

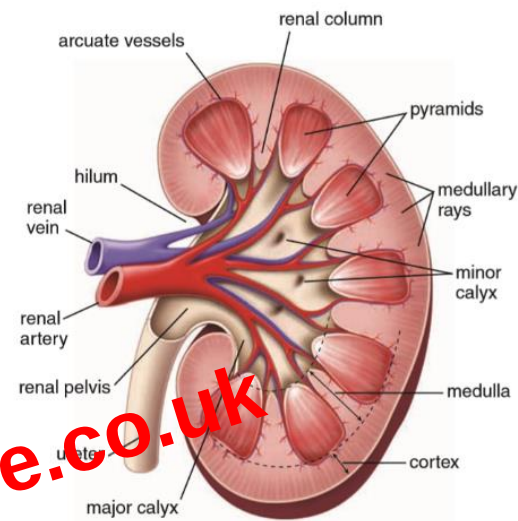
- III. **Cortical labyrinths (pars convoluta)**: area **between medullary rays**, containing renal corpuscles, convoluted tubules, and collecting tubules.
- IV. **Uriniferous tubule**: nephron and its **connecting tubule**, that will connect to collecting duct, in the medullary ray.

Medulla – Contains:

- I. **Straight tubules** (of nephron): continue from cortex into the medulla.
- II. **Collecting ducts**: continue from cortex into the medulla.
- III. **Vasa recta**: capillary network accompanying tubules and ducts from cortex into medulla. Runs in parallel with various tubules. Present only in juxta-medullary nephron. The vessels represent the vascular part of the **countercurrent exchange system** that regulates the concentration of urine.

IV. **Tubules in the medulla:**

- a. Form **Pyramids** – 8-18 conical structures (base-cortex & apices-renal sinus). Each pyramid is divided into **outer medulla** (divided into **inner stripe** and **outer stripe** – to locate specific parts of nephron) adjacent to cortex and **inner medulla**.
- b. **Renal columns (of Bertin)** – cap of cortical tissue over pyramids that extend “spills” peripherally around lateral portion of the pyramid. regarded as part of medulla.
- c. **Papilla** – apical portion of the pyramid. projects into **minor calyx** (extension of renal pelvis). **area cribrosa** – Tip of papilla, perforated by openings of collecting ducts.
- d. 2-3 **Minor calyx** become **major calyx** that empty into renal pelvis.



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4) Distal straight Tubule:

- **thick ascending limb** – Part of ascending limb of loop of Henle, in medullary rays of medulla and cortex.
- **cell characteristics:** large **cuboidal**, apical nucleus – forms bulge into lumen. Basolateral **folds** that contain many mitochondria and few not developed microvilli.
- **function:** transports ions from tubular lumen to interstitium. electroneutral transporter enters ions from lumen to cell. Then they leave the cell to interstitium – Na^+ by active transport, K^+ and Cl^- by diffusion. K channel enable K ions to leak back to tubule lumen > lumen is **more positive** > positive ions as Ca and Mg are **pushed** to be reabsorbed **in interstition**. *no water movement.
- **Uromodulin** – also **Tamm-Horsfall protein**. protein produced by **epithelial cells** of thick ascending limb. It influences NaCl reabsorption and urine concentration ability.
****Blue text** – Uromodulin 1) modulates cell adhesion and signaling by **cytokines**.
2) Inhibits the aggregation of Ca oxalate crystals – **prevent kidney stones**.
3) defend from urinary infection. Found in urine in case of **inflammatory kidney diseases**.

5) Distal convoluted tubule:

- **Location:** Cortical labyrinth, 1/3 of proximal convoluted tubule length, 5 mm. pass between **macula densa** and connecting tubule.
- **Cell characteristics:** similar to cells of distal straight tubules, but **taller** and have **no developed brush borders**.
- It was previously belived that Aldosterone acts on distal convoluted tubule, but new researches show that it acts on collecting tubules.
- Cells of this tubule have **highest Na/K ATPase activity** to interstitium → increase ion transport → **most ions reabsorb** to body.
- The tubule is impermeable to water.
- **function:**
 - a) regulate **Ca reabsorption** by signal of **parathyroid hormone**.
 - b) reabsorption of ions:
 - **Na^+ reabsorption** – instead of K that is secreted into tubule.
 - **urine acidification** – by bicarbonate reabsorption and H secretion.
 - **Cl^- Reabsorption** – by Na/Cl transporters.
 - **Ammonium Secretion** – due to bicarbonate generation.

6) Connecting tubule:

- Transition between distal convoluted tubule and cortical collecting duct.
- **Pathway:** 1) in sub-capsular nephron it joins directly to cortical collecting duct.
2) in mid-cortical and juxtamedullary nephrons **few connecting tubules merge** > form **arched connecting tubule** > connect **cortical connecting duct**.
- **Cell Characteristics:** simple epithelium, changes from Distal Convoluted Tubule epithelium to collecting duct epithelium, and may include the 2 kinds.
- **Function:** **K secretion** by principal cells. Secretion is regulated by **mineralocorticoids** from adrenal cortex.

b) **Urothelial permeability barrier** –

- **Uroplakin proteins (UPIa 1-3)** – cover the luminal surface of transitional epithelium and form **urothelial plaques** that make this layer **impermeable** to small molecules. These proteins make the outer leaflet of membrane lipid bilayer twice as thick as the inner leaflet > form asymmetrical appearance named **asymmetric unit membrane (AUM)**.
- **Hinge regions** – separates parts of **urothelial plaques**. contain all other non-plaque proteins.
- tight junctions Aid in formation of permeability barrier.
****Blue text: uropathogenic Escherichia coli bacteria** cause 85% of urinary tract infections. It binds and colonize transitional epithelium by FimH adhesins that interact with **uroplakins proteins**.
- Permeability barrier is maintained despite dynamic changes of stretching.

2. **lamina propria**: – with Dense collagen fibers, many cells and lymphocytes.

****NO muscularis mucosa, NO submucosa.**

B) **Muscularis layer**:

- In the tubular portions – ureters and urethra – usually 2 layers of **smooth muscle** beneath the lamina propria:
 - a) **Longitudinal layer** – inner layer that has no spiral pattern.
 - b) **Circular layer** – outer layer that has tight spiral pattern. (opposite to that of the muscularis externa of the intestinal tract).
- Smooth muscle is **mixed** with CT to form **parallel bundles**.
- Peristaltic contractions move urine from minor calyces through ureter to the bladder.

1) **Ureter**:

- **Function**: conducts urine from the renal pelvis to the urinary bladder.
- **Shape**: 24-34 cm long. Travels obliquely on the bladder and distal part enters it. Usually the ureter is embedded in the retroperitoneal adipose tissue.
- **Epithelium**: **Transitional epithelium** = **urothelium**.
- **smooth muscle layer**: 2 main layers and 2 additional layers.
 - a) inner longitudinal layer,
 - b) middle circular layer,
 - c) outer longitudinal layer – present **only at distal end** of ureter, where it passes through bladder wall and becomes part of it.
- **Adventitia layer**: contain adipose tissue, vessels, nerves.
- As the bladder distends or its smooth muscles contract → the openings of the ureters are compressed to **prevent urine** reflux into ureters and **prevent spread of infections to kidney**. Infections in bladder are common mostly in female.

