جامعة الملك سعود
King Saud University

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MED439
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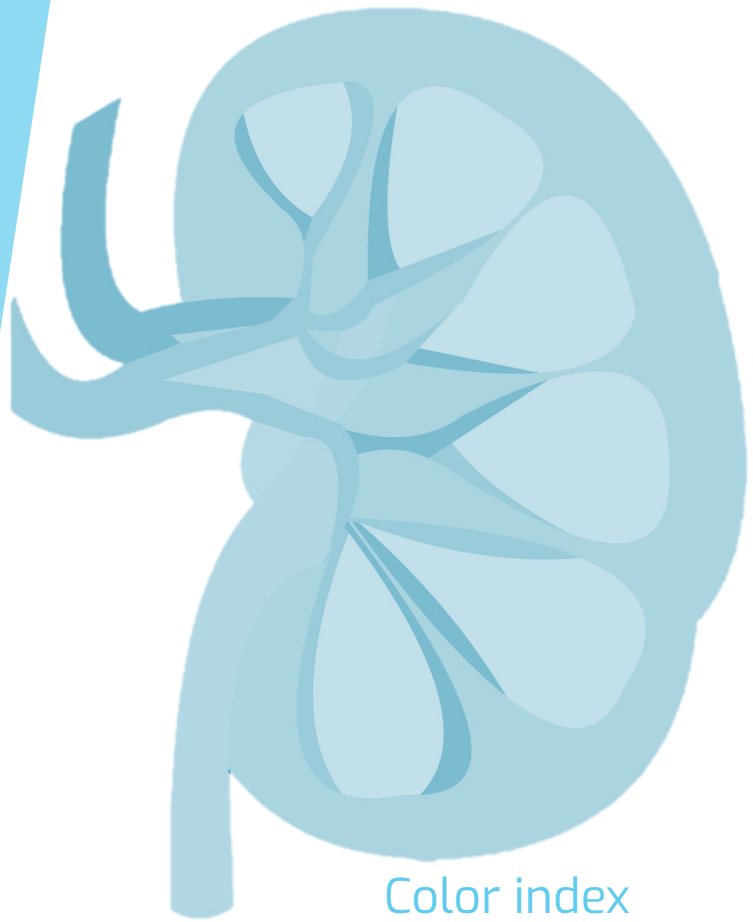


Histology of the kidney

Color index

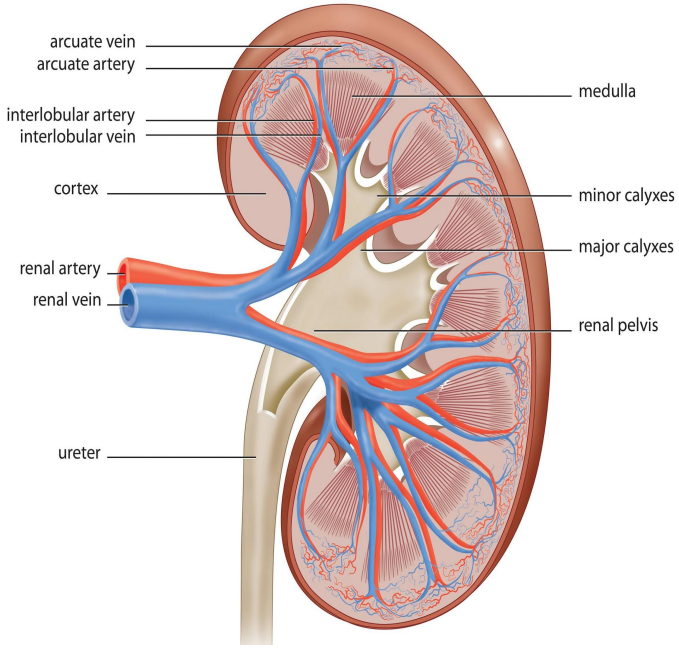
- boys & girls slides
- important
- Notes
- extra

Objectives:

By the end of this lecture, the student should be able to describe:

- The microscopic structure of the renal cortex and medulla.
- The histology of renal corpuscle, proximal and distal tubules, loop of Henle,and collecting tubules & ducts.
- The histological structure of juxtaglomerular apparatus.
- The functional structures of the different parts of the kidney.

The kidney



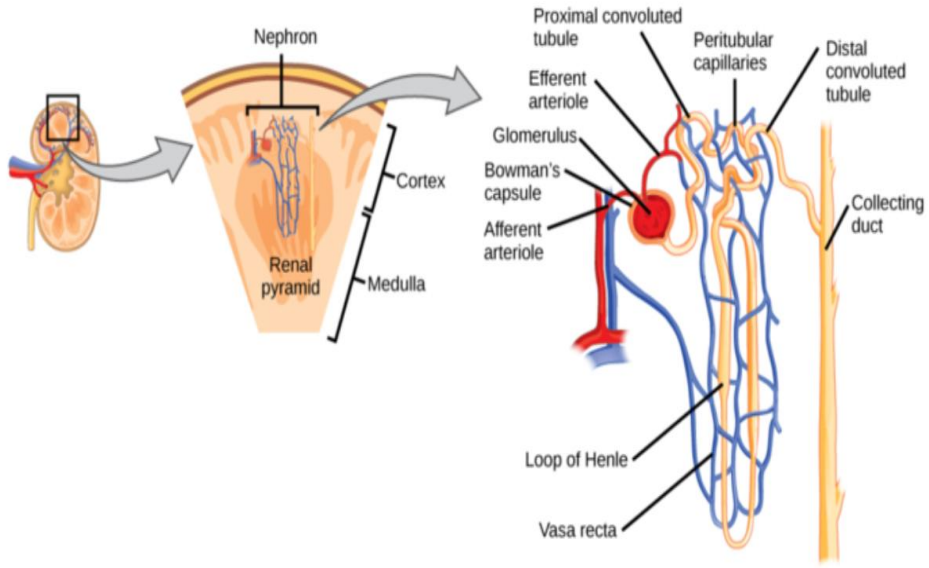
- Cortex: Dark brown and granular.
- Medulla: 6-12 pyramid-shape regions (renal pyramids)
- The base of pyramid is toward the cortex (cortico-medullary border)
- The apex (renal papilla) toward the hilum, it is perforated by 12 openings of the ducts of Bellini in region called area cribrosa. The apex is surrounded by a minor calyx.
- 3 or 4 minor calyces join to form 3 or 4 major calyces that form renal pelvis.
- Pyramids are separated by cortical columns of Bertin.

Uriniferous tubule

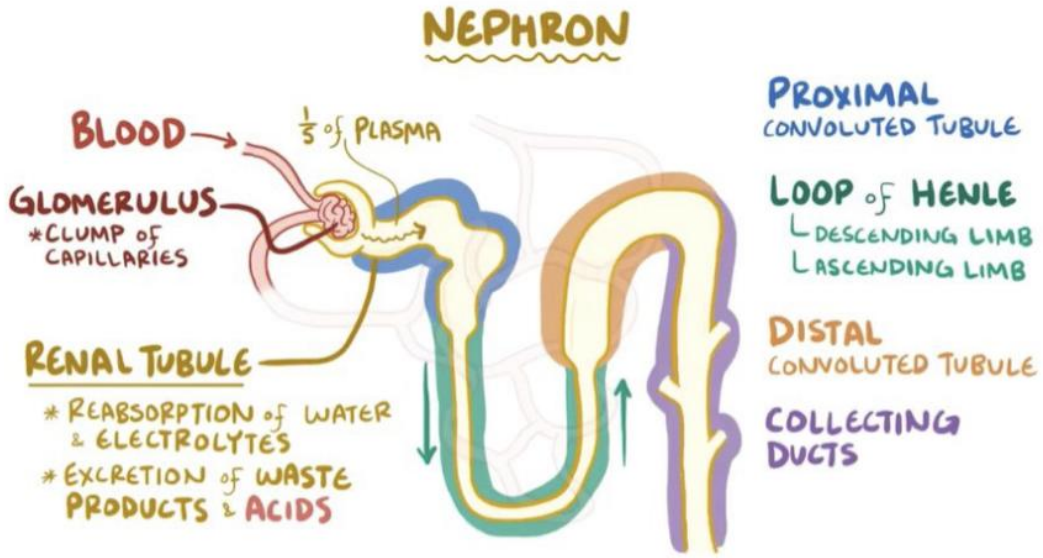
It is the **functional unit** of the kidney Is formed of:

1. Nephron.
2. Collecting tubule.

- The tubules are densely packed.
- The tubules are separated by thin stroma and basal lamina.



Nephron



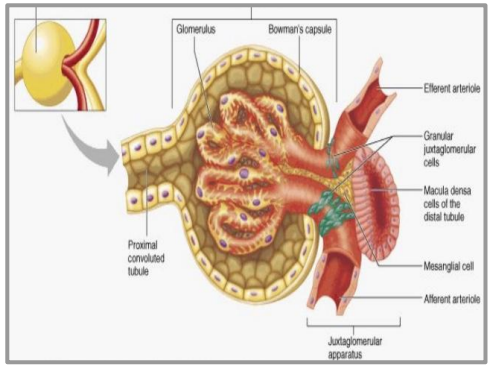
There are 2 types of nephrons: "according to position"
Cortical nephrons. "85% of nephrons" up in the cortex
Juxtamedullary nephrons. "Juxta=near" near to the medulla

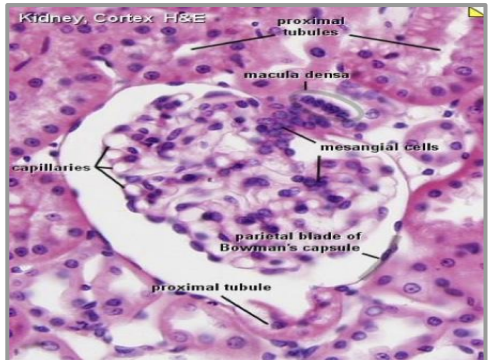
It is formed of :

1. **Renal corpuscle.**
2. **Proximal tubule.**
3. **Thin limbs of Henle's loop.**
4. **Distal tubule**

1- Renal corpuscle

The renal corpuscle is composed of glomerulus "a tuft of capillaries" surrounded by Bowman's capsule





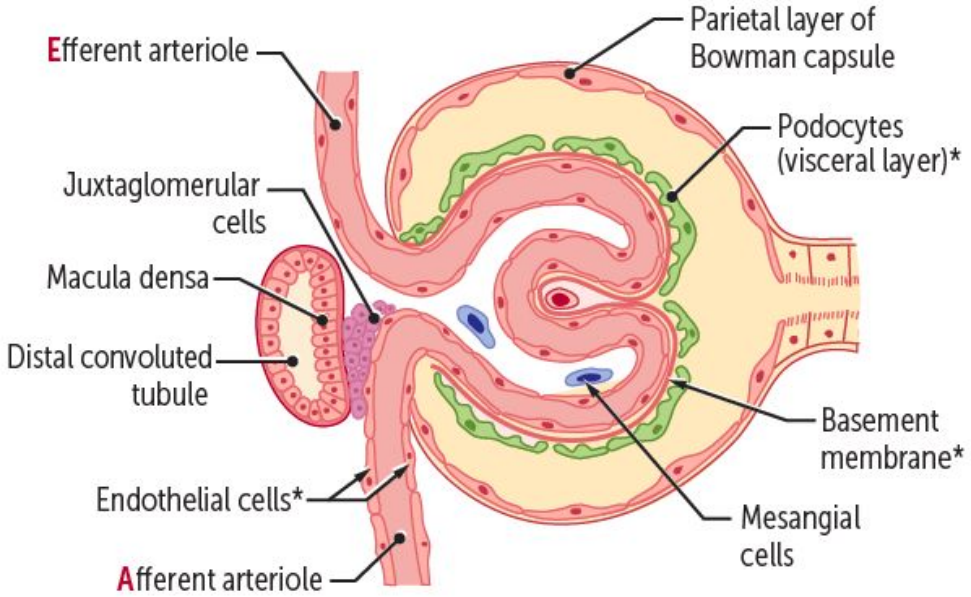
- **Glomerulus**; (tuft of **fenestrated capillaries "without diaphragm"**)
- **Bowman's capsule**;

1. Parietal layer outer layer (simple squamous epithelium)
2. urinary space accumulation of fluids in it
3. visceral layer or podocytes. "Podocytes are simple squamous epithelium modified cells of the visceral layer"

- **Mesangial cells**; (intra-glomerular cells).

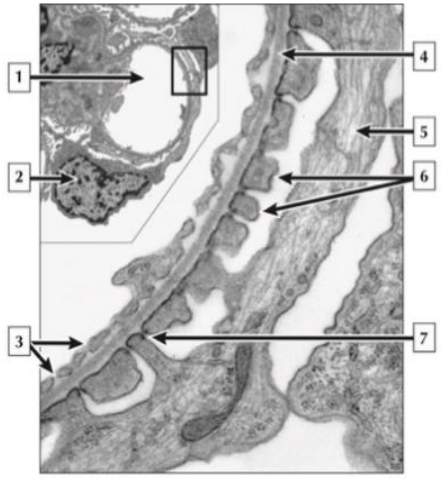
Glomerular Filtration Barrier

- **Endothelial** wall of the glomerular capillaries.
- **The glomerular basal lamina** (inner and outer laminae rarae and middle lamina densa).
  "Laminae rarae = 2 pale layers | lamina densa = 1 dark layer in the middle"
- Visceral layer of Bowman's capsule **(podocytes)**
- Podocytes have primary (major) processes and secondary (minor) processes "pedicles".
- Between pedicles (on the surface of capillaries) there are **filtration slits** that have **filtration slit diaphragms.**

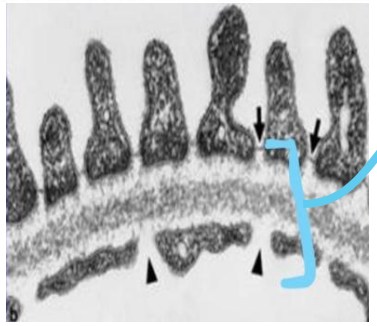


*Components of glomerular filtration barrier.

Cross-section of glomerulus A

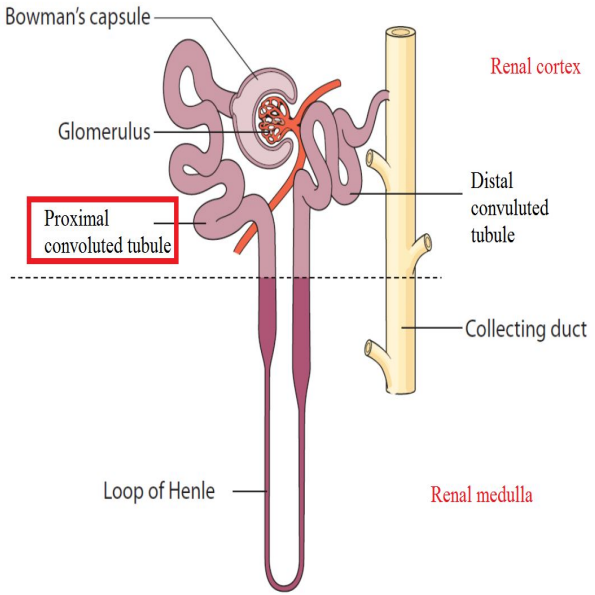


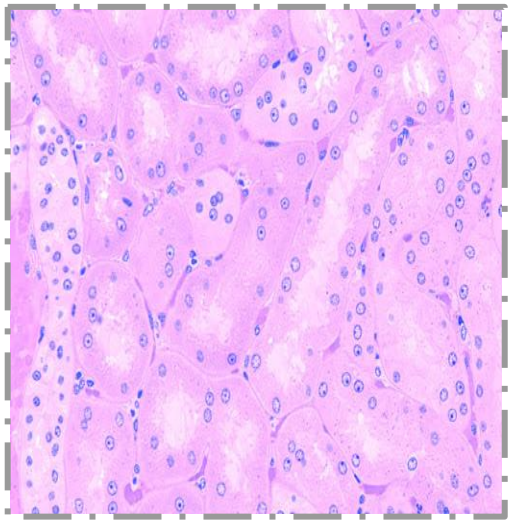
1. Glomerular capillary
2. Nucleus of podocyte
3. Fenestrae of capillary endothelial cell
4. Basement membrane
5. Primary process of podocyte
6. Pedicels of podocyte
7. Slit membrane



The glomerular basal lamina: notice the 2 pale layers "laminae rarae" and the dark layer in the middle "lamina densa"

2. Proximal convoluted tubule





The Longest tubule in the kidney

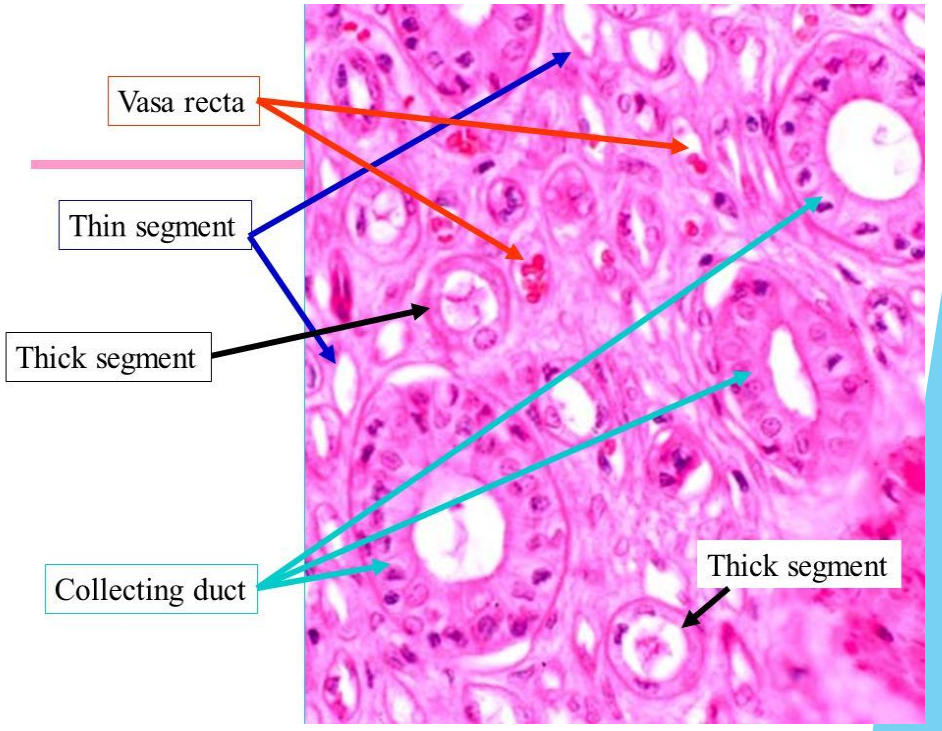
It is composed of **simple cuboidal epithelium** (large cells with round nuclei) **with acidophilic cytoplasm.**

The cells have striated or **brush border** (microvilli) to help reabsorption most components of the filtrate of the plasma 70% and secreted into the interstitial because it's rich of blood capillaries then go to the circulation **and lateral inter-digitations** Not well defined which allow continuation between the cells together

They have well-defined basal lamina.

thick wall and brushy lumen

3. Thin limbs of Henle's loop



It has 3 regions:

1. **Descending thin limb.**
2. **Crest of Henle's loop.**
3. **Ascending thin limb.**

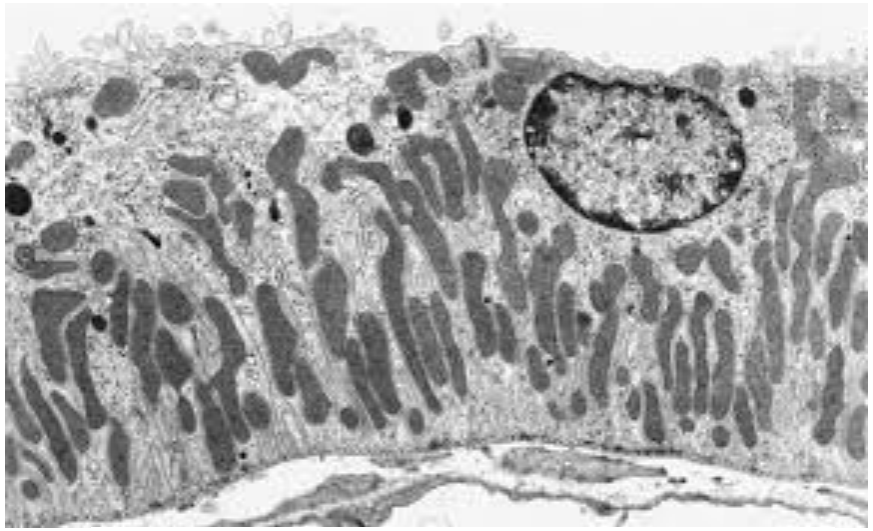
- **NB: It is longer in juxta-medullary nephron than in cortical nephron.** It is composed of **simple squamous epithelium.**

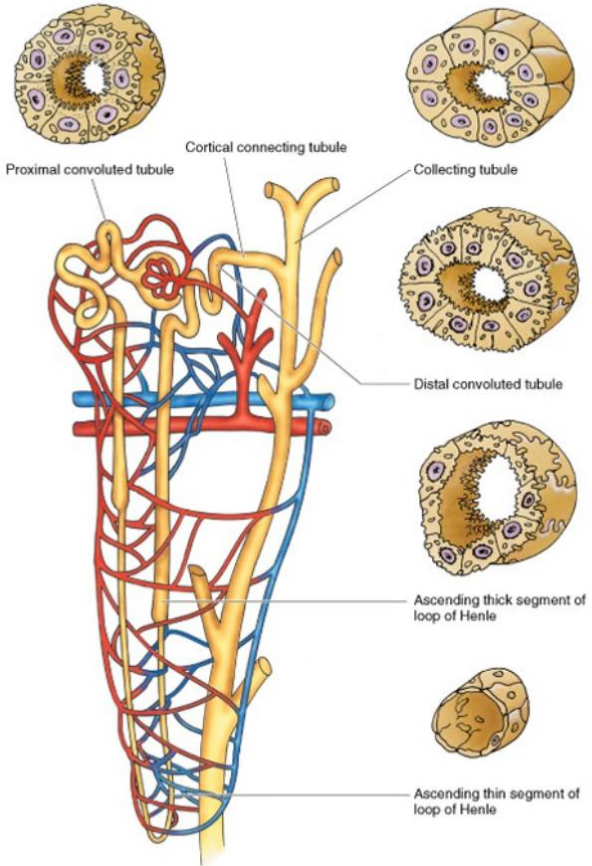
4. Distal convoluted tubule

It starts at the macula densa.
macula densa (tall columnar & narrow cells).
The Distal convoluted tubule is formed of **low cuboidal epithelium**.

NB: Because distal convoluted tubules are **much shorter than** proximal convoluted tubules, any section of renal cortex presents many more sections of proximal convoluted tubules.
Distal tubules **drain into** collecting tubules.
thin wall clear lumen

- No brush border
- Wider Lumen
- Have less microvilli than proximal convoluted tubule

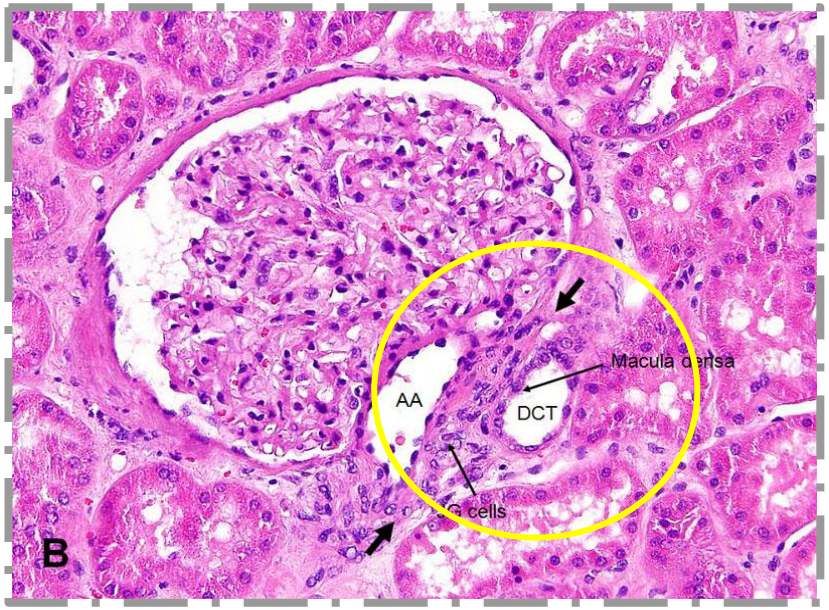


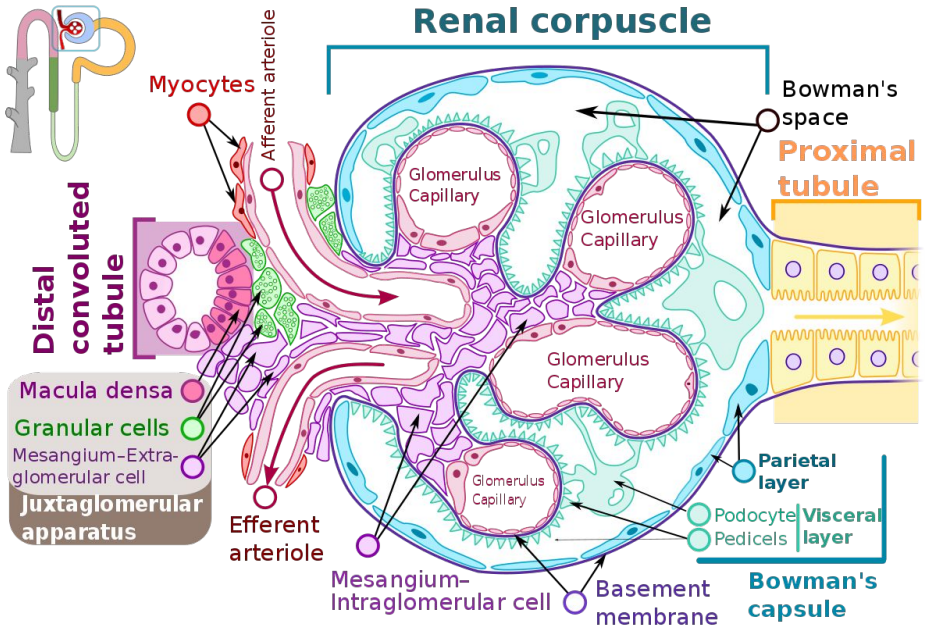


Juxtaglomerular apparatus (it is not part of the glomerulus, but it's close to it)

It has 3 components :

1. **The macula densa** of distal tubule: **tall cells with centrally-placed nuclei** (Columnar cells). These cells send impulses to the **juxtaglomerular cell** through the **extraglomerular mesangial** cells to increase the secretion of renin when blood pressure decreases.
2. **Juxtaglomerular cells** of afferent glomerular arteriole (modified smooth muscles of tunica media). Nuclei are **round** with **granular cytoplasm** . ***they secrete renin**
3. **The extraglomerular mesangial cells.**





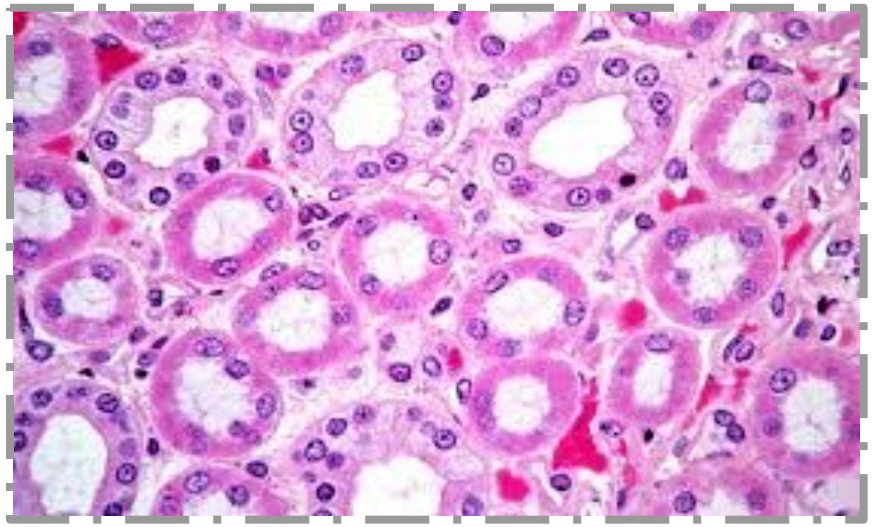
Collecting tubules

Are composed of **simple cuboidal epithelium.**

They aren't part of nephron.

They have 3 regions:

1. Cortical: Simple Cuboidal Epithelium
2. Medullary: Simple Cuboidal Epithelium.
3. Papillary ducts (ducts of Bellini): **Simple Columnar Epithelium** They open in area cribrosa. **They are impermeable to water except in presence of ADH.**



Area cribrosa is the tip of the renal papilla (apex) that meets the end of the ducts of Bellini.

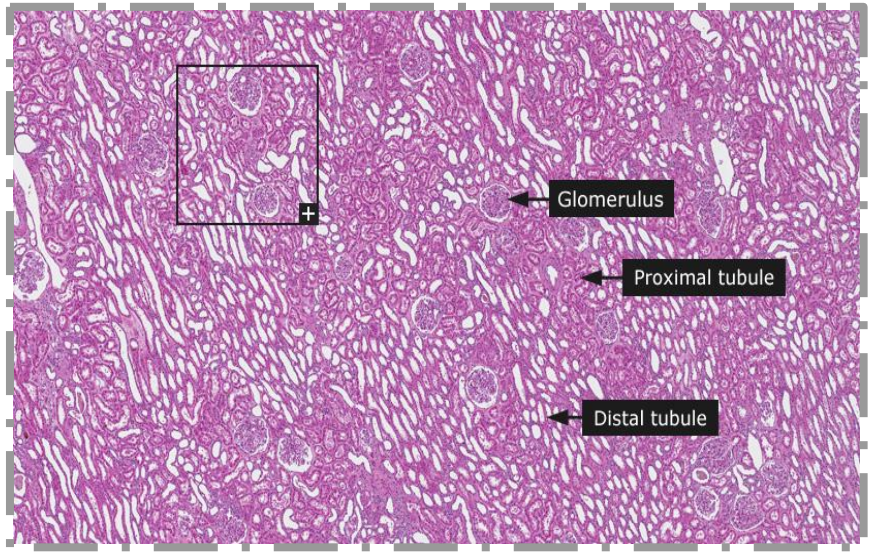
Renal interstitium

It is a very flimsy, scant amount of loose connective tissue that contains:

1-Fibroblast

2-Macrophages

3-Interstitial cells : They secrete medullipin I, which is converted in the liver into medullipin II, that **lowers blood pressure.**



Juxtaglomerular apparatus secretes renin that increases blood pressure, while renal interstitium secretes medullipin that decreases blood pressure.

SUMMARY

<table>
<tr><td>Kidney structure</td><td colspan="3">Cortex: Dark brown and granular
Medulla: 6-12 Renal pyramid
- Base: toward the cortex (cortico-medullary border)
- Apex (renal papilla): toward the hilum, it is perforated by 12 openings of the ducts of Bellini in region called area cribrosa</td></tr>
<tr><td rowspan="3">The function unit of kidney (Uriniferous tubule)</td><td rowspan="2">Nephrons</td><td>Types</td><td colspan="2">1- Cortical nephrons 2- Juxtamedullary nephrons</td></tr>
<tr><td rowspan="2">Formed of</td><td>Renal corpuscle</td><td>- Glomerulus: tuft of fenestrated capillaries without diaphragm
- Bowman's capsule: parietal layer, urinary space & visceral layer (podocytes)
- Mesangial cells: intraglomerular cells</td></tr>
<tr><td>Renal tubules</td><td>- Proximal convoluted tubule: composed of simple cuboidal epith, that have striated or brush border
- Thin limbs of Henle's loop: composed of simple squamous epith
1-Descending thin limb
2-Crest of Henle's loop
3-Ascending thin limb
- Distal convoluted tubule: composed of low cuboidal epith & starts at the macula densa</td></tr>
<tr><td>Collecting tubules</td><td colspan="3">Composed of simple cuboidal epith. They have 3 regions:
1- Cortical: simple cuboidal epithelium
2- Medullary: simple cuboidal epithelium
3- Papillary ducts (ducts of Bellini): simple columnar epithelium</td></tr>
<tr><td>Glomerular filtration barrier</td><td colspan="3">1- Endothelial wall of the glomerular capillaries 2- The glomerular basal lamina 3-Visceral layer of Bowman's capsule (podocytes)
Podocytes have primary processes and secondary processes (pedicles), between pedicles there are filtration slit diaphragms</td></tr>
<tr><td>Renal interstitium</td><td colspan="3">Scant amount of loose connective tissue that contains: fibroblast, macrophages & interstitial cells (secrete medullipin that↓BP)</td></tr>
<tr><td>Juxtaglomerular apparatus</td><td colspan="3">It has 3 components:
- Macula densa of distal tubule: tall cells with centrally-placed nuclei
- Juxtaglomerular cells: Nuclei are round with granular cytoplasm they secrete renin
- Extraglomerular mesangial cells</td></tr>
</table>

1) The functional unit of the kidney:

A) minor calyx
B) major calyx
C) Uriniferous tubule
D) Nephron

2) 3 or 4 minor calyces join to form:

A) tubules
B) major calyces
C) nephron
D) bertin

3) A tuft of fenestrated capillaries is called:

A) glomerulus
B) Bowman's capsule
C) Collecting duct
D) Henle's loop

4) The modified cells of the visceral layer of Bowman's capsule called:

A) nephron
B) Podocytes
C) Mesangial cells
D) Macula densa

5) Renal interstitium contains:

A) macrophages
B) plasma cells
C) Fibroblast
D) A+C

6) Which of the following are incorrect about collecting tubules:

A) Endothelial wall of the glomerular capillaries.
B) composed of simple cuboidal epithelium
C) they aren't part of nephron
D) A+C

1)C
2)B
3)A
4)B
5)D
6)A

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اللهم إنا نسألك باسمك العظيم الأعظم، الذي إذا دعيت به أجبت، وإذا سئلت به أعطيت، وبأسمائك الحسنى كلها ما علمنا منها وما لم نعلم، أن تجيب لنا الدعاء وترفع عن البلاء والوباء

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