Anatomy of the urinary system

Plan of the lecture:

1. Anatomy of the urinary system.
2. Perineum.
3. Retroperitoneal space.

The plan of answer
of the any internal organ anatomy

1. Organ name (Russian, English, Latin, Greek).
2. Function of organs.
3. Topography of organ (holotopiya, skeletotopiya, sintopiya).
4. External structure of an organ (form, parts, surfaces, lobes, grooves, hilum, etc.).
5. Internal structure of organ:

a) Structure of the wall coats of **tubular** organs (characteristic of mucous, fibrous, muscular, adventitia or serosa layers).

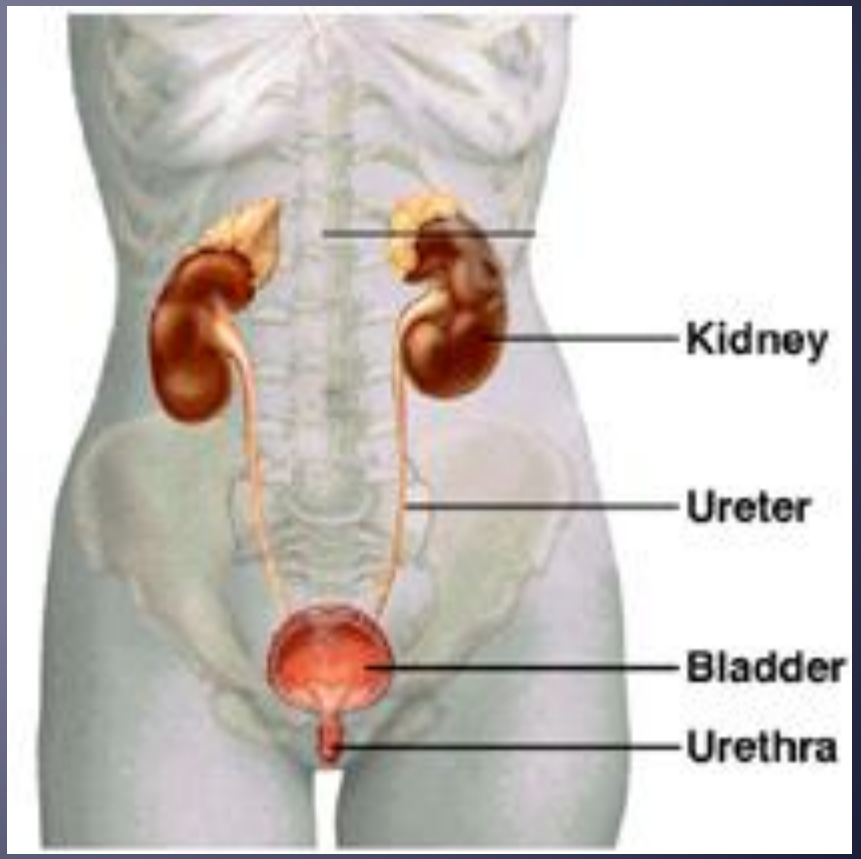
b) Internal structure of **parenchymatous** organs (lobes, hilum, segments, structurally functional units, features of intraorganic blood circulations).

6. Types of a covering of abdominal organs by peritoneum.

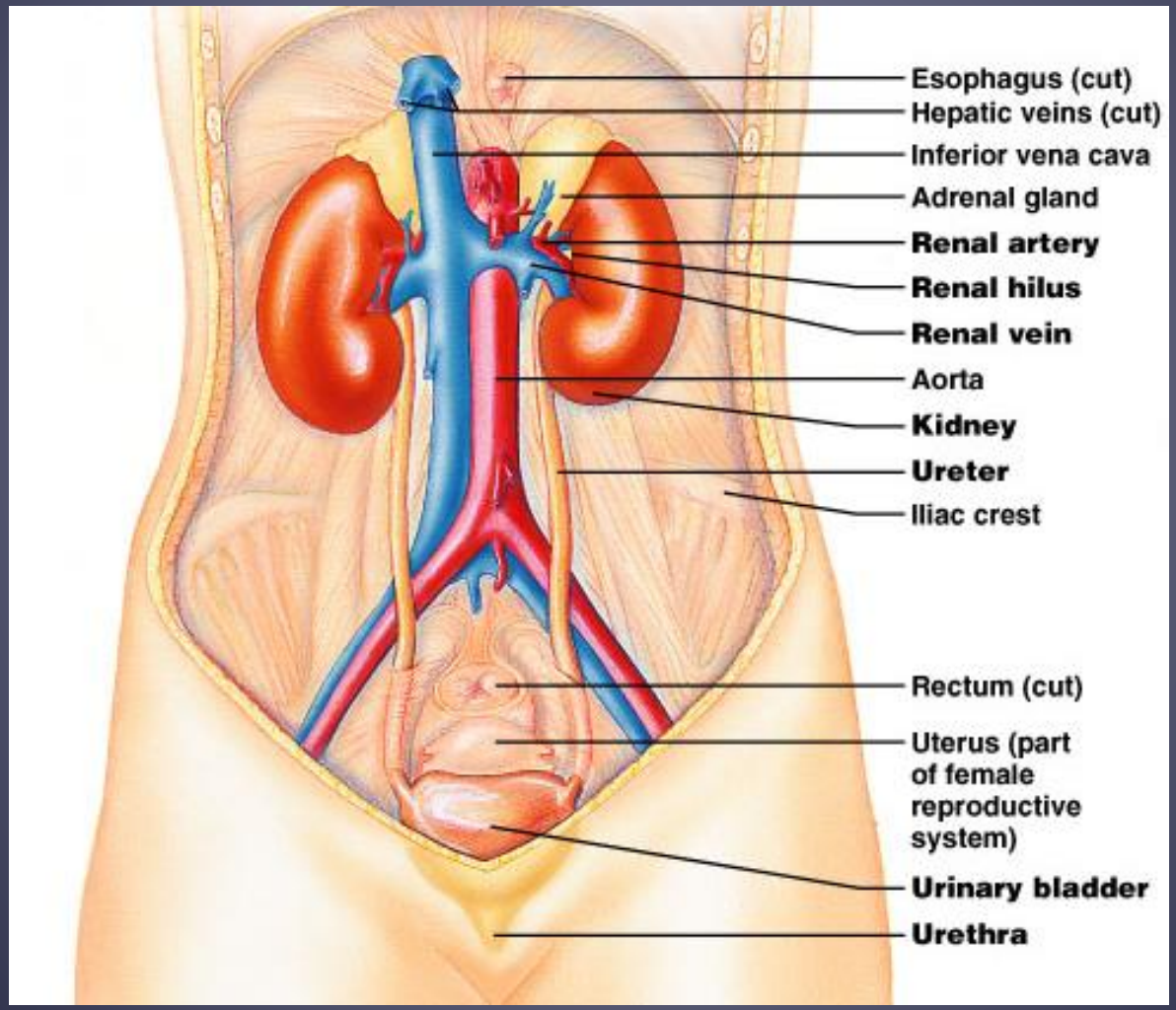
The urinary system consists of the kidneys, ureters, urinary bladder, and urethra.

The functions of the of urinary system are:

- 1. elimination wastes from the body,
- 2.regulation blood volume and pressure,
- 3. control levels of electrolytes and metabolites,
- 4.regulation blood pH.

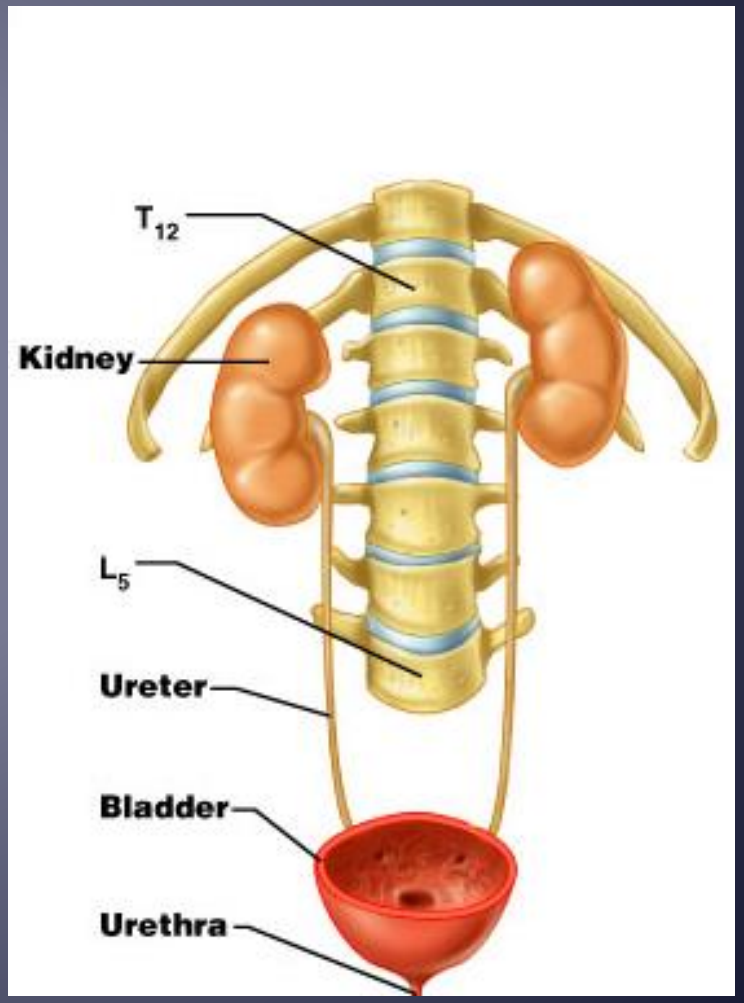


Kidneys


Esophagus (cut)
Hepatic veins (cut)
Inferior vena cava
Adrenal gland
Renal artery
Renal hilus
Renal vein
Aorta
Kidney
Ureter
Iliac crest
Rectum (cut)
Uterus (part of female reproductive system)
Urinary bladder
Urethra

Kidneys =
Ren = Nephros= Почки

Skeletotopy: The paired kidneys are located between the twelfth thoracic and third lumbar vertebrae, one on each side of the vertebral column.

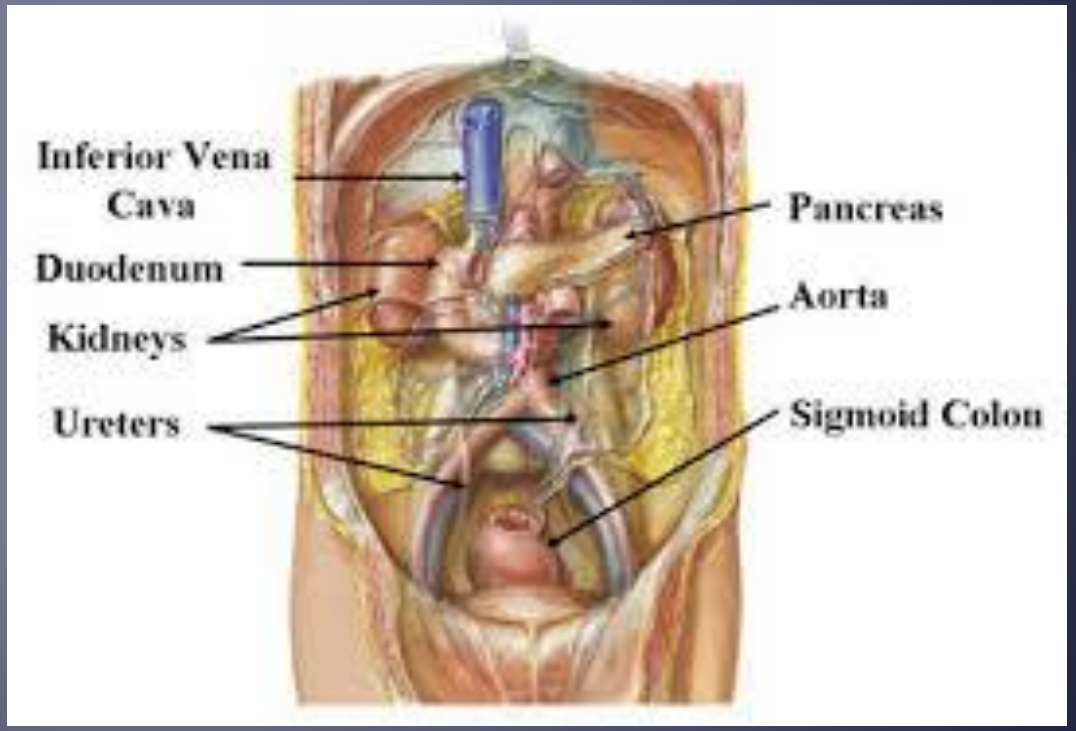


Kidneys

Holotopy:

Right kidney – epigastric, umbilical and right lateral regions.

Left kidney - epigastric and left lateral regions.



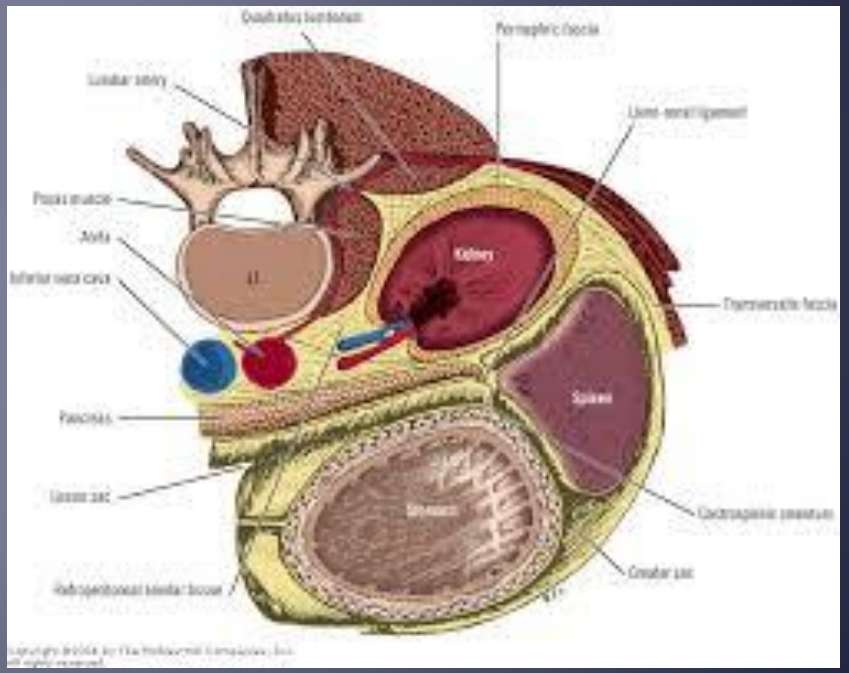
Kidneys

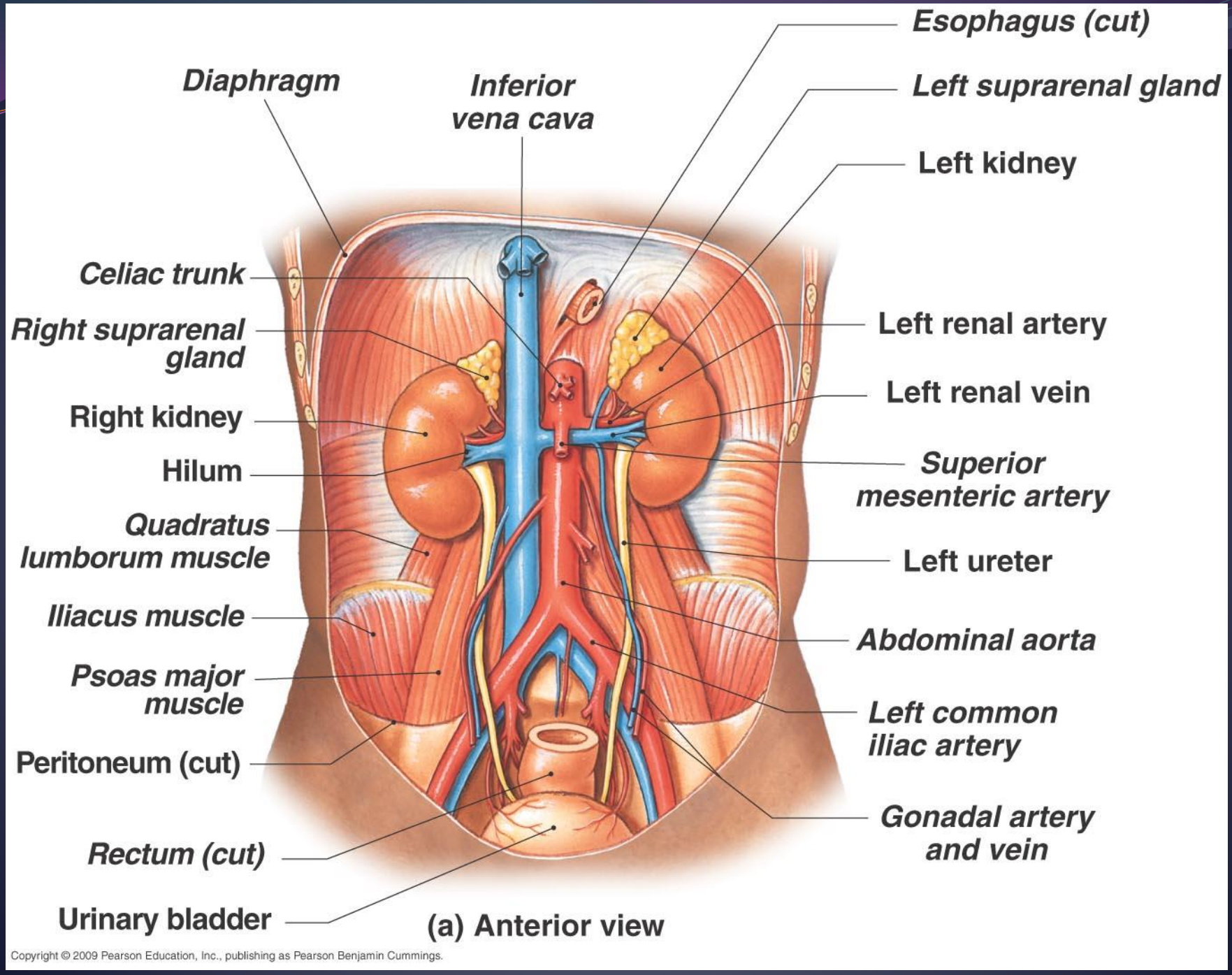
Syntopy:

Kidneys have **retroperitoneal location**.

Right kidney: Anteriorly - suprarenal gland and liver.
Medially – is descending part of duodenum.
Posteriorly – diaphragm and back muscles.

Left kidney: Anteriorly - suprarenal gland, stomach, pancreas and jejunal loops.
Lateral border - spleen.
Posteriorly – diaphragm and back muscles.

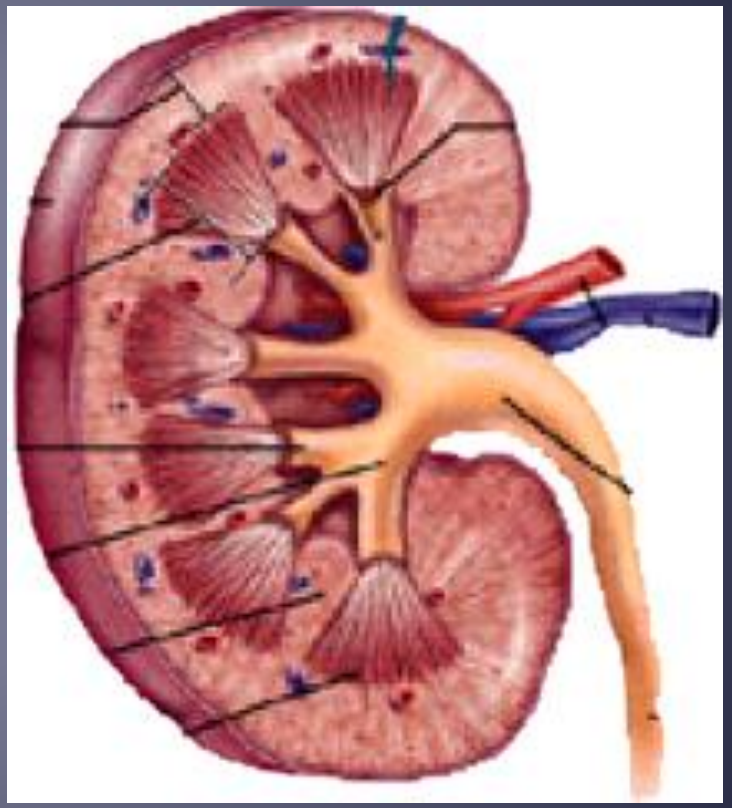




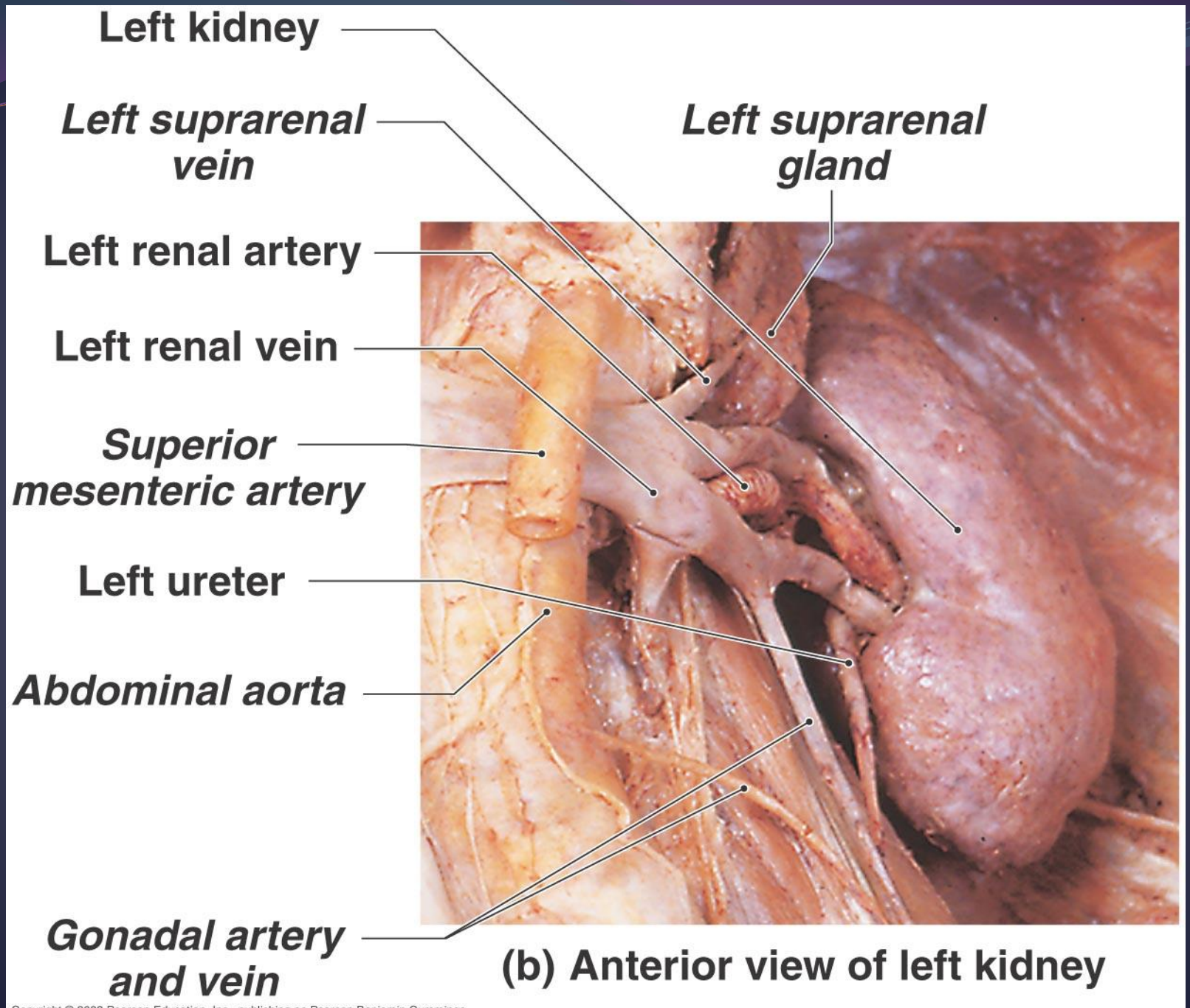
Kidneys

Each kidney has:

- two poles
- two borders
- two surfaces

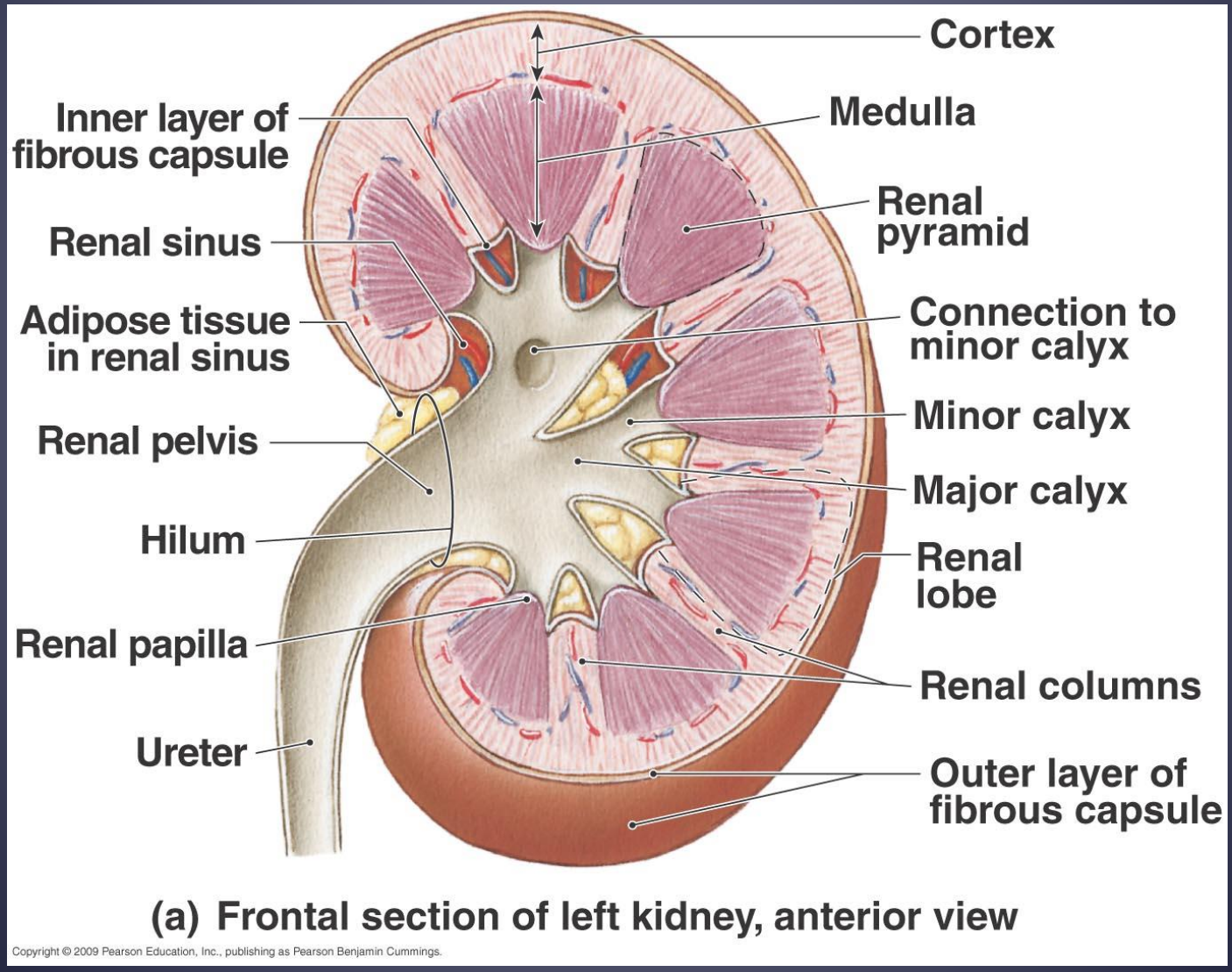


!!!! Position of renal hilum elements (from anterior to posterior): renal vein, renal artery, ureter *(VAU)*



Internal structure

Kidneys



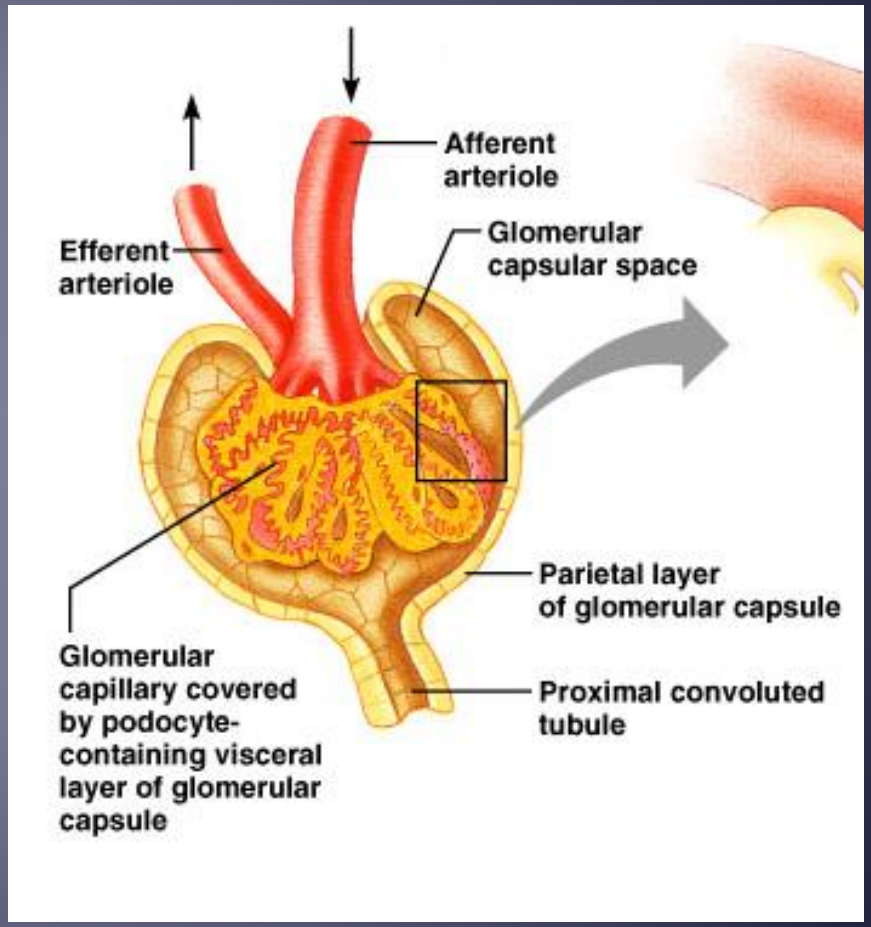
Nephron is the structure-functional unit of kidney.

It has two parts:

1. a renal corpuscle
2. renal tubules.

Renal corpuscle: only in cortex and includes:

1. Tuft of capillaries called ***glomerulus***
2. Surrounded by cup-shaped, hollow ***glomerular (Bowman's) capsule***

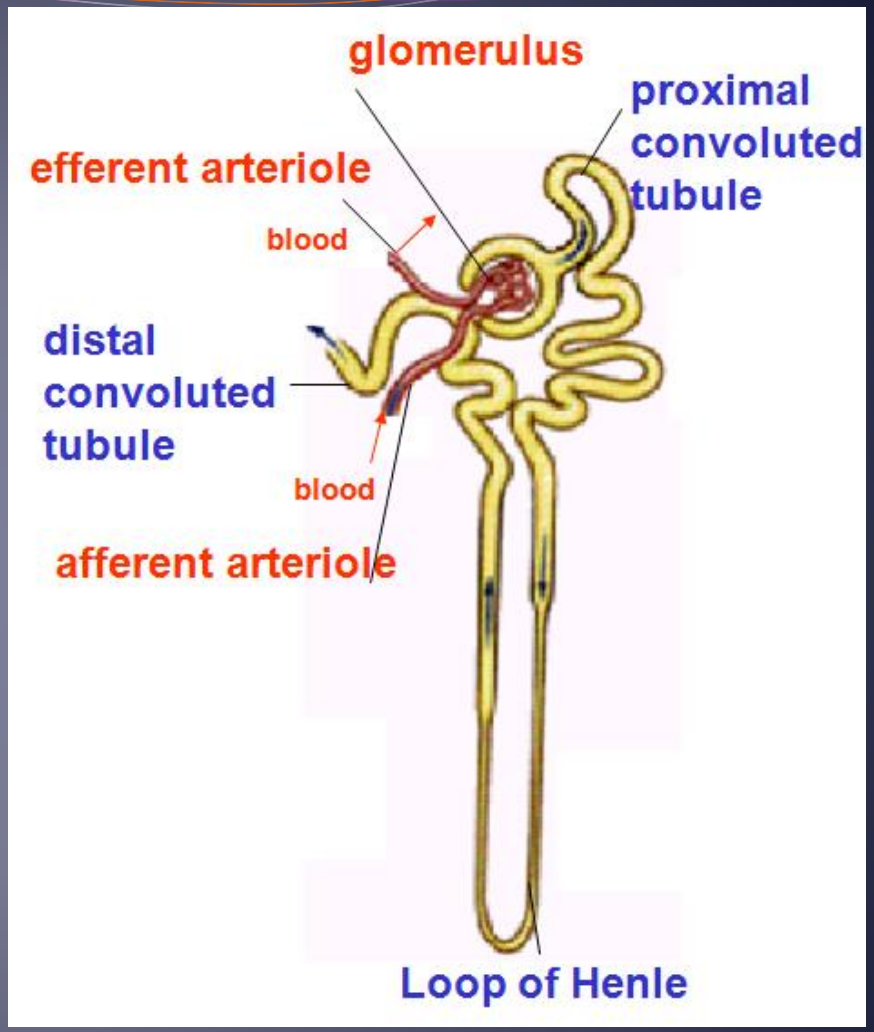


Nephron

- Renal corpuscle
- Renal tubulars

Tubular section includes:

- Proximal convoluted tubule
- Loop of Henle
- Distal convoluted tubule
- Collecting ducts



- **The proximal convoluted tubule.** Controlled absorption of glucose, sodium, and other solutes goes on in this region.
- **The loop of Henle.** This region is responsible for concentration and dilution of urine.
- **The distal convoluted tubule.** This region is responsible for absorbing water back into the body.

99% of the water is normally reabsorbed, leaving highly concentrated urine to flow into the collecting duct and then into the renal pelvis.

Blood Supply

Aorta gives off right and left renal arteries

Renal arteries divides into 5 segmental arteries which enter into hilus of kidney

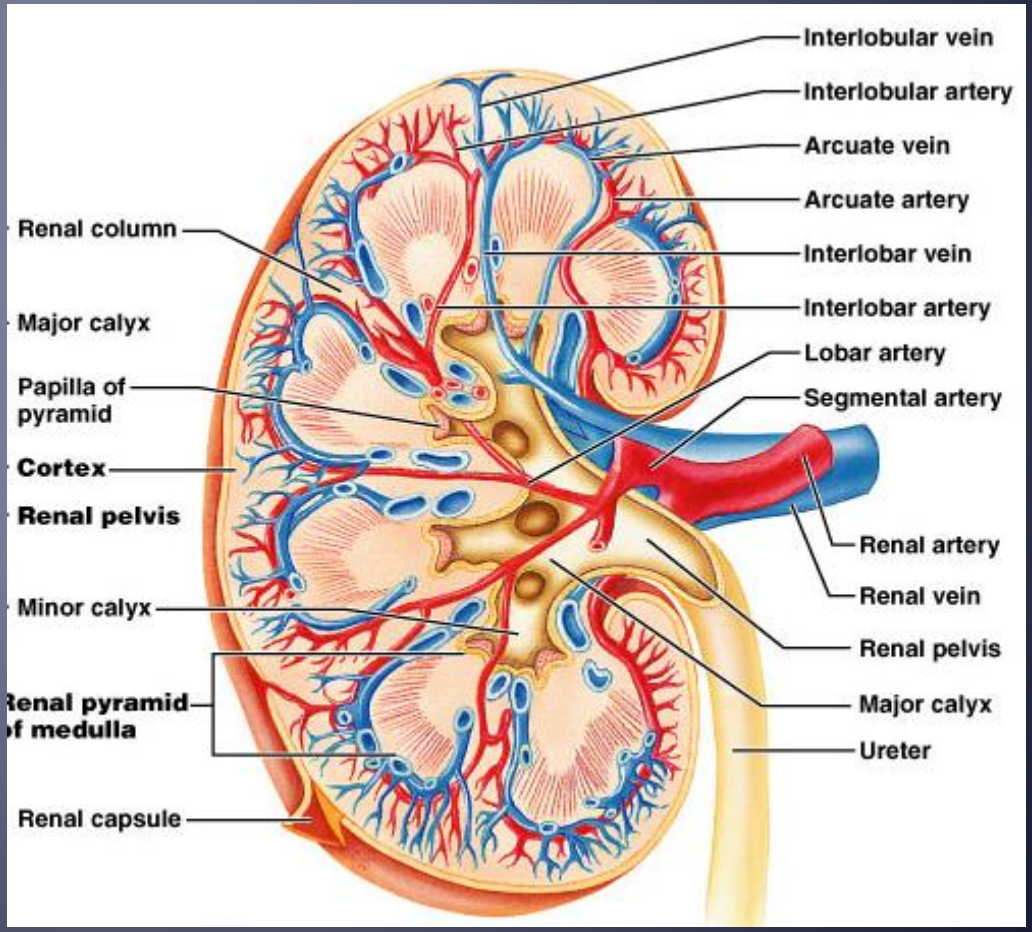
Segmental branch is divided into lobar arteries

Lobar arteries are divided into interlobars

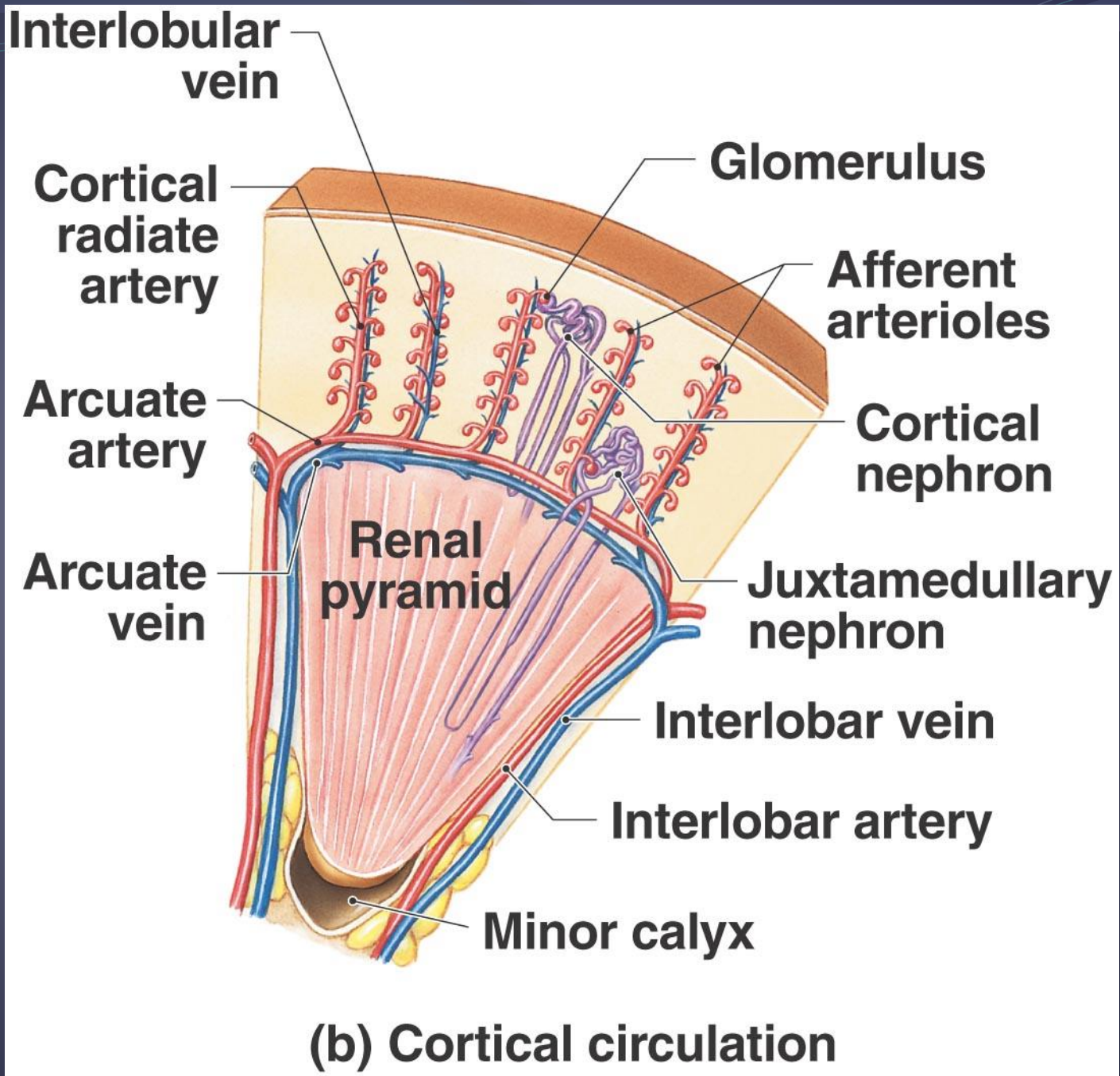
Interlobars are divided into arcuate arteries of medulla and cortex injunction

Arcuate ateries send interlobular arteries into cortex

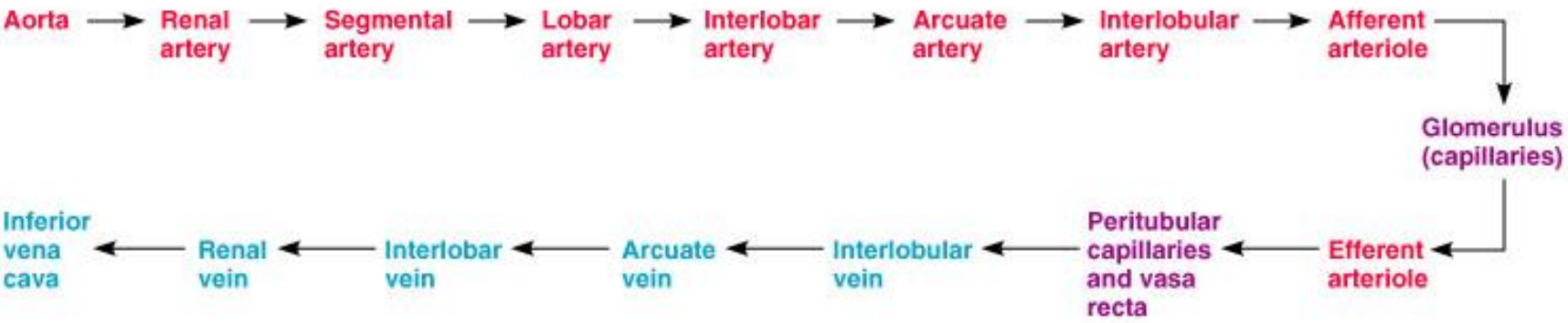
Cortical radiate arteries give rise to ***glomerular arterioles.***



Nephron

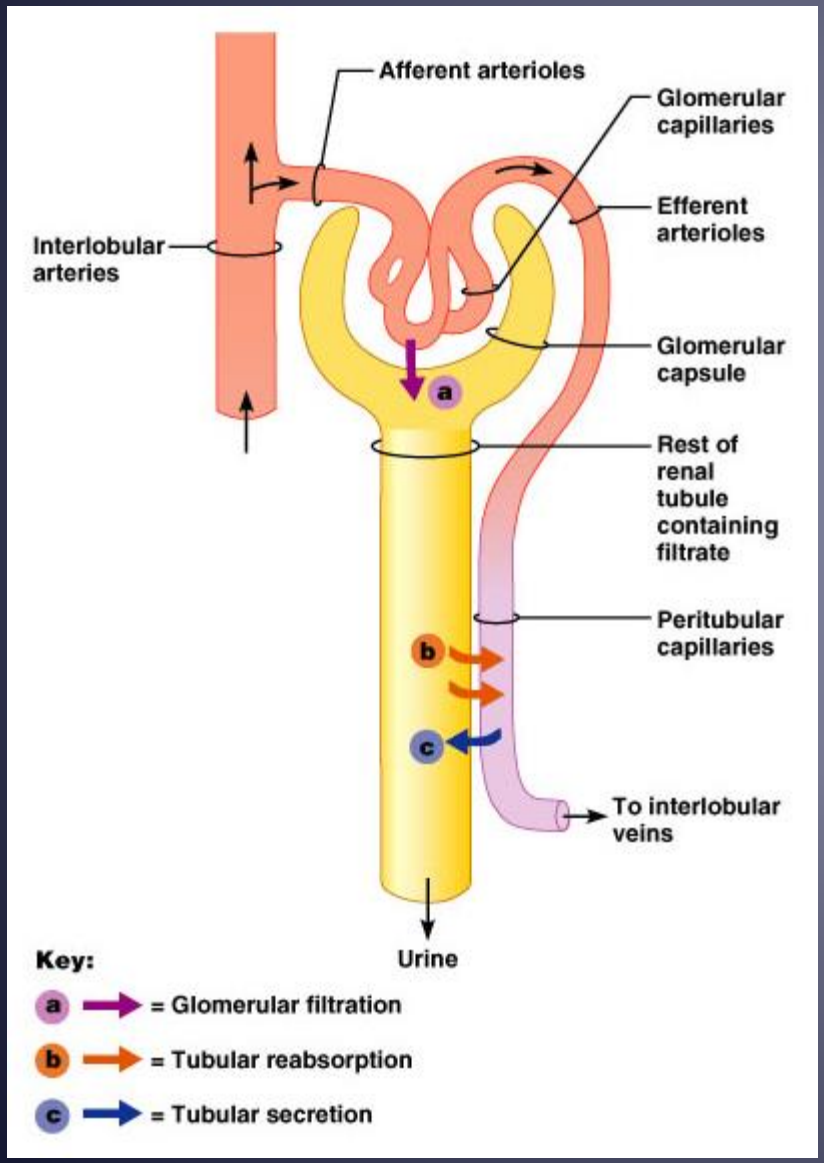


Nephron blood suply



- The glomerular capillary bed is unusual in having arterioles going both to it and away from it (afferent and efferent), instead of a vein going away as most.
- It is also unusual in having two capillary beds in series (one following the other).
- This division of blood vessels in kidney is called "a magic rete".

Nephron



More than a million of these tubules act together to form the urine

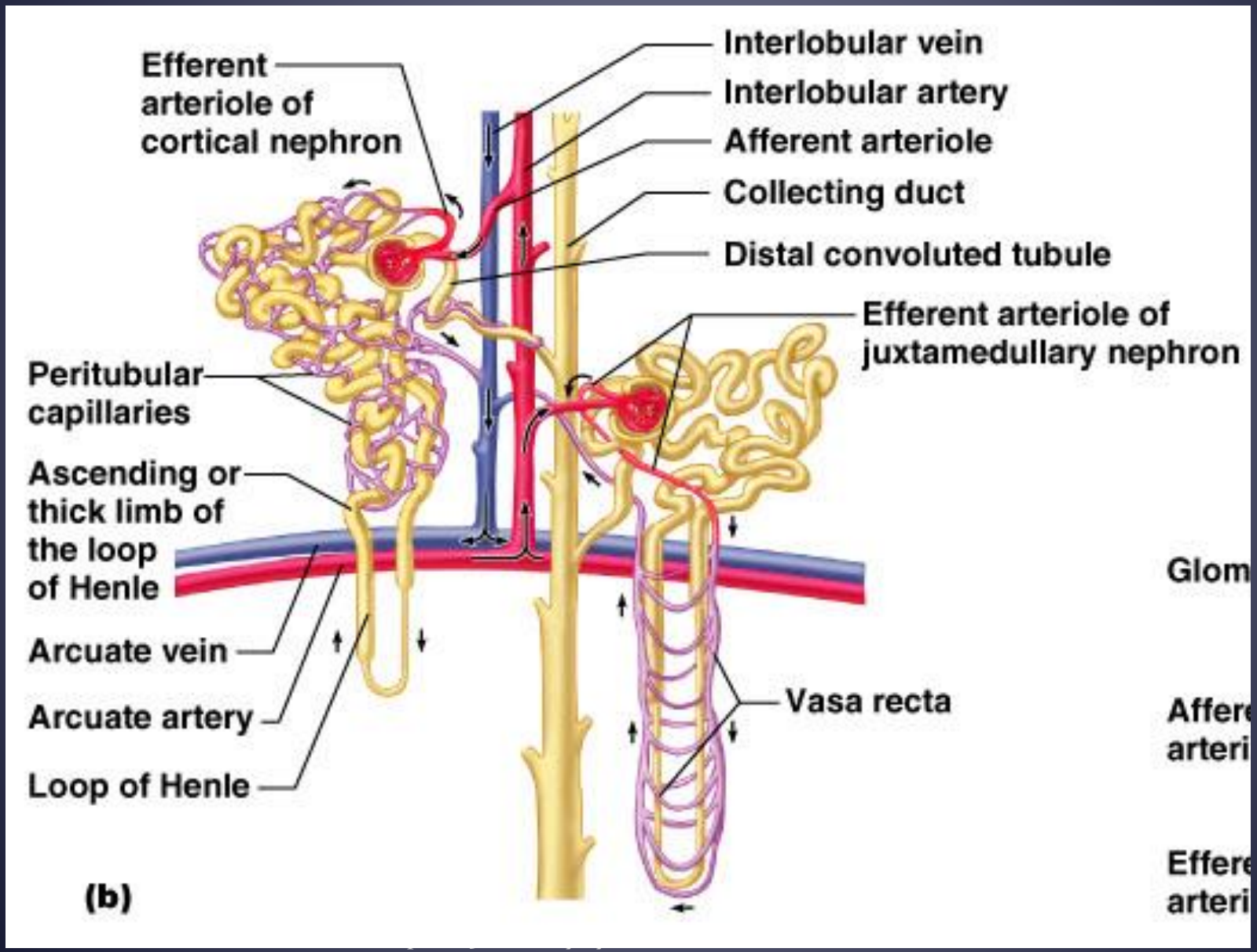
Three main mechanisms of urine formation

a. Glomerular filtration
b. Tubular reabsorption
c. Tubular secretion

Two major parts

1. A urine-forming nephron
2. A collecting duct which concentrates urine by removing water from it

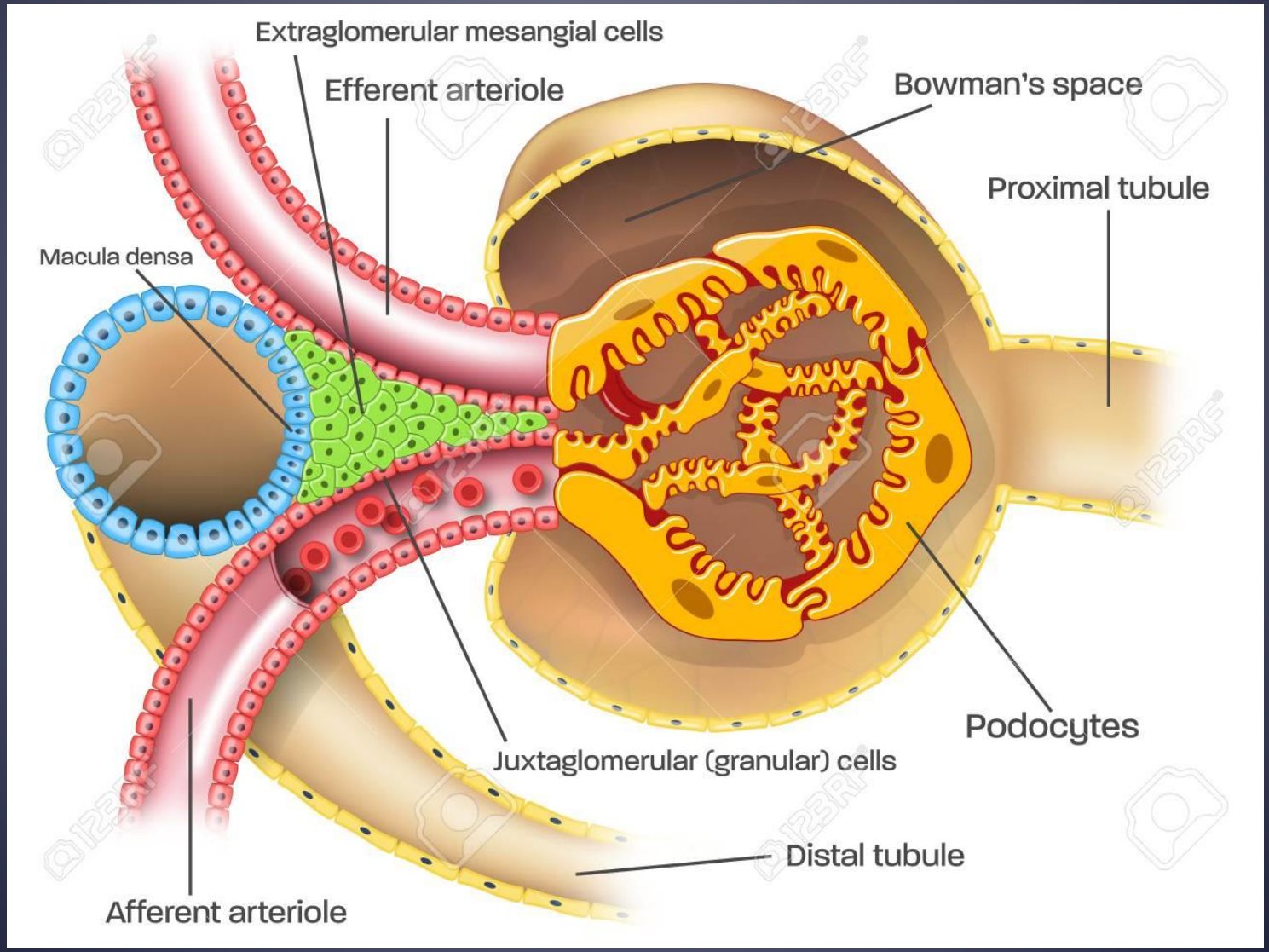
Nephron


Efferent arteriole of cortical nephron
Interlobular vein
Interlobular artery
Afferent arteriole
Collecting duct
Distal convoluted tubule
Efferent arteriole of juxtamedullary nephron
Peritubular capillaries
Ascending or thick limb of the loop of Henle
Arcuate vein
Arcuate artery
Loop of Henle
Vasa recta
(b)

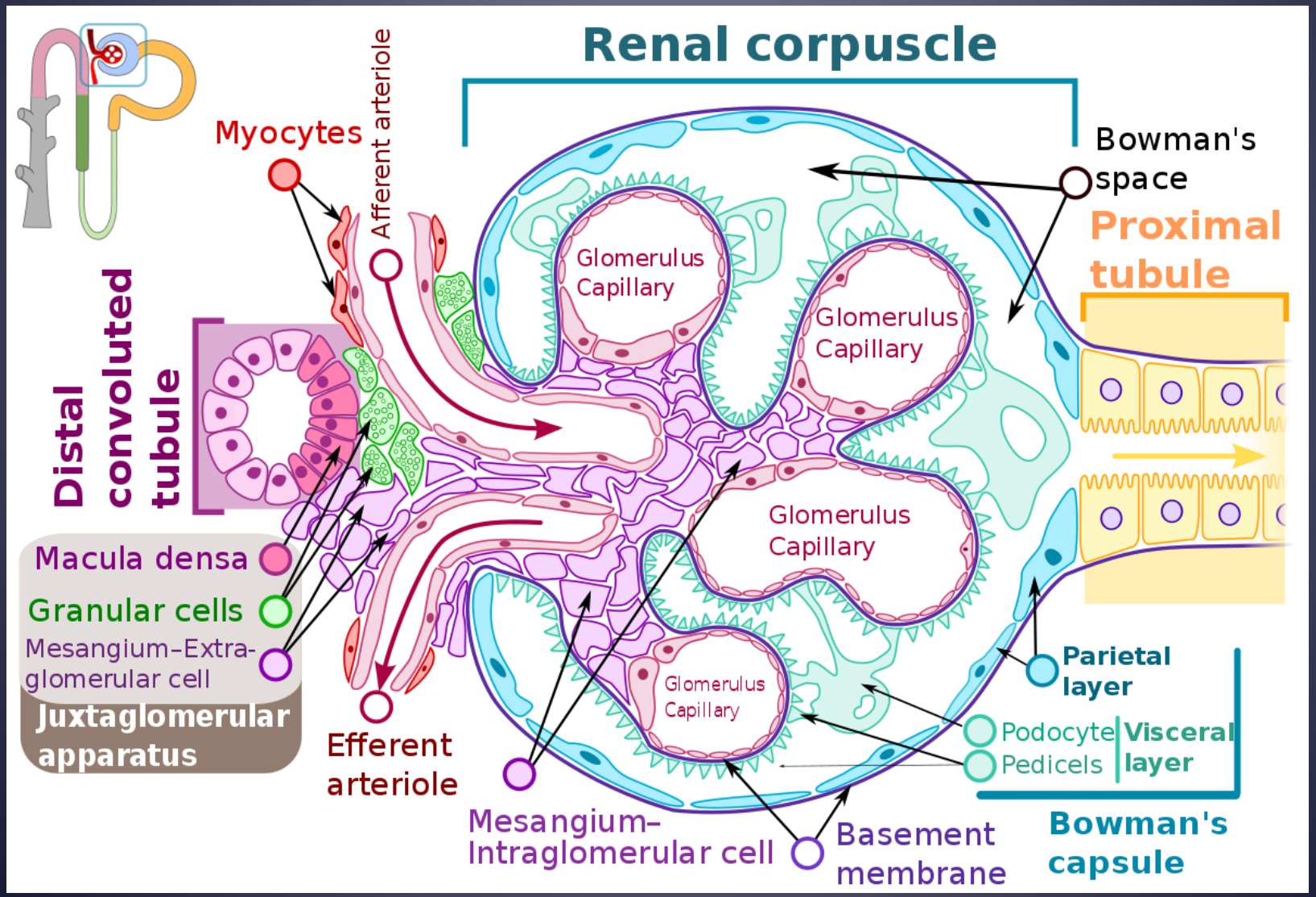
Juxtaglomerular apparatus of kidney

- The juxtaglomerular apparatus lies between the glomerulus and the distal convoluted tubule of the same nephron. This location is critical to its function in regulating renal blood flow and thus the glomerular filtration rate (GFR).
- The juxtaglomerular apparatus consists of three cell types: the **macula densa cells**, **the juxtaglomerular cells** and the **extraglomerular mesangial cells**.
- Because of its location in the nephron, it is highly sensitive to changes in volume as induced by various diuretic classes, and thus it is sensitive to changes in kidney perfusion pressure.
- Its main function is to regulate blood pressure and the filtration rate of the glomerulus. The macula densa is a collection of specialized epithelial cells in the distal convoluted tubule that detect sodium concentration of the fluid in the tubule. In response to elevated sodium, the macula densa cells trigger contraction of the afferent arteriole, reducing flow of blood to the glomerulus and the glomerular filtration rate. The juxtaglomerular cells, derived from smooth muscle cells, of the afferent arteriole secrete renin when blood pressure in the arteriole falls. Renin increases blood pressure via the renin-angiotensin-aldosterone system. Lacis cells, also called extraglomerular mesangial cells, are flat and elongated cells located near the macula densa.

Juxtaglomerular apparatus of kidney



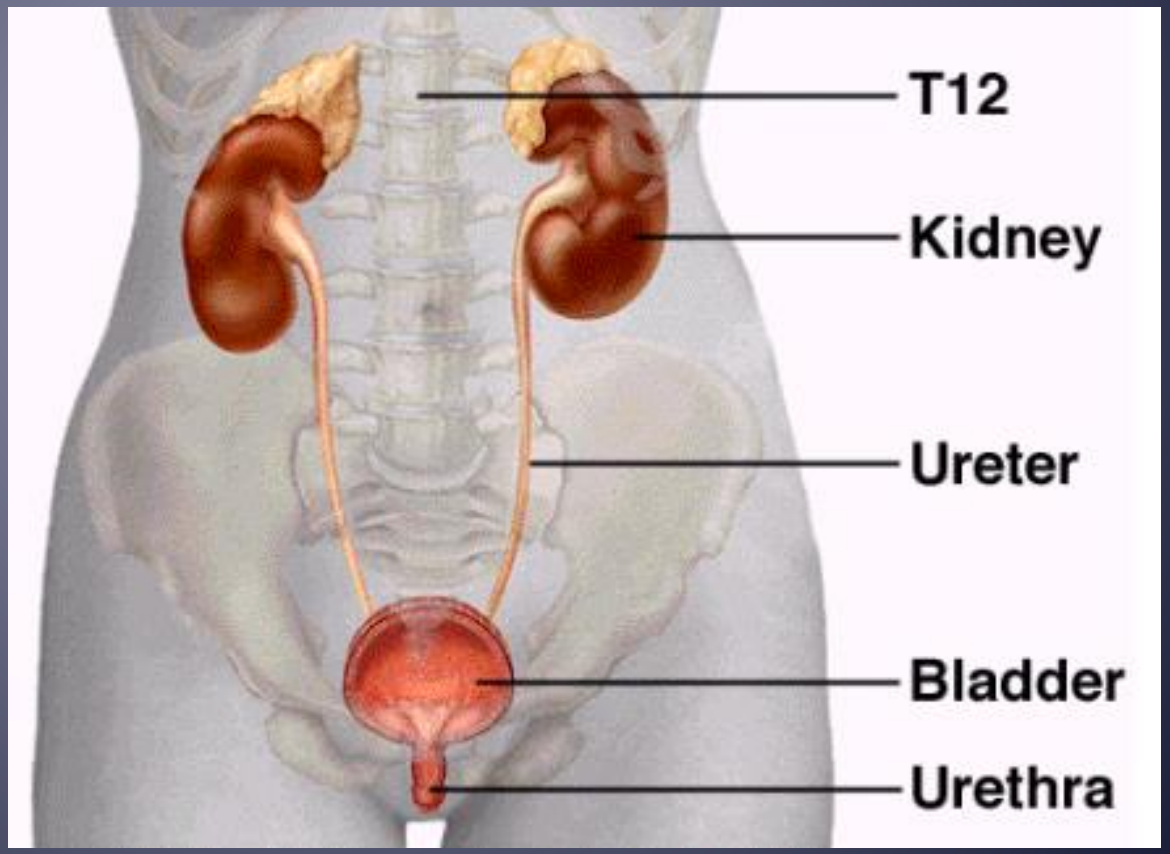
Juxtaglomerular apparatus of kidney



The Ureters

The ureters are muscular tubes leading urine from the renal pelvis to the urinary bladder.

Function:
Ureters actively propel urine to the bladder via response to smooth muscle stretch



Ureters

The ureter has three parts:

- abdominal ureter - from the renal pelvis to the pelvic brim
- pelvic ureter - from the pelvic brim to the bladder
- intravesical or intramural ureter - within the bladder wall

Ureters

Syntopy:

Abdominal ureter

- posteriorly - psoas muscle; genitofemoral nerve; common iliac vessels; tips of L2-L5 transverse processes
- anteriorly: right ureter - descending duodenum (D2); gonadal vessels; right colic vessels; ileocolic vessels
  left ureter - gonadal artery; left colic artery; loops of jejunum; sigmoid mesentery and colon
- Laterally : right ureter - IVC

Pelvic ureter

- posteriorly - sacroiliac joint, internal iliac artery
- Inferiorly: male - seminal vesicle
  female - lateral fornix of the vagina
- anteriorly : male - ductus deferens
  female - uterine artery (in the broad ligament)
- Laterally: female - cervix

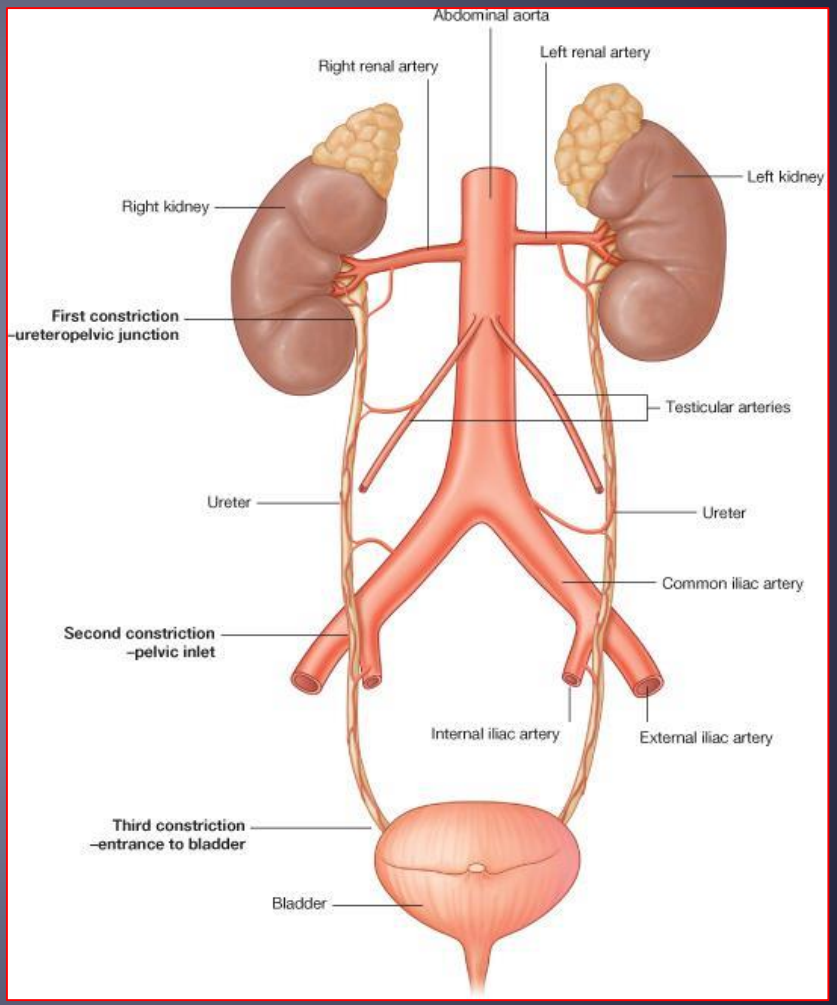
Ureters

Constrictions

(sites of obstruction and stone impaction)

The ureter has a diameter of 3mm, but there are three constrictions:

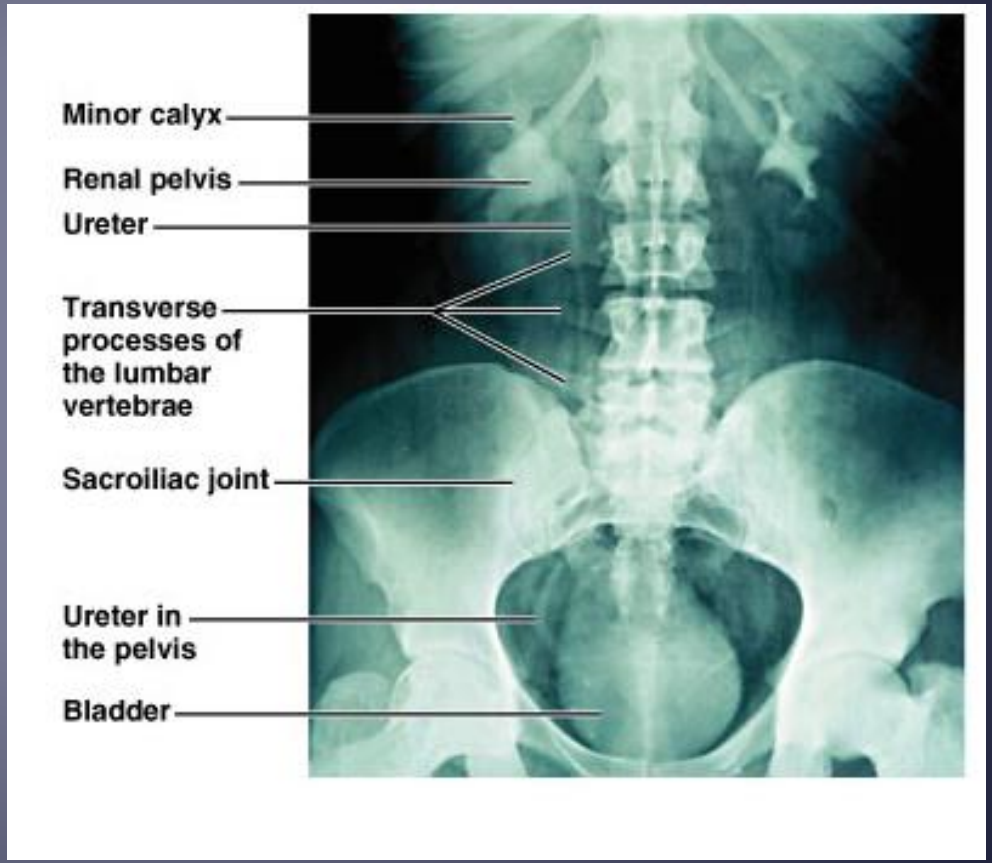
- at the pelvi-ureteric junction (PUJ) of the renal pelvis and the ureter
- as the ureter enters the pelvis and cross over the common iliac artery bifurcation
- at the vesicoureteric junction (VUJ) as the ureter enters the bladder wall



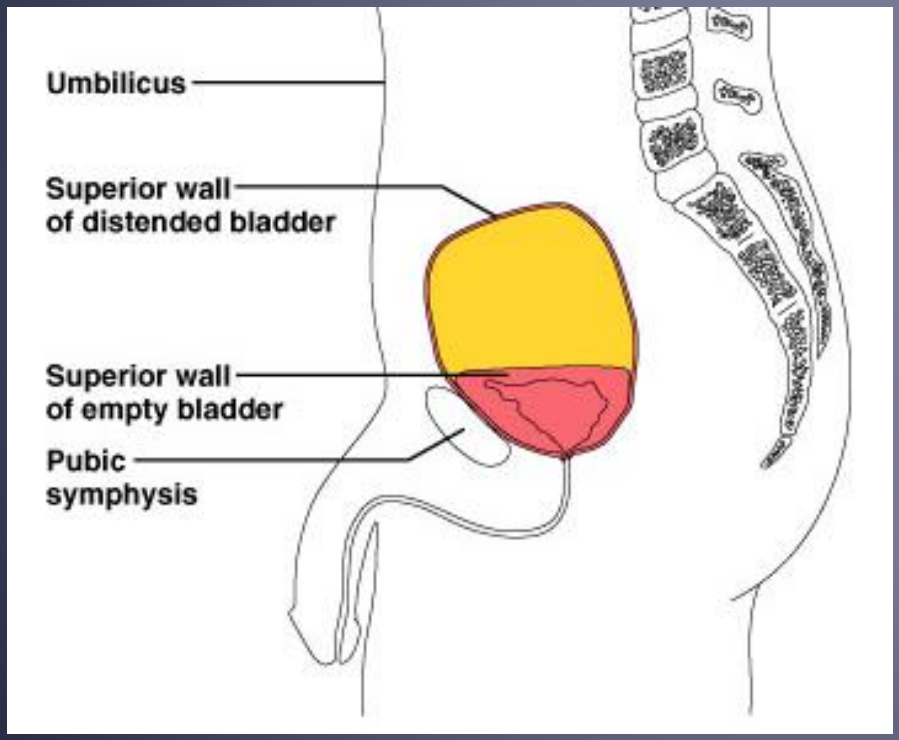
Ureters=Мочеточник

Ureters have a threecoats wall

- Transitional epithelial mucosa
- Smooth muscle muscularis
- Fibrous connective tissue (adventitia)



Urinary Bladder = Cystis = Мочевой пузырь

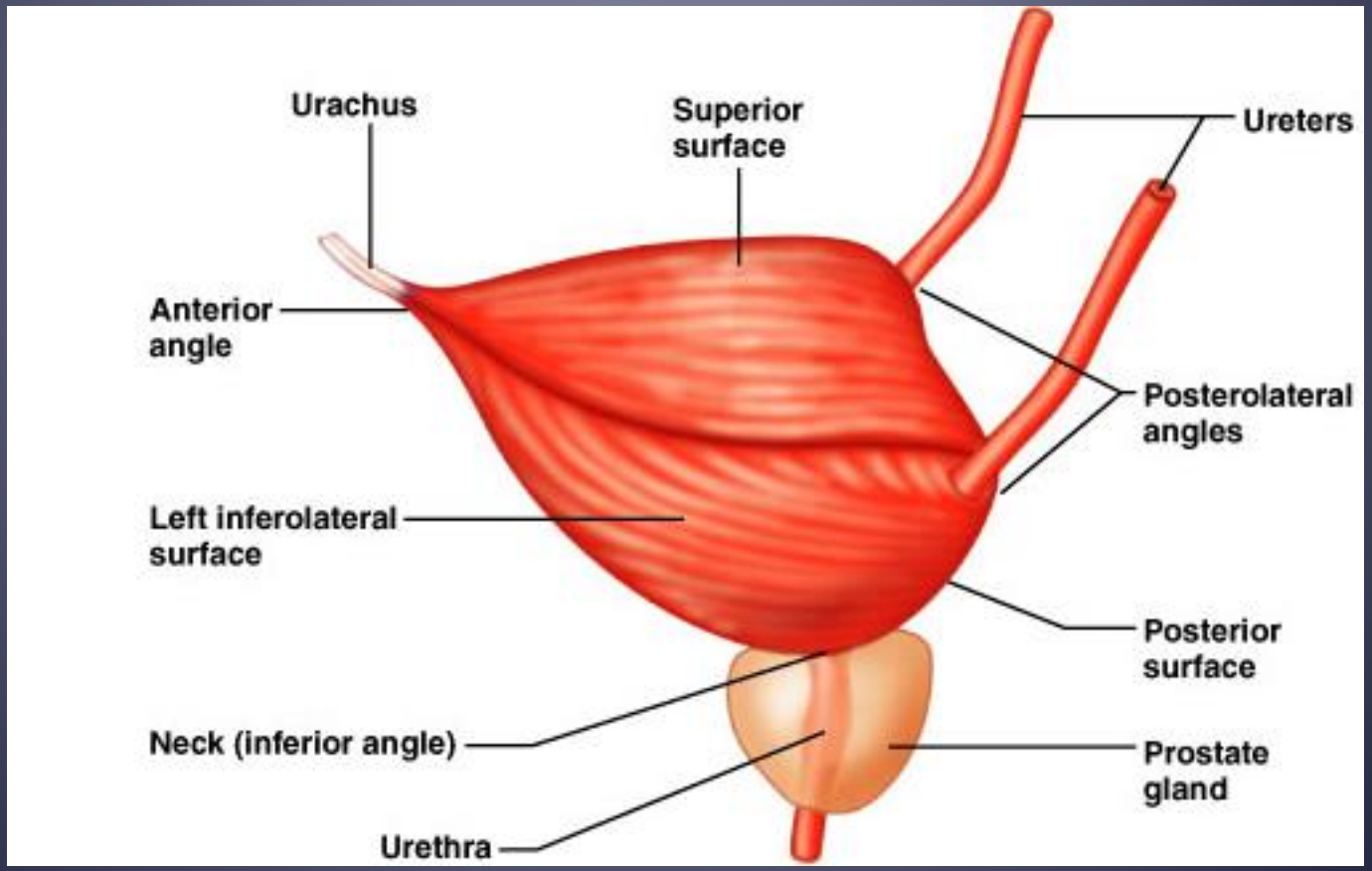


- Collapsible muscular sac
- Stores and expels urine
- Lies on pelvic floor posterior to pubic symphysis
  - Males: anterior to rectum
  - Females: just anterior to the vagina and uterus

The bladder has three openings: two for the ureters and one for the urethra.

Urinary Bladder

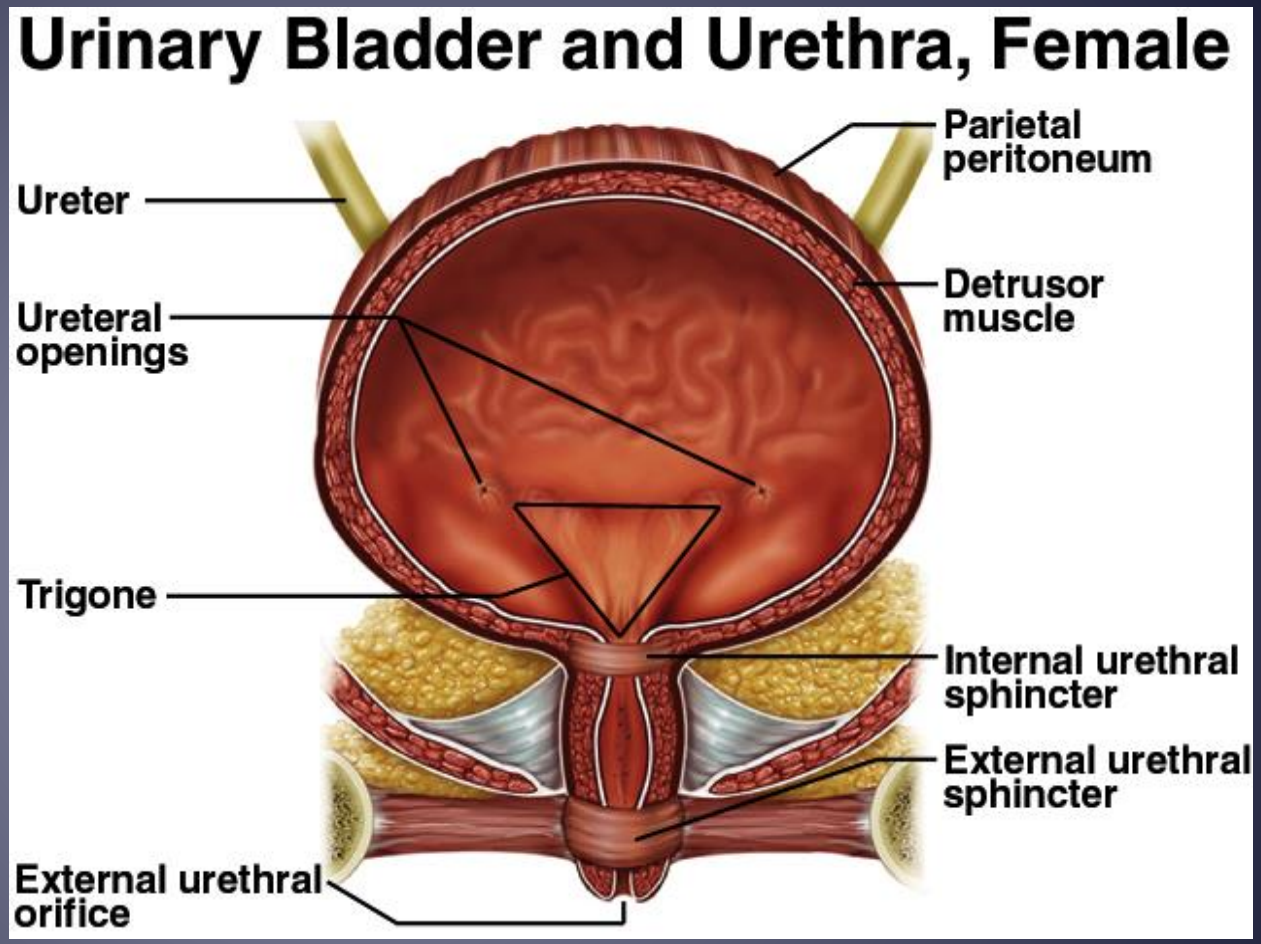
has an apex, a body and a fundus



Urinary Bladder

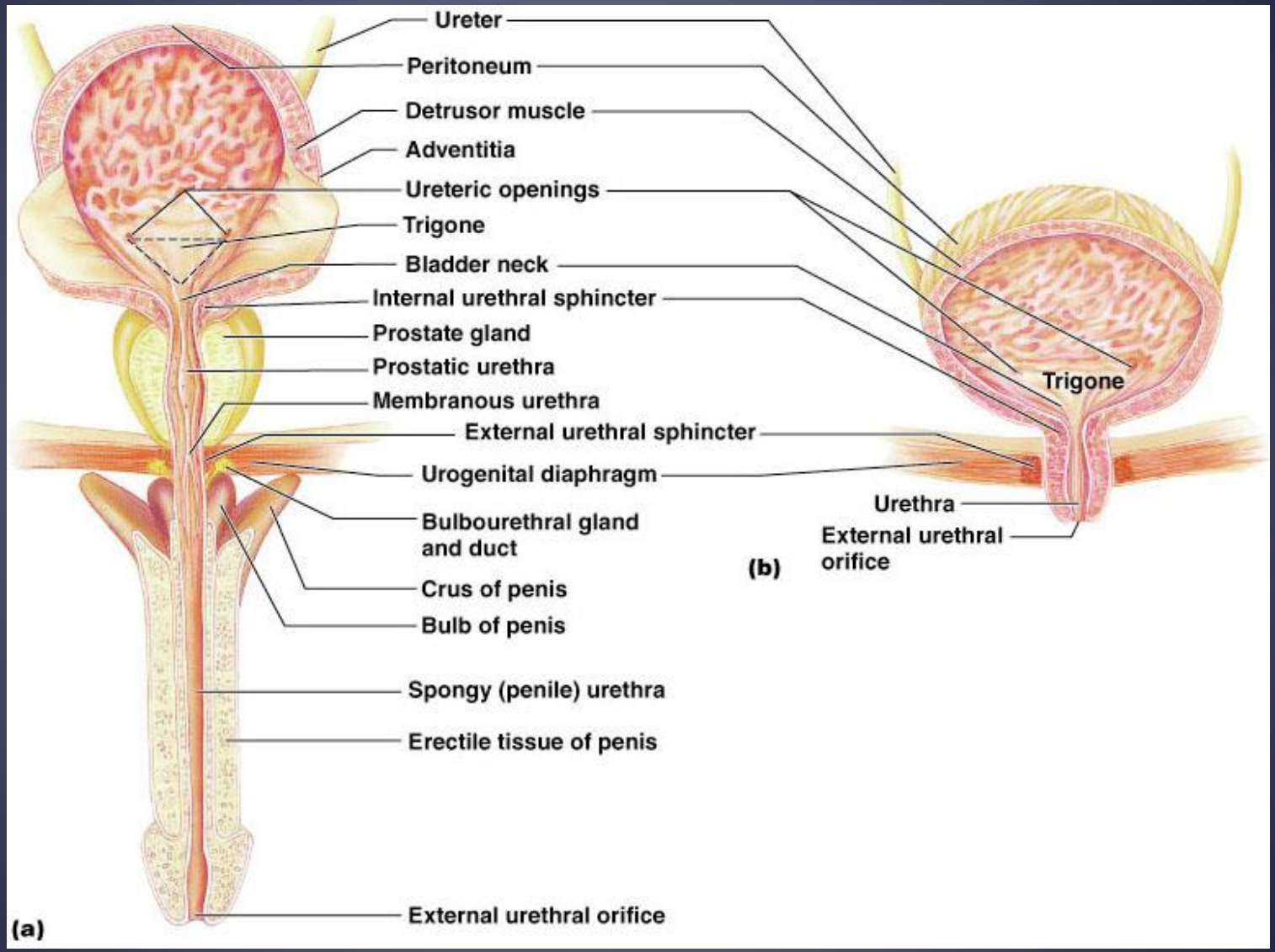
Internal structure.

The urinary bladder is a hollow tubular organ. Therefore it's wall consists of three coats.



NB! There is a triangular area, called the trigone, formed by three openings in the floor of the urinary bladder.

Urinary Bladder



Sexual distinctions

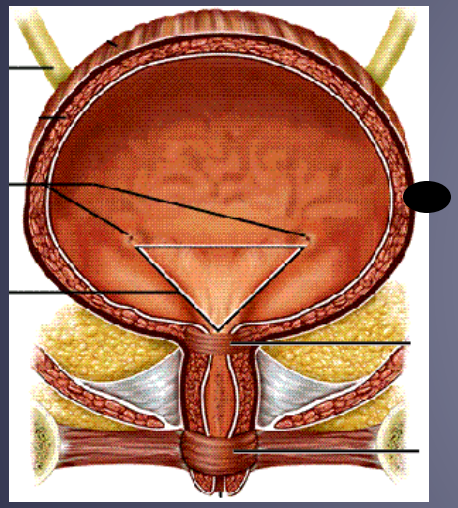
Urethra

The **urethra** **is the tube** through which urine passes from the bladder to the exterior of the body.

The **wall** of an urethra consists of usual layers.

Urethra

The male and female urethras differ slightly in length and morphology.



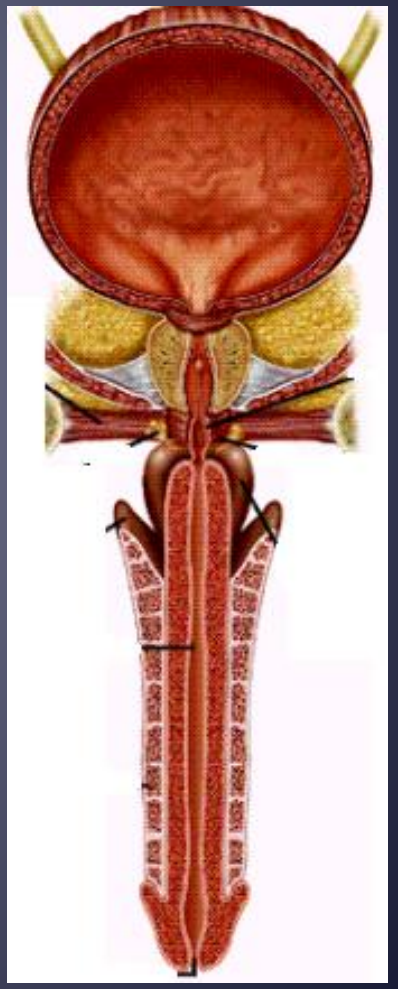
Females

3-4 cm

greater risk of urinary tract infections

Male

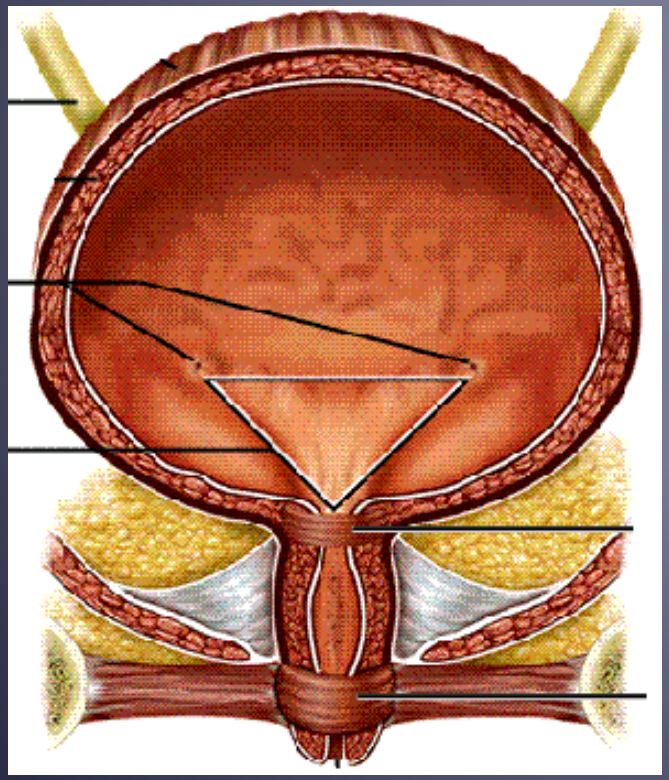
~18 cm



Urethra

In both sexes:

- internal urethral sphincter- under involuntary control.
- external urethral sphincter - under voluntary control



internal urethral sphincter

external urethral sphincter

Urethra

- The female urethra is tightly bound to the anterior vaginal wall
- Its external opening lies anterior to the vaginal opening and posterior to the clitoris

the Urinary System
Resume

- The urinary system rids the body of waste materials, regulates fluid volume, maintains electrolyte concentrations in body fluids, controls blood pH, secretes erythropoietin, and renin.
- The components of the urinary system are the kidneys, ureters, urinary bladder, and urethra.
- The primary organs of the urinary system are the kidneys, which are located retroperitoneally between the levels of the twelfth thoracic and third lumbar vertebrae.
- The cortex and medulla make up the parenchyma of the kidney.
- The central region of the kidney is the renal pelvis, which collects the urine as it is produced.
- The functional unit of the kidney is a nephron, which consists of a renal corpuscle and a renal tubule.
- The ureters transport urine from the kidney to the urinary bladder.
- The urinary bladder is a temporary storage reservoir for urine.
- The urethra is the final passageway for the flow of urine.
- The flow of urine through the urethra is controlled by an involuntary internal urethral sphincter and voluntary external urethral sphincter.

The retroperitoneal space (retroperitoneum) = Забрюшинное пространство

The retroperitoneal space (retroperitoneum) is the anatomical space (sometimes a potential space) in the abdominal cavity behind (retro) the peritoneum.

It has no specific delineating anatomical structures. Organs are retroperitoneal if they have peritoneum on their anterior side only.

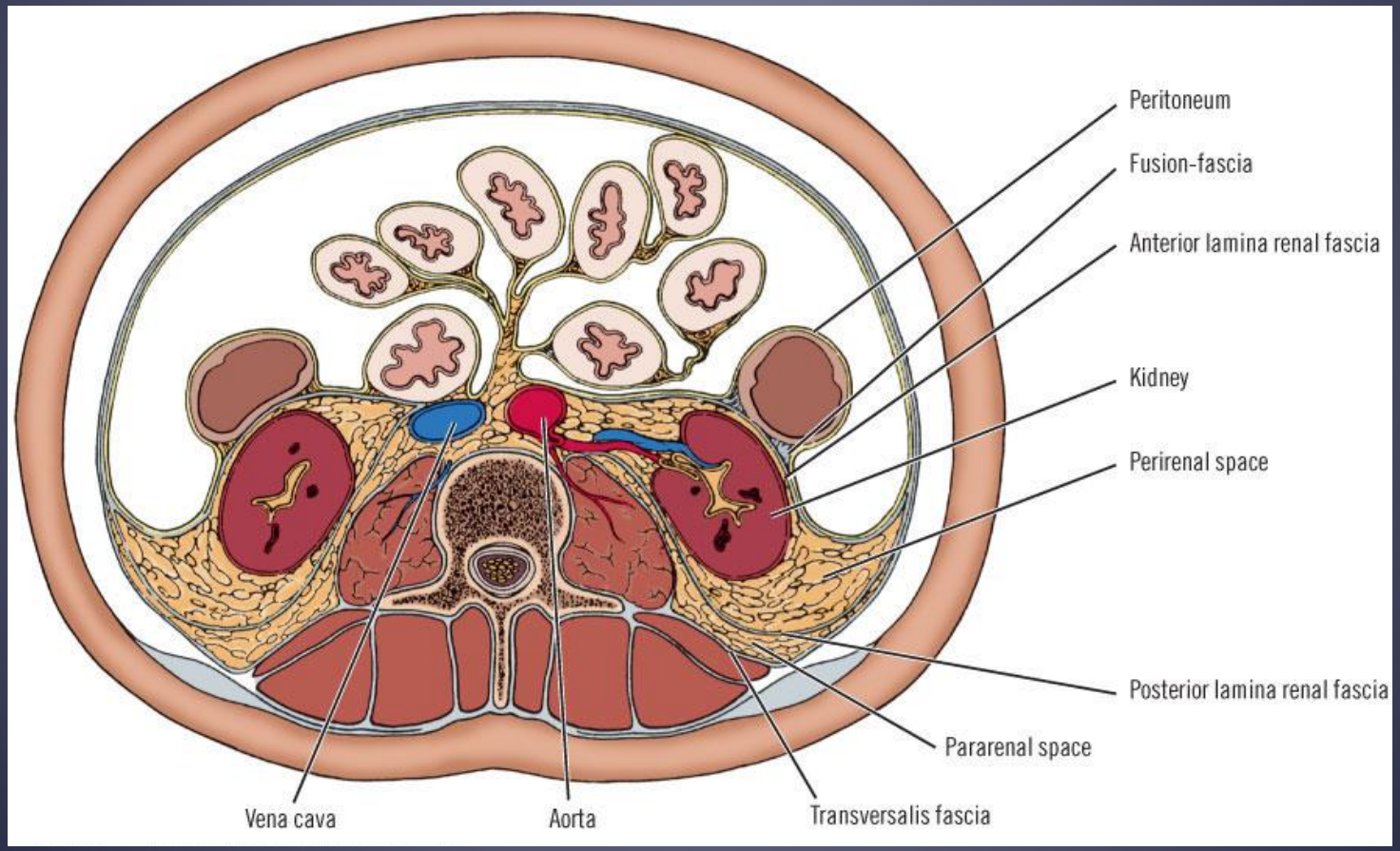
The retroperitoneal space (retroperitoneum) = Забрюшинное пространство

- It extends from the 12th thoracic vertebra and 12th rib above to the sacrum and iliac crest below.

The **retroperitoneum** can be further subdivided into the following:

- -Perirenal space (**paranephros**)
- -Anterior pararenal space
- -Posterior pararenal space

The retroperitoneal space (retroperitoneum) = Забрюшинное пространство



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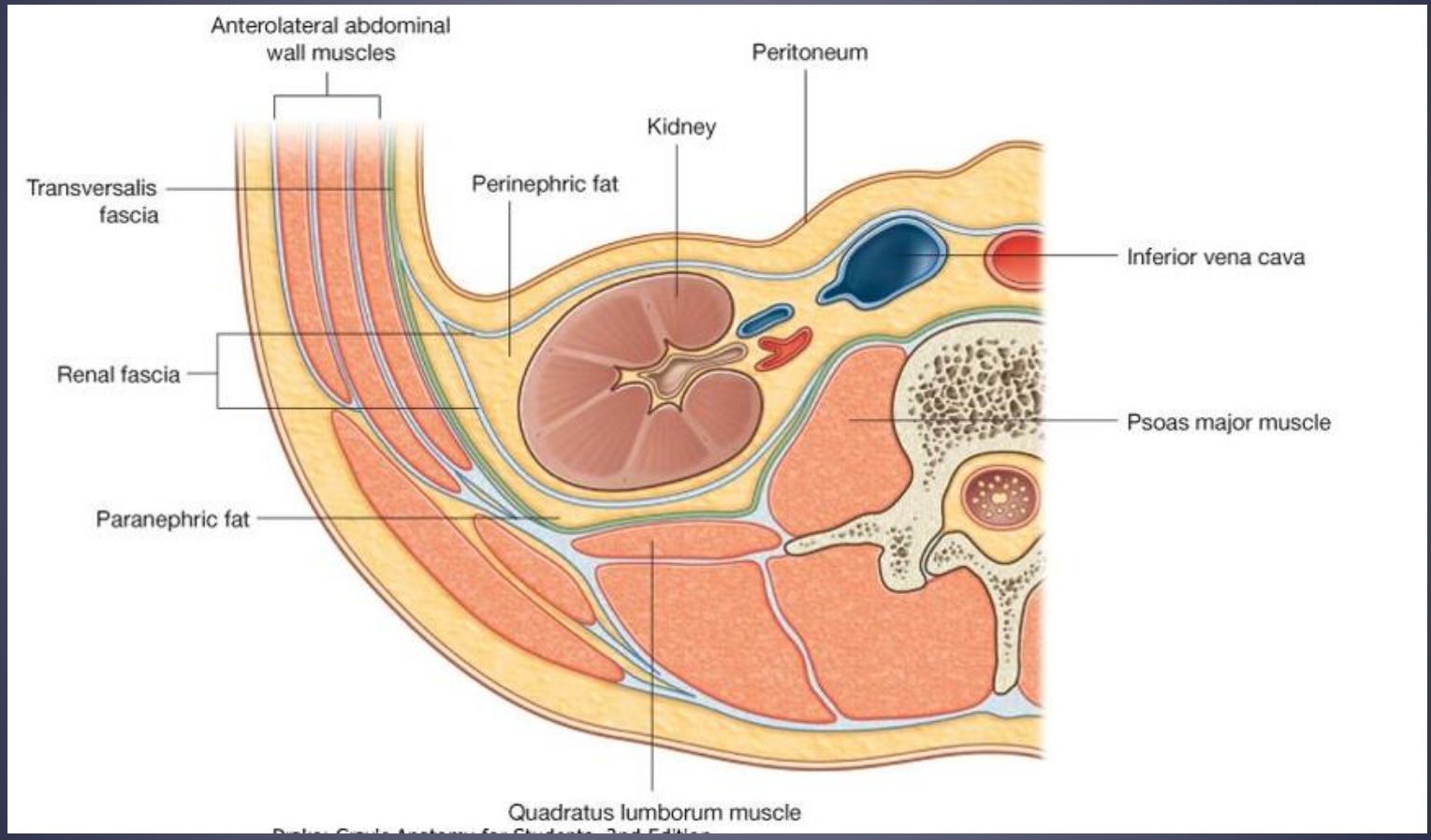

The retroperitoneal space (retroperitoneum) = Забрюшинное пространство

Retroperitoneal organs are

- -urinary bladder
- -adrenal glands
- -kidneys
- -ureter
- -aorta
- -inferior vena cava
- -rectum (part, lower third is extraperitoneal)
- -the head, neck, and body of the pancreas
- -the duodenum, except for the proximal first segment, which is intraperitoneal

Thank you for your attention!