THE KIDNEY

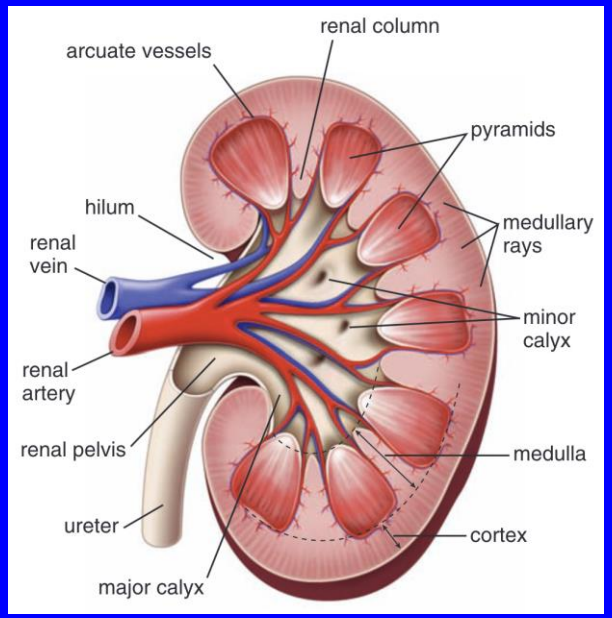
Objectives:

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

- The microscopic structure of the renal cortex and renal 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 relationship of the different parts of the kidney.

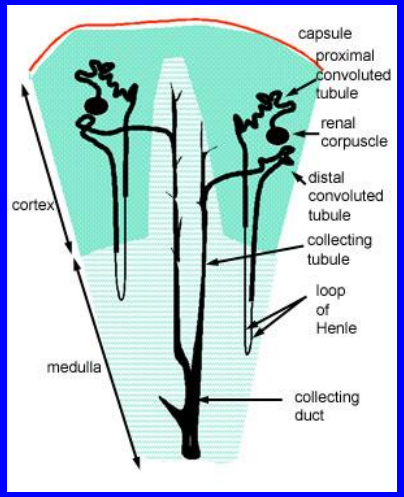
The Kidney

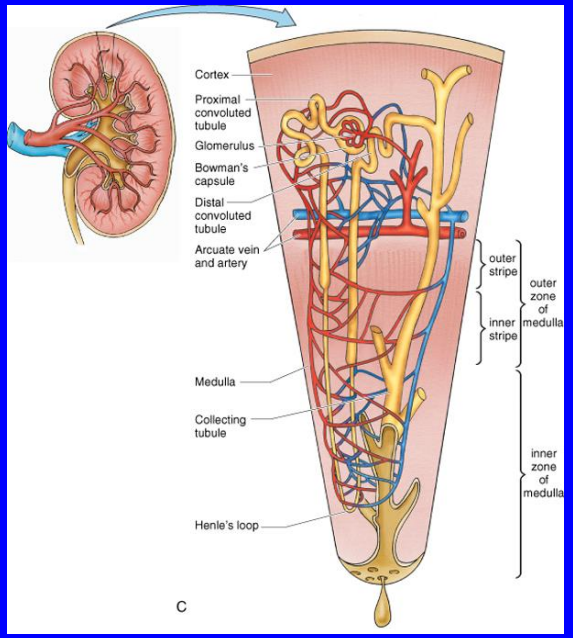
- **Cortex:** dark brown and granular.
- **Medulla:** 6-12 pyramid-shape regions called *renal pyramids*:
  - The base of each pyramid is toward the cortex (cortico-medullary border).
  - The apex (*renal papilla*) is toward the hilum, it is perforated by 12 openings of the *ducts of Bellini* in a region 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 the renal pelvis.
  - Pyramids are separated by *cortical columns of Bertin*.



Uriniferous Tubules

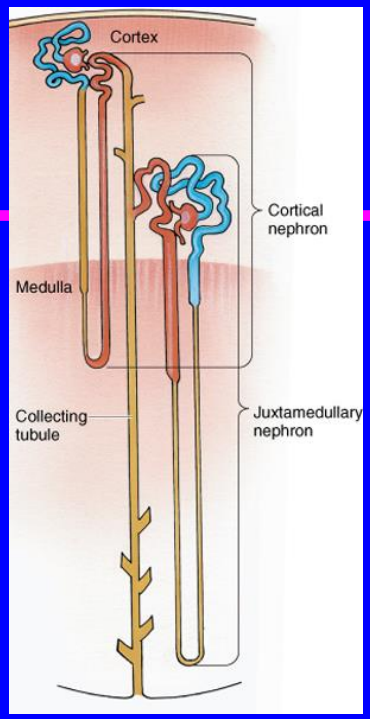
- The functional units of the kidney.
- Each is formed of:
  1. A Nephron, and
  2. A Collecting tubule.
- The uriniferous tubules are densely packed so that the connective tissue stroma of the kidney is scant.
- The uriniferous tubules are separated from the connective tissue stroma by a basal lamina.

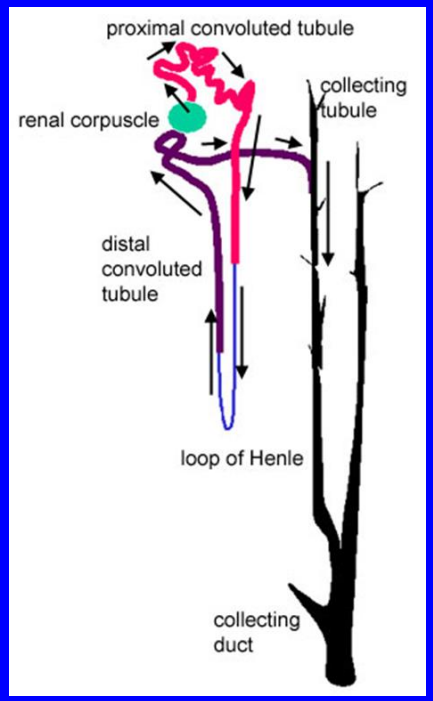




Nephrons

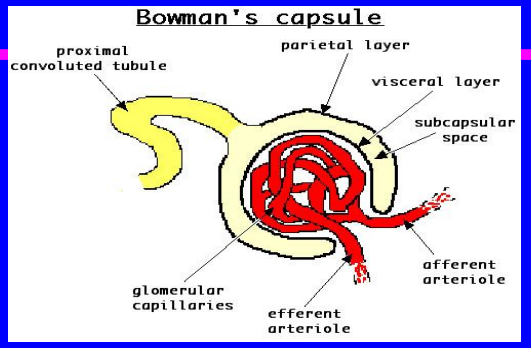
- About 1 million in each kidney.
- There are 2 types of nephrons:
  a. Cortical nephrons.
  b. Juxtamedullary nephrons.
- Each nephron is formed of :
  1. Renal corpuscle.
  2. Proximal tubule.
  3. Thin limbs of Henle's loop.
  4. Distal tubule.

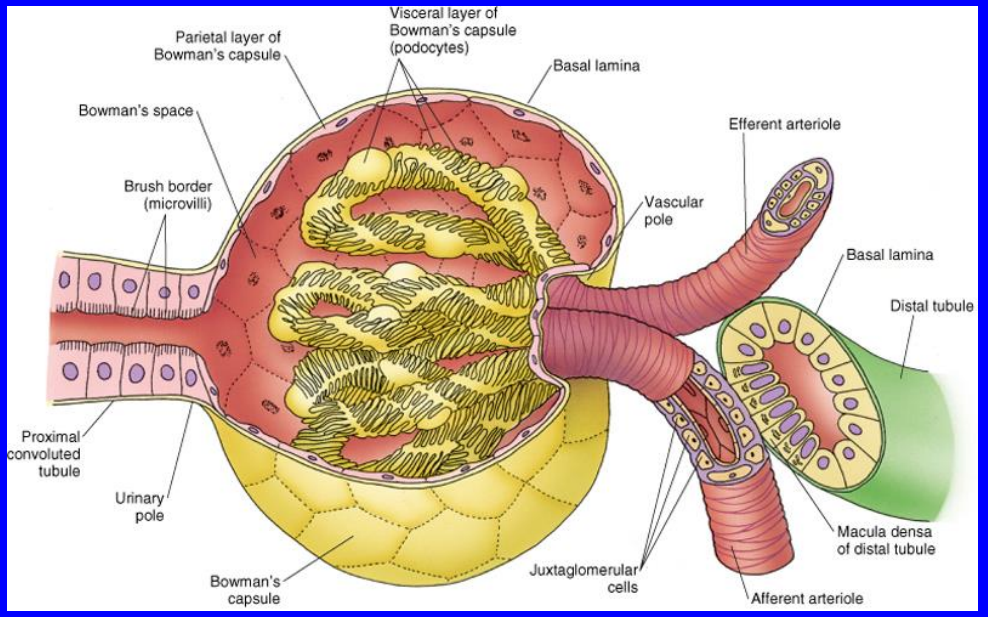


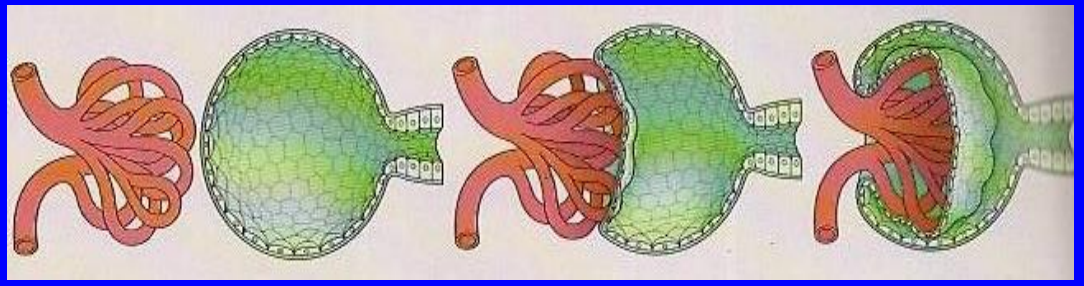


Renal Corpuscle

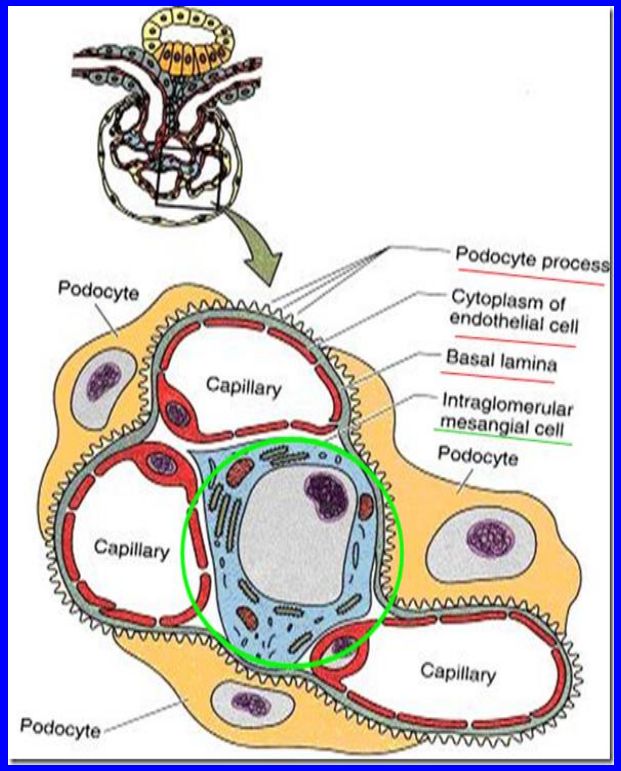
- Glomerulus; tufts of fenestrated capillaries "without diaphragm".
- Bowman's capsule; parietal layer, urinary space and visceral layer or podocytes.
- Mesangial cells; intra-glomerular cells.

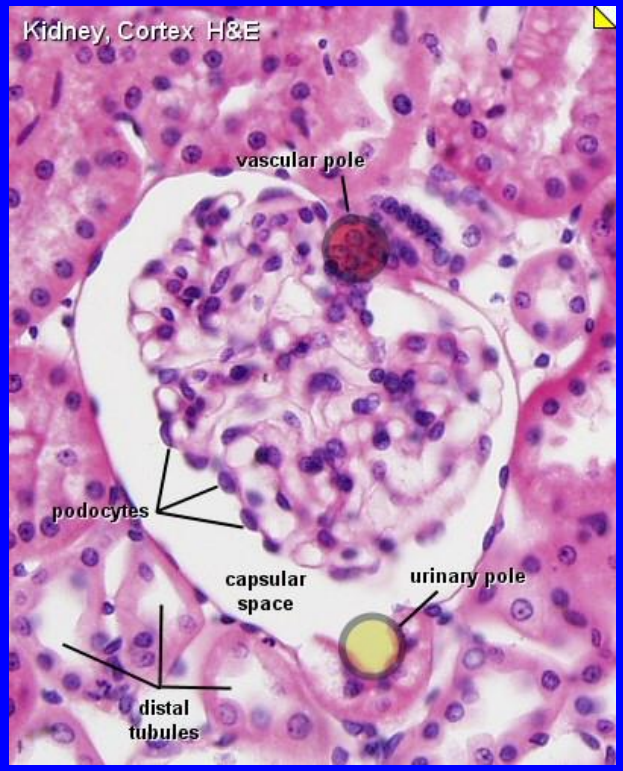


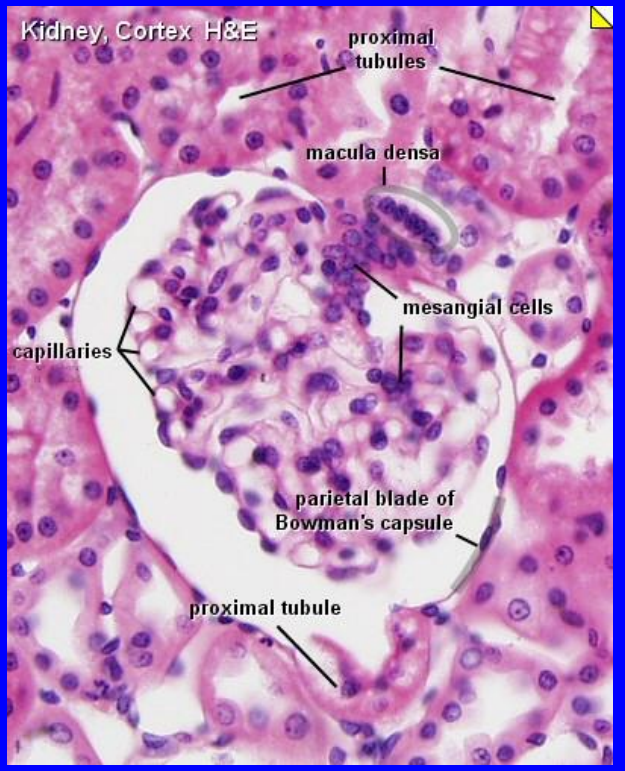




Renal Corpuscle

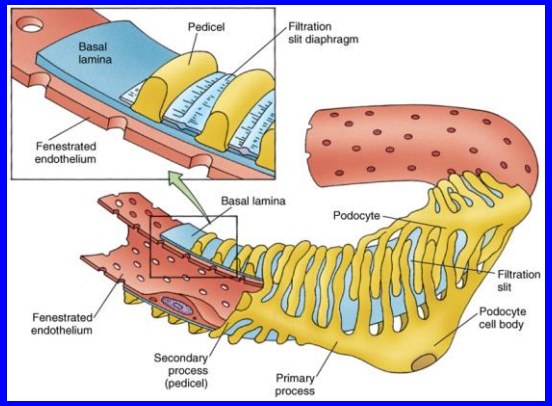


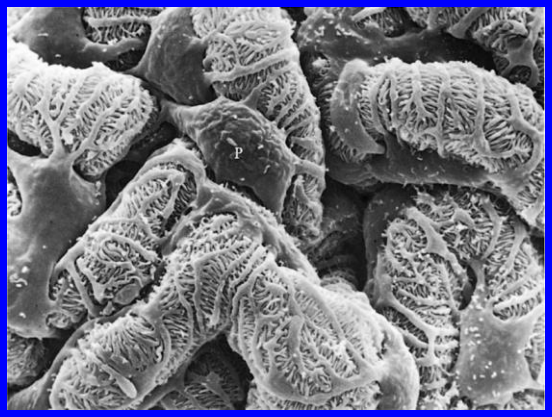


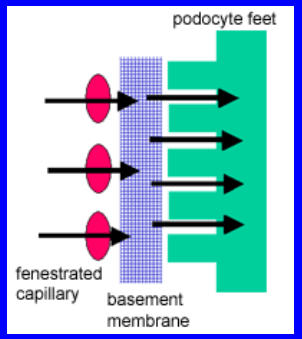


Glomerular filtration barrier

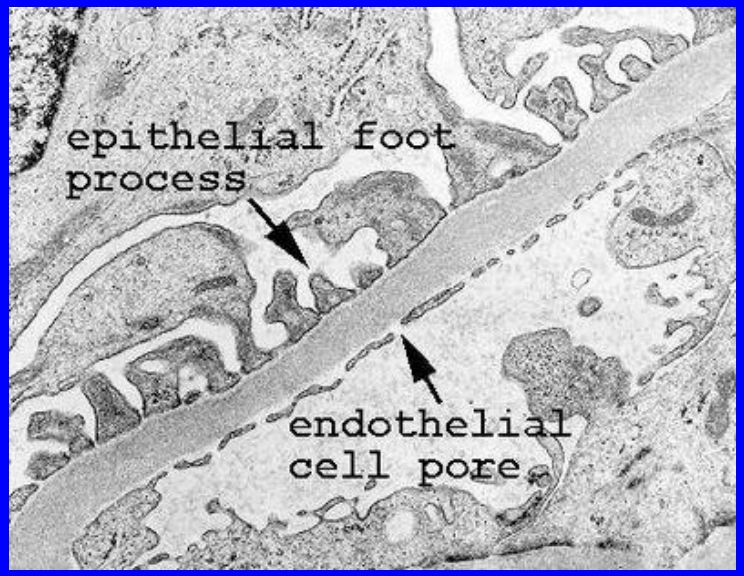
- *Endothelial wall* of the glomerular capillaries.
- *The glomerular basal lamina* (inner and outer laminae rarae and middle lamina densa).
- Visceral layer of Bowman's capsule (*podocytes*).
- Podocytes have primary (major) processes and secondary (minor) processes (pedicles).
- Between pedicles (on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

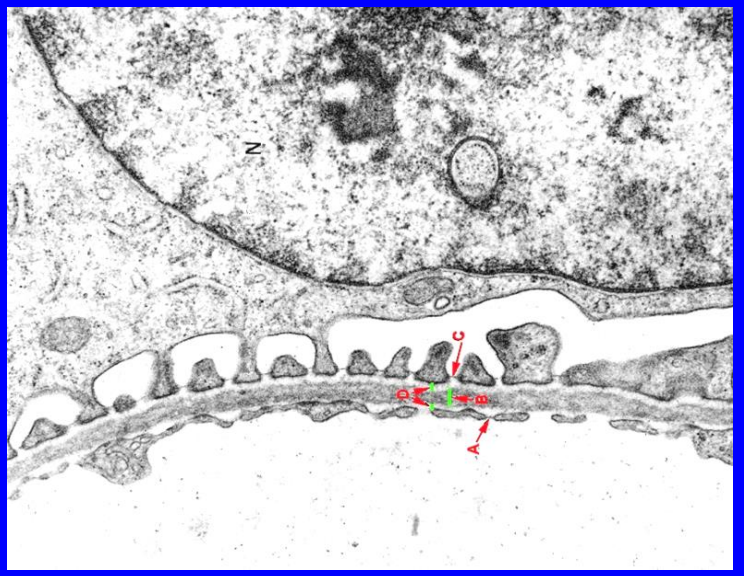


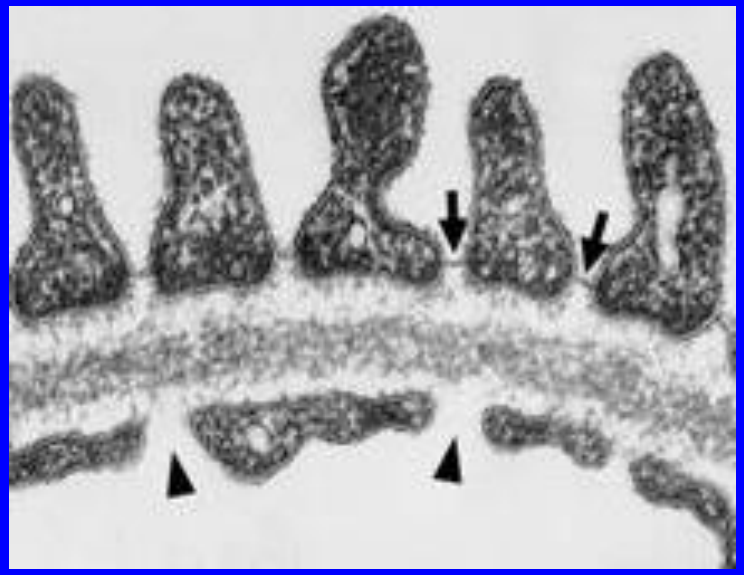


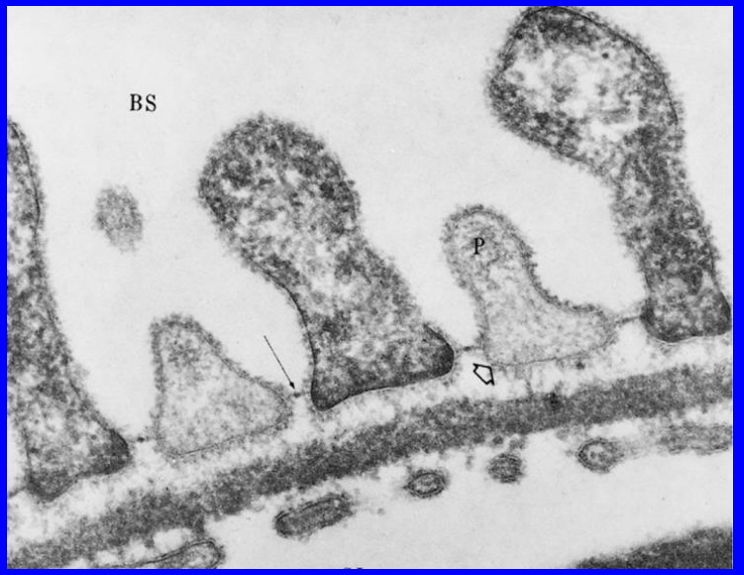


Glomerular filtration barrier

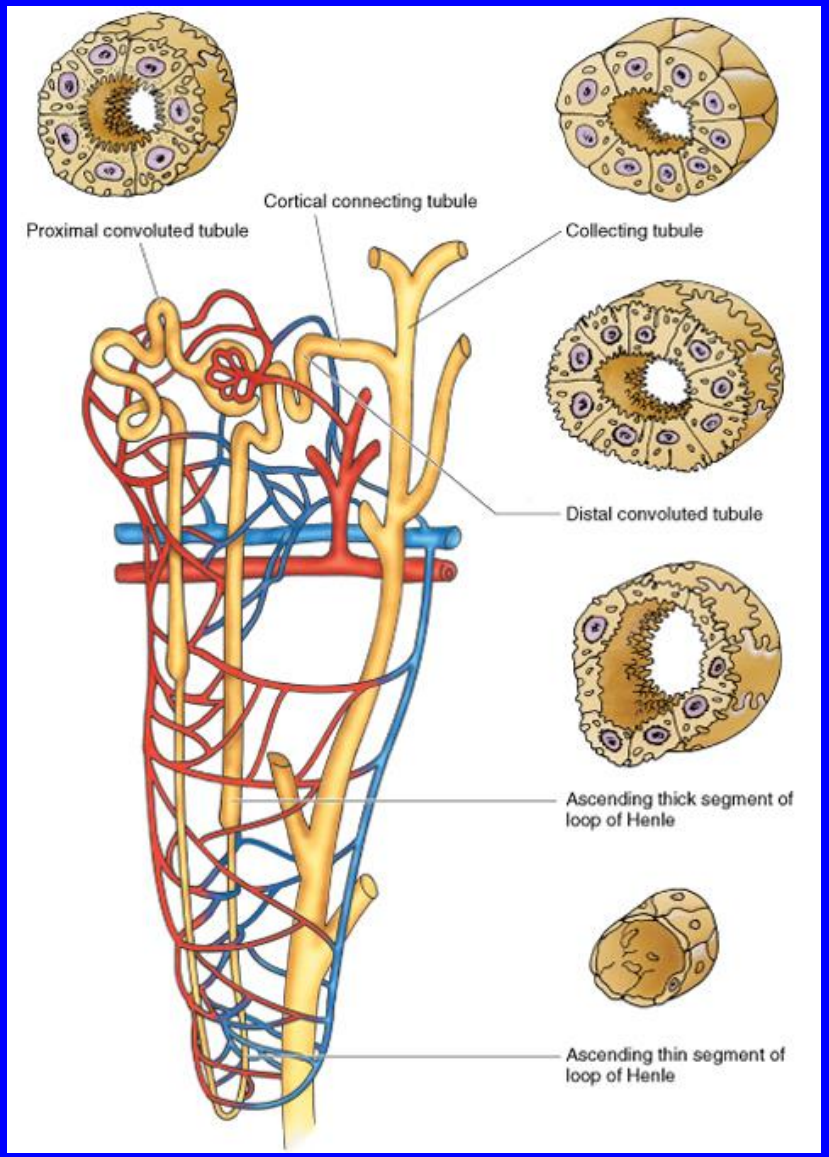


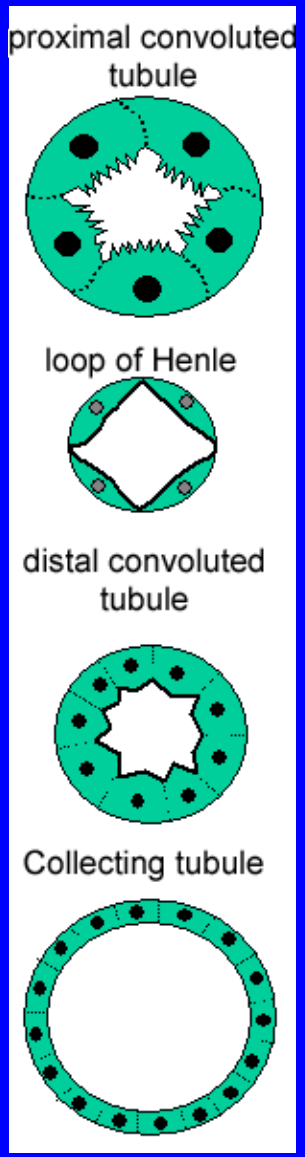


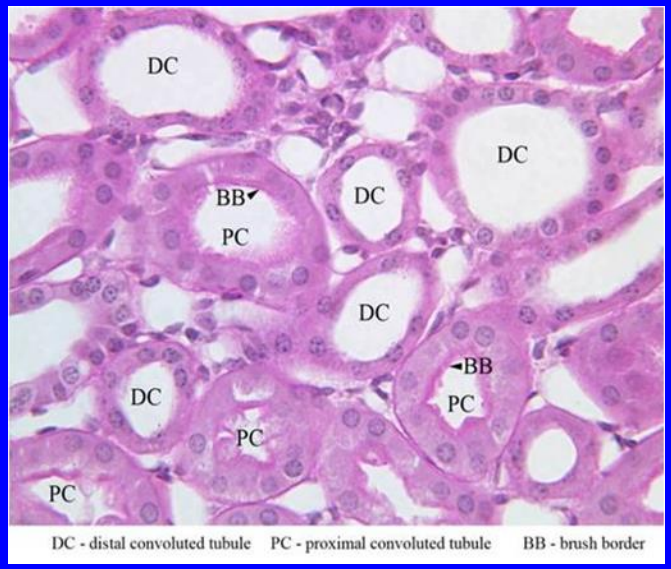




Renal Tubules

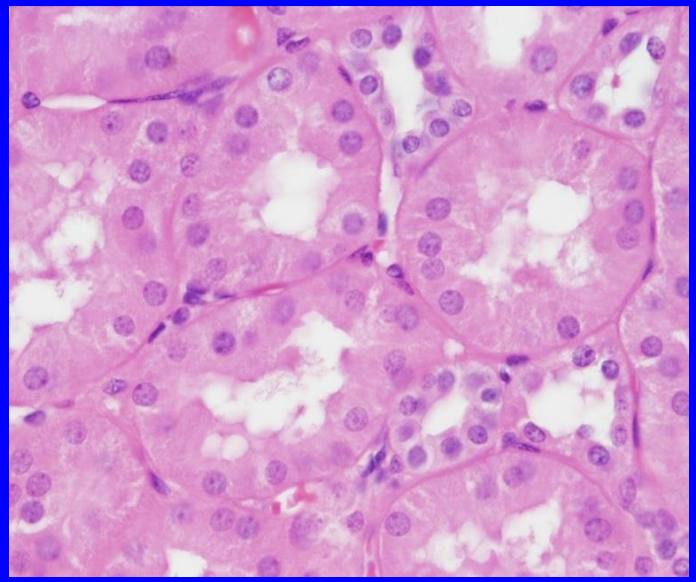
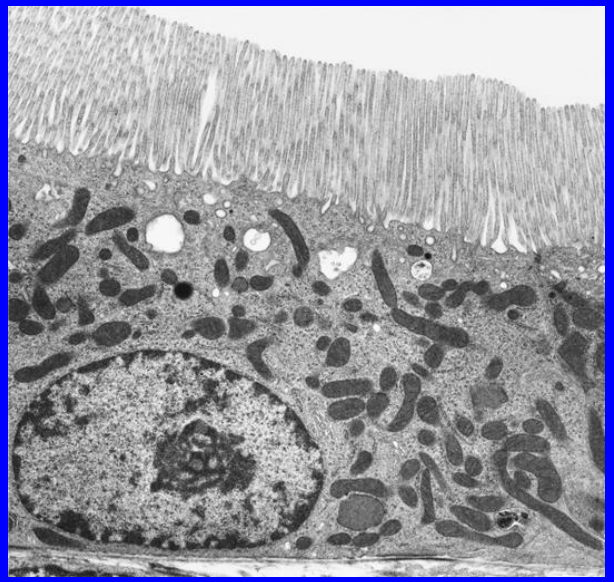
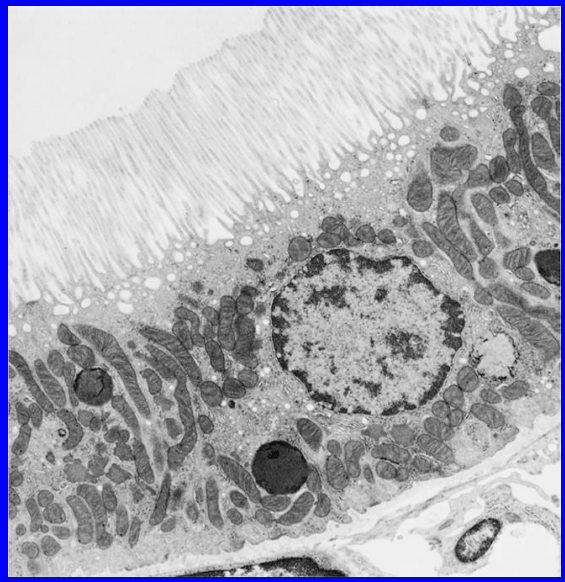






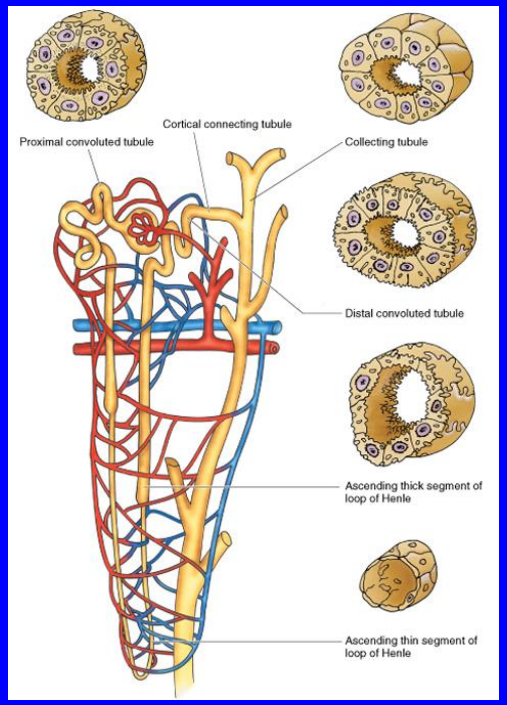
Proximal convoluted tubule

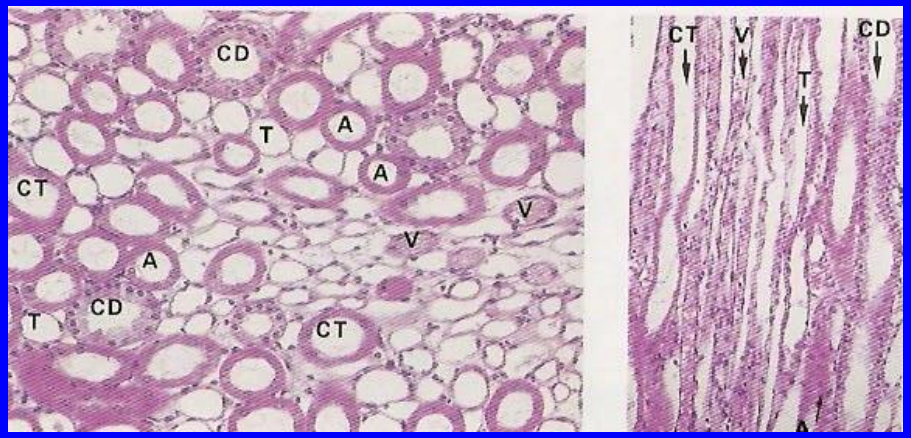
- It is composed of simple cuboidal epith. with acidophilic cytoplasm. The cells have striated or brush border and lateral inter-digitations.
- They have a well-defined basal lamina.

Thin limbs of Henle's loop

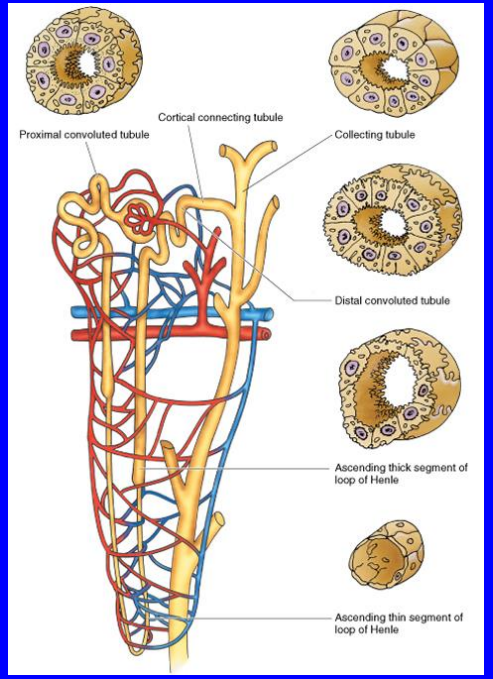
- It has 3 regions:
  1. Descending thin limb.
  2. Crest of Henle's loop.
  3. Ascending thin limb.
- It is longer in juxta-medullary nephrons than in cortical nephrons.
- It is composed of simple squamous epithelium.

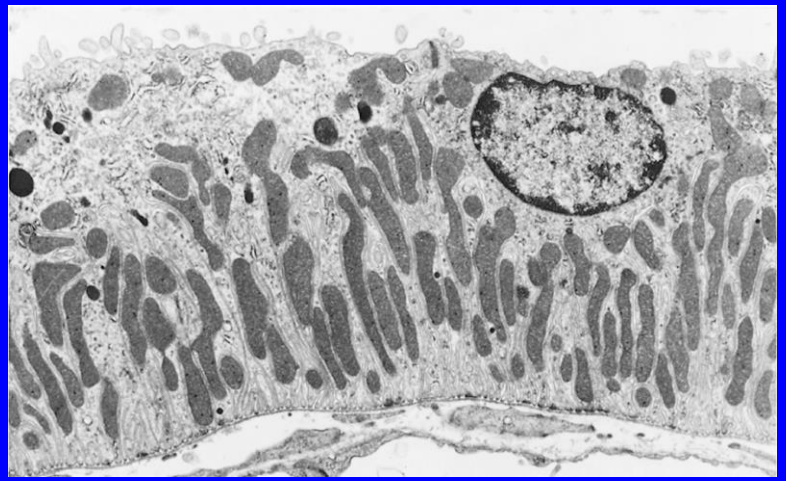




Distal convoluted tubule

- It starts at the macula densa.
- Cells of the macula densa are tall and narrow columnar.
- The distal convoluted tubule is formed of low cuboidal epith.
- Because distal convoluted tubules are much shorter than proximal convoluted tubules, any section of renal cortex presents many more sections of proximal convoluted tubules than sections of distal convoluted tubules.
- Distal tubules drain into collecting tubules.



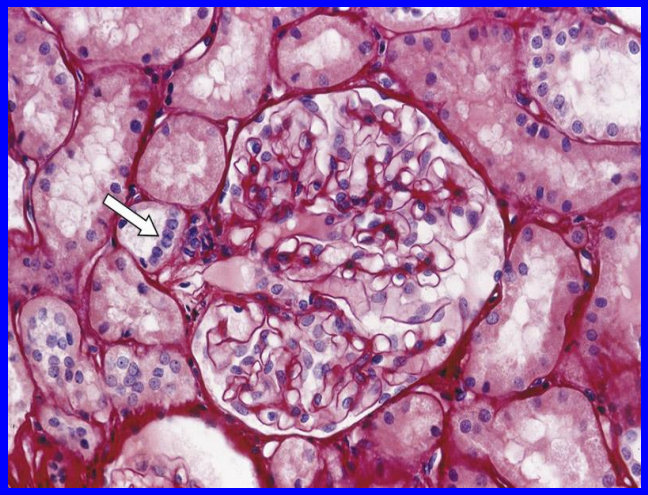


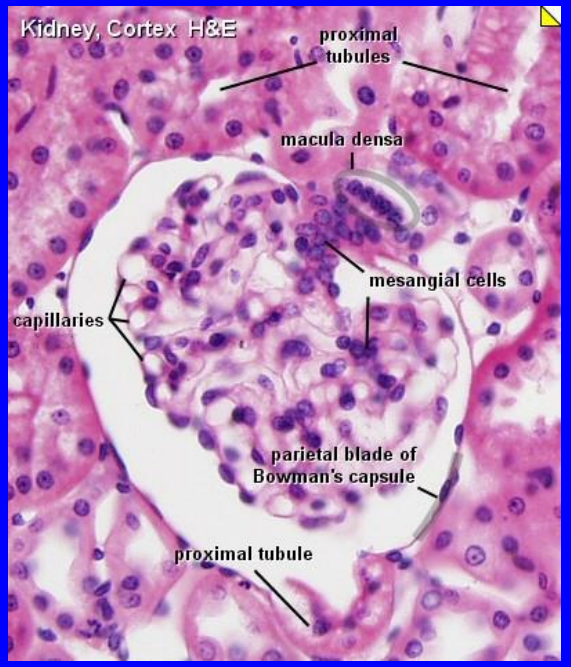
Feature	Proximal convoluted tubule	Distal convoluted tubule
Length / Convolution / Frequency in section	Longer / More convoluted / More commonly seen	Shorter / Less convoluted / Less commonly seen
Diameter	Larger (60 mm)	Smaller (20-40 mm)
Lumen	Narrower	Wider
Cells: • Nucleus • Cytoplasm	Fewer cells per section Ill-defined cell boundaries Round – Vesicular Basal Deep acidophilic / granular Apical brush border Basal striations	More cells per section Well-defined cell boundaries Round – Vesicular Central or apical Pale acidophilic / less granular No apical brush border No basal striations
EM: • Mitochondria • Apical part of the cell: - Vesicles - Cytoplasmic canaliculi • Cell membrane: - Apical microvilli - Lateral interdigitations - Basal infoldings	 Numerous Yes Yes Extensive, closely packed Extensive Extensive	 Not as numerous No No Few, blunt Not as extensive Not as extensive

Juxtaglomerular apparatus

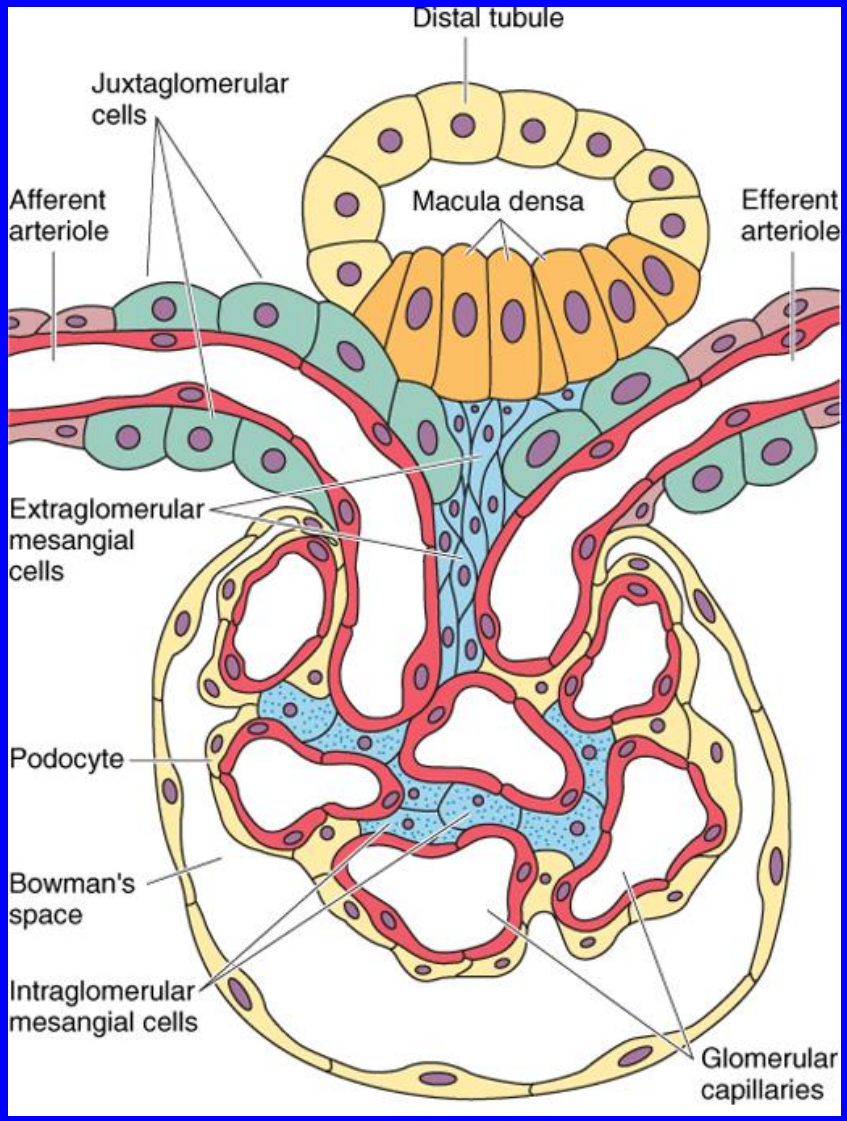
It has 3 components:

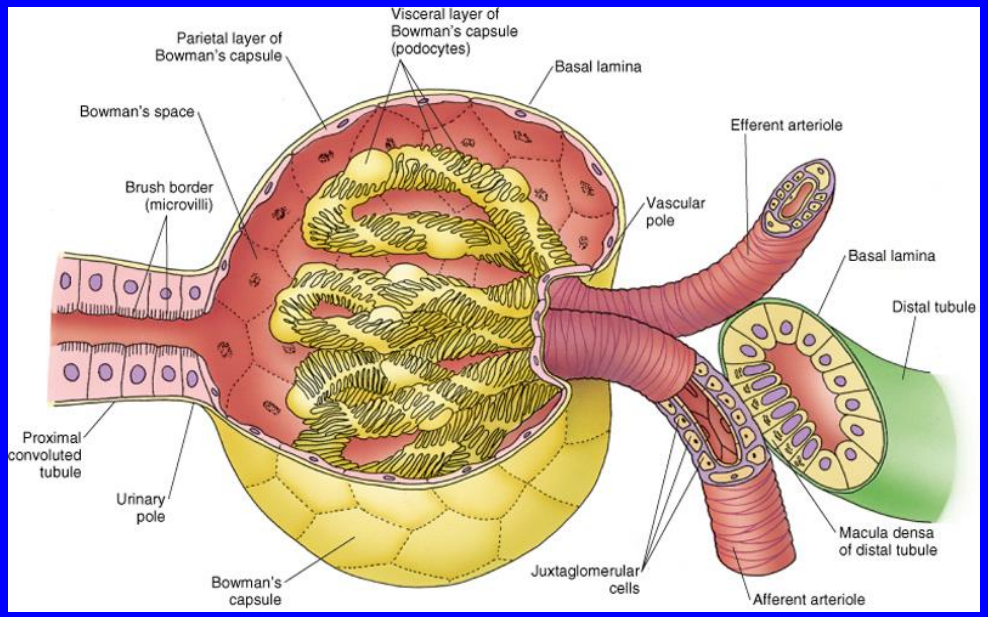
1. Macula densa of distal tubule: Tall cells with centrally-placed nuclei.
2. Juxtaglomerular cells of afferent glomerular arteriole (modified smooth muscle of tunica media). Nuclei are round with granular cytoplasm. They secrete renin.
3. Extraglomerular mesangial cells.





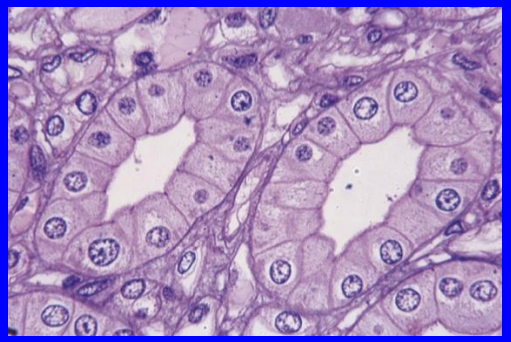
Juxtaglomerular apparatus

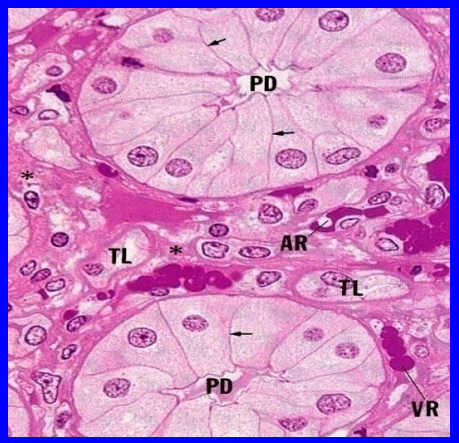


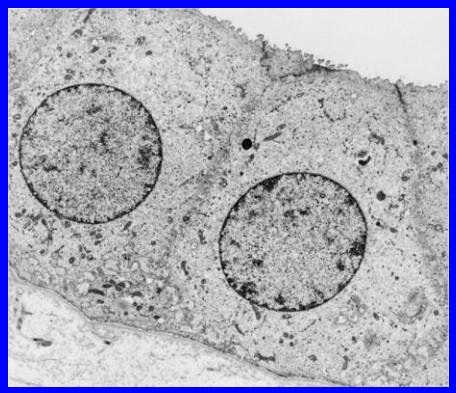


Collecting Tubules

- Are composed of simple cuboidal epithelium.
- They aren't part of nephron.
- They have 3 regions:
  1. Cortical: S. Cuboidal Epith.
  2. Medullary: S. Cuboidal Epith.
  3. Papillary ducts (ducts of Bellini): S. Columnar Epith.
     - » They open in area cribrosa.
     - » They are impermeable to water except in presence of ADH.







Renal Interstitium

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

1. Fibroblasts.
2. Macrophages.
3. Interstitial cells: They secrete medullipin I, which is converted in the liver into medullipin II, that lowers blood pressure.

Best Wishes