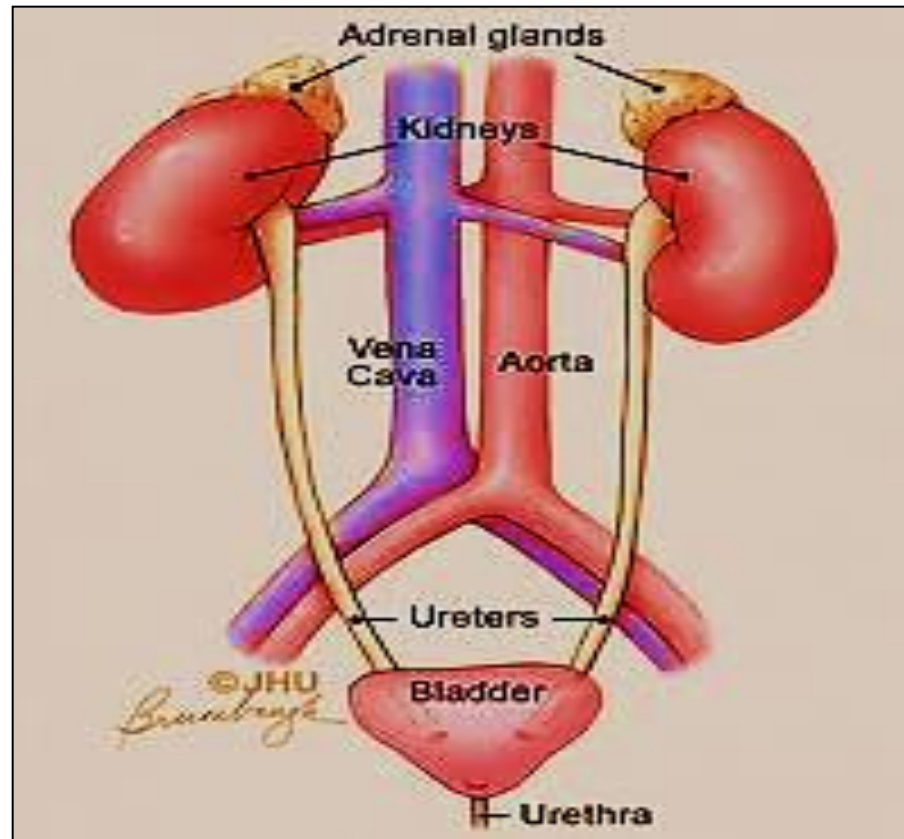


The Urinary System



:The urinary system consists of

kidneys (Filtrate blood) 2

ureters 2

Urinary bladder

Urethra

:Function

Removing waste & water from body

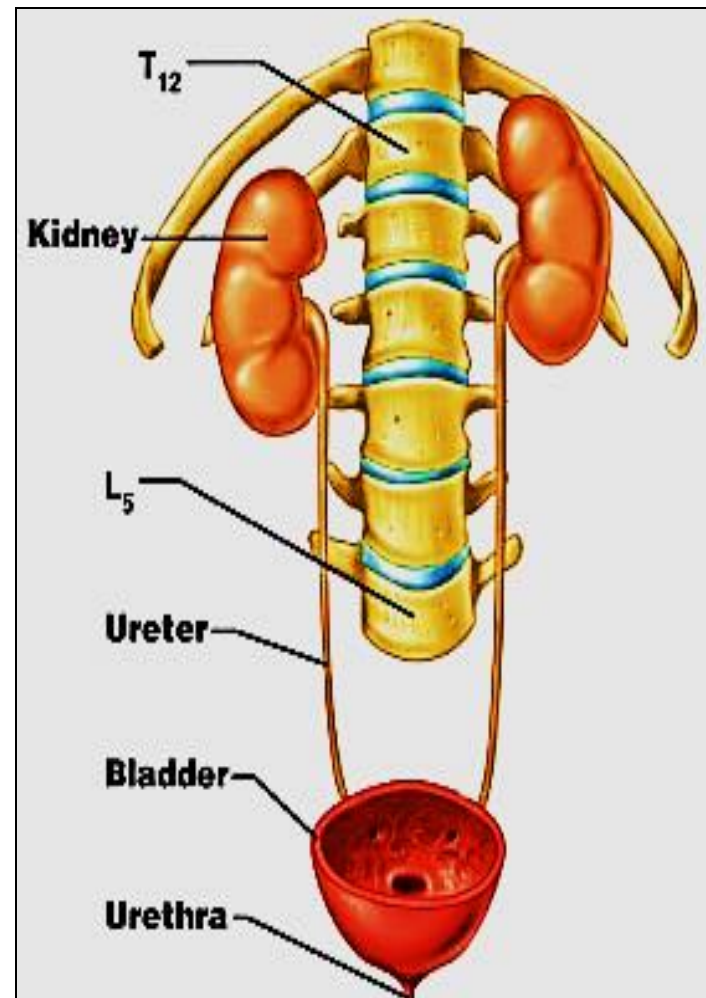
Reabsorption of vital nutrients

Maintain acid /base balance

Help in control blood pressure

Help in produce red blood cells (EPO Hormone)

Produce Calcitriol (Vit. D) regulate Ca^+ → healthy bones



Kidneys

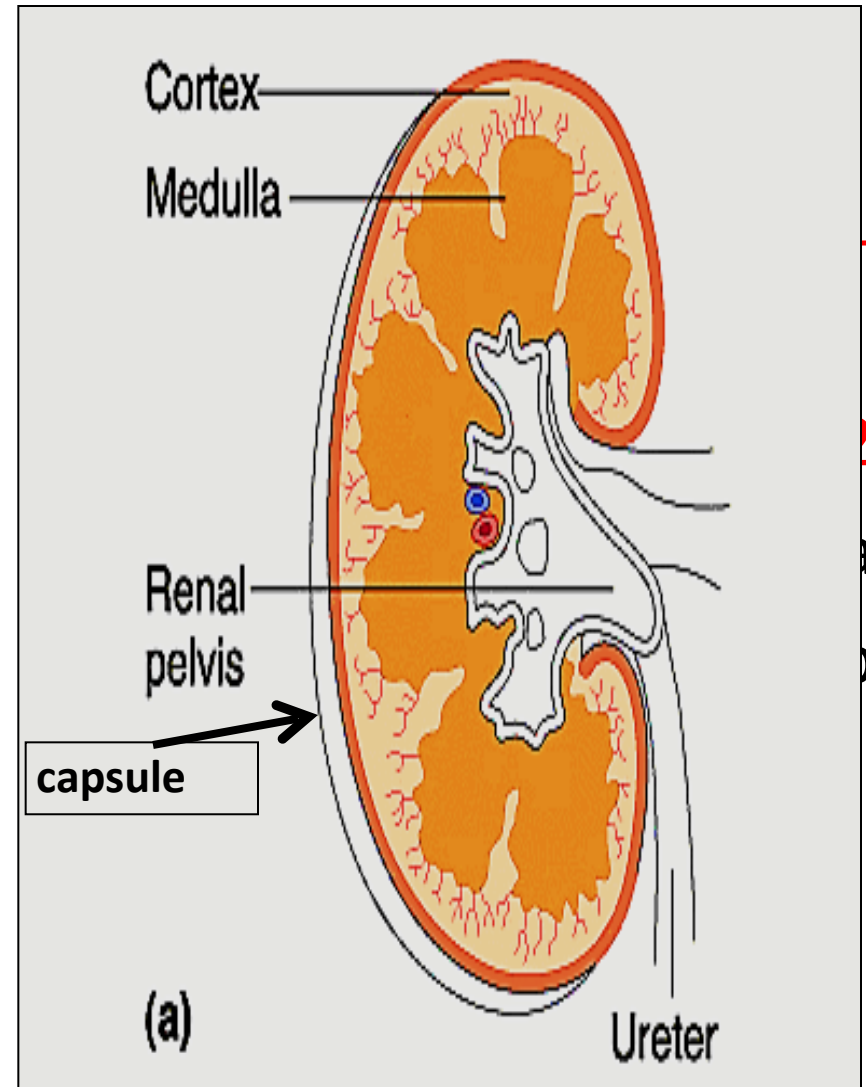
:structure of the Kidney

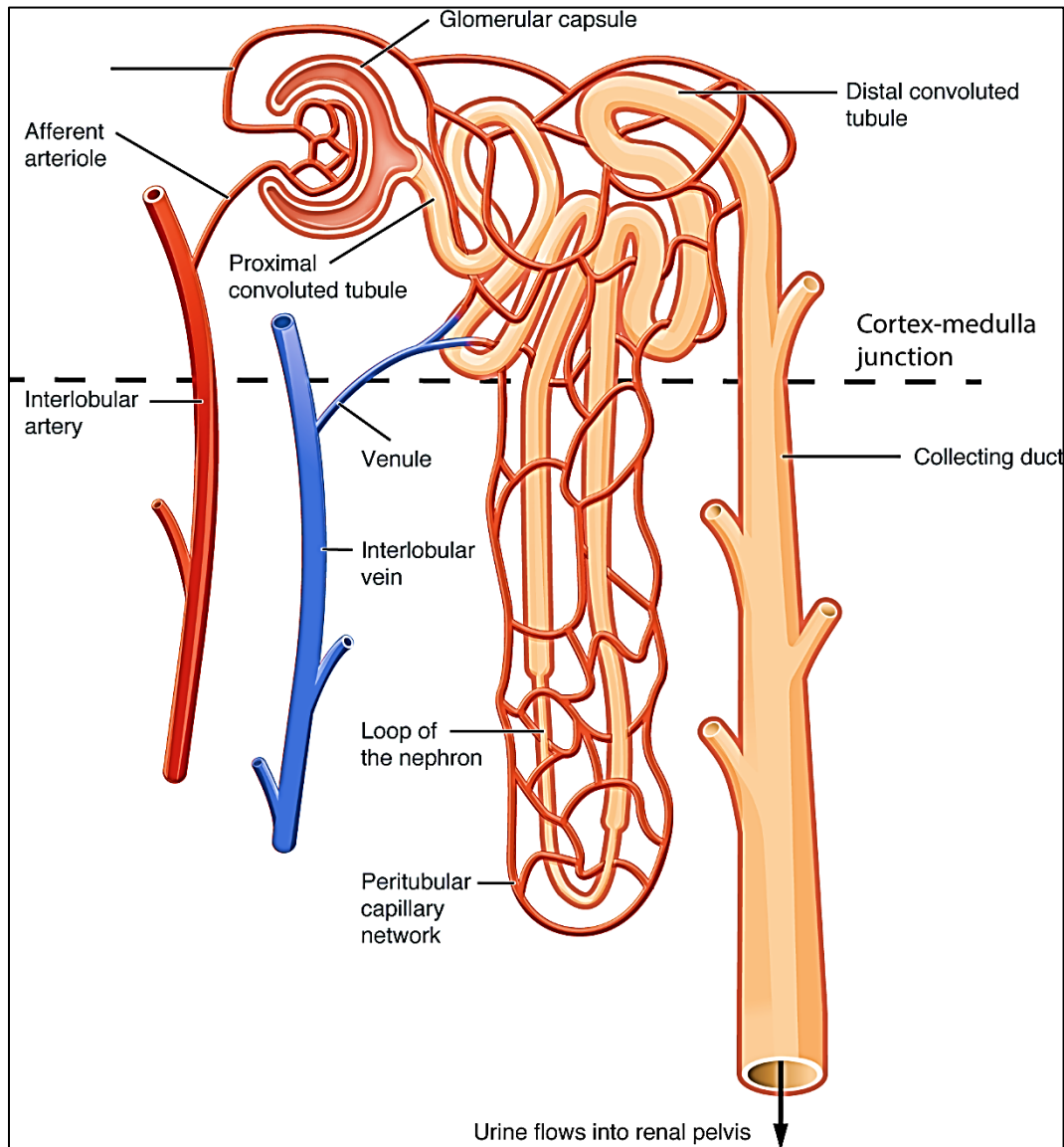
Stroma : capsule

:Parenchyma

Cortex (outer part)

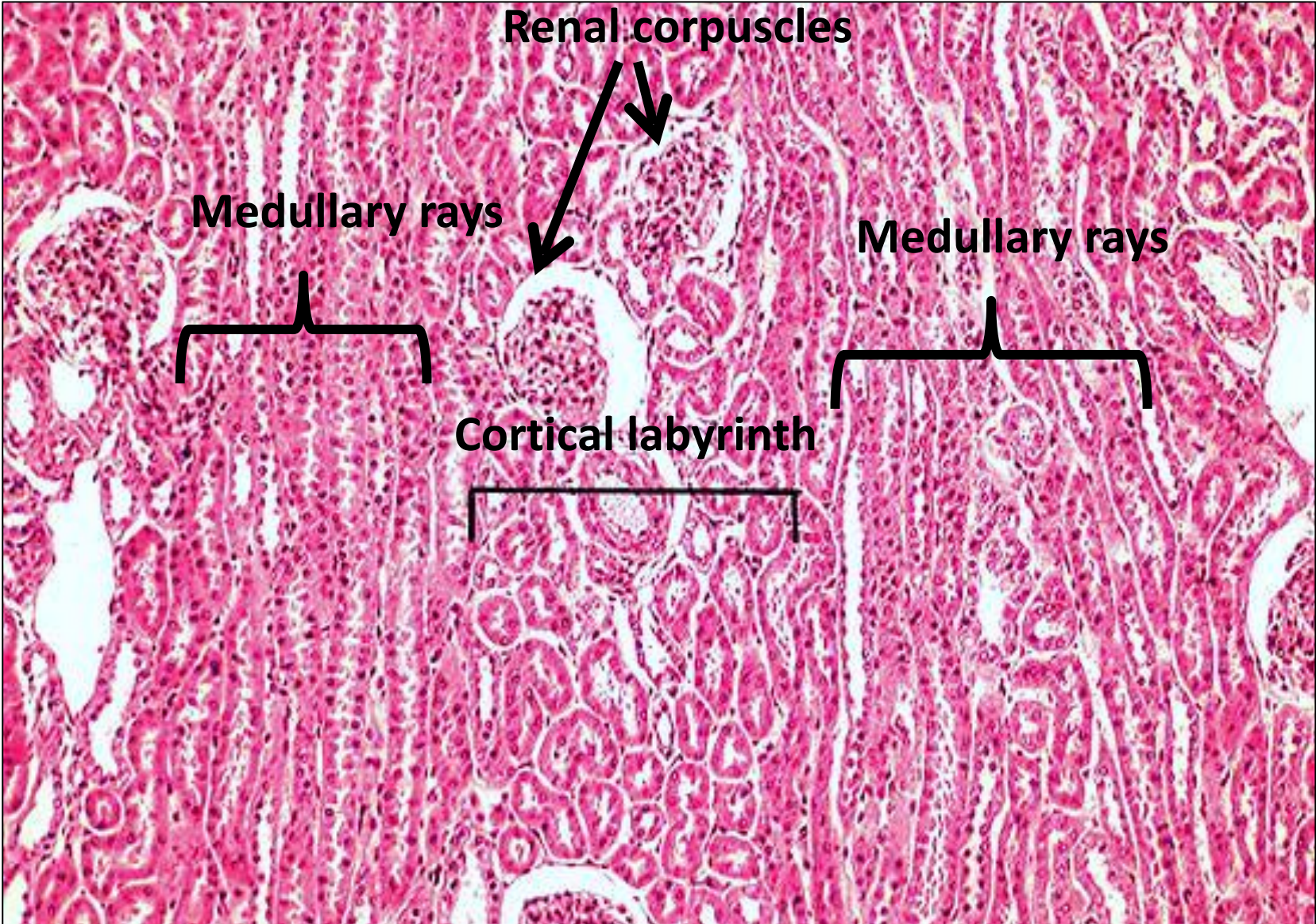
Medulla (inner part)





Nephron

is the microscopic structural and functional unit of the kidney that perform filtration of blood



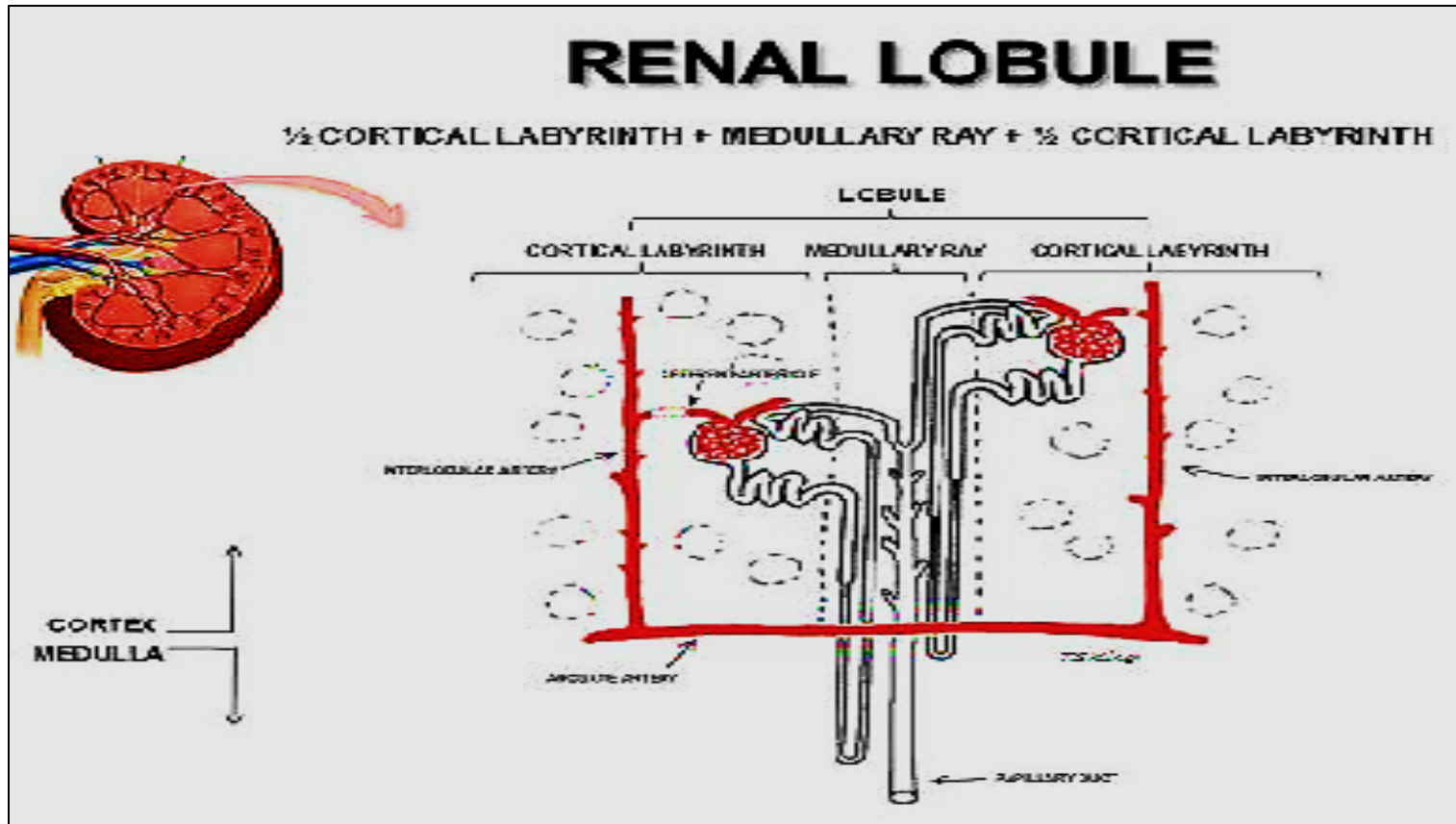
Cortex: contains

Cortical labyrinth + medullary rays + renal columns

Cortical labyrinth: contains renal corpuscles and
.convoluted tubules

Medullary rays: are regions where parallel arrays of
straight portions of **loop of Henle's + collecting ducts**
travel perpendicular with the capsule (extend from the
.cortex to the medulla)

Bands of cortical labyrinths separate the medullary
rays. Each medullary ray with 1/2 of the adjacent
.cortical labyrinth on either side is a **lobule**



Renal lobule defined within **cortex**

.The tissue between 2 interlobular arteries is defined as lobule

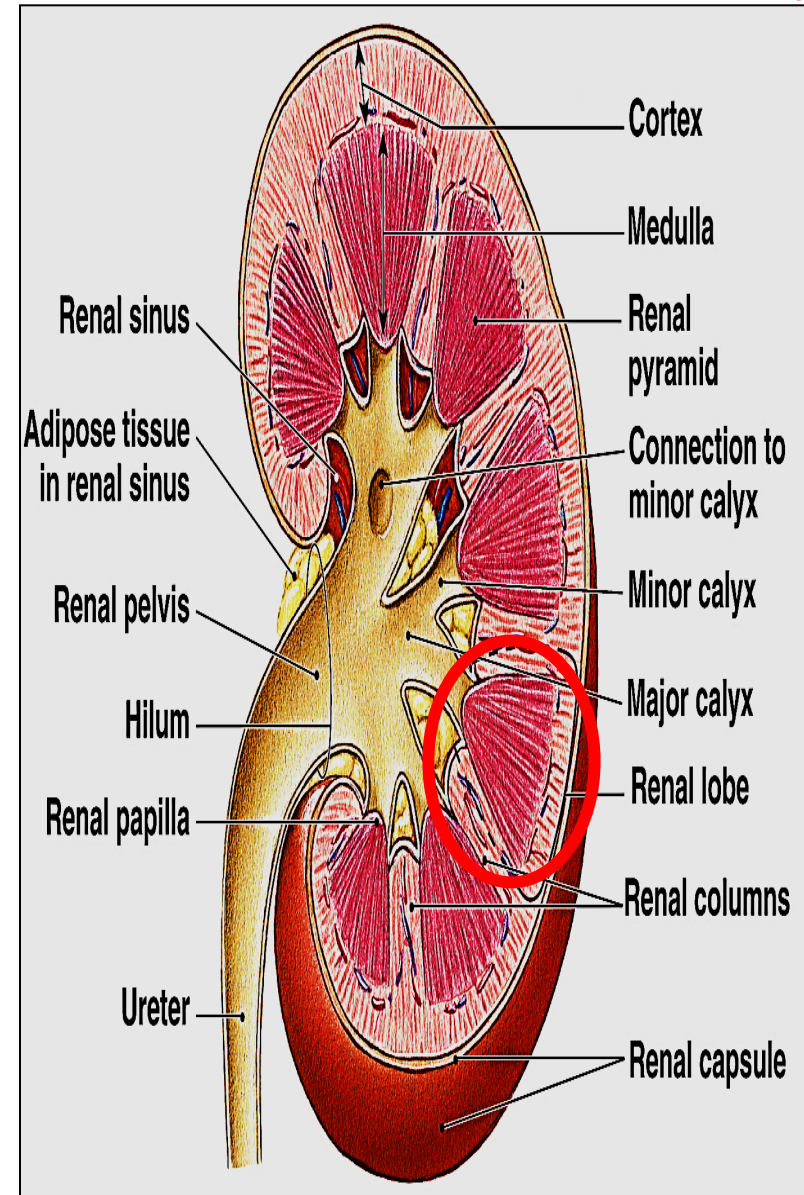
.Interlobular arteries bisect Labyrinth

Thus a lobule consists of ½ of labyrinth on one side of medullary ray & ½ of labyrinth on the other side . Nephrons of that lobule drain in a single collecting duct

The medulla : consists of 8- 15 conical structures called **renal pyramids**

The renal pyramids separated by cortical C.T. extensions called **renal columns (Bertin columns)** contain BV & renal tubules

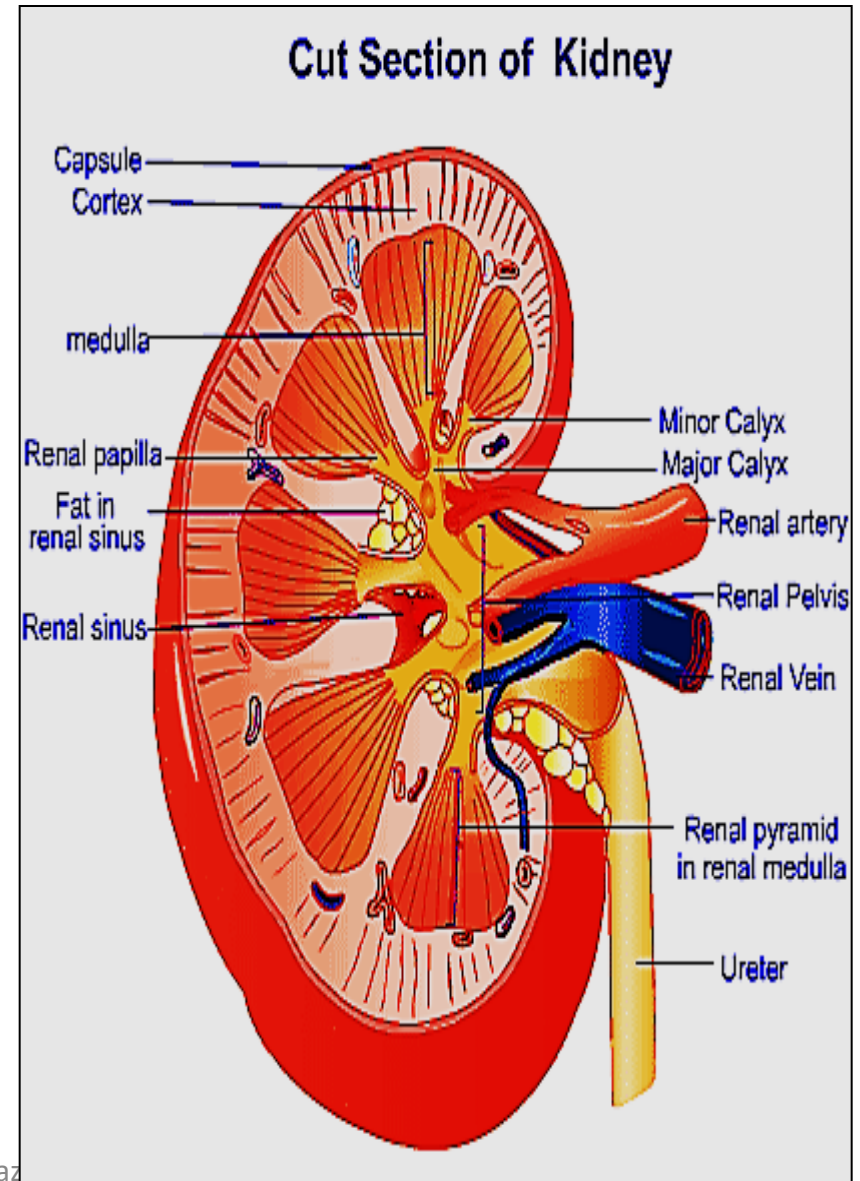
+ Each medullary pyramid & the cortical tissue at its base along its sides form a **renal lobe**



The apex of each pyramid is called **renal papillae** •

The renal papillae projects into a **minor calyx**

minor calyces join to 3-4 form a **major calyx**, which empty into **renal pelvis**





URINARY SYSTEM



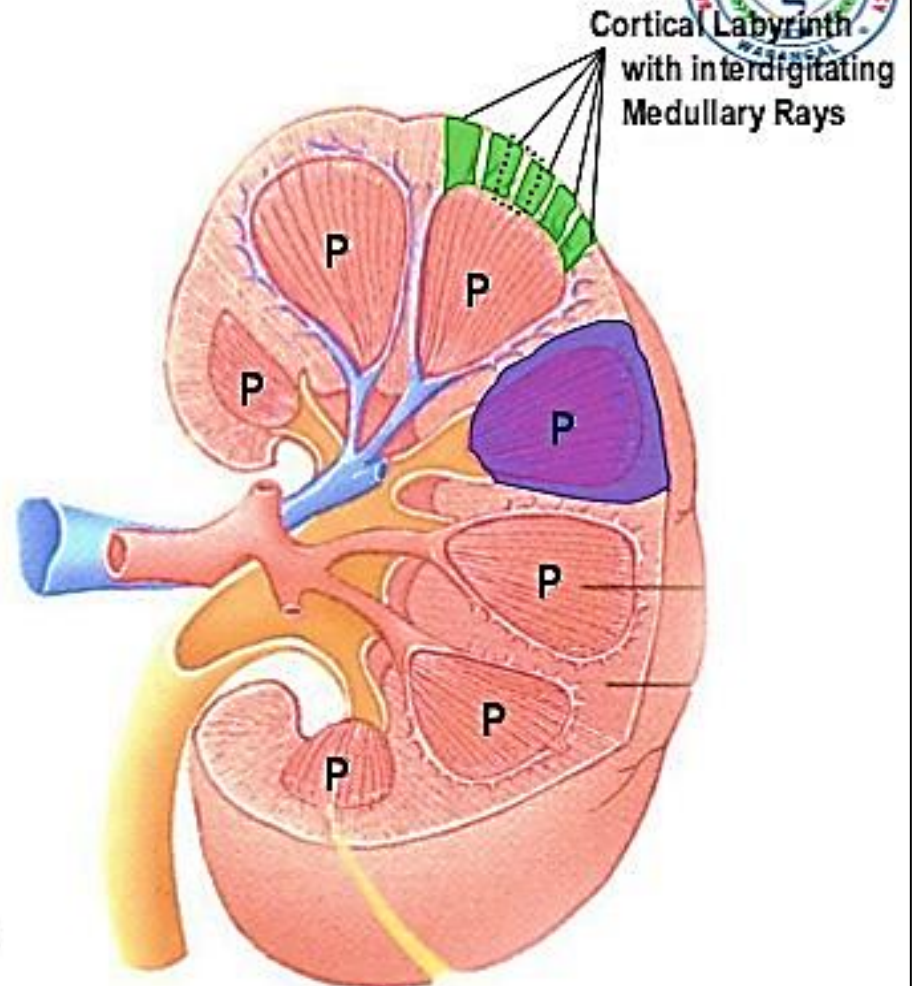
● KIDNEY (ORGANIZATION)

RENAL LOBE

- a single pyramid with its associated overlying cortex

RENAL LOBULE

- defined within cortex and involves a single medullary ray (central axis of lobule) with adjacent adjacent cortical labyrinth
- defined as a functional unit that consists of a collecting duct and all the nephrons that it drains



sudheerkumar kamarapu

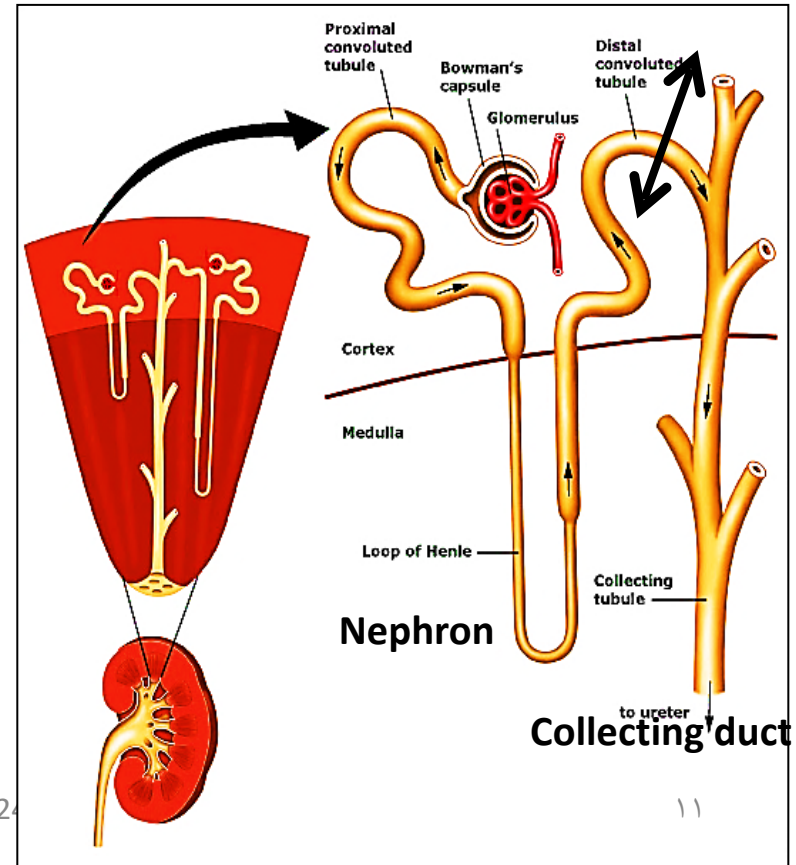
17

The uriniferous tubule

Consists of 2 parts: nephron + collecting duct

Nephron : the structural & functional unit of the -1 kidney that filter blood → which **produce urine**

Collecting duct: concentrate -2 carries urine → to minor calyx &



A- The nephron

Each kidney contains 1- 1.4 million nephrons

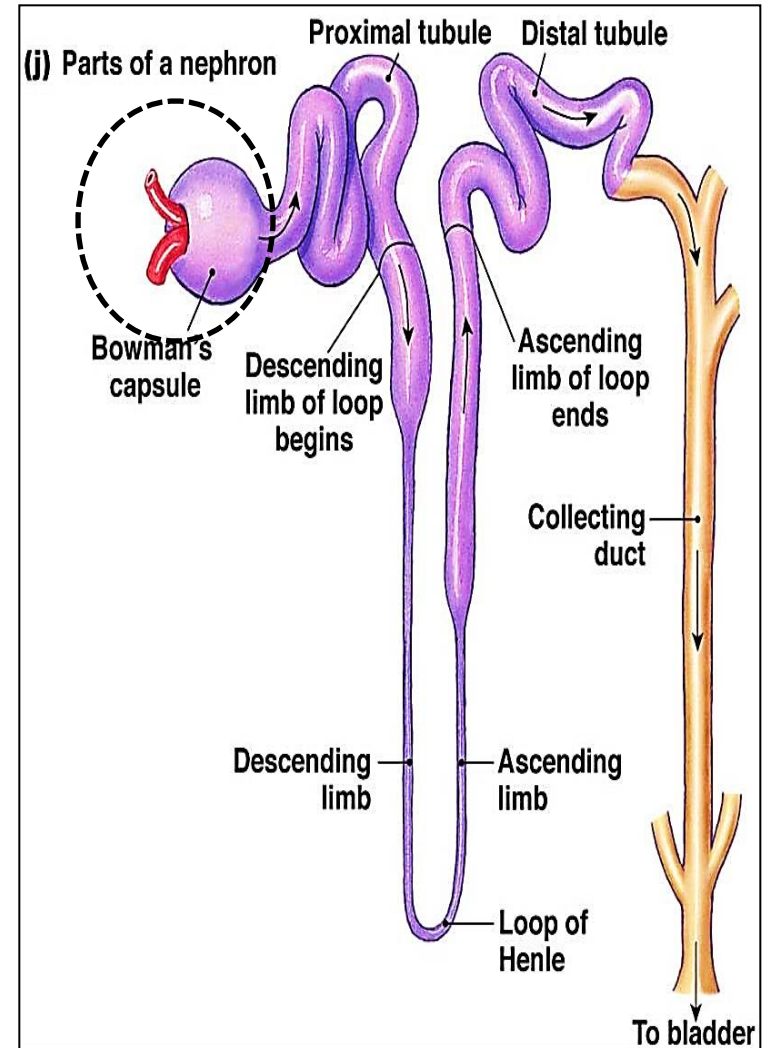
:Each nephron consists of

Renal (malpighian) corpuscle -1

Proximal convoluted tubule (PCT) -2

Loop of Henle -3

Distal convoluted tubule (DCT) -4

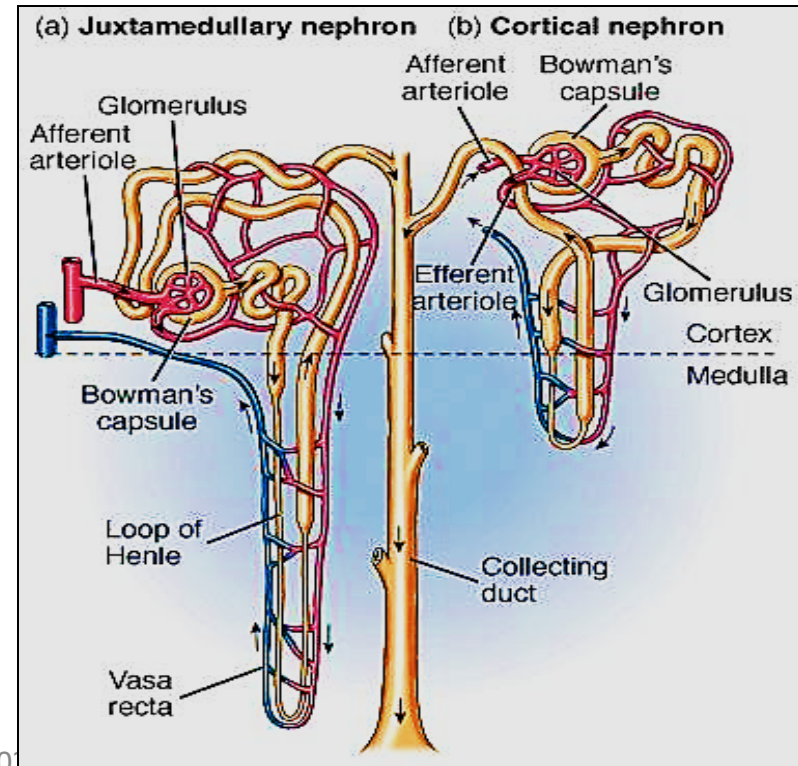


:Classification of nephrons

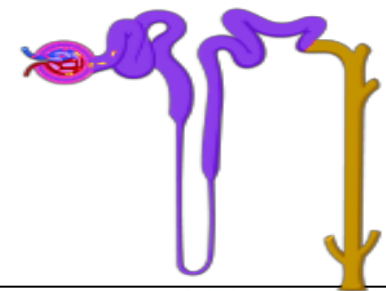
Cortical nephrons: 85%, short loop of Henle, extend close to cortico-medullary junction ➤

Juxta-medullary nephron: has long Loop of Henle, extend deep in the medulla ➤

They are responsible for setting up medullary osmotic gradient production of concentrated → hypertonic urine



Renal (Malpighian) corpuscle



Renal corpuscle is where blood filtration occurs

:it has 2 parts

urinary & vascular parts

Bowman's capsule - 1

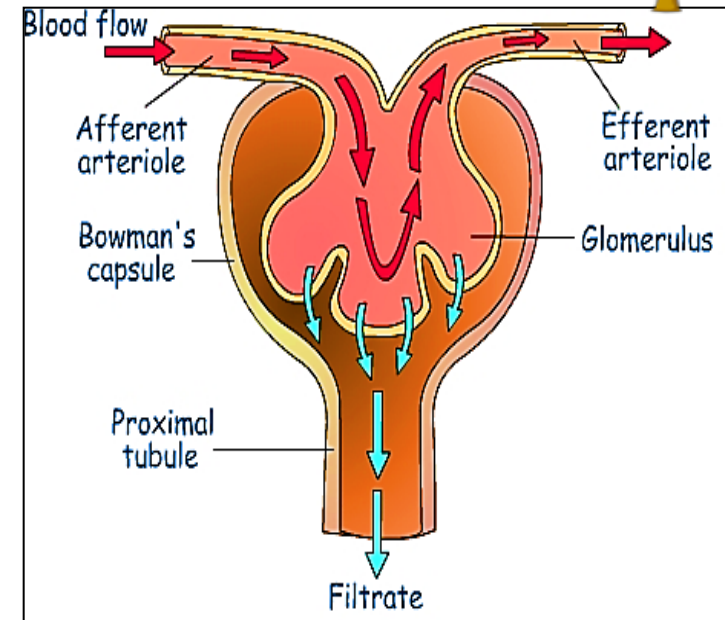
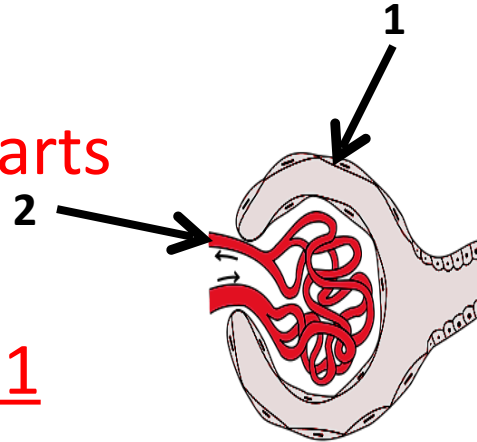
:*Double walled chamber has*

Inner/ visceral layer (podocytes)

Outer /parietal layer (simple squamous epithelium)

: Glomerulus -2

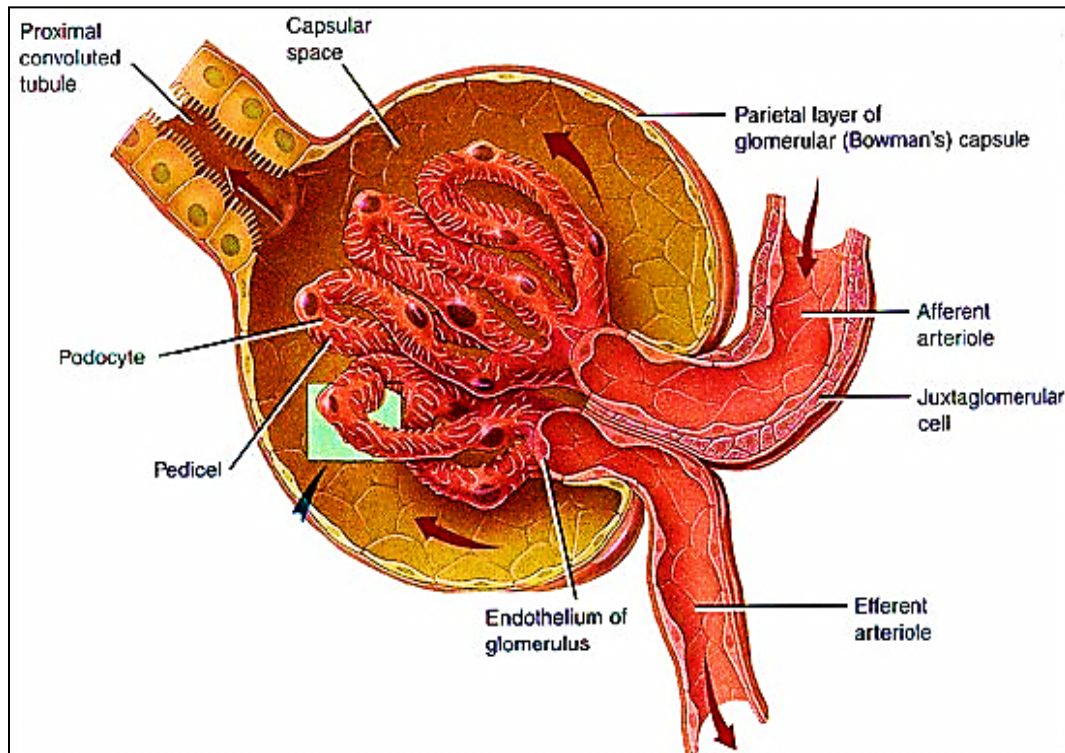
Tuft of capillaries, inside the capsule, supplied by afferent arteriole & drained by efferent arteriole



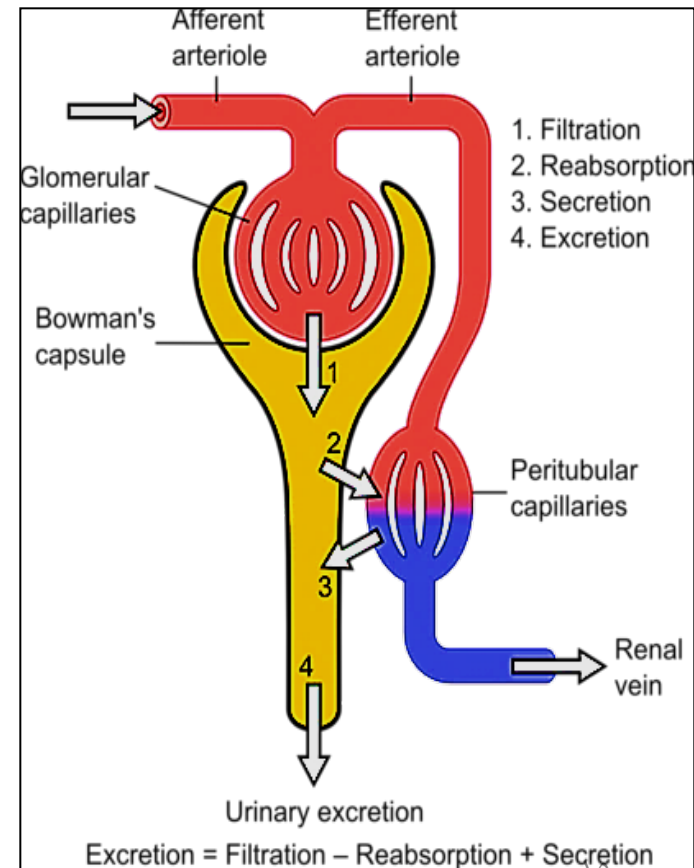
Glomerulus

The prefiltered blood enter the glomerulus through afferent a & .filtered blood exit through efferent a

The afferent arteriole has **a thicker media**, and **larger diameter** than the efferent one to create a high glomerular pressure → large quantities of filtrate

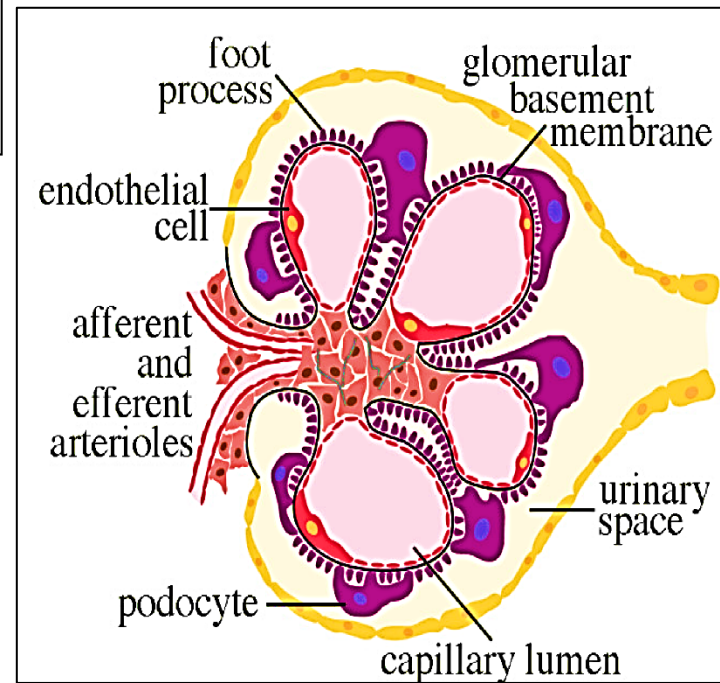
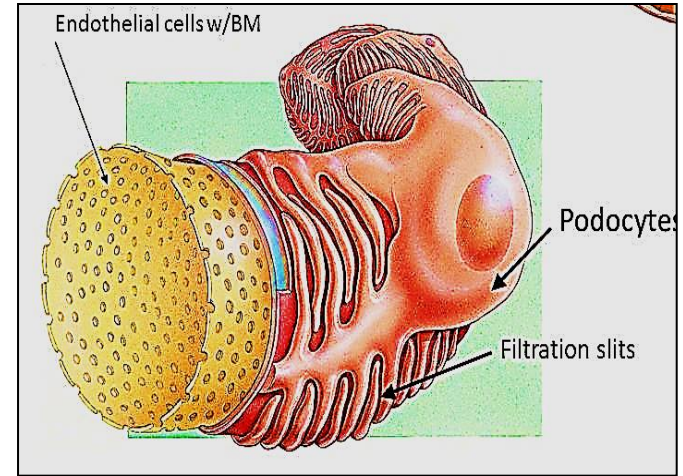


Prof Dr. Hala El-mazar 2024



The wall of the glomerular capillaries is lined with fenestrated endothelial cells (70 – 100 nm), restrict the passage of blood cells & proteins with continuous basement membrane formed of type IV collagen (-ve charged) which repel portions (-ve charged) from escaping through (if Abs attack BM cause damage → **glomerulonephritis**)

Bowman's capsule visceral layer is lined with special cells called **Podocytes**
Outer layer lined e simple squamous epithelium



Podocytes

They are flattened cells with several primary processes

Each 1ry process send numerous

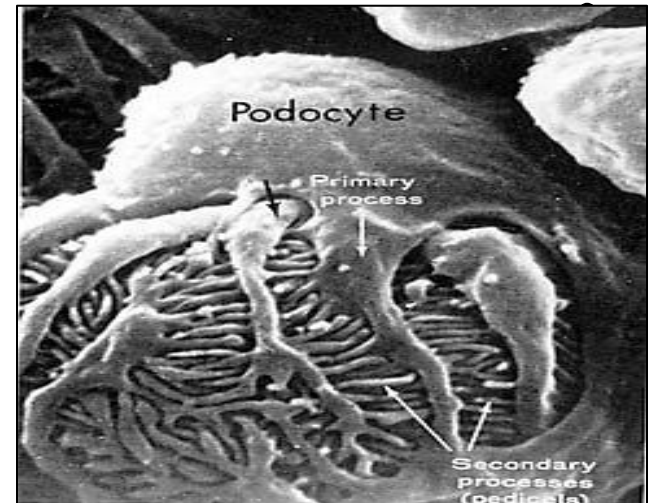
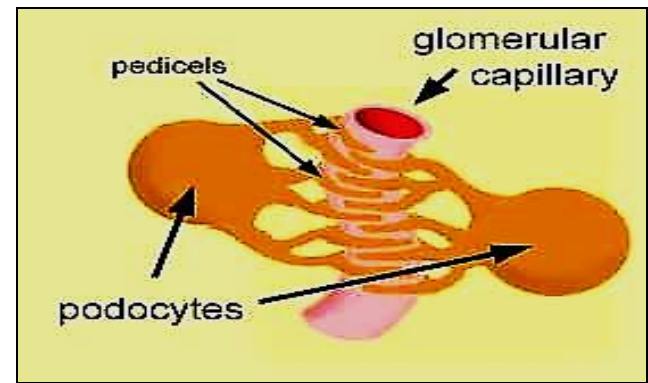
2ry process (**pedicles**)

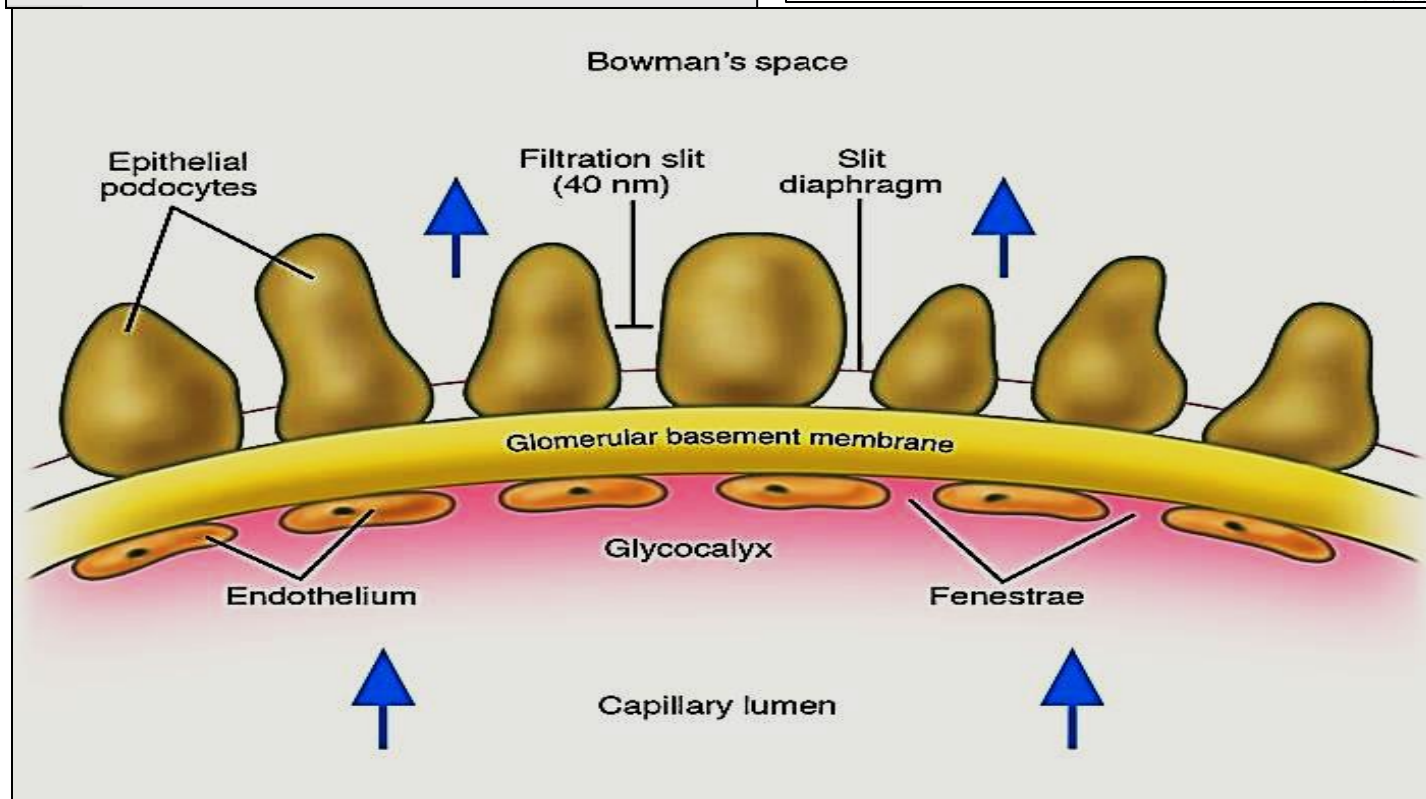
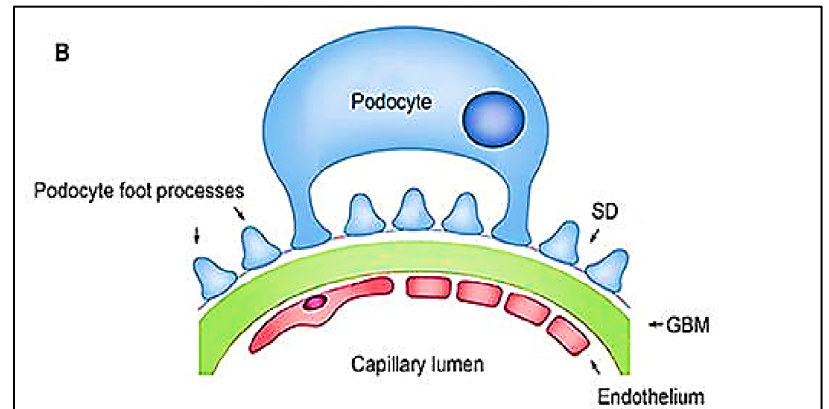
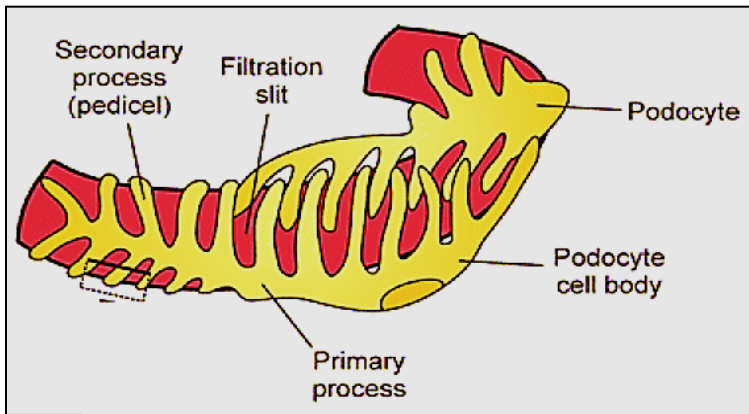
Encircle the underlying bl. capillary

2ry process interdigitate with each other

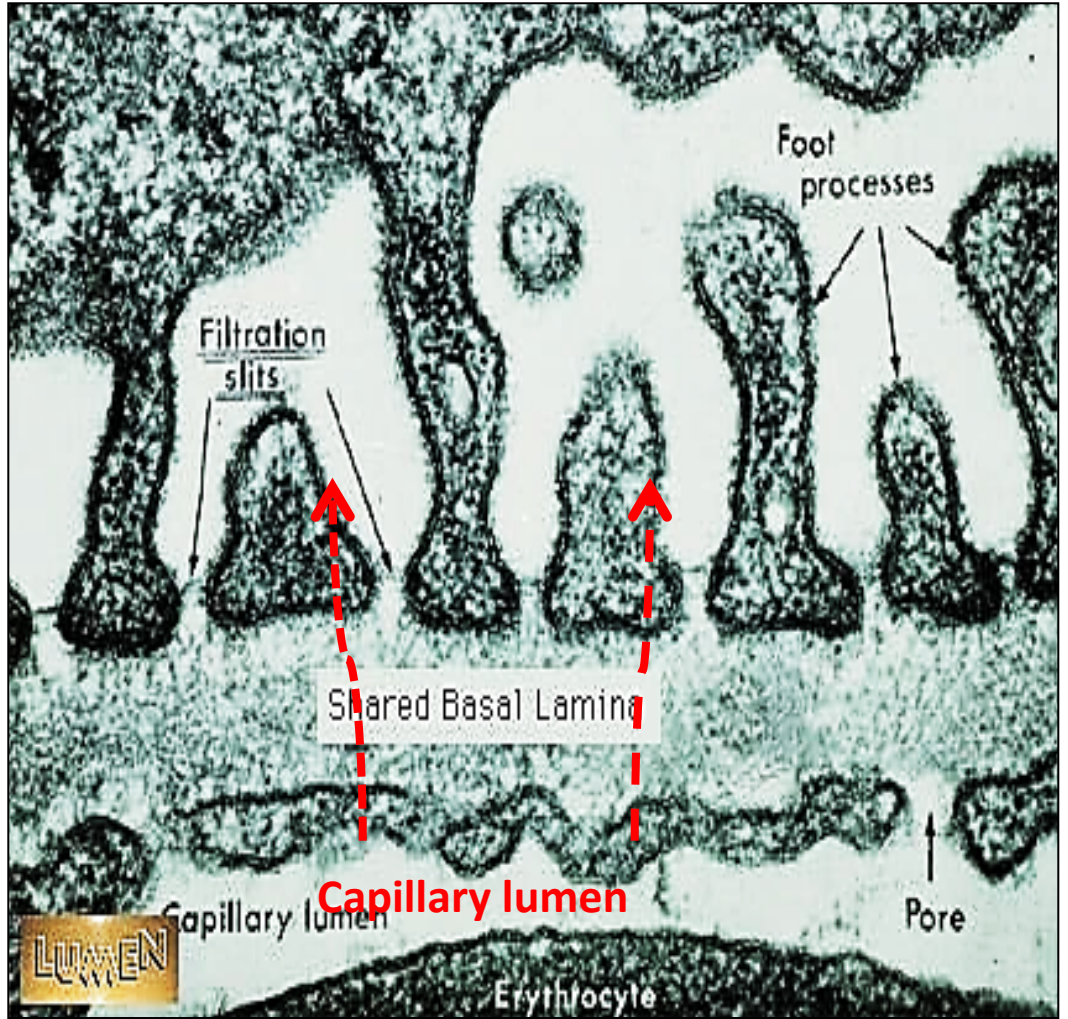
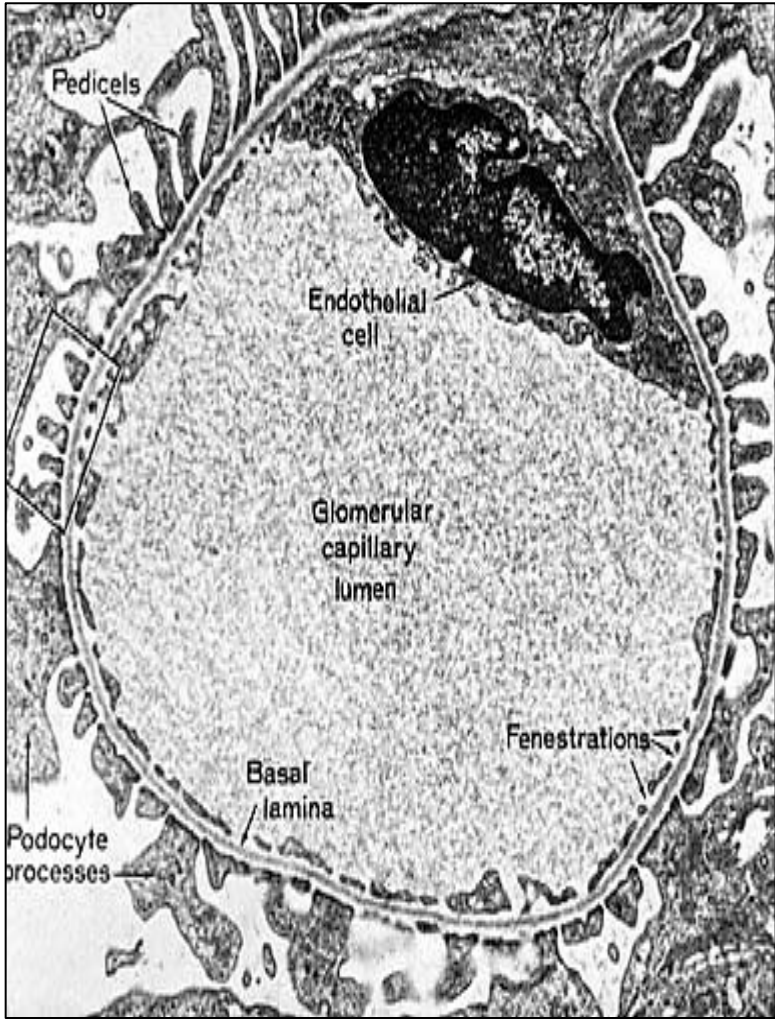
Forming minute spaces in-between called **filtration slits** •
closed by semipermeable **diaphragm (10- 40 nm)**

they comprise the main filtration barrier in the •
glomerulus they also express vit D receptors

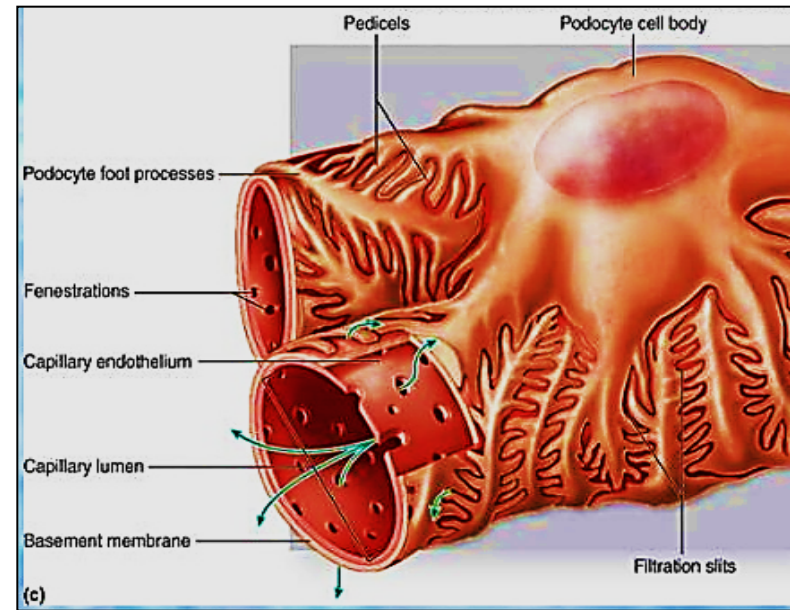




Filtration slits & slit diaphragm

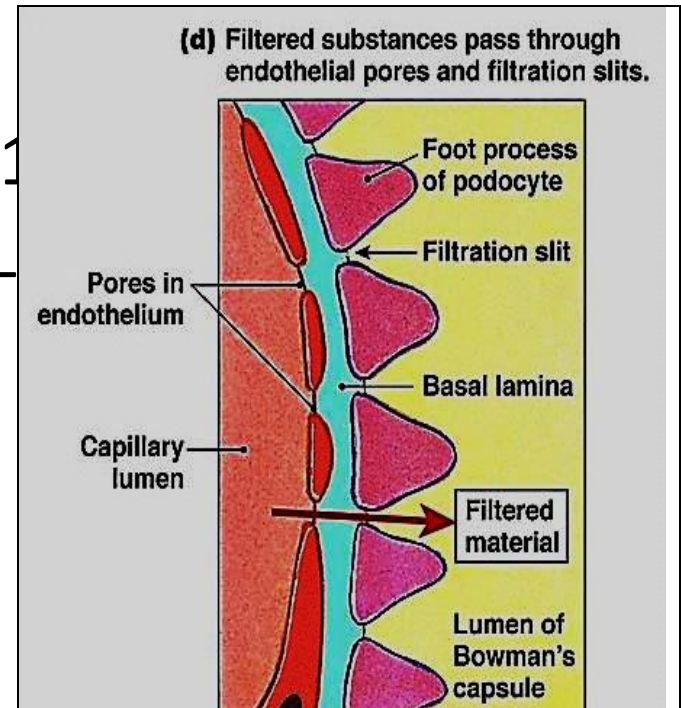


The cytoplasm of Podocytes
,contains ↑free ribosomes, rER
Mitochondria , Golgi, **actin**
.microfilaments (contractility)



:Function of podocyte

formation of blood renal barrier -1
Renewal of glomerular basement
membrane (GBM)



Blood Renal Barrier

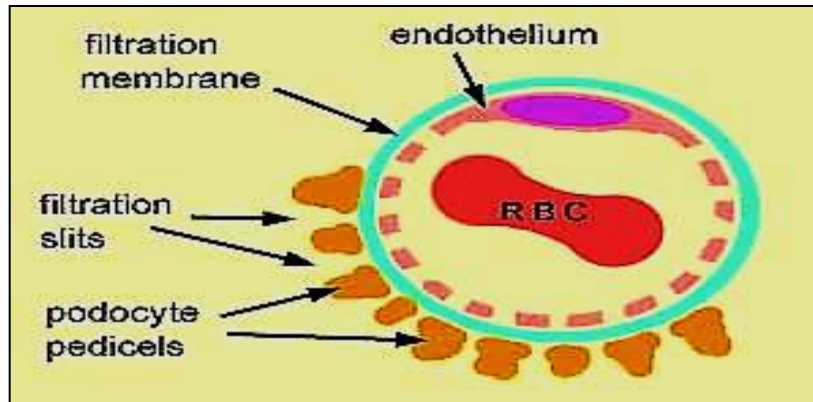
Barrier that separate blood inside glomerular capillaries from glomerular filtrate inside Bowman's space & through which filtration of blood occur

:Formed of 3 layers

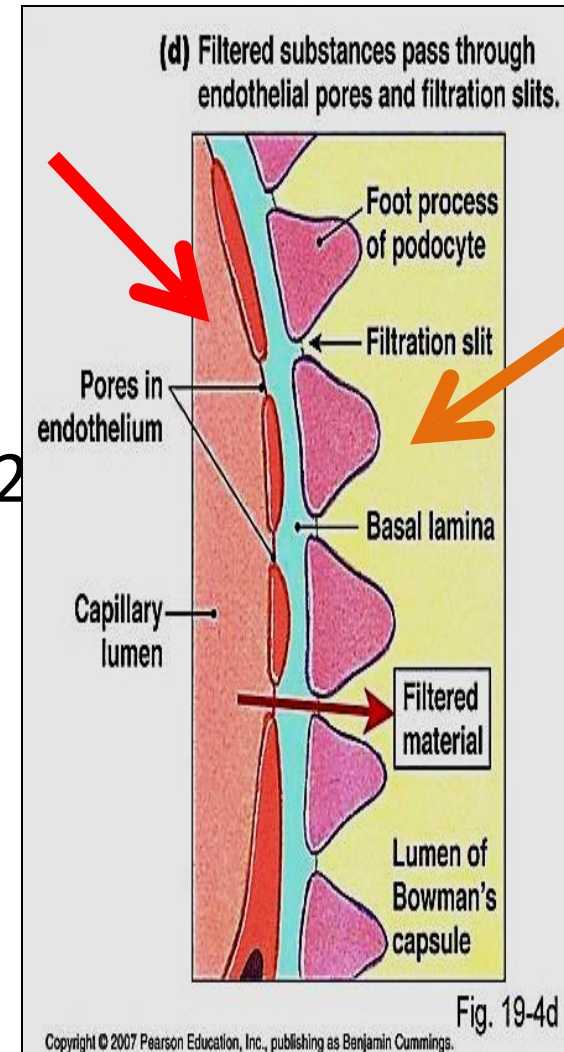
Glomerular endothelium (fenestrated) -1

Basement m. (continuous & -ve charged) -2

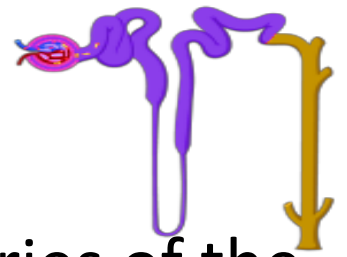
Filtration slit diaphragms -3



024



Mesangial cells



Specialized cells found around glomerular capillaries of the kidney

:They are 2 types

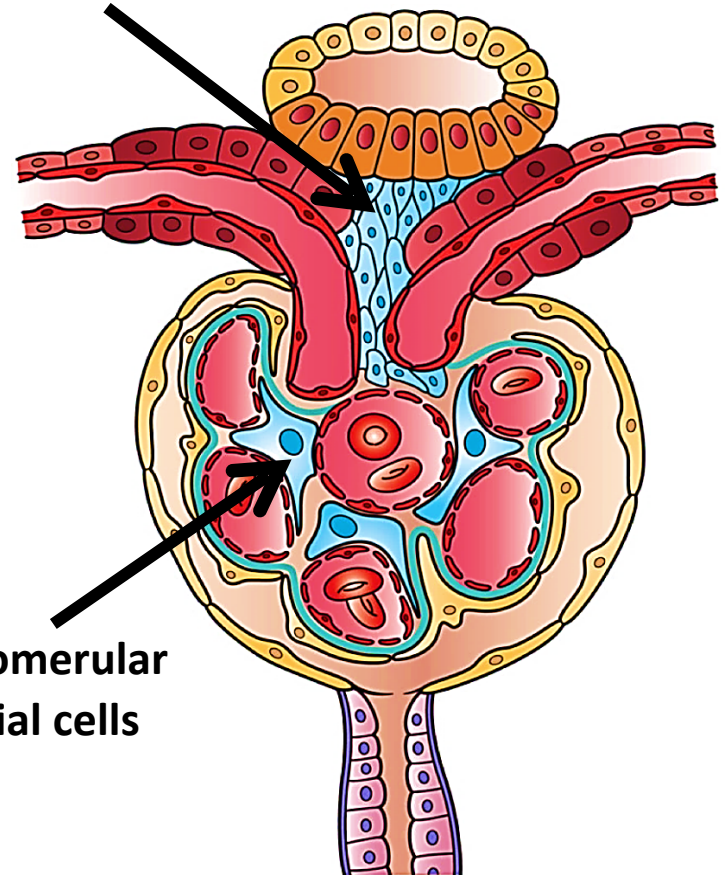
: Intra -glomerular -1

located along glomerular capillaries within renal corpuscle

: Extra-glomerular (Lacis cells) -2

located at the vascular pole

Extra-glomerular mesangial cells



Intra-glomerular mesangial cells

:Intra-glomerular mesangial cells

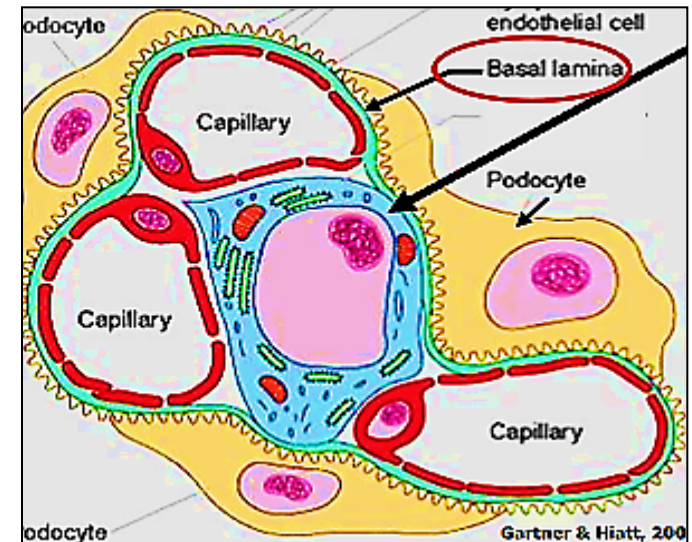
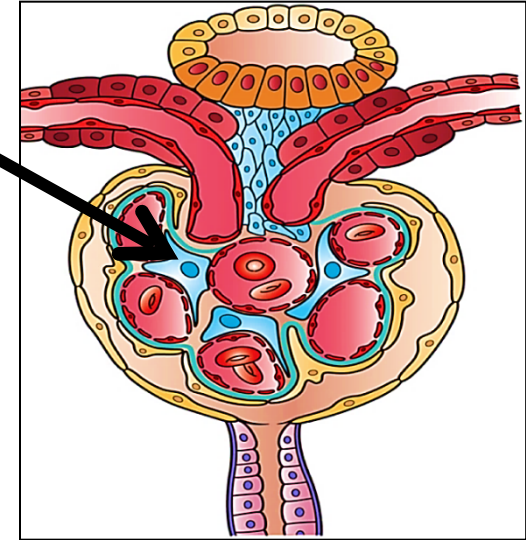
Specialized **pericytes** located between the endothelial cells & the basement membrane of glomerular capillaries form **mesangium**

:Function

Filtration: regulate bl. flow of glomerular -1
→ capillaries by their contractile activity
control GFR

Structural support to glomerulus -2

Phagocytosis & renewal of BM -3

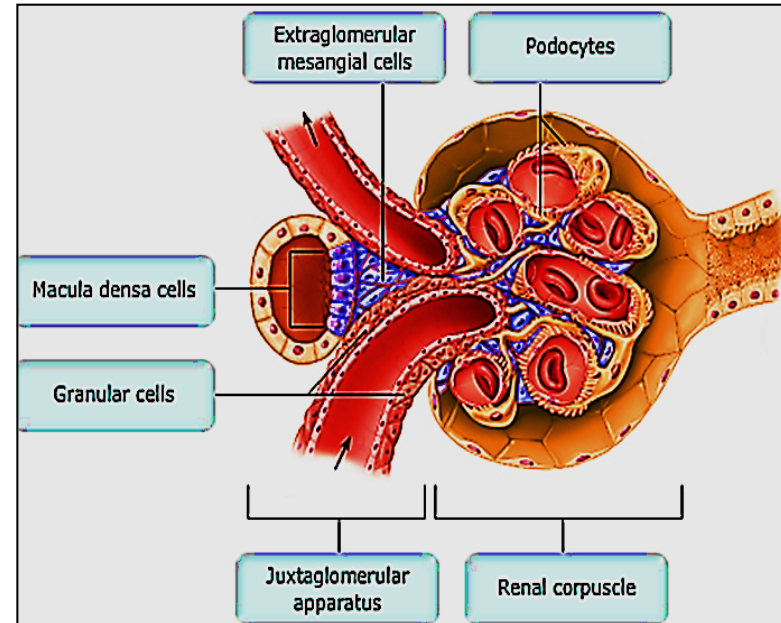


:Extra-glomerular mesangial cells (Lacis cells)

Specialized **smooth ms cells** found outside the glomerulus
, at the vascular end

:Function

Role in regulation of bl flow to -1
kidney & systemic bl. pressure via
Renin-Angiotensin-Aldosterone
system



Part of **Juxta-glomerular apparatus**, together with -2
macula densa & granular cells

.may play role in secretion of erythropoietin Hormone -3

Juxtaglomerular apparatus

Located at the vascular end of renal corpuscle

:Consists of 3 components

Macula densa -1

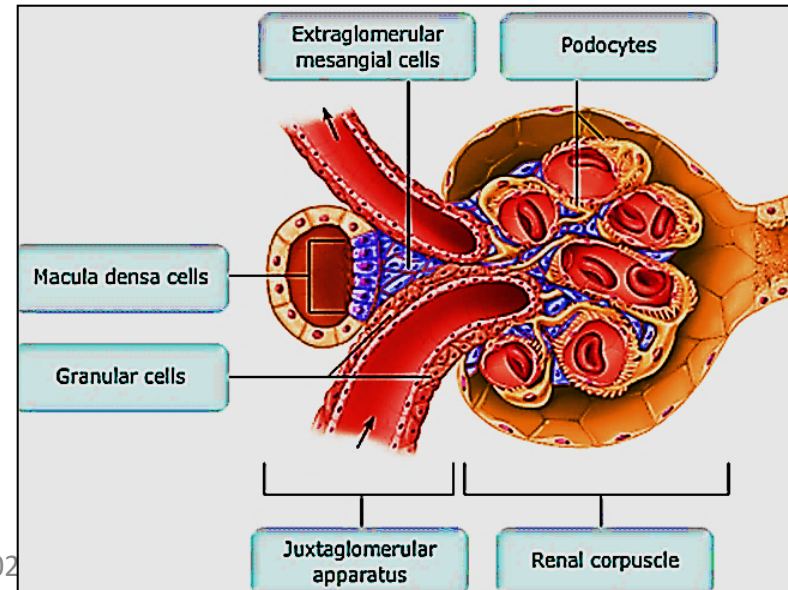
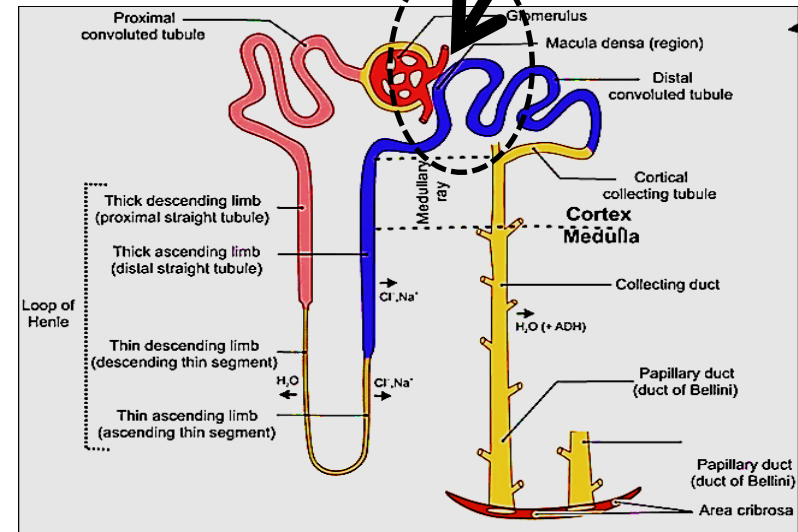
(.lining of distal convoluted T)

Granular (juxtaglomerular) cells -2

(wall of afferent arteriole)

Lacis cells -3

(Extra-glomerular mesangial cells)



:Macula densa (Nacl) -1

The part of DCT that fits between the aff. & eff. Arterioles .1

Cells ↑ in length → become columnar

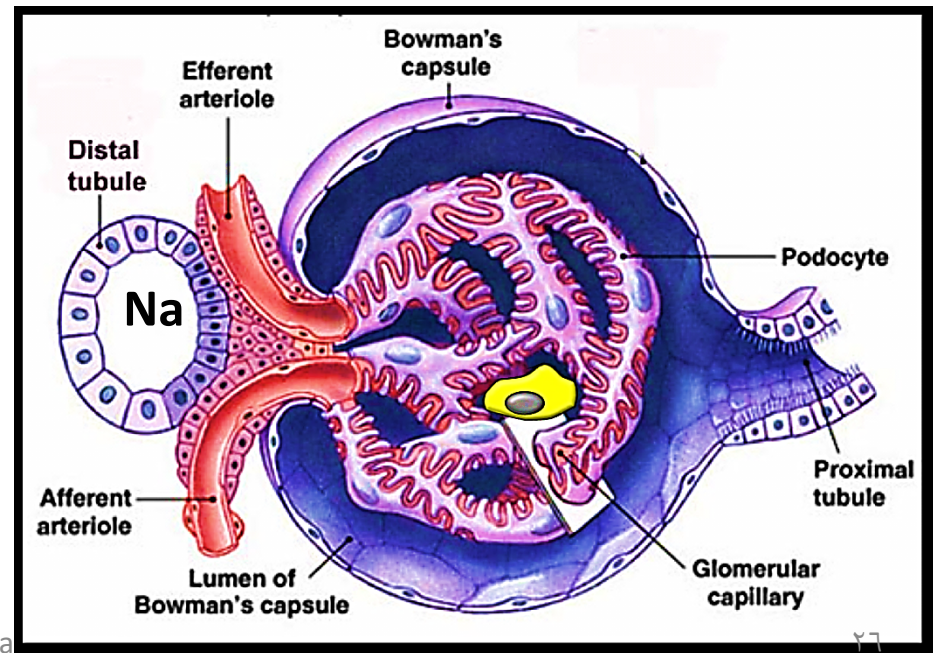
The nuclei of cells become **apical**, deeply stained & closely packed appear as dark spots .2

Golgi complex is **infra-nuclear** (basal) .3

Basement membrane is lost, so these cells are in contact with granular cells .4

:Function

Act as osmoreceptors that monitor the level of Na^+ ions of the filtrate in the lumen of DCT



:Juxtaglomerular cells (granular) cells -2

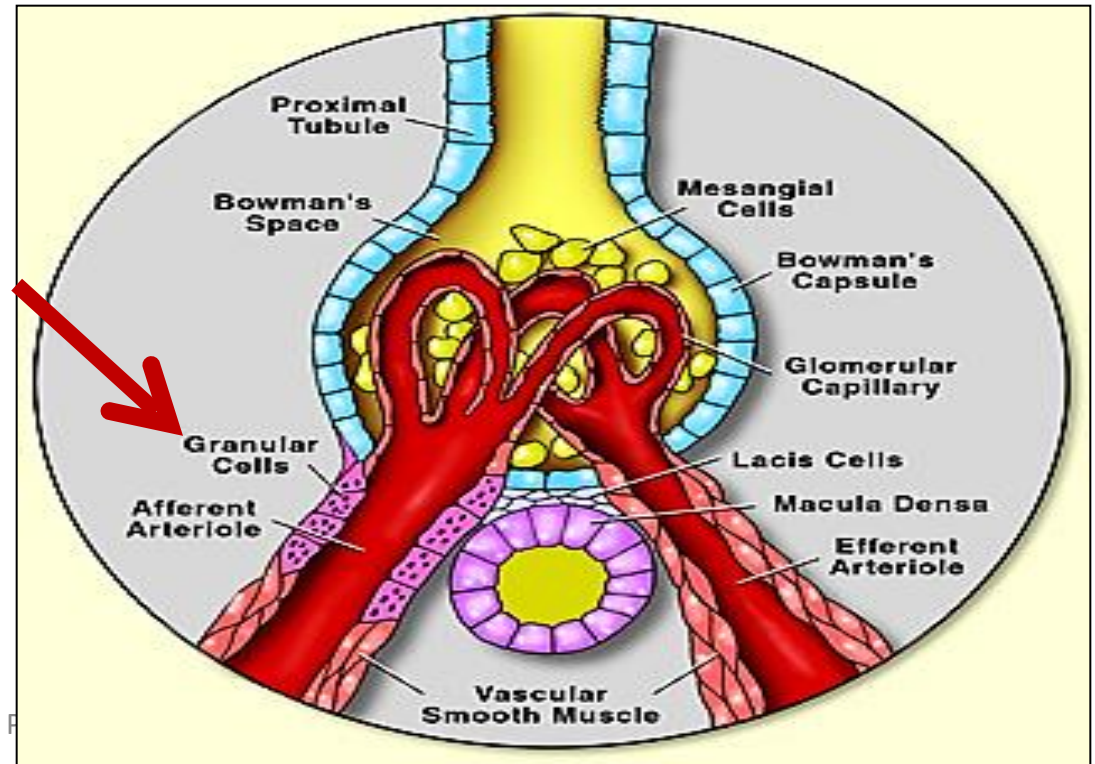
Modified smooth muscle cells present in the tunica media •
of the afferent arteriole

Nuclei of cells become rounded instead of being elongated •

Cytoplasm contain secretory granules contain **Renin H** •

:Function

Secrete **Renin H**



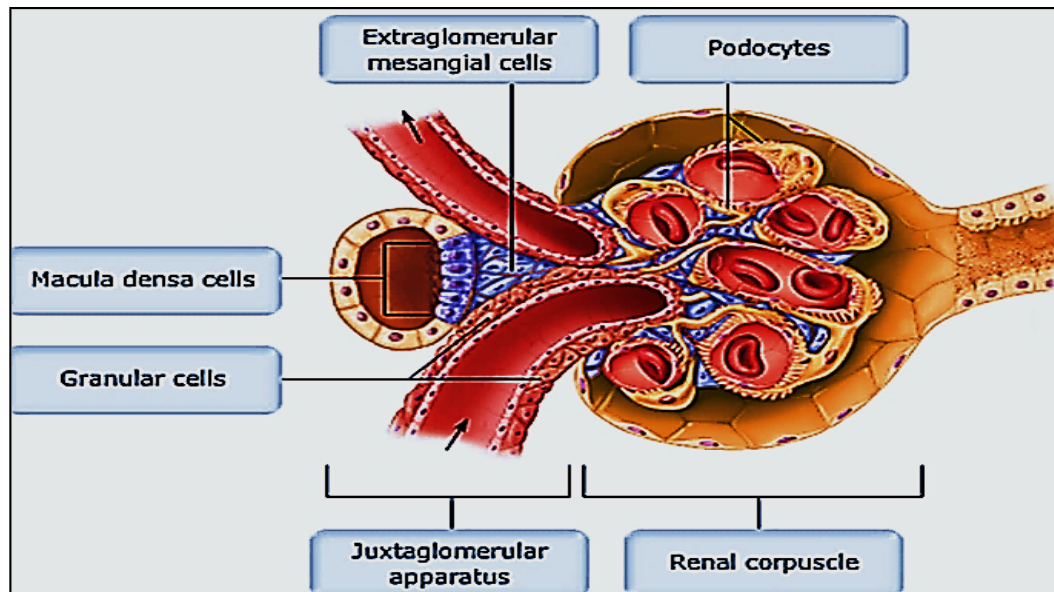
:Extraglomerular mesangial cells (Lacis cells) -3

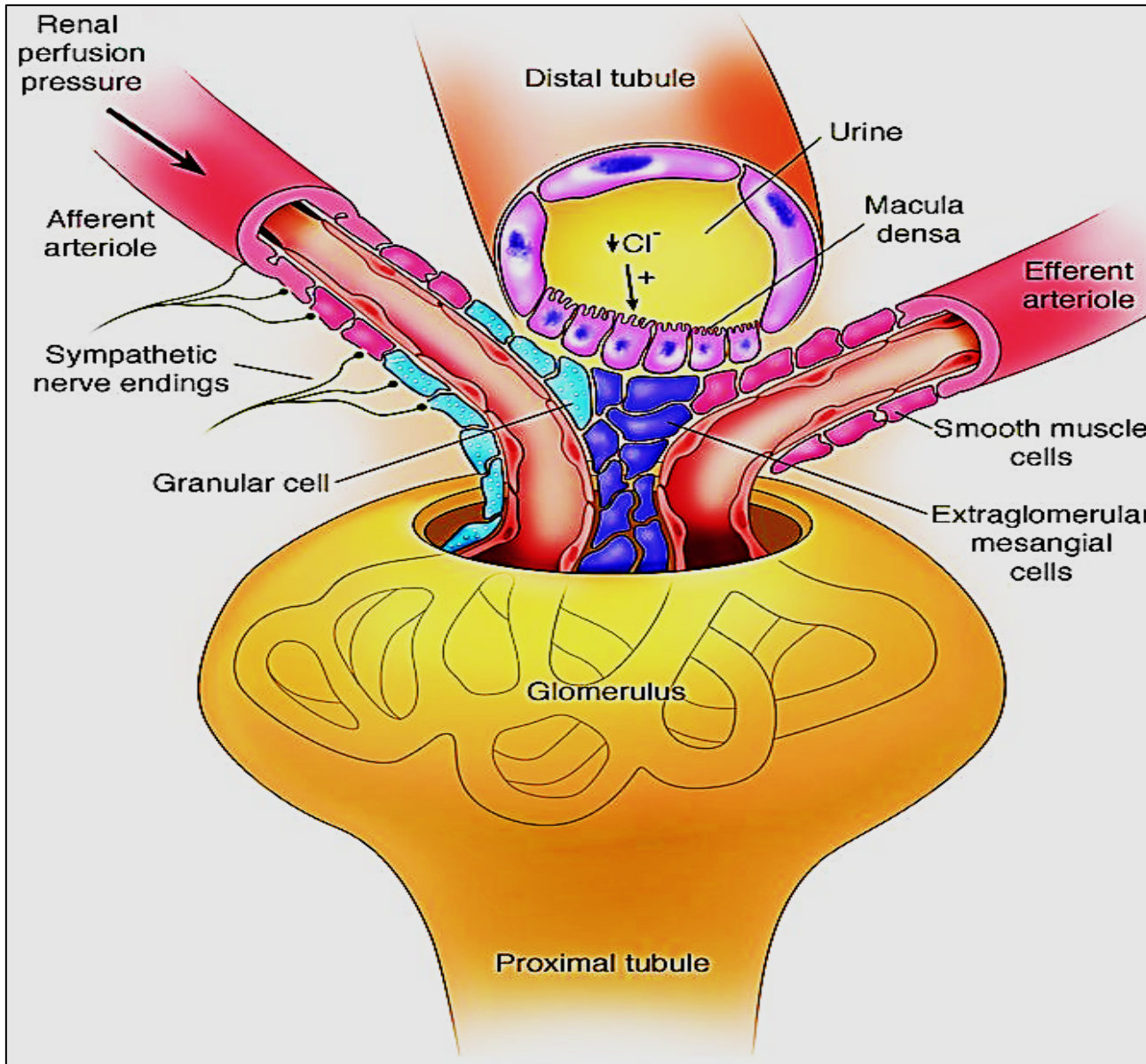
Small pale stained cells occupy the space between the afferent arteriole, eff. arteriole & macula densa

:Function

Supportive

Transmit signals from macula densa → glomerulus → vasoconstriction of blood vessels

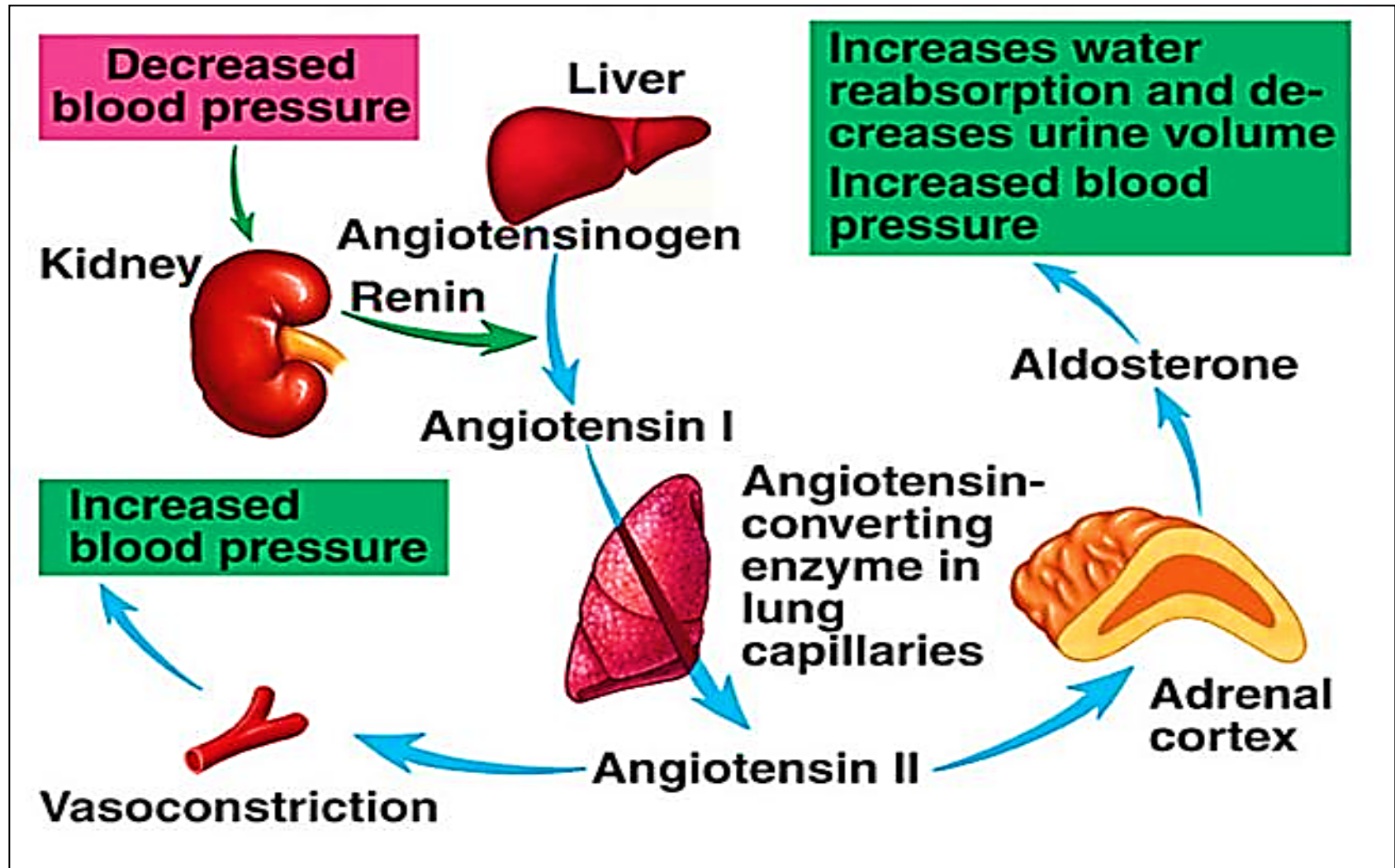




Juxta glomerular apparatus

:Function of Juxtaglomerular apparatus

Regulation of glomerular filtrate rate & blood pressure through the Renin-angiotensin – Aldosterone system



Mechanism of Renin- angiotensin – aldosterone

Drop in blood pressure or blood volume

volume of glomerular filtrate ↓ →

.Na & Cl concentration In DCT ↓ →

Macula densa monitor these changes →

JG cells → Renin ++ →

changes angiotensinogen in blood (formed by liver)→ →
angiotensin I → lung (has ACE) → angiotensin II

:Angiotensin II is

potent vasoconstrictor

release of Aldosterone from adrenal cortex & ++
ADH from posterior pituitary

Aldosterone promotes reabsorption of NaCl by DCT ➤

ADH promotes water reabsorption from collecting tubules ➤

Both will cause ↑ blood pressure

Proximal & distal convoluted tubules

PCT

Longer + narrow lumen

Lined e 3-5 cells

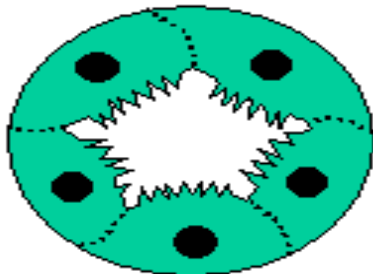
Ill-defined cell borders

apical brush border

Reabsorption of water (Na^+ pump), sugar , amino acids

Secrtion of some metabolites
(penicillin , dyes, ammonia)

proximal convoluted tubule



DCT

Shorter + wide lumen

- Lined e 5-8 cells

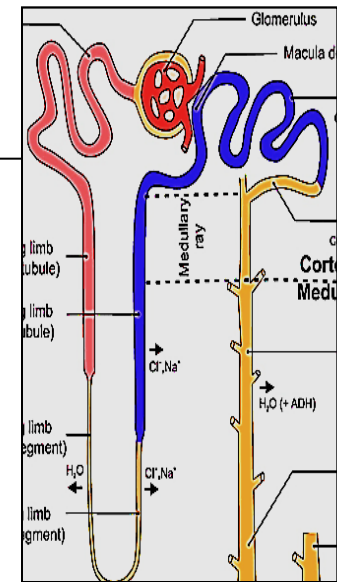
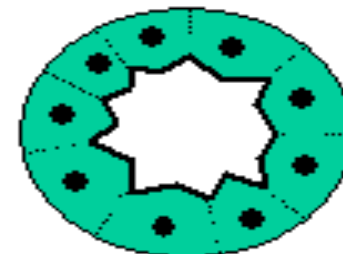
- clear cell borders

- **No brush border**

- Reabsorption of water under effect of Aldosterone

-

distal convoluted tubule



Loop of Henle

Variable in length

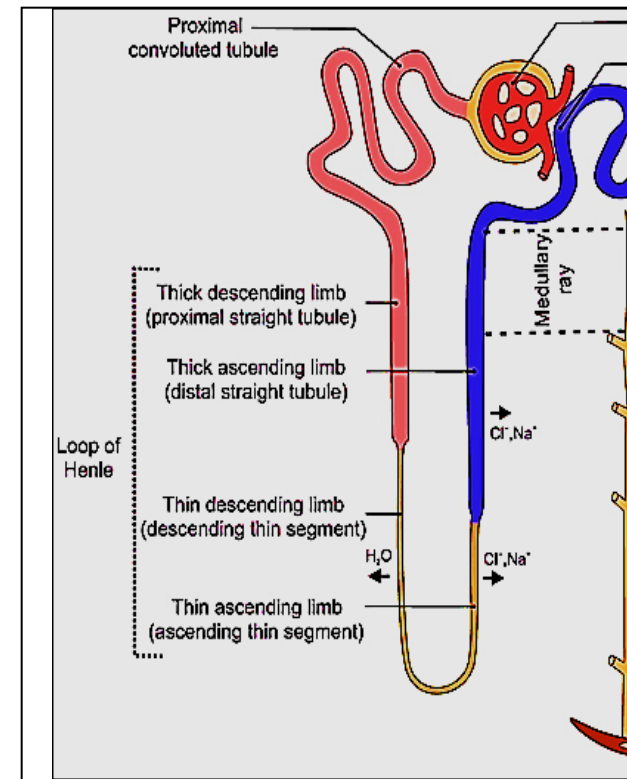
Thin segment: lined by simple squamous

Thick segment: lined by simple cubical

It descend from cortex to medulla

:Function

Create concentration gradient in the medulla of kidney → produce hypertonic urine



,The **descending limb** has \uparrow permeability to water



permeability to ions \downarrow

.The **ascending limb** is permeable to ions



.impermeable to water

The collecting ducts

The excretory portion of renal tubules, under **ADH**

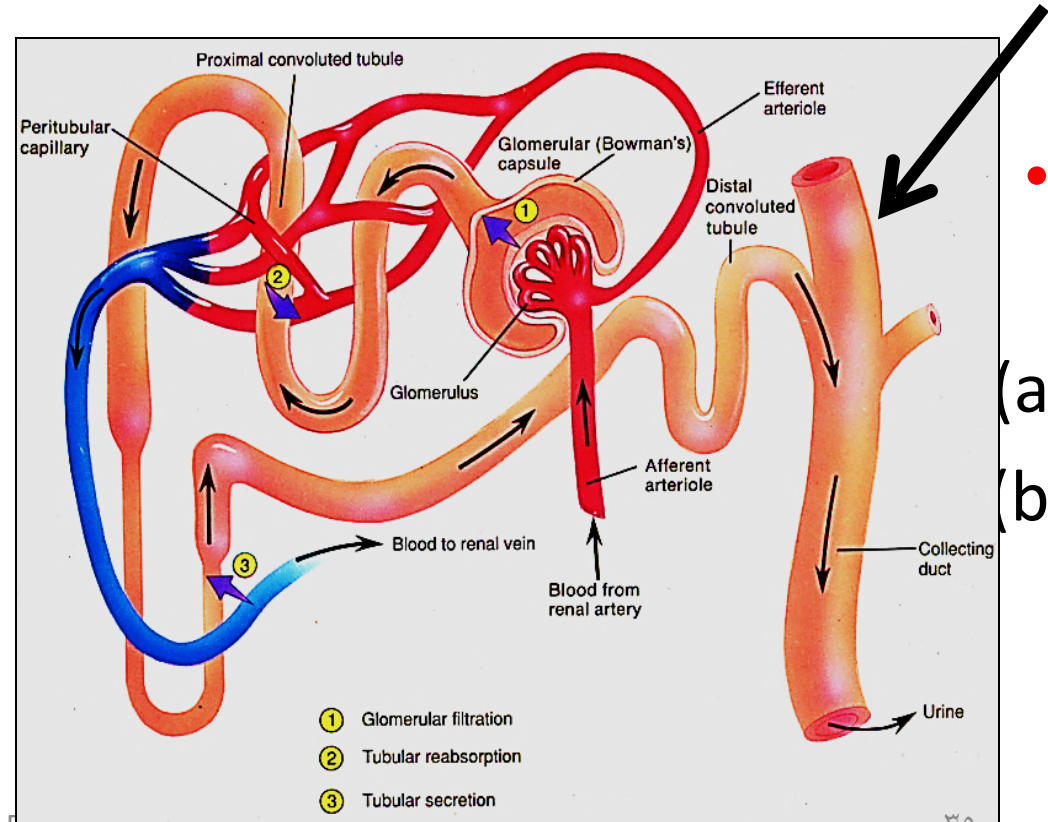
Lined with simple cuboidal epithelium. Each 6-8 collecting ducts drain into → tips of medullary pyramid

types of cells line 2

collecting tubules

Principle cells

Intercalated cells



Principle cells

Numerous

→ **Very sensitive to ADH**

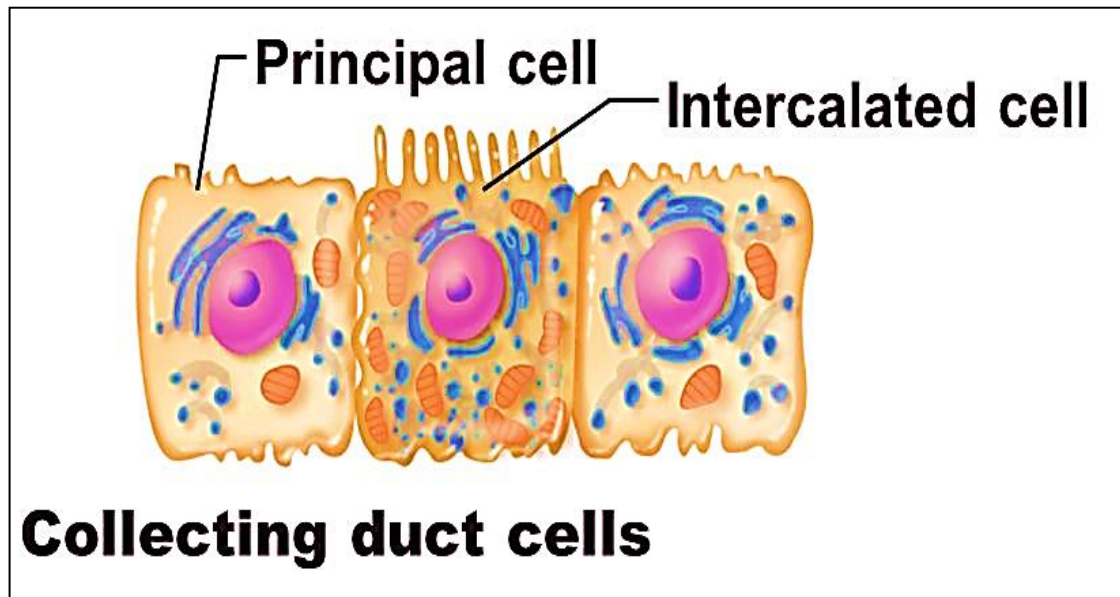
Responsible for the ability of collecting tubules to **concentrate urine**

Reabsorb water

Reabsorb Na & secrete K

Intercalate cells

- Few, have apical microfolds
- types alpha & Beta 2
- **Regulate acid- base balance**
- Alpha → H^+ ion → acid urine
- Beta → HCO_3^- → alkaline urine



ureters

: Muscular tube formed wall is formed of

Mucosa - Muscularis – adventitia

Mucosa

Transitional epithelium + CT lamina propria



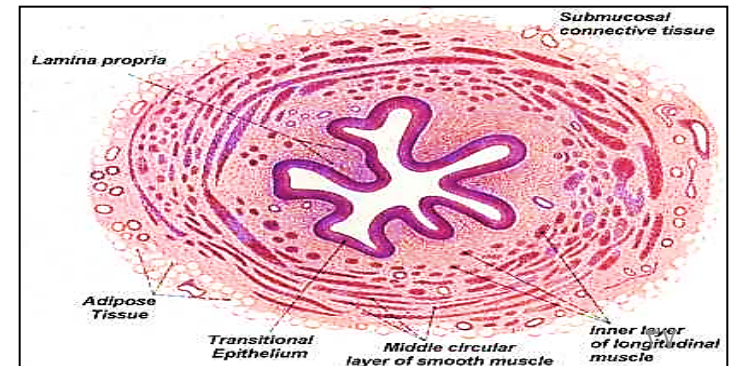
Muscularis

Upper 2/3 of ureter: inner longitudinal & outer circular

Lower 1/3 of ureter: additional outer longitudinal

Adventitia

Loose areolar CT



Urinary bladder

:Mucosa

Transitional epith. + lamina propria

:Musculosa

IL , MC & OL (detrusor ms.)

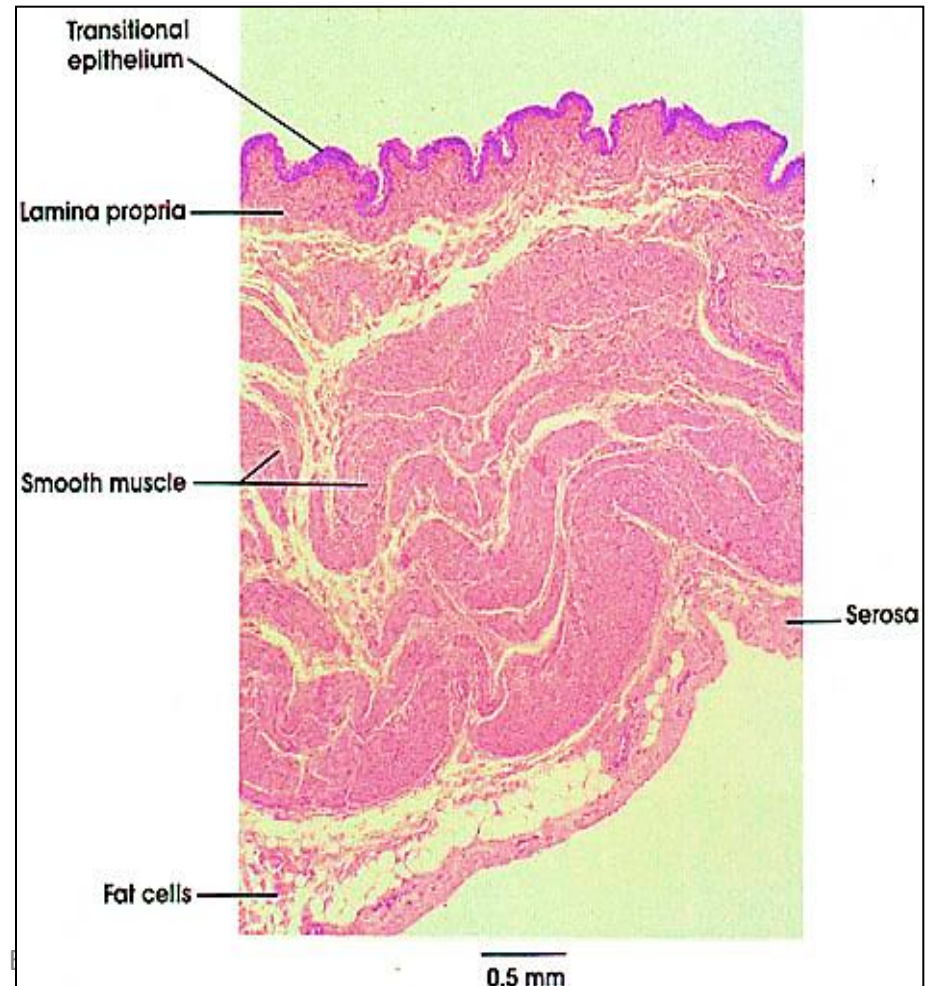
, At the neck of bladder

→the *middle circular* form

internal urethral sphincter

:serosa

Loose areolar CT



urethra

A-Male urethra

Prostatic – membranous – penile

:Prostatic urethra

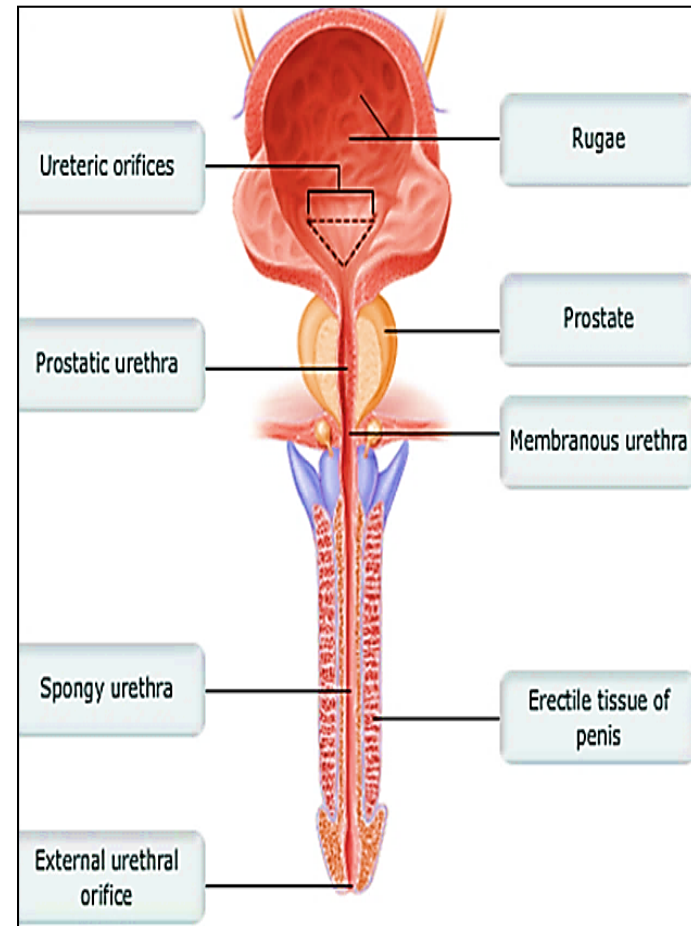
Lined e **transitional** epithelium

:Membranous urethra

Lined e **stratified columnar** epithe

:Penile urethra

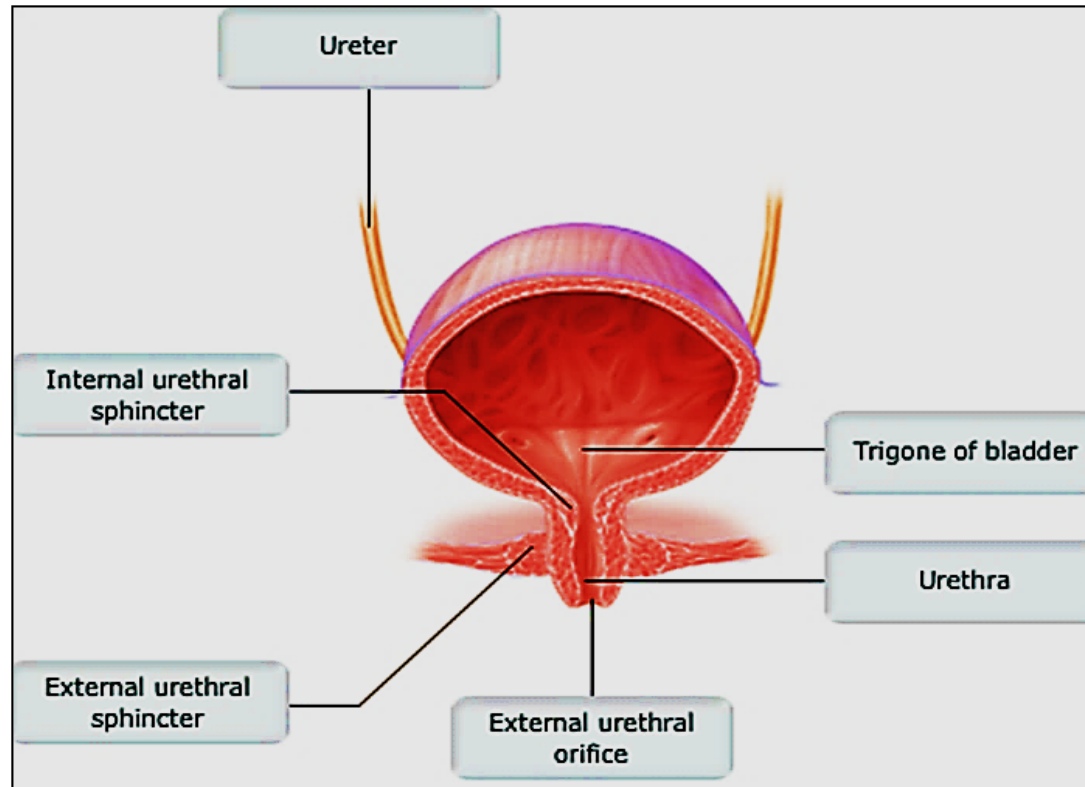
Lined e **stratified columnar** epith which → **stratified squamous** in its distal part (fossa navicularis)



B- Female urethra

Short straight tube

Lined with **transitional** epithelium, then **stratified squamous** at its distal part



Thank you

