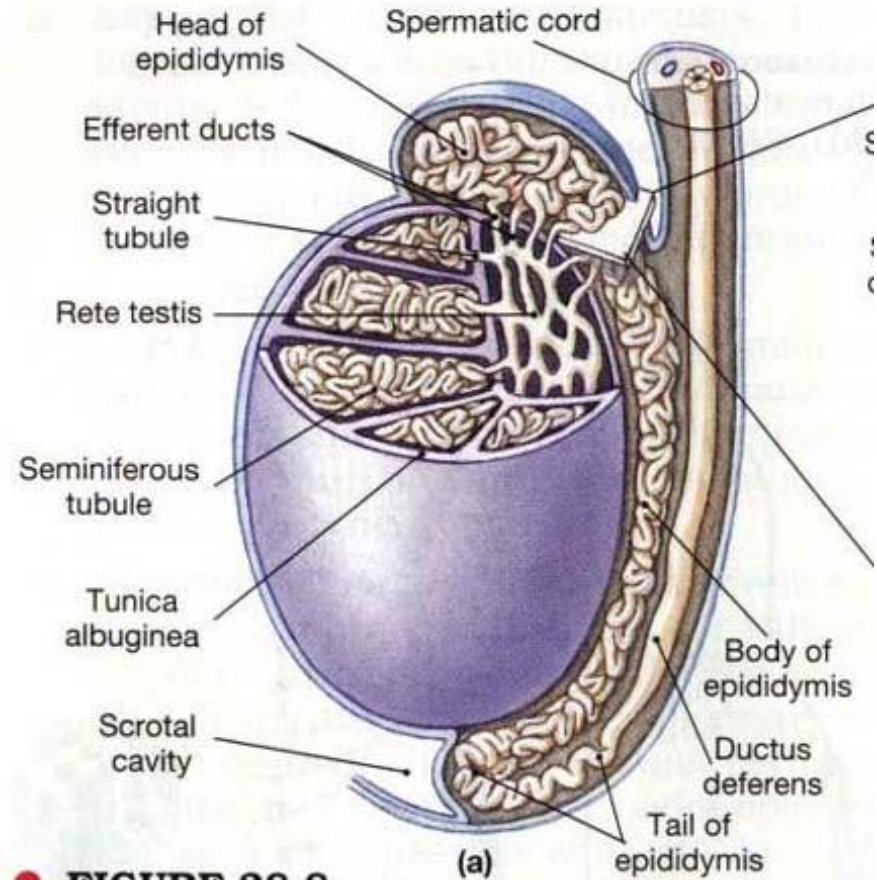
Protective supporting structures for the testes

- **Spermatic cord**
(testicular artery, spermatic vein, nerves, vas deferens, external and internal cremaster muscle)
- **Pampiniform plexus**
 - heat exchange
 - testosterone exchange
 - pulse pressure eliminator
- **Tunica dartos muscle**
- **Gubernaculum**
(connective tissue)



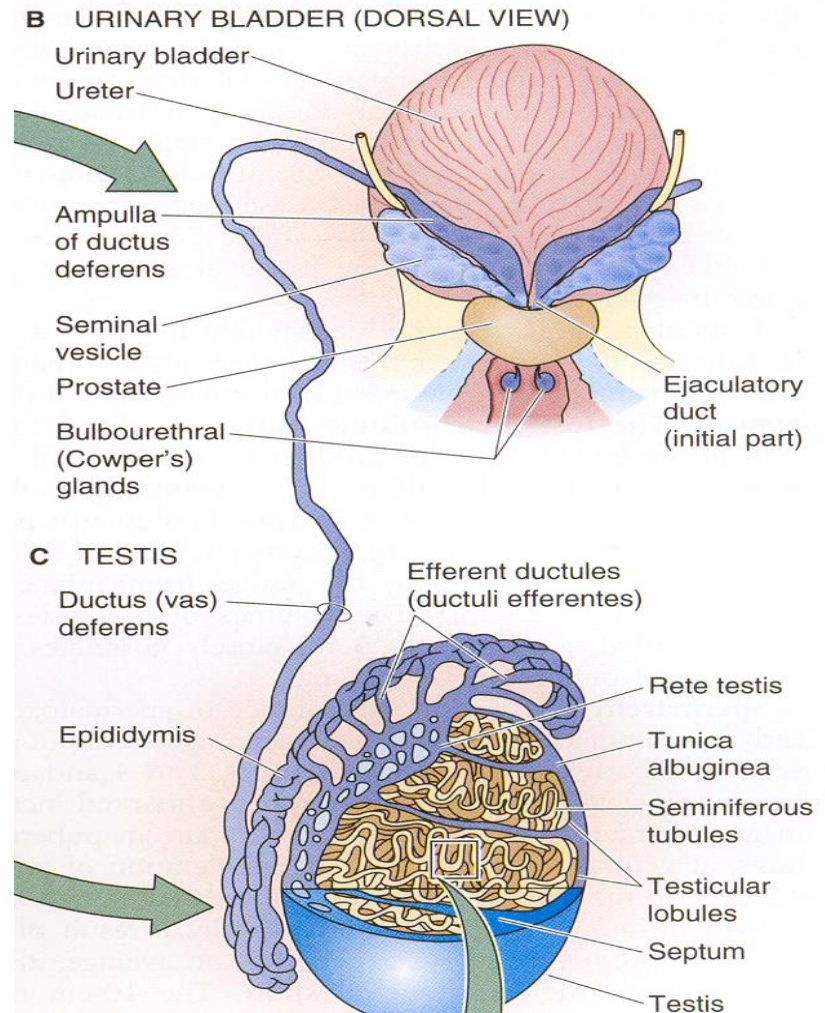
Secondary sex organs (leading to exterior)

- **Vas efferentia - ductuli efferentes:** 15 to 20 small ducts conduct spermatozoa and condense into single epididymal tube in body of epididymis; upper, posterior pole of testis;
- **epididymis:** compact mass extending down over posterior aspect of testis; extremely tortuous, tightly coiled tube; first part of ductus deferens; Epididymis - head, body and tail (caput, corpus, cauda)



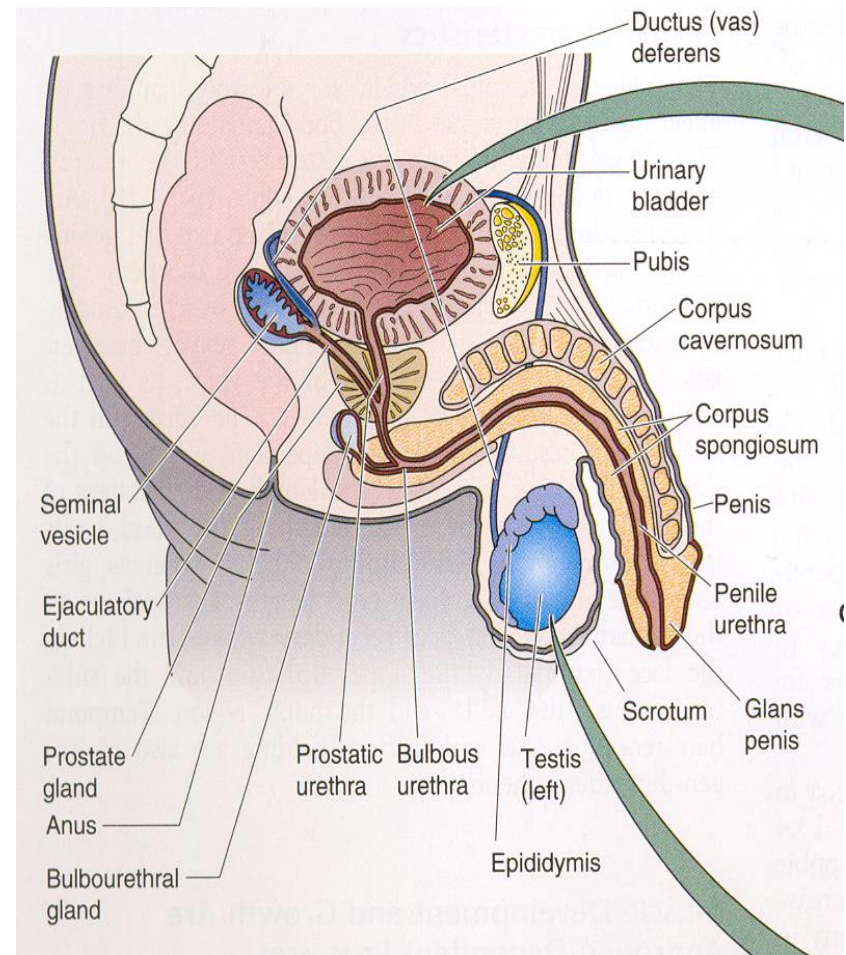
Secondary sex organs (leading to exterior)

- **Vas deferens - ductus** (vas as in vasectomy) **deferens**: inner and outer layers of longitudinally oriented smooth muscle, intermediate layer of circular muscle; sympathetic nervous innervation; strong peristaltic contractions expel ejaculum;
- Ampulla of vas deferens - dilated distal portion = **ampulla**: receives short ducts from **seminal vesicle** to become **ejaculatory ducts**



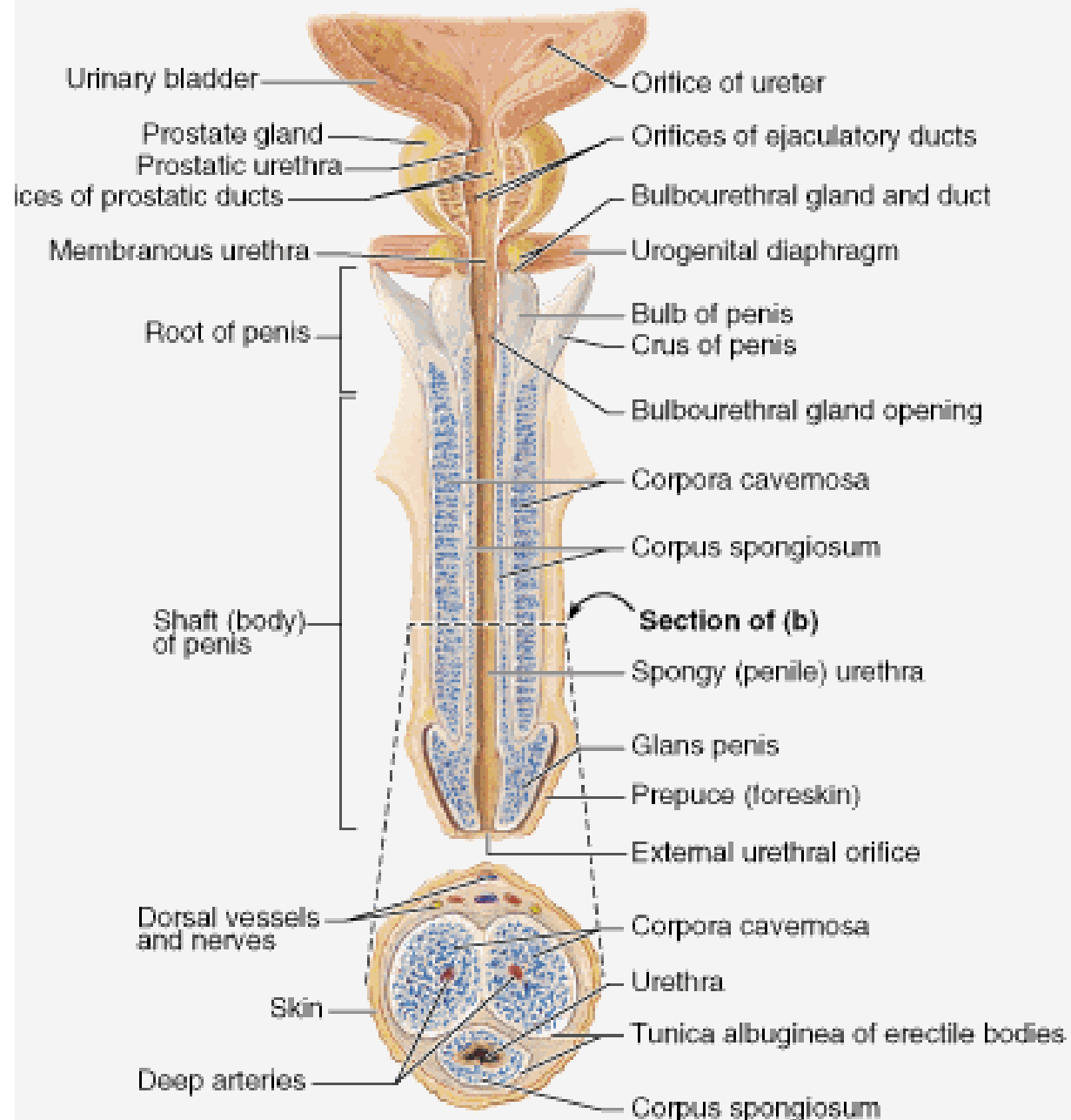
Secondary sex organs (leading to exterior)

- **ejaculatory ducts:** combining ducts from **seminal vesicles** and ductus deferens; converge to join **urethra** (**prostatic urethra:** passes through prostate gland)
- **Urethra** (pelvic and penile)
- **Penis**



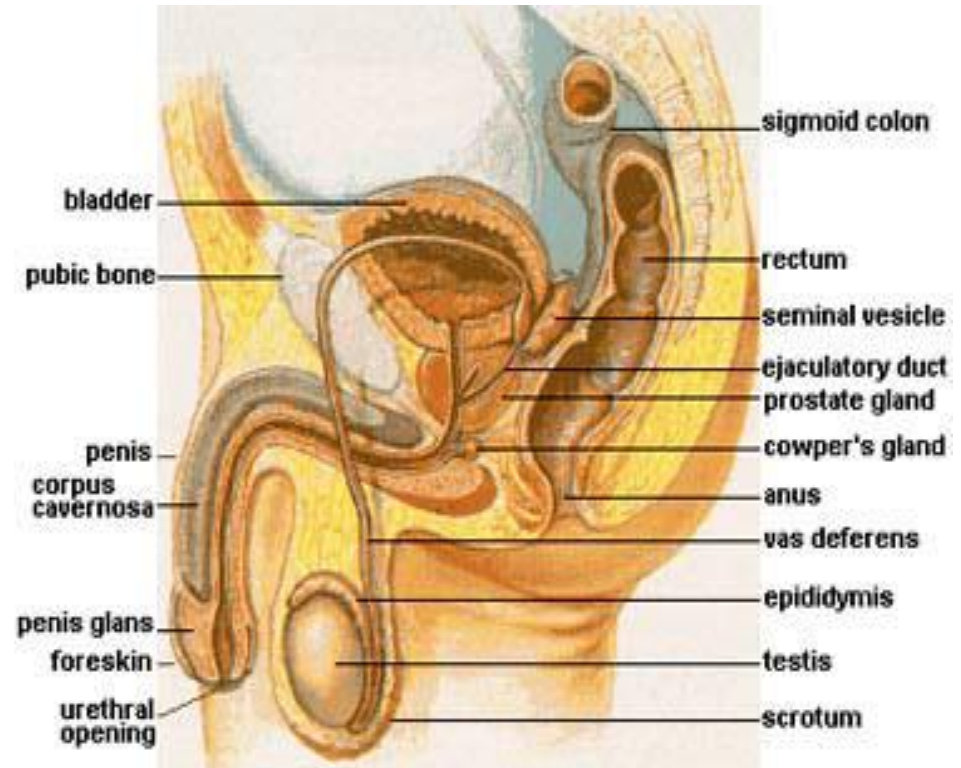
Penis

- 3 cylindrical masses of erectile tissue: paired **corpora cavernosa penis** (dorsal); **corpora cavernosum urethrae** (or **corpora spongiosum**) surrounding **penile urethra** and forming **glans penis**.
- **tunica albuginea**: condensed fibro-elastic tissue invests cavernous bodies; continuous with loose ct of hypodermis (allows thin penile skin to move) containing prominent blood vessels
- **penile erectile tissue** (of cavernous bodies): broad vascular lacunae or **cavernous sinuses** supported by **trabeculae** of fibro-elastic tissue and smooth muscle;
- **penile urethra**: deep outpocketings continuous with ducts of simple acinar glands = **paraurethral glands** and **bulbo-urethral glands (of Cowper)** lubricate; mucoid secretion
- **urethral meatus**: external opening lined by **stratified squamous epithelium** continuous with skin of glans



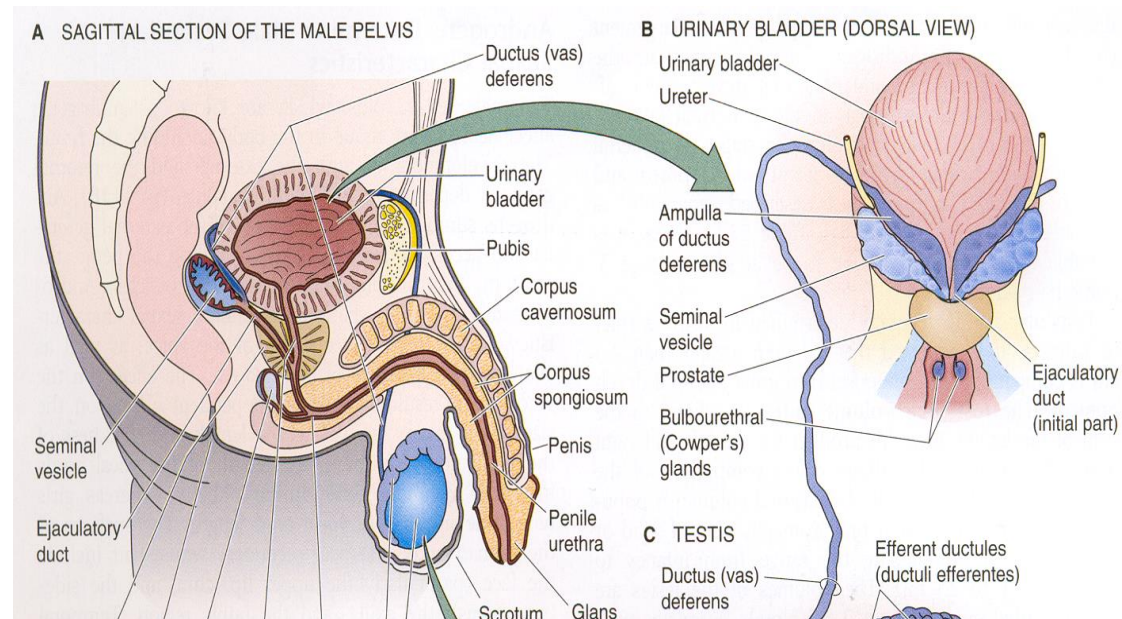
Accessory glands

- Seminal vesicles (glandulae vesiculares or vesicular glands)
- Prostate (body and disseminate portions)
- Cowper's (bulbo-urethral) gland



Seminal vesicle

- glandular diverticulum of ductus deferens; secrete more than half volume seminal fluid; honeycombed appearance; produce yellowish viscid alkaline fluid containing fructose, fibrinogen, vitamin C and prostaglandins; innervated by sympathetic nervous system



- bilobed gland; lobes separated by thick **central stroma** also containing bladder neck and **prostatic urethra**, **ejaculatory ducts**, **urethral sinuses** & **urethral crest**; separated by **septa** into 50 or so poorly defined **lobules**; thin, milky secretory product rich in citric acid and hydrolytic enzymes: fibrinolysin

Prostate gland

