

## Urinary system

- Objectives to know about:
- KIDNEYS
- RENAL FUNCTION
- Structure and function of each component of nephron
- Blood Filtration barrier.
- Juxtaglomerular complex.
- Ureters, Bladder – & Urethra

Functions of this system:

1-Regulation of : Blood ionic composition.-Blood PH.-Blood volume-Blood pressure

2-Production of hormones erythropoietin

3-Excretion of waste product

Urinary system –Is composed of:

A. Kidneys -B. Ureters -C. Bladder – D. Urethra

The Kidneys

Each kidney is divided into:

Outer Cortex

Inner Medulla: that composed of 10-12 renal pyramids

Their base of is project toward the cortex extended as(medullary rays).

Their apex is renal papilla is surround the opening of minor calyx.

Renal columns are cortical tissue extends between the pyramids.

Each kidney contains around 1 million functional units called

Uriniferous tubules are:

1. Nephron about (30.40mm) long ,(1-4) million in each kidney composed of:

Renal corpuscles , Proximal convoluted tubules ,Thin and thick segment loop of Henle , Distal convoluted tubules.

2. collecting tubules and duct 20mm long

**Nephron** :Basic structural and functional unit of the kidney. Its main function regulates the concentration of water and soluble substances like sodium salts by filtering the blood, reabsorbing what is needed and excreting the rest as urine.

### **Renal Corpuscle:**

glomerulus and Bowman's capsule

**Glomerulus**-Is a network of blood capillaries about (10-20) capillaries loop surrounded by Bowman's capsule.

**Bowman's capsule:** encloses the glomerulus.

It is two layers:

1- Parietal layer :is lined by simple squamous epithelium.

2-Visceral layer :the podocytes are modified epithelial cells have multiple processes and pedicles that surround the glomerular capillaries.

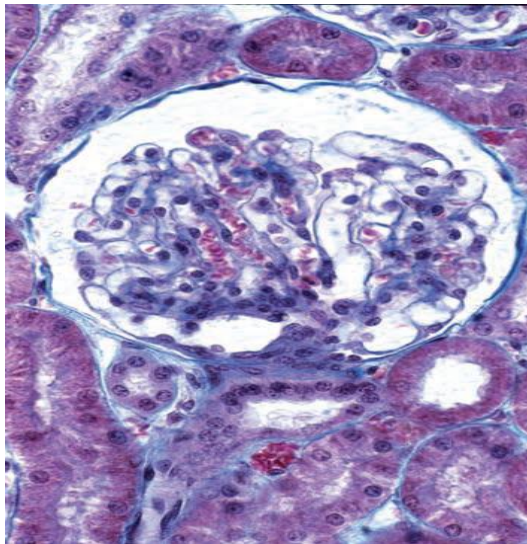
The spaces between adjacent pedicles, called the filtration slits.

The pedicels interdigitate with each other and attach to the basal lamina of the capillary endothelium.

### **Function of the podocytes**

1-Mechanical support; they act to prevent the rupture of the glomerular capillaries due to blood pressure .

2-The secondary processes support the hydrostatic pressure exerted on the basement membrane during filtration.



**Glomerular Filtration Barrier:** Is composed of:

1- The fenestrated endothelium of the glomerular capillaries.

2- The podocytes layer of Bowman's capsule

3- A thick basement membrane of both cells..

**Proximal convoluted tubules:** are found in cortex receives the filtrate from urinary space of bowman's capsule.

1- Are lined by high cuboidal epithelial cells that have rounded nucleus centrally located .

2- The cells have microvilli (brush border) required for reabsorption.

3- The cytoplasm is acidophilic (H&E),

The cytoplasm appears striated at the base of cells, due to elongated mitochondria.

These epithelial cells are adapted for fluid and ion exchange. They reabsorbs about 65-70 of glomerular filtrate.

**Loops of Henle:** U. shaped structure, composed of thin and thick segments.

Thin segment: is lined by simple squamous epithelium about (3-5) cells are seen, they resemble the capillary except, their nuclei protrude more into the lumen.

Thick segment: is lined by simple cuboidal epithelium. The cytoplasm is faintly stained, they similar to distal C.T. the loops maintain the osmotic gradient in renal parenchyma.

**Distal convoluted tubules:** Are found in cortex.

They are lined by low cuboidal epithelial cells.

Have short microvilli or no microvilli on their apical surface (shorter than in P.C.T or absent).

Have large lumen ( larger than P.C.t)

Faintly stained (less acidophilic than P.C.T).

The cells are adapted for fluid and ion exchange.

**Collecting tubules and ducts:**

The distal convoluted tubules empty into the collecting tubules.

The collecting tubules extend into the renal medulla and merge to form the large papillary ducts of Bellini that empty into the calyces.

The smaller tubules are lined with simple cuboidal epithelium.

As they approach the papillary ducts, the lining becomes columnar.

**Mesangial cells**

Are found in glomerulus adhering to the wall of capillaries, in places where the basal lamina forms a sheath that is shared by two or more capillaries.

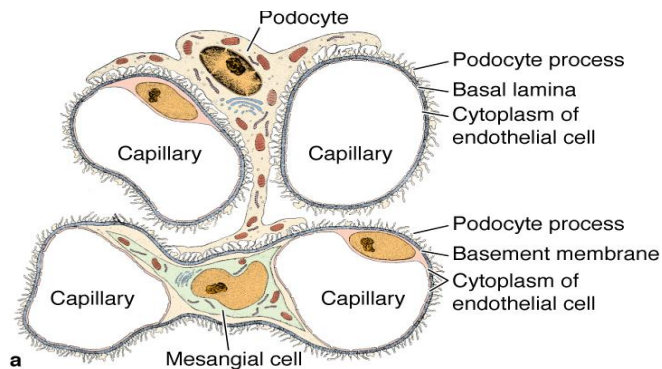
**Mesangial cell functions:**

Pericyte – like population cells.

Support – give support to podocytes.

**Secretion = secret extra cellular matrix.**

**Phagocytosis: removed residues and aggregated protein from glomerular basement membrane.**



### **Juxtaglomerular apparatus:**

**At the point where the distal tubule is in contact with the afferent and efferent arterioles of its own renal corpuscle, modification occur in both.**

**It has 3 components:**

- 1. The macula densa**
- 2. Juxtaglomerular cells**
- 3. The extraglomerular mesangial cells (laci cells).**

**1. Juxtaglomerular cells: Are modified smooth muscle cells in the tunica media of afferent arterioles of renal corpuscles. These cells produce rennin, to maintain the blood pressure.**

**2- Macula densa: It is an adaptation of distal tubular epithelium at Cells of the distal tubule wall become columnar.**

**Function of the macula densa:**

**Provides "information" concerned with the composition of filtrate in the distal tubule.**

**This "information" in the form of molecular signals, regulates the secretion of renin.**

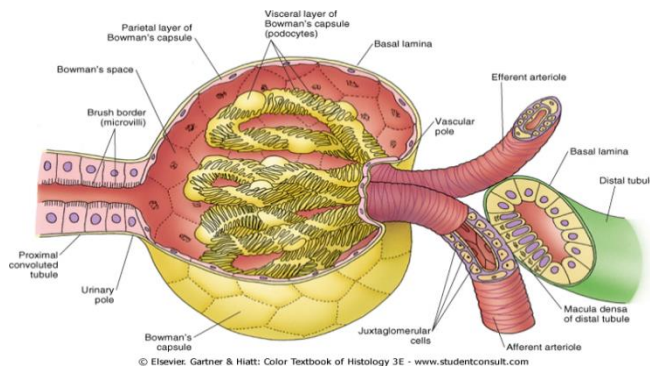
- 3. The extraglomerular mesangial cells (laci) :**

**These cells occupy the region bordered by the macula densa at the base and afferent and efferent arterioles at the sides.**

**They are supporting cells as mesangial cells inside the glomerulus. They transmit signals from macula densa into the glomerulus.**

**The macula densa and JG cells monitor the nephron function and adjust blood pressure to maintain filtration in the glomerulus and adequate fluid flow in the nephron. The macula densa monitors osmotic concentration in the fluid in the nephron and secretes local hormones that alter JG cell secretion.**

The JG cells monitor blood pressure in the afferent arteriole and secrete renin, that converts angiotensinogen in blood plasma to angiotensin I which is converted to angiotensin II in the lungs. Angiotensin II causes arteriole constriction throughout the body, raising blood pressure.



## Excretory passages

The calyces, pelvis, ureter, bladder and urethra.

**Ureter:** Three basic layers are:

**Mucosa:** epithelium is transitional epithelium and lamina propria ,

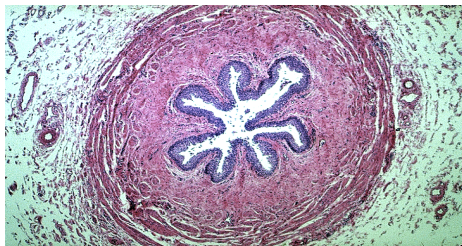
It stretches when ureters fill.

**Muscularis:**

Inner longitudinal, outer circular layers

An outer longitudinal layer is present in the lower 1/3 of human ureters.

**Adventitia or serosa**(loose FECT - mesothelium



**Urinary Bladder:**

Is reservoir for urine its wall is folded when it is empty, become smooth and thin in full bladder. The wall as in ureter composed of :

**Mucosa:** is composed of lining epithelium and connective tissue as lamina propria.

**Muscle coat.** 3 layers of smooth muscle bundles,

inner longitudinal, middle circular, and outer longitudinal.

**Adventitia and serosa** on the upper region of the bladder

The lining epithelium is transitional have the ability to change. (It is changeable)

In empty bladder (relaxed bladder), it is about (5-6) layers of cells.

Full bladder the epithelium becomes (3-4) layer of cells and the outer most layer become squamous.

How can transitional epithelium of urinary bladder change its shape?

The superficial cells (facet cells) of epithelium called umbrella cells and are highly differentiated to protect underlying cells, responsible for the osmotic barrier between urine and lamina propria. They are hold together by desmosomes and tight junctions.

These cells are composed of rigid, thick regions (plaques) interspersed by normal cells membrane, so when the bladder is empty the plaques regions are folded into irregular folds along the membrane, this disappear when the cells stretched.

**Muscle coat:** Smooth muscle fibers run in many directions but near the neck of bladder the muscle arrange in three layers = inner and outer run longitudinally, while the middle run circularly.

**Urethra** :is fibro muscular tube, differ in size, structure in male than in female,

**FEMALES urethra:** It is about 3-5 cm long.

**MUCOSA:** Lining epithelium

In the initial part transitional epithelium

In the distal part stratified squamous epithelium

A short region between the transitional and stratified squamous epithelia is pseudostratified columnar to stratified columnar epithelium.

Lamina propria =fibro- elastic connective tissue.

**MUSCULAR layer:** 2 or 3 layers of smooth muscle, inner longitudinal layer and outer circular layer (surrounded by skeletal muscle in sphincter region), may have additional longitudinal smooth muscle.

**ADVENTITIA** = loose connective tissue

**Male urethra**

Is the terminal part for both urinary and genital system, about 20cm long has three segments:

1-Prostatic urethra: About (3-4cm) long from the neck of bladder through prostate gland. It is lined by transitional epithelium.

2- Membranous urethra:

(1 cm) long extend from apex of prostate gland to the bulb of penis. It is lined by stratified or pseudo stratified columnar epithelium. It is surrounded by external sphincter of skeletal muscle.

**3- Penil (spongy) urethra: Is extend for about (15 cm) extends from the membranous urethra through penis (corpus spongiosum) to the external urethral orifice Lined by pseudostratified or stratified columnar except at opening it is stratified squamous**

**Histology: In both male and females the urethra starts out as transitional cell but quickly becomes stratified squamous in the female.**

**The male urethra is more variable but ends up stratified squamous as well.**