

# Human Anatomy & Embryology

**Lecture: Urinary system**

**Done by: Meerna Ayman**

**Edited by: Mahmoud Obeidat**

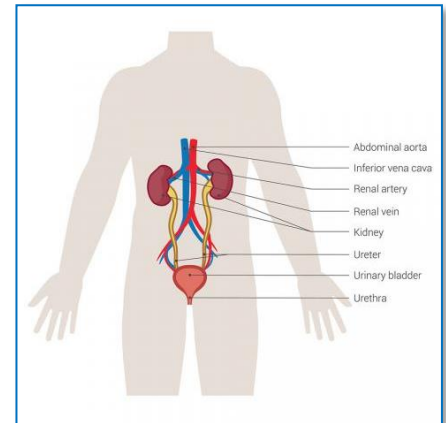


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# URINARY SYSTEM

## ❖ Introduction

The urinary system, also known as the renal system or urinary tract, consists of the kidneys, ureters, bladder, and the urethra. The purpose of the urinary system is to eliminate waste from the body.

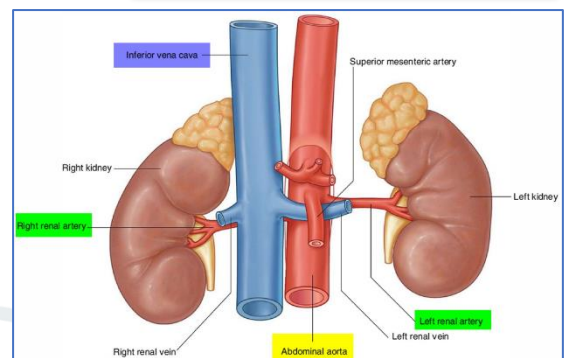


## ❖ Urinary system parts

### ✚ Kidneys

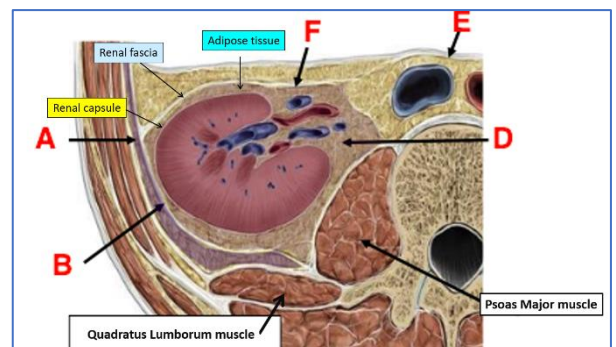
#### ➤ Brief description:

- Shape: The **kidneys** are two **bean-shaped** organs, **reddish-brown** colored, each about the size of a fist 🗨️.
- has: anterior + posterior surfaces, superior + inferior poles, lateral + medial borders.
- medial border has indentation (depression) called **renal sinus**, housing renal **Hilum** (the place where arteries, veins, nerves [+ ureters in the case of kidney] go in and out off an organ).
- surface is not flat, but segmented.
- Function: kidneys remove wastes and extra water to make urine.



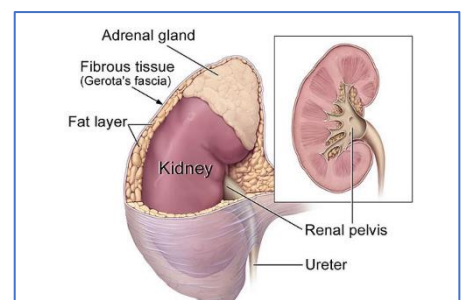
#### ➤ Location & position:

- Kidneys are located just below the rib cage, on the posterior abdominal wall, one on each side of your spine.
- lateral to the psoas major muscle, anterior to the quadratus lumborum muscle.
- Right kidney is inferior and medial to the liver (makes an impression on the inferior surface of the liver), so it is slightly lower than left kidney (thus lower pole of left is higher than right one).
- Left kidney is medial to spleen.



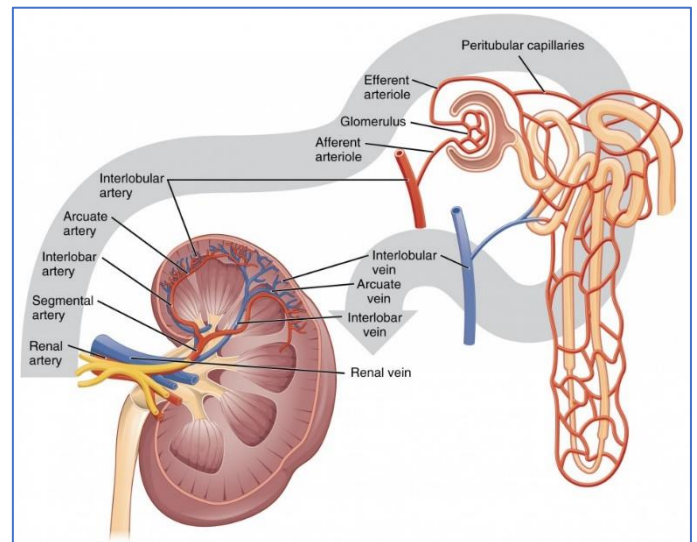
#### ➤ Coverings:

- three external layers:
  1. **renal fascia (Gerota's fascia, fibrous tissue, outermost layer)**, around perirenal fat capsule.
  2. **perirenal fat capsule: fat layer** around the renal capsule.
  3. **renal capsule (innermost layer)**, which then surround the space of the renal cortex.
- Adrenal gland (suprarenal gland) above the kidney.
- Parietal peritoneum: fixes the kidney to the posterior abdominal wall.



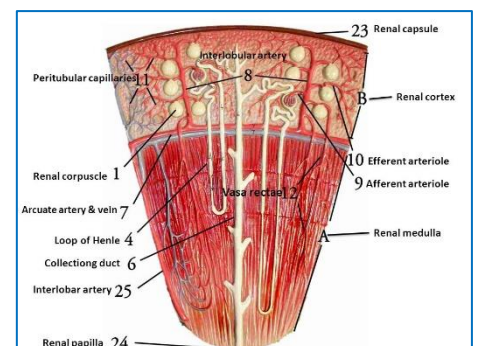
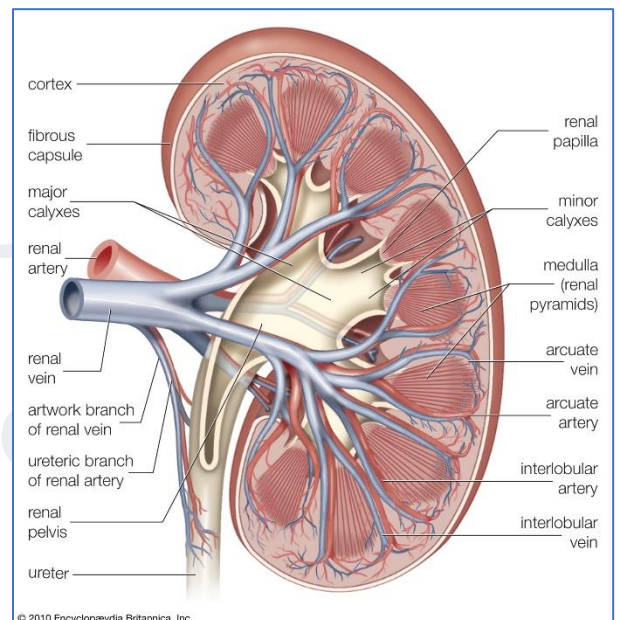
➤ **Blood supply:**

- circulation: Aorta → Renal artery → segmental artery → interlobar artery (not lobular) → arcuate artery → Interlobular artery → Afferent arterioles → glomerulus → Efferent arterioles → peritubular capillaries → veins (same names of arteries, reflected) → Renal vein → inferior vena cava.
- Renal artery: the only artery that comes at right angle out of the abdominal aorta (as the doctor said).
- The inferior vena cava is right to the aorta, therefore the Right renal vein is shorter than the Left renal vein.
- Renal vein joins inferior vena cava in the posterior abdominal wall.



➤ **Internal structures:**

- **Renal Cortex:**
  - The outer portion of kidney between the renal capsule and the renal medulla.
  - it forms a **light red** outer zone with a number of projections (cortical columns) that extend down between the pyramids.
  - Contains Glomeruli.
- **Renal Medulla:** a group of pyramids (8-18) appear **darker red**.
- **Pyramids:**
  - triangular structures that form renal medulla.
  - kidney is divided into lobes, each consists of 1 pyramid + ½ renal column from the right and other from the left + piece of cortex.
- **Renal Papilla:** narrowest part of the pyramid (the apex containing part of pyramid).
- **minor calyx:** the beginning of the drainage system, found in the tip of papilla which drains into minor calyx.
- **Major Calyx:** several minor calyces will collect into one major calyx.
- **Renal pelvis:** the point where two or more major calyces join together. Sometimes it presents entirely inside the kidney and sometimes part of it is outside the kidney at the renal sinus.



- **Nephron:**

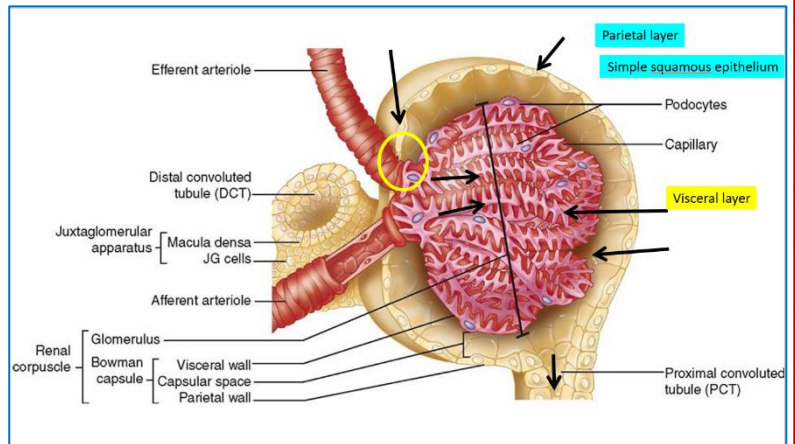
- functional unit of the kidney.
- Made of two parts:

1) Vascular part: Afferent arteriole (enters the nephron) → Glomerulus → Efferent arteriole (exits the nephron).

- **Glomerulus:** network of capillaries, located at the beginning of a nephron.

- Function: filtration of blood.
- The afferent arteriole is larger than efferent, so this will generate a pressure inside the glomerulus aids in filtration.

2) Collecting part: Bowman's capsule → Proximal tubule → loop of Henle → Distal tubule → Collecting duct.



- **Bowman's capsule (renal capsule):** cup-like sac, that glomerulus invaginates it (in same way of a fist invaginates a balloon).

- it Has 2 layers:

1. parietal (outer) layer, made by simple squamous epithelium.
2. visceral (inner) layer. The visceral layer is made by **podocytes**, which are cells in the Bowman's capsule that wrap around capillaries of the glomerulus, forming the epithelial lining of Bowman's capsule.

- Between visceral and parietal layers there is a space called the **renal space** contains fluid which is filtered out from the glomerulus.

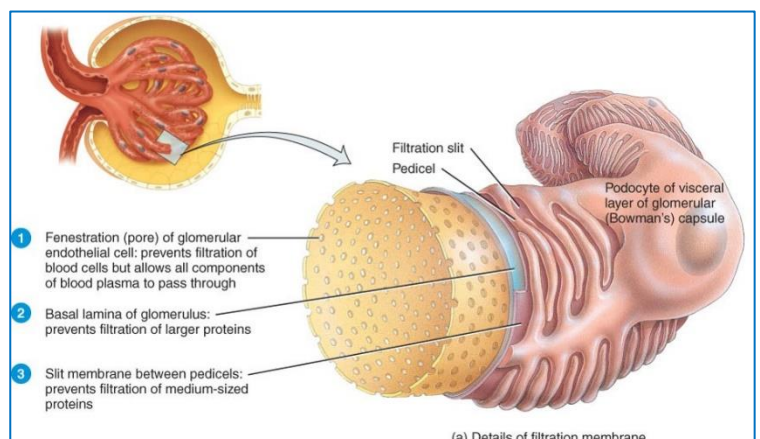
- **podocytes** will send primary central process and this process will send side branches called secondary processes going to cover a capillary of the glomerulus (look at the image below).

- spaces between these secondary processes is called **filtration slits**, which fluid come out from capillary after passing through fenestrations.

- **Renal corpuscle:**

- = Glomerulus + Bowman's capsule.
- Location: renal cortex. It cannot be found in medulla.

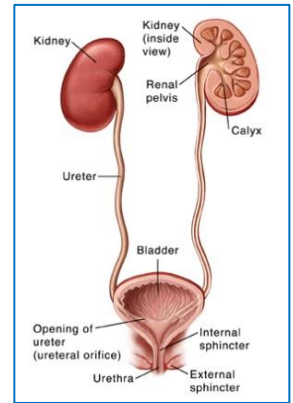
- this is a capillary of glomerulus.
- Type of capillary: **fenestrated capillary**, these fenestrations (pores) allow fluid and wastes to exit the capillary but don't allow cells.



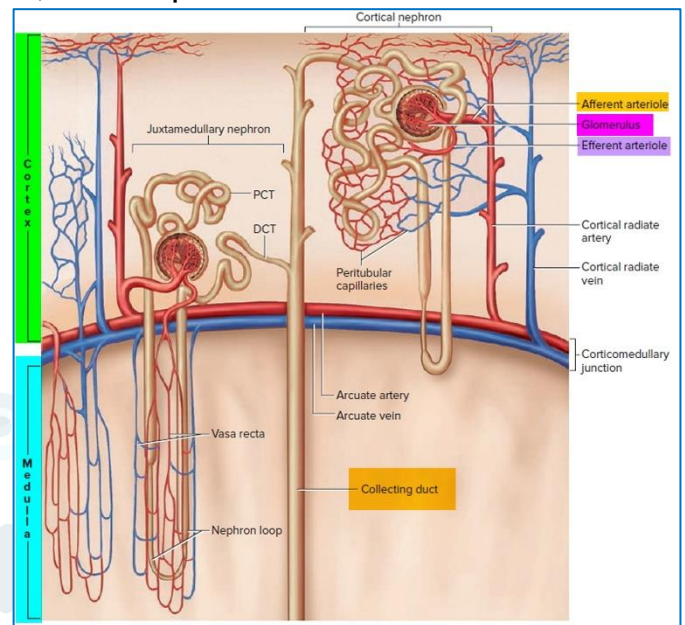
- We want to collect the product of filtration and carry it through a system of tubules. Some tubules will absorb and others will secrete substances, and the result (urine) will be excreted from the body.

**These tubules are:**

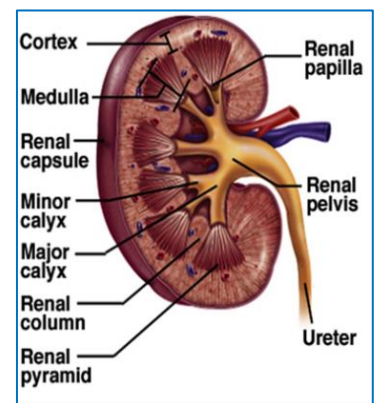
- **Proximal convoluted tubules:** attached to Bowman's capsule, fluid comes out from renal space then enters proximal convoluted tubules.
  - lined with simple cuboidal epithelium (that sometimes can be high nearly as columnar epithelium).
  - function: contributes to urine formation by secreting and reabsorbing some substances.



- **Loop of Henle:** long U-shaped portion of the tubule system, connects proximal with distal tubules.
  - lined with simple squamous epithelium.
  - loop of Henle can be divided into three main segments: the thin descending limb, the thin ascending limb, and the thick ascending limb, which is connected to distal convoluted tubules.
  - a part of loop of Henle -including turning point- must be immersed into medulla (a pyramid).
  - are all the renal corpuscles have the same Height level in the cortex? No:
    - some are near the outer part (**cortical nephrons**), and its loop of Henle is little immersed in medulla.
    - some are near the inner medullary pyramid (**juxtamedullary nephrons**, juxta= neighbour), and its loop of Henle is much more immersed in medulla.



- **Distal convoluted tubules:** attached to loop of Henle, drains into the collecting duct.
  - less convoluted than proximal tubules.
  - lined with simple cuboidal epithelium, lumen is narrower than proximal tubules.
  - no secretion or reabsorption occurs here.



- **Collecting duct:** several distal tubules drain in a single collecting duct, which in turn drains into medullary papilla.

What comes after medullary papilla?

- The **collecting system** starts at the **minor calyx** where the **papilla** opens at the **minor calyx** (which can be identified by its attachment to the tip of medullary pyramid).
- two or more minor calyces collect into a **major calyx**.
- two or more major calyces collect into **renal pelvis**.

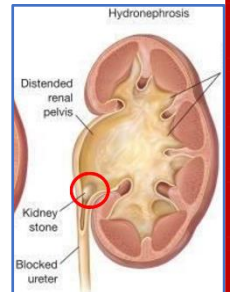
At this point, we have finished kidney and its structures. What's next?

**SUMMARY**

- Bowman's capsule drain to >> proximal convoluted tubules >> loop of Henle made of descending loop into the medullary pyramid + point of turning + ascending part of loop (thin then thick part) >> thin becomes thick again and exit medulla >> distal tubules >> collecting duct: collects from many nephrons and drains in medulla (papilla).

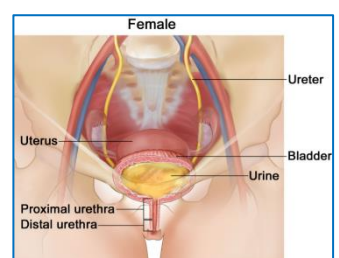
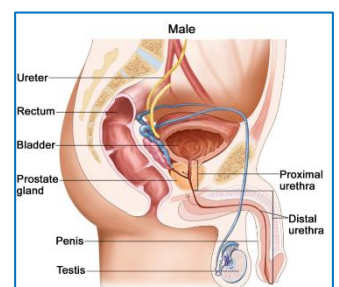
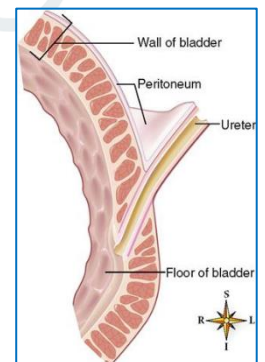
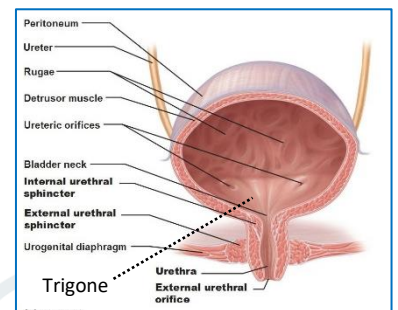
## Ureters

- A Ureter starts after renal pelvis, then descend in front of psoas major along with posterior abdominal wall, taking the shape of S letter.
- muscular tube, 25cm long, 1cm wide.
- mucosa is transitional, waterproof (no absorption or secretion).
- muscles: smooth muscle. Fibers arrangement: inner longitudinal + outer circular (opposite from intestine).
- in the inferior 3rd: additional outer longitudinal muscle layer = three layers of muscle at inferior 3<sup>rd</sup>.
- Then it crosses common iliac artery and vein, entering the pelvis to join bladder obliquely, which will give it a valvular action.
- if there is a stone blocking the bigging of the ureter; the whole system is going to dilate.



## Bladder

- Location: in the pelvis, posterior to the pubis symphysis. in females, it's anterior to the vagina and inferior to the uterus.
- shape is not constant; it depends on how much it's filled with urine.
- muscular organ:
  - ✓ Muscle type: smooth muscle.
  - ✓ Fibers arrangement: cross cross.
  - ✓ another name: **Detrusor muscle**.
- the bladder is covered by peritoneum.
- the type of epithelium of the bladder is transitional, waterproof.
- the inner surface isn't uniform; it has trabeculations, but it has smooth triangular area called trigone.
- **Trigone:** the only always-smooth surface of the bladder. it is bounded by two openings of the ureters and then internal urethral opening.
  - bladder receives the two opening of the two ureters and has an opening for urethra to excrete its contents of urine.
- Urine must pass only in one physiological direction:
  - when the ureter brings urine in the urinary bladder it's going to be distended.
  - the urine can't go back again to the kidney because of valvar mechanism at the point of the oblique entry of ureters into bladder:
    - when the bladder is distended, the bladder wall is going to exert pressure on the part of the ureter in the urinary bladder wall preventing the urine from going back into ureters.
- The bladder empties its contents through urethra.



## Urethra

- Urethra: tube that connects the urinary bladder to the outside the body for the removal of urine from the body of both females and males.
- There are differences between male urethra and female urethra:
  - male urethra is much longer, female urethra is 4cm long. This shortness makes it nearer to the external environment, and bacteria can get in easier, therefore inflammations of urethra and urinary bladder is more common in females.

THE END

