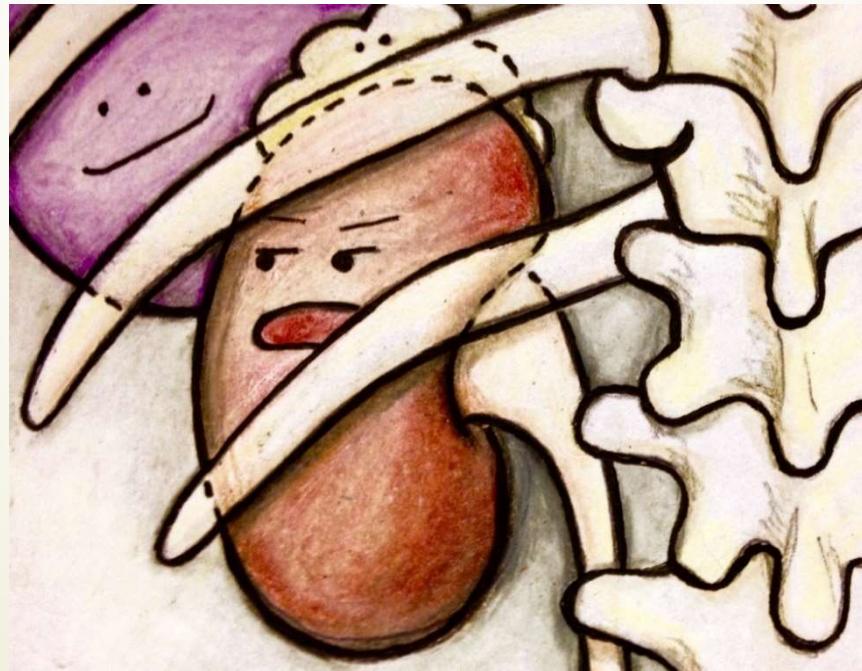




# Urinary System

Dr. Ahmed Salman

Assistant professor of anatomy & embryology





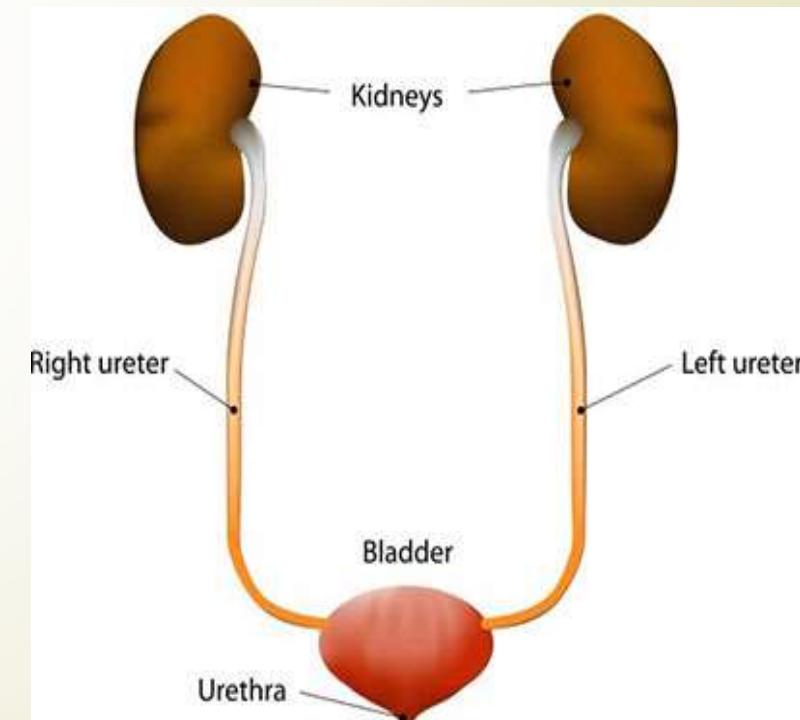
Dr Ahmed Salman



The urinary system is composed of two kidneys ,two ureters ,urinary bladder and urethra

The main function is

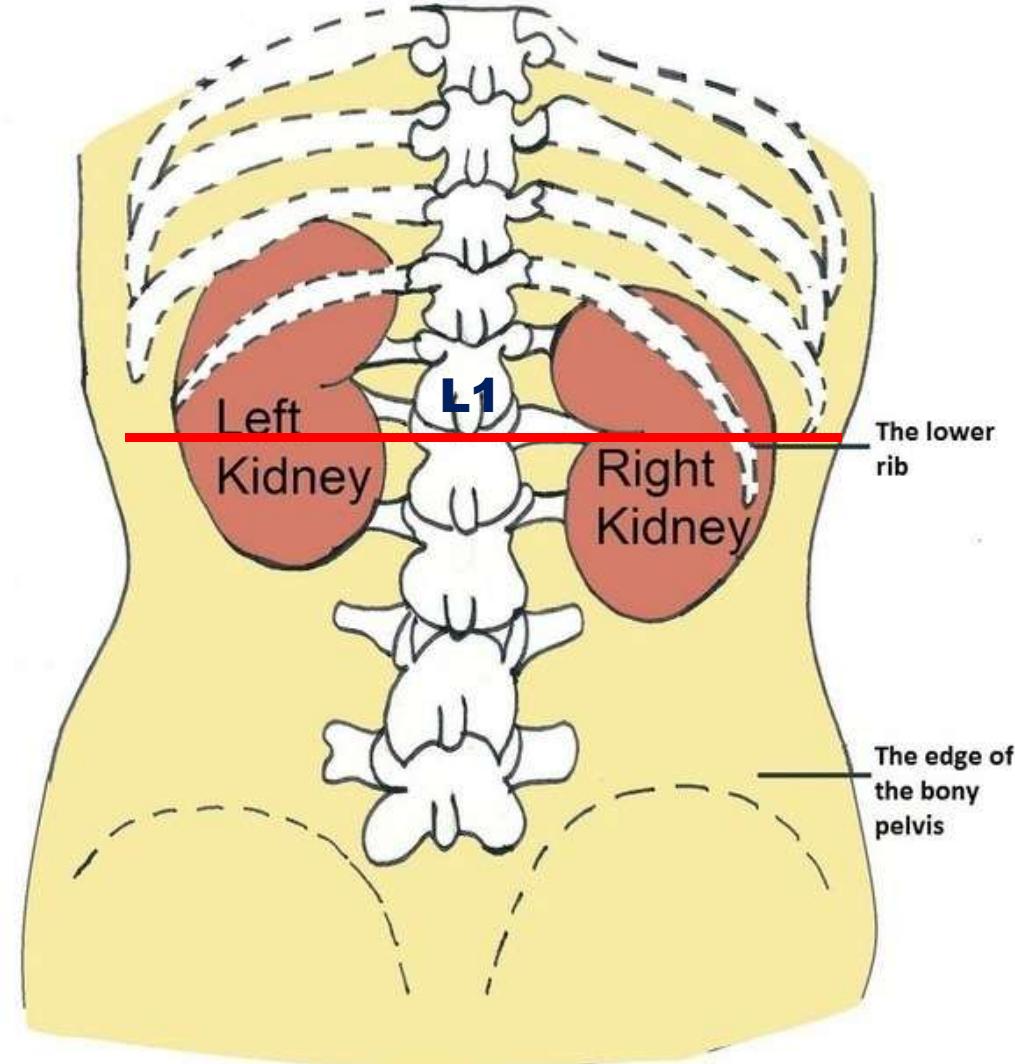
- Excrete most of the waste products of metabolism.
- Control the water and electrolyte balance within the body .
- Maintain the acid-base balance of the blood.



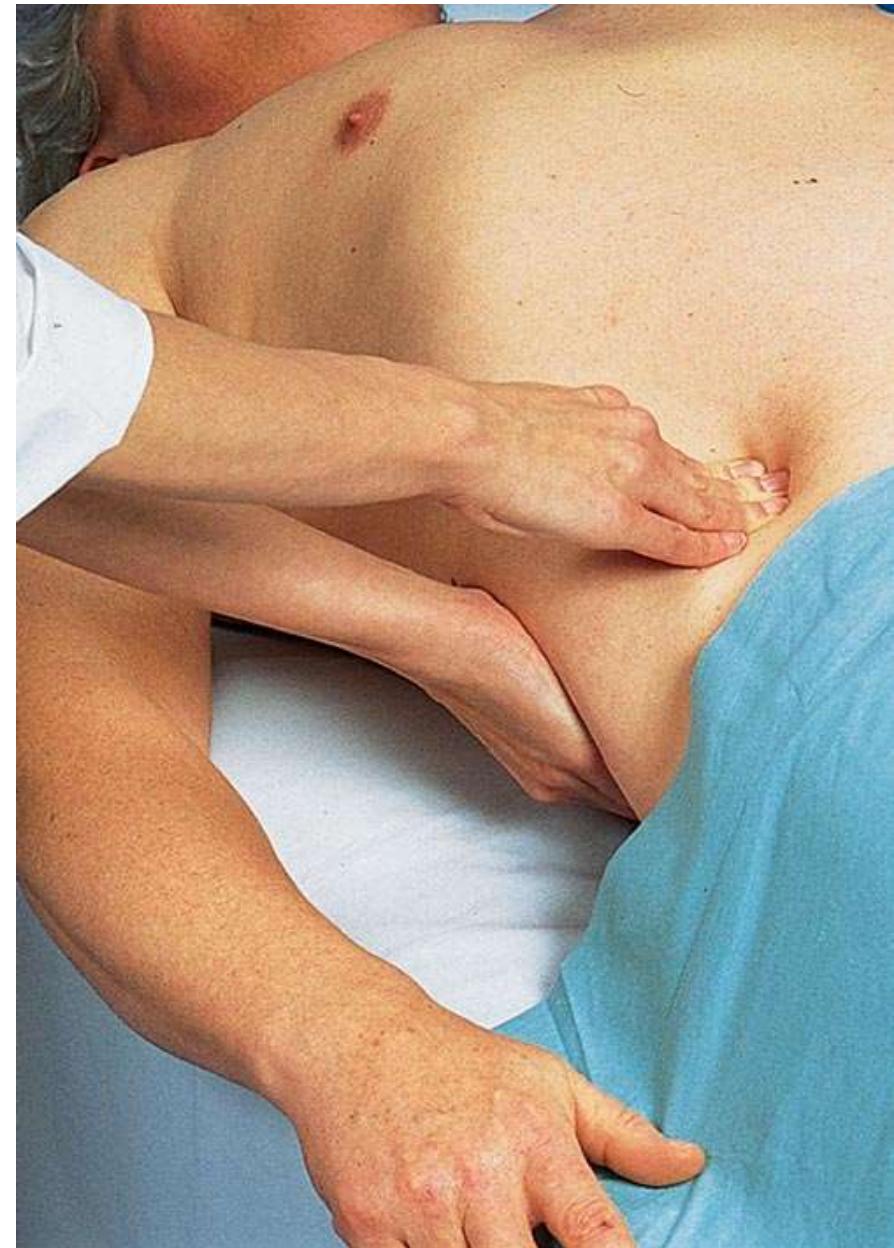
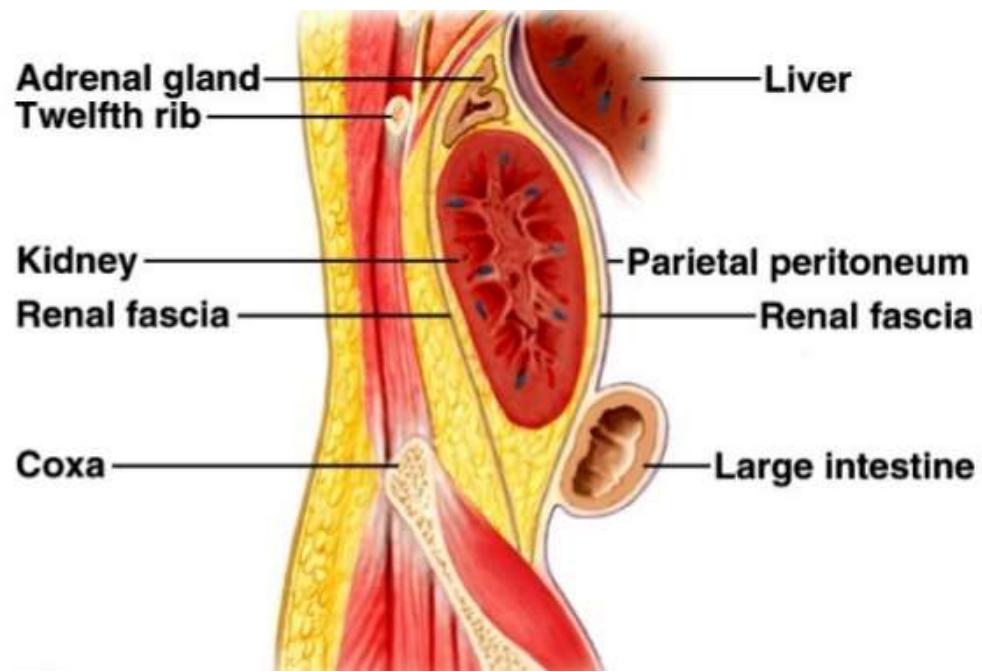
# Kidneys

## Location:

- The kidneys are retroperitoneal organs, on the posterior abdominal wall .
- They are located at paravertebral gutters opposite T12, L1, L2, L3 vertebrae.
- The right kidney is about 1.25 cm lower than the left.
- The upper pole of the **right kidney** reaches the 12th rib and that of **left kidney** reaches 11th rib.
- The hilum of right kidney is just below transpyloric plane (L1), and that of the left kidney is just above it.



- Kidneys Can be palpated in thin people ,By press between 11<sup>th</sup> and 12<sup>th</sup> ribs and iliac crest (posteriorly) and below costal margin (anteriorly)



## General Features of the Kidneys:

The kidneys has :-

- **Two poles** (upper and lower)

The upper pole is nearer to the midline than the lower pole.

The inferior pole of right kidney is about one finger breadth above iliac crest

- **Two borders** (lateral and medial).

The lateral border is smooth and **convex**

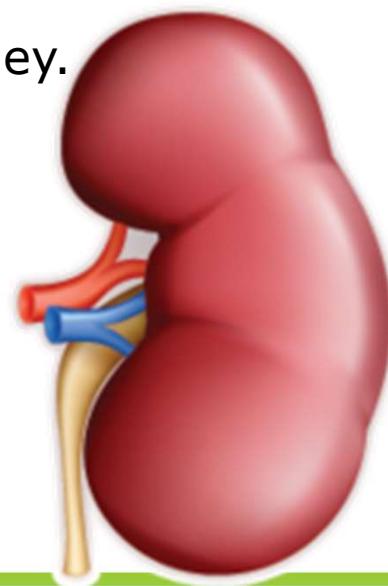
the medial is concave and presents a **hilum** at its middle.

The hilum leads to a space within the kidney, called the **sinus** of the kidney.

The structures passes through the hilum are renal vein, renal artery, renal pelvis.

The renal vein is most anterior and renal pelvis is most posterior.

- **Two surfaces** (anterior and posterior).



## Coverings of the kidney :-

From the cortex outwards

**1- Fibrous capsule:** surrounds the kidney all around

**2- The perirenal fat:** surrounds the kidney all around

**3- Renal fascia:** it is formed of 2 layers which cover the front and back of the kidneys.

### The renal fascia is continuous

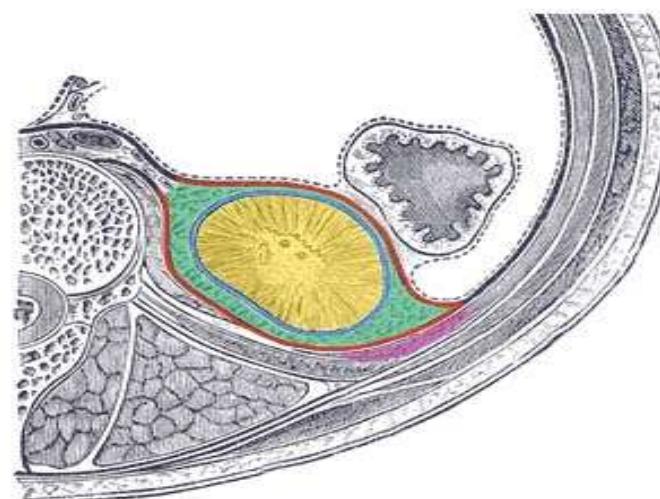
**Laterally** with fascia transversalis,

**Medially** with the fascia around the renal vessels, aorta and IVC.

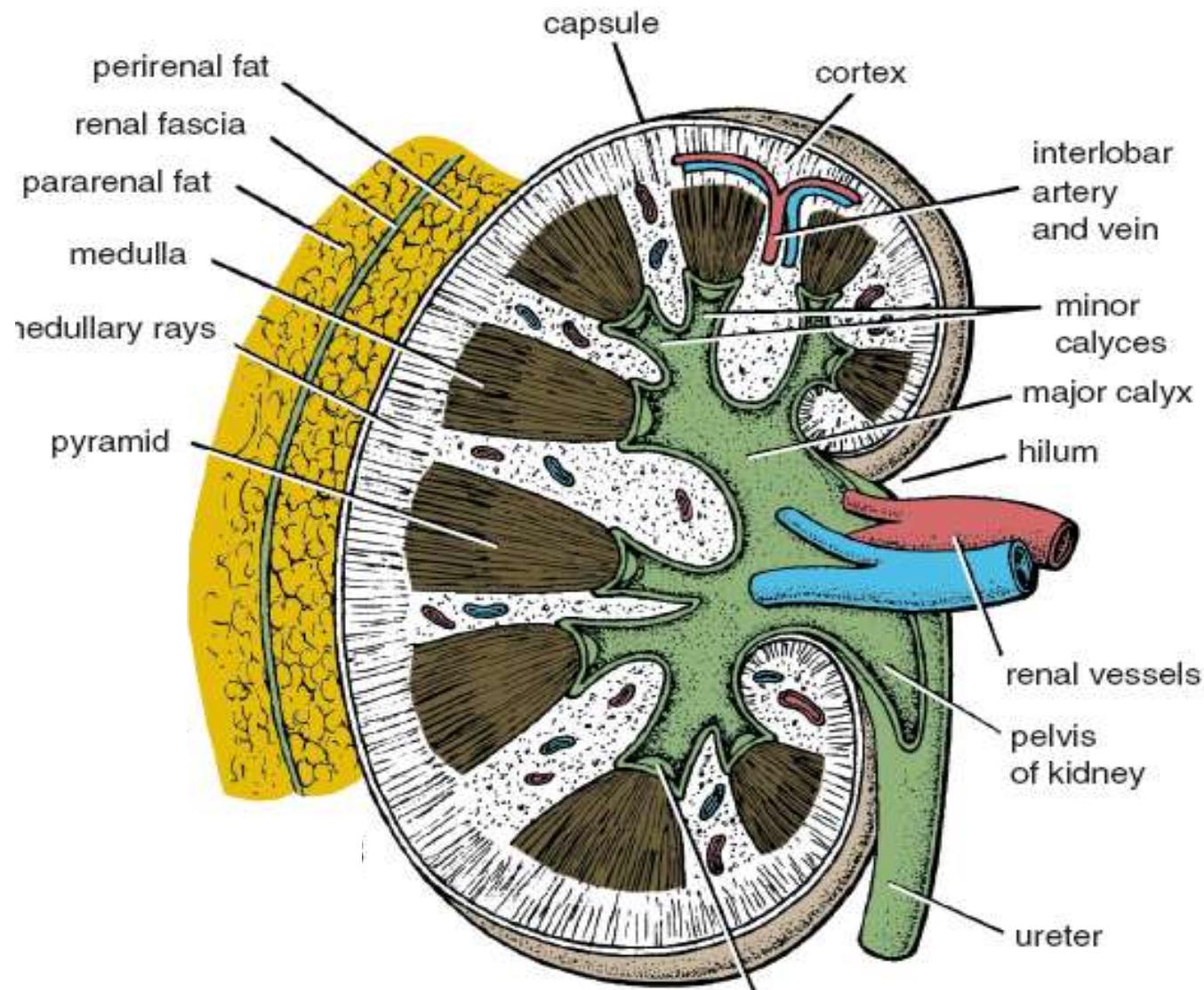
**Superiorly** with the diaphragmatic fascia after forming a separate compartment for the suprarenal gland.

**Inferiorly** it remains separate in front and back of the ureter.

**4- Pararenal fat :** outside the renal fascia, most condensed **posterior** to the kidney



- █ Kidney
- █ Renal capsule
- █ Perirenal fat
- █ Renal fascia
- █ Pararenal fat

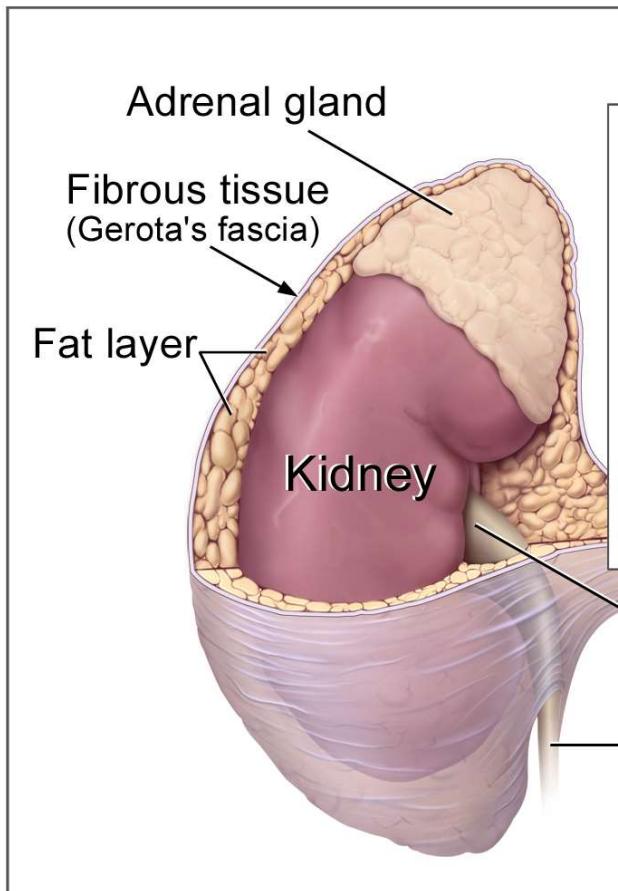
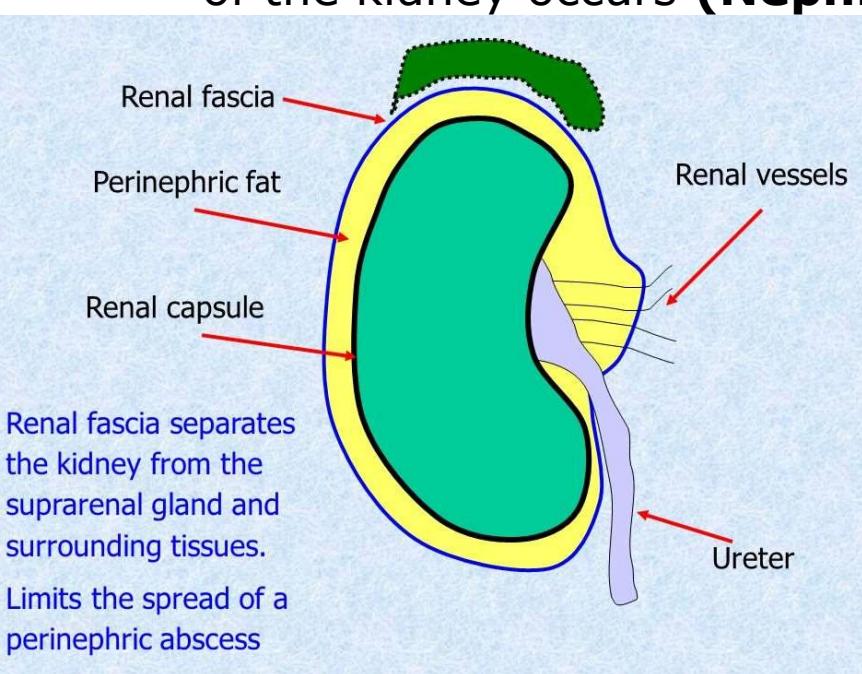


## Supporting factors of the kidney :-

The kidney is kept in situ by

- Adjacent organs
- Abdominal pressure
- Perirenal fat
- Renal Fascia
- Pararenal fat
- Renal Blood vessels and ureters

If the fat absorbed, as in rapid weight loss, descent of the kidney occurs (**Nephroptosis**).



### **Clinical notes :**

**Nephroptosis** cause intermittent pain in the renal region, relieved by lying down.

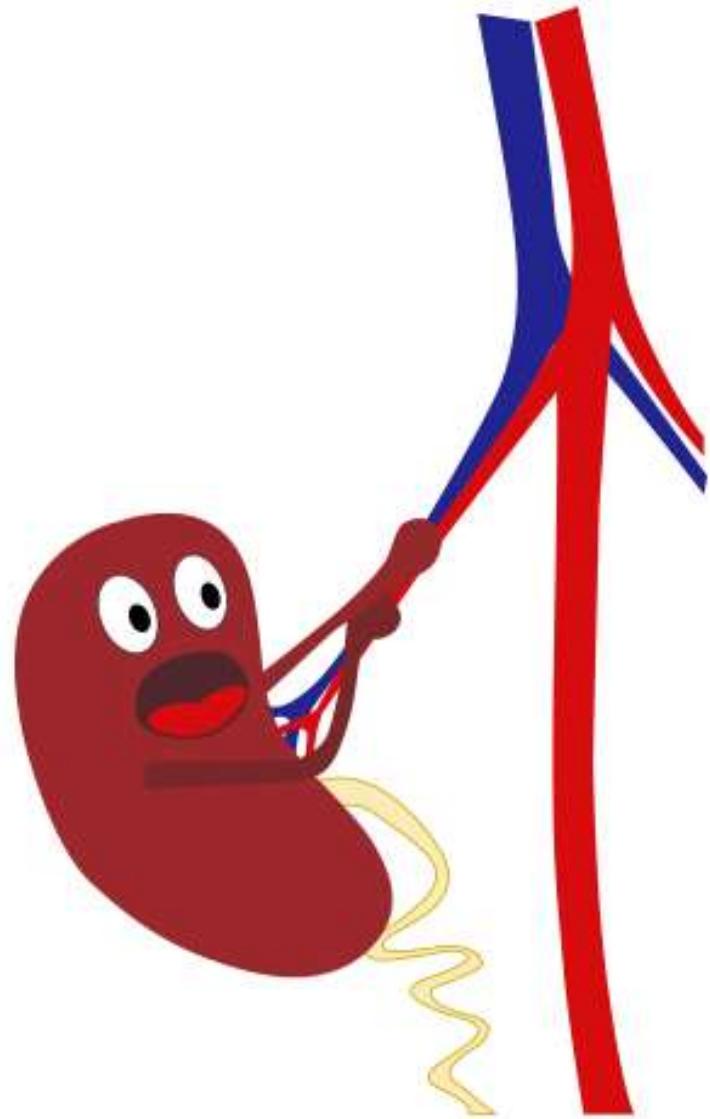
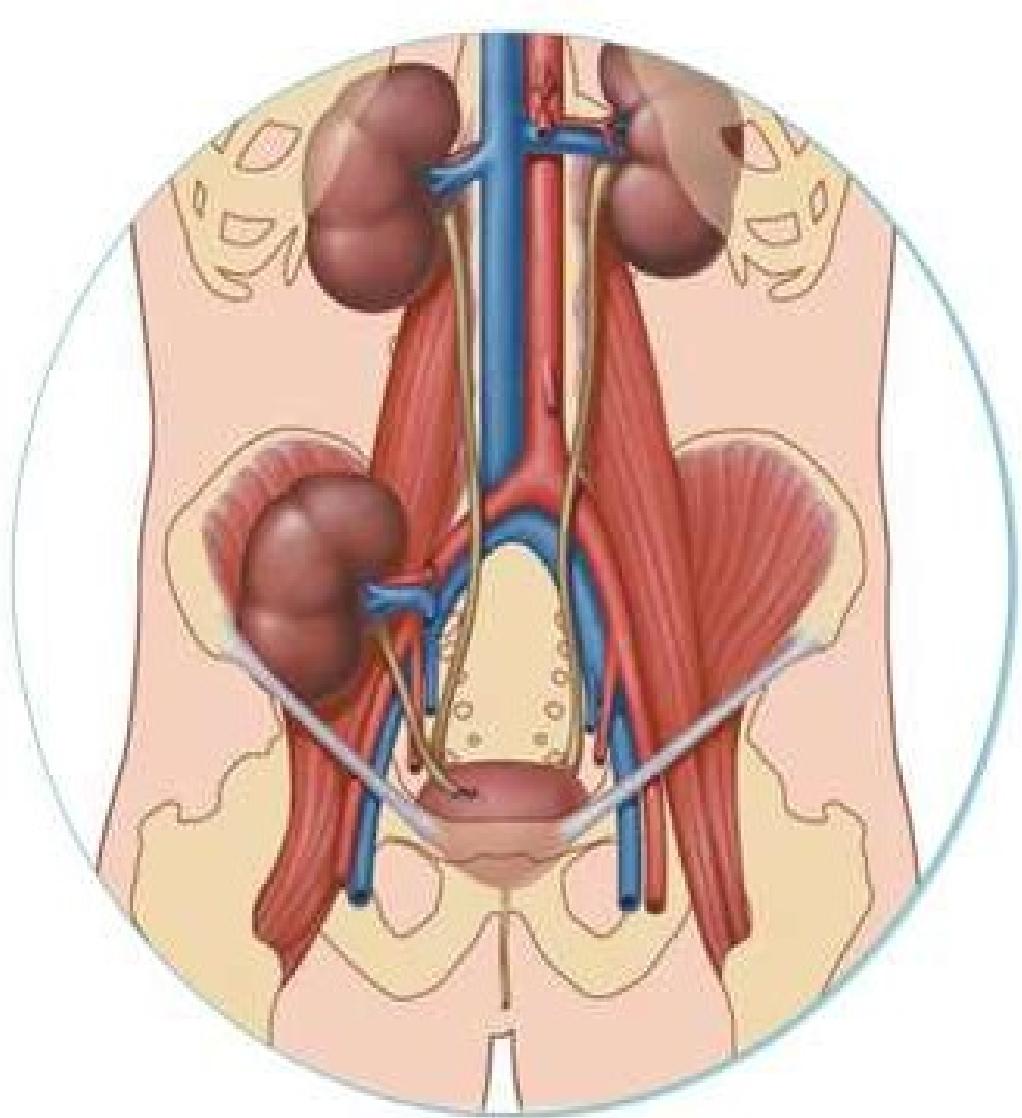
This pain as result of traction on the renal vessels.

### **Kidneys Transplantation**

The site of renal transplantation is the iliac fossa of the greater pelvis ,due to lack of inferior support for the kidneys in the lumbar region

### **Perinephric Abscess** (pus around the kidney)

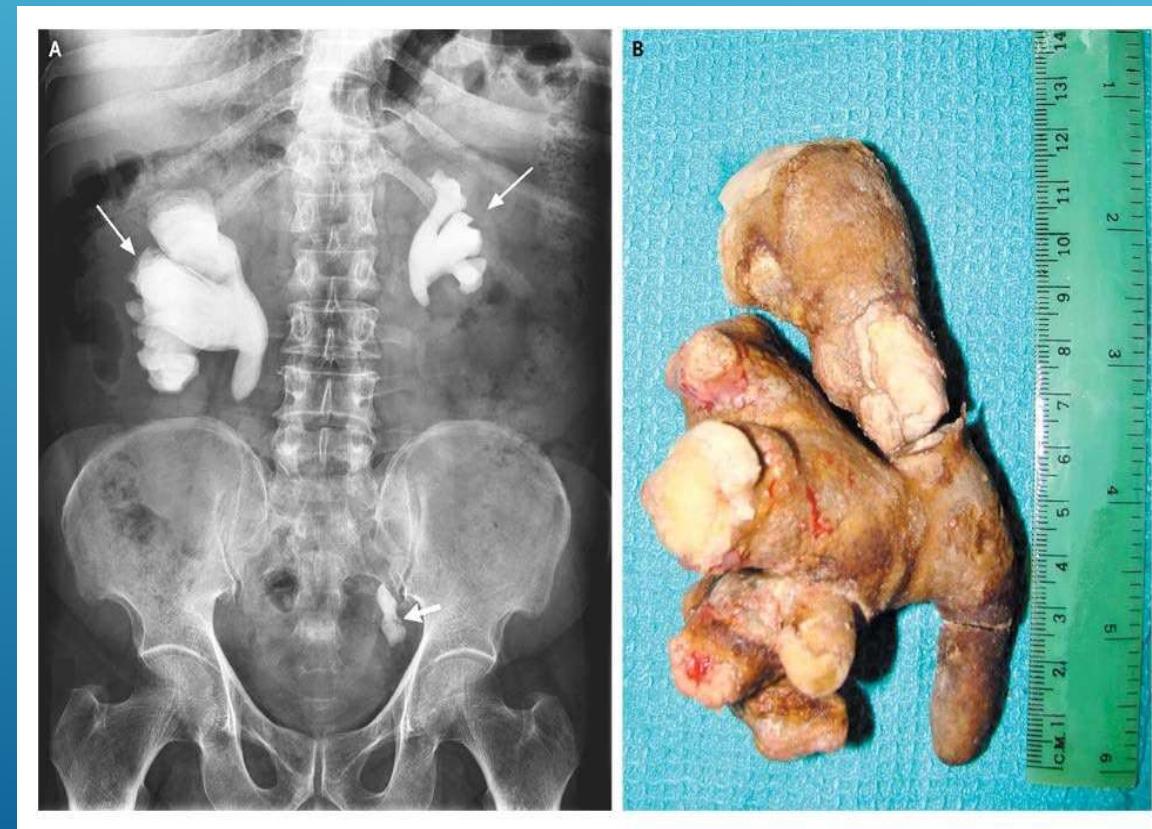
- The attachments of the renal fascia to the renal vessels and ureter, usually preventing the spread of pus to the contralateral side.
- Pus from an abscess (or blood from an injured kidney) may spread into the pelvis between the loosely attached anterior and posterior layers of the renal fascia.

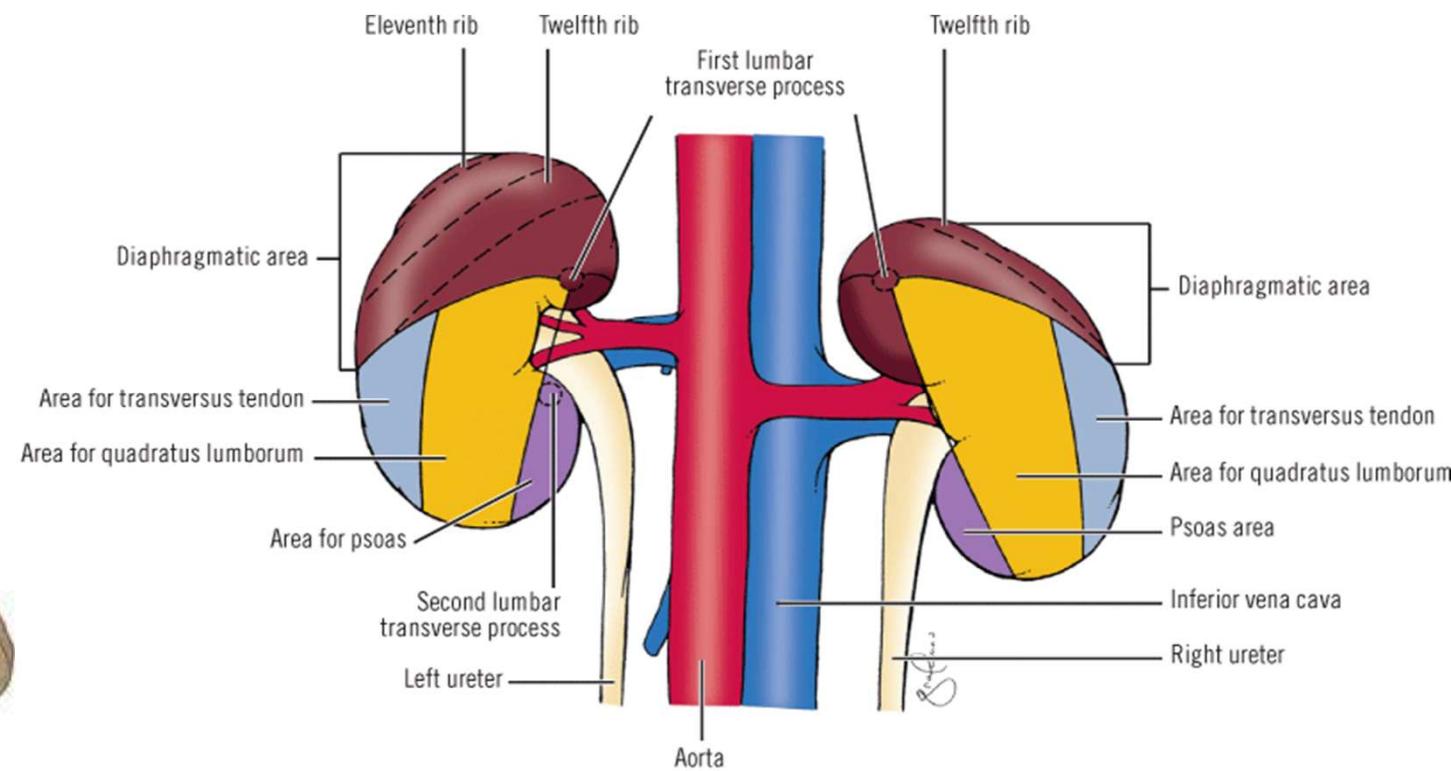
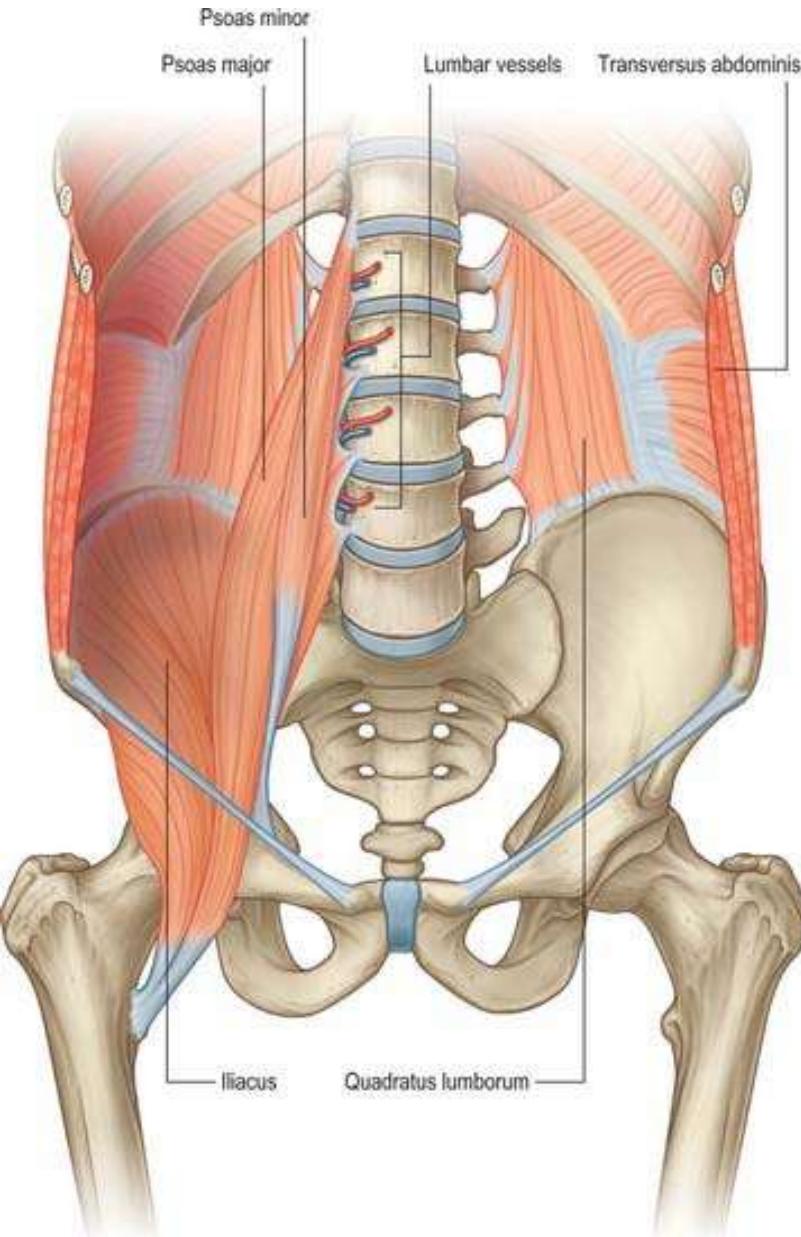


**Bushra ,25 years old married female, complaining of severe renal colic. X-ray and ultrasonography revealed staghorn renal stone.**

**1- What the structures may be cut off during surgical removal of this stone ?**

**2- After the operation her husband asked the doctor when she can drink and eat ?**





## **Relation of the Kidneys**

**Posterior relations;** are nearly similar for both kidneys

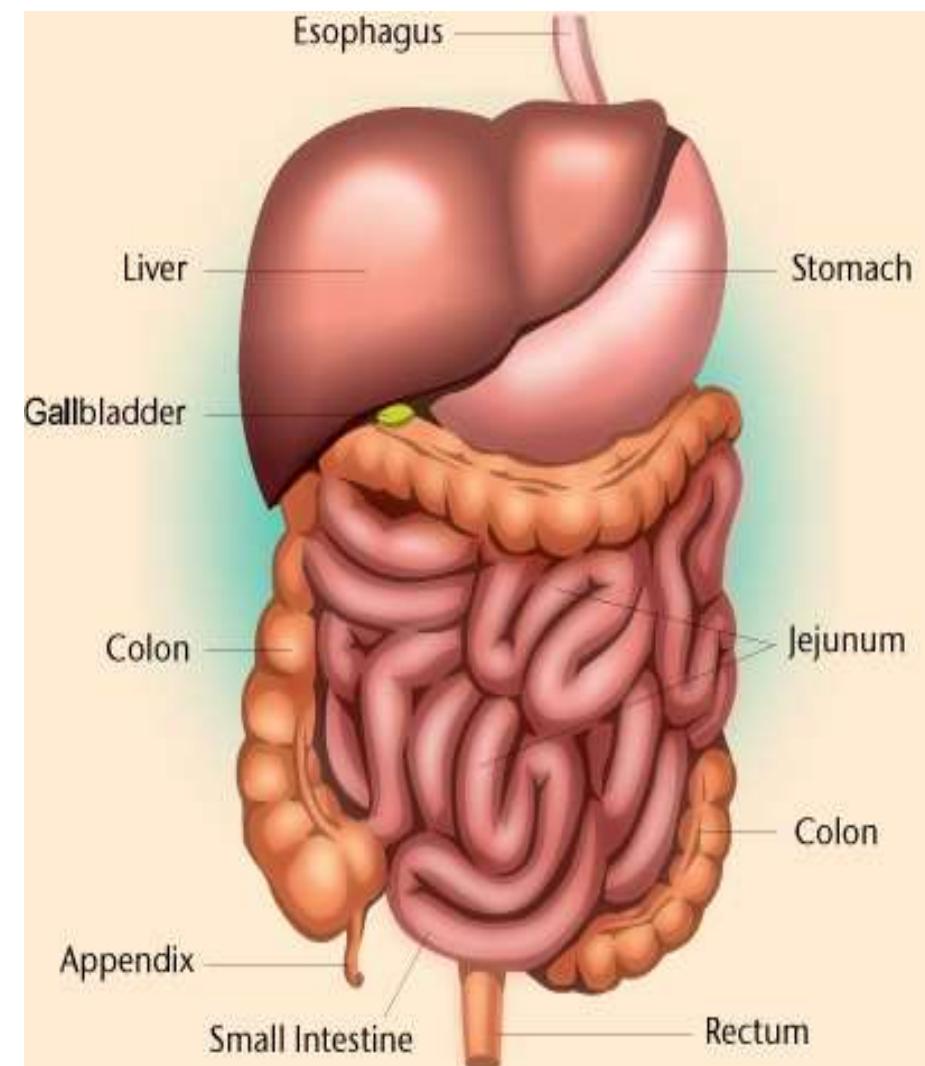
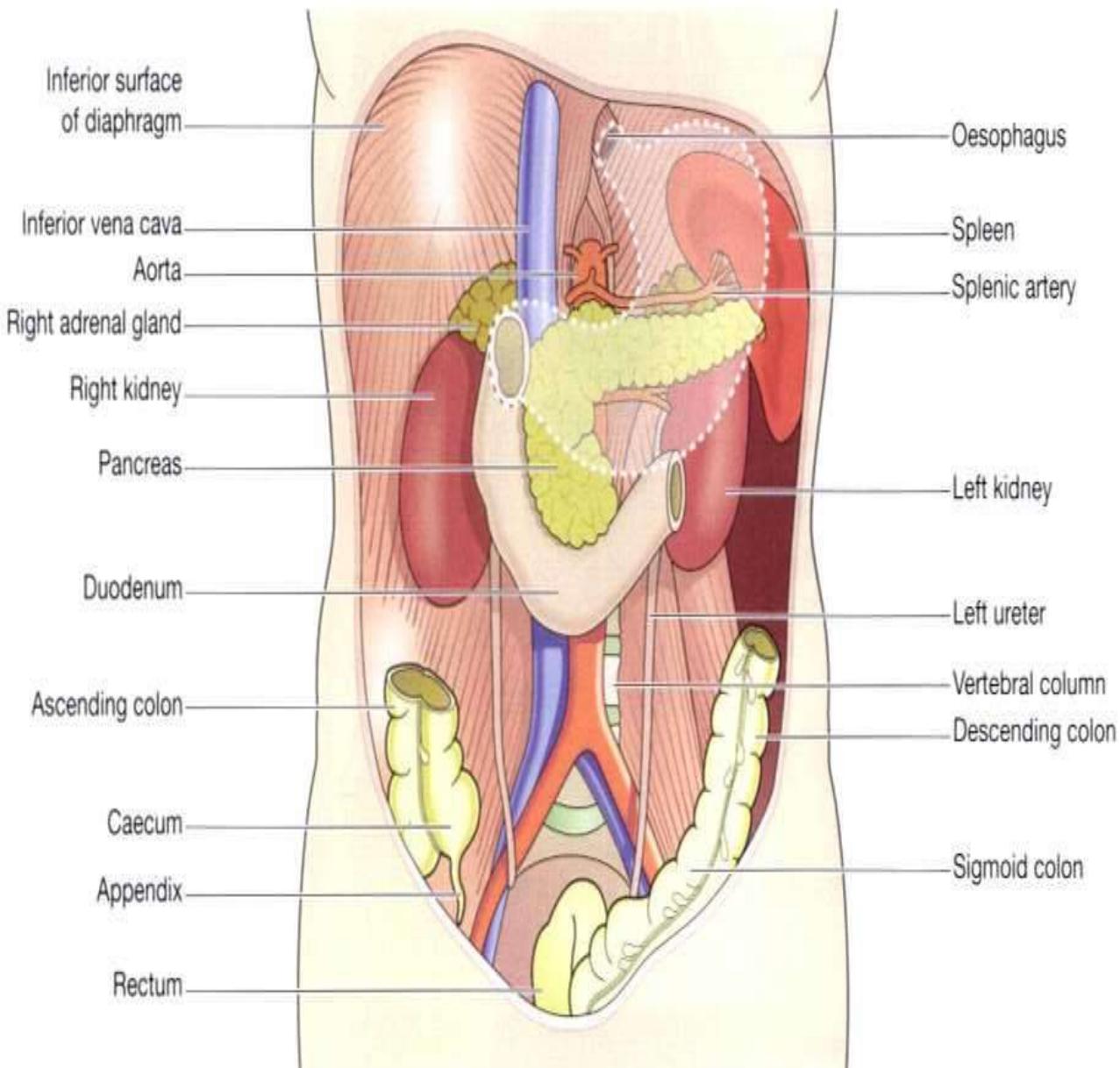
**1- Four muscles,** diaphragm (superiorly), psoas major, quadratus lumborum and transversus abdominis.

**2-Four neurovascular structures;** subcostal vessels, and subcostal, iliohypogastric, and ilioinguinal nerves.

**3-Pleura and ribs,** the diaphragm separates the upper part of each kidney from the costo-diaphragmatic recess of the pleura and 12th rib on right side and 11<sup>th</sup> and 12<sup>th</sup> ribs on left side.

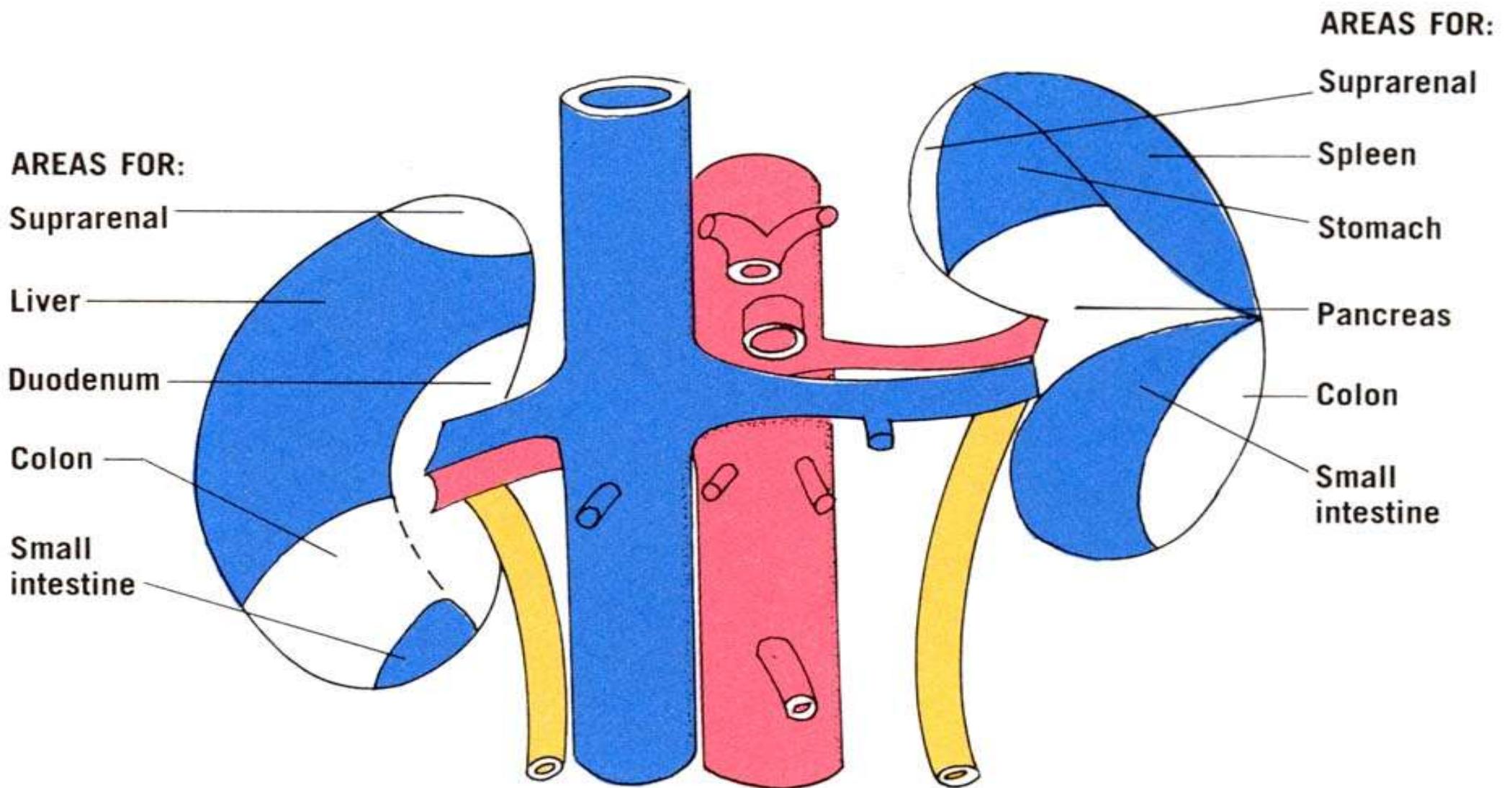
## **Pleura Injury**

➤ During Renal surgical operations Due to close relation between costo-diaphragmatic recess of the pleura and kidney



## Anterior relations

Right Kidney	Left Kidney
Right suprarenal gland	Left suprarenal gland
Second part of duodenum	Spleen with lienorenal ligament, Body of pancreas with splenic vessels
Right lobe of liver (with <b>hepatorenal pouch</b> in between)	Posterior surface of stomach ( <b>with lesser sac</b> in between)
Right colic flexure (hepatic flexure)	Descending colon
Coils of the small intestine	Coils of the small intestine
Ascending branch of right colic artery	ascending branch of left colic artery

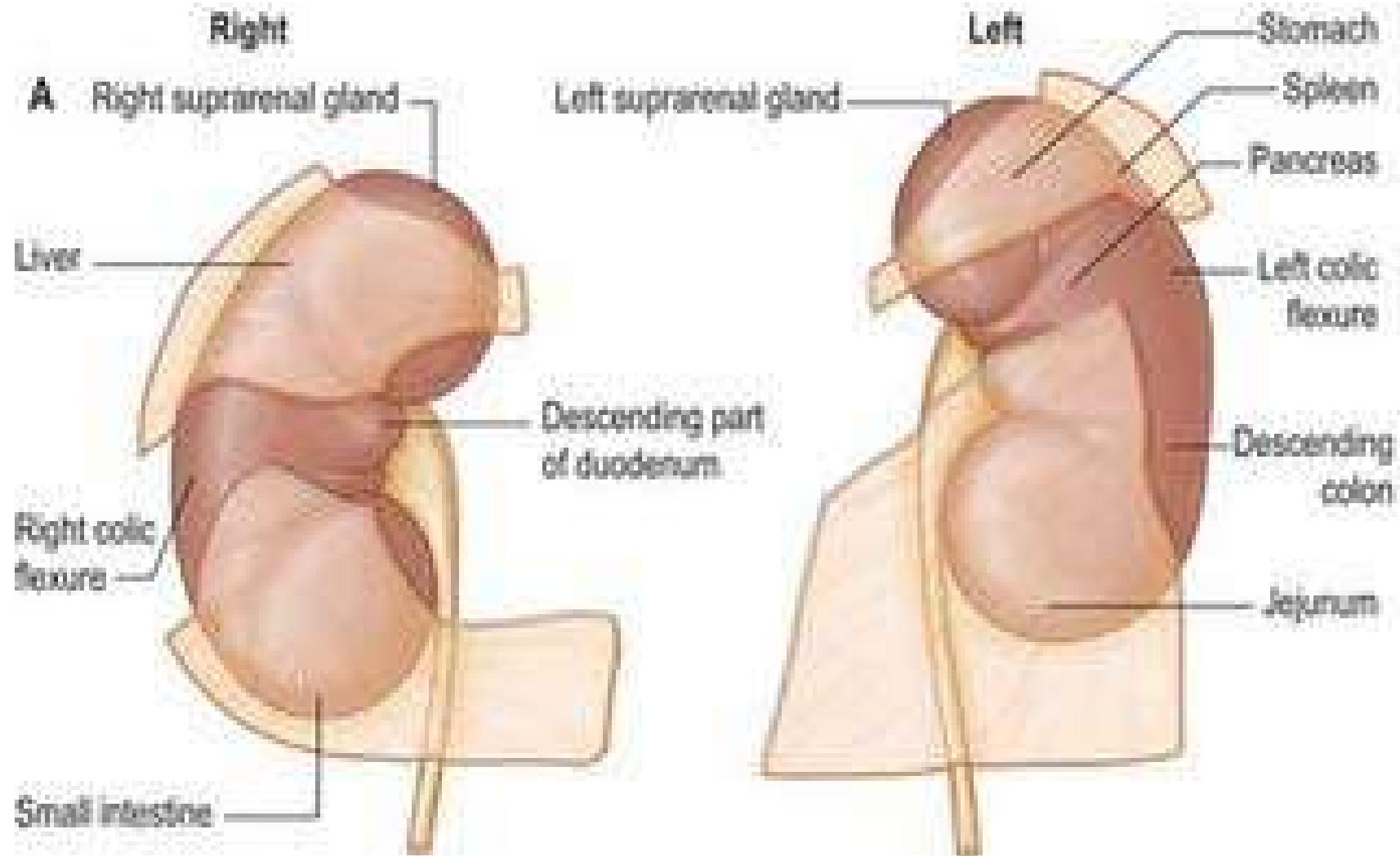


## Peritoneal covering of the kidney :-

Although, the kidneys are ***retroperitoneal***, the anterior surface of each kidney has 3 ***bare areas*** not covered by peritoneum.

***The other retroperitoneal structures*** are interposed between front of kidneys and the parietal peritoneum of posterior abdominal wall.

Bare areas on right kidney	Bare areas on left kidney
Suprarenal area	Suprarenal area
Duodenal area	Pancreatic area
Colic area (hepatic flexure)	Colic area (descending colon)



## **Structure of the kidney :-**

The Kidneys has *two zones (outer cortex and inner medulla)* surrounding **sinus** of the kidney.

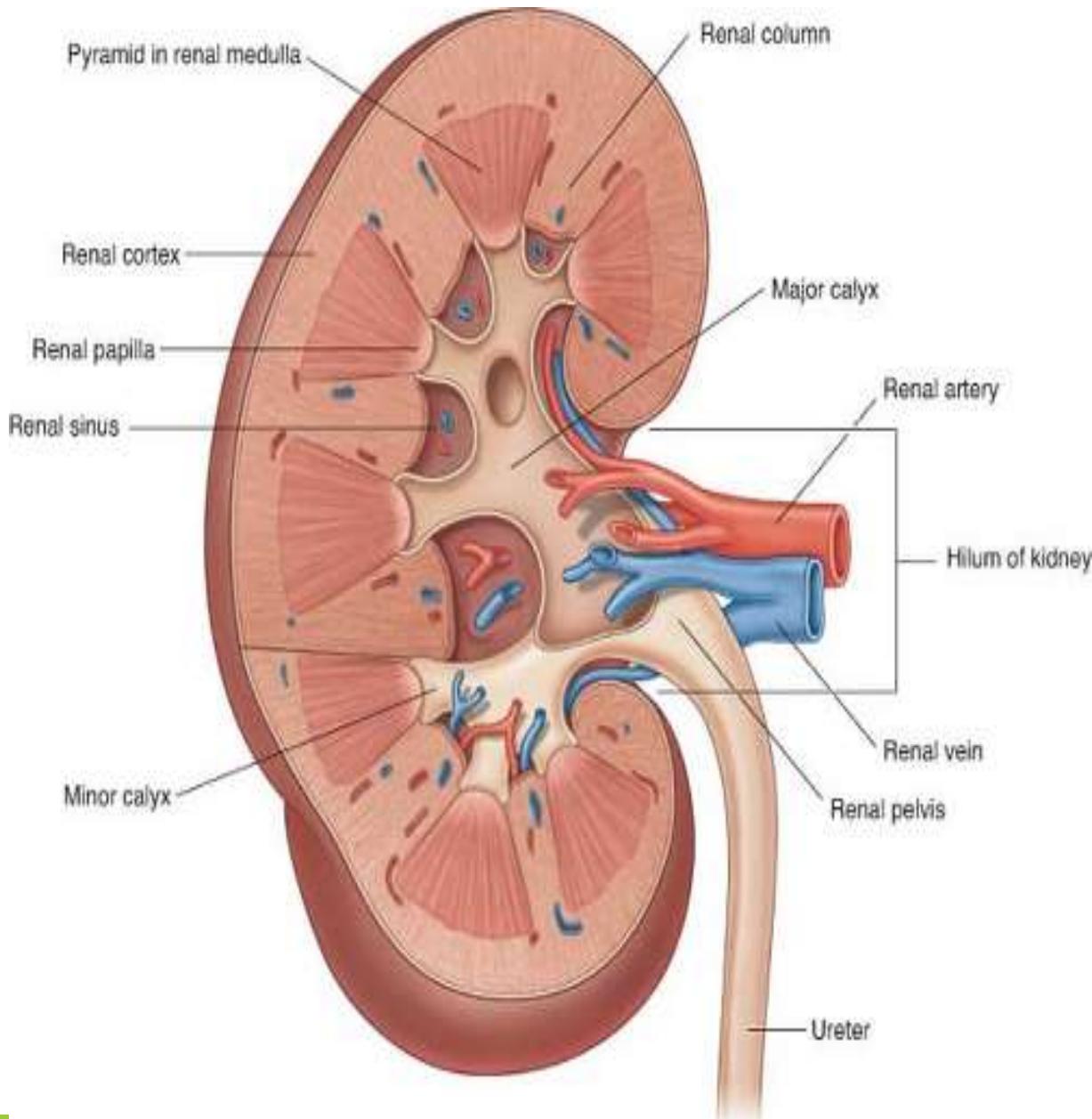
**1- Cortex;** pale and adjacent to the capsule. It is divided into;

Cortical arches which form caps **over** the bases of the medullary pyramids.

**2- Medulla;** is darker, deep to the cortex.

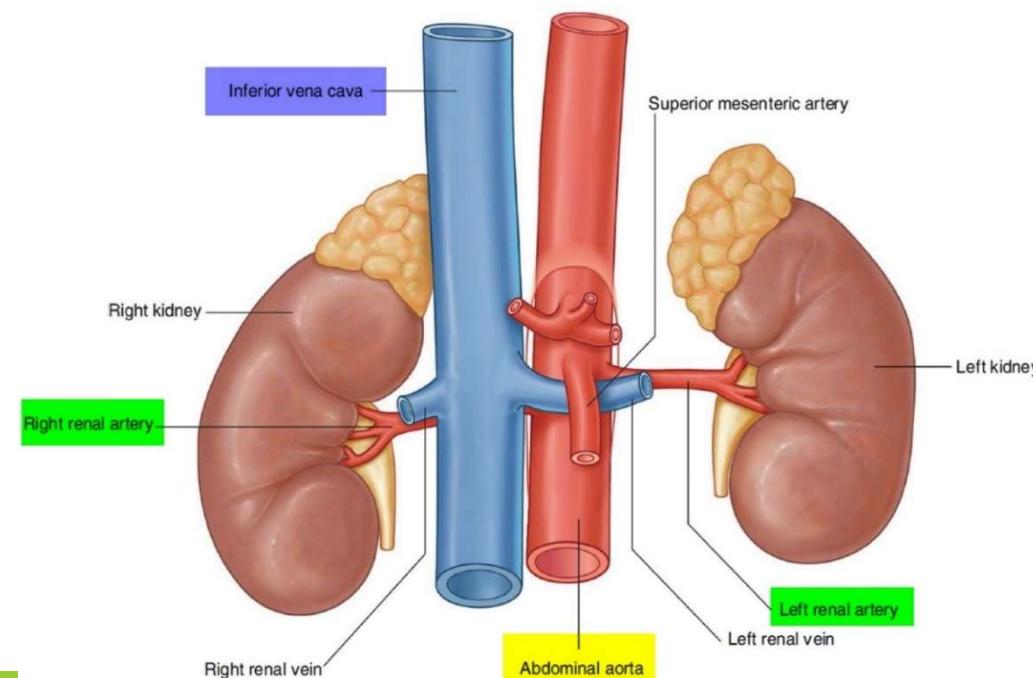
- It is formed of 7-14 pyramids
- Each pyramid has a **base** directed towards the cortex and an **apex** called renal papilla
- The part of cortex **between** the medullary pyramids is called Renal columns
- Each pyramid with its cap of cortex form a *lobe* of the kidney (7-14 lobes)

- The minor calyces are about 5-12 per kidney. Each is a short funnel like tube which receives renal papillae
- The minor calyces unite to form 2-3 major calyces (in each kidney) and these in turn, unite to form the renal pelvis.



## Arterial blood supply

- The renal arteries arise from the side of abdominal aorta, opposite the upper border of L2 vertebra.
- The right renal artery is **longer** than the left and **passes posterior to IVC**
- The renal artery gives inferior suprarenal artery,
- It divides into **5 segmental** arteries which are **end** arteries.
- Collectively, the cortex receives over  
**10 times** more blood than the medulla



**Renal Artery**

**5 Segmental arteries**

**Lobar arteries**

one for each renal pyramid

**Interlobar arteries**

run toward the cortex on each side of the renal pyramid

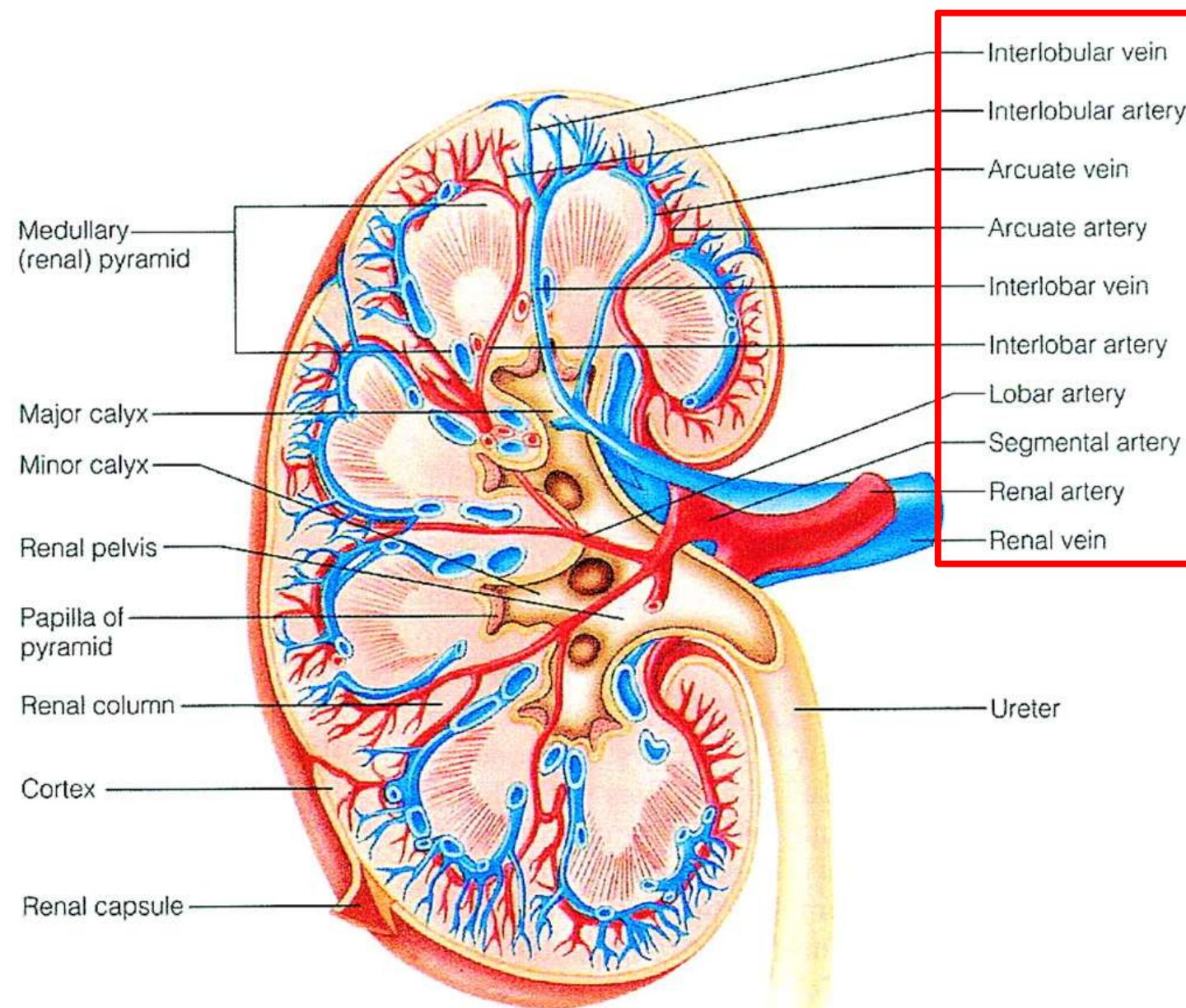
**arcuate arteries**

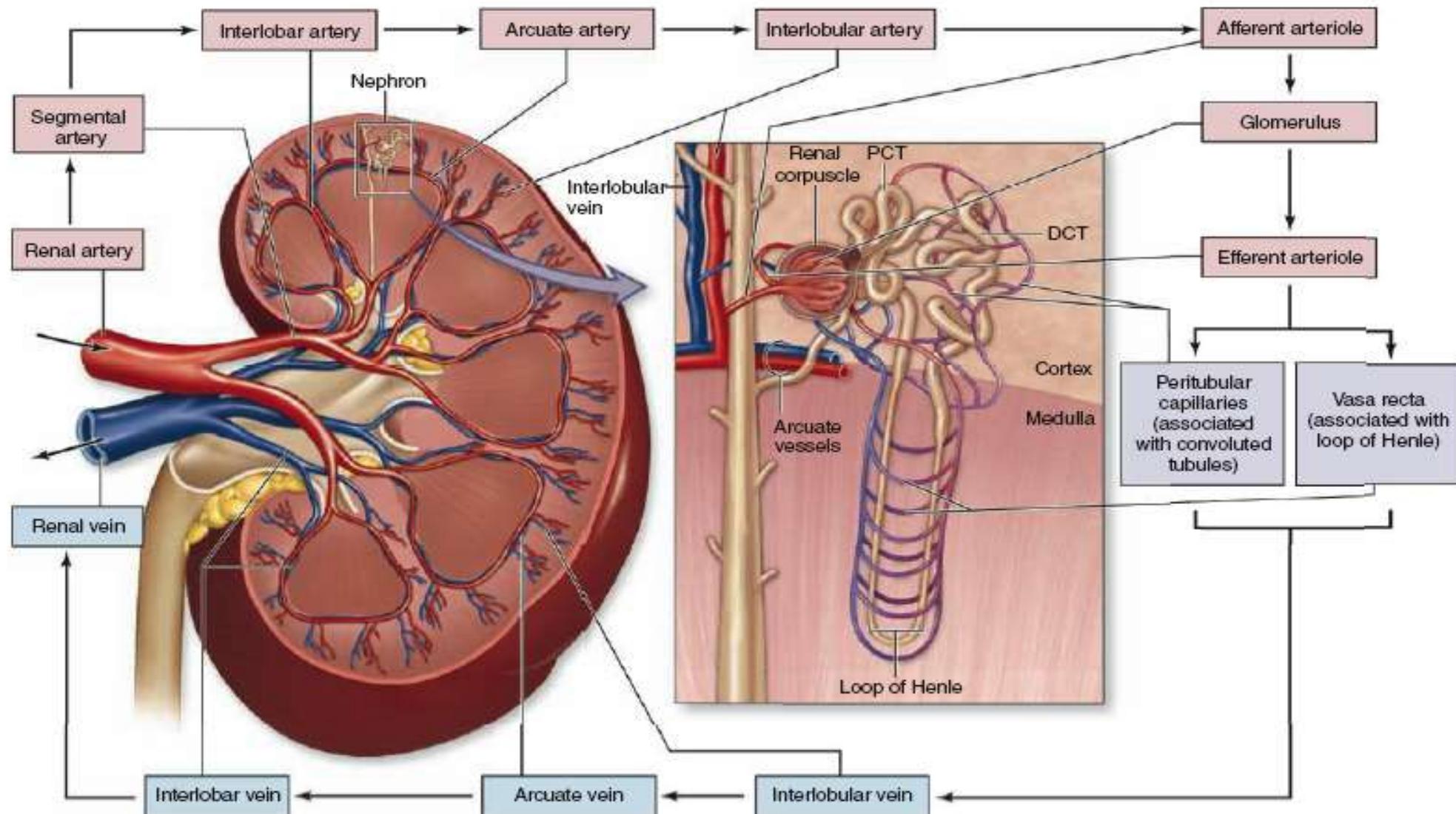
arch over the bases of the pyramids

**interlobular arteries**

ascend in the cortex

**glomerular arterioles**





## Venous drainage

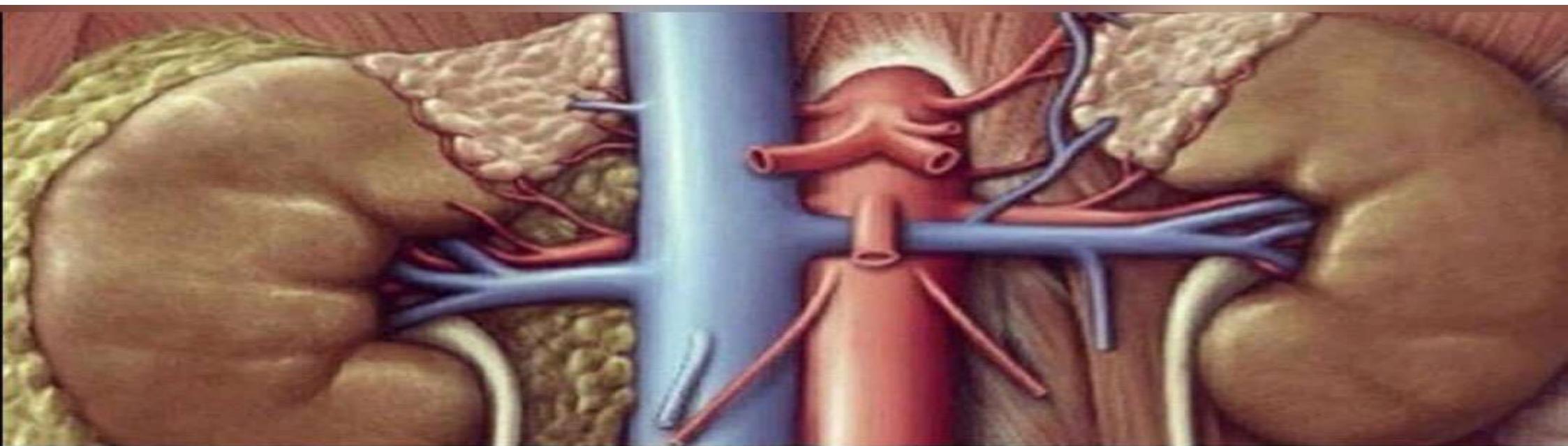
- \* **Both right and left renal veins open directly into IVC**
- **Left renal vein is** longer than the right and passes anterior to the aorta below origin of the ***superior mesenteric artery***.
- **The-left vein receives** the left suprarenal and left gonadal vein.

## Lymph drainage

To lateral aortic lymph nodes.

## Nerve supply :-

By renal plexus derived from the coeliac plexus and supplemented by the lowest splanchnic nerve. It is mainly vasomotor in function.

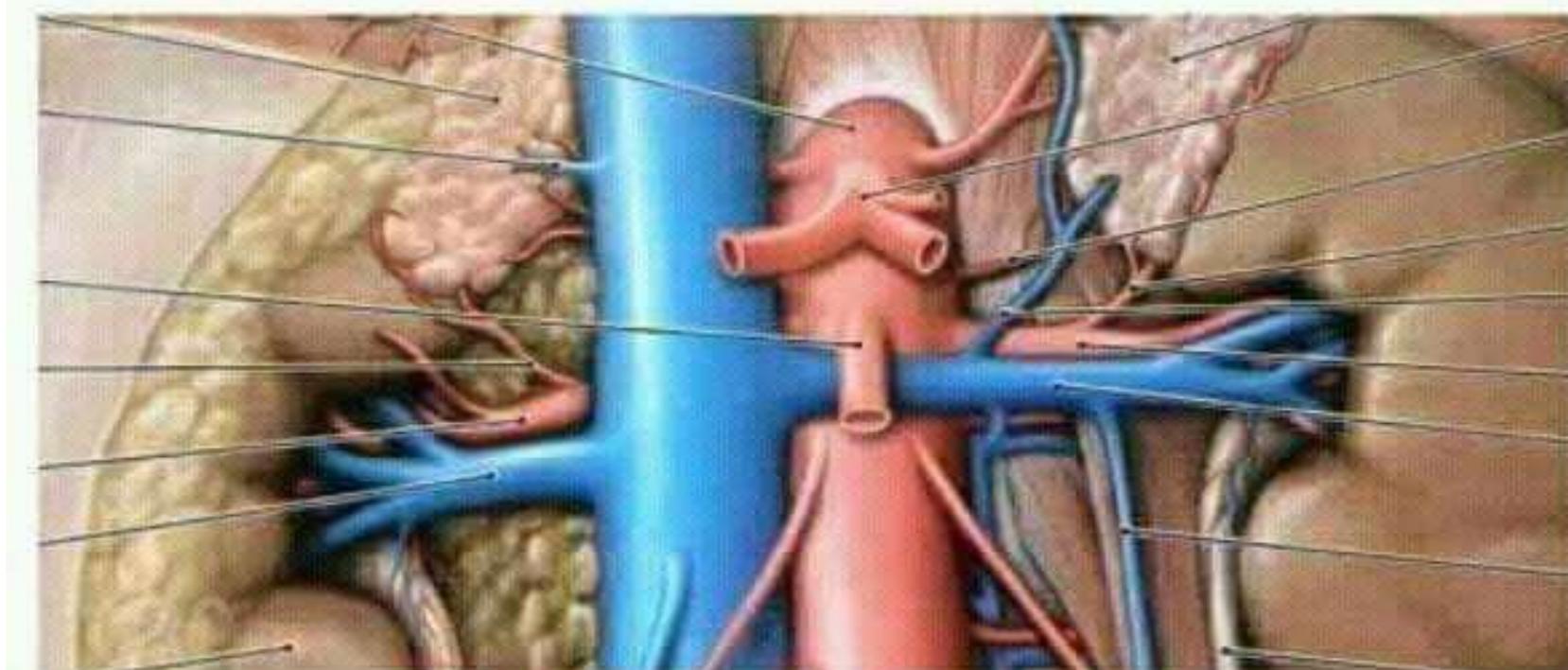


## **Renal Vein Entrapment Syndrome (Nutcracker syndrome)**

Compression of left renal vein between the SMA anteriorly and the abdominal aorta posteriorly .

### **Clinical presentation**

Haematuria due to renal venous hypertension, rupture of thin-walled veins into the collecting system



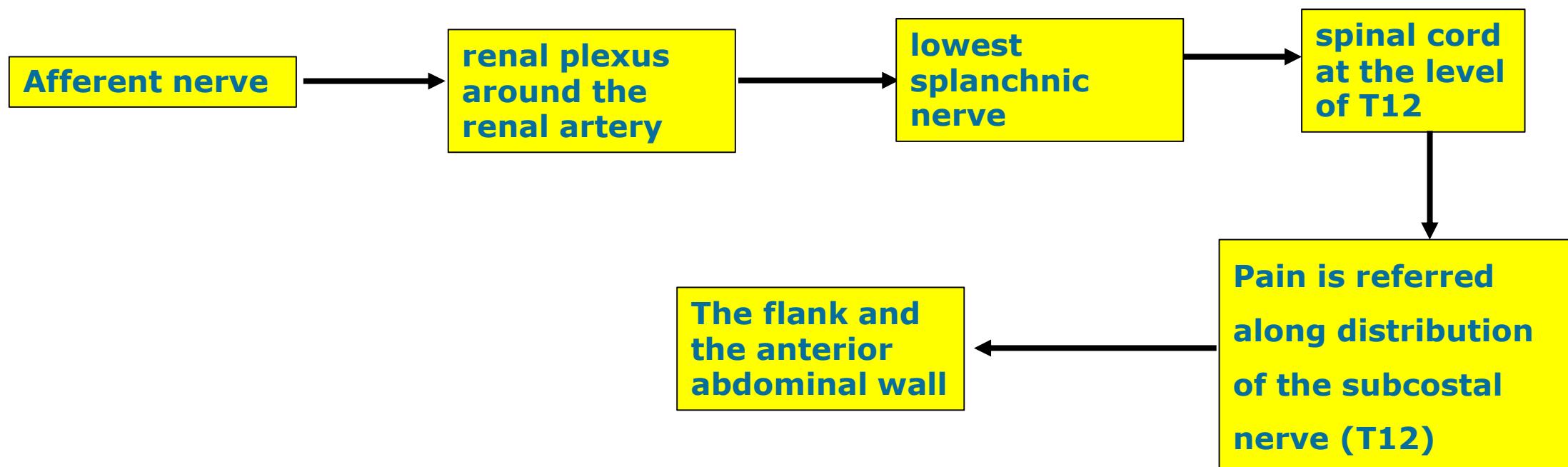
# RENAL CALCULI

- \* ↑ Incidence in male over age 40.
  - \* Nausea and vomiting
  - \* Pain radiates in a flank area
  - \* Hematuria
  - \* Sharp, sudden, severe pain: may be intermittent depending on stone movement)
  - \* Risk factors-etiiology
    - Infection
    - urinary stasis
    - immobility
    - hyper calcemia
    - ↑Uric Acid
    - ↑Urinary oxalate level
- Diagnosis:
- UA  
Cystoscopy  
IVP  
Renal  
Stone Analysis  
KUB (X-ray)  
Serum: Calcium  
Oxalate  
Uric acid
- 

## Renal Pain

Renal pain varies from a dull ache to a severe pain in the flank

Renal pain can result from stretching of the kidney capsule or spasm of the smooth muscle in the renal pelvis.



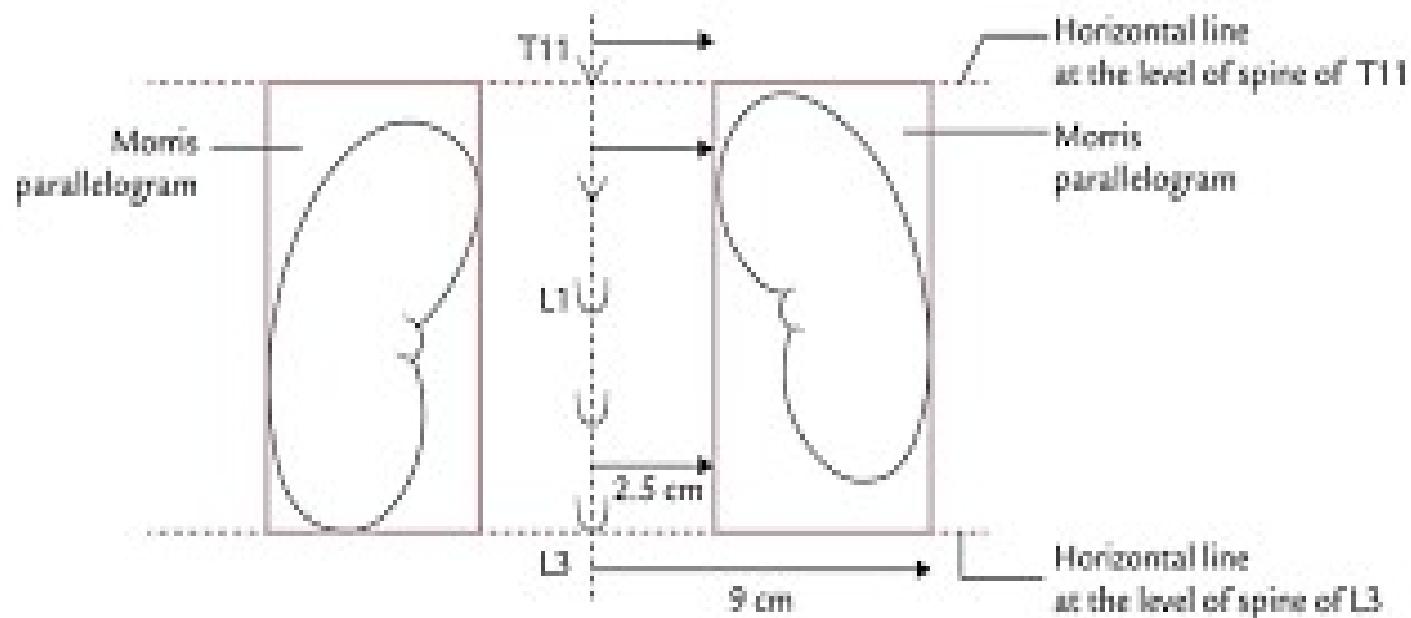
## Surface anatomy of the Kidneys

### Morris rectangle :

**Two vertical lines** are drawn; one and three inches from the middle line.

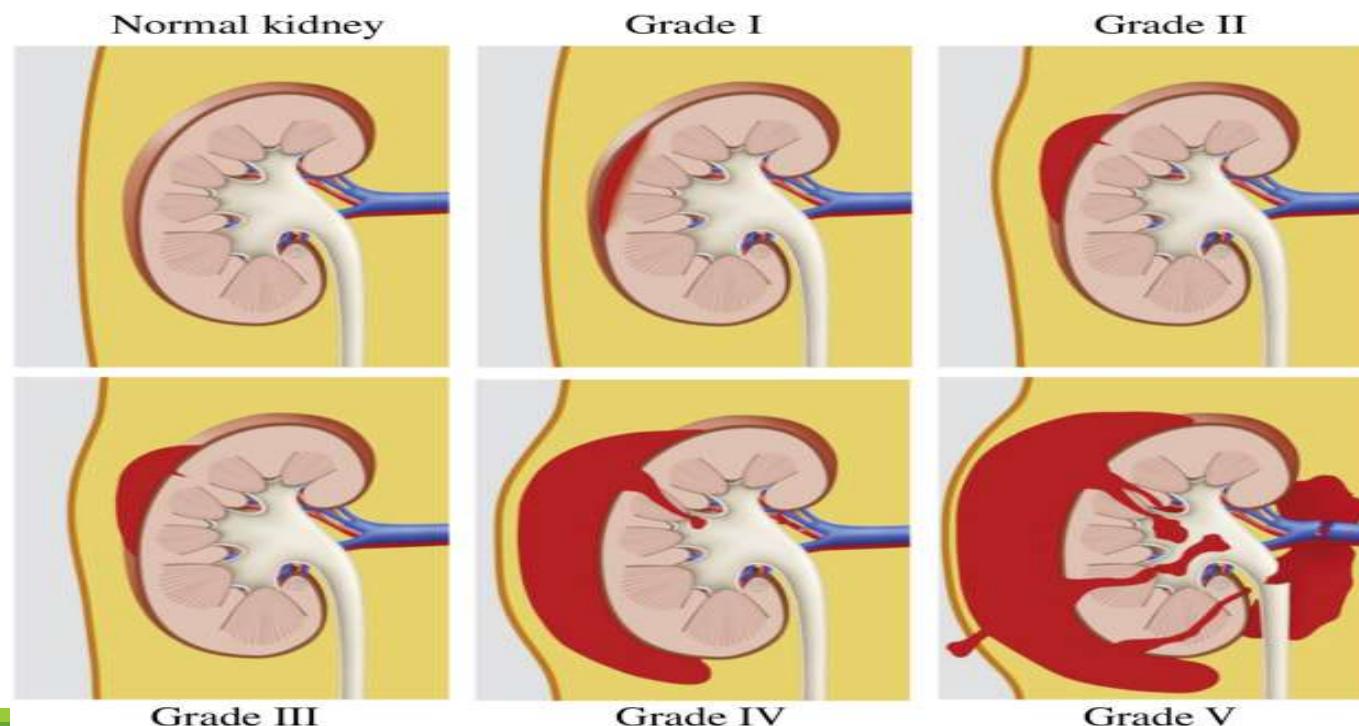
**Two horizontal planes** are drawn opposite the spines of T11 and L3 .

- The upper end lies **1 inch** from midline opposite upper end of **T12 vertebra**.
- The hilum is **2 inches** from midline at the **transpyloric plane (L1)**
- The lower end is **3 inches** from the midline opposite **L3 vertebra**



## Kidney Trauma

- ❖ The kidneys are well protected by the lower ribs, the lumbar muscles, and the vertebral column.
- ❖ A severe blunt trauma to the abdomen may crush the kidney against the last rib and the vertebral column.
- ❖ Depending on the severity of the blow, the injury varies from a mild bruising to a complete laceration
- ❖ Because 25% of the cardiac outflow passes through the kidneys, renal injury can result in rapid blood loss





## **The ureters:**

The ureters are muscular tubes which convey urine from kidneys to the urinary bladder.

The ureter lies behind and adheres to the parietal peritoneum of the posterior abdominal wall.

The ureter is about 10 inches (25 cm) and has 2 parts; abdominal and pelvic, each is 5 inches long.

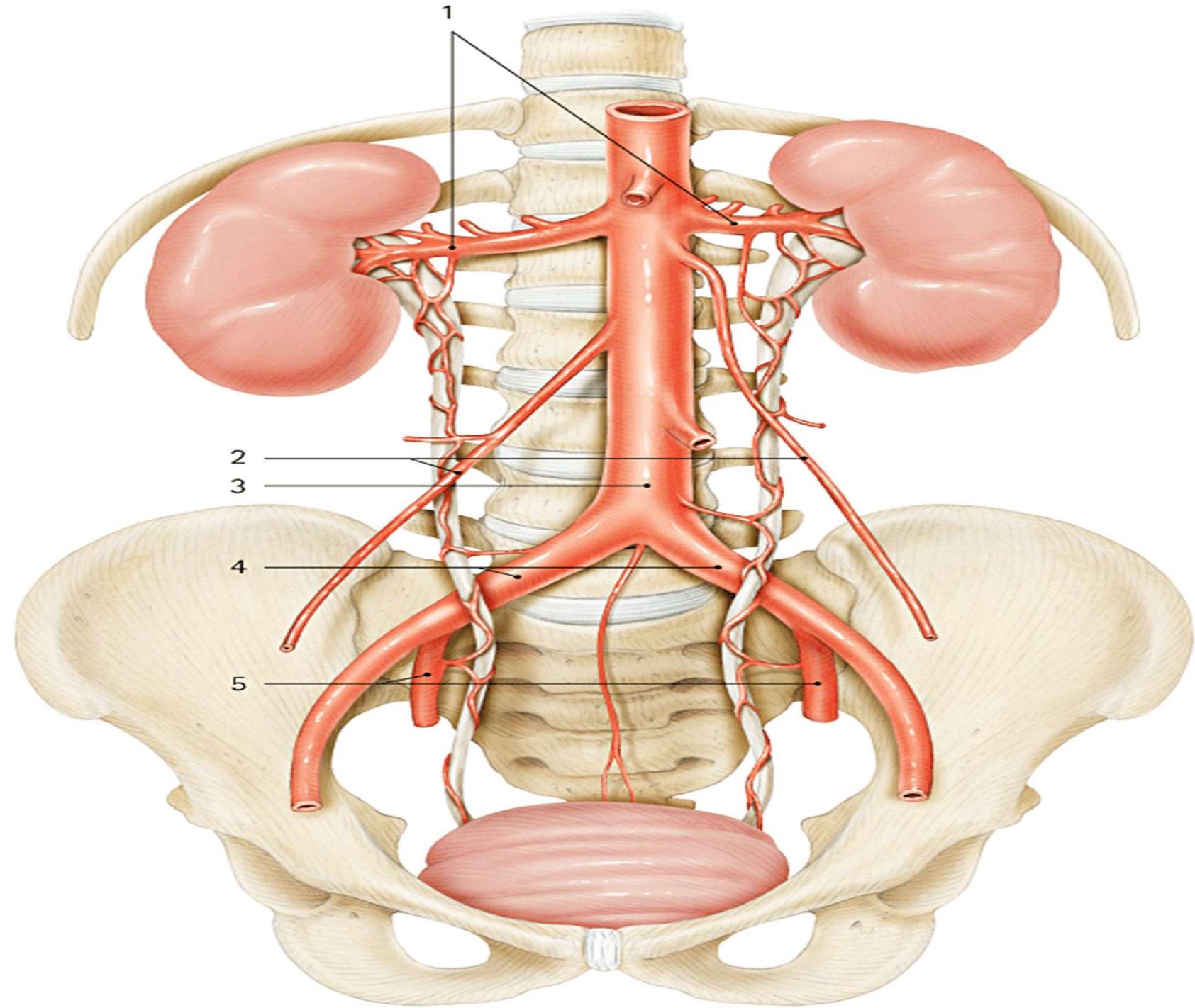
## Course of the ureter

### **The abdominal part**

- Begins from the lower end of the renal pelvis (it is the pelvi-ureteric junction),
- It descends downwards and medially on psoas major muscle towards the pelvic brim.
- It crosses the *end of the common or beginning of the external iliac artery* to become the pelvic part.

### **The pelvic part**

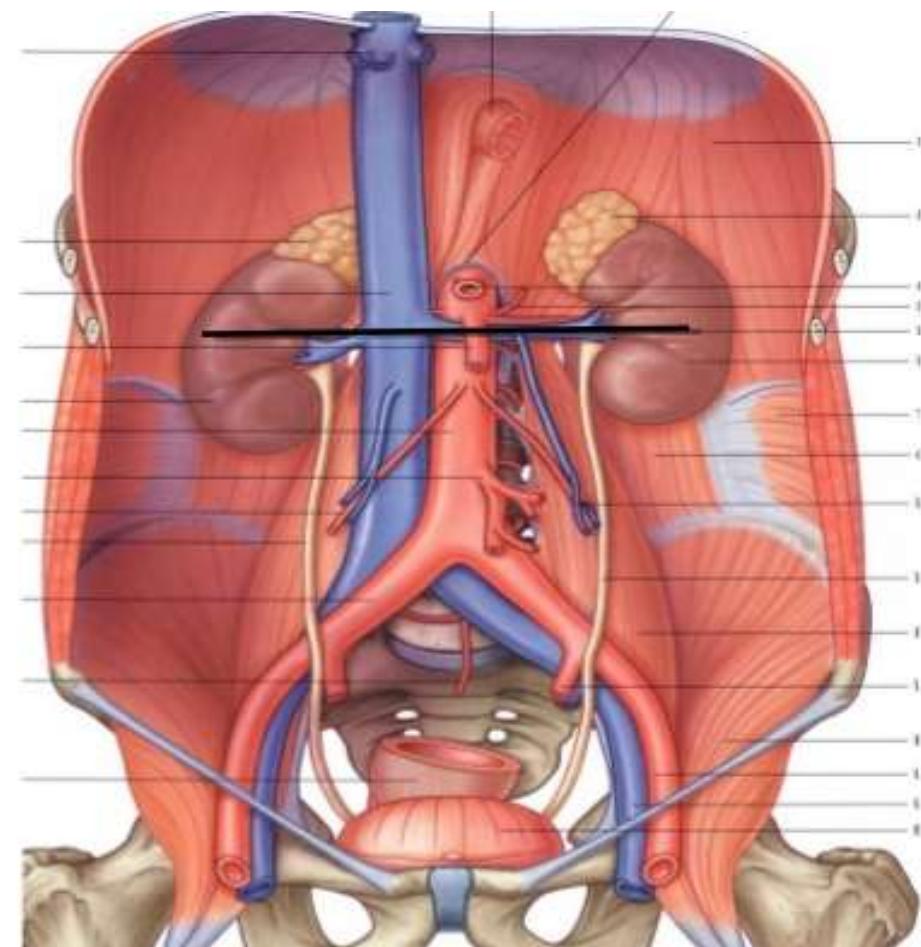
- Descends downwards and backwards along the anterior margin of greater sciatic foramen till the ischial spine. It forms posterior boundary of the ovarian fossa.
- It runs forwards on pelvic floor to open in the wall of the urinary bladder.
- It is crossed by the vas deferens in **male** and uterine artery in **females**.
- It pierces the wall of the bladder obliquely to open at the superolateral angle of the trigone.
- This oblique termination of the ureter prevents regurgitation of urine from bladder to the ureter



## Relations of the abdominal part of ureter:-

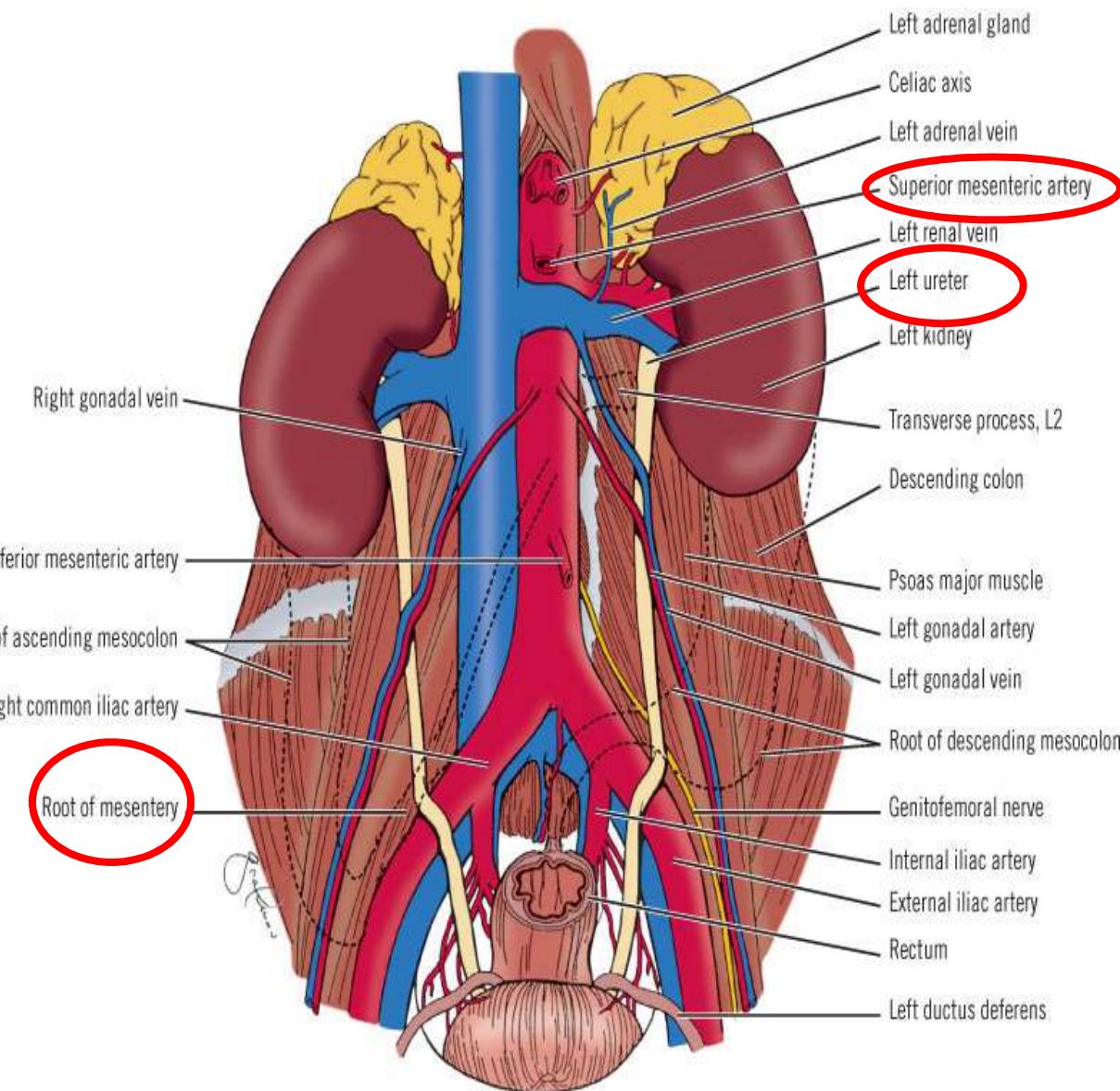
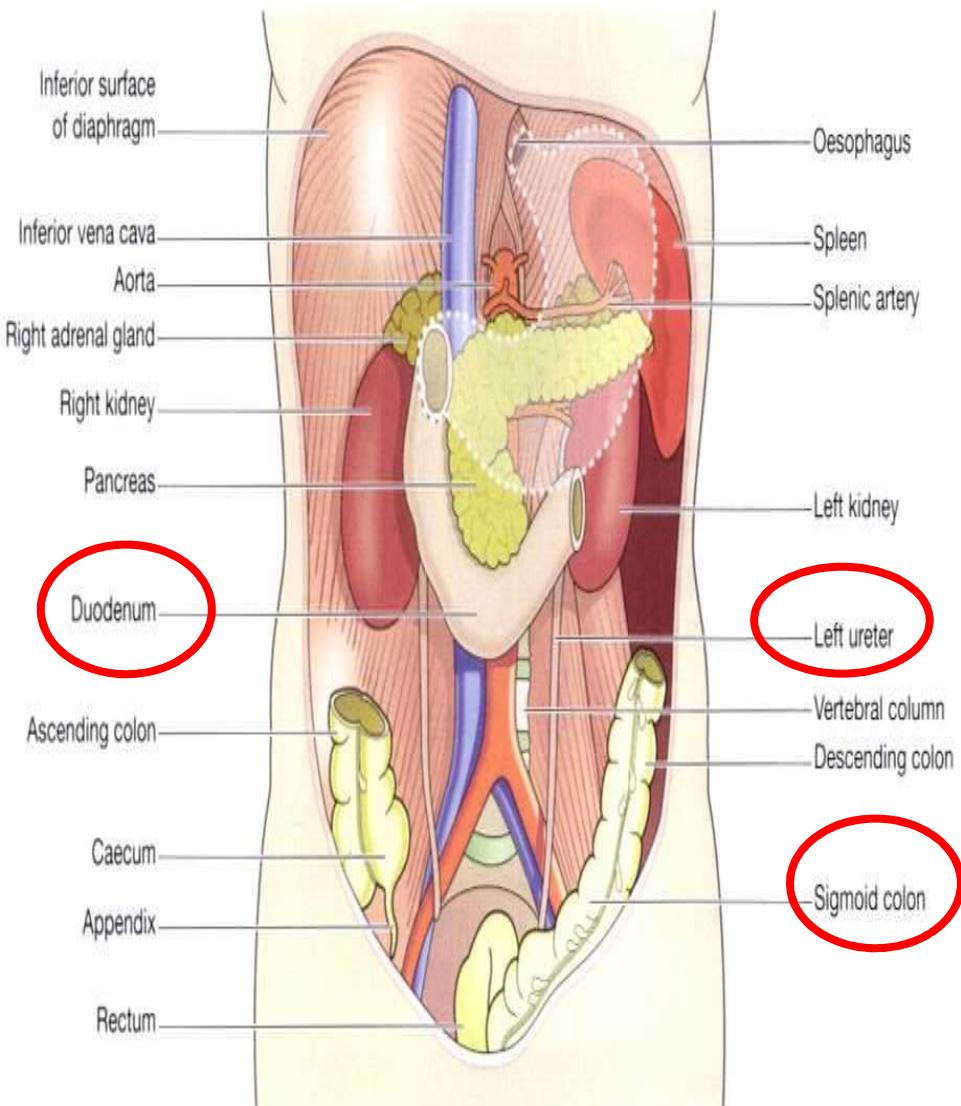
### **Posterior Relation (BOTH SIDES)**

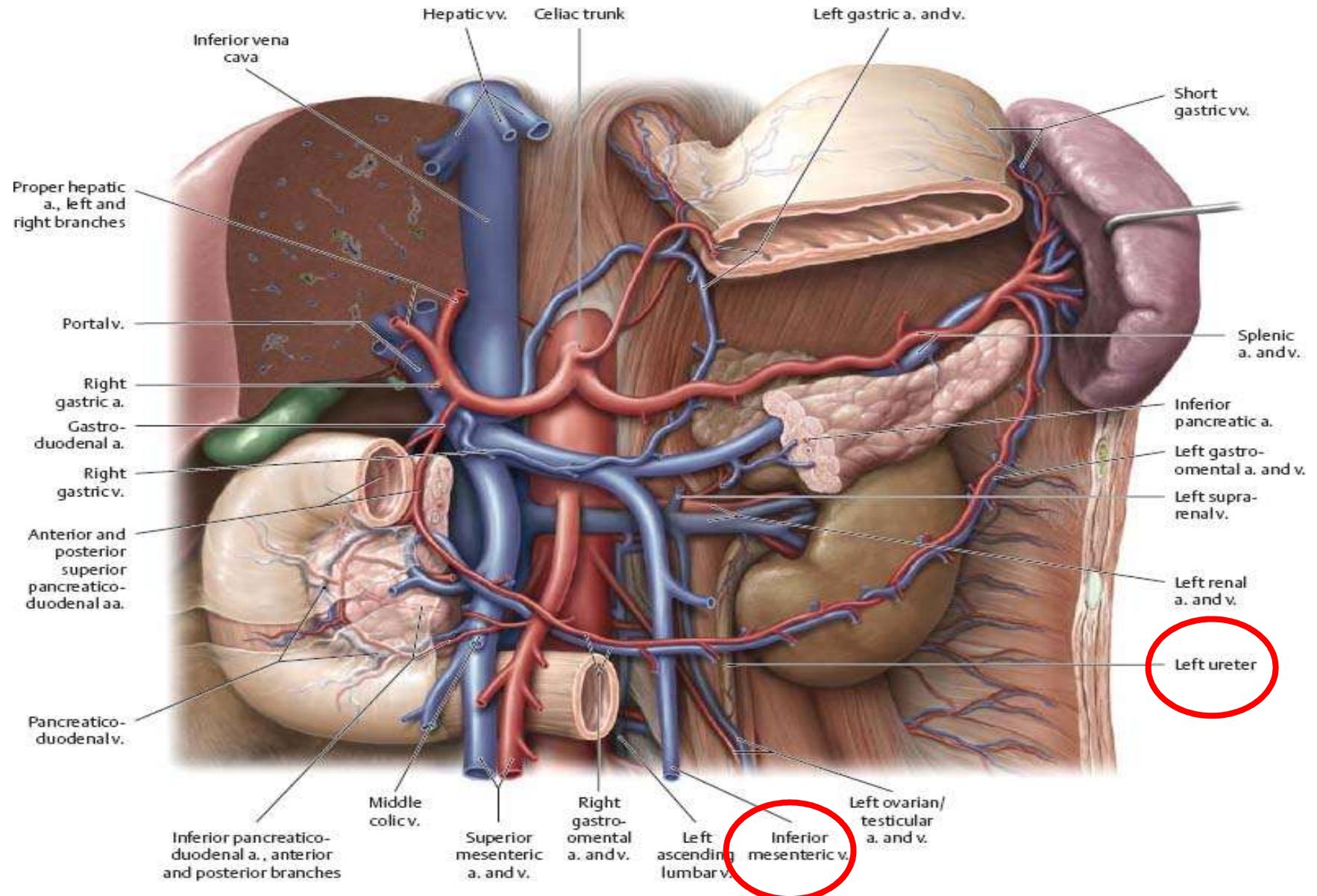
- 1.Psoas major muscle separating the ureter from the tips of the transverse processes of the lumbar vertebrae (2-5)
- 2.Genitofernoral nerve
- 3.Termination of common or beginning of external iliac artery



## Anterior and medial relations

	<b>Right ureter</b>	<b>Left ureter</b>
<b>Anterior relation</b> <i>Intestinal structures</i>	<ol style="list-style-type: none"><li>Third part of the duodenum at its beginning</li><li>Terminal ileum near the pelvic brim</li></ol>	<ol style="list-style-type: none"><li>Sigmoid colon near the pelvic brim</li></ol>
<b>Peritoneal elements</b>	<ol style="list-style-type: none"><li>Parietal peritoneum of the posterior abdominal wall</li><li>Root of the mesentery</li></ol>	<ol style="list-style-type: none"><li>Parietal peritoneum of the posterior abdominal wall</li><li>Apex of sigmoid mesocolon <u>with its intersigmoid recess</u></li></ol>
<b>vessels</b>	<ol style="list-style-type: none"><li>Right gonadal vessels</li><li>Superior mesenteric vessels</li><li>Right colic vessels</li><li>Ilio-colic vessels</li></ol>	<ol style="list-style-type: none"><li>Left gonadal vessels</li><li>Left colic vessels</li><li>Sigmoid vessels</li></ol>
<b>Medial relation</b>	<ul style="list-style-type: none"><li>• <b>Inferior</b> vena cava</li></ul>	<ul style="list-style-type: none"><li>• <b>Inferior</b> mesenteric vein</li></ul>

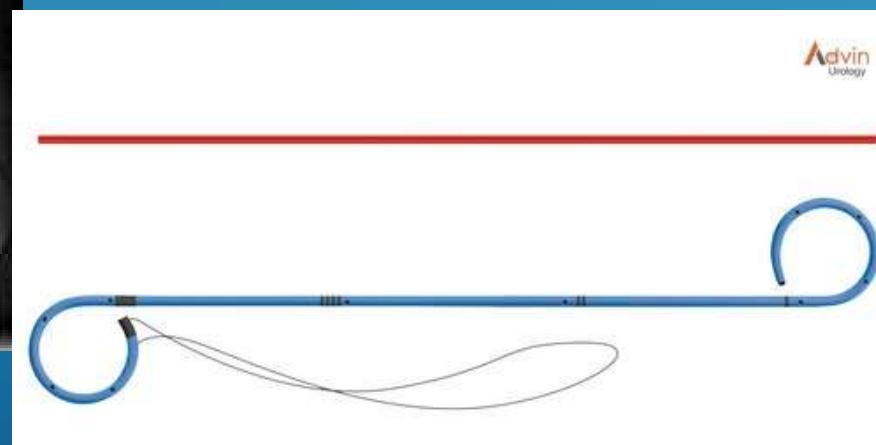




Boshera ' husband complained from sever renal colic , referred to his scrotum and tip of the penis ,IVU revealed ureteric occlusion and the doctor decided to insert double J catheter .

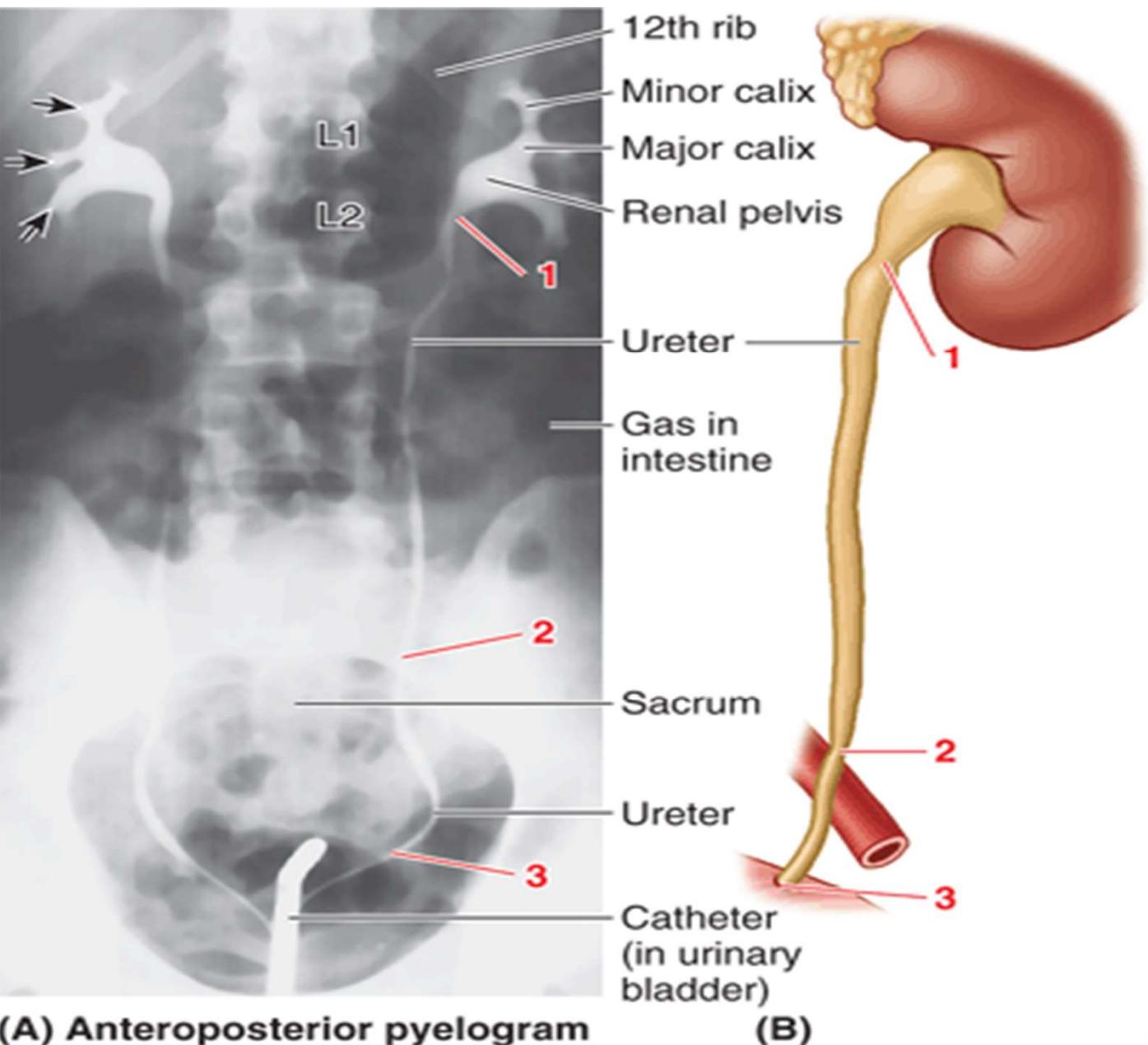
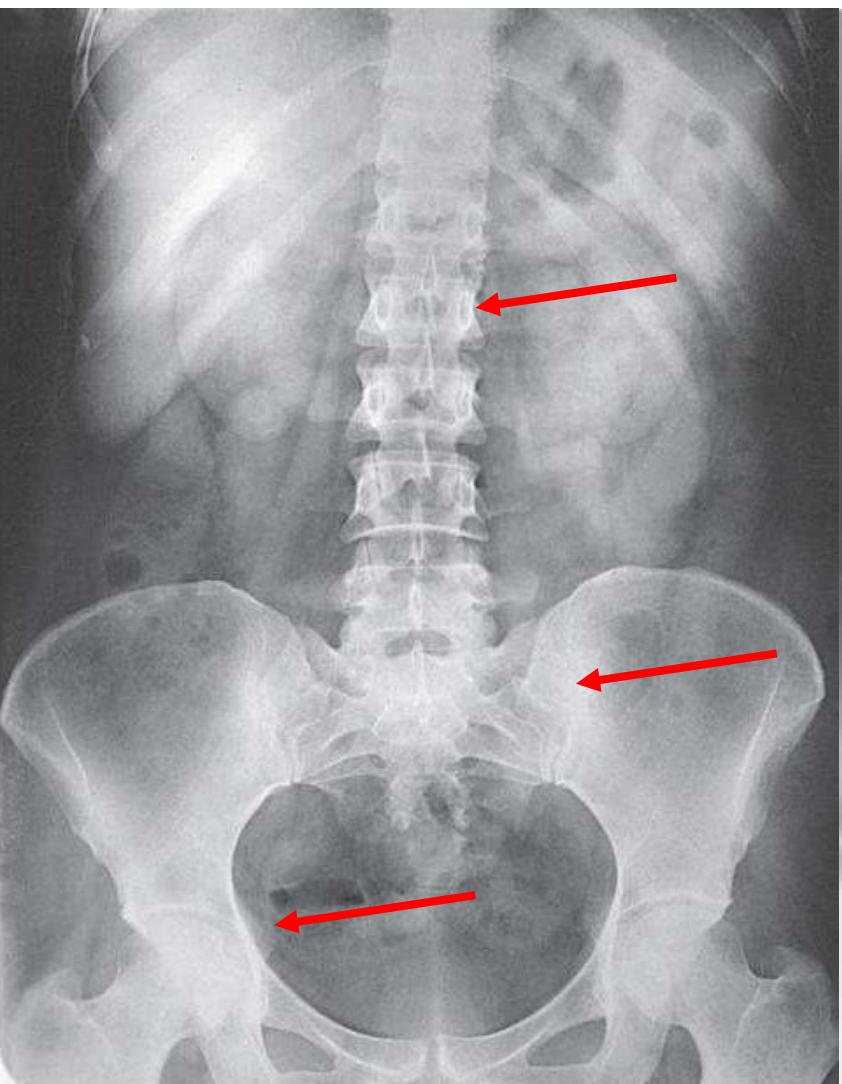


Dr Ahmed Salman



## Constrictions of the ureters

Site of constriction	Corresponding bony Level
At pelvi-ureteric junction	Near the tip of the transverse process of L2 vertebra
At pelvic brim	In front of sacroiliac joint.
In the wall of the urinary bladder  <b>(it is the <i>narrowest point</i> of the whole ureter)</b>	Just medial to the ischial spine.



## Arterial blood supply :-

- ❖ Abdominal part receives branches from renal artery, abdominal aorta, gonadal and common iliac arteries
- ❖ Pelvic part receives branches from vesical, middle rectal and uterine arteries

## Lymph drainage:-

To lateral aortic, common iliac lymph nodes.

### **Nerve supply :-**

- ✓ The ureter receives sympathetic fibers from T11 – L2 segments of spinal cord.
- ✓ Sensory fibers from the ureter enter the spinal cord through the same segments.
- ✓ Ureteric colic begins in the loin and is referred to groin, anterior aspect of the thigh through genitofemoral nerve (L1,L2) and scrotum or labium majora

### **Surface markings :-**

The ureter begins at a point on the transpyloric plane, 5 cm from the midline

It enters the bladder at the pubic tubercle.



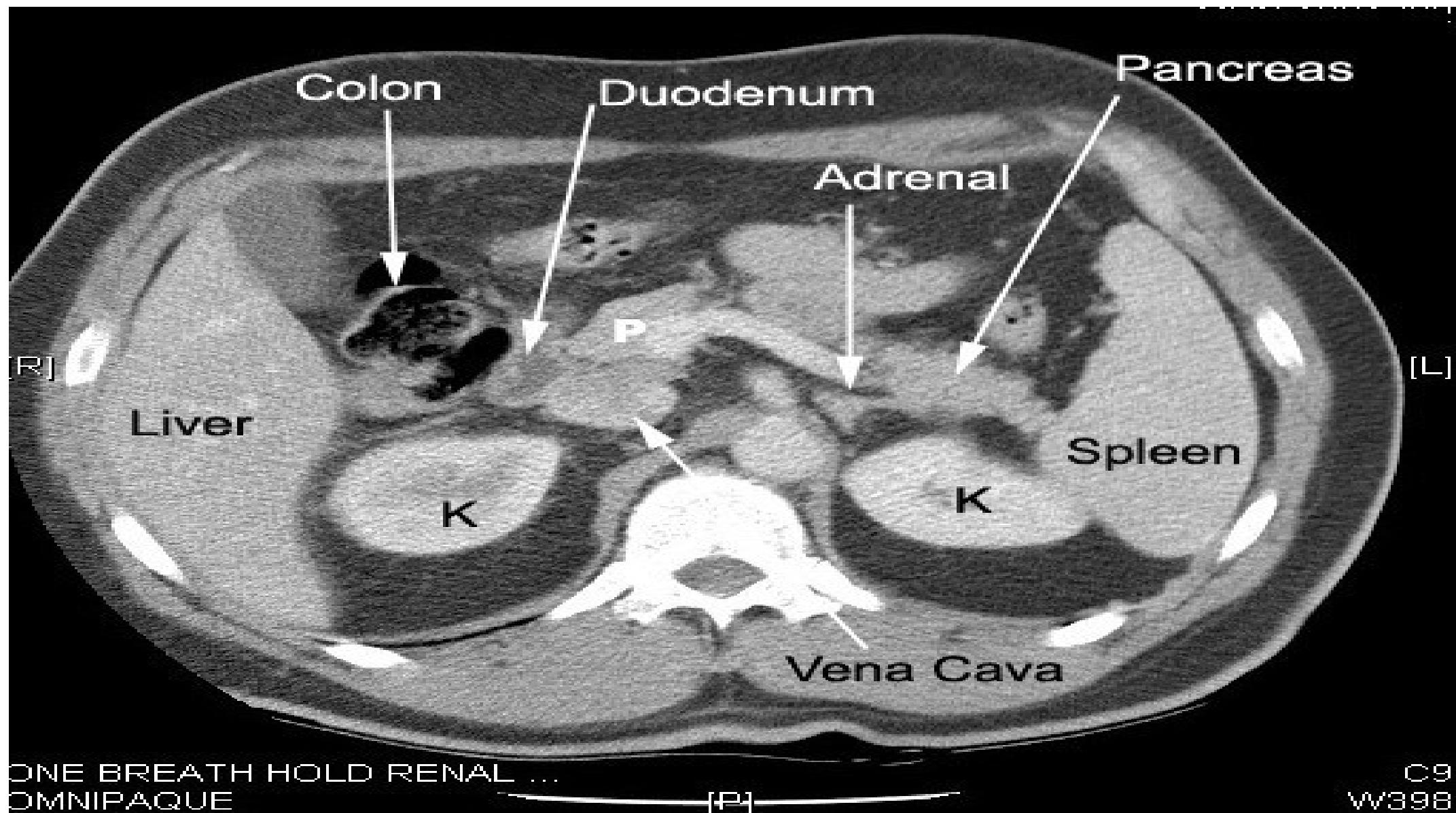
**Intra Venous Urogram  
IVU**



**IVU**



**KUB**



## MRI Abdomen



## MRI Abdomen

DR AHMED SALMAN