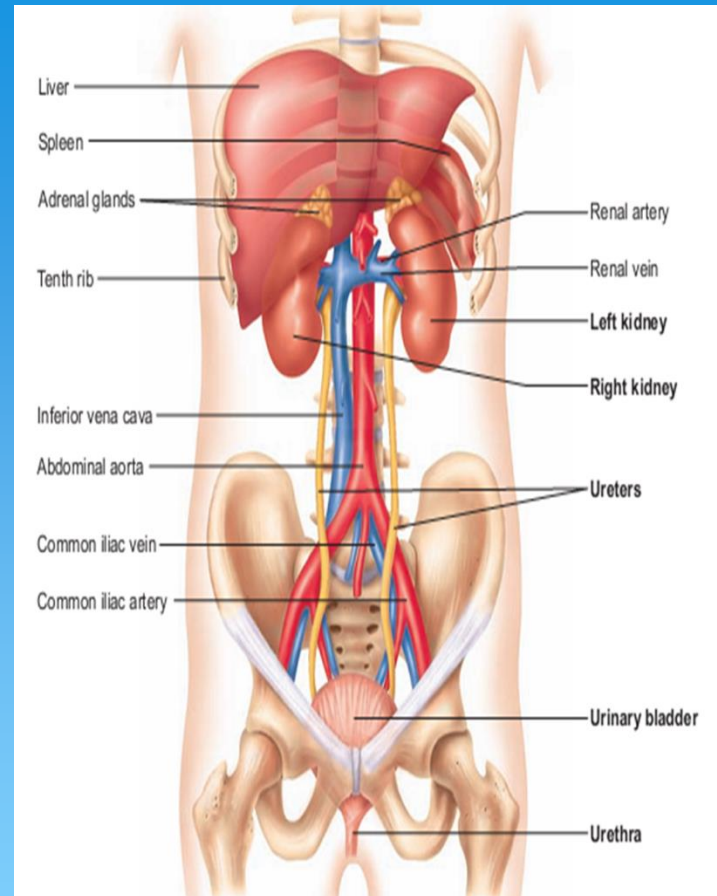


ANATOMY

Urinary system

1st Prof

Pharm.D



Urinary system

Composition of urinary system:

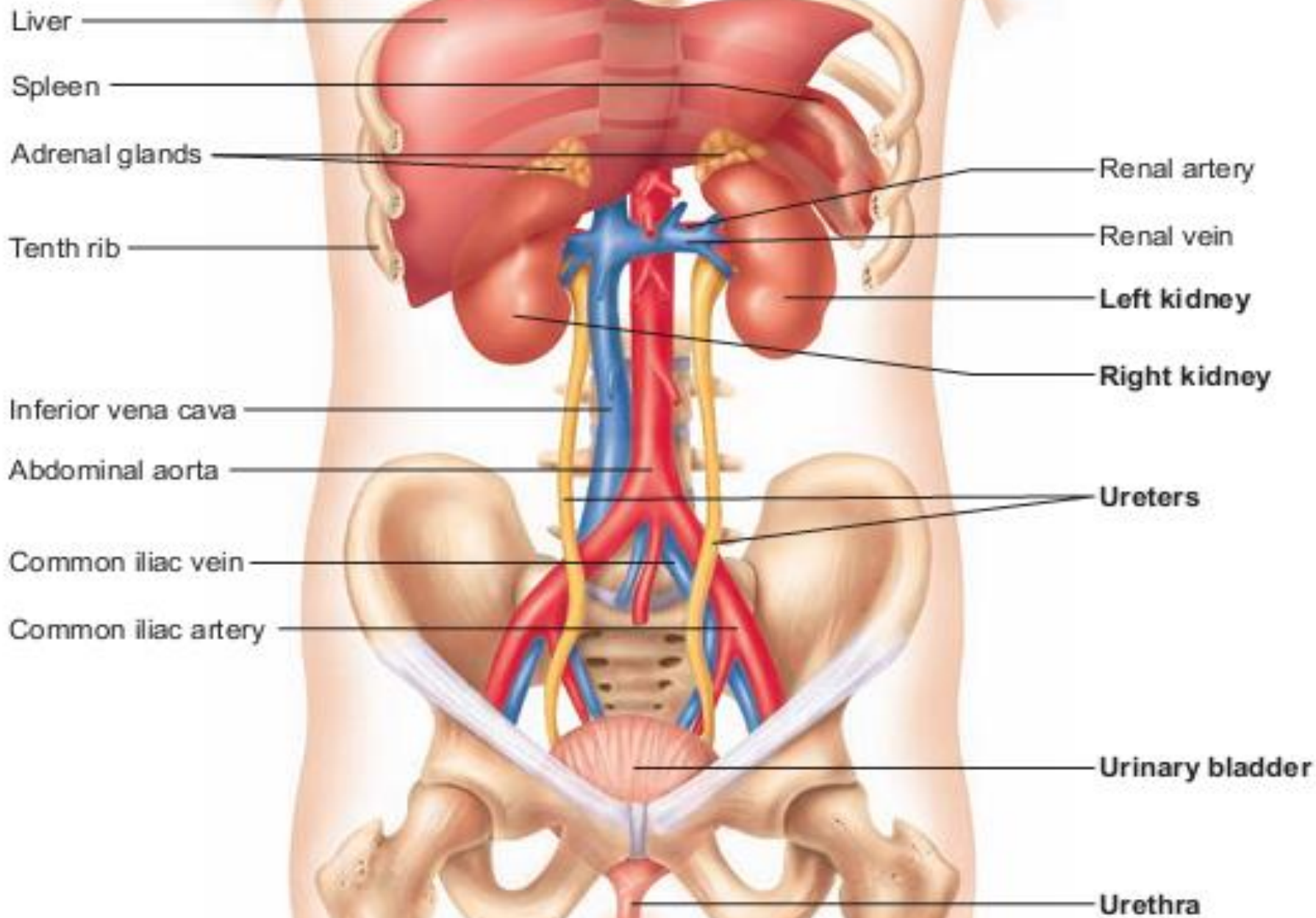
- * The urinary system consists of
 - ☐ two kidneys,
 - ☐ two ureters,
 - ☐ the urinary bladder,
 - ☐ the urethra.

Kidneys

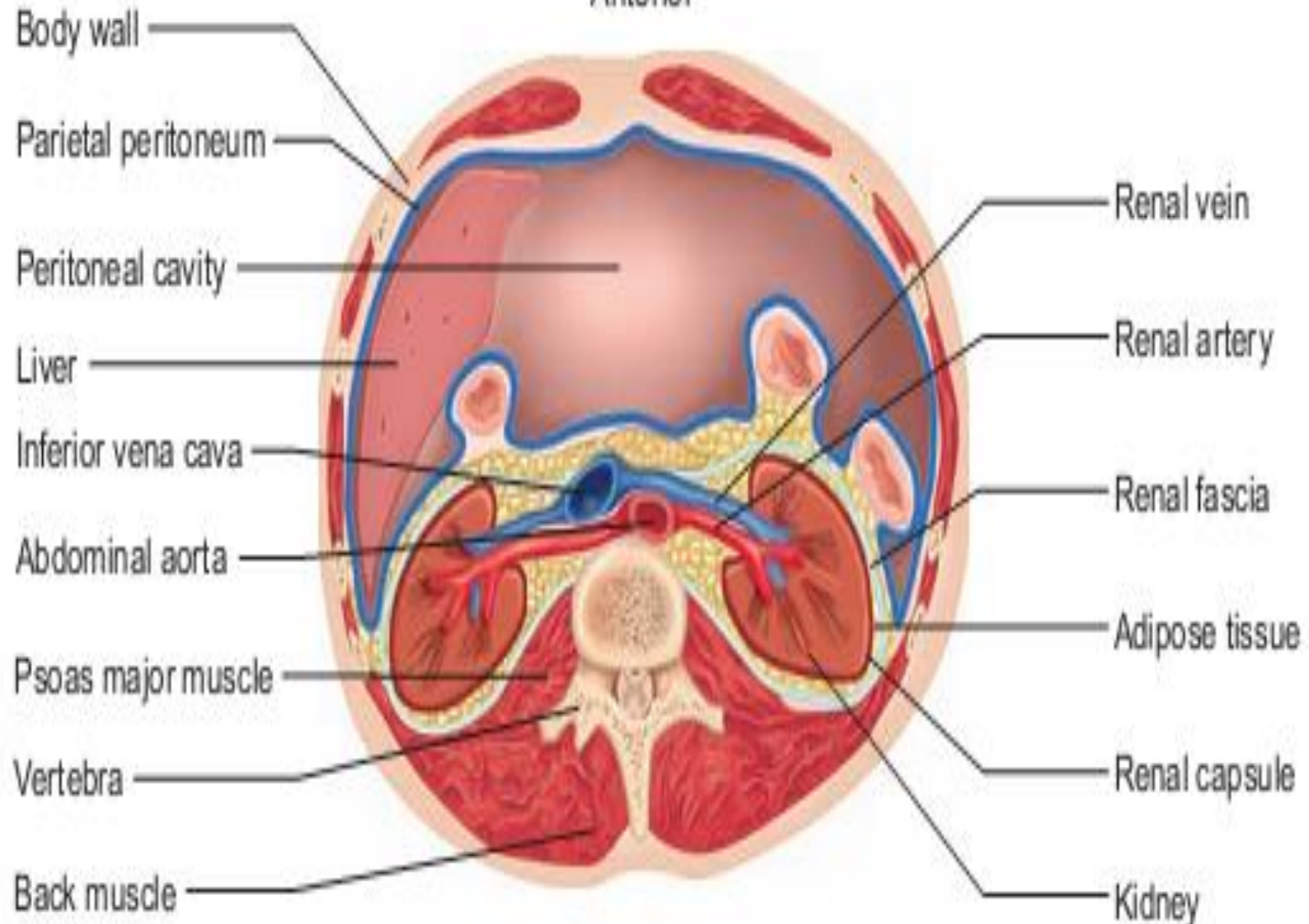
- * Kidneys are paired, reddish, bean-shaped organs responsible for formation of urine by blood filtration

Location

- * Kidneys are positioned against the posterior wall of the abdominal cavity (retroperitoneal) between the levels of the twelfth thoracic and the third lumbar vertebrae
- * The right kidney is usually 1.5 to 2.0 cm lower than the left because of the large area occupied by the liver on the right side.



Anterior



Posterior

External anatomy of kidneys

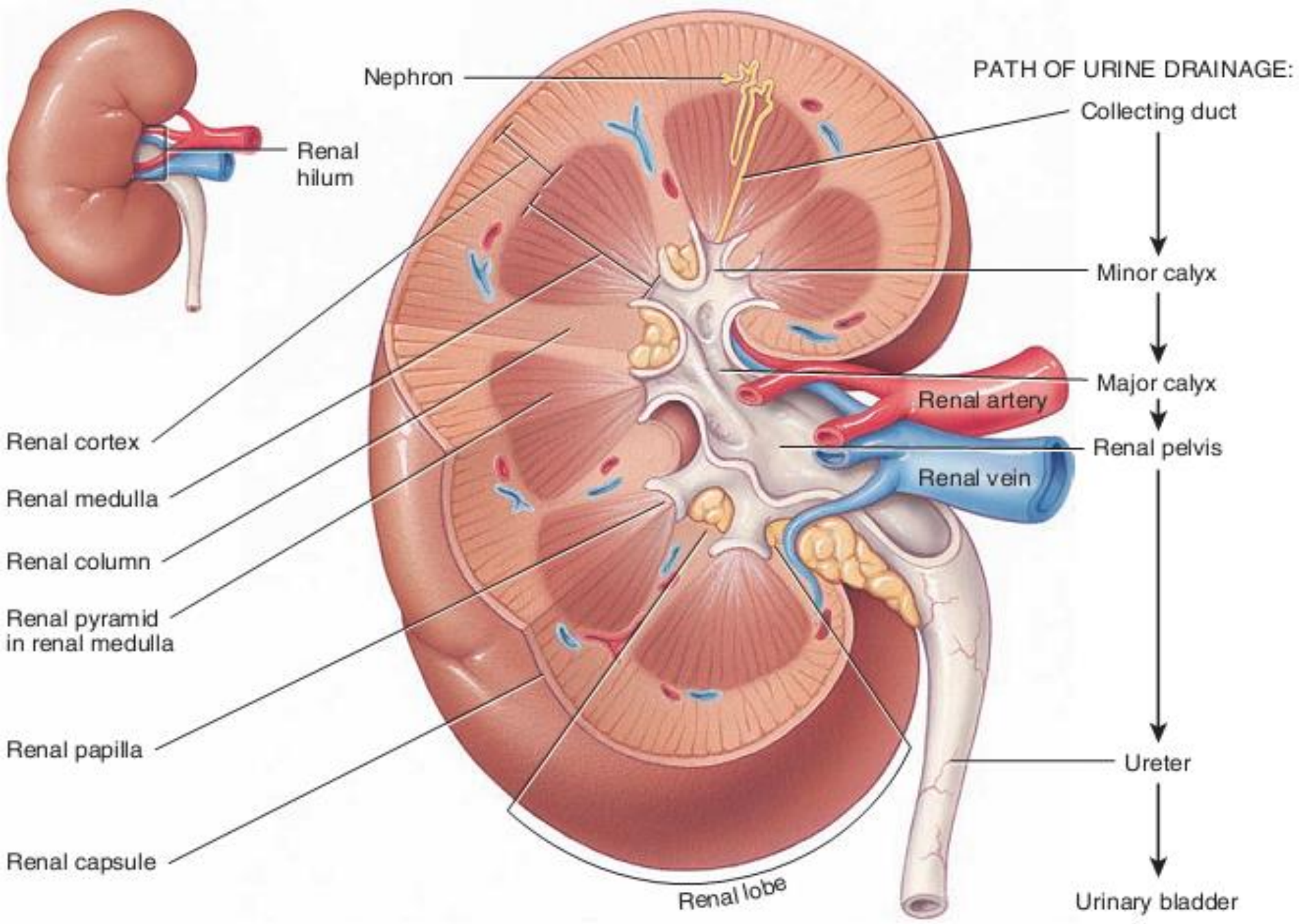
- * Each adult kidney is a bean-shaped organ about 11.25 cm (4 in.) long, 5.5 to 7.7 cm (2–3 in.) wide, and 2.5 cm (1 in.) thick.
- * Each kidney is embedded in a fatty fibrous pouch consisting of three layers:
 - ❑ The renal capsule - layer of dense fibrous connective tissue surrounding each kidney, protects kidney from trauma and infection and maintain its shape
 - ❑ Renal adipose capsule – layer of adipose tissue surrounding the renal capsule functions as a shock absorber, cushioning the kidneys against mechanical shock.
 - ❑ Renal fascia - thin layer of connective tissue surrounding the adipose tissue, anchors the kidney to the posterior abdominal wall
- * The lateral border of each kidney is convex, whereas the medial border is strongly concave
- * On the medial border is hilum, a depression through which renal artery, vein and nerves enter and leave kidney
- * The superior border of each kidney is capped by the adrenal gland

Internal anatomy of kidneys

- * The coronal section of the kidney show two distinct regions and a cavity.
- * The outer light red coloured is called cortex, the inner dark red-brown coloured called medulla and cavity is called as renal sinus
- * The medulla has distinctive conical structures called renal pyramids
- * The renal pyramids has a base and an apex. The apex is called renal papillae and they point towards renal sinus
- * The base is directed towards the cortex (outside). The base of pyramids makes border between cortex and medulla

- * The cortex occupies outer portion of the kidney and it invaginates deep into the medulla in between the renal pyramids. These extensions of cortex into medulla are called renal columns
- * The cavity of the kidney collects and transports urine from the kidney to the ureter. It is divided into several portions.
- * The papilla of a renal pyramid projects into a small depression in the renal sinus called the minor calyx.
- * Several minor calyces unite to form a major calyx. In turn, the major calyces join to form the funnel-shaped renal pelvis.
- * The renal pelvis collects urine from the calyces and transports it to the ureter.
- * A human kidney is divided into 8 to 15 renal lobes. A renal lobe consists of a medullary pyramid and some cortical substance from the renal columns adjacent to it on either side, as well as the cortex external to the pyramid base.

- * Together, the renal cortex and renal pyramids of the renal medulla constitute the parenchyma or functional portion of the kidney.
- * Within the parenchyma are the functional units of the kidney—about 1 million microscopic structures called nephrons.
- * Filtrate formed by the nephrons drains into large papillary ducts, which extend through the renal papillae of the pyramids.
- * The papillary ducts drain into cuplike structures called minor calyces which drain into major calyces. Each kidney has 8 to 18 minor calyces and 2 or 3 major calyces.
- * A minor calyx receives urine from the papillary ducts of one renal papilla and delivers it to a major calyx.
- * From the major calyces, urine drains into a single large cavity called the renal pelvis and then out through the ureter to the urinary bladder



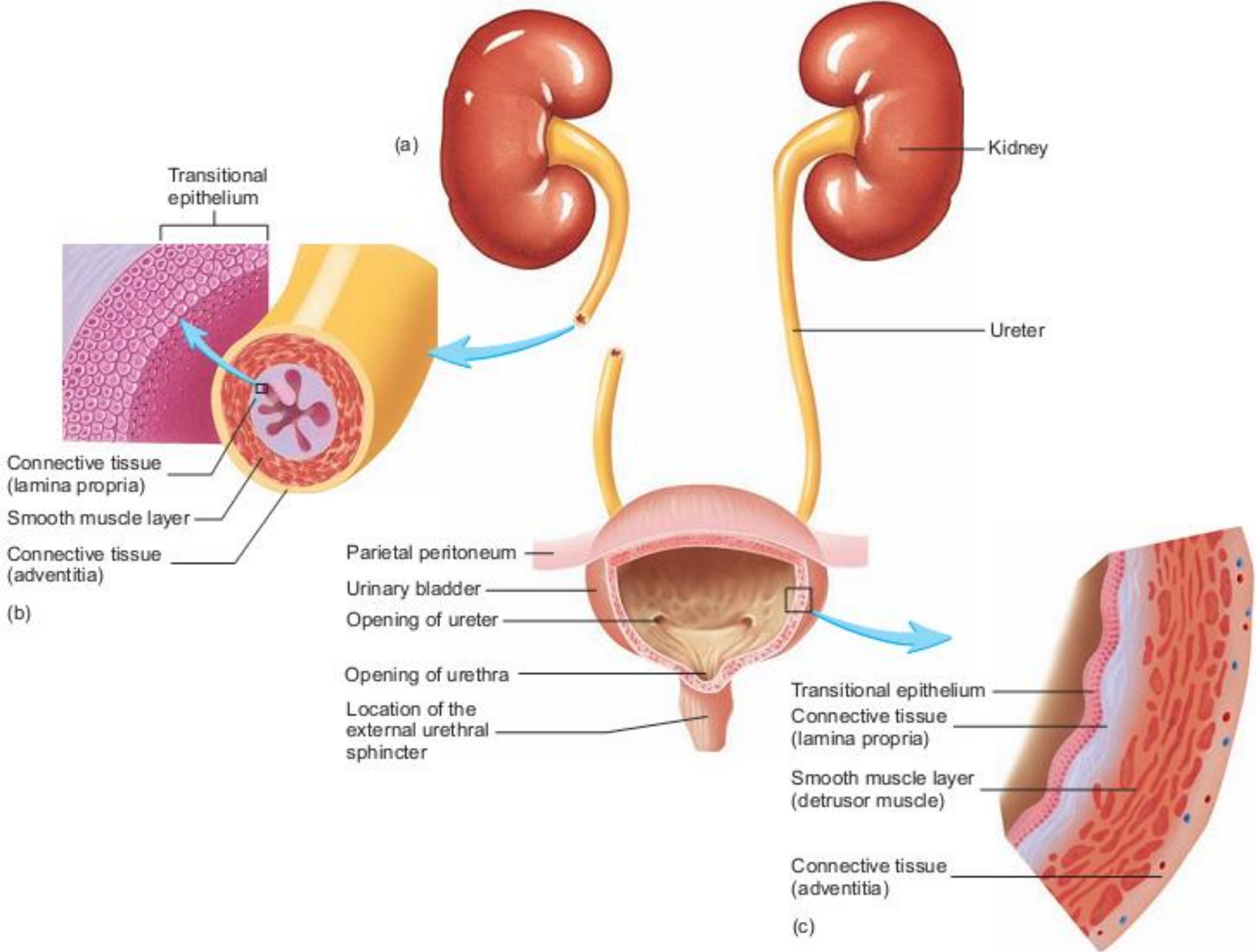
(a) Anterior view of dissection of right kidney

Ureters

- * The ureters are long, fibromuscular tubes that conduct urine from the kidneys to the urinary bladder.
- * Each tube averages 25 centimeters in length and is retroperitoneal
- * The ureters originate at the renal pelvis as it exits the hilum of the kidney, and then extend inferiorly .
- * At the level of base of urinary bladder they curve medially to enter the posterolateral wall of the of the urinary bladder inferiorly

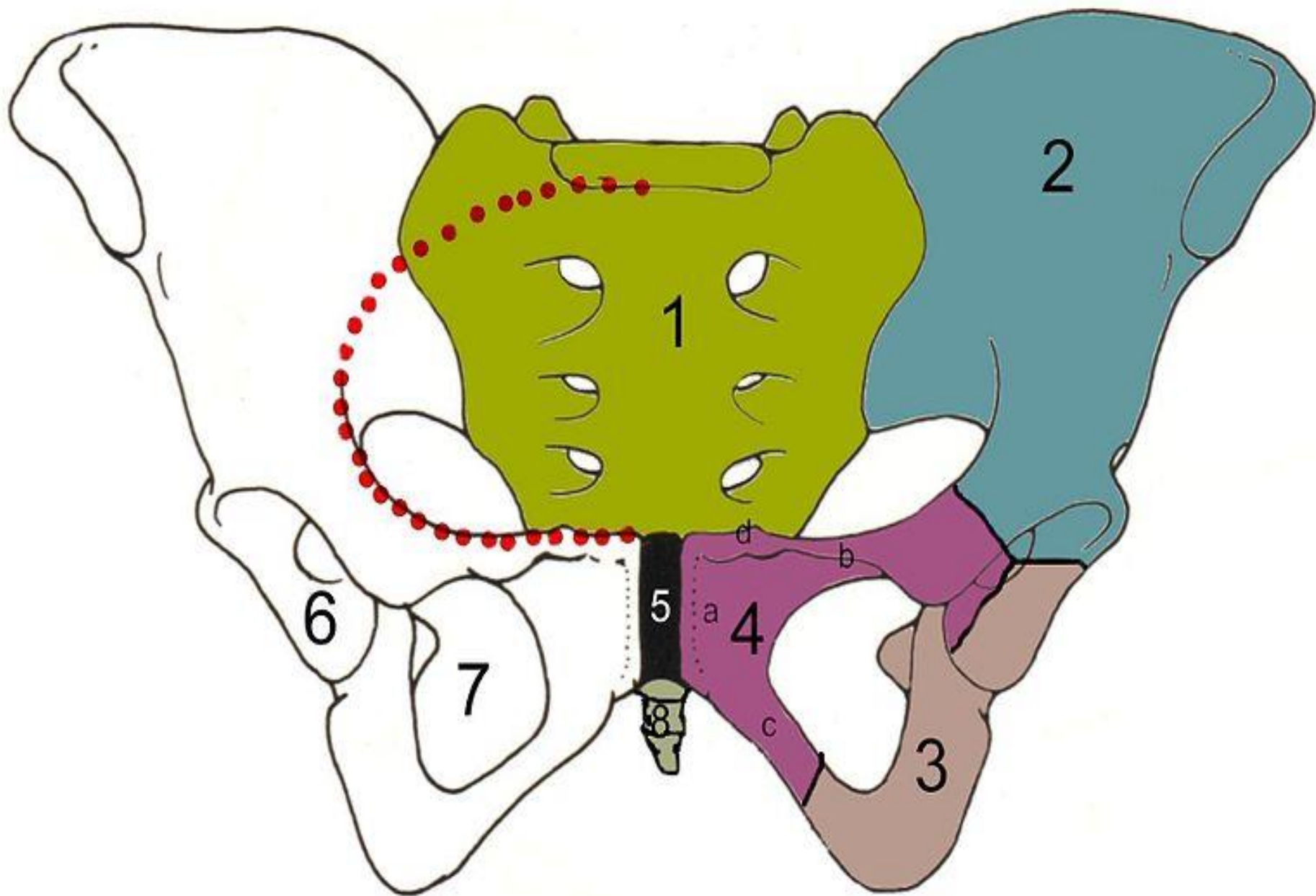
* The ureter is made up of three layers or tunic:

- ❑ Mucosa – innermost coat, made up of mucous membrane of transitional epithelium and lamina propria which is made up of areolar connective tissue. The transitional epithelium can stretch to accommodate variable amount of urine. The goblet cells in mucosa secretes mucous to protect the cells from urine
- ❑ Muscularis - next to mucosa is muscularis. It is made up of two layers of muscles the inner longitudinal and outer circular. The distal one third of ureter contain another longitudinal muscular layer. The muscularis exhibit peristaltic movement to propel the urine through its length
- ❑ Adventitia – outer most layer made up of loose connective tissue. It anchors the ureter to posterior abdominal wall through its extensions.



Urinary bladder

- * The urinary bladder is a saccular organ for storage of urine
- * The urinary bladder is a retroperitoneal organ, since only its superior surface is covered with peritoneum
- * The urinary bladder is positioned immediately posterior to the pubic symphysis
- * The shape of the urinary bladder is determined by the volume of urine it contains. An empty urinary bladder is pyramidal. As it fills, it becomes ovoid and bulges upward into the abdominal cavity
- * A fibrous, cordlike median umbilical ligament extends toward the umbilicus from the anterosuperior border of the urinary bladder.
- * The base of the urinary bladder receives the ureters, and the urethra exits at the inferior angle, or apex. The region surrounding the urethral opening is known as the neck of the urinary bladder



- * The wall of urinary bladder is made up of four layers:

The mucosa –

- * the innermost layer
- * composed of transitional epithelium that becomes thinner as the urinary bladder distends and the cells are stretched.
- * Further distension is permitted by folds of the mucosa, called rugae, which can be seen when the urinary bladder is empty.
- * Fleshy flaps of mucosa, located where the ureters pierce the urinary bladder, act as valves to prevent a reverse flow of urine toward the kidneys as the urinary bladder fills.
- * A triangular area known as the trigone is formed on the mucosa between the two ureteral openings and the single urethral opening. The internal trigone lacks rugae; it is therefore smooth in appearance and remains relatively fixed in position as the urinary bladder changes shape during distension and contraction.

Submucosa -

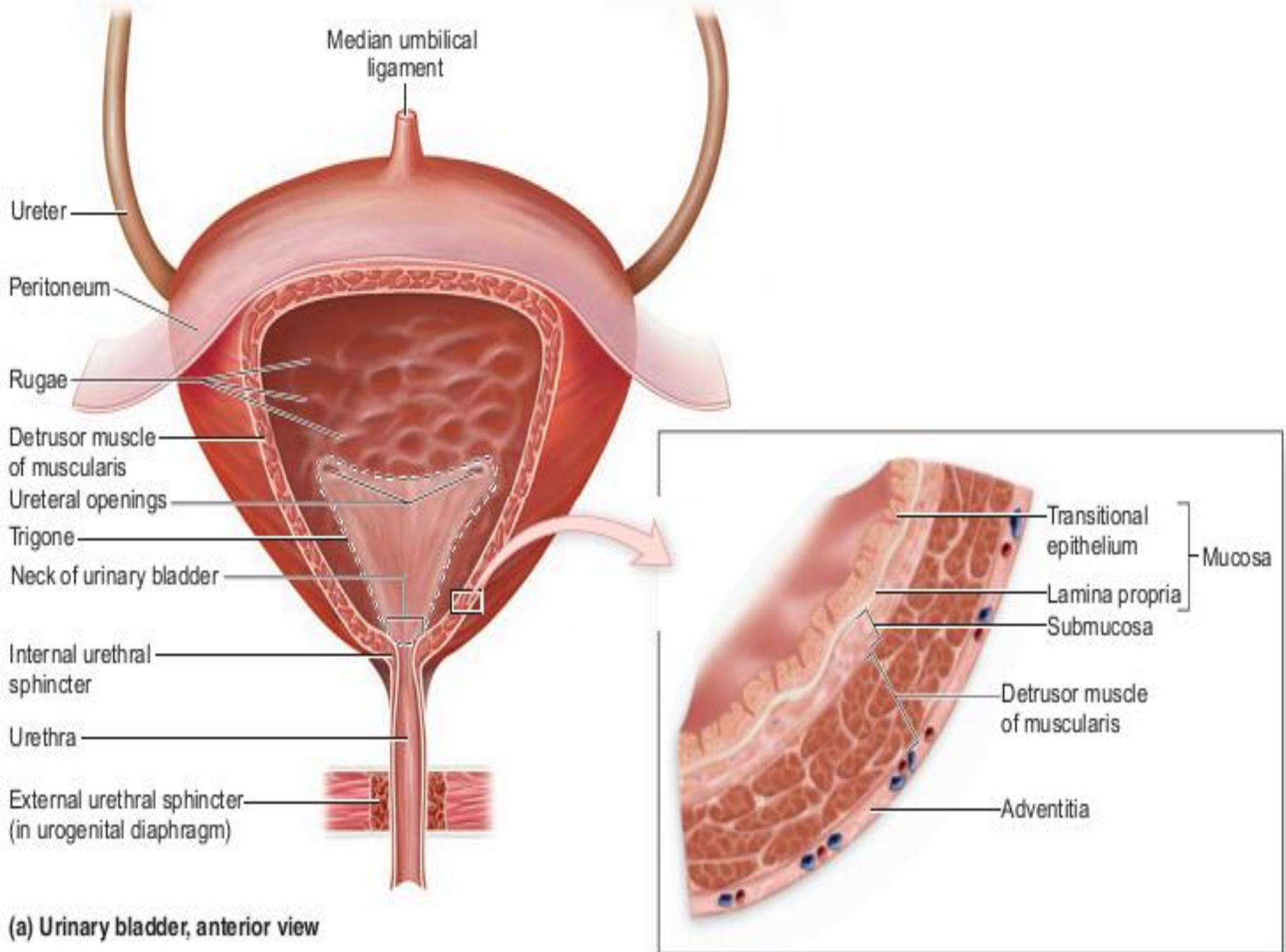
- * The second layer of the urinary bladder
- * functions to support the mucosa

The muscularis

- * consists of three interlaced smooth muscle layers collectively called the detrusor muscle.
- * At the neck of the urinary bladder, the detrusor muscle is modified to form the superior (called the internal urethral sphincter) of urethra.

Adventitia

- * The outer covering of the urinary bladder is the adventitia.
- * Made up of areolar connective tissue



(a) Urinary bladder, anterior view

Urethra

- * The urethra is a fibromuscular tube that originates at the neck of the urinary bladder and conducts urine to the exterior of the body
- * The male urethra is different from female urethra as male urethra also perform reproductive function.

Four basic anatomic feature common in male and female urethra :

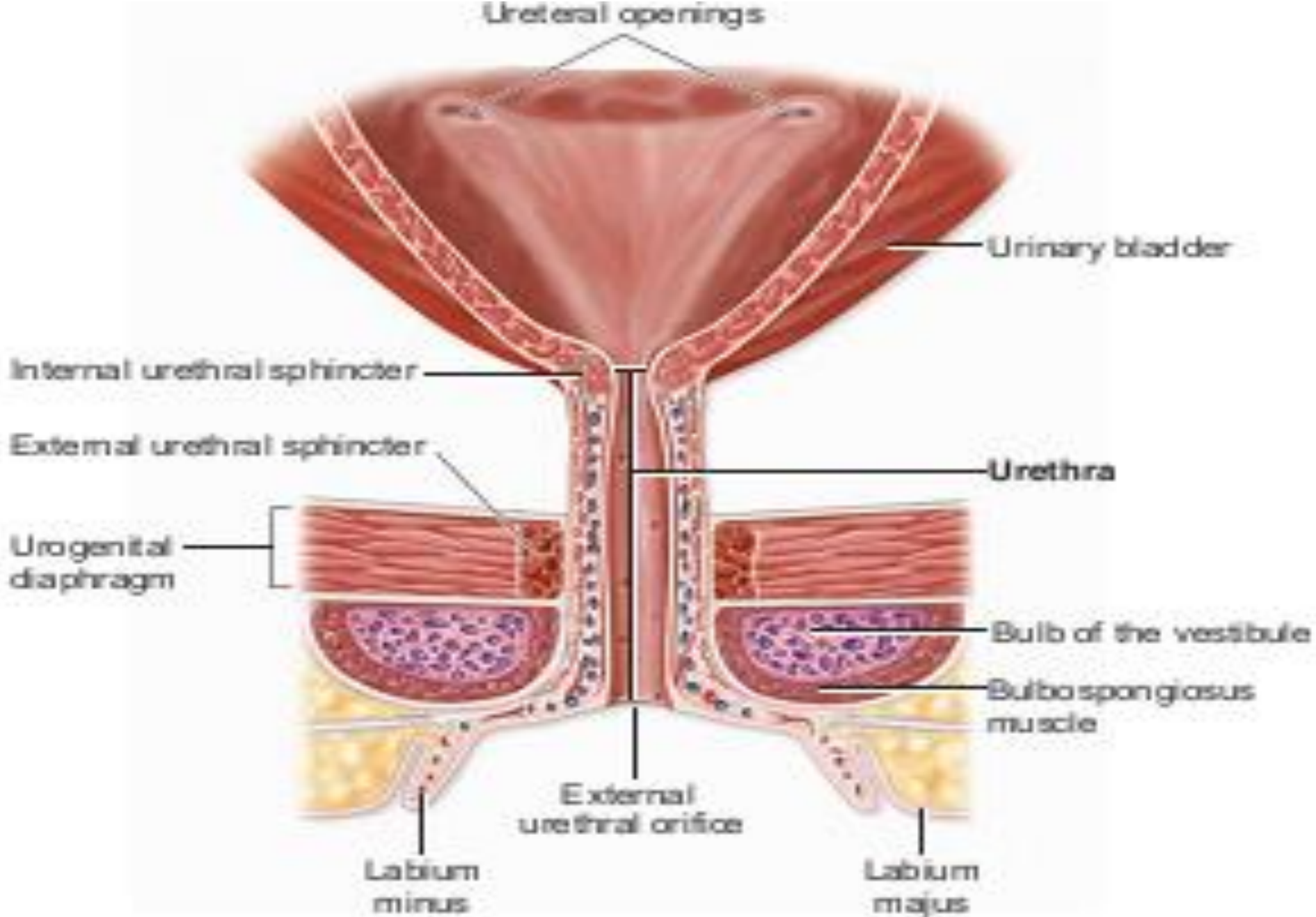
- ❑ Innermost mucous membrane lining releasing mucus
- ❑ Layer of smooth muscle next to mucus membrane oriented longitudinally
- ❑ Urethral glands embedded in urethral wall releasing mucus
- ❑ Two muscular sphincters;
 - ❖ The internal urethral sphincter – involuntary sphincter made up by the detrusor muscles of bladder
 - ❖ The external urethral sphincter – voluntary sphincter made up of skeletal muscles

Female urethra

- * The urethra of the female is a straight tubular organ, about 4 cm (1.5 in.) long
- * empties urine through the urethral orifice into the vestibule between the labia minora.
- * The urethral orifice is positioned between the clitoris and vaginal orifice

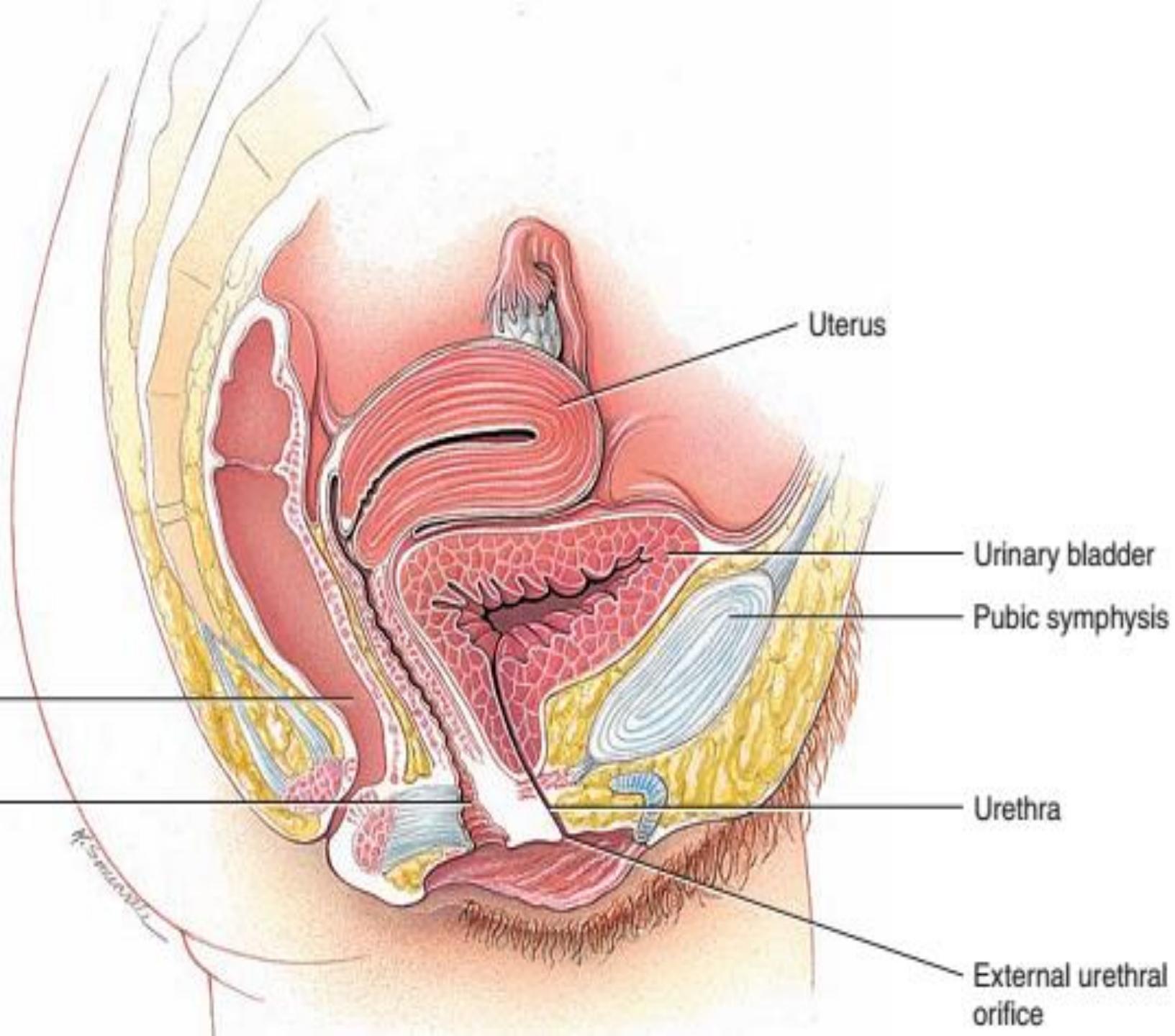
Male urethra

- * About 20cm long
- * It has three parts:
 - Prostatic part - proximal part, pass through prostate gland near the neck of urinary bladder, receives drainage from small ducts of the prostate and two ejaculatory ducts of the reproductive system
 - Membranous part – short portion about 0.5 cm , pass through the urogenital diaphragm, external urethral sphincter is located in this portion
 - Spongy part - longest portion (15 cm), extending from the outer edge of the urogenital diaphragm to the external urethral orifice on the glans penis , some part of this portion is surrounded by erectile tissue



(a) Female urethra

Sagittal
plane



Uterus

Urinary bladder

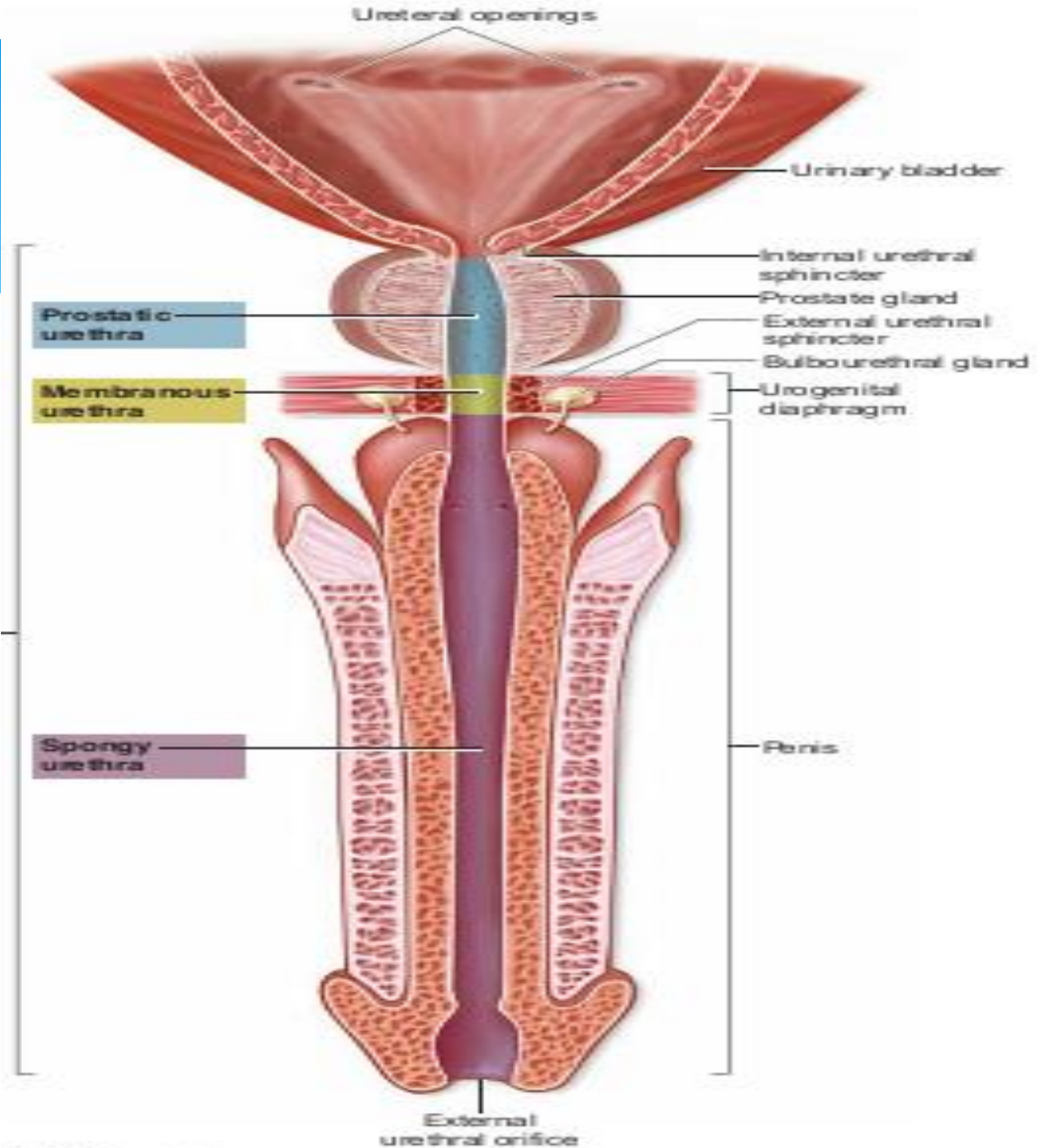
Pubic symphysis

Rectum

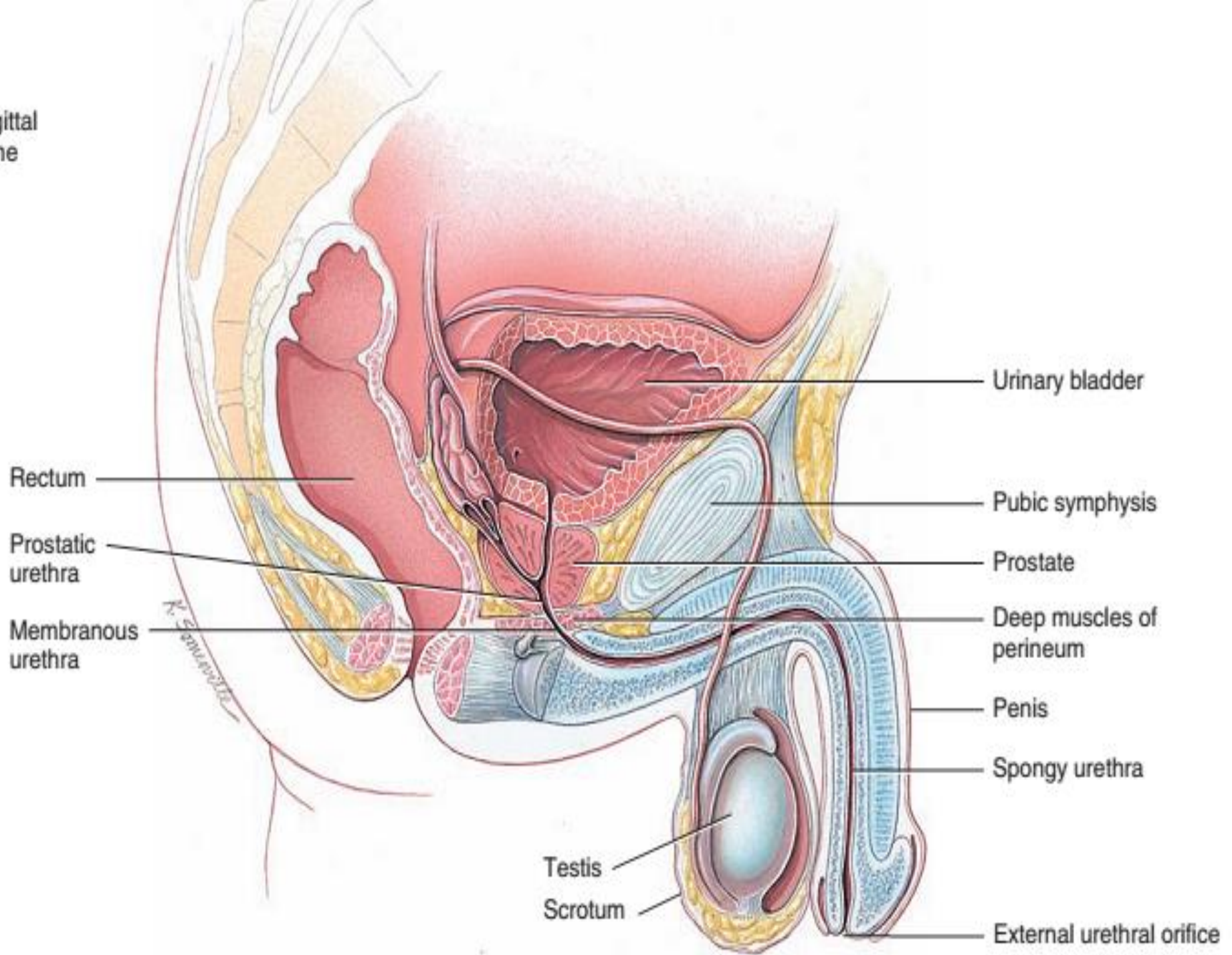
Vagina

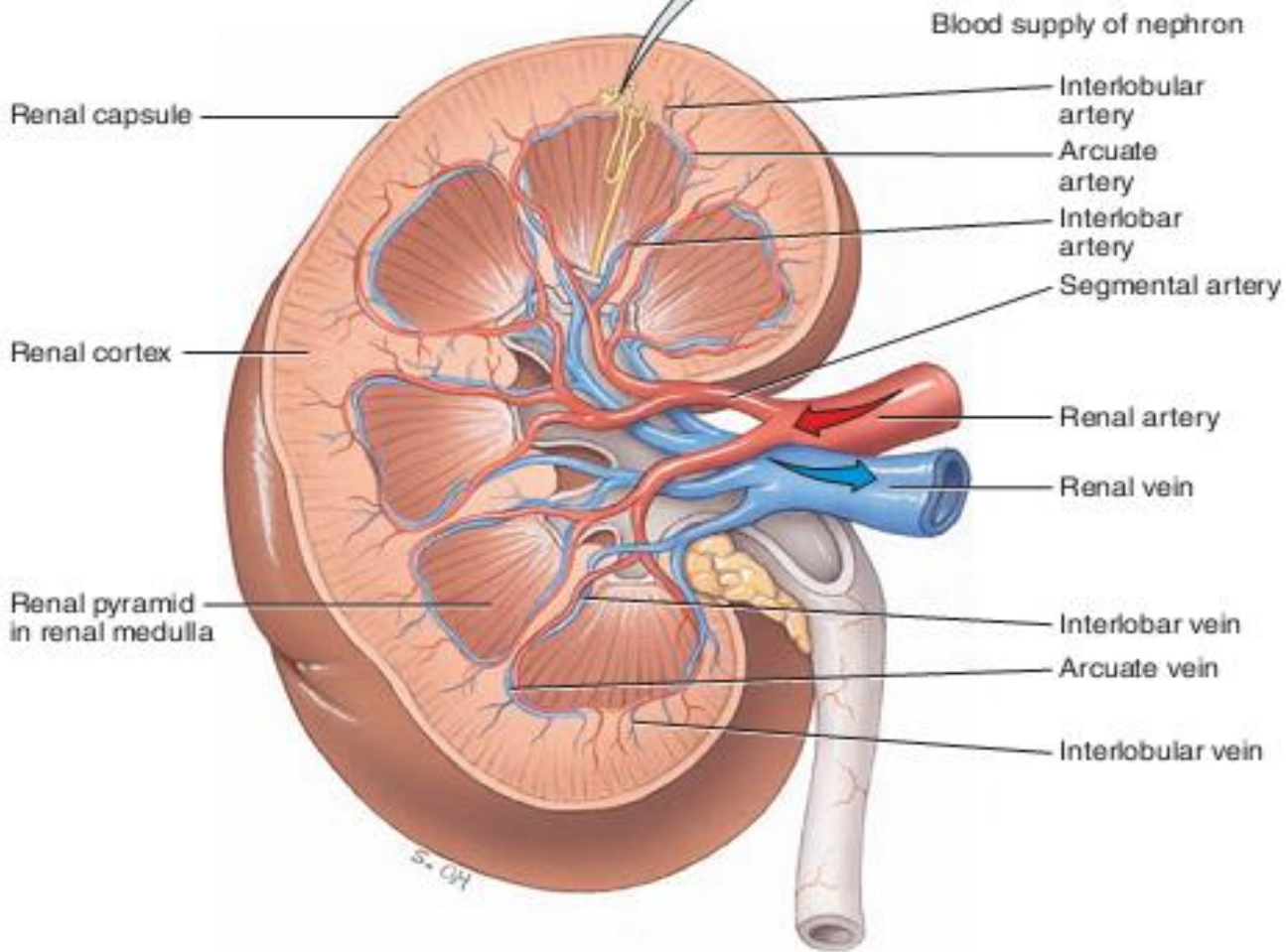
Urethra

External urethral
orifice

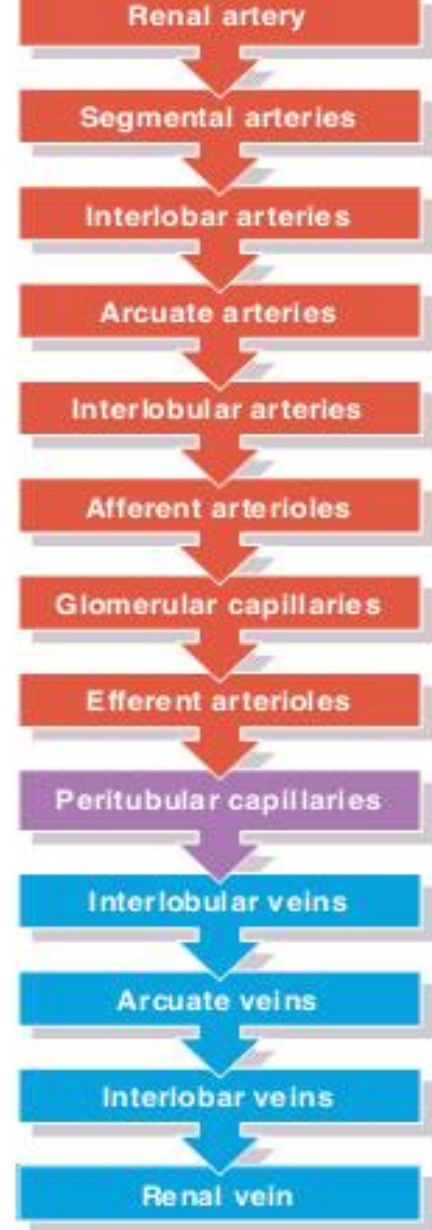


Sagittal
plane

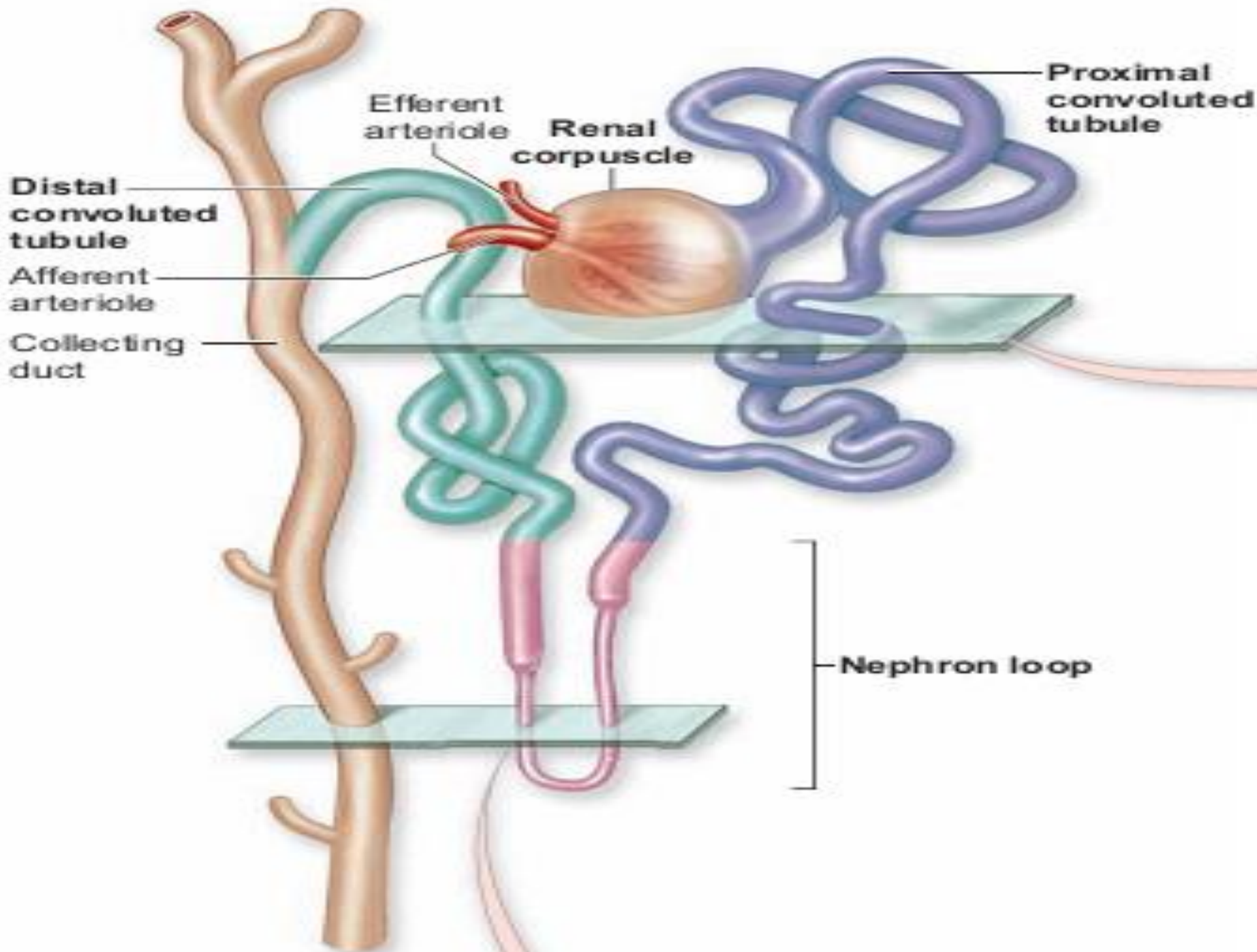




(a) Frontal section of right kidney

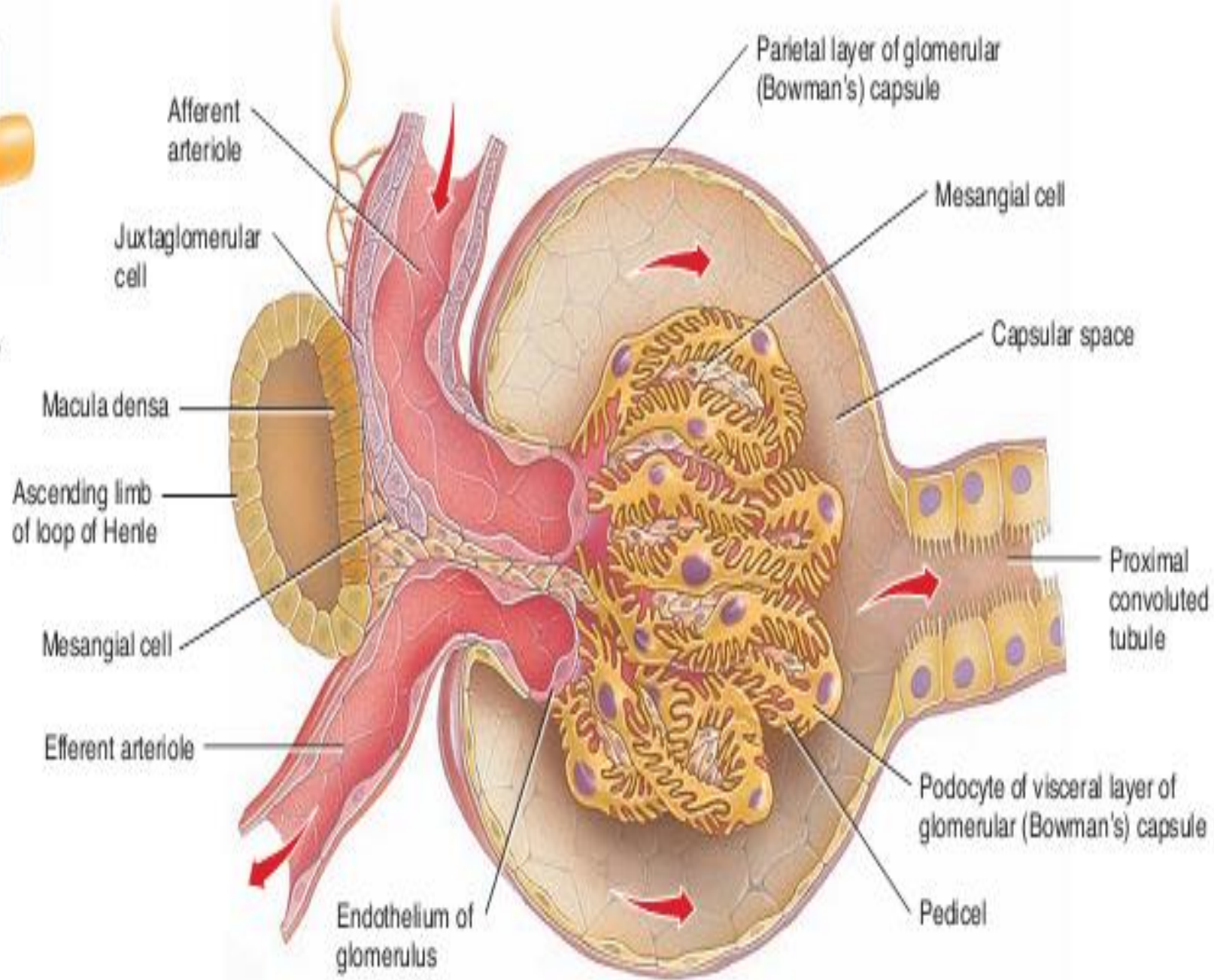


(b) Path of blood flow





Renal corpuscle (external view)



Afferent arteriole

Juxtaglomerular cell

Macula densa

Ascending limb of loop of Henle

Mesangial cell

Efferent arteriole

Endothelium of glomerulus

Parietal layer of glomerular (Bowman's) capsule

Mesangial cell

Capsular space

Proximal convoluted tubule

Podocyte of visceral layer of glomerular (Bowman's) capsule

Pedicel

(a) Renal corpuscle (internal view)

