الكلية	العلوم
القسم	علوم حياة
المادة باللغة الانجليزية	Histology
المادة باللغة العربية	علم الانسجة
المرحلة الدراسية	الثالثة
اسم التدريسي	د.هند يونس خلف عبدالله
عنوان المحاضرة باللغة الانجليزية	Urinary System Tissue
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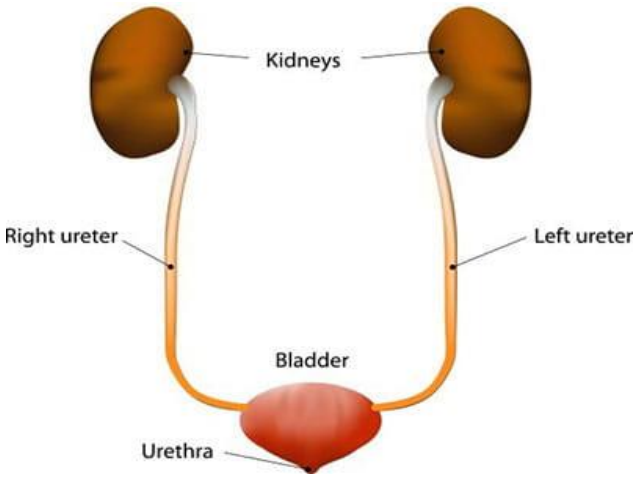
Histology of Urinary System

The urinary system consists of the paired kidneys; paired ureters, which lead from the kidneys to the urinary bladder; and the urethra, which leads from the bladder to the exterior of the body

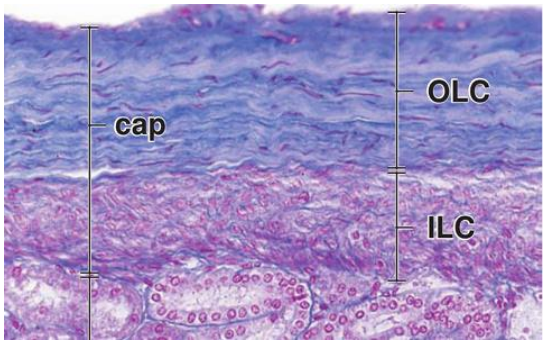
. The kidneys play an important role in body homeostasis by conserving fluids and electrolytes and by disposing metabolic waste , This process occurs in tiny structures called **nephrons**

The kidney also functions as an endocrine organ. Synthesis and secretion of the glycoprotein hormone erythropoietin (EPO) which acts on the bone marrow and regulates red blood cell formation in response to de creased blood oxygen concentration. Synthesis and secretion of the acid pro tease renin, an enzyme involved in control of blood pressure and blood volume.



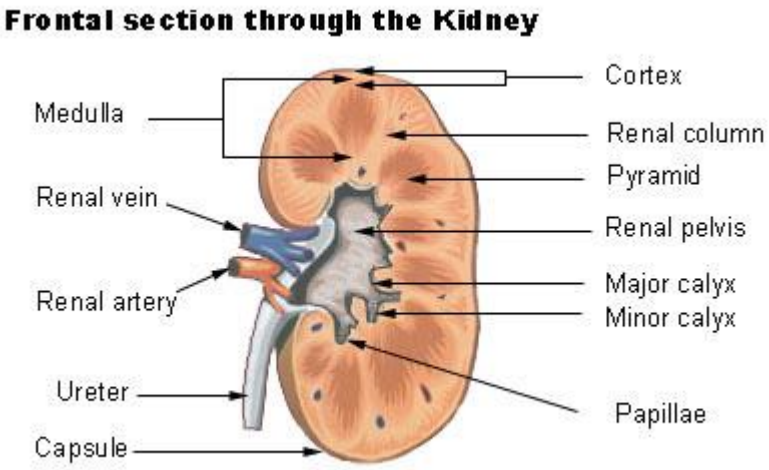
General structure of Kidney

The kidney surface is covered by a connective tissue capsule. The capsule consists of two layers: an outer layer of fibroblasts and collagen fibers, and an inner layer with a cellular component of myofibroblasts

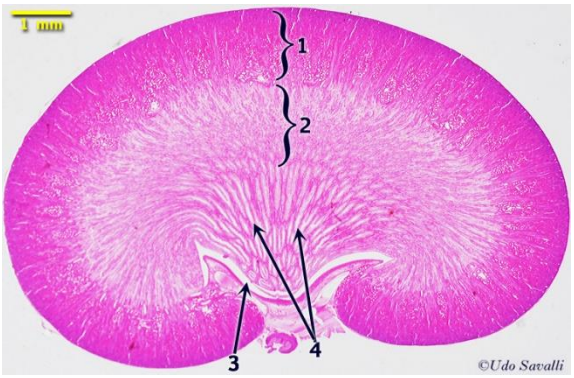


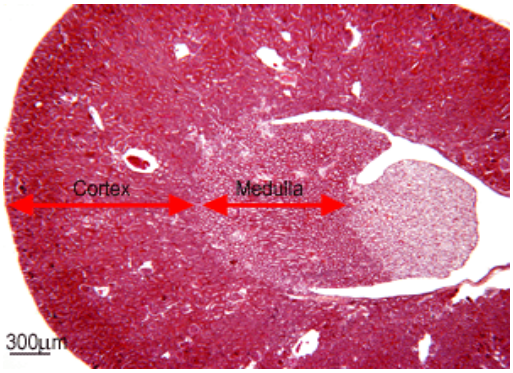
Kidney can be divided into two distinct regions:

- Cortex, the outer reddish-brown part
- Medulla, the much lighter colored inner part



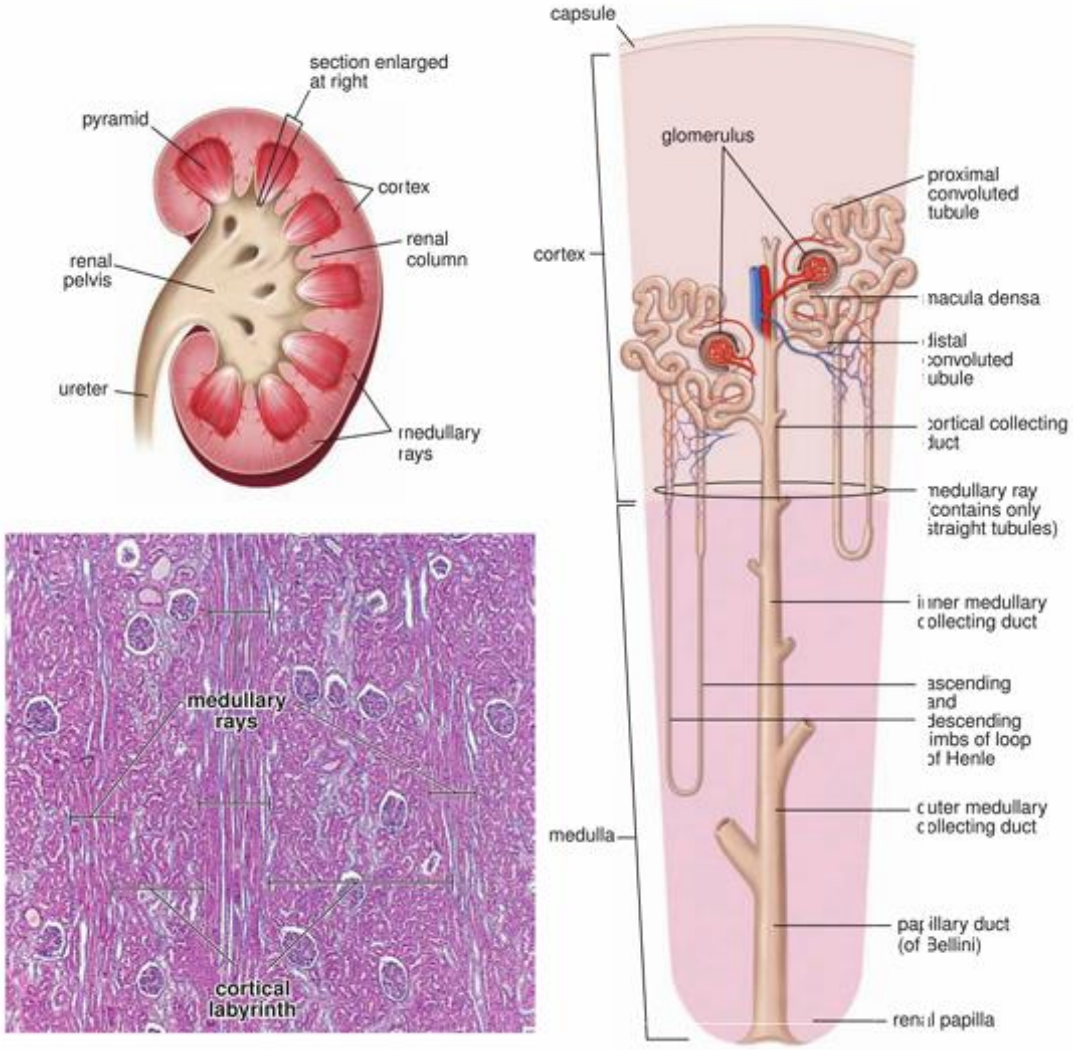
The renal cortex is the outer layer of the kidney tissue. It is darker than its underlying renal medulla because it receives over 90% of the kidney blood supply. The cortex has a grainy appearance, as it mostly contains ovoid and coiled parts of the nephrons (renal corpuscles and convoluted tubules).



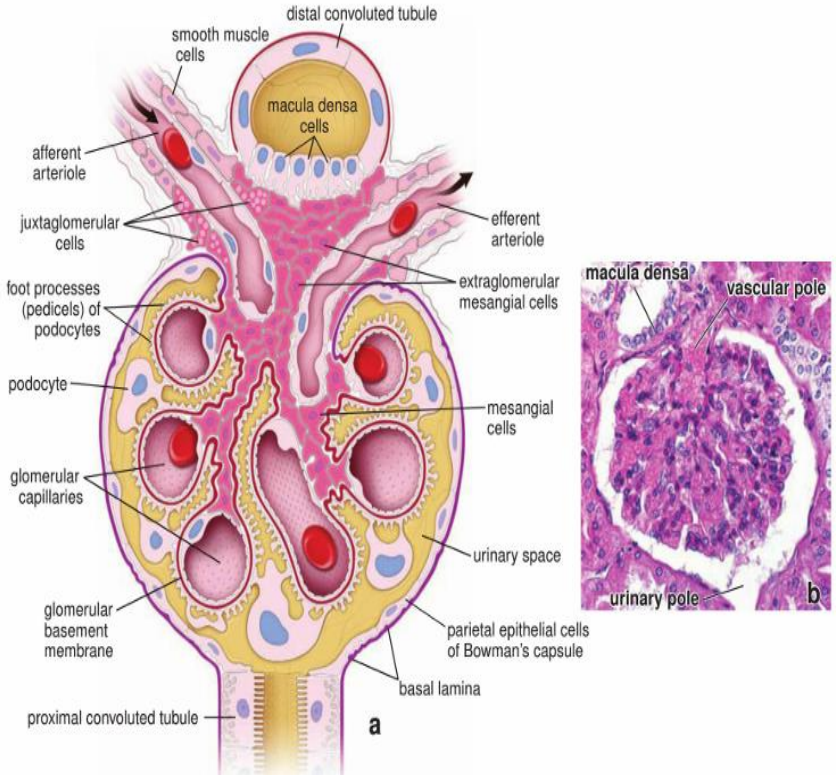


The renal medulla appears striped, as it contains vertical nephron structures (tubules, collecting ducts). The tubules in the medulla, because of their arrangement and differences in length, collectively form a number

of conical structures called pyramids .Usually 8 to 12 but as many as 18 pyramids may be present in the human kidney. The bases of the pyramids face the cortex, and the apices face the renal sinus. The apical portion of each pyramid, which is known as the papilla, projects into a minor calyx, a cup-shaped structure that represents an extension of the renal pelvis. The tip of the papilla, also known as the area cribrosa,

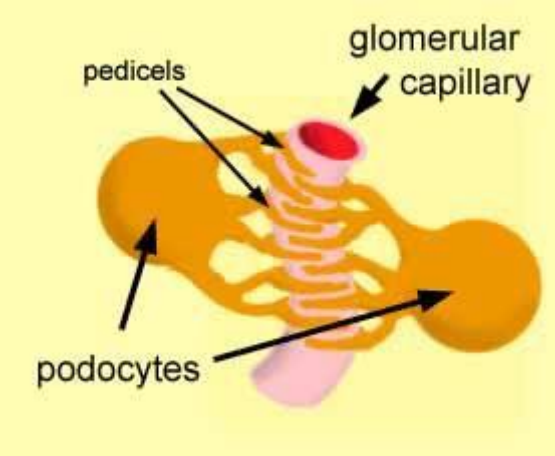


the basic functional unit of kidneys is the **nephron** that consists of a The renal corpuscle and its associated tubules through which the glomerular filtrate passes before it emerges as urine .The renal corpuscle represents the beginning of the nephron. It consists of the glomerulus, a tuft of capillaries composed of 10 to 20 capillary loops. Bowman's capsule is the initial portion of the nephron, where blood flowing through the glomerular capillaries undergoes filtration to produce the glomerular ultrafiltrate. The glomerular capillaries are supplied by an afferent arteriole and are drained by an efferent arteriole that then branches, forming a new capillary network to supply the kidney tubules. The site where the afferent and efferent arterioles penetrate and exit from the parietal layer of Bowman's capsule is called the vascular pole. Opposite this site is the urinary pole of the renal corpuscle, where the proximal convoluted tubule begins .



The glomerular capsule consists of two layers (parietal and visceral), which bound a cavity called the glomerular capsular space (Bowman's / urinary space). The inner visceral layer is made of special cells called podocytes.

(Is a highly differentiated squamous epithelial cell that plays a crucial role in maintaining the structure and function of the glomerular filtration barrier in the kidney).



The outer parietal layer is made of simple squamous epithelium and is continuous with the nephron tubules.

Thus, The kidney filtration apparatus is formed by three layers of tissue; endothelium of the glomerular capillaries, glomerular basement membrane (GBM) and podocytes (visceral layer of renal capsule).

the remaining parts of the nephron (the tubular parts) are as follows:

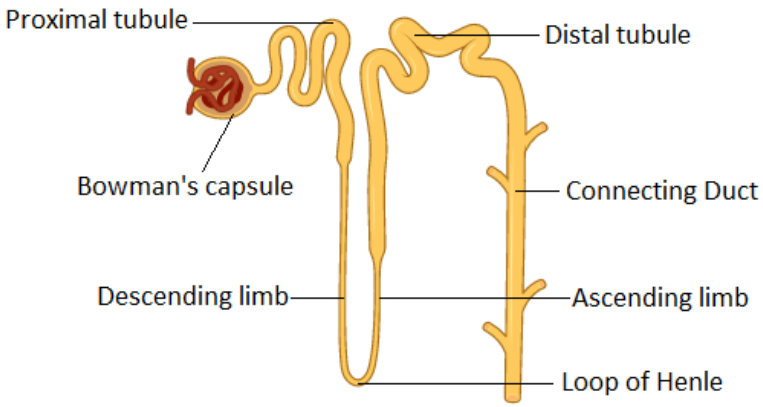
- Proximal tubule; convoluted proximal tubules and straight proximal tubule
- Nephron loop; descending and ascending limbs(**loop of Henle**)
- Distal tubule; straight distal tubule and convoluted distal tubule

The proximal tubule is the first part of the tubular system, composed of simple cuboidal epithelium, rich in mitochondria and microvilli (brush border). This morphology is adapted to the proximal tubule function of absorption and secretion(More than half of the previously filtered water and molecules are returned to the blood (reabsorption) by the proximal tubules).

The nephron loop(loop of Henle)is the U-shaped bend of a nephron , it consists of two parts; thin descending and thin ascending limbs.Both limbs are composed of simple squamous epithelium.

The distal tubule also consists of straight and convoluted segments. The straight distal tubule (thick ascending limb) and the thin ascending limb of the nephron loop .Both parts of the distal tubule are composed of simple cuboidal epithelium, similar in morphology to the proximal tubule.

At its termination, the distal convoluted tubule empties into a cortical collecting duct that lies in the medullary ray via connecting tubule or a shorter tubule simply called the connecting tubule.



Parts of Nephron

The collecting ducts or tubules which are concerned with transport of urine from nephrons to pelvis of ureter. The collecting ducts unite to form ducts of Belini, which open into minor calyces through papilla.

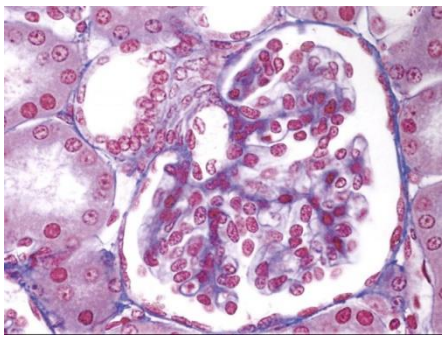
Types of Nephrons

- **cortical nephrons**
- **Juxtamedullary nephrons**
- **midcortical nephrons**

Juxtaglomerular apparatus

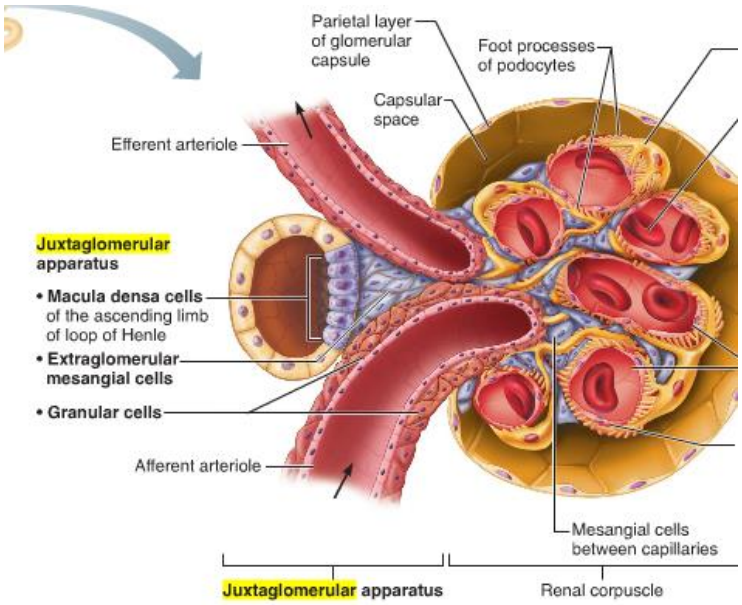
Nestled into the vascular pole of the nephron is a collection of cells called the juxtaglomerular apparatus (JGA).It is formed by 3 types of cells

1- macula densa composed of simple cuboidal epithelium,its function is osmoreceptor



2- juxtaglomerular granular (JGC) cells (modified smooth muscle) its function secretion renin ,secretion of erythropoietin

3- extraglomerular mesangial (Lacis) cells.small cells like network that contact the JGC and macula densa by gap junction

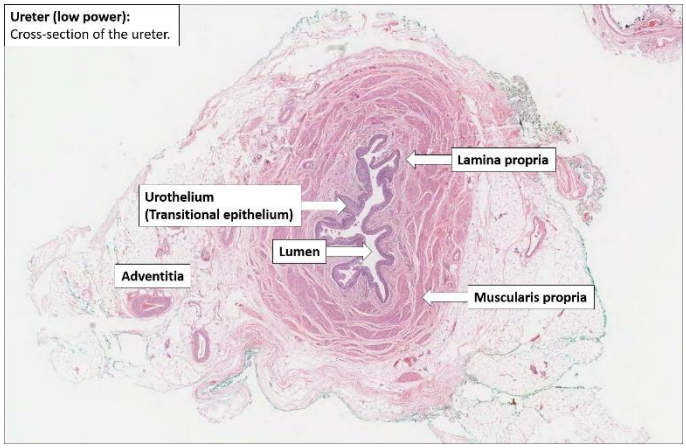


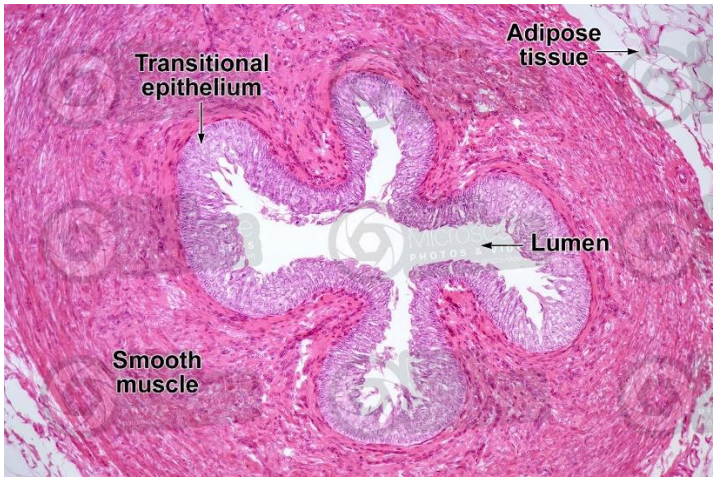
The juxtaglomerular apparatus has two key functions;

- regulates glomerular blood flow and filtration rate
- regulates systemic blood pressure

The Ureters

The ureters are bilateral, muscular, tubular structures, responsible for taking urine from one kidney to the urinary bladder for storage, prior to excretion. The lumen of each ureter is lined by a mucosal layer of urothelium (transitional epithelium) and a thick fibroelastic lamina propria lies underneath the epithelium. The mucosa of the ureters executes a protective function in general. The remainder of the ureteral wall is composed of multiple layers of smooth muscle and connective tissue. There are two muscular layers in the wall of the ureter: an inner longitudinal and a middle circular layer. As the ureter is usually embedded within the retroperitoneal adipose tissue, this also forms the adventitia (outer layer) of the ureter.





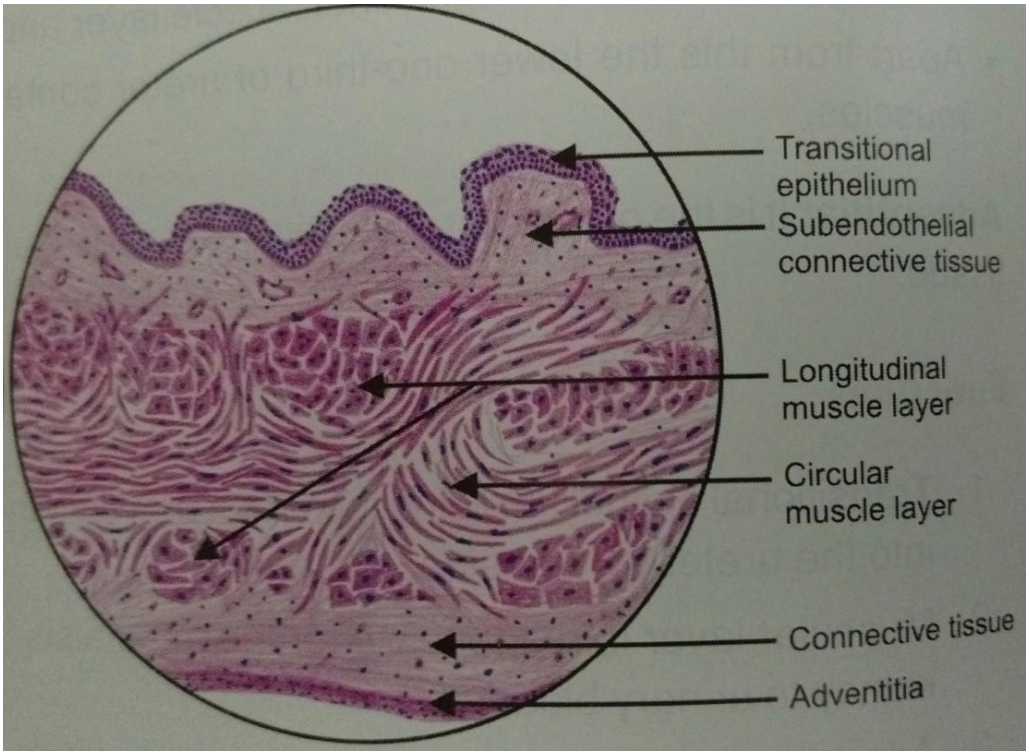
Urinary bladder and urethra

The urinary bladder and urethra are pelvic urinary organs whose respective functions are to store and expel urine outside of the body in the act of micturition (urination).

The urinary bladder contains three openings, two for the ureters (ureteric orifices) and one for the urethra (internal urethral orifice), with the triangular region defined by these three openings known as the trigone. The wall of the urinary bladder is comprised of smooth muscle fibers collectively known as the detrusor muscle. Similar to the ureters, the urinary bladder is lined by a mucosal layer of transitional epithelium (urothelium) which helps to accommodate for large volume changes.

Like most urinary organs, the urethra is lined with a mucosal layer of transitional epithelium (urothelium). Deep to the urothelium, a dense collagenous lamina propria can be found. Additionally, two layers of smooth muscle (inner longitudinal, outer circular) lie beneath the lamina propria.

The course of urethra is different between males and females.



How glomerular filtration works

With up to 180 liters per day passing through the nephrons of the kidney, it is quite obvious that most of that fluid and its contents must be reabsorbed.

The first step in making urine is to separate the liquid part of blood (plasma), which contains all the dissolved solutes, from blood cells.

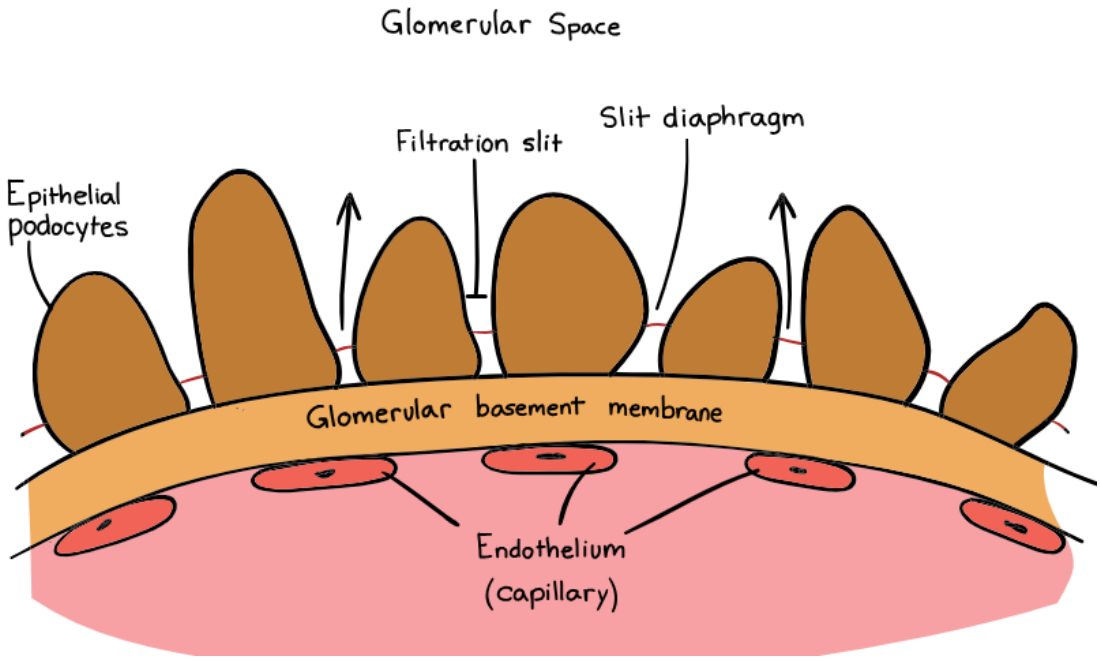
Blood that is about to be filtered enters a glomerulus, located at the end of each nephron, called a glomerular capsule. Glomerular capillaries have small pores in their walls, just like a very fine mesh sieve. Most capillary beds are sandwiched between arterioles and venules (the small vessels delivering blood to and collecting blood from capillary beds), The glomerulus, on the other hand, is sandwiched between two arterioles - afferent arterioles deliver blood to the glomerulus, while efferent arterioles carry it away.

efferent arterioles are smaller in diameter than afferent arterioles. As a result, pressurized blood enters the glomerulus through a relatively wide tube, but is forced to exit through a narrower tube. Together, these unique features plus the fact that the heart is supplying kidneys with over a liter of blood per minute (around 20% of its output) maintain a high glomerular capillary pressure and the filtration function of the kidney, regardless of fluctuations in blood flow.

The physical characteristics of the glomerular capillary wall determine what is filtered and how much is filtered into the glomerular capsule. Working from the inside out, the capillary walls are made up of three layers:

- Endothelium - this has relatively large pores (70-100 nanometers in diameter), which solutes, plasma proteins and fluid can pass through, but not blood cells.

- Basement membrane - this membrane is also made up of three layers, and is fused to the endothelial layer. Its job is to prevent plasma proteins from being filtered out of the bloodstream.
- Epithelium - this layer consists of specialized cells called podocytes. These cells are attached to the basement membrane by foot processes (pedicels). They wrap around the capillaries, but leave slits between them, known as filtration slits. A thin diaphragm between the slits acts as a final filtration barrier before the fluid enters the glomerular space.



Then ,starting tubular reabsorption processes(Tubule reabsorption is the process by which molecules from the glomerular filtrate are returned back to the plasma) .Metabolically important molecules (water, ions, and organic molecules) are completely reabsorbed so that there is no need to constantly ingest (or produce) these molecules. Waste products are not fully reabsorbed so that they can be removed from the body and do not build up a concentration into a toxic level.