Physiology (code)-year 2

Renal physiology

Lecture 1 (Urinary system : Functional unit of the kidney)

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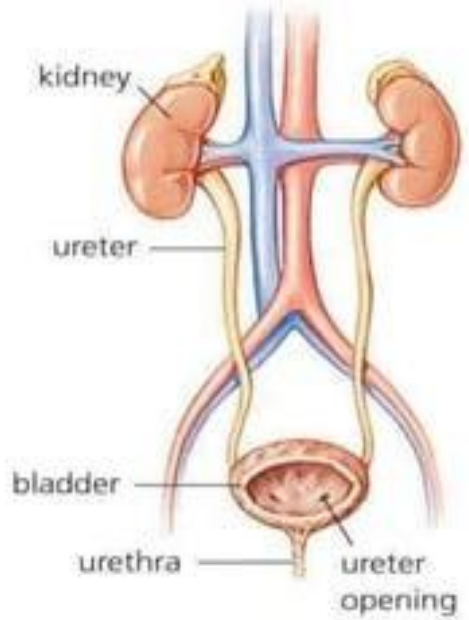
Learning objectives

- To describe parts of Renal System
- To describe the structure and function of building unit for kidney (nephron)
- Study how can nephron filter the urine

•**The Urinary System :** is also known as the renal system or urinary tract, "The urinary system consists of organs, muscles, tubes, and nerves that are responsible for producing, transporting, and storing urine".

Parts of Renal system: The urinary tract is made up of the following organs:

- A pair of Kidneys – forms the urine
- A pair of Ureters – transports the urine
- A urinary Bladder – stores urine
- A Urethra – carries urine out side the body



Kidney is the major organ of urinary system .It is situated in the retro peritoneal position in the superior lumbar region . The right kidney present slightly lower than the left.

- Mass of an adult kidney is 150 -250 g
- It is about 12 cm long and 6 cm wide & 3 cm thick
- The superior wall of the kidney is attached to the adrenal gland
- They produce urine through which waste materials such as urea & ammonium are excreted.
- They also reabsorbs glucose and amino acids
- Also, it performs some secretory functions E.g.: ***Calcitriol, erythropoietin & renin***

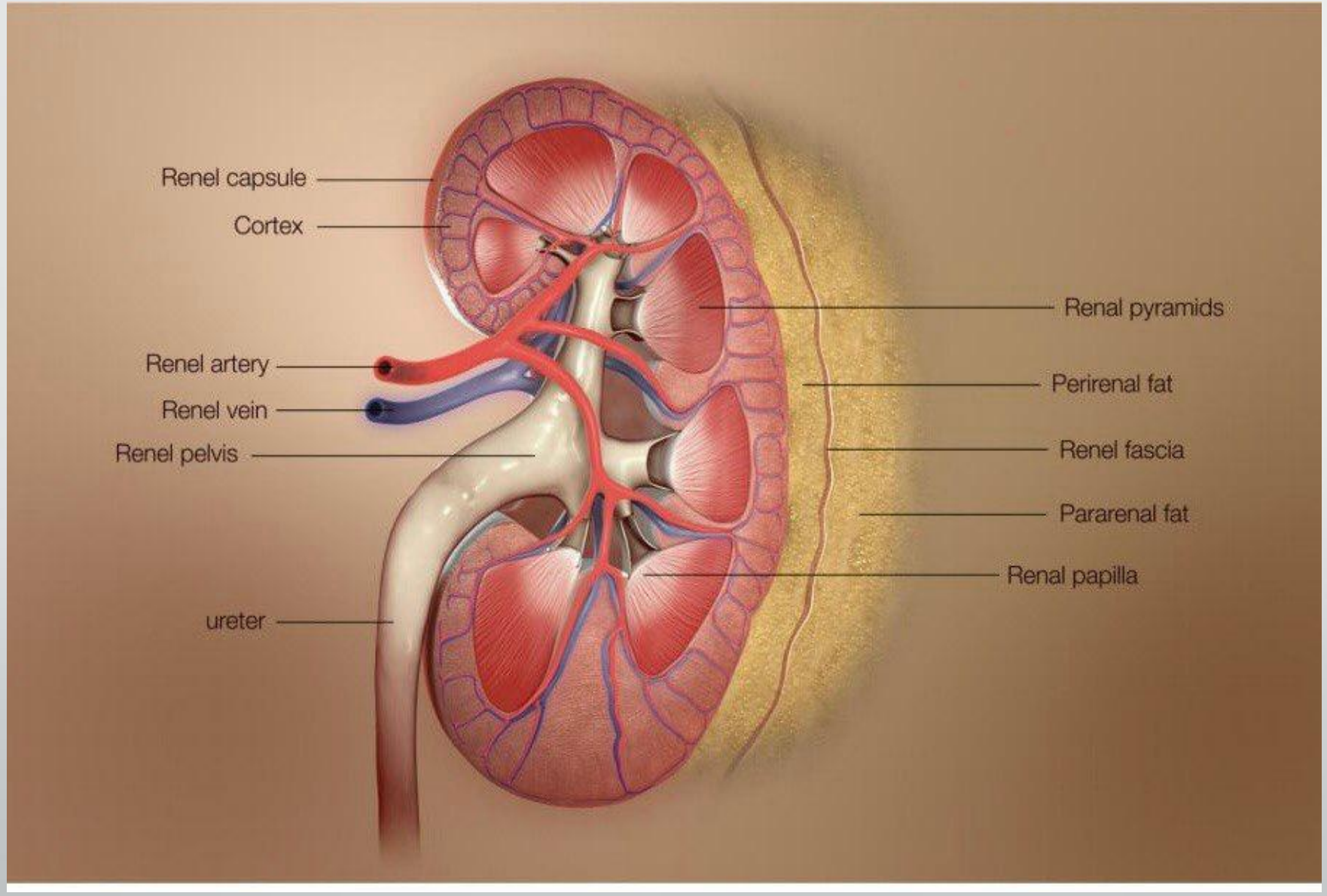
Functions of Kidney

1) Regulate the concentration of Na+, K+, Ca2+, Cl- in the blood
2) Regulation of blood pH
3) Regulation of blood volume
4) Regulation blood pressure
5) Regulation blood osmolarity
6) Regulation blood glucose level
7) Production of hormones
8) Excretion of waste and foreign substances

Layers of the kidney:

Kidney is covered by three connective tissue layers :

- **Renal Fascia** – outer layer, made up of dense connective tissue – Attaches kidney to peritoneum and posterior abdominal wall.
- **Adipose capsule:** it is the middle layer – contains thick adipose tissue – holding the kidney in place & protect it from physical trauma.
- **Renal capsule:** innermost layer – consist of thin layer of dense irregular connective tissue – protect kidney from infection & physical trauma.


Renel capsule
Cortex
Renel artery
Renel vein
Renel pelvis
ureter
Renal pyramids
Perirenal fat
Renel fascia
Pararenal fat
Renal papilla

Internal Structure of the Kidney : The kidney is divided in to three different zones **RENAL CORTEX, RENAL MEDULLA, RENAL PELVIS**

RENAL CORTEX:

This is the outer most zone

- It is light in colour
- Has granular appearance

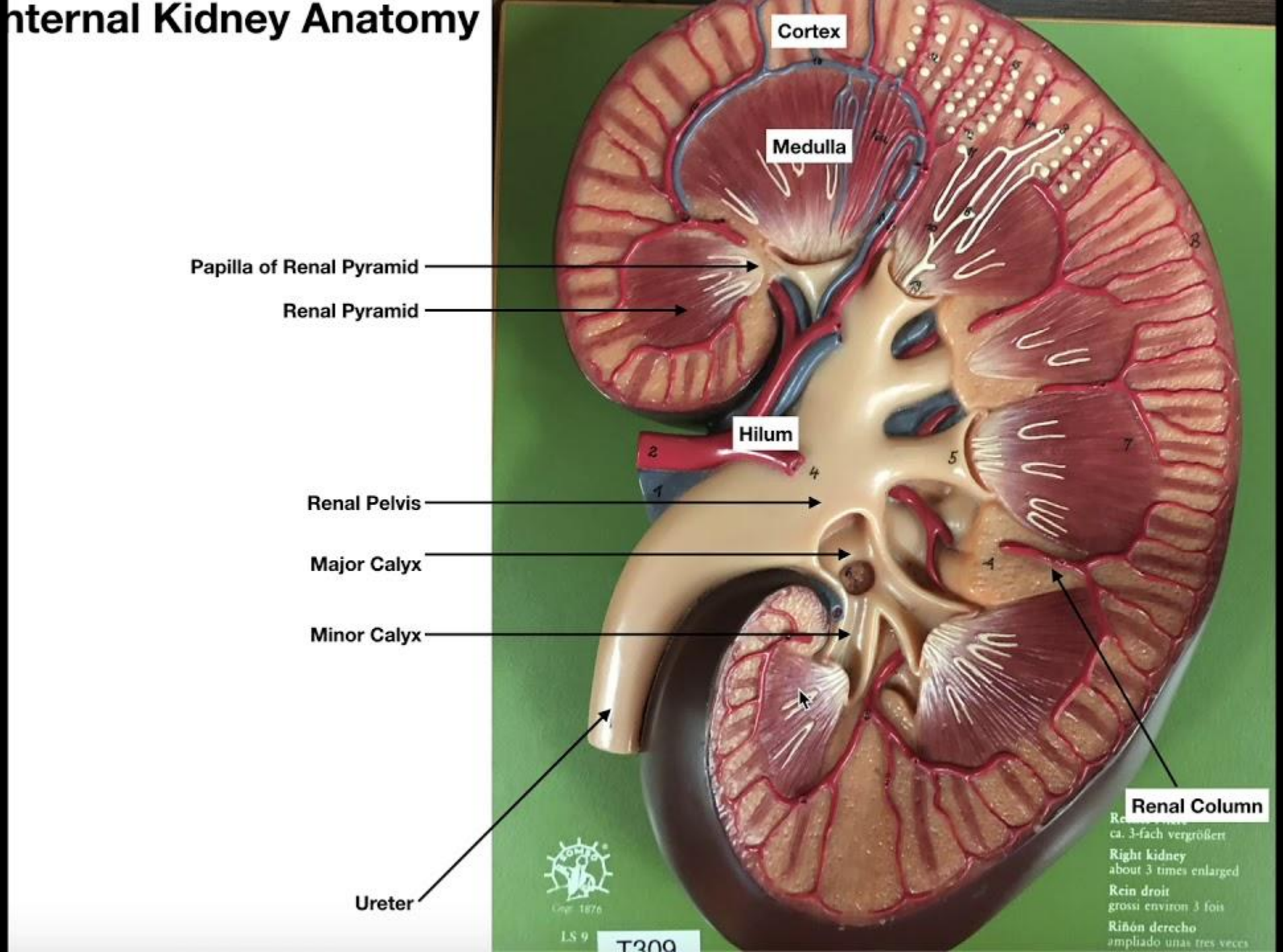
RENAL MEDULLA:

- This zone lies beneath the cortex
- It is darker in colour
- It consist of medullary and renal pyramids - a cone shaped tissue mass the broad bases facing towards the cortex and consist of apex– sharp base - Facing internally

RENAL PELVIS: It is the funnel shaped tube which joins the ureter at the hilum:

- The branches emerging from pelvis form two or three major calyces which further divided in to cup shaped minor calyces.
- Urine is collected by the calyces & continuously drained from the papillae and emptied in to renal pelvis ⟹ ureter and finally in to the bladder for storage.
- The walls of the calyces, pelvis & ureter are smooth muscles
- These smooth muscles undergoes rhythmic contraction to propel urine.

nternal Kidney Anatomy



•**NEPHRONS :** It is the basic structural and functional unit of the kidney.

•It have many functions:

1) It filters the waste products from the blood.
2) Reabsorbs the required nutrients in to the body and excrete the remaining things in the urine.
3) Thereby it regulates the water and sodium salt concentration in the blood.

Types of Nephron:

•***Cortical Nephrons*:** renal corpuscles present near the renal cortex

•***Juxtamedullary Nephrons:*** renal corpuscles present near the renal medulla

Nephrons are made up of :

RENAL / MALPIGHIAN CORPUSCLES It is also known as **Malpighian body,**

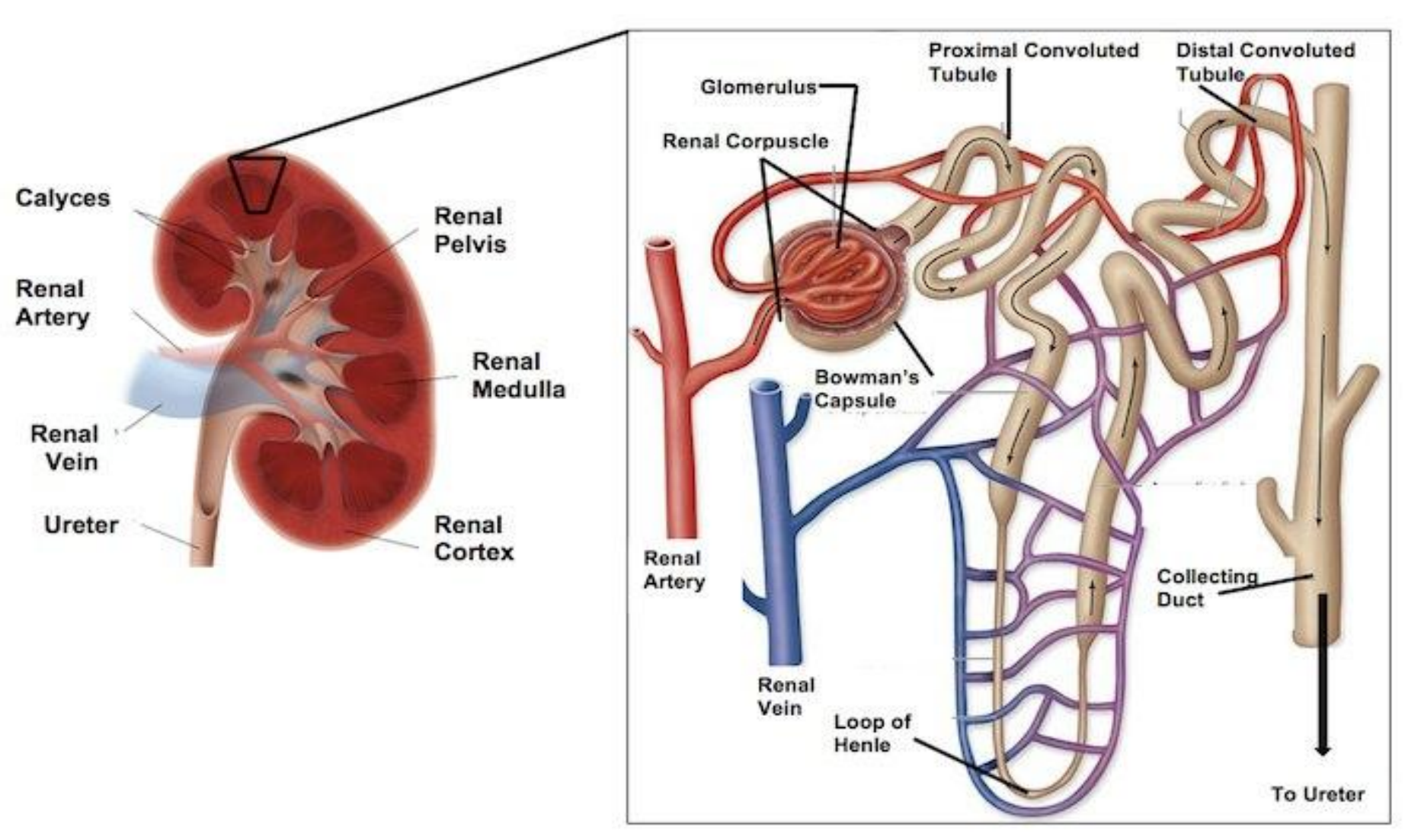
Each Malpighian corpuscle is made up of **Glomerulus & Bowman's/ Glomerular Capsule.**

• Filtration of larger waste molecules out of the body.

RENAL TUBULES

• Reabsorption of water and small waste solute molecules and secretion of waste material .

Nephron


Calyces
Renal Pelvis
Renal Artery
Renal Medulla
Renal Vein
Ureter
Renal Cortex
Proximal Convoluted Tubule
Distal Convoluted Tubule
Glomerulus
Renal Corpuscle
Bowman's Capsule
Renal Artery
Renal Vein
Collecting Duct
Loop of Henle
To Ureter

Glomerulus

- It is a mass of capillaries which is supplied with blood by an afferent arteriole of the renal artery.
- Blood pressure with in the glomerulus provides the driving force for water and solutes to be filtered out of the blood and reach the Bowman's capsule.
- The remaining blood passes into the efferent arteriole (narrower than the afferent arteriole) blood along with reabsorbed substances reaches the vasa recta (collecting capillaries attached to the convoluted tubules).
- The vasa recta and the efferent venules coming from other nephrons combine to join the **Renal Vein** and the main blood circulation .

Bowman’s or Glomerular Capsule

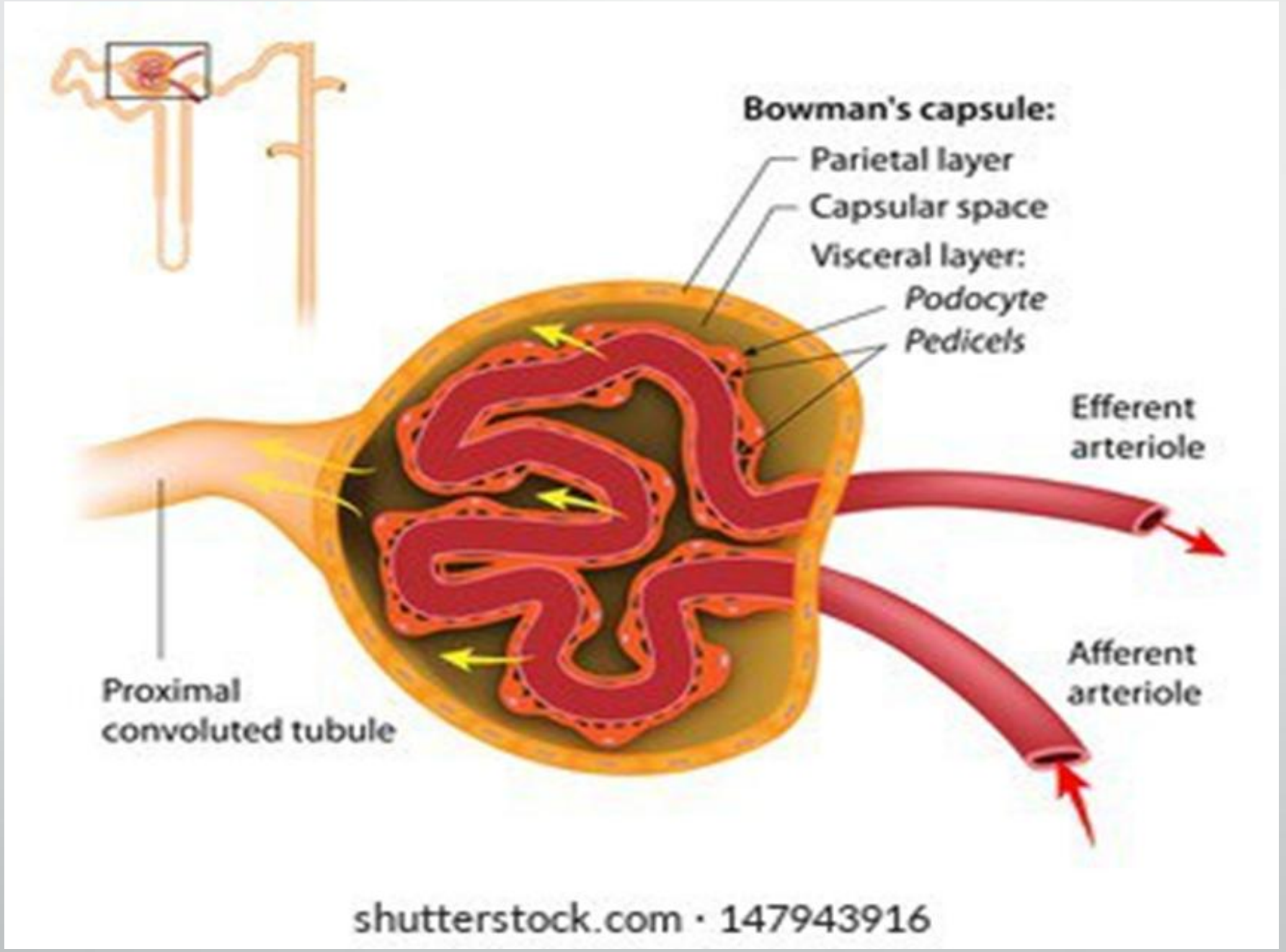
It is a capsule that surrounds the glomerulus .It is made up of :

Visceral inner layer - contains specialized cells called **podocytes** &

Parietal outer layer - contain single layer of flat cells called simple squamous epithelium.

Fluids from the glomerulus blood for filter through the podocytes

The glomerular filtrate is then processed along the nephron to form urine .


Bowman's capsule:
Parietal layer
Capsular space
Visceral layer:
Podocyte
Pedicels
Efferent arteriole
Afferent arteriole
Proximal convoluted tubule
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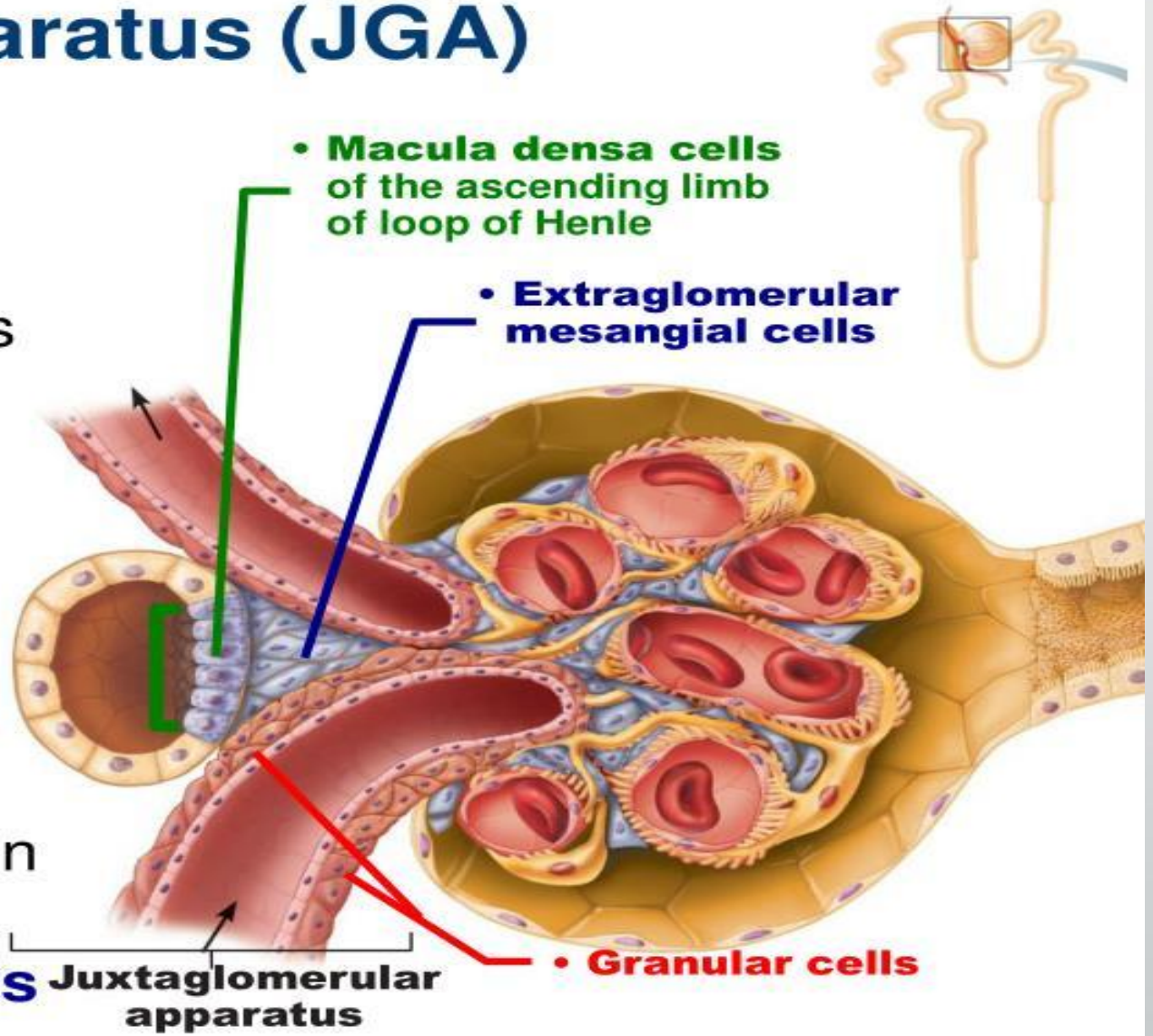
Juxtaglomerular Apparatus (JGA)

- Regulates filtration and b. p.
- **Granular cells** (juxtaglomerular, or JG cells)
  - Enlarged, smooth muscle cells of arteriole(s)
  - Granules contain renin
  - Sense blood pressure (baroreceptors)
- **Macula densa**
  - Tall, closely packed cells of ascending limb
  - Chemoreceptors sense NaCl in filtrate
- **Extraglomerular mesangial cells**
  - May pass signals b/n macula densa/granular cells



RENAL TUBULE

This 3 cm long tubule exits the glomerular capsule

•A renal tubule is made up of :

a. PROXIMAL CONVOLUTED TUBULE (PCT)

b. LOOP OF HENLE

c. DISTAL CONVOLUTED TUBULE (DCT)

d. COLLECTING DUCT

Proximal Convoluted tubule (PCT):

It is the initial and longest sub-division of the renal tubule through which the glomerular filtrate flows.

- It is made up of **simple cuboidal epithelium cells.** They have prominent microvilli projecting into the lumen of the proximal tubule.
- These microvilli forms brush border - which increases the surface area.

THE LOOP OF HENLE

This hairpin-bend structure has a **descending limb** and an **ascending limb** and is found in the medulla of the kidney.

The descending limb contains **simple squamous epithelium** and has thin walls permeable to water and penetrates deep into the medulla but the ascending limb has thicker **simple cuboidal epithelium**, relatively impermeable walls that returns to the cortex.

Surrounding the loop is a network of capillaries, one part of which has the same hairpin structure and is called the **vasa recta**.

•Distal Convoluted Tubule (DCT)

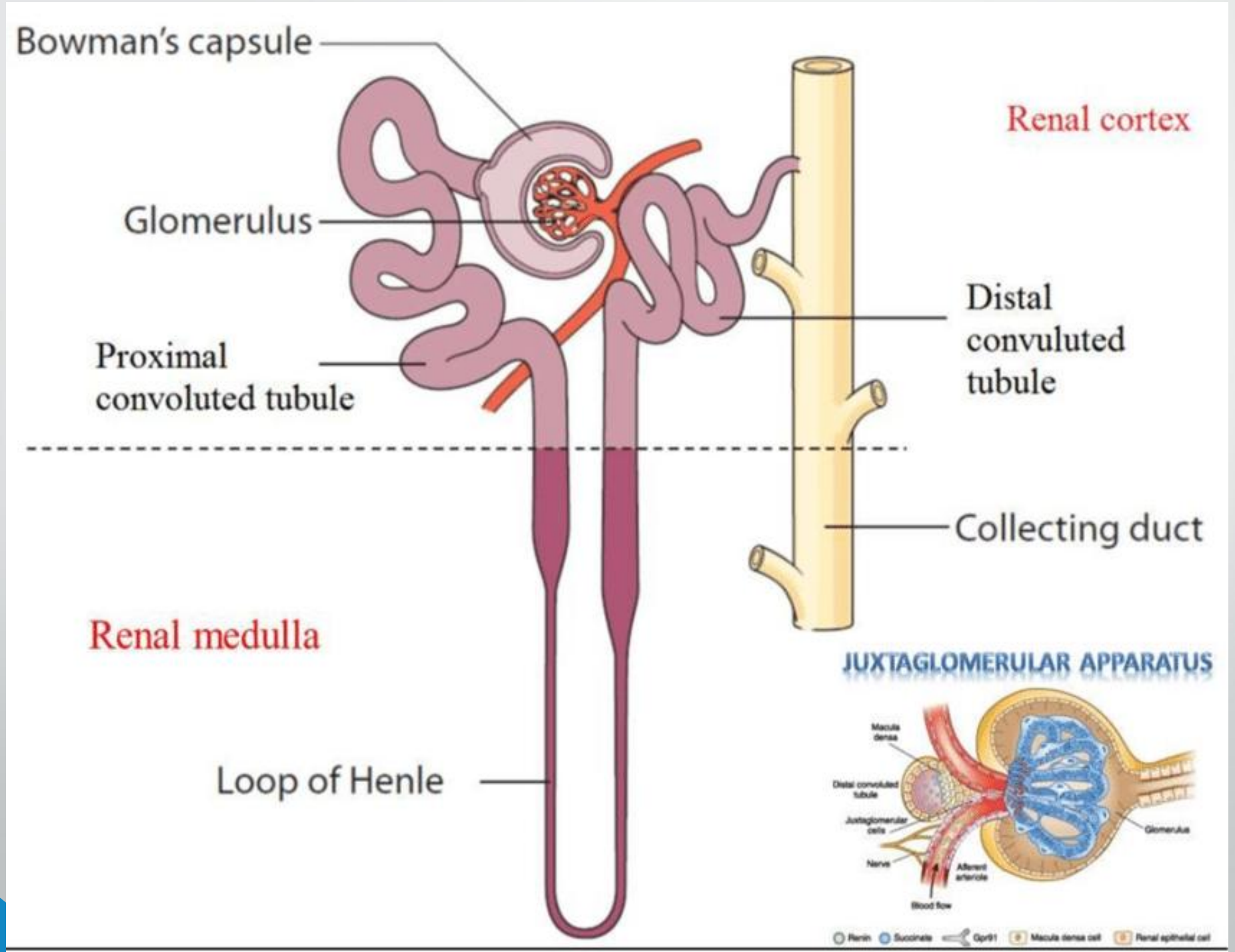
•It is the final sub-division of the renal tubule through which the golmerular filtrate flows.

•It contains **simple cuboidal epithelium**; but lacks the brush border.

•COLLECTING DUCT:

•Each collecting duct travels through the medullary pyramids ,

• The collecting tubules after receiving glomerular filtrate from many nephrons , approach the renal pelvis , where they fuse together and empty urine into the minor calyces via papillae of the pyramids .


Bowman's capsule
Glomerulus
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THANKS