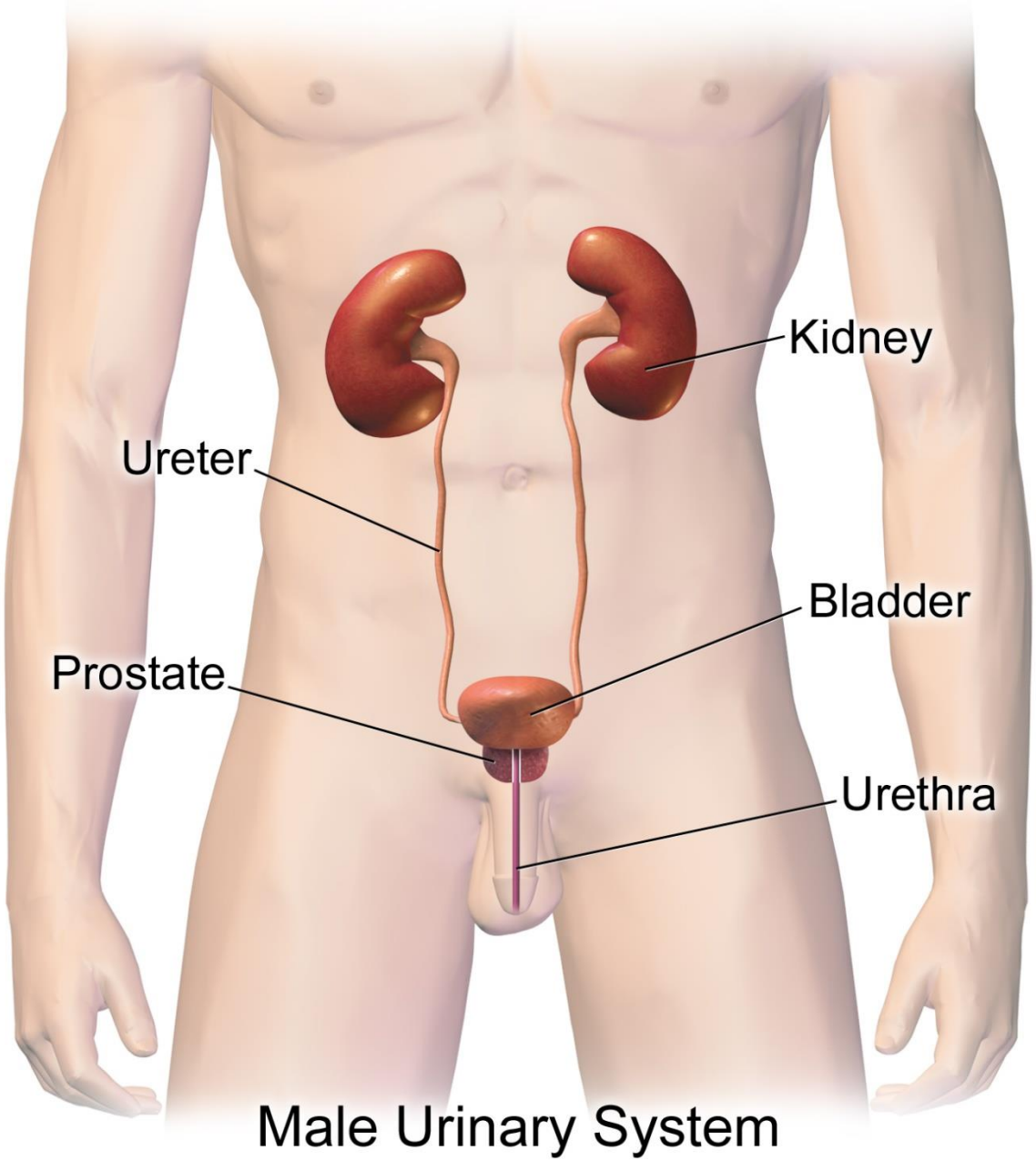
URINARY SYSTEM

Urinary System Organs

- Kidneys are major excretory organs
- Urinary bladder is the temporary storage reservoir for urine
- Ureters transport urine from the kidneys to the bladder
- Urethra transports urine out of the body



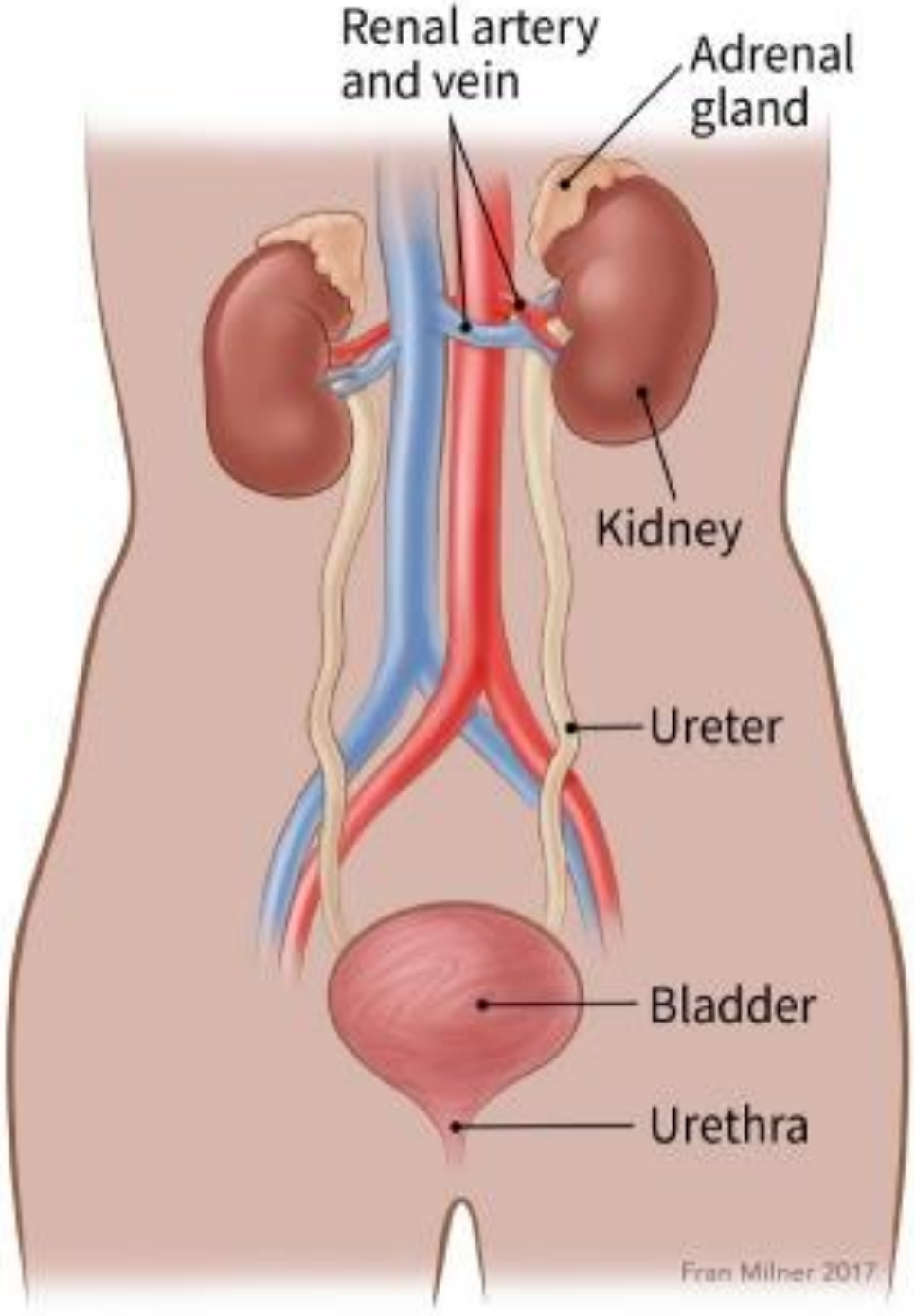
Male Urinary System

KIDNEY

- **Synonyms » renes and nephros**
- **Definition - pair of excretory organs situated on the posterior abdominal wall, one on each side of the vertebral column, behind the peritoneum.**
- **They remove waste products of metabolism and excess of water and salts from the blood, and maintain its pH.**

Location- epigastric, hypochondric, lumbar and umbilical regions

- **Vertically they extend from T12- L3.**
- **The right kidney is slightly lower than the left, and the left kidney is a little nearer to the median plane than the right.**
- **The long axis of the kidney is directed downwards and laterally, so that the upper poles are nearer to the median plane than the lower poles.**


Renal artery
and vein
Adrenal
gland
Kidney
Ureter
Bladder
Urethra
Fran Milner 2017

- **The transverse axis is directed laterally and backwards.**
- **In the foetus the kidney is lobulated and is made up of about 12 lobules.**
- **After birth the lobules gradually fuse, so that in adults the kidney is uniformly smooth.**

- **SIZE- 11cm long, 6cm broad and 3 cm thick**
- **Wt.- 150gm in male**

  135gm in female
- **Left kidney is little longer and narrower than the right kidney**
- **Color- reddish-brown**

External Features- bean-shaped.

- **2 pole- upper and lower**
- **2 border- medial and lateral**
- **2 surface-anterior and posterior**

- **Upper pole- is broad and is in close contact with the corresponding suprarenal gland.**
- **Lower pole- is pointed.**
- **Anterior surface- irregular**
- **Posterior surface- flat**
- **Lateral border- convex.**
- **Medial border- concave. Its middle part shows a depression, the hilus or hilum.**

Hilum- anterior to posterior side:

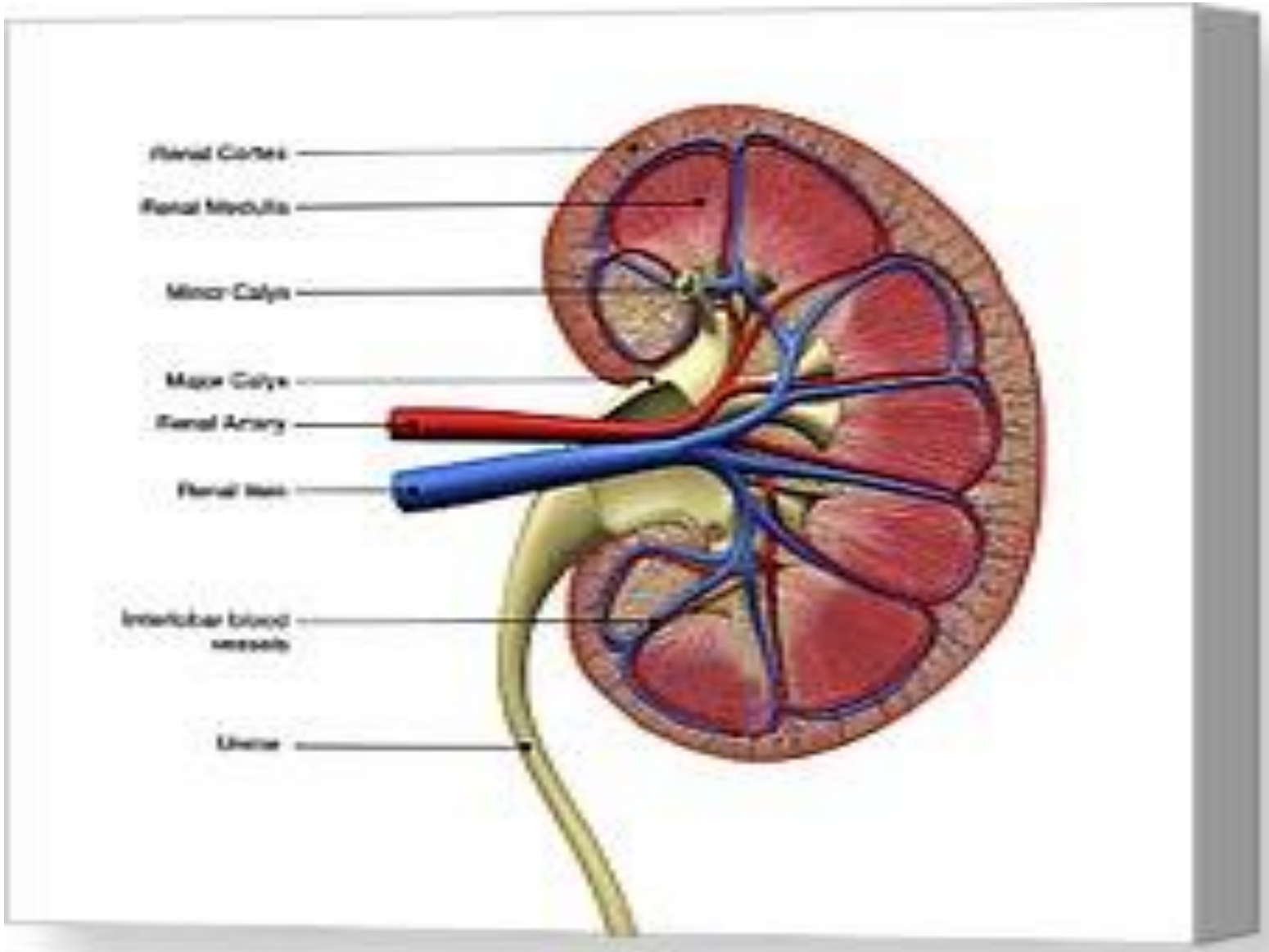
(1) renal vein

(2) renal artery

(3) renal pelvis, which is the expanded upper end of the ureter.

NOTE- 1. The transpyloric plane passes through the upper part of the hilus of the right kidney, and through the lower part of the hilus of the left kidney.

2. Retroperitoneal organs and are only partly covered by peritoneum anteriorly.


Renal Cortex
Renal Medulla
Minor Calyx
Major Calyx
Renal Artery
Renal Vein
Interlobar blood vessels
Ureter

Relation	Anterior	Posterior
Left	•Suprarenal gland •Spleen •Stomach •Pancreas •Left colic flexure •Jejunum	•Diaphragm •11th and 12th ribs •Psoas major, quadratus lumborum and transversus abdominis •Subcostal, iliohypogastric and ilioinguinal nerves
Right	•Suprarenal gland •Liver •Duodenum •Right colic flexure	•Diaphragm •12th rib •Psoas major, quadratus lumborum and transversus abdominis •Subcostal, iliohypogastric and ilioinguinal nerves

Coverings of Kidney- The kidneys are encased in complex layers of fascia and fat. They are arranged as follows (deep to superficial):

1. **fibrous capsule/ renal capsule: tough fibrous capsule, which closely invests the kidney and lines the renal sinus.**
2. **Perirenal or perinephric fat: collection of extraperitoneal fat. It is thickest at the borders of the kidney and fills up the extra space in the renal sinus.**
3. **Renal fascia: encloses the kidneys and the suprarenal glands.**

This is a fibroareolar sheath which surrounds the kidney and the perirenal fat called as the fascia of Gerota. It consists of an anterior layer or fascia of Toldt and a posterior layer or fascia of Zuckerkandl .

4. Pararenal fat – mainly located on the posterolateral aspect of the kidney. It fills up the paravertebral gutter and forms a cushion for the kidney

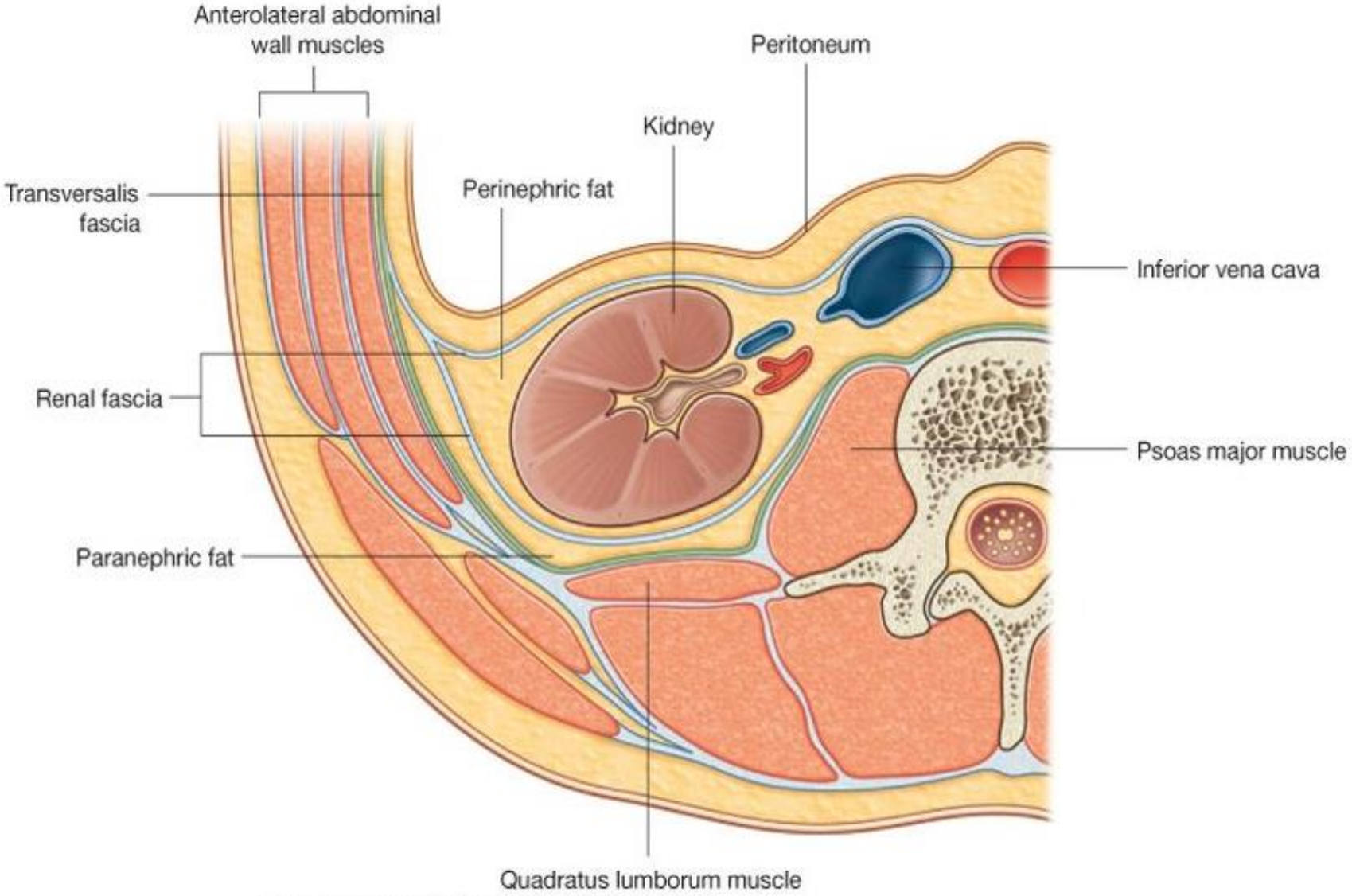


Figure 4.138 Organization of fat and fascia surrounding the kidney.

INTERNAL STRUCTURE

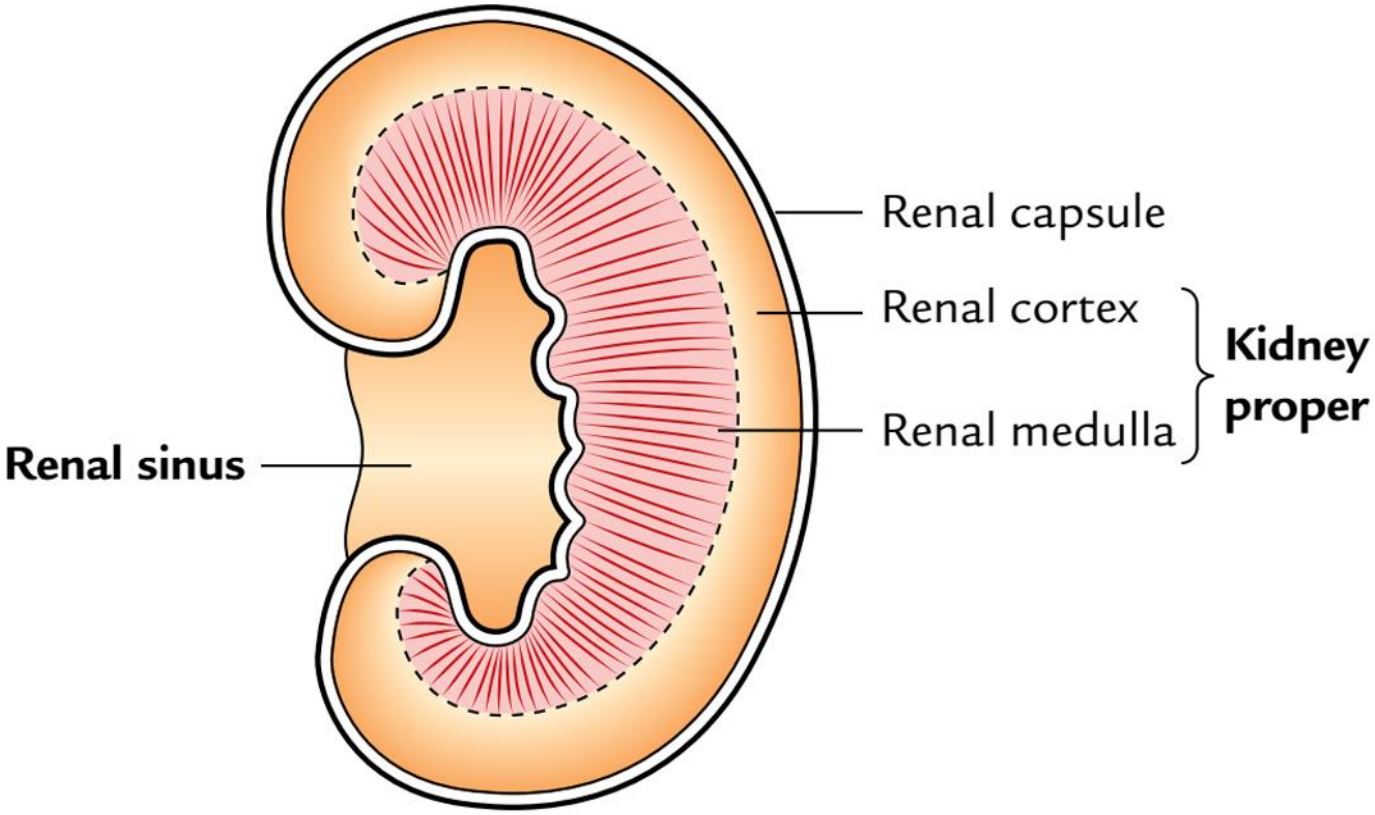
- **Coronal section of the kidney shows:**

(a) an outer, reddish brown cortex;

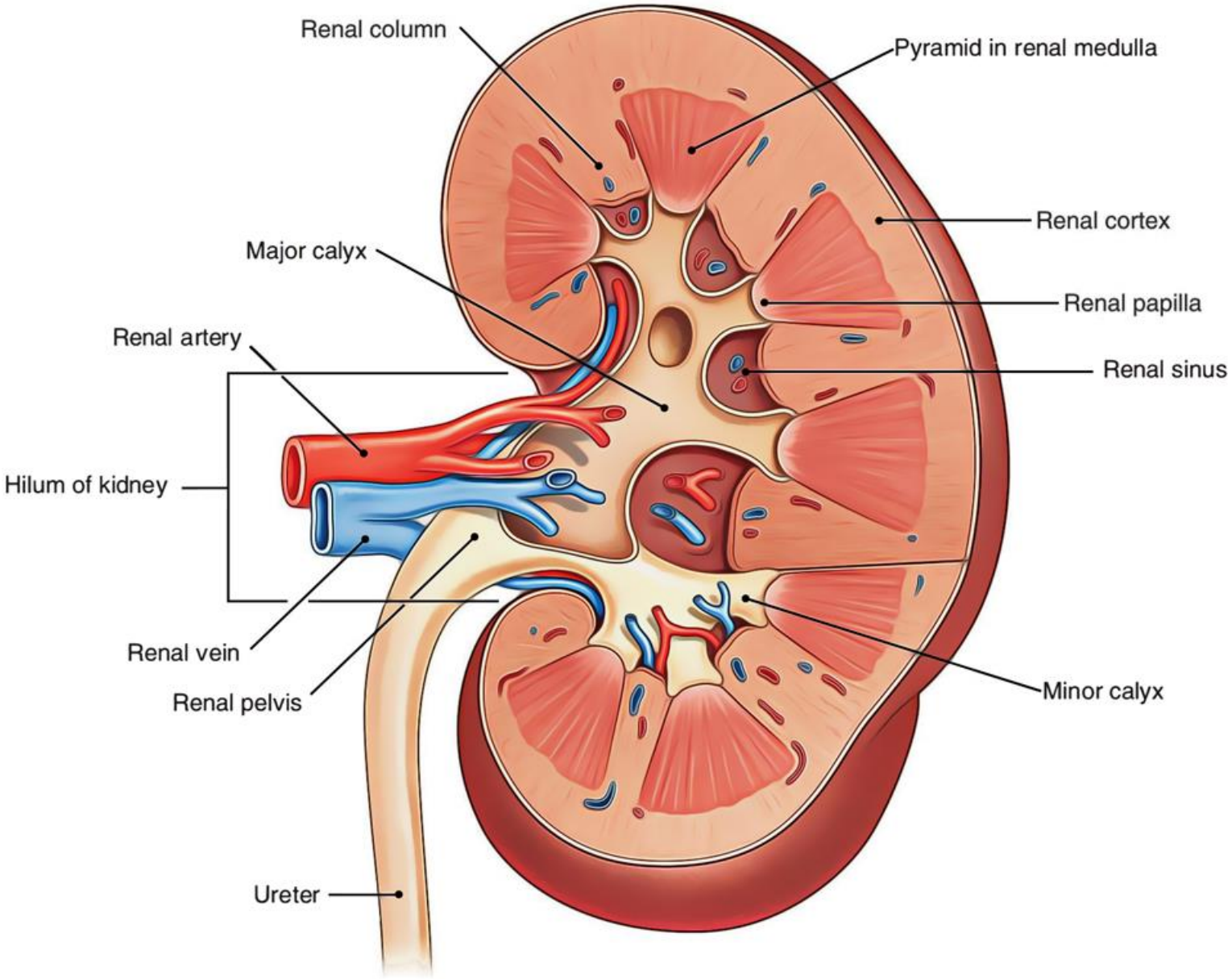
(b) an inner, pale medulla; a

(c) a space, the renal sinus

The cortex extends into the medulla, dividing it into triangular shapes – these are known as renal pyramids.


Renal capsule
Renal cortex
Renal medulla
Kidney proper
Renal sinus

- The apex of a renal pyramid is called a renal papilla.
- Each renal papilla is associated with a structure known as the minor calyx, which collects urine from the pyramids.
- Several minor calyx merge to form a major calyx.
- Urine passes through the major calyx into the renal pelvis, a flattened and funnel-shaped structure.
- From the renal pelvis, urine drains into the ureter, which transports it to the bladder for storage.
- The medial margin of each kidney is marked by a deep fissure, known as the renal hilum. This acts as a gateway to the kidney – the renal vessels and ureter enter/exit the kidney via this structure.


Renal column
Pyramid in renal medulla
Renal cortex
Major calyx
Renal papilla
Renal artery
Renal sinus
Hilum of kidney
Renal vein
Renal pelvis
Minor calyx
Ureter

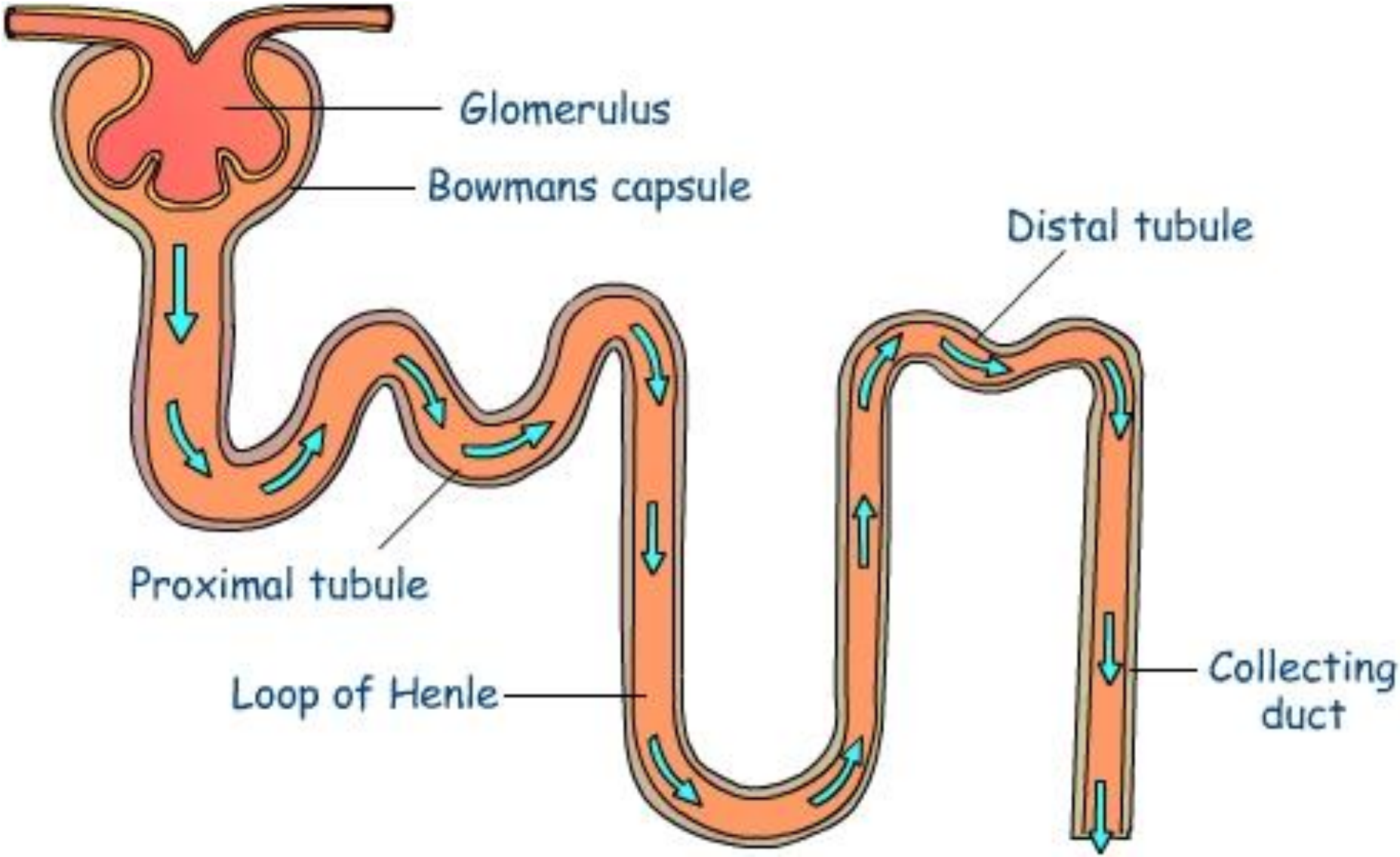
- **The renal sinus is a space that extends into the kidney from the hilus. It contains (a) branches of the renal artery; (b) tributaries of the renal vein; and (c) the renal pelvis.**
- **The pelvis divides into 2 to 3 major calices, and these in their turn divide into 7 to 13 minor calices. Each minor calyx ends in an expansion which is indented by one to three renal papillae.**

Histology

- **Histologically, each kidney is composed of one to three million uriniferous tubules. Each tubule consists of following parts-**

A. **Secretory part, called the nephron, which elaborates urine. Nephron is the functional unit of the kidney, and comprises:**

1. **Renal corpuscle or Malpighian corpuscle- filtration of substances from the plasma made up of glomerulus (a tuft of capillaries) and Bowman's capsule;**
2. **Renal tubule- for selective resorption of substances from the glomerular filtrate, made up of the proximal convoluted tubule, loop of Henle with its descending and ascending limbs, and the distal convoluted tubule.**


Glomerulus
Bowmans capsule
Distal tubule
Proximal tubule
Loop of Henle
Collecting duct

B. **Collecting tubule-** **begins as a junctional tubule from the DCT. Many tubules unite together to form the ducts of Bellini which open into the minor calices through the renal papillae.**

c. Juxtaglomerular apparatus- The juxtaglomerular apparatus is a specialized structure formed by the distal convoluted tubule and the glomerular afferent arteriole. It is located near the vascular pole of the glomerulus and its main function is to regulate blood pressure and the filtration rate of the glomerulus.

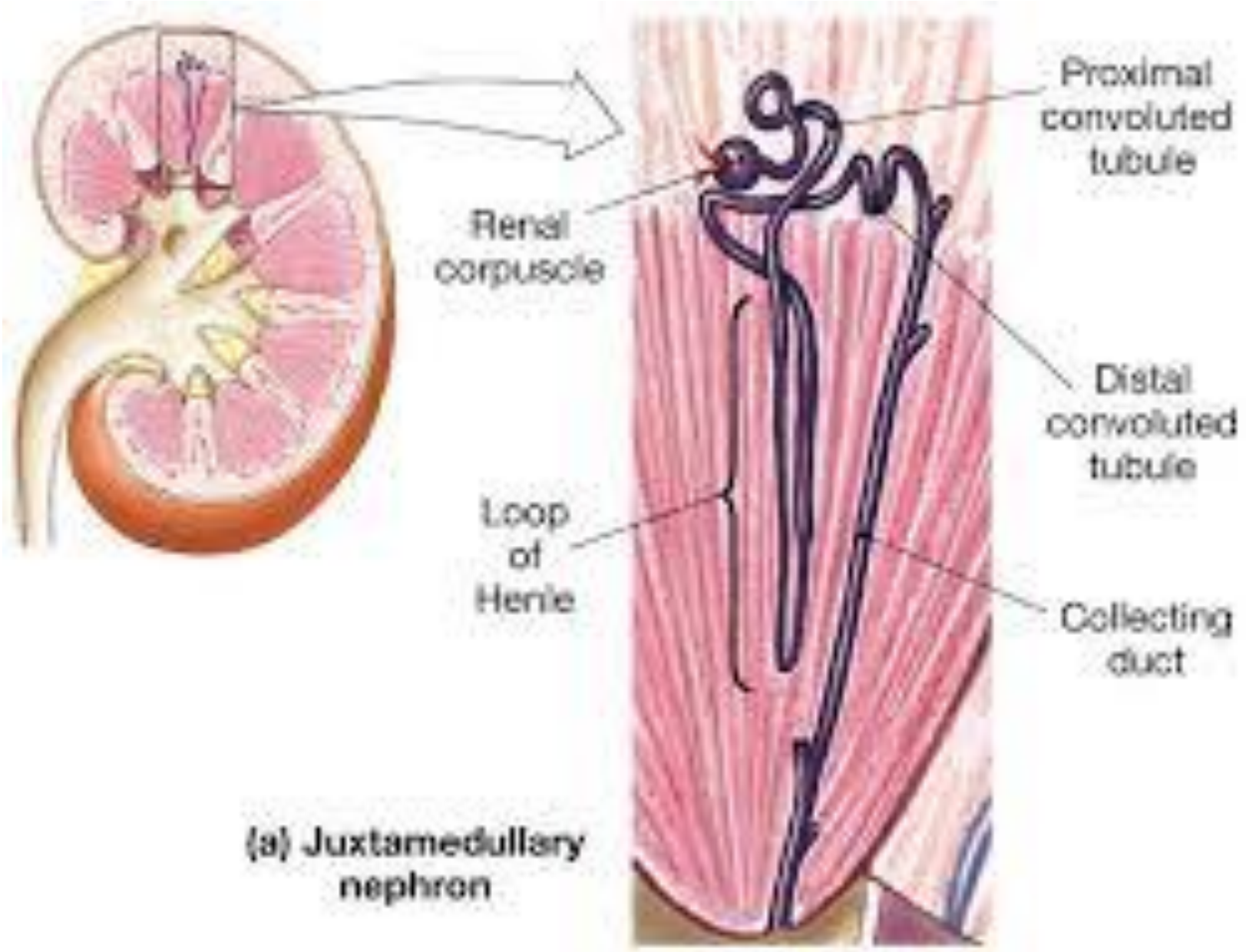
The apparatus consists of

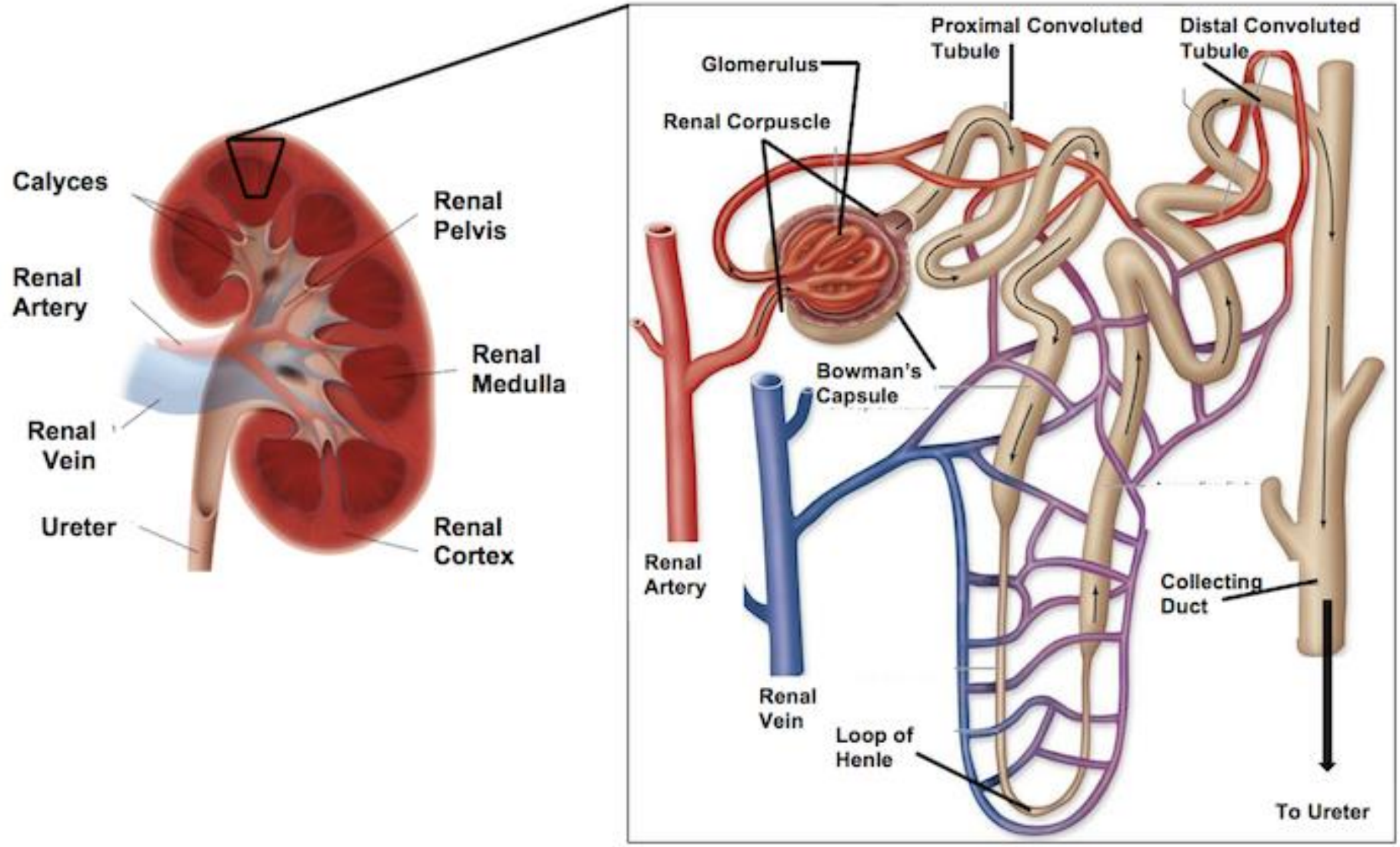
(a) macula densa

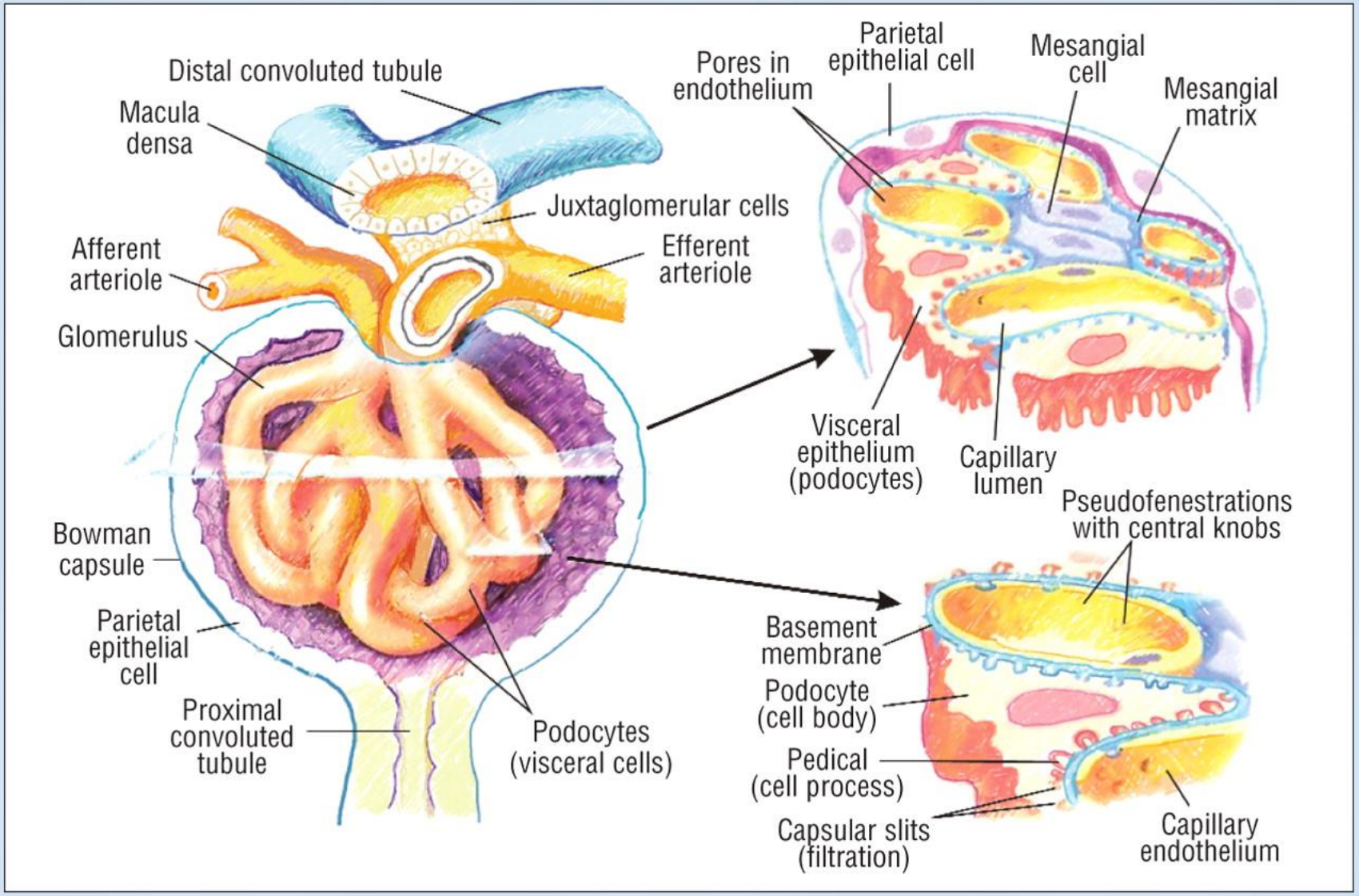
(b) juxtaglomerular cells

(c) Some agranular cells between macula densa and the glomerulus proper.

- **The cortex contains the renal corpuscle, proximal, and distal convoluted tubules. The medulla contain the loops of Henle and collecting ducts.**


Proximal convoluted tubule
Renal corpuscle
Distal convoluted tubule
Loop of Henle
Collecting duct
(a) Juxtamedullary 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



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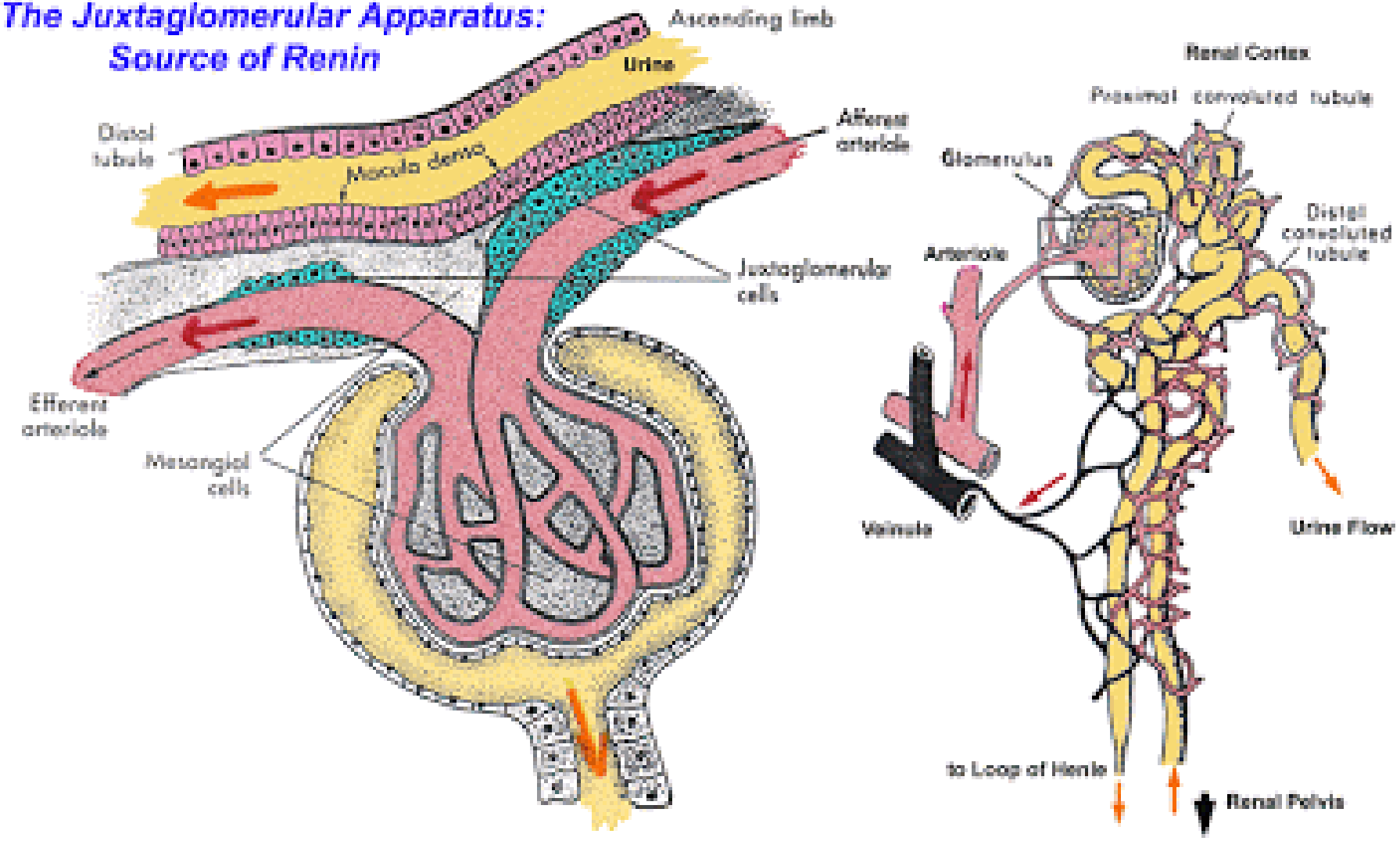
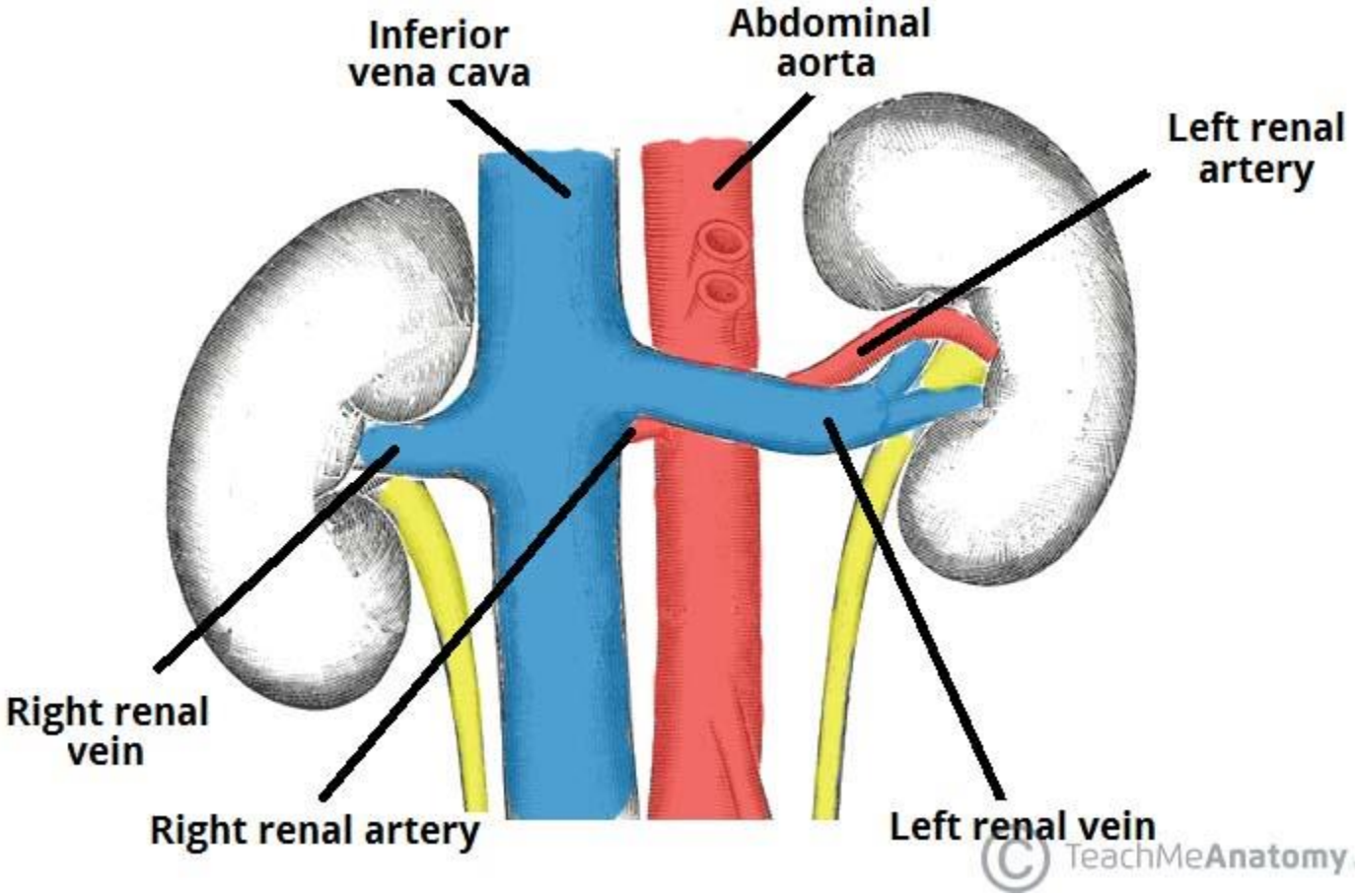
The Juxtaglomerular Apparatus: Source of Renin



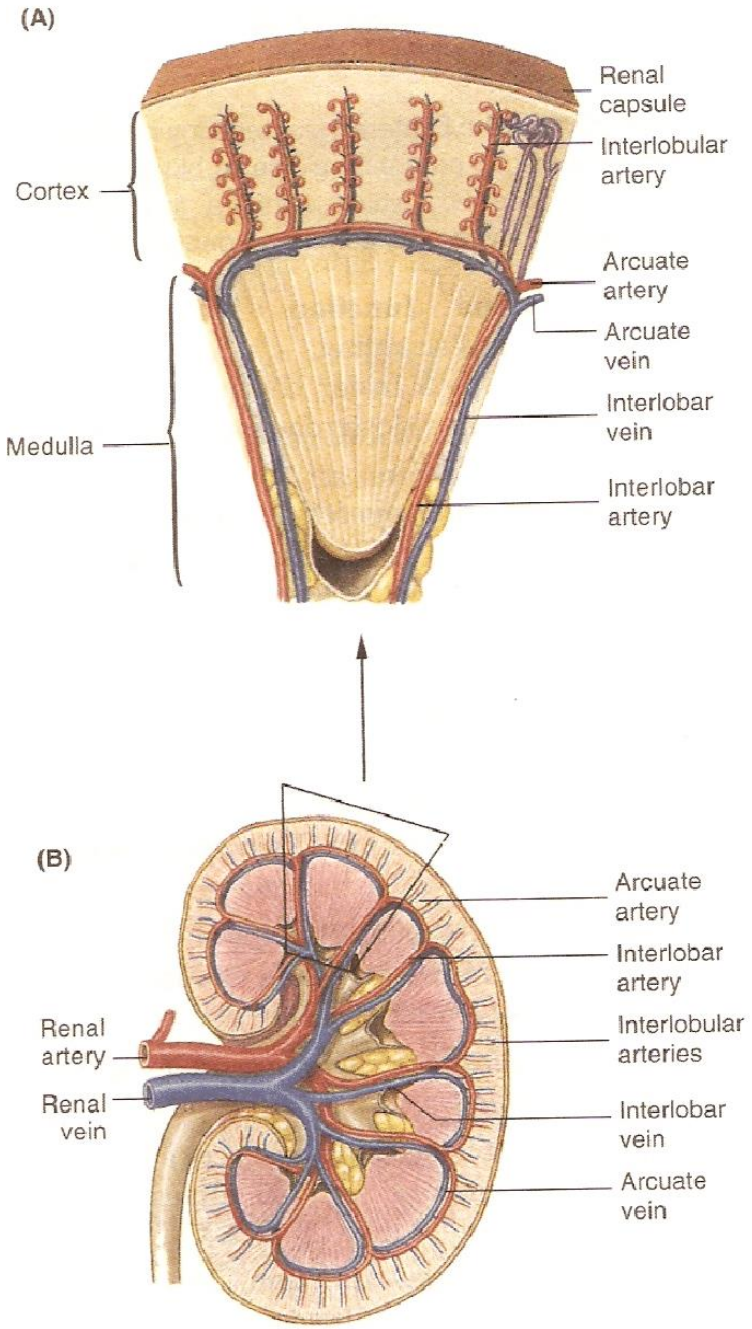
Arterial Supply- The kidneys are supplied with blood via the renal arteries, which arise directly from the abdominal aorta, immediately distal to the origin of the superior mesenteric artery. Due to the anatomical position of the abdominal aorta (slightly to the left of the midline), the right renal artery is longer, and crosses the vena cava posteriorly.

Each renal artery enters the kidney via the renal hilum, dividing into segmental branches. These branches undergo further divisions to supply the renal parenchyma.


Inferior vena cava
Abdominal aorta
Left renal artery
Right renal vein
Right renal artery
Left renal vein
© TeachMeAnatomy

- Each segmental artery divides into lobar arteries, usually one for each pyramid.
- Each lobar artery divides into 2-3 interlobar arteries which run on each side of the pyramid.
- At the corticomedullary junction, the interlobar arteries divide into arcuate arteries which arch over the bases of the pyramids, at right angles to the interlobar arteries.
- The arcuate arteries give off interlobular arteries which run radially into the cortical substance at right angles to the arcuate arteries.
- The interlobular arteries do not anastomose with their neighbours, and therefore are end arteries.

- **The interlobular arteries pass through the cortex, dividing one last time to form afferent arteriole*s*.**
- **The afferent arterioles form a capillary network, the glomerulus, where filtration takes place. The capillaries come together to form the efferent arterioles.**


(A)
Renal capsule
Interlobular artery
Cortex
Arcuate artery
Arcuate vein
Interlobar vein
Medulla
Interlobar artery
(B)
Arcuate artery
Interlobar artery
Interlobular arteries
Renal artery
Renal vein
Interlobar vein
Arcuate vein

Venous Drainage

- **left and right renal veins and empty directly into the inferior vena cava.**

Lymphatics

- **lateral aortic (or para-aortic) lymph nodes**

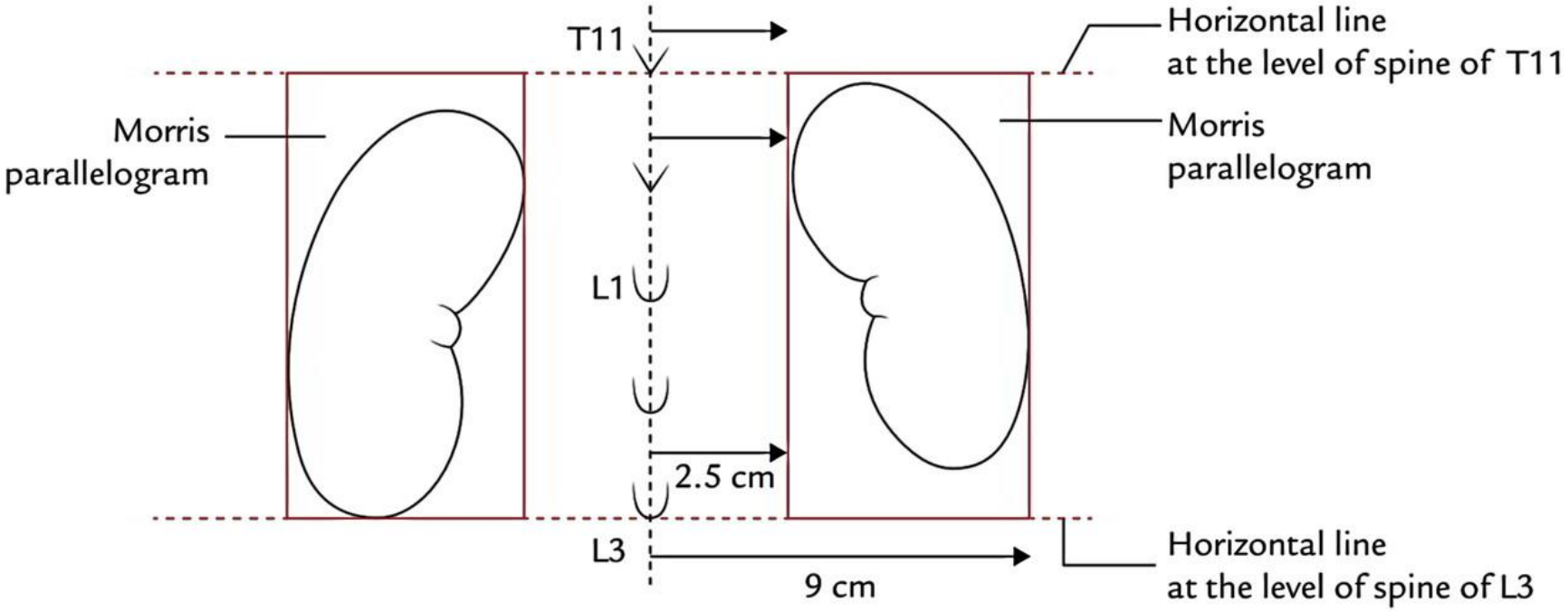
Innervation- from the renal nerve plexus

- **The renal nerve plexus is supplied by fibers from the abdominopelvic (especially the least) splanchnic nerves.**

Surface Marking

- **It can be marked both on the back as well as on the front.**
- **On the back: It is marked within Morris parallelogram which is drawn in the following way.**

Two horizontal lines are drawn, one at the level of the eleventh thoracic spine and the other at the level of the third lumbar spine. Then two vertical lines are drawn, one 2.5 cm and the other 9 cm from the median plane. The hilum lies opposite the lower border of the L1 spine lower on right side.


T11
Horizontal line
at the level of spine of T11
Morris
parallelogram
Morris
parallelogram
L1
2.5 cm
L3
9 cm
Horizontal line
at the level of spine of L3

- **On the front: The bean-shaped kidney is marked with the following specifications :**

(1) On the right side the centre of the hilum lies 5 cm from the median plane a little below the transpyloric plane; and on the left side it lies 5 cm from the median plane a little above the transpyloric plane, just medial to the tip of the 9th costal cartilage.

(2) The upper pole lies 4 to 5 cm from the midline, halfway between the xiphisternum and the transpyloric plane right one, a little lower.

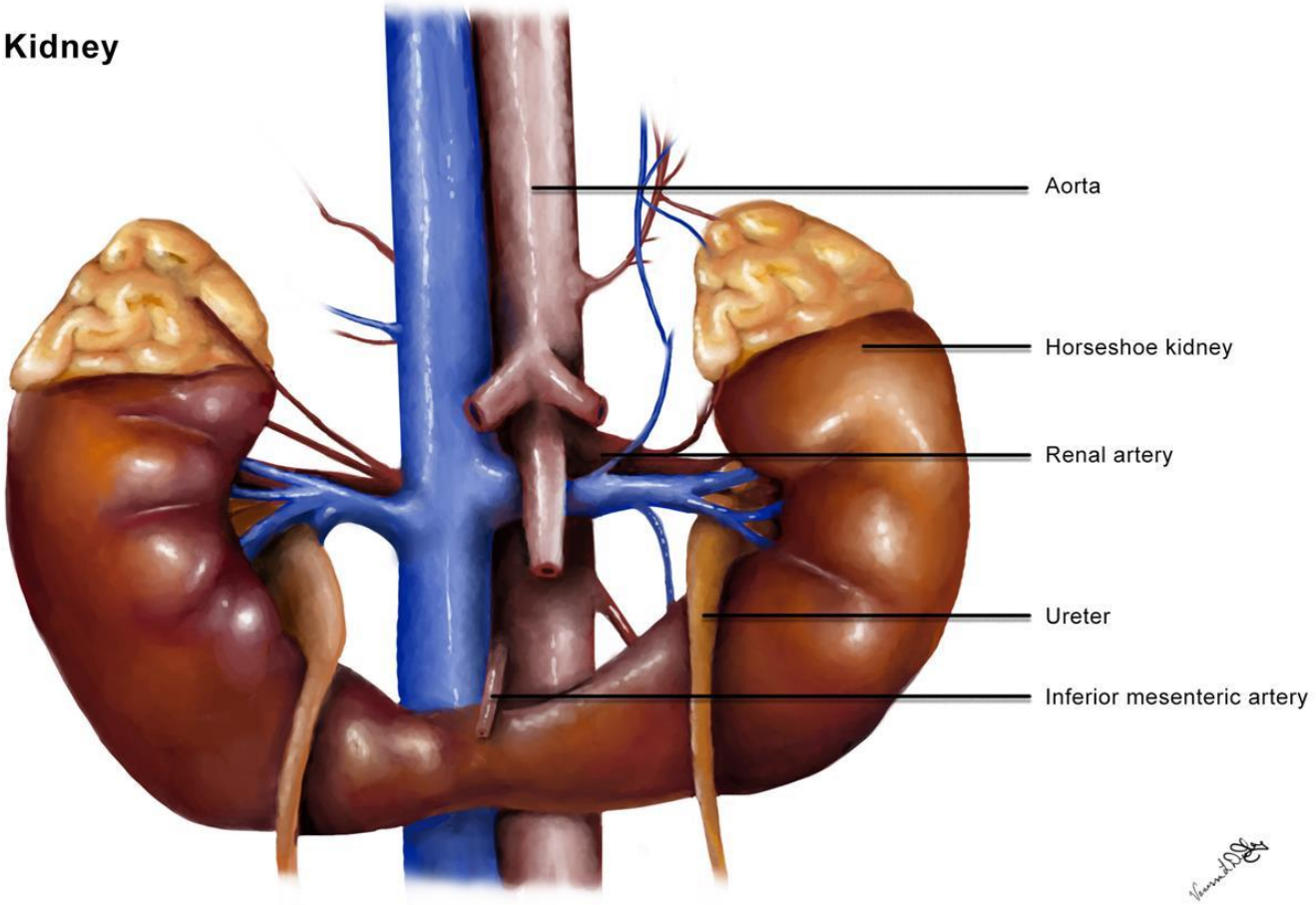
(3) The lower pole lies 6 to 7 cm from the midline on the right side at the umbilical plane and on the left side at the subcostal plane.

Applied aspect

1. **Congenital Abnormalities of the Kidneys**

- **Pelvic Kidney**
- **Horseshoe Kidney- A horseshoe kidney (also known as a cake kidney or fused kidney) is where the two developing kidneys fuse into a single horseshoe-shaped structure.**

Horseshoe Kidney



2. Renal Dysgenesis- underdevelopment of the kidneys. There are two main forms:

- **Renal agenesis – complete failure of one or both kidneys to develop. It is most commonly unilateral.**
- **Renal hypoplasia – the kidneys develop with a normal architecture, but are of a smaller size.**

3. Abdominal trauma
4. Renal Stones- Renal stones or calculi may form in the kidney from salts in the body, and travel into the ureter or bladder. They commonly cause intolerable loin to groin pain of colicky nature, which may be referred to the genitals/testis. If the stone is larger than the lumen of the ureter, it may cause obstruction and resulting infection.