

Urinary System - Histology

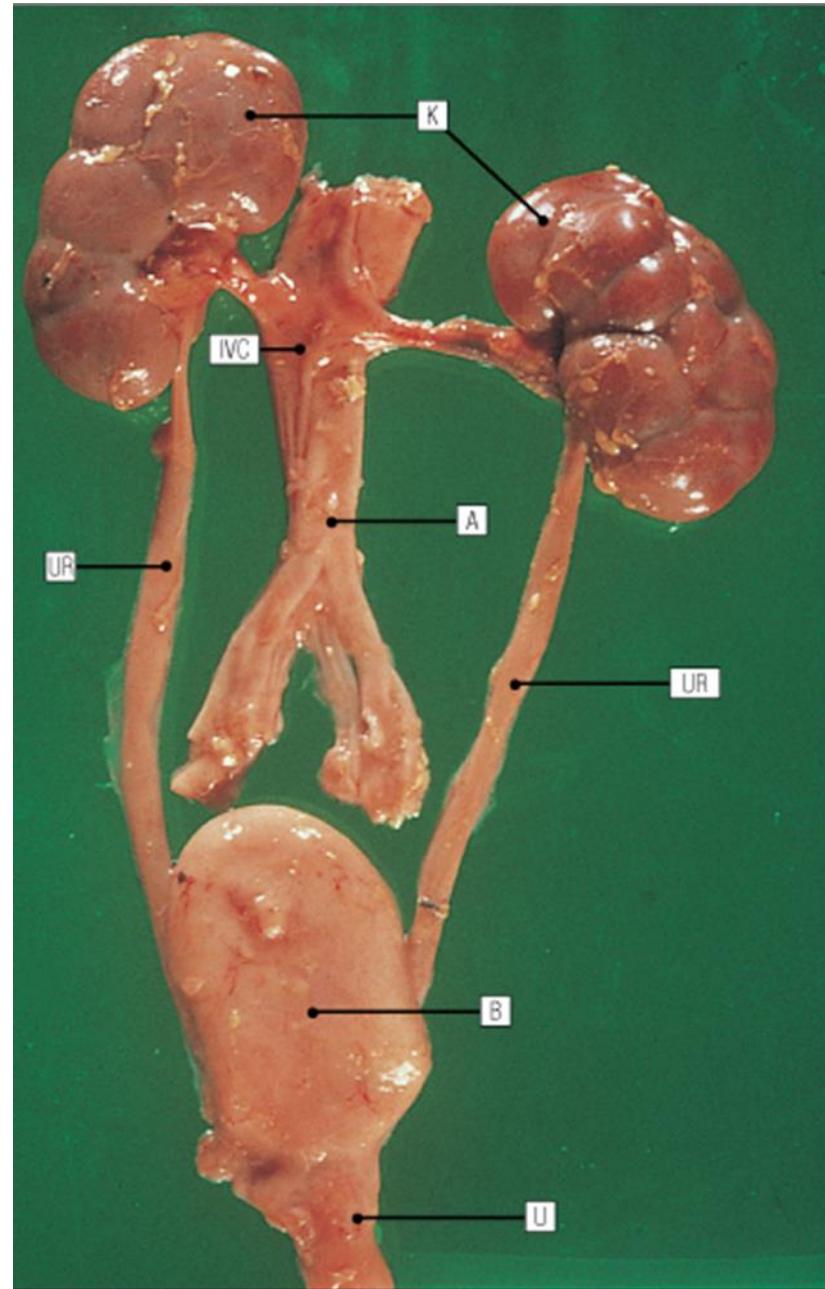
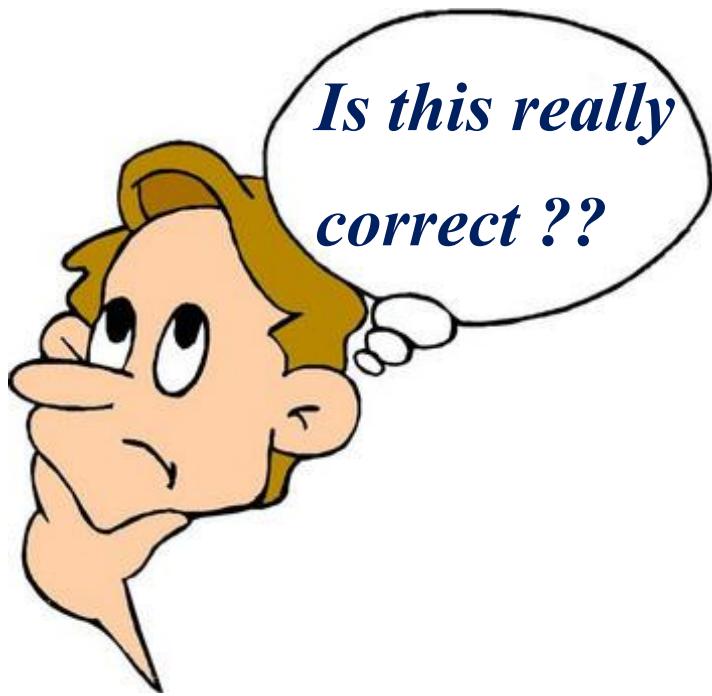
Objectives

- Describe the structure of the kidney.
- Name the major parts with their locations of a nephron.
- Explain the organization of a renal corpuscle.
- Describe the ultrastructure of the filtration barrier of the kidney.

Objectives

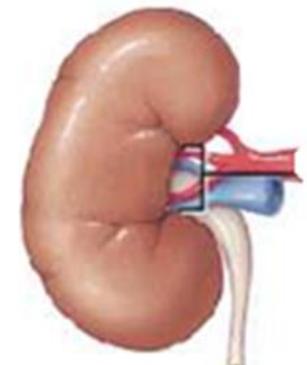
- Describe the structure and function of the PCT, DCT, LH and CD.
- Describe the terms :
 Macula densa & Juxtaglomerular apparatus
- Describe the lining epithelium & the way smooth muscle is arranged in the urinary passages.

Urinary Organs

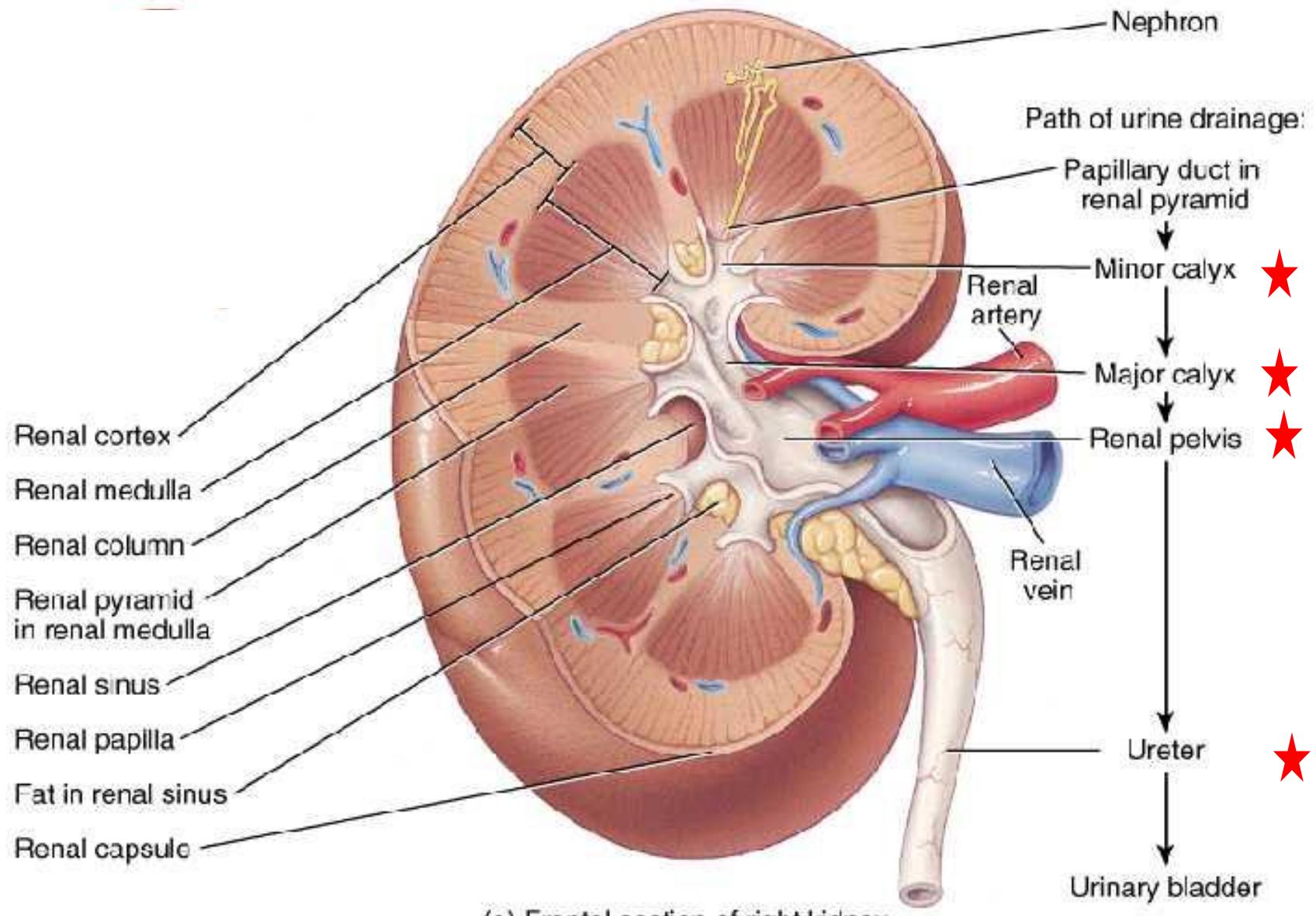


Kidney

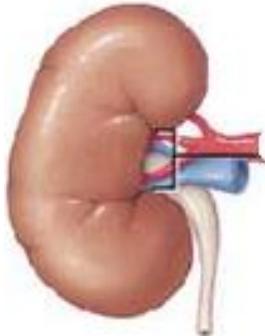
- Separates metabolic wastes from blood
 - Regulates the composition of plasma: acid-base balance
 - Excretion of bioactive substances
 - Regulation of arterial blood pressure : renin
 - Production of erythropoietin: *RBC formation*
 - Conversion : calcitriol (active form of Vit. D)
 - Gluconeogenesis : starvation (AA → CHO)
-
- Renal function involves specific activities
 - filtration , secretion , reabsorption



Kidney



Kidneys – bean shaped organs



lie on the posterior abdominal wall
medial border- concave, lateral border- convex
central part- deep vertical fissure



hilum (a central recess called renal sinus)

lie the artery ,vein, lymphatics, nerves & **renal pelvis**

- outside the hilum, renal pelvis continues as ureter
- Within the sinus renal pelvis divides into 2/3 branches -
Major calices giving off several **minor calices**
- Expanded end of each minor calyx is indented & moulded around 1-3 **renal papillae** → apices of **renal pyramids**

Structure of the Kidney

Outer/external cortex - reddish area

Inter/ internal medulla



8-18 Renal pyramids

- pale striated conical masses
- bases lie against the outer cortex
- Apices converge towards the renal sinus forming **papillae**

Histology of the Kidney

- Compound tubular gland
- Consist of 2 parts.

Stroma



Paranchyma

Renal capsule

Dense fibrous connective tissue

Few scattered smooth muscle fibers

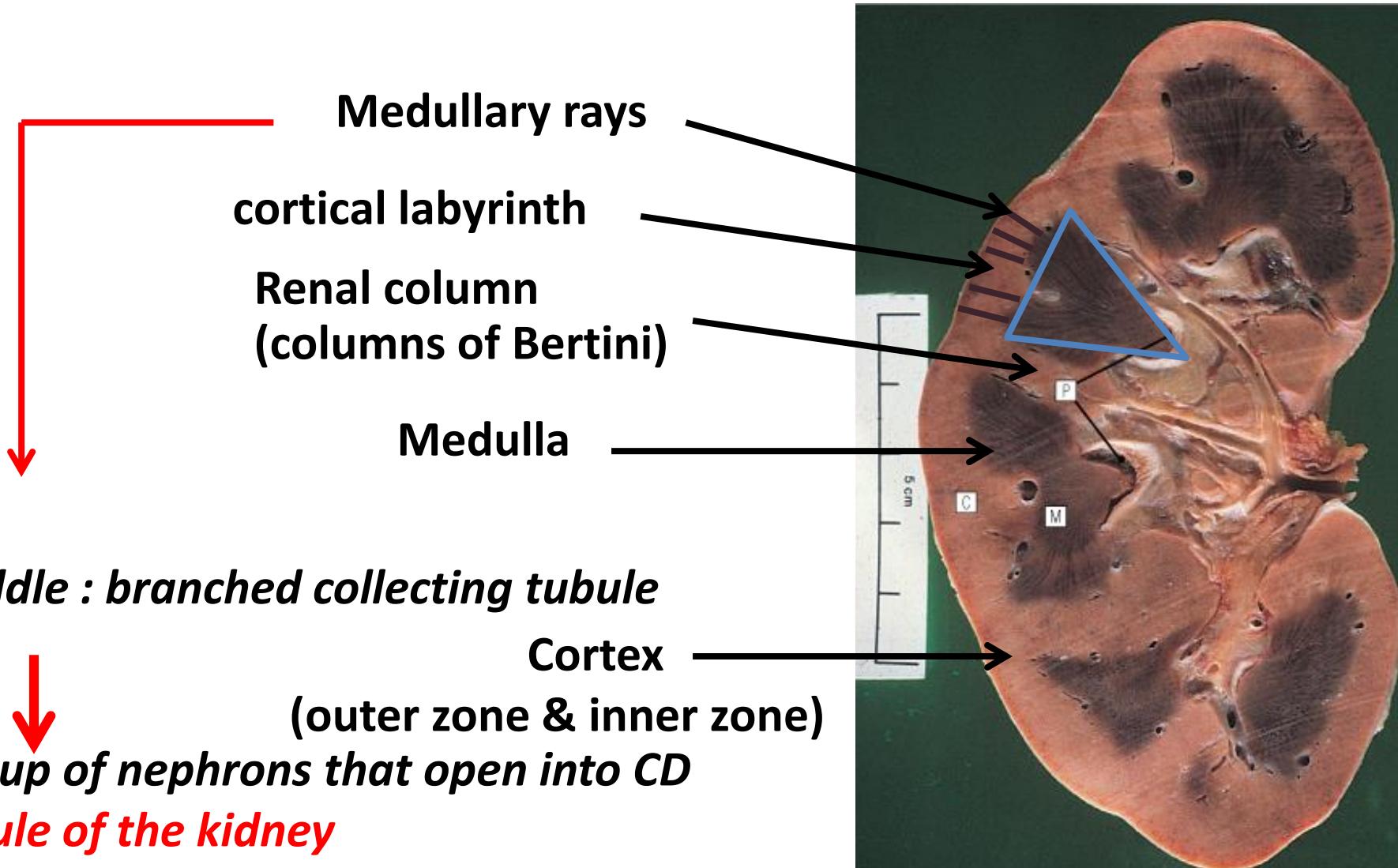
Loosely attached to the kidney

No septae or trabeculae

Made up of uriniferous tubules
large number
closely packed
Both cortex and renal pyramid

Structure of the Kidney

- Each pyramid + cortex that ‘caps’ it = **kidney lobe** (8-18)



Uriniferous tubule

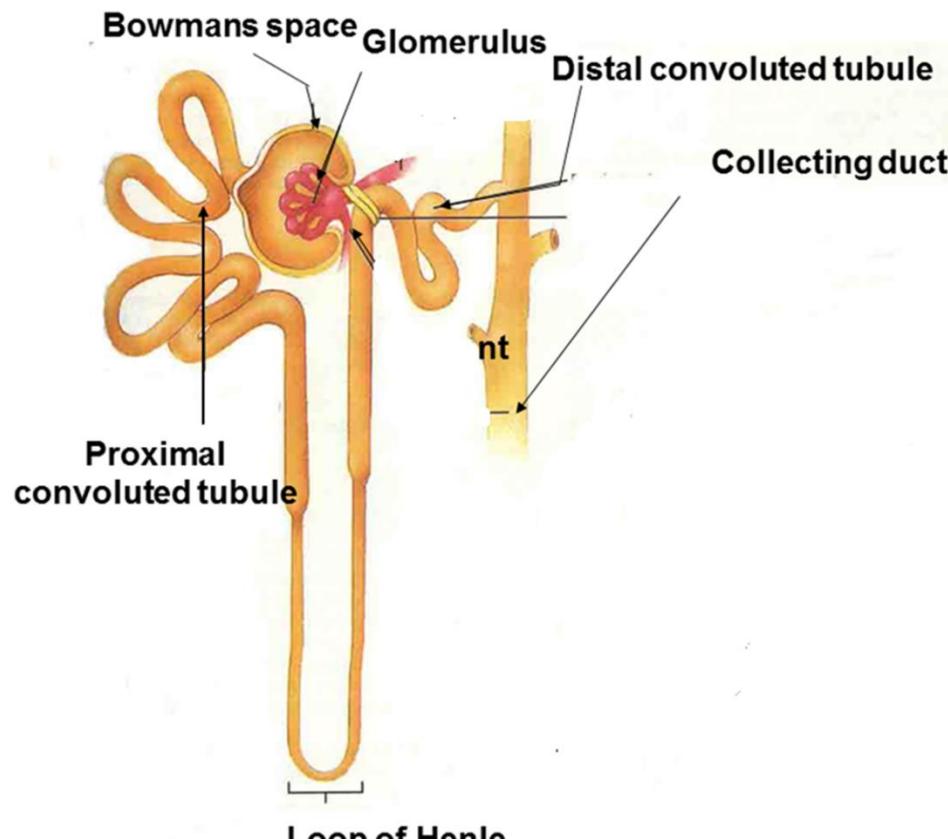
Functional unit

Nephron

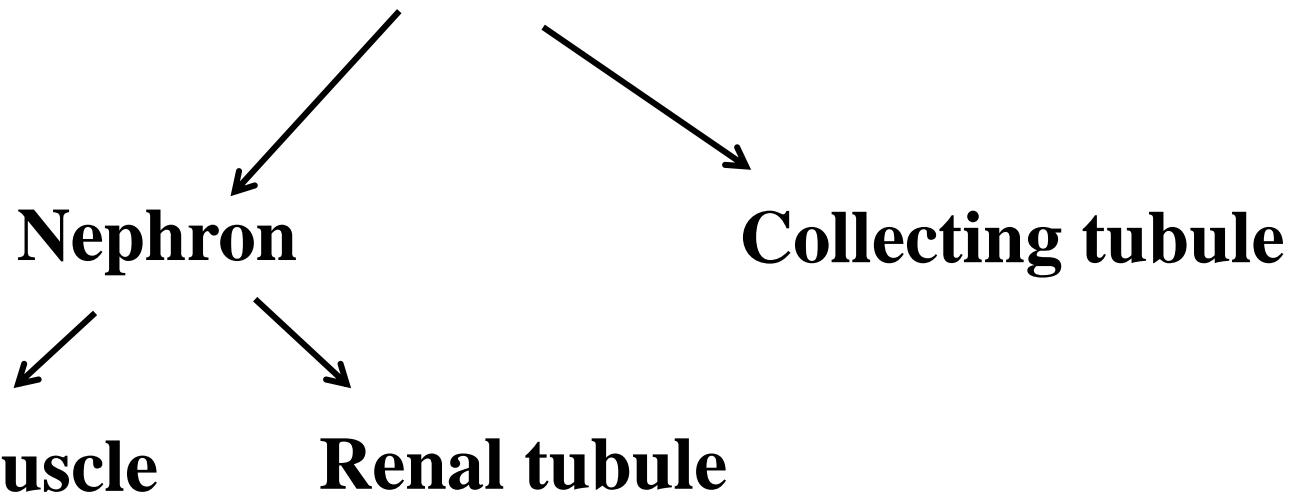
Collecting tubule

Renal corpuscle

Renal tubule



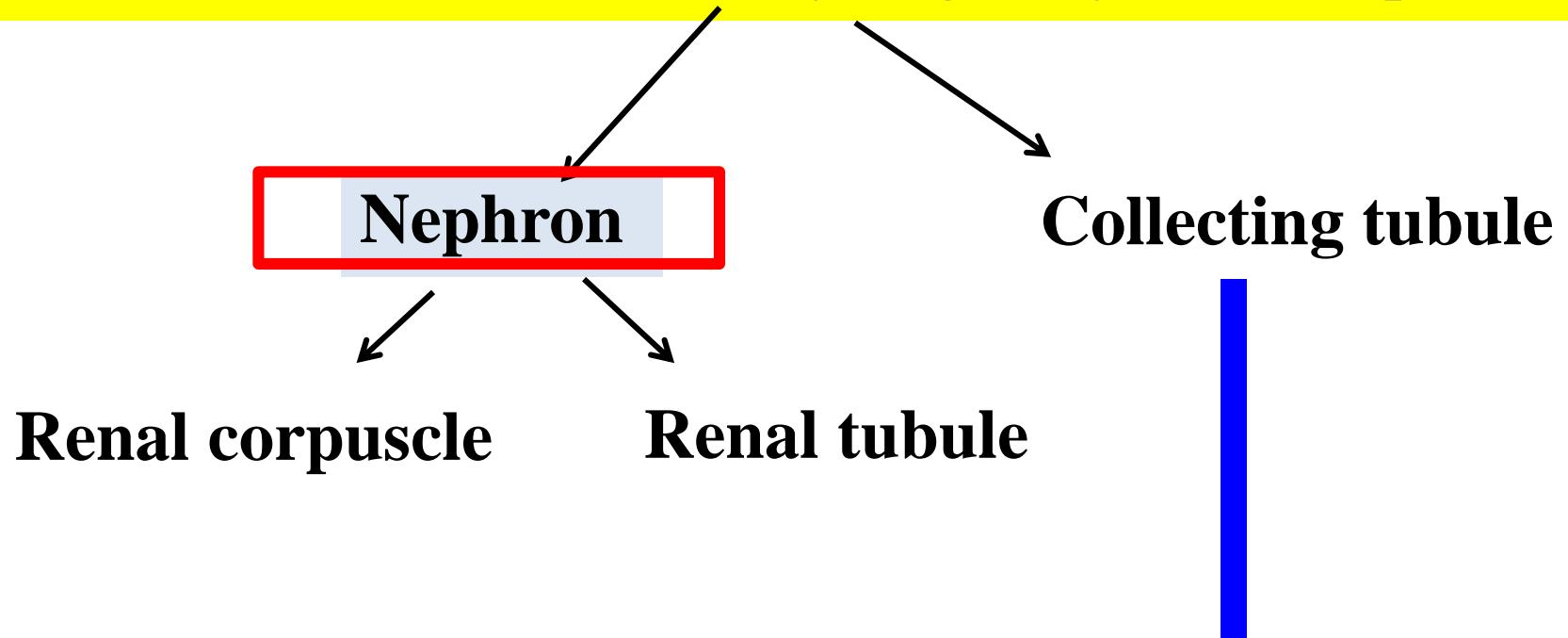
Uriniferous tubule (2 embryologically distinct parts)



- **filtration** – substances are permitted to pass into nephrons.

- **secretion** – filtered liquid gains some additional material(waste and excess substances)
- **reabsorption** – some substances are returned to the blood.

Uriniferous tubule (2 embryologically distinct parts)



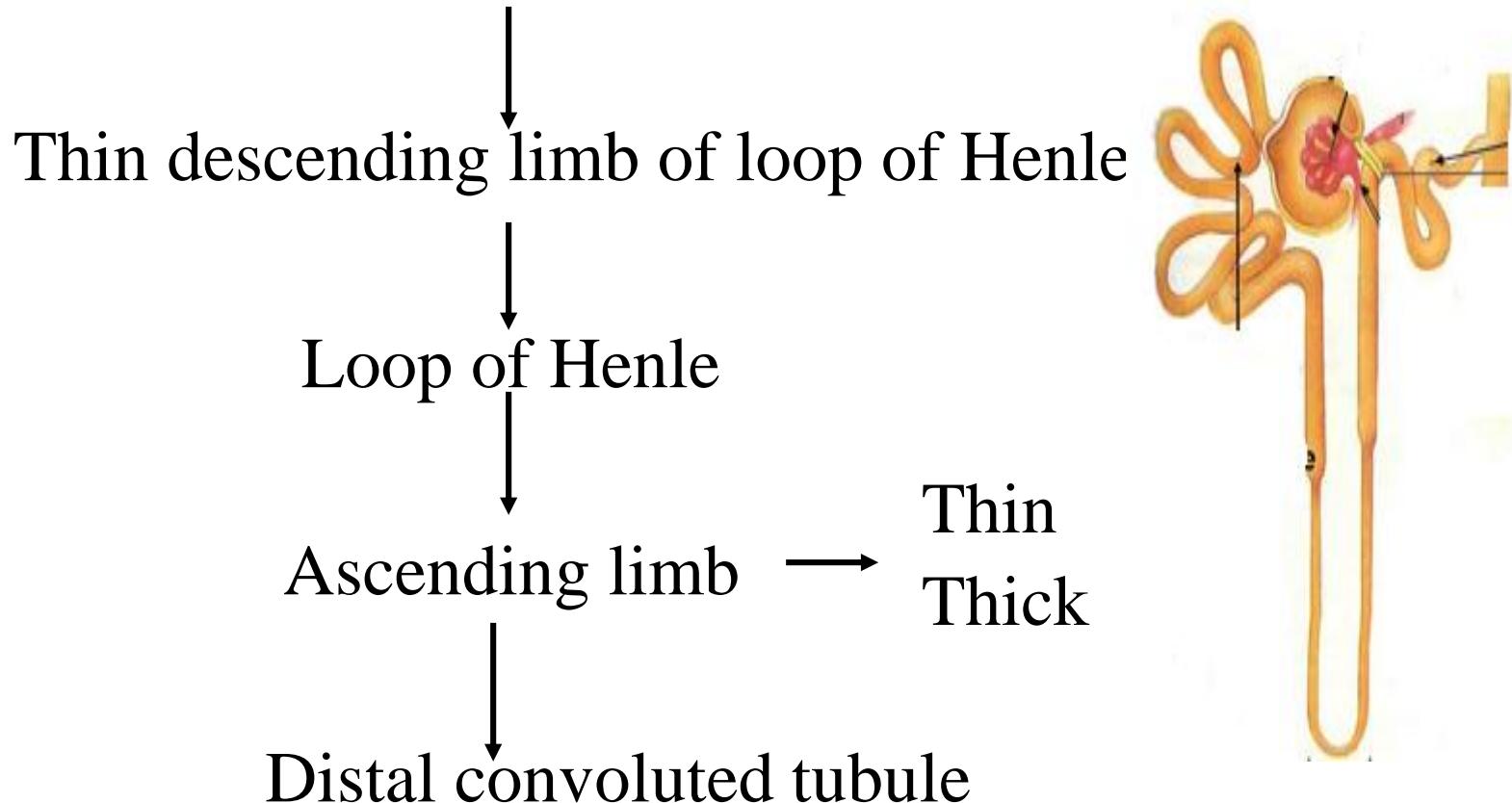
carries fluid from number of renal tubules to a terminal papillary duct (Duct of Bellini)

opens into a minor calyx at the apex of a renal papilla.

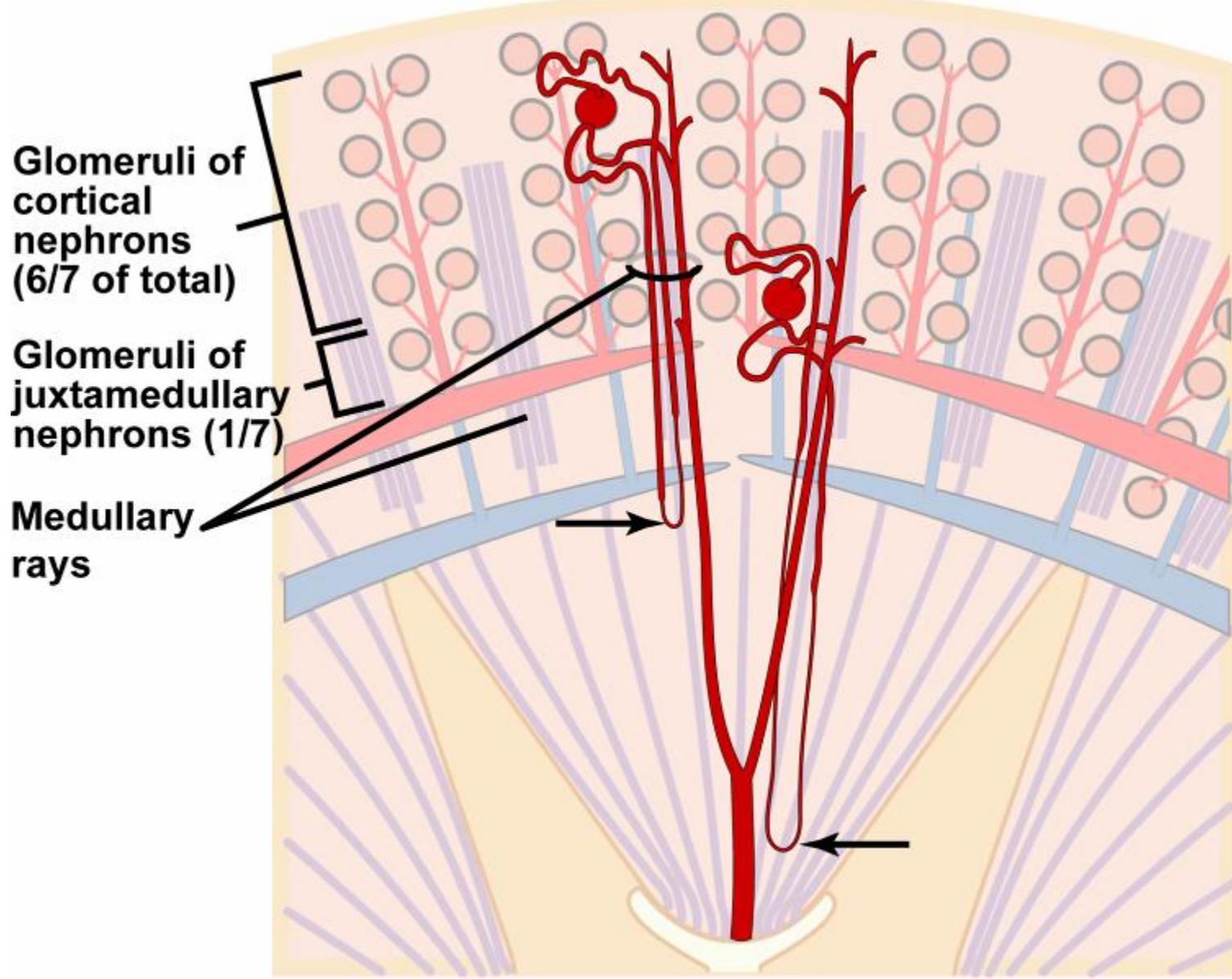
This area shows a cribiform appearance-Lamina cribrosa

Nephron: Functional Unit of the Kidney

Renal corpuscle → proximal convoluted tubule

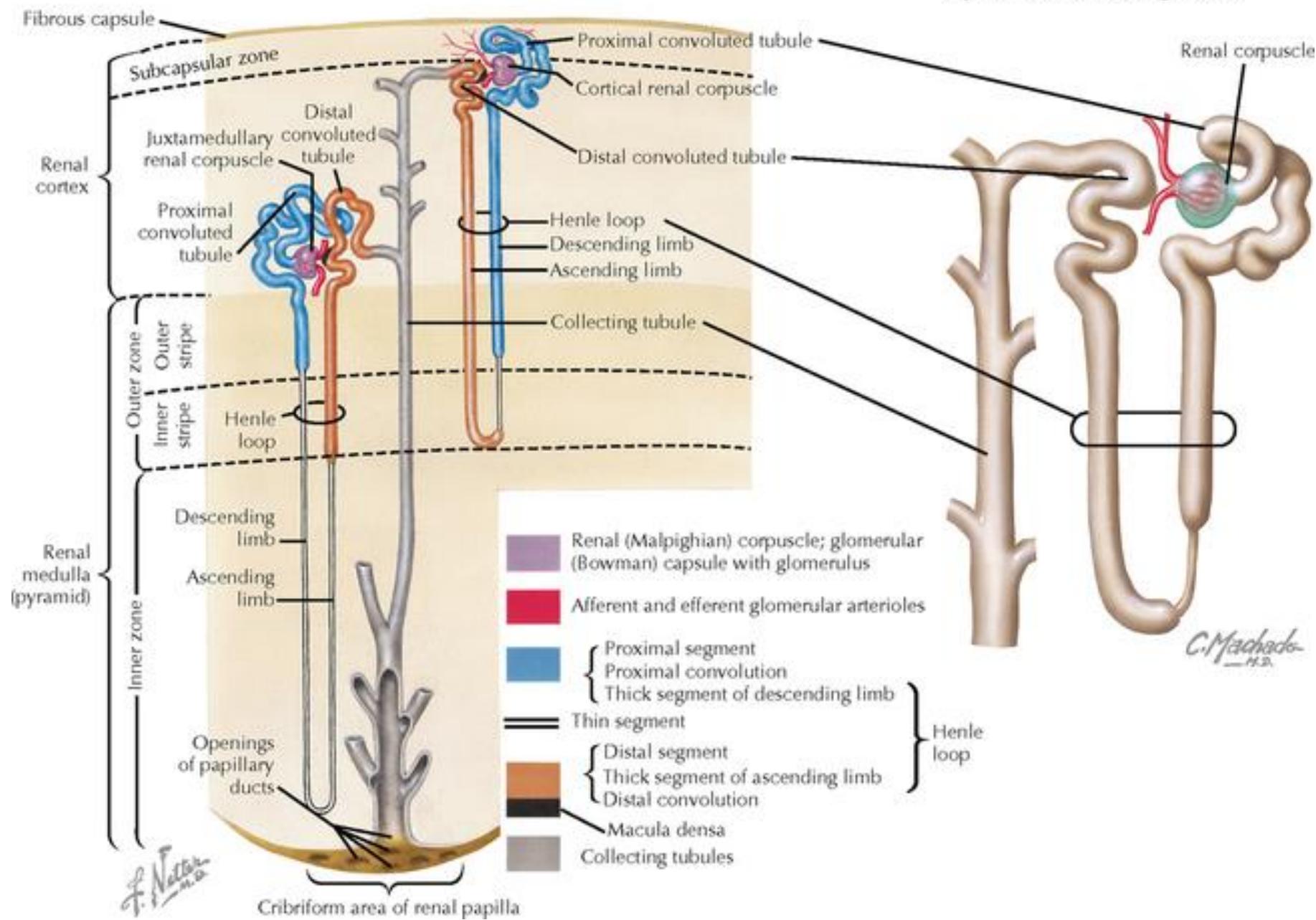


2 Types of nephrons : Cortical & juxtamedullary



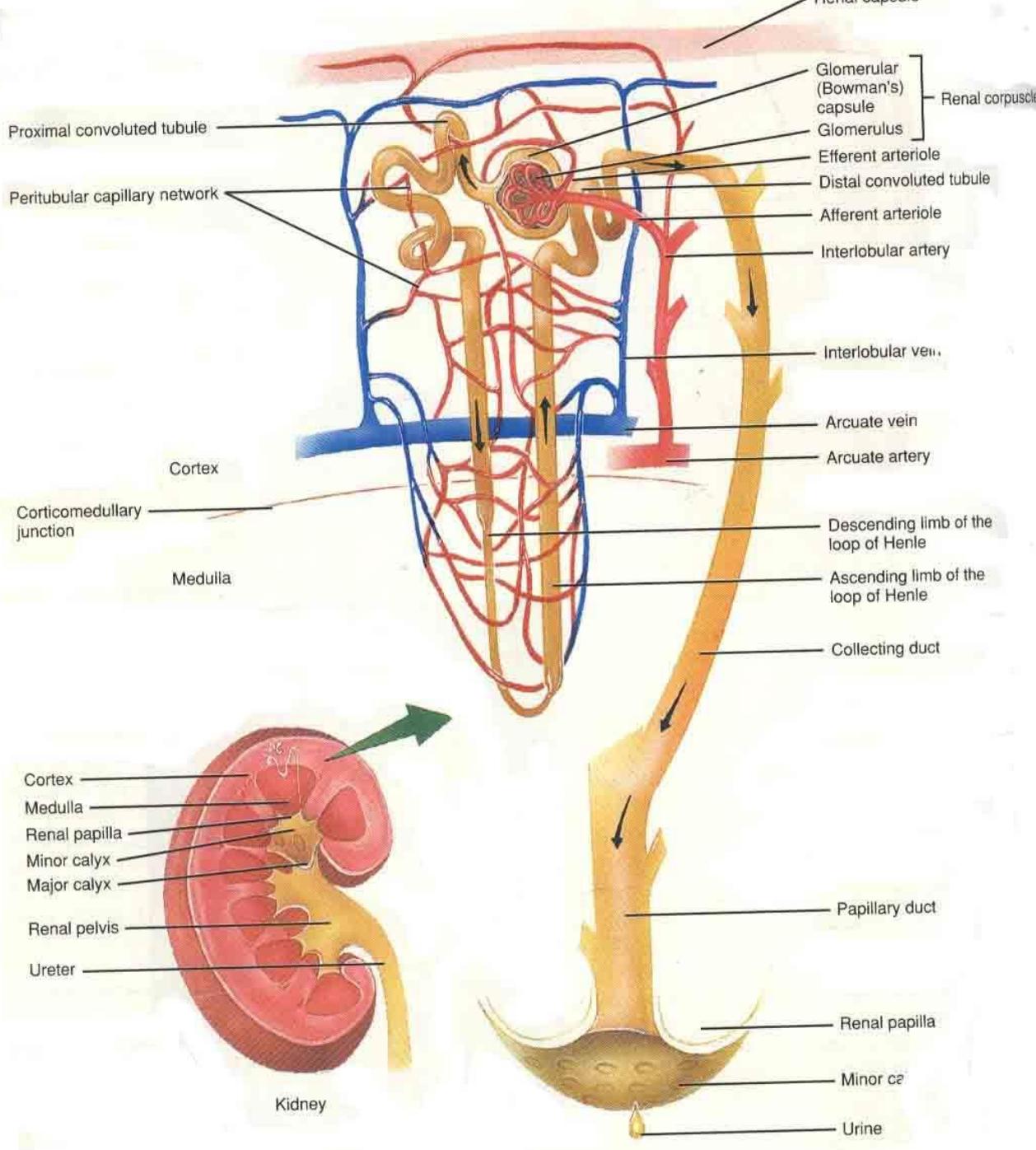
▼ The uriniferous tubule.

▼ High-magnification schema of the nephron and a collecting tubule.



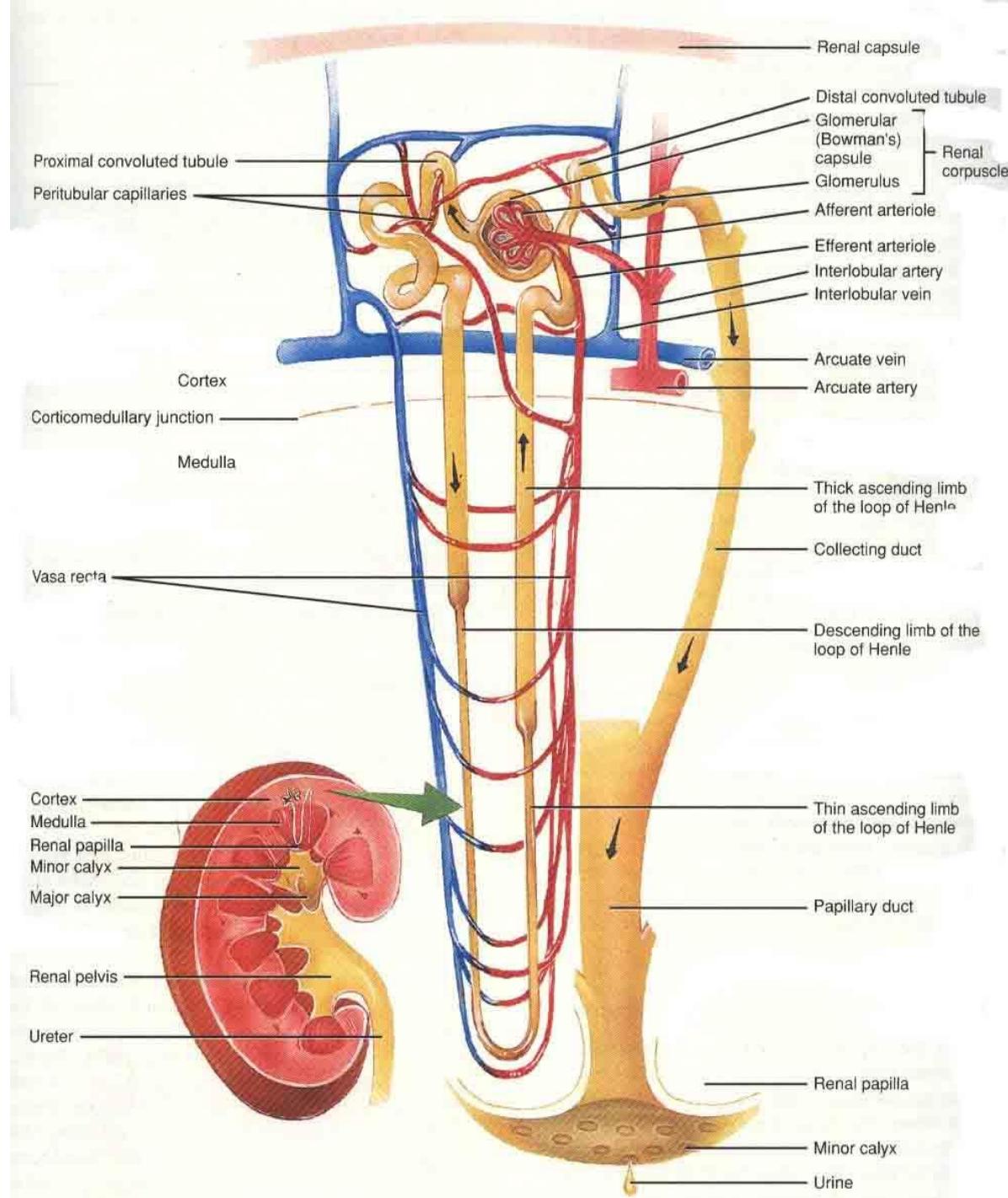
Cortical nephrons

- *Location : cortex*
- *Function : Filtration , absorption & secretion*
- *Associated with peritubular capillaries*
- Very short thin descending limbs
- No thin ascending limbs

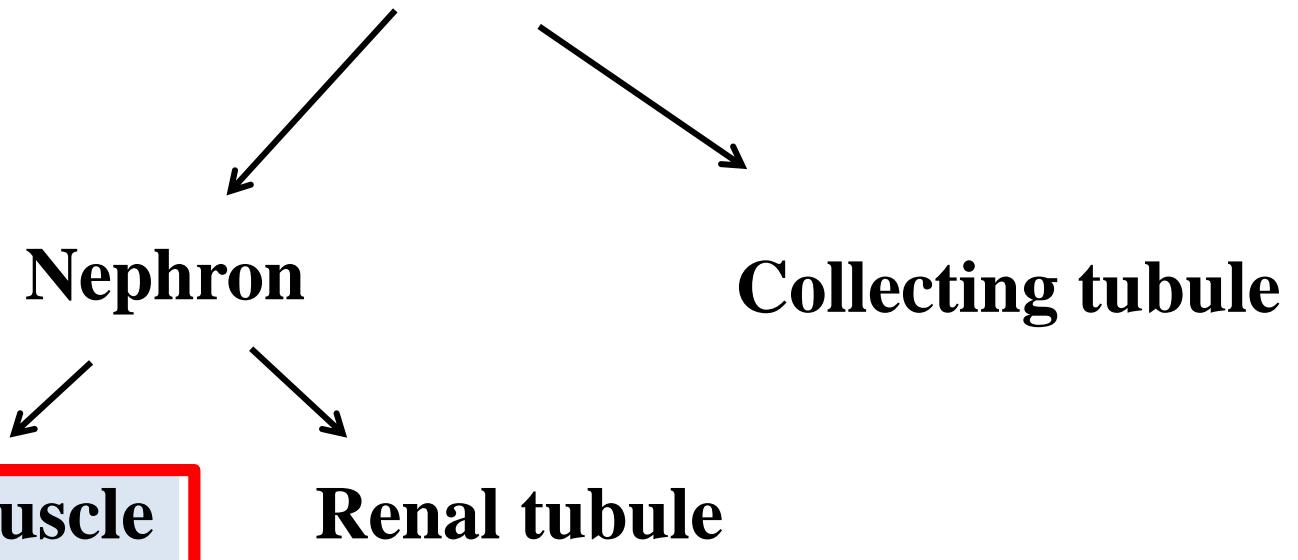


Juxta-medullary nephrons

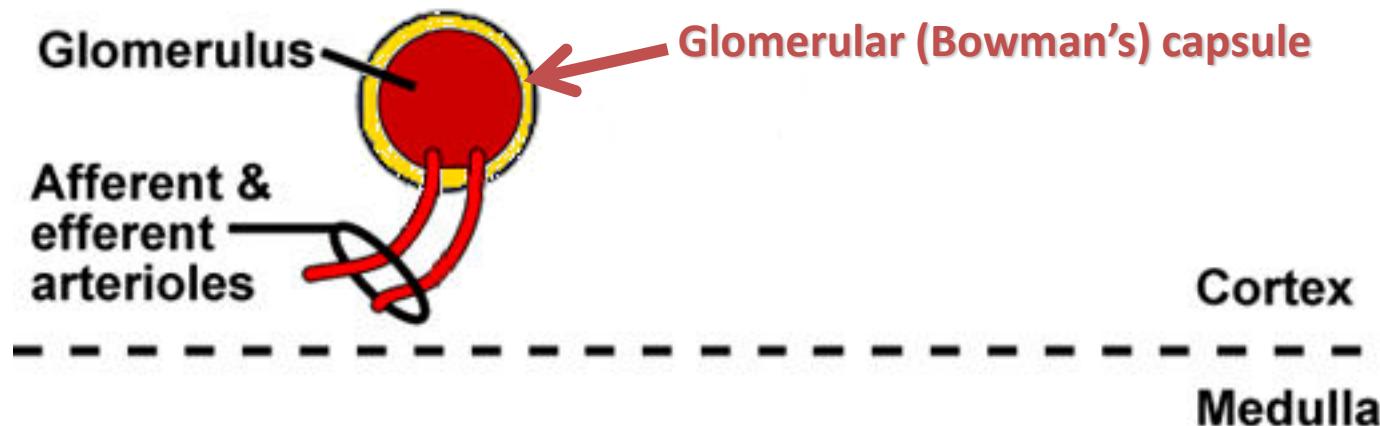
- *Location: close to medulla*
 - *Function : Filtration , absorption & secretion*
 - *Specially responsible for production of hypertonic urine*
 - *Associated with vasa recta*
-
- very long loops extend deep into the medulla
 - short thick descending limb.
 - long thin descending and ascending limbs
 - long thick ascending limb.



Uriniferous tubule



Renal Corpuscle



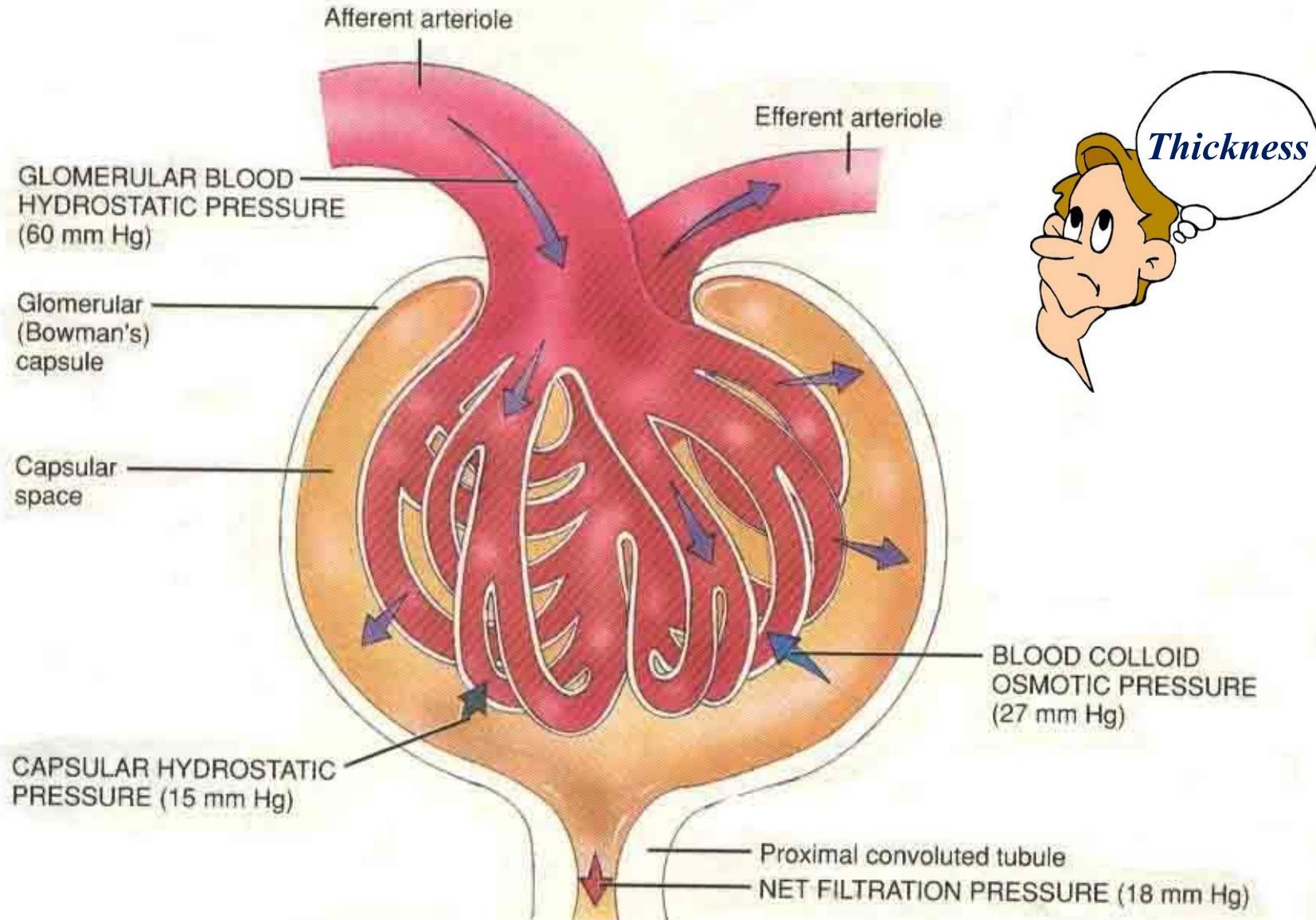
Glomerulus

- Tuft of capillaries from **afferent arteriole** giving rise to capillary loops which drain into **efferent arterioles**
- **Glomerular capillary** - **fenestrated endothelium with open fenestrae.**

Bowman's capsule

- Double walled epithelial cup (visceral & parietal layers)
- Encloses urinary space which contains provisional urine

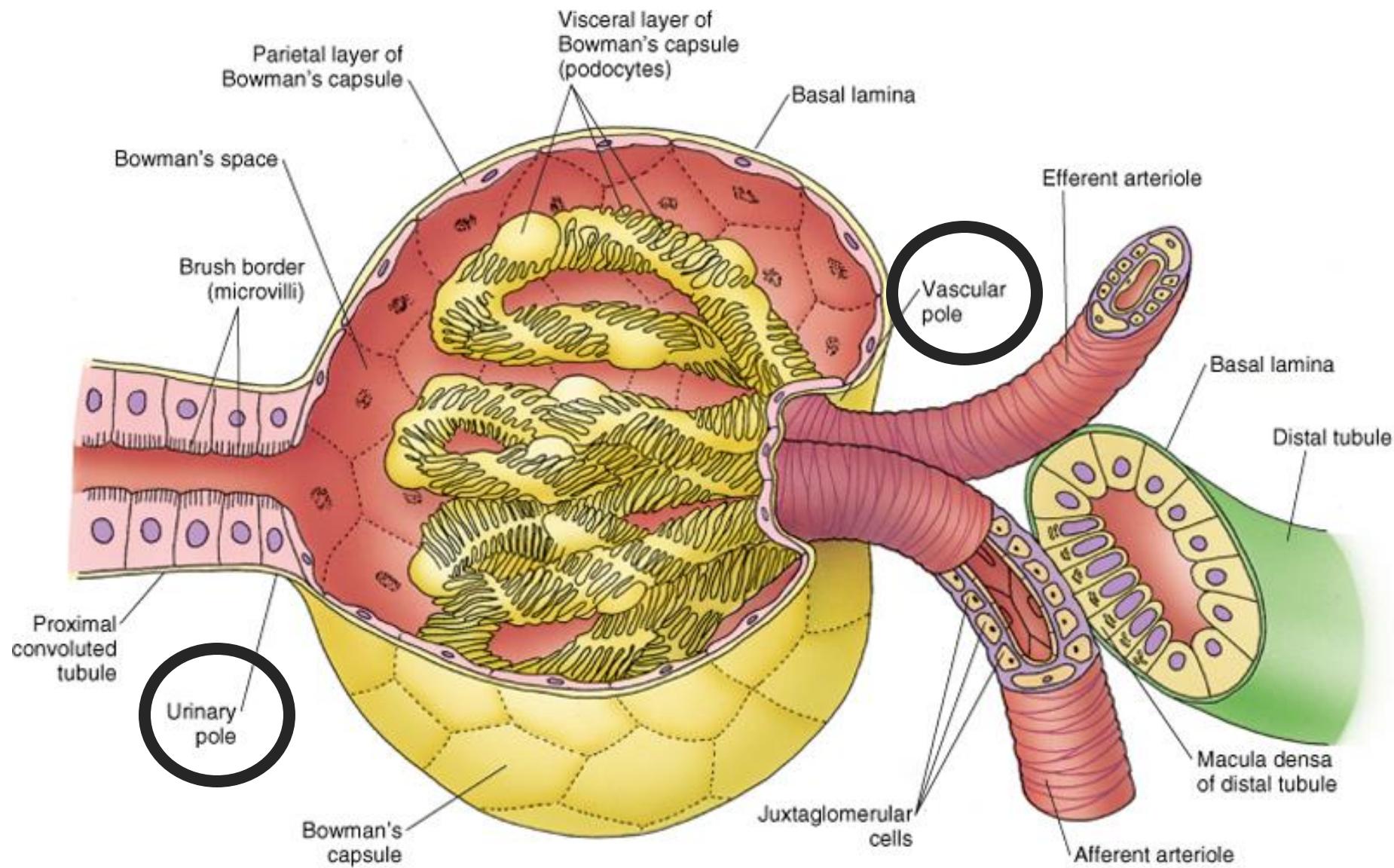
Renal Corpuscle - Glomerulus



Renal Corpuscle - Glomerulus

- Both arterioles have smooth muscles in the media
- Wall of **afferent arteriole** is thicker
- Difference in their respective tonus enable
 - * *to maintain a hydrostatic pressure* along the entire length of glomerular capillaries.
 - * *to produce large quantities of urine.*

Renal Corpuscle



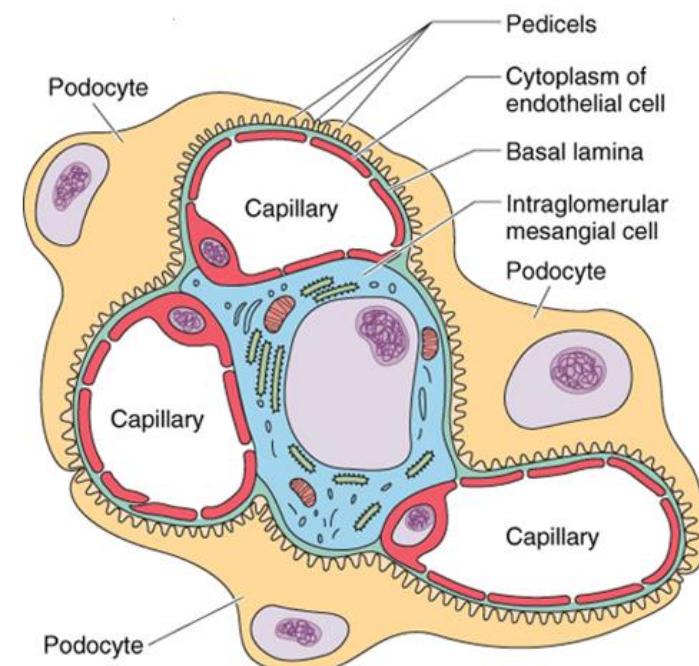
Mesangial cells

Mesangial cells

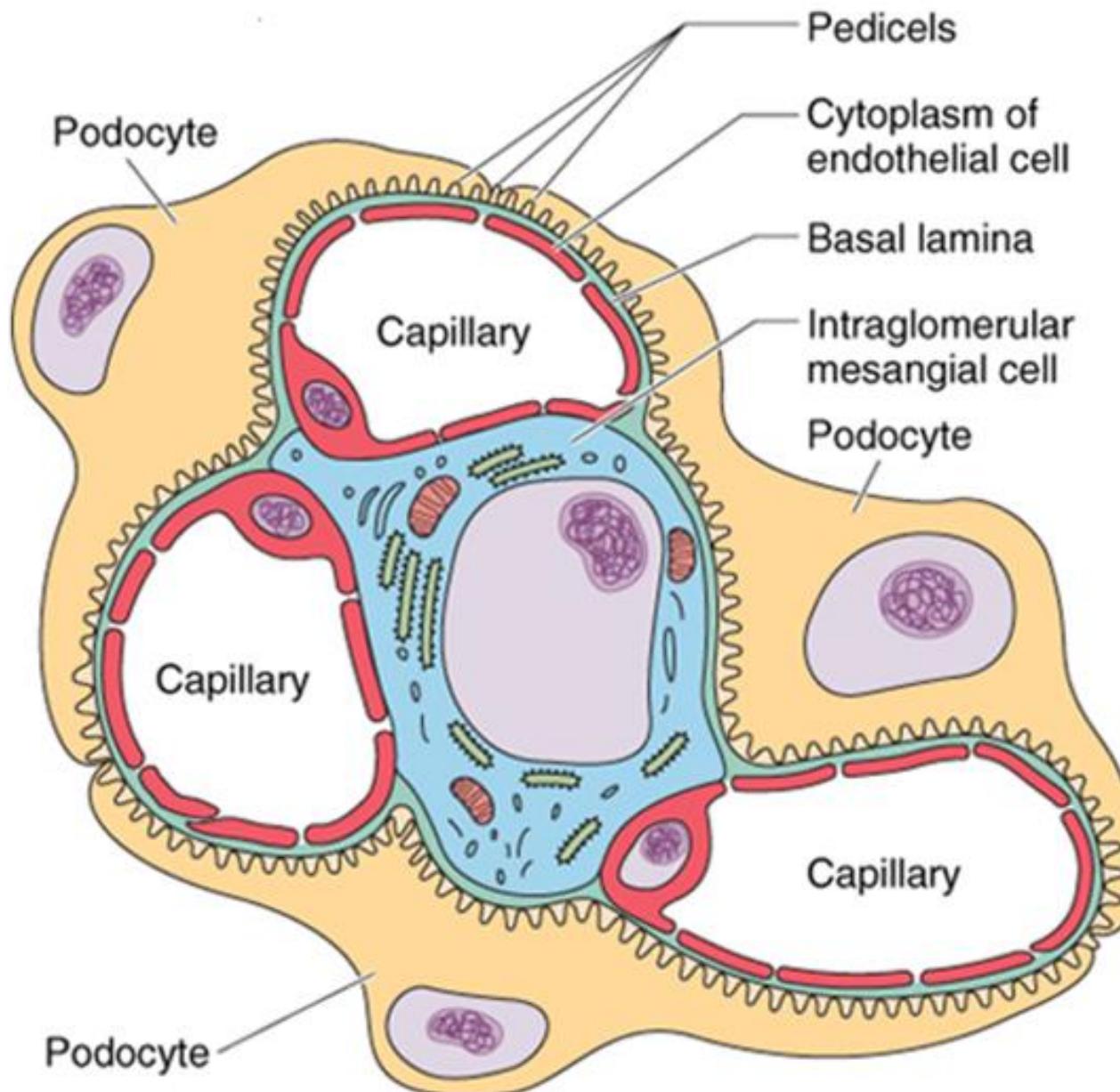
Located within stalk of capillary tuft (*intraglomerular mesangium*) as well as the vascular pole (*extraglomerular mesangium/lacis cells*).

Functions :

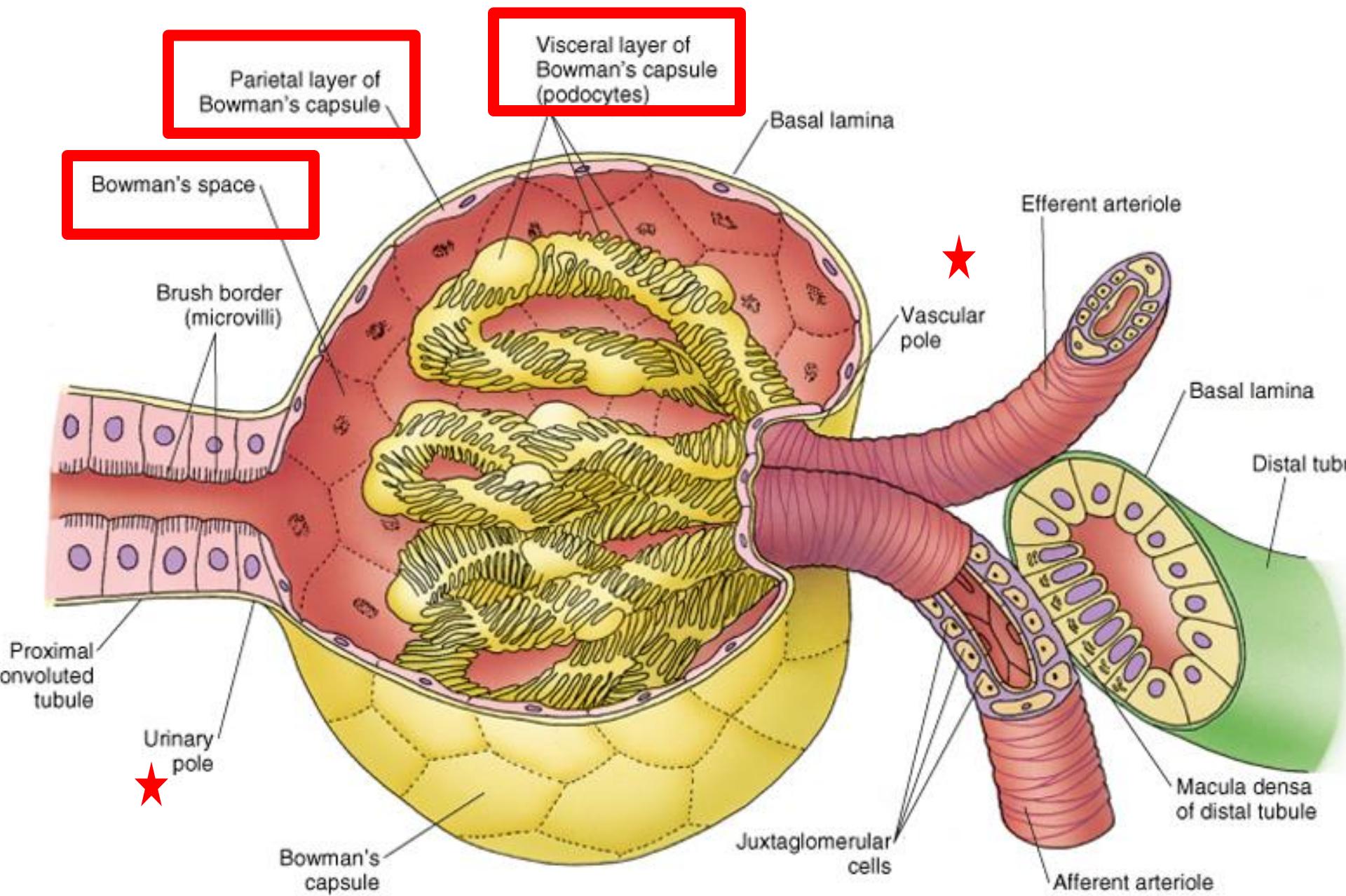
- structural support,
- phagocytic function
(keep filtrate free of debris)
- synthesize extracellular matrix
- produce chemical mediators
- contractile property



Mesangial cells



Renal Corpuscle – Bowman's capsule



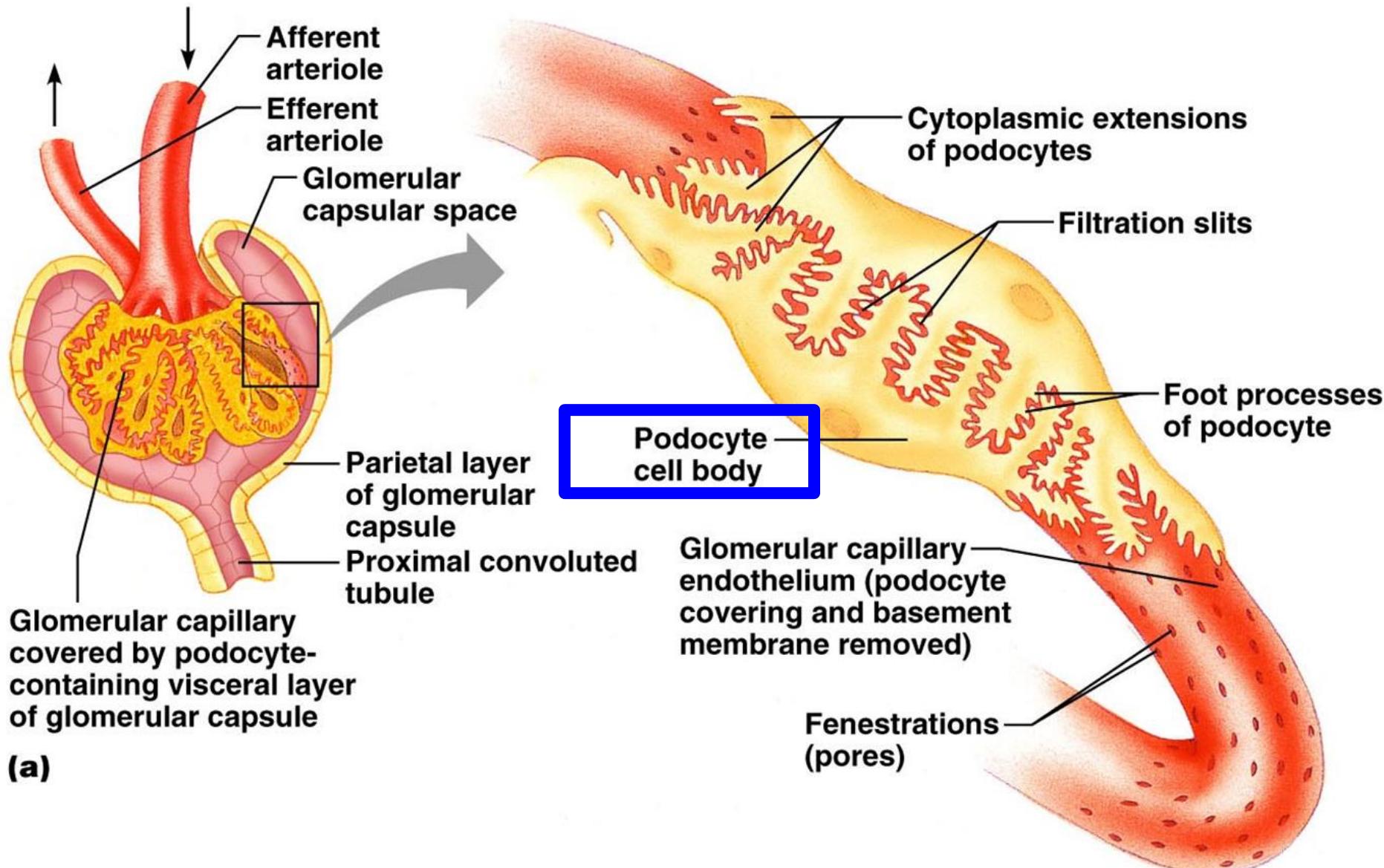
At the vascular pole

- Cells of the visceral layer becomes extensively modified during development
- Visceral layer becomes continuous with the squamous epithelium of the parietal layer.

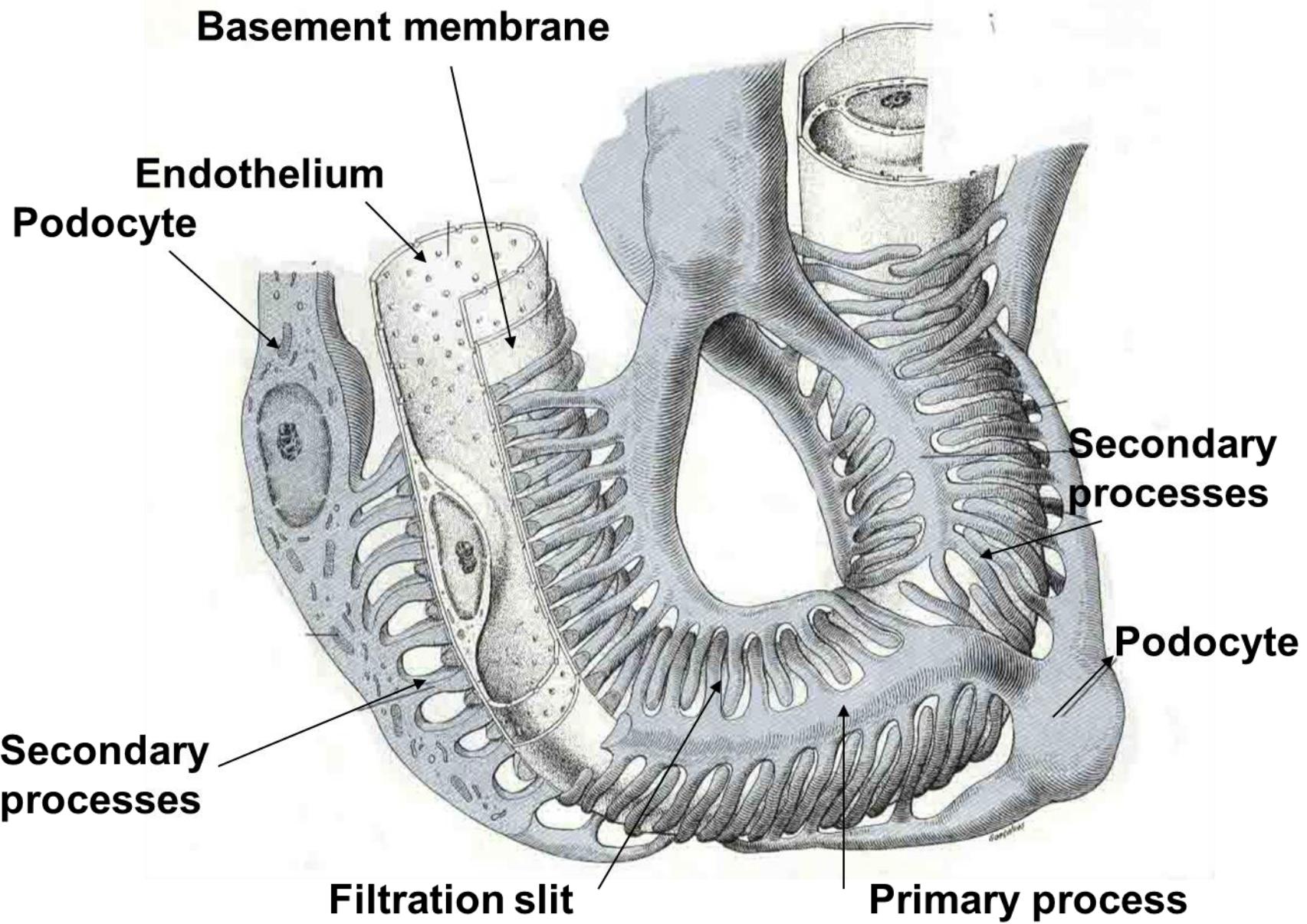
At the urinary pole

- Capsular epithelium continues as the cuboidal epithelium of the neck of the proximal tubule.

Bowman's capsule - Visceral layer



Bowman's capsule - Visceral layer

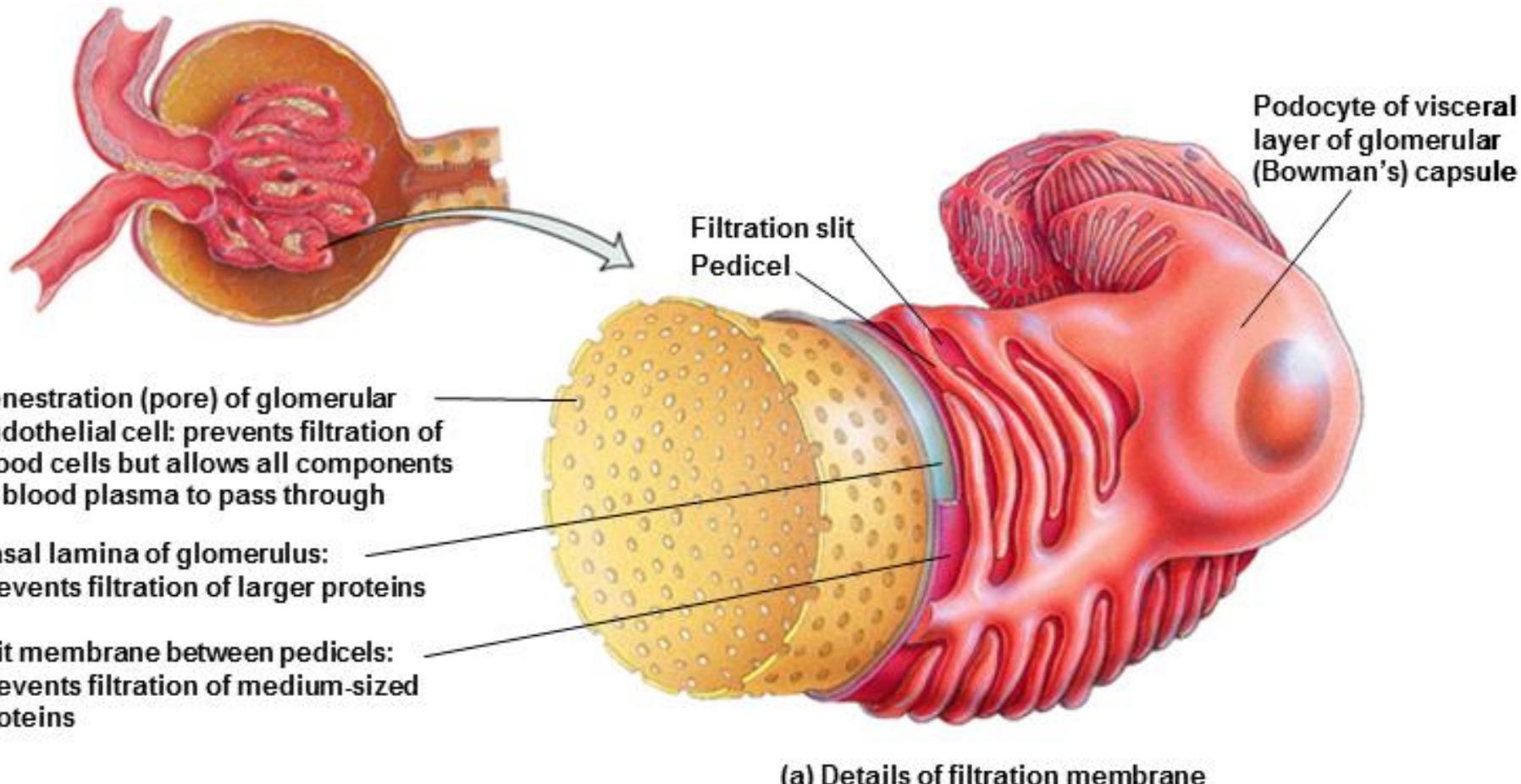


Podocytes

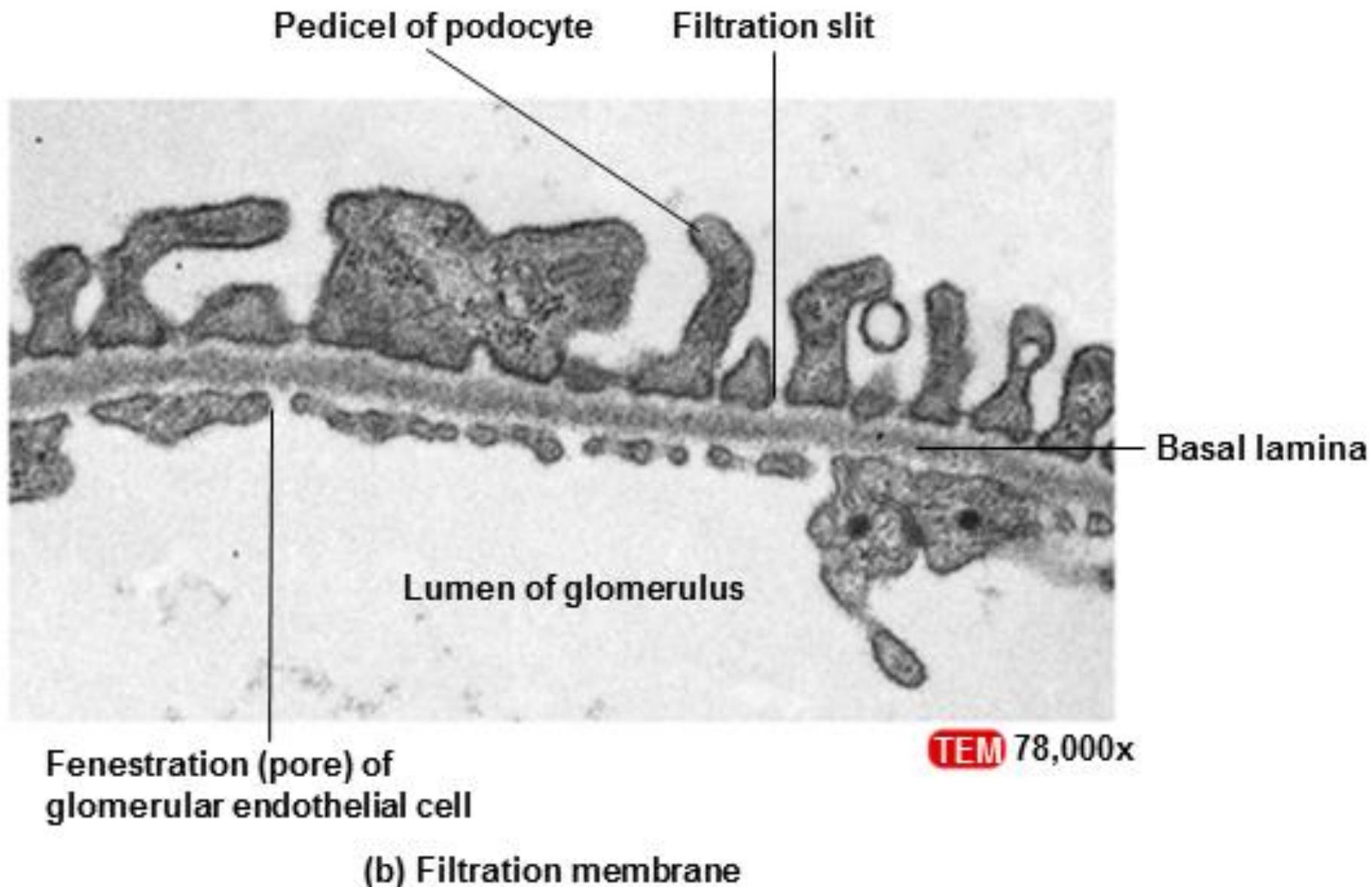
- stellate cells
- closely applied to the capillaries.
- radiating **primary processes** embrace the vessels
- Primary processes give off **secondary processes / Podocyte feet / foot processes**
- secondary processes interdigitate with corresponding foot processes of neighboring podocytes
- This forms system of intercellular clefts - **filtration slits** (20-30 nm. wide)
- each slit spanned by a thin **filtration slit diaphragm**

Glomerular filtration barrier

Barrier : between blood in glomerular capillaries & capsular space of Bowman.



Glomerular filtration barrier



Glomerular filtration barrier

- 1. fenestrated endothelium** of the glomerular capillaries.
This will not hold back anything smaller than platelets.

- 2. Glomerular basement membrane (electron dense-lamina densa)**

physical barrier - selective macromolecular filter

(prevention of plugging : continuous blood flow & phagocytic activity of glomerular mesangial cells)

charge barrier (-ve proteoglycan) - Cationic molecules

- 3. Glomerular epithelium –filtration slit diaphragm**
present between adjacent foot processes.
Additional molecular sieve.

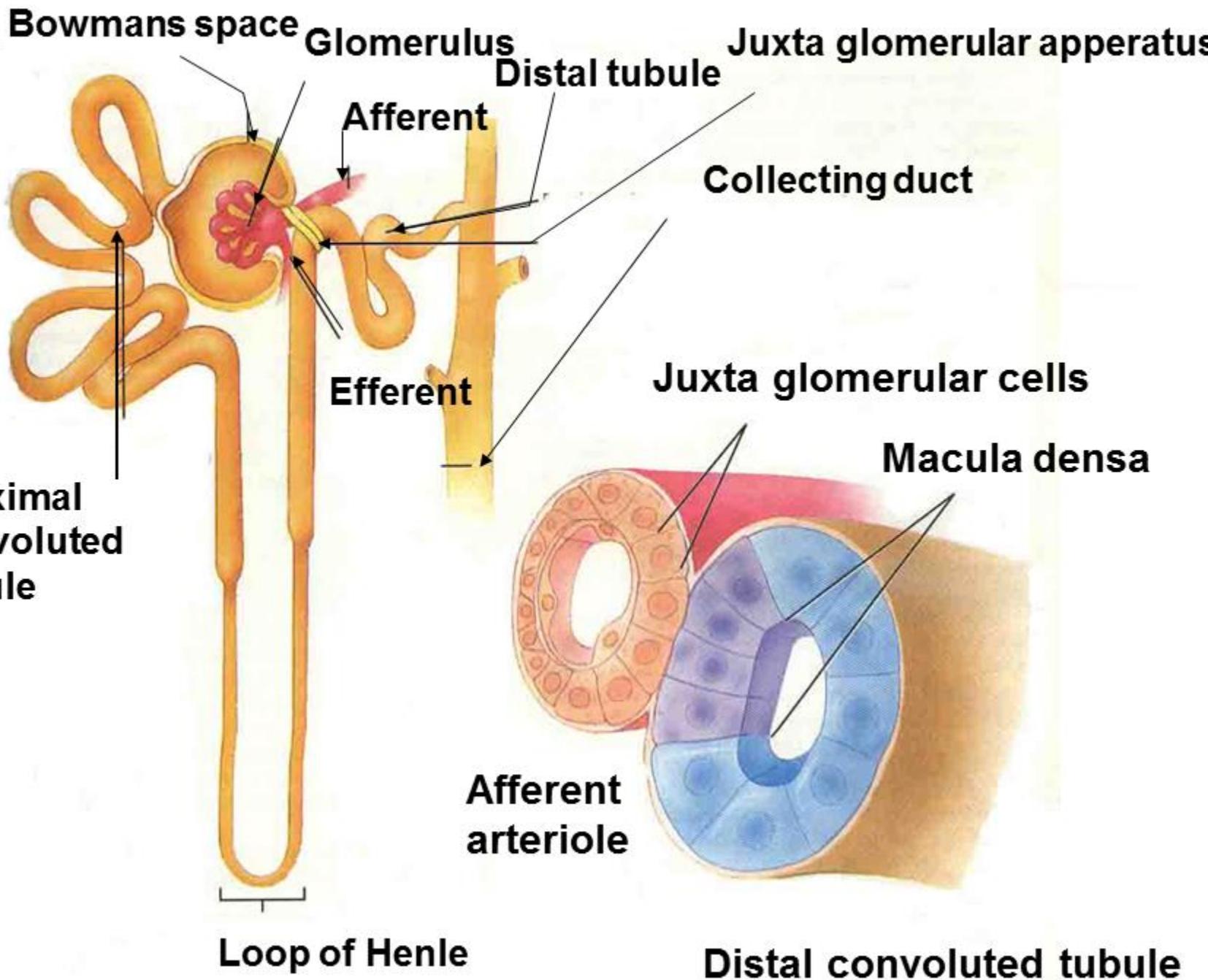
Let's Take a Break...back in 10 mins

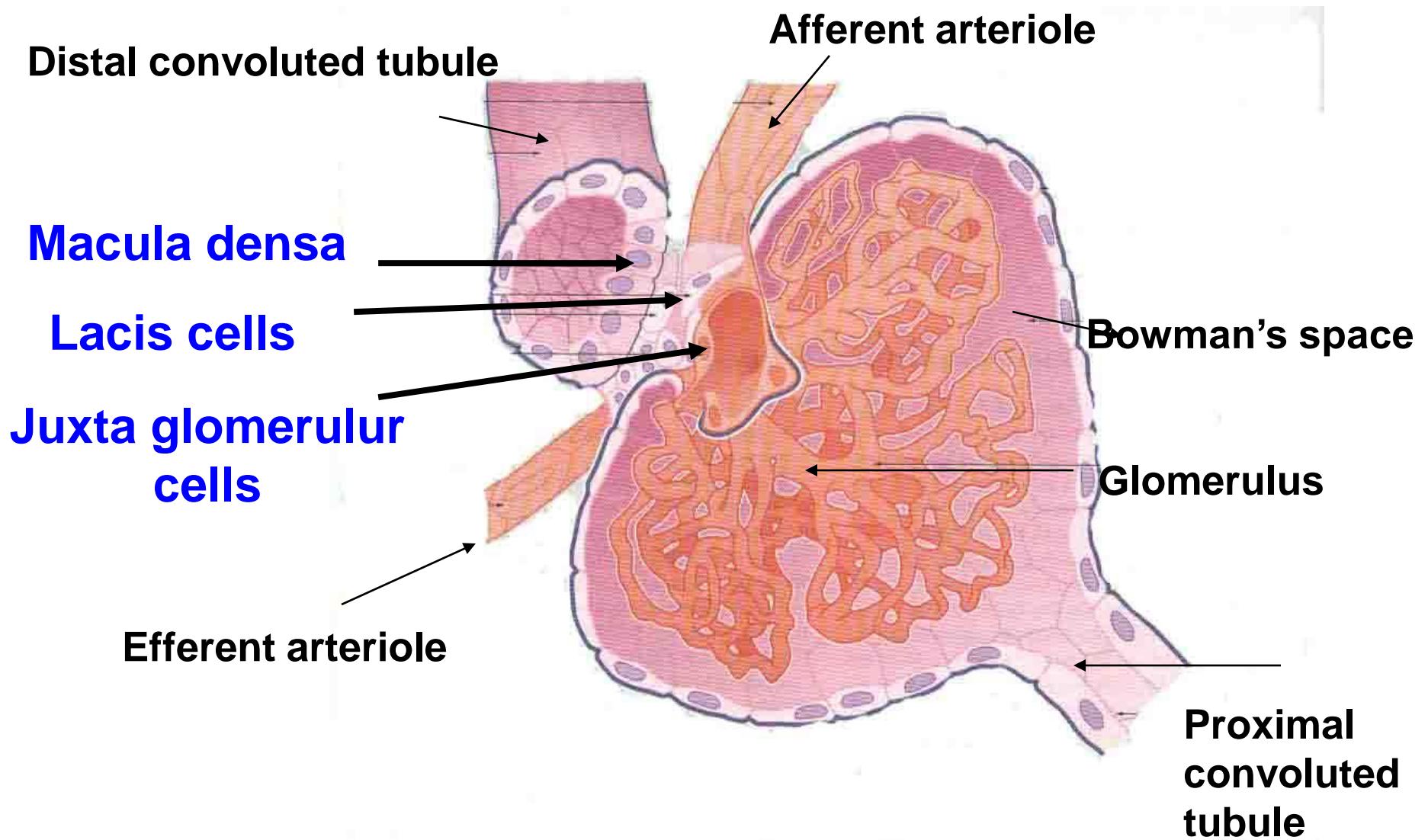




BC - Bowman's capsule (parietal layer) Pod - podocyte (visceral layer of Bowman's capsule)
MD - macula densa JG - juxtaglomerular cells DC - distal convoluted tubule

Nephron





Vascular pole : cell types

Vascular pole : cell types

- vascular pole : distal convoluted tubule fits between the afferent and efferent arterioles.
- A specialized region present in the **distal tubule** at this site.

In the wall of the tube facing the glomerulus

- epithelial cells → narrower than usual
- nuclei come closer together → densely nucleated



Macula Densa

- Between macula densa and glomerulus, between afferent and efferent arterioles Lacis cells are located
- They are group of small cells with pale stained nuclei



extra glomerular mesangial cells /lacis cells

- **Most significant feature of the vascular pole**
Presence of specially modified smooth muscle cells in the media of afferent arteriole known as juxta glomerular (JG cells) cells

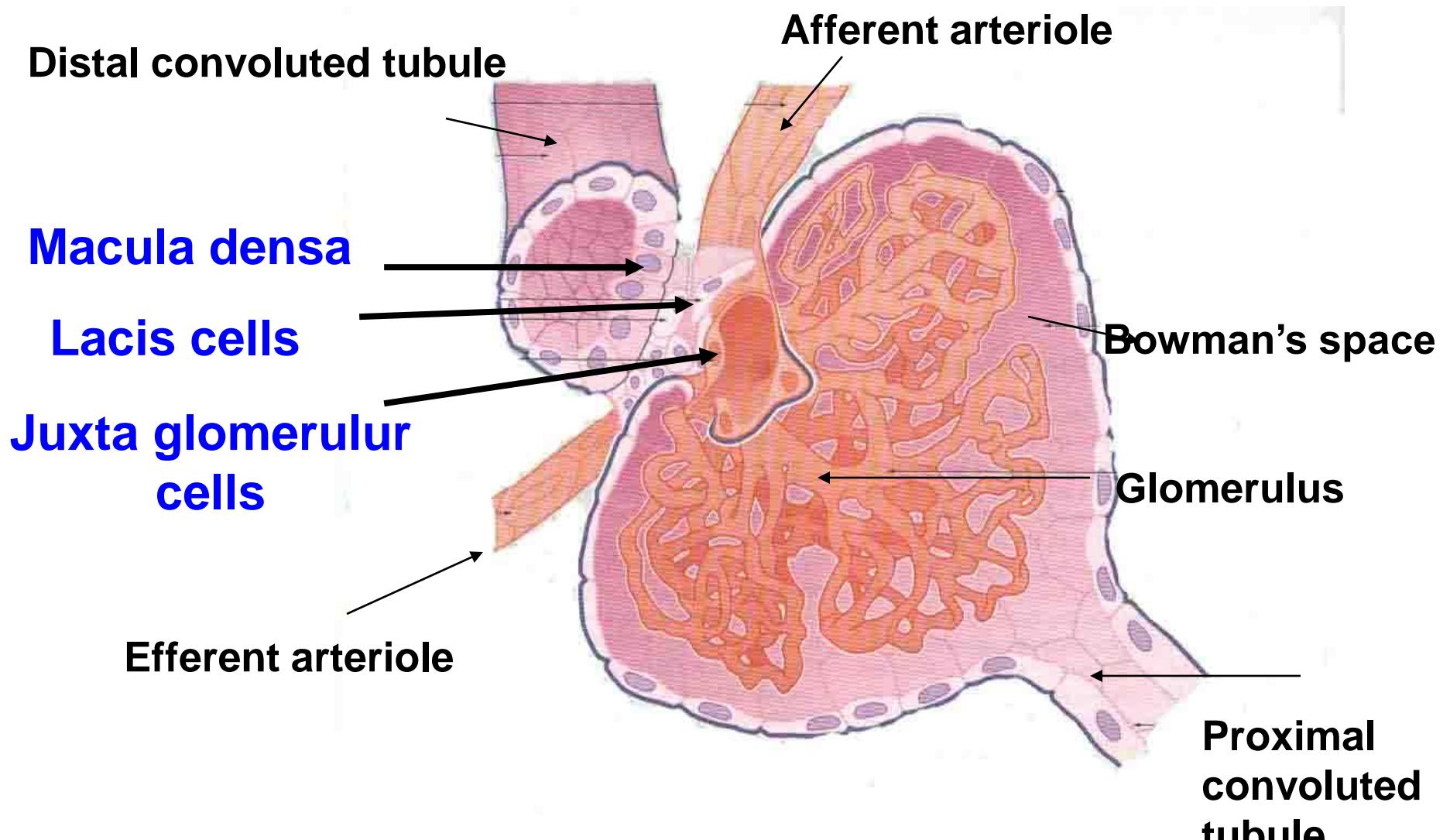
Vascular pole : cell types

- Unlike smooth muscle cells JG cell nuclei are rounded
- Cytoplasm contain large secretary granules

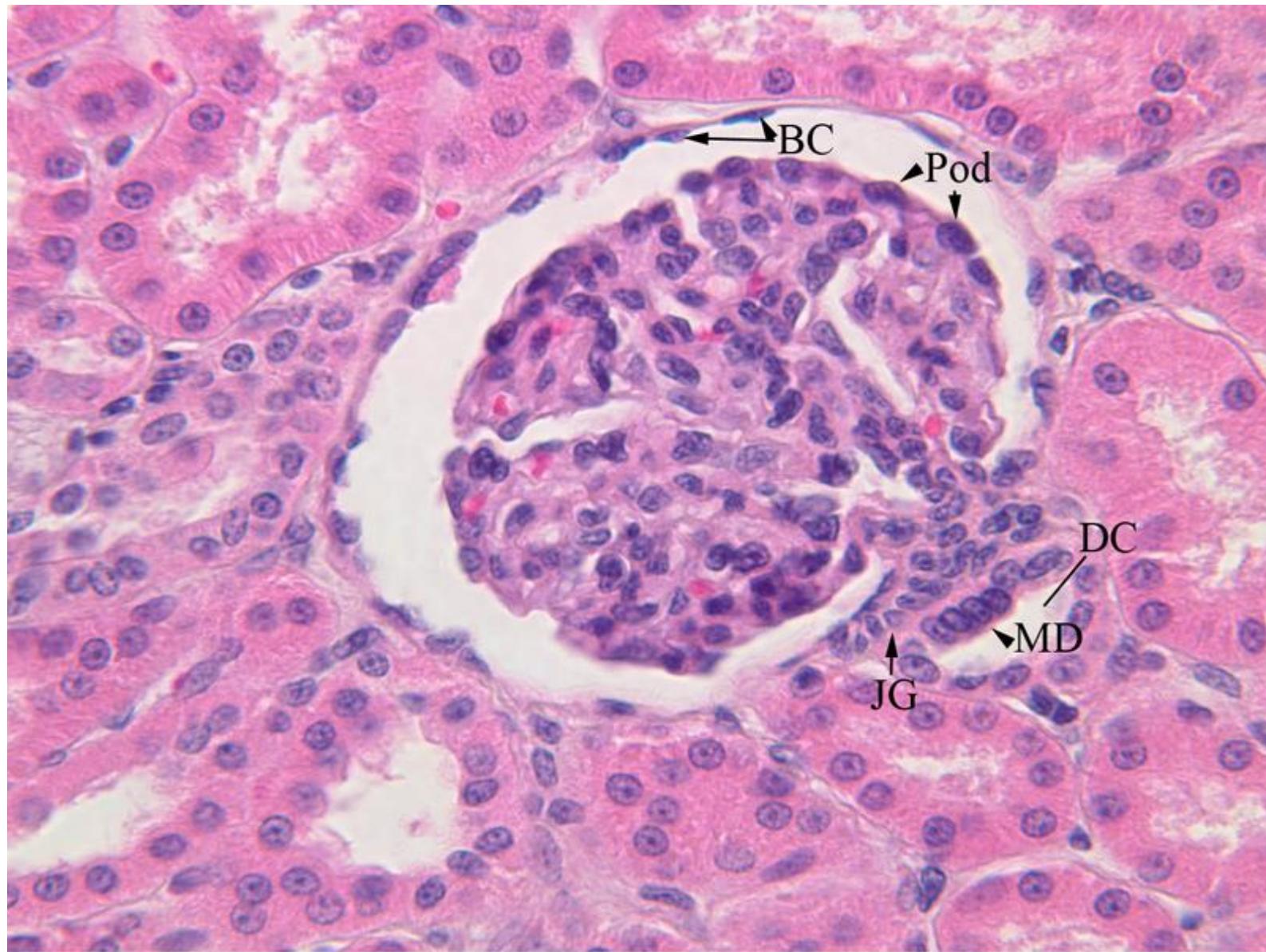
Macula densa + lacis cells + JG cells together known as

Juxta glomerular complex

- JG cells are important for regulation of blood pressure
- Granules contain Renin enzyme
- When, decrease in blood pressure Renin enzyme is liberated into blood stream

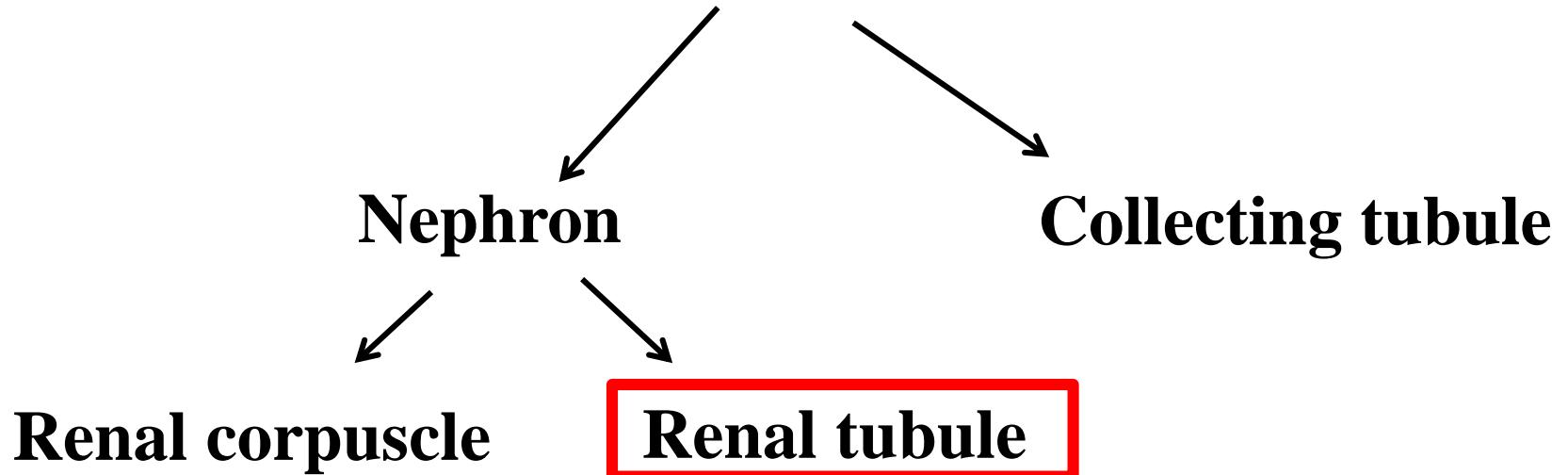


Cell types & functions ????

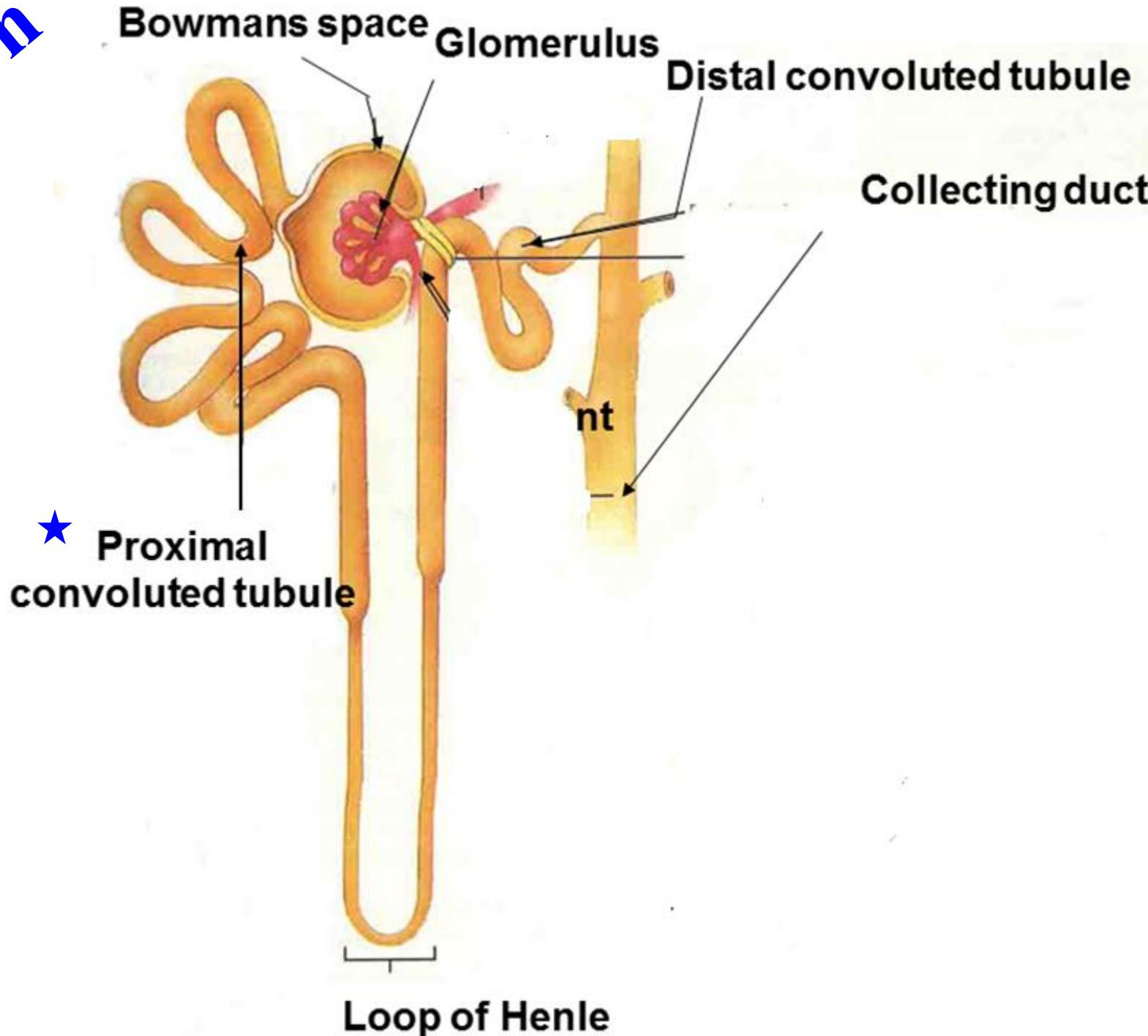


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Uriniferous tubule



Nephron





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Proximal convoluted tubule/ PCT

- Longer than the DCT
- More cut sections are seen near the renal corpuscles.
- Lined by simple cuboidal epithelium.
- Cells are larger and wider
- More acidophilic.
- Basal spherical nucleus.

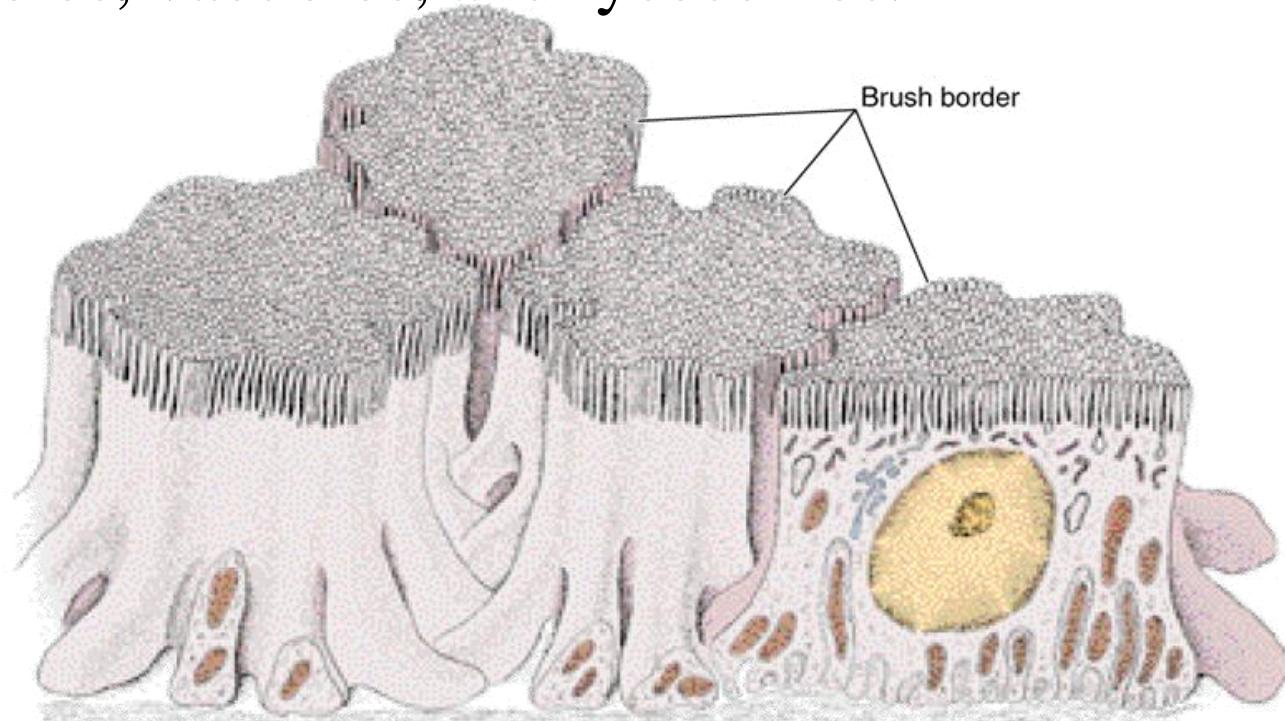
Proximal convoluted tubule

- Lateral borders are indistinct as they interdigitate with adjacent cells.
- Luminal borders are covered with microvilli – **striate or brush border.**
- PCT absorbs- water, many ions, glucose , amino acids.
- PCT excretes certain metabolites, dyes, drugs
- Active transport of Na and Cl
- Shows the features of ion transporting cells.

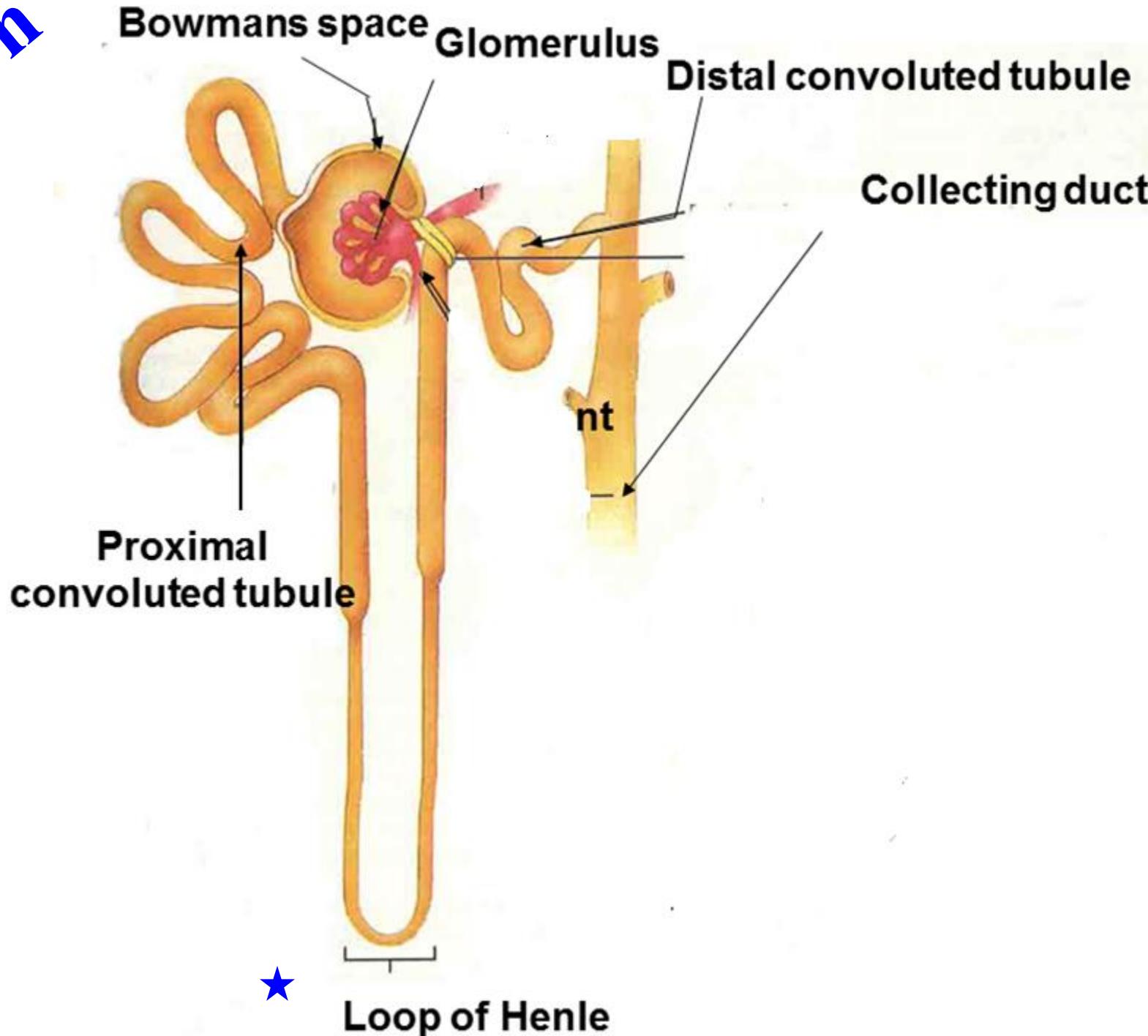
Proximal convoluted tubule

Simple cuboidal epithelium

- a. Well developed brush border (apical microvilli), contains peptidases.
- b. Basal striations and lateral interdigitations.
- c. Prominent endocytotic apparatus with pinocytic vesicles, vacuoles, and lysosomes.



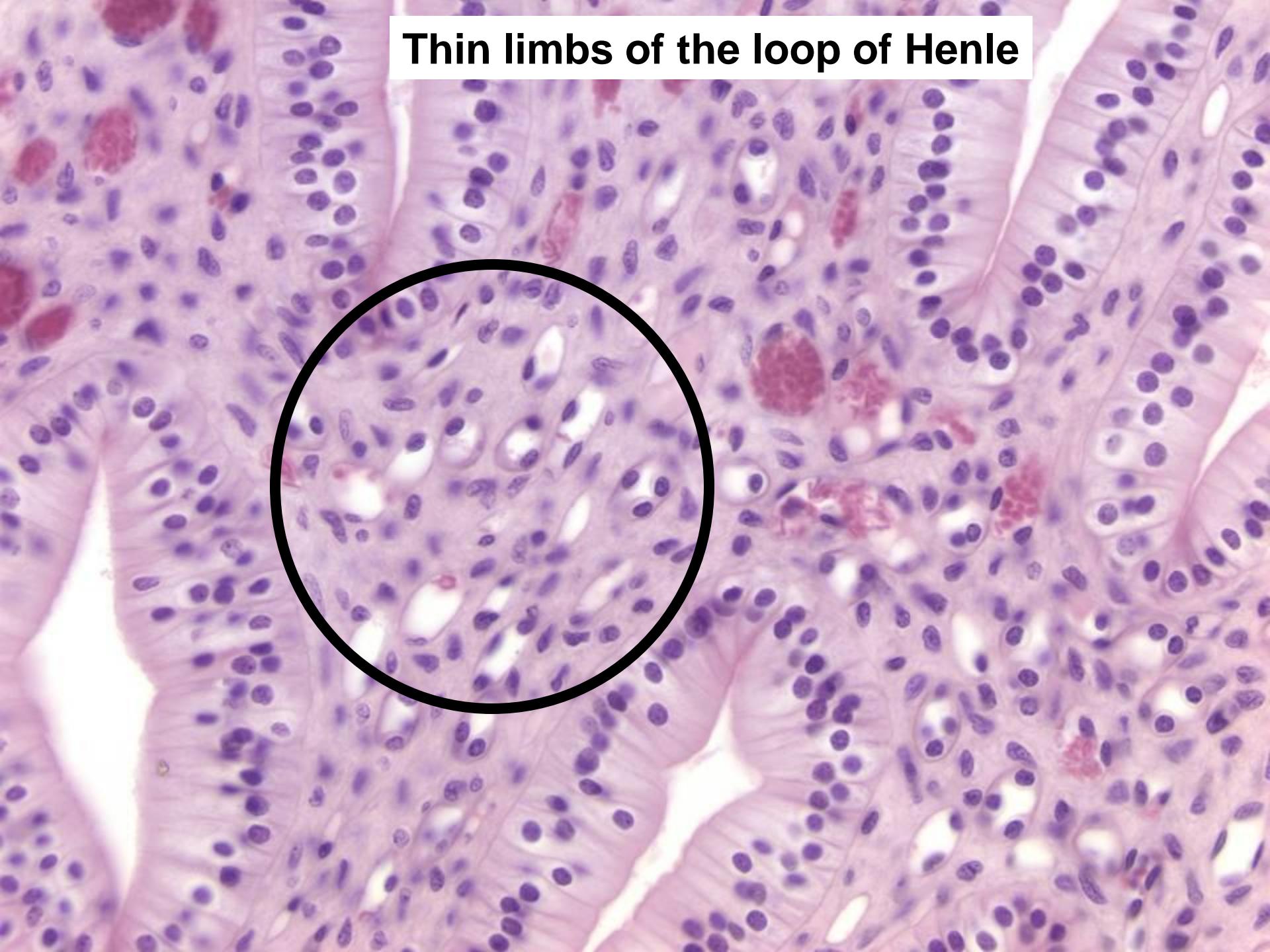
Nephron



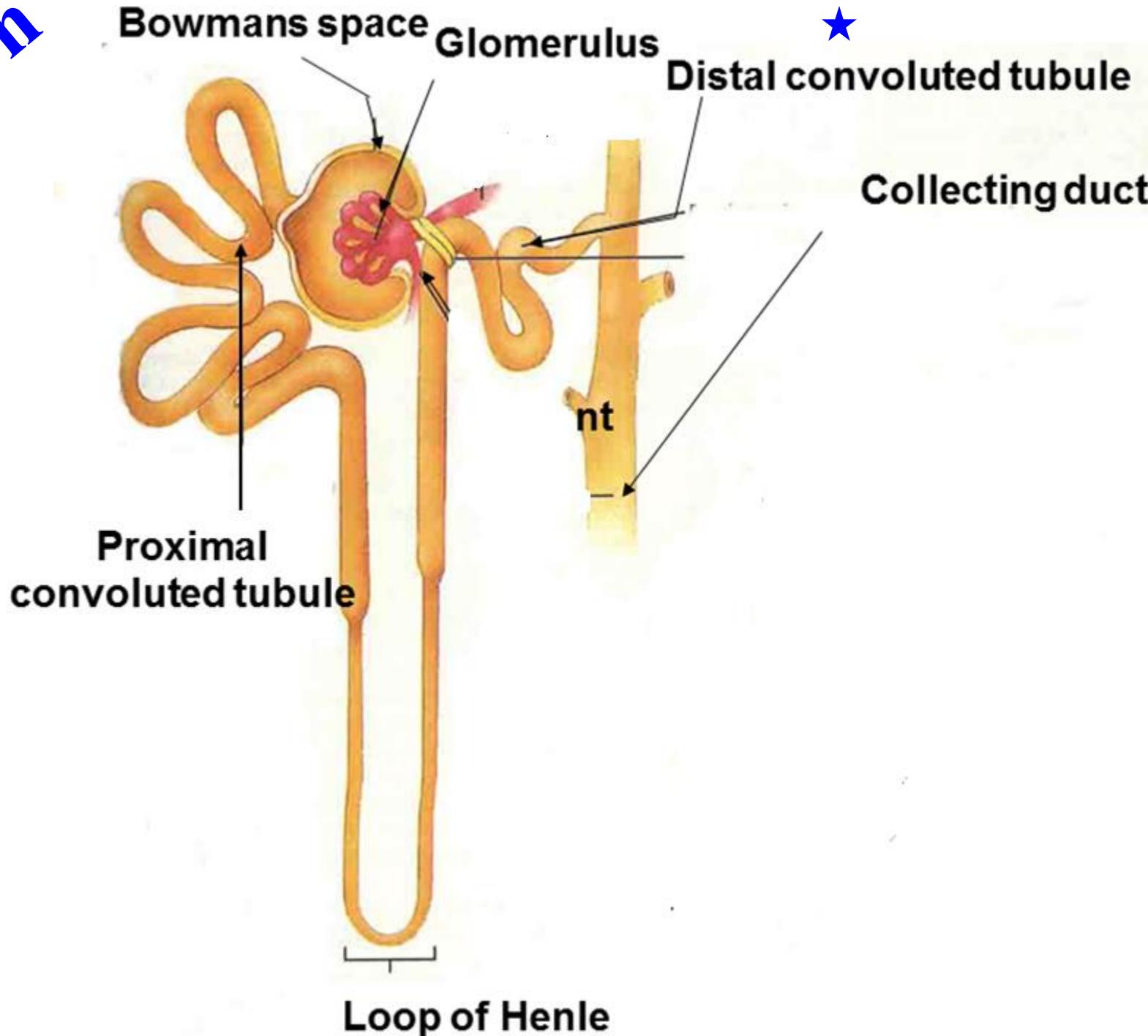
Loop of Henle

- Thick descending portion- continuation of PCT
structurally similar to PCT
- Thin descending portion
- Thin ascending portion
- Thick ascending portion-
represent the beginning of distal tubule
approaches the vascular pole of the glomerulus and
continue as DCT
- All thin segments are lined by a single layer of
squamous epithelium

Thin limbs of the loop of Henle



Nephron



Distal convoluted tubule

- Most distal part of the nephron.
- Like PCT, is situated in the renal cortex.
- Begins at the macula densa at the vascular pole.
- Pursues a tortuous course until it reaches the proximal end of the collecting tubule.

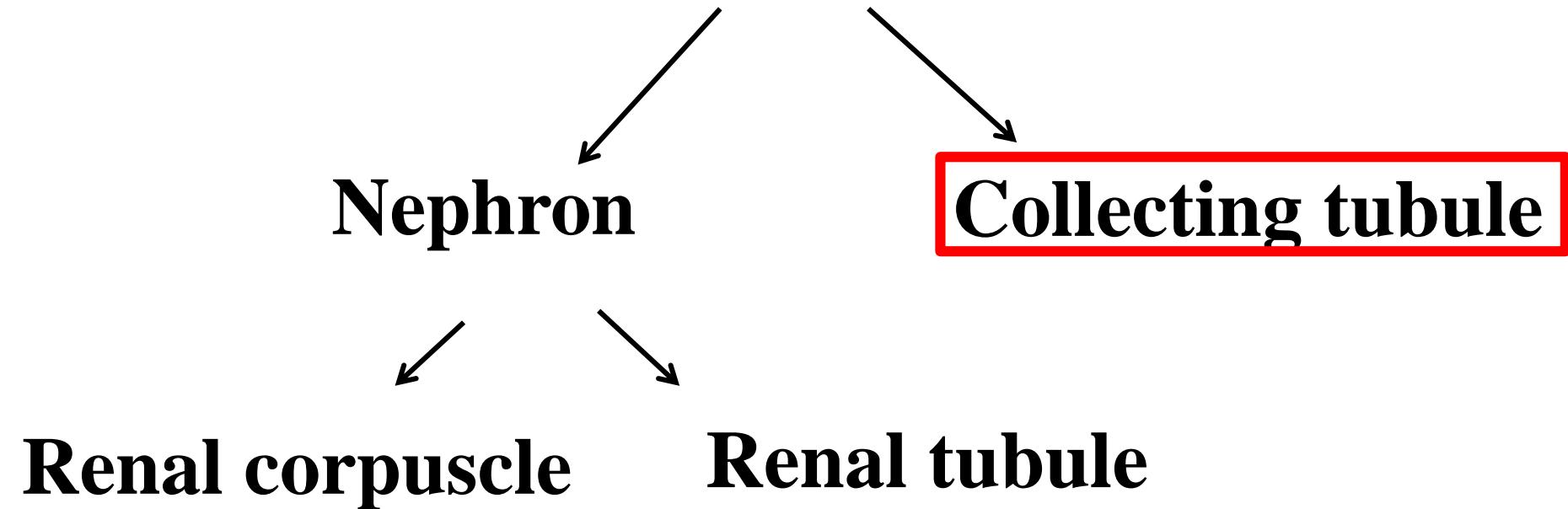
Distal convoluted tubule

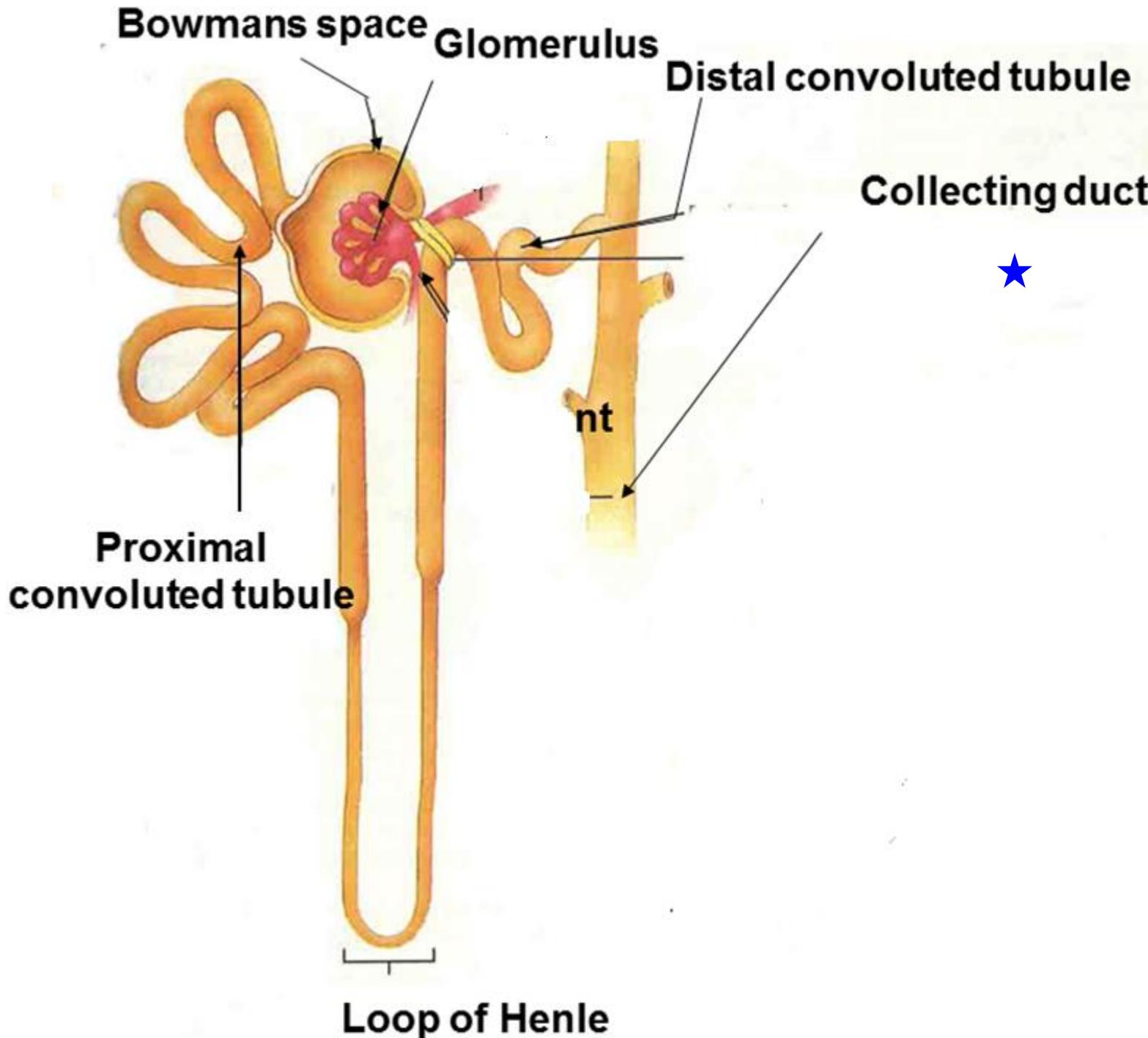
- Being shorter than PCT, less numerous sections.
- Cells are not as large as PCT
- Less acidophilic.
- More spherical nuclei in the wall.
- Lumen is wider.
- Does not exhibit a distinct striate border.
- Lateral borders are more distinct.



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Uriniferous tubule

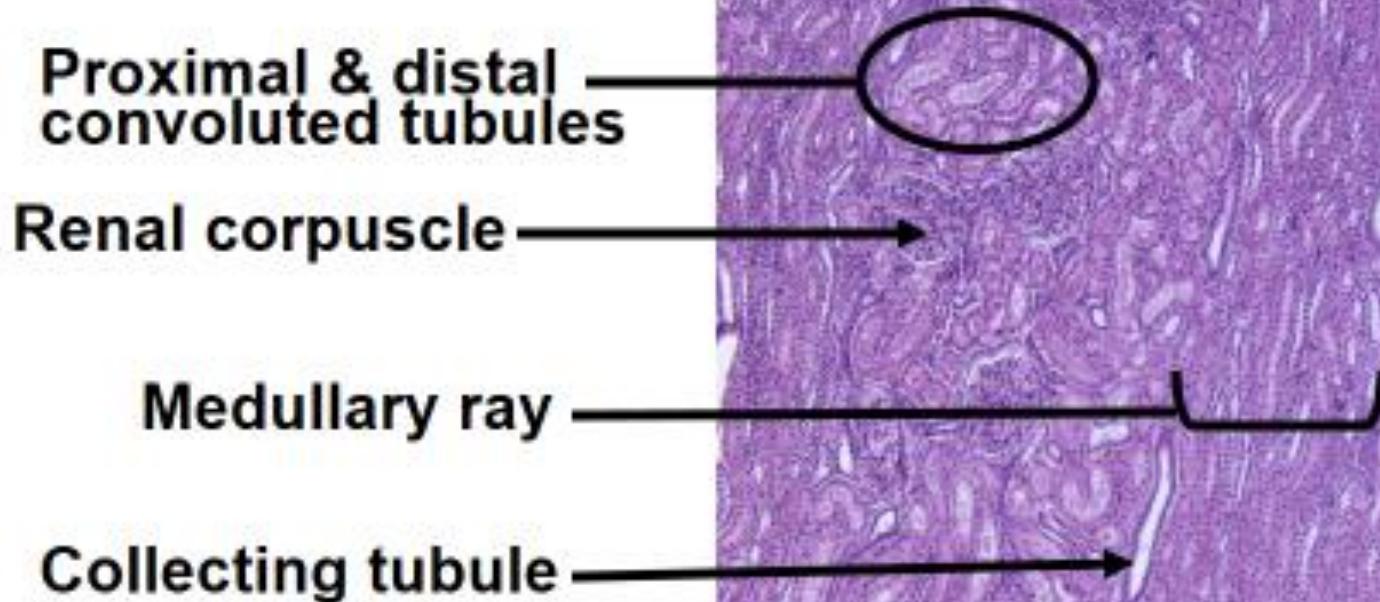


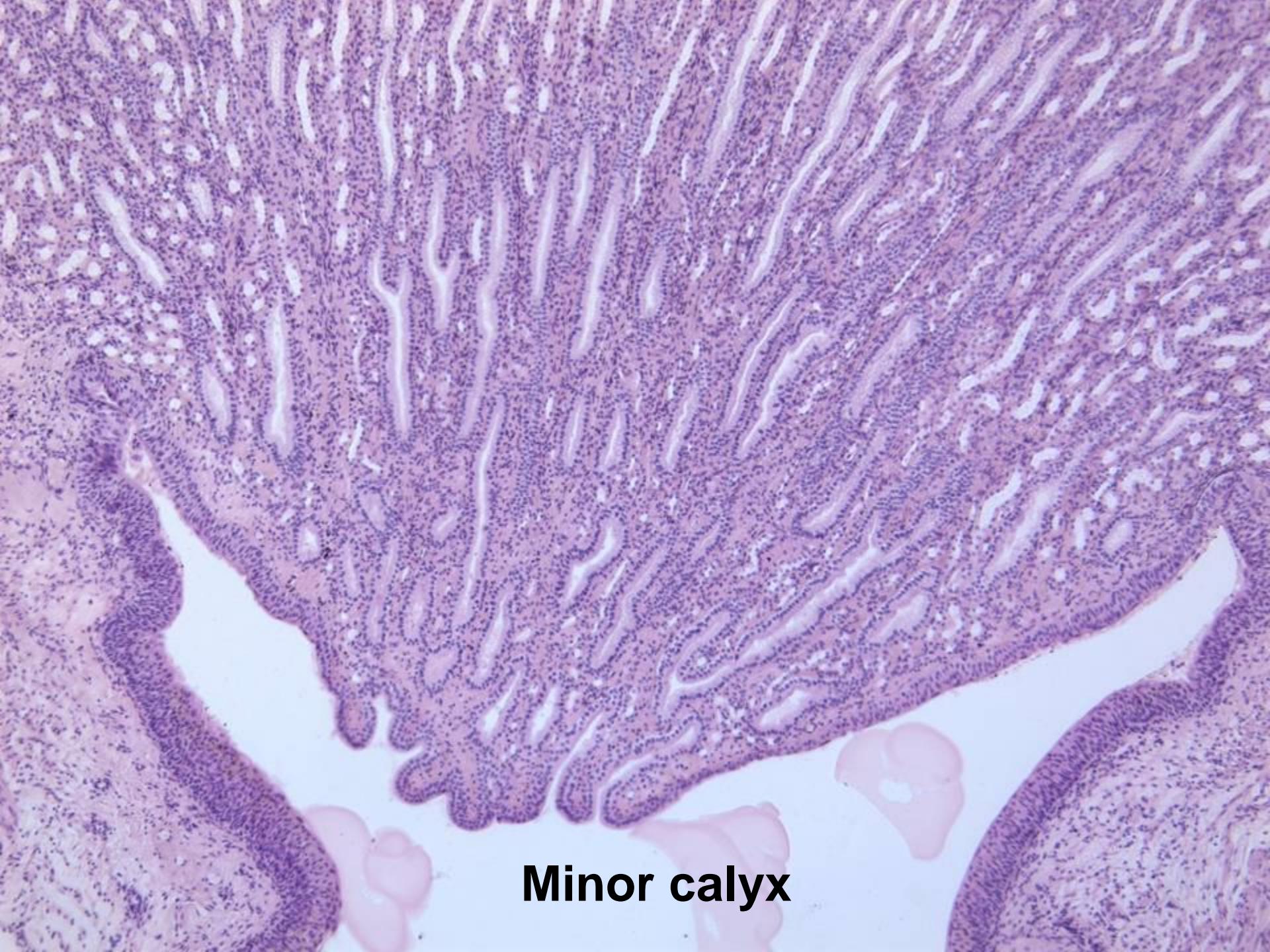


Collecting tubules

- They are distinguishable as they are made up of cuboidal or columnar cells.
- Wider lumen.
- Lateral borders of the cells are distinct.
- Key activities:
 - resorb water in response to vasopressin
 - resorb sodium in response to aldosterone

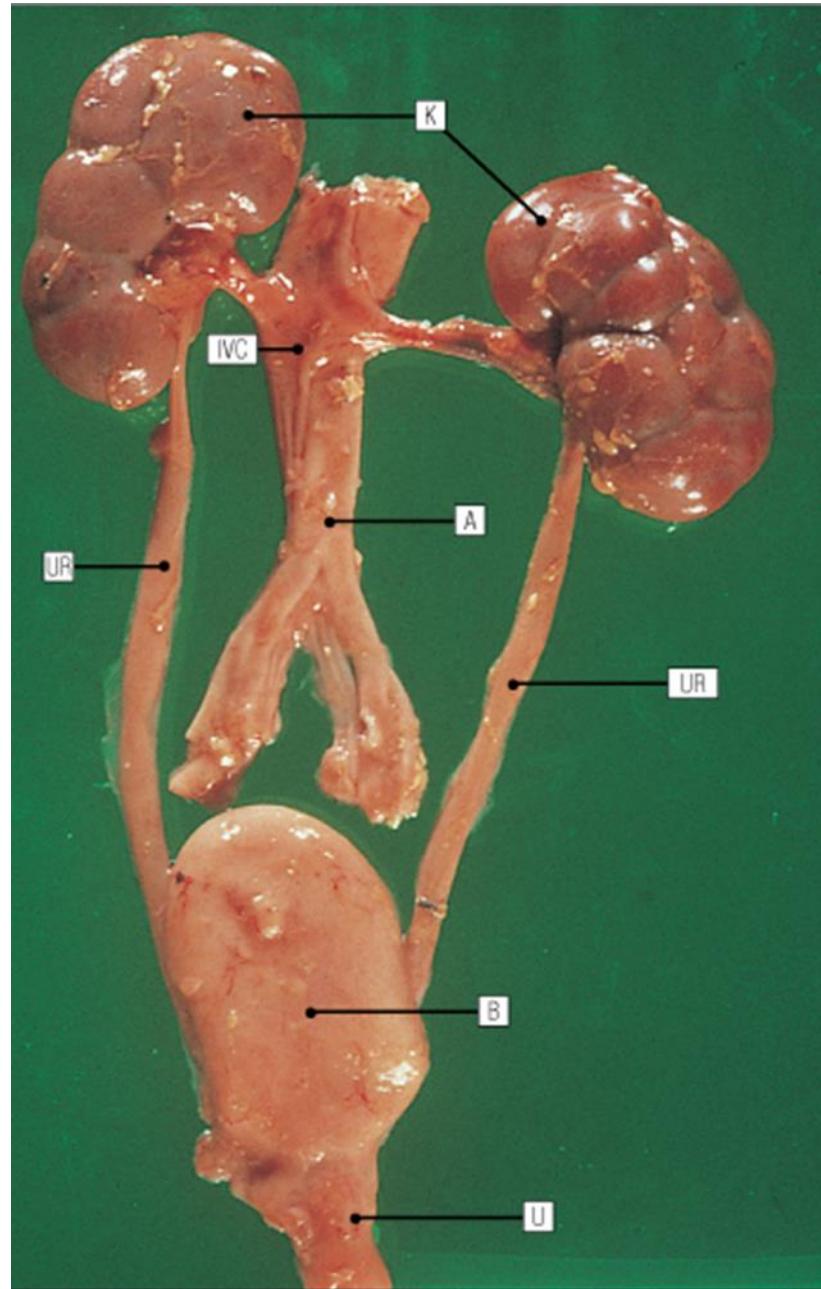
Collecting tubules





Minor calyx

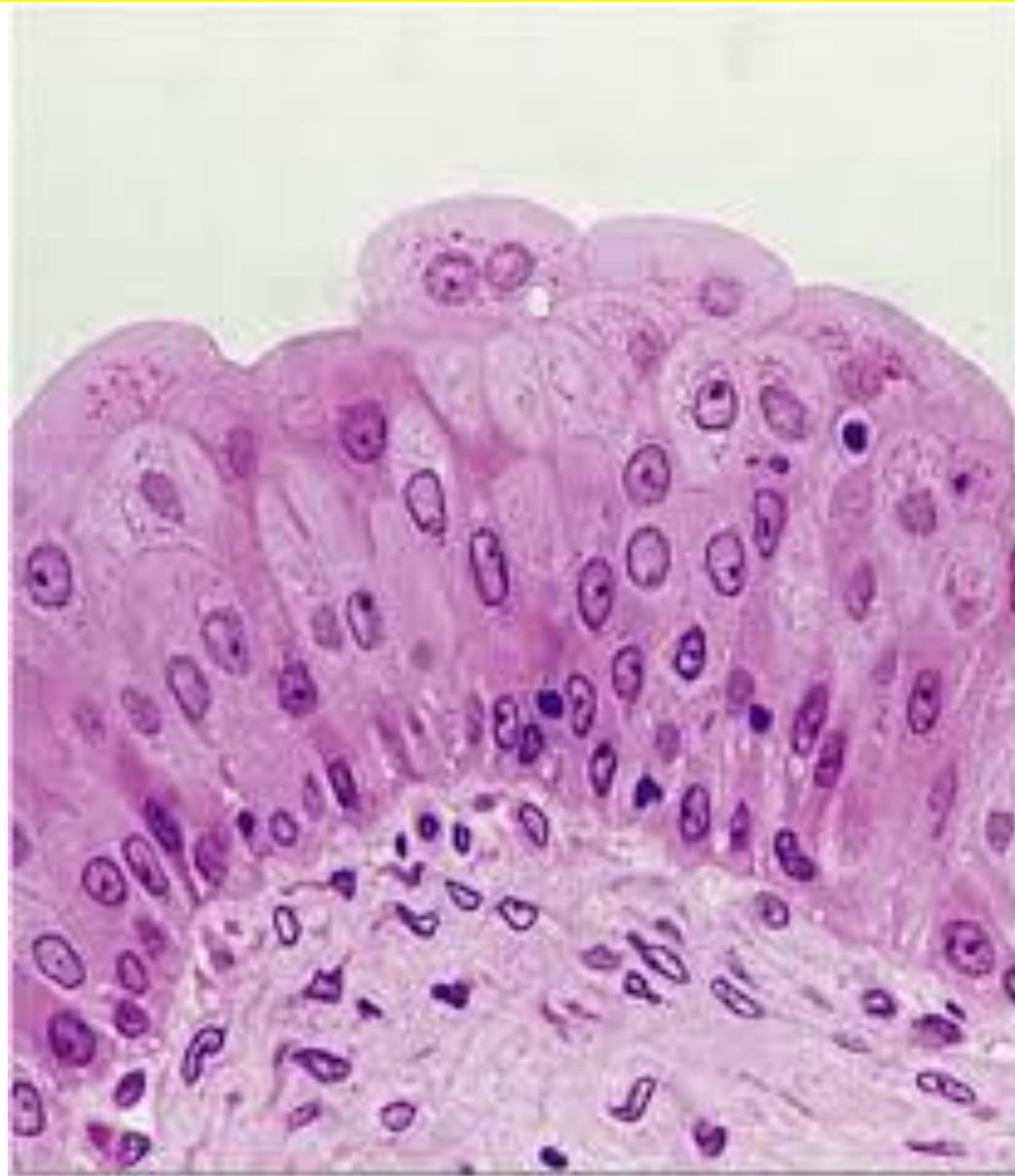
Urinary Organs



Ureters



Transitional epithelia



Ureters

- excretory ducts —————> fairly thick muscular wall
- Epithelium -transitional
- Lamina propria – prominent longitudinal folds
 - stellate appearance
- Muscular- upper 2/3rds – inner longitudinal and outer circular smooth muscles.
- In the lower third -3 layers – additional outer layer of longitudinal- important for peristaltic contractions .
- Outer most adventitia.

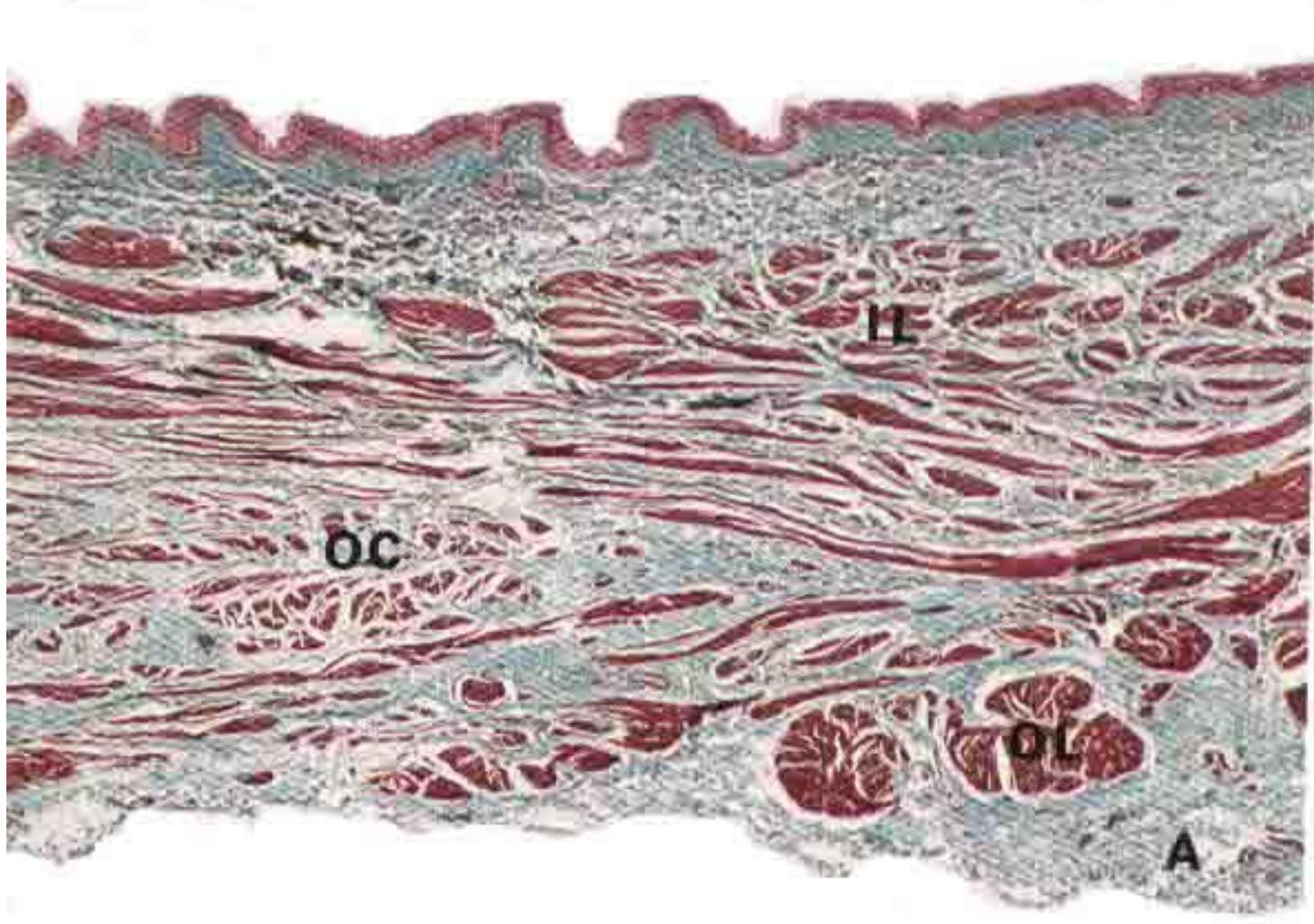
Urinary bladder

Urinary bladder- muscular reservoir → store of urine

3 layers-

- inner epithelium- transitional
in the contracted state → numerous mucosal folds
flattened with distension
- Muscular- 3 layers of smooth muscles like in lower part of the ureter.
- Adventitia- fibro-elastic connective tissue

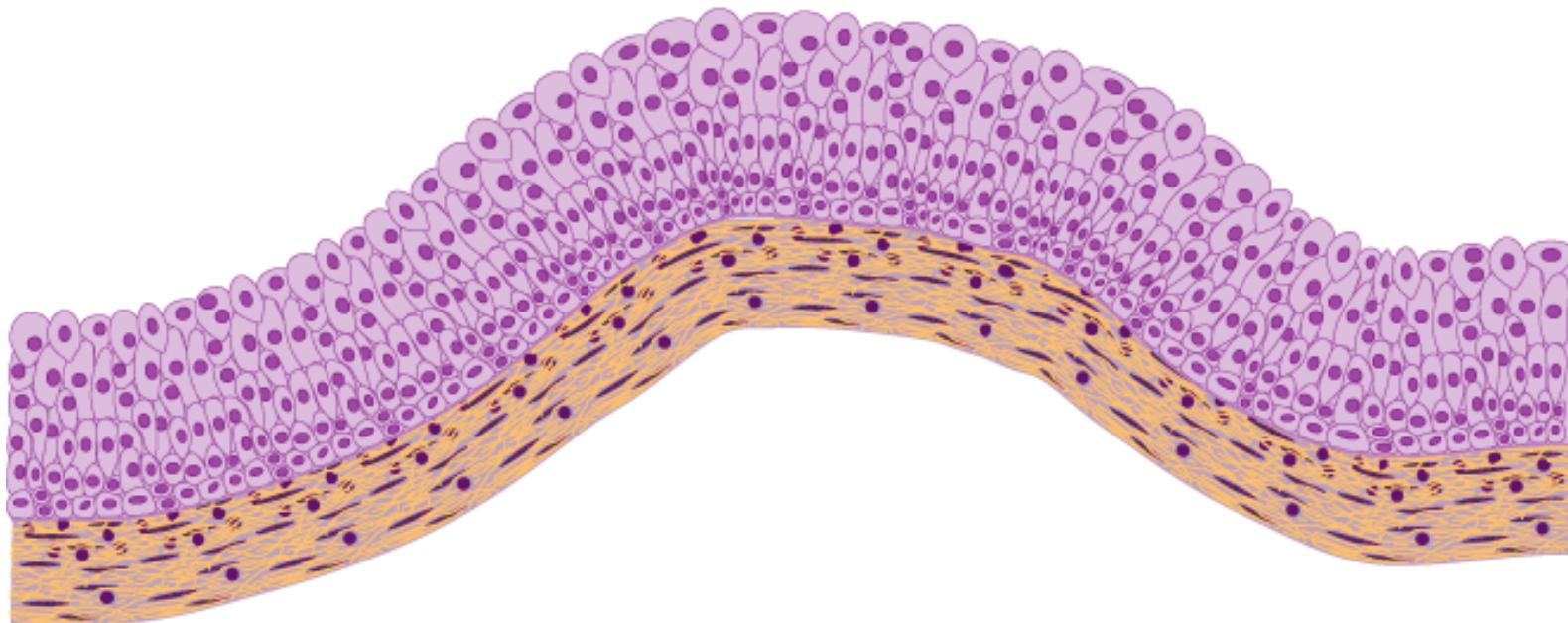
Urinary bladder



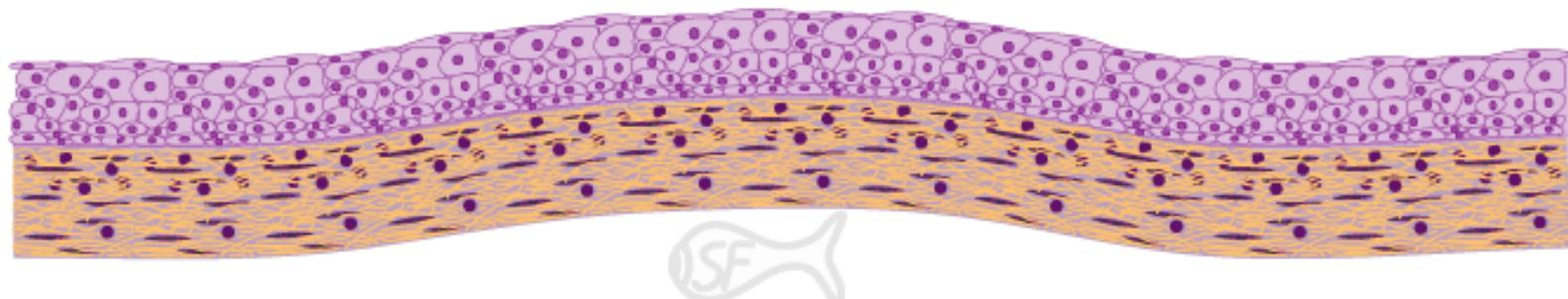
Section of the Bladder

Transitional epithelia changes depending on how full the urinary bladder is

Relaxed



Stretched (note dome cells become squamate)



Dome cells

Calyx epithelia

Urethrea

Unpaired excretory passage

Convey urine from the bladder to exterior of the body

Males: shared with the reproductive system

Female: simple , fairly straight muscular-walled tube

Female urethra:

- lined mostly by stratified/ pseudostratified columnar epithelium (near bladder – transition epithelium & near external urethral orifice – stratified squamous nonkeratinized)
- thick fibroelastic lamina propria
- small mucosal glands
- Muscular coat: inner longitudinal & outer circular layers of smooth mm
- Near external urethral orifice- skeletal mm fibers : sphincter urethrae

FEMALE URETHRA

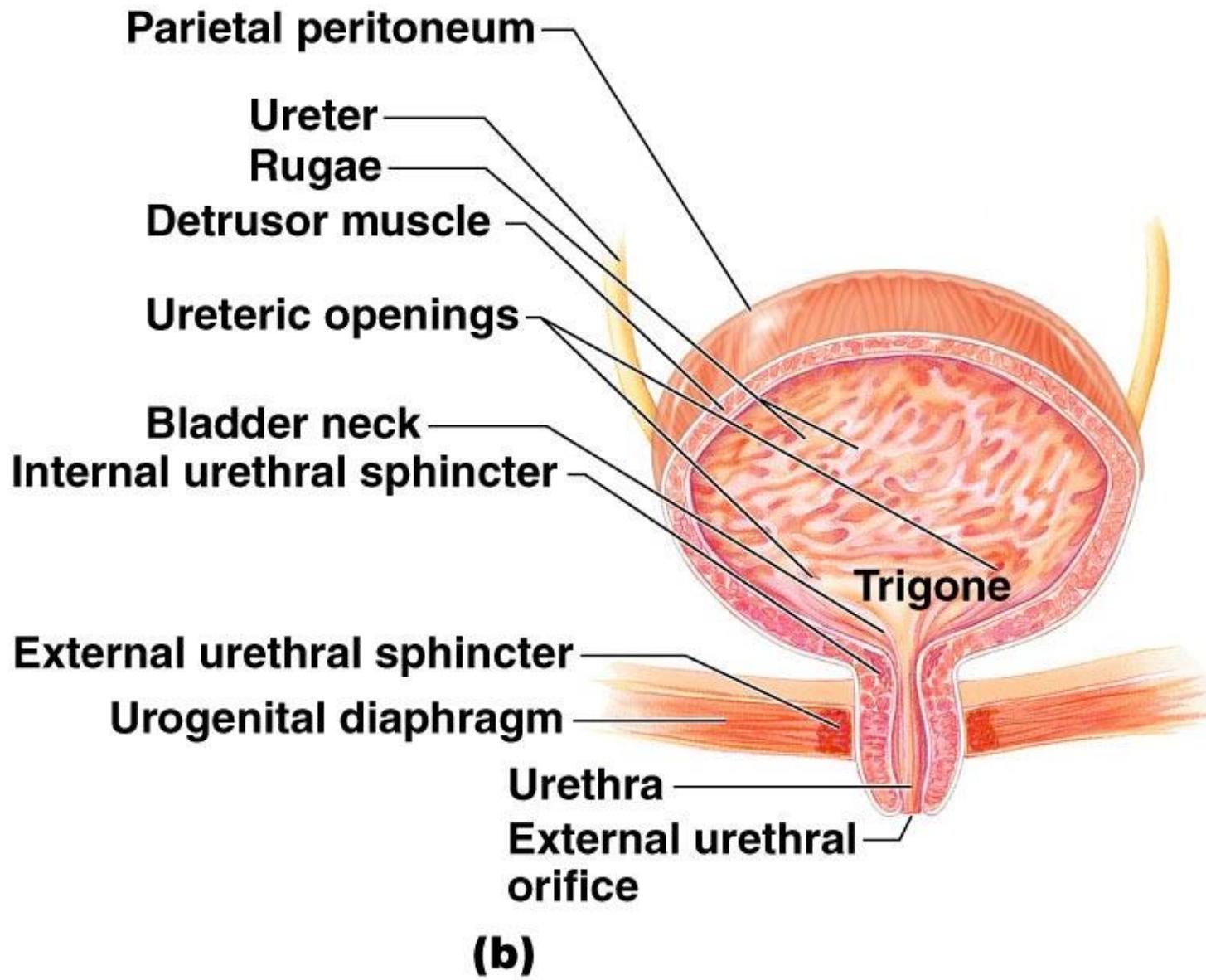


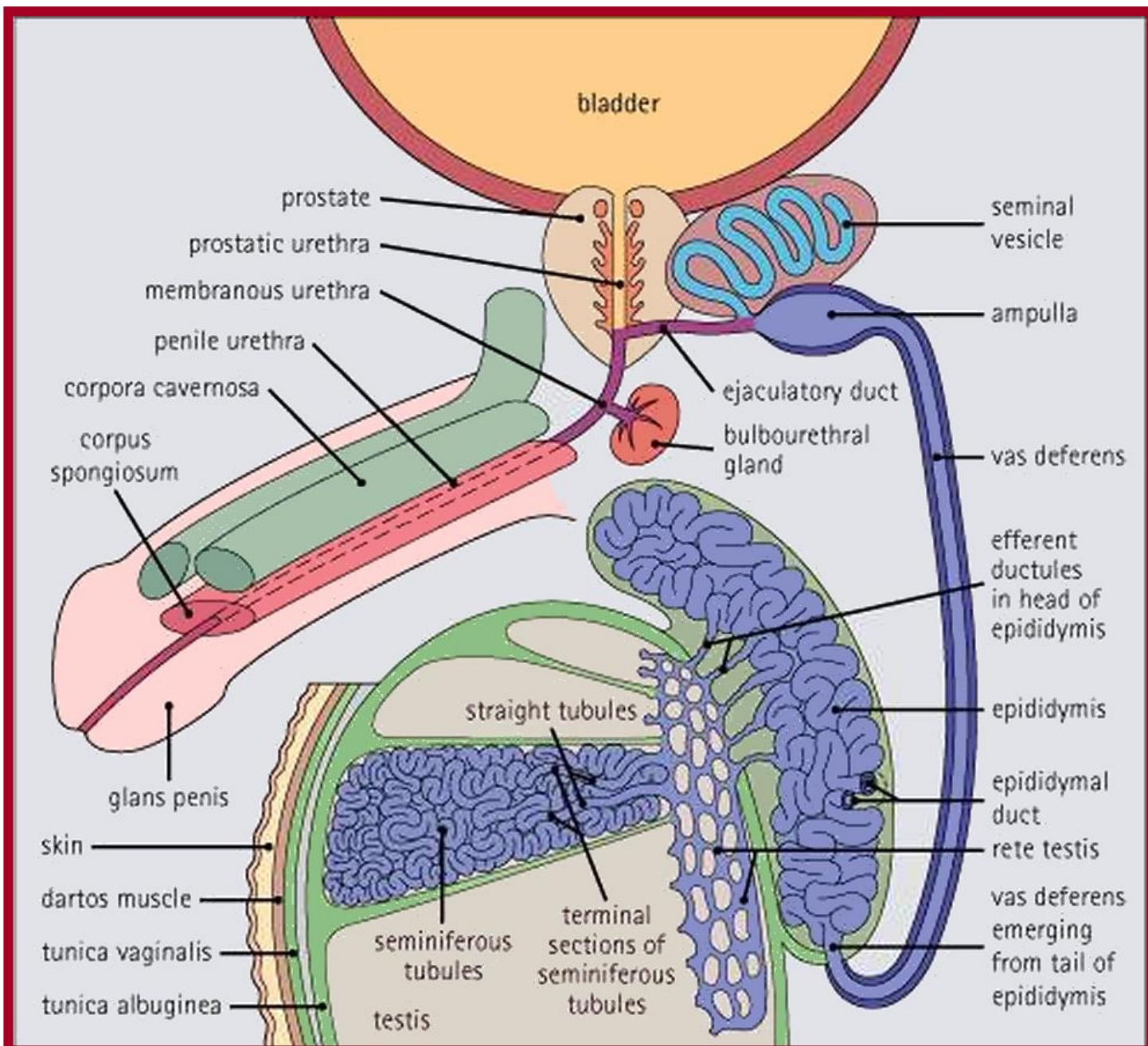
Figure 23.16b

Urethra

Male urethra:

- 3 parts : prostatic : pseudostratified / stratified columnar epithelium
 - membranous : stratified columnar epithelium
 - penile : stratified columnar epithelium at most distal part stratified squamous
- Glands:
 - Tubuloalveolar compound glands : viscous lubricating secretion under conditions of sexual arousal.
 - Urethral glands: mucus secretion
 - 2 bulbourethral glands

MALE URETHRA



Summary

References

Basic Histology - L.U.Junqueira

Wheater's Functional Histology

THANK YOU

