

Histology of renal tubules and  
collecting ducts; function and  
blood circulation of kidney



# PROXIMAL TUBULE

Ultrafiltrate drains into the proximal tubule at the urinary pole

The simple squamous epithelium of the parietal layer of Bowman capsule



The simple cuboidal epithelium of proximal tubule

## PROXIMAL TUBULE

→ -**the convoluta** (proximal convoluted tubule)

Consisting much of the renal cortex

60µm in diameter and about 14 mm long

→ -**the pars recta** of the proximal tubule (descending thick limb of Henle Loop)

Descends in medullary rays within the cortex in cortical nephrons and then within the medulla to become continuous with the loop of Henle

# PROXIMAL TUBULE

Simple cuboidal epithelium

**Eosinophilic** and granular appearing cytoplasm

Apical surface. has microvilli forming a prominent **brush border**

A lack of distinct lateral surface

Cuboidal cells sit on a well-defined basement membrane, easily demonstrated by the PAS reaction

Each cross section 6-8 large round nuclei are included in the plane

Height of the epithelium cells varies with their functional state -low cuboidal to high cuboidal-



# PROXIMAL TUBULE

**Apical canaliculi, vesicles, and vacuoles, lysosomes** (endocytic complex) –function in protein absorption

Prominent interdigitations along their lateral borders, which interlock adjacent cells with one another

Basal striations consisting of elongate **numerous mitochondria** oriented vertically to the basal surface

These mitochondria supply energy for the active transport of  $\text{Na}^+$  out of the tubule

Apically situated occluding junctions block the paracellular pathway

Apical cell membrane has **glucose transporters,  $\text{Na}^+\text{K}^+$  -ATPase pump**

Basolateral cell membrane possesses  **$\text{Na}^+\text{K}^+$  -ATPase pump and glucose and aa transporters**

Each cell has a **primary cilium** which is monitoring flow & composition of ultrafiltrate

# FUNCTION OF THE PROXIMAL TUBULE

**Resorbs** from the glomerular filtrate all of the glucose, amino acids and small proteins

Resorbs %60-%80 sodium chloride and water

Sodium is actively pumped out of the cell at the basolateral cell membranes by **Na<sup>+</sup>K<sup>+</sup>-ATPase pump** and is followed by Cl<sup>+</sup>

The water also passes mostly tight junctions & aquaporin 1 channels located in basolateral cell membrane

**Exchanges** H<sup>+</sup> in the interstitium for HCO<sub>3</sub><sup>-</sup> in the filtrate

**Secretes** organic solutes (e.g., creatinine, oxalate, bile salts) and certain foreign substances (e.g. penicillin) into the filtrate



*Brush border*

# THIN LIMB OF HENLE LOOP

- ❖ This is a U-shaped structure
- ❖ Have three regions in juxtamedullary nephrons:

**thin descending limb**

**Henle Loop**

**thin ascending limb,**

both composed of simple squamous epithelia. The straight part of the proximal tubule has an outer diameter of about 60  $\mu\text{m}$ , but it narrows abruptly to about 15-20  $\mu\text{m}$  in the thin limbs of the loop. The wall of the thin segments consists only of squamous cells with few organelles (indicating a primarily passive role in transport) and the lumen is prominent

- ❖ In cortical nephrons-1-2 mm long or may be absent
- ❖ Juxtamedullary nephrons have 9-10 mm

## DESCENDING THICK LIMB OF THE LOOP OF HENLE

❖ **Descending thick limb of the Henle loop** is the straight portion (pars recta) of the proximal tubule

Lined by **cuboidal epithelium** & has prominent **brush border**

**Functions** are similar to convoluted tubule



# THIN LIMB OF HENLE LOOP

Squamous epithelial cells

A few short microvilli

Nuclei of the cells bulge into the lumen

Resemble capillaries in cross-section, (*they may be distinguished from capillaries, in that their epithelial cells are slightly thicker, their nuclei stain less densely & their lumina contain no blood cells*)

## **Descending thin limb,**

Possess many aquaporin 1 channels

Very permeable to water as well as permeable to ions ( $\text{Na}^+$  &  $\text{Cl}^-$ )

**Henle Loop,** mostly impermeable to water

**Ascending thin limb,** completely impermeable to water but possesses many  $\text{Na}^+$  &  $\text{Cl}^-$  channels, which permit these ions to enter the cell from the lumen of the tubule & exit the cell into the renal interstitium. Urea enters the lumen of the ascending thin limb

## ASCENDING THICK LIMB OF THE HENLE LOOP

The straight portion of the **distal tubule (pars recta )** located in medulla  
9-10 mm length and 30-40  $\mu\text{m}$  in diameter

**Cuboidal epithelial** cells that possess only a few microvilli

Large cuboidal cells stain lightly with eosin

Apical nucleus

**Mitochondria** compartmentalized with in basal plasma membrane infoldings

Manufacture & release a glycoprotein **uromodulin (Tamm-Horsfall prt)** which reduces the forming of kidney stones and infections

actively transport sodium and chloride ions out of the tubule against a concentration gradient into the hyaluronate-rich interstitium, making that compartment hyperosmotic. This causes water to be withdrawn passively from the thin descending part of the loop, thus concentrating the filtrate.

## DISTAL CONVULATED TUBULE

It is much **shorter cuboidal epithelial cells**, short microvilli

**Wider lumen** than proximal convoluted tubule

**Lacks of a brush border**

**Basal interdigitations** are much more extensive ,**elongated mitochondria are located cytoplasm of deep infoldings** of the basal plasma membrane

9-10 mm, 30-40  $\mu\text{m}$  in diameter and located in **cortex**

**Function** : If the aldosterone stimulates, resorbs  $\text{Na}^+$  from the filtrate and actively transports it into the renal interstitium, also transfers  $\text{K}^+$ ,  $\text{NH}_4^+$  &  $\text{H}^+$  into the filtrate from the interstitium

# COLLECTING TUBULES

Origins from the ureteric bud so **they are not part of nephron**

A short **connecting tubules** join the distal convoluted tubules **to** collecting tubules

Aproximately 20 mm long

They have segments in both cortex & medulla

- Cortical collecting tubules
- Medullary collecting tubules
- Papillary collecting tubules

# COLLECTING TUBULES

**Cortical collecting tubules** are located in medullary rays

They are lined by a simple epithelium containig two types of **cuboidal cells**

- 1. Principal (light) cells** oval and centrally located nucleus, possess a single primary cilium, few mitochondria .They are ADH sensitive and possess numerous aquaporin 2 channels
- 2. Intercalated (dark) cells**, are less numerous than principal cells ; Possess apical microplicae and abundance of mitochondria
  - $\alpha$ -intercalated- release  $H^+$  ions into the tubular lumen and acidifying urine
  - $\beta$ -intercalated- resorbing  $H^+$  and secreting  $HCO_3^-$

## MEDULLARY COLLECTING TUBULES

In the outer medulla , are similar to the cortical collecting tubules

Lined by principal and intercalated cells but when moves to the inner medulla only principal cells stay

Excrete hydrogen ions into the lumen of the duct

# PAPILLARY COLLECTING TUBULES

## *Ducts of Bellini*

Large collecting tubules (200-300 $\mu$ m in diameter )

formed from converging smaller tubules

Lined by **tall columnar principal cells**, each cell possesses a primary cilium which is probably responsible for monitoring the urine in its lumen

Empty at the **area cribrosa** ,a region of at the apex of renal pyramid that has 10-25 openings

Collecting tubules are impermeable to water , in the presence of ADH they become permeable