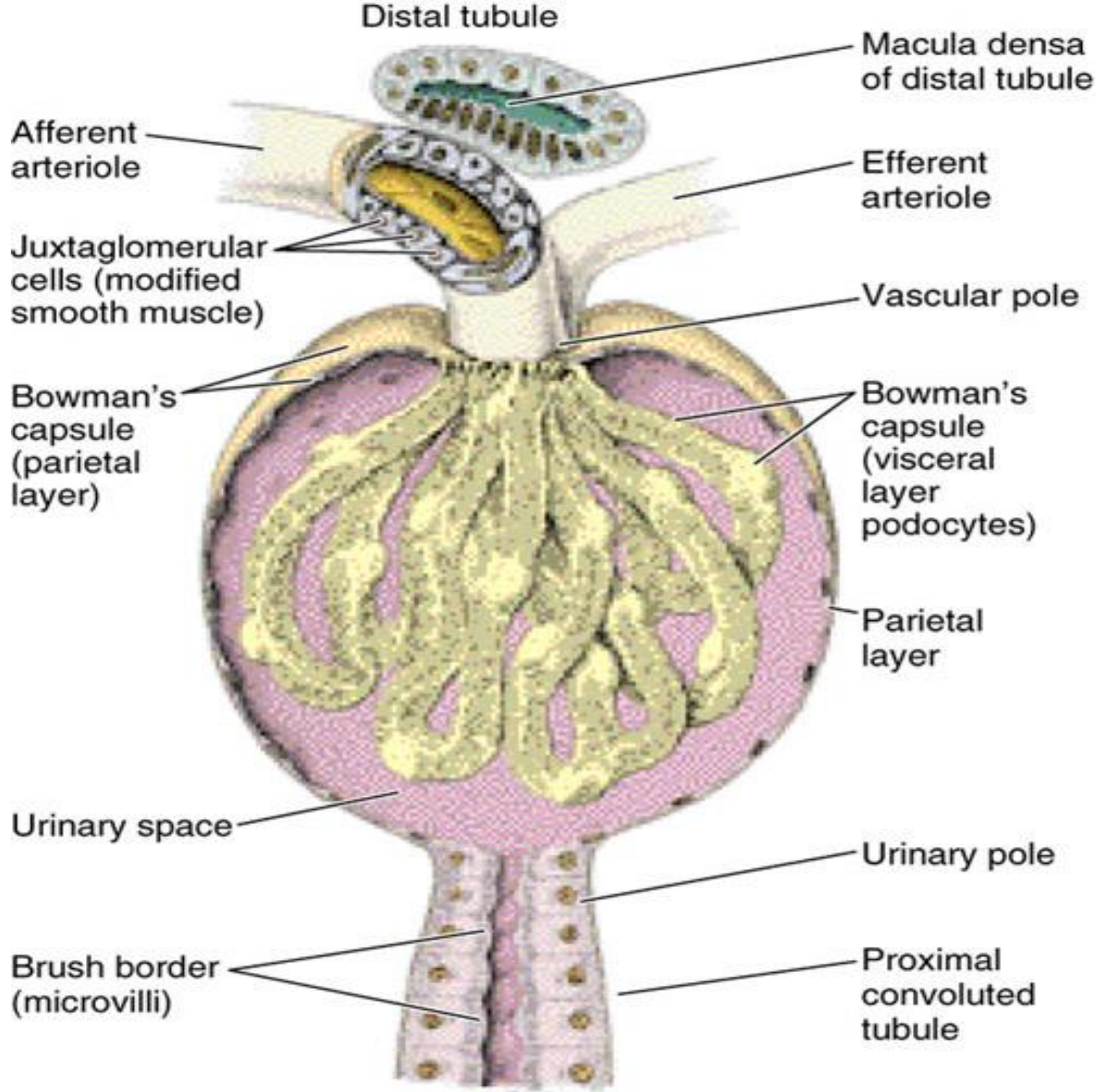


Abdominal Organs

THE KIDNEYS

Prof. TALIB J.Kadhim

Diyalla University



THE KIDNEYS

- Gross & microscopic anatomy
- **The kidneys serve a No. of important FUNCTION:**
 1. Maintaining **fluid & electrolyte balance**
 2. Maintaining **acid –base balance**

3- J.G.A Produce **rennin** (an enzyme converting a polypeptide in blood, **angiotensinogen**, to **angiotensin I** whose actions include the:

*(1)elevation of blood pressure and
(2)stimulation of aldosterone release*

from the adrenal cortex, increasing resorption of sodium ions from the distal convoluted tubules), vital role in **controlling BP**

5- Erythropoietin ,affecting
RBC production

5- Calcium metabolism
,(absorption)by converting of
vit.D to active form dihydroxy
vit.D.

- **Erythropoietin**, also known as **erythropoetin** or **erthropoyetin** or **EPO**, is a glycoprotein hormone that controls erythropoiesis, or red blood cell production. It is a cytokine (protein signaling molecule) for erythrocyte (red blood cell) precursors in the bone marrow. Human EPO has a molecular weight of 34 kDa.

Importance of epo

- Also called **hematopoietin** or **hemopoietin**, it is produced by interstitial fibroblasts in the kidney in close association with [peritubular capillary](#) and [tubular epithelial tubule](#). It is also produced in perisinusoidal cells in the [liver](#). In addition to erythropoiesis, erythropoietin also has other known biological functions. For example, it plays an important role in the brain's response to neuronal injury.^[1]

- **Problems with erythropoietin**
- Individuals can suffer from having too much erythropoietin in the blood or from having an erythropoietin deficiency. High levels of the hormone often occur when the body experiences chronic low levels of blood oxygen or if tumors produce the hormone. When this occurs, the patient will develop a high red blood cell count, which is called **polycythaemia**.

- This can produce few symptoms, but sometimes will produce itching, dizziness, joint pain, and fatigue.
- Low levels of erythropoietin occur when someone is suffering from chronic kidney diseases. Low red blood cell counts cause anemia; symptoms include fatigue, **shortness of breath, increased heart rate, and dizziness**

- ¹ EPO is also involved in the wound healing process.^[2]
- When exogenous EPO is used as a performance-enhancing drug, it is classified as an erythropoiesis-stimulating agent (ESA). Exogenous EPO can often be detected in blood, due to slight differences from the endogenous protein, for example, in features of posttranslational modification.

increase of blood pressure (may be associated with –

-renal disease,

-juxtaglomerular cells

*hypertrophy); they contain **renin** within their granules, an enzyme converting a polypeptide in blood, **angiotensinogen**, to **angiotensin I**.*

- *This is converted by other enzymes (notably in the lungs) into **angiotensin II**, a polypeptide whose actions include the **elevation of blood pressure** and **stimulation of aldosterone release** from the **adrenal cortex**, increasing **resorption of sodium ions** from the **distal convoluted tubules**.*

juxtaglomerular apparatus

determining the final concentration of the urine.

Renin secretion may be controlled by at least three factors):

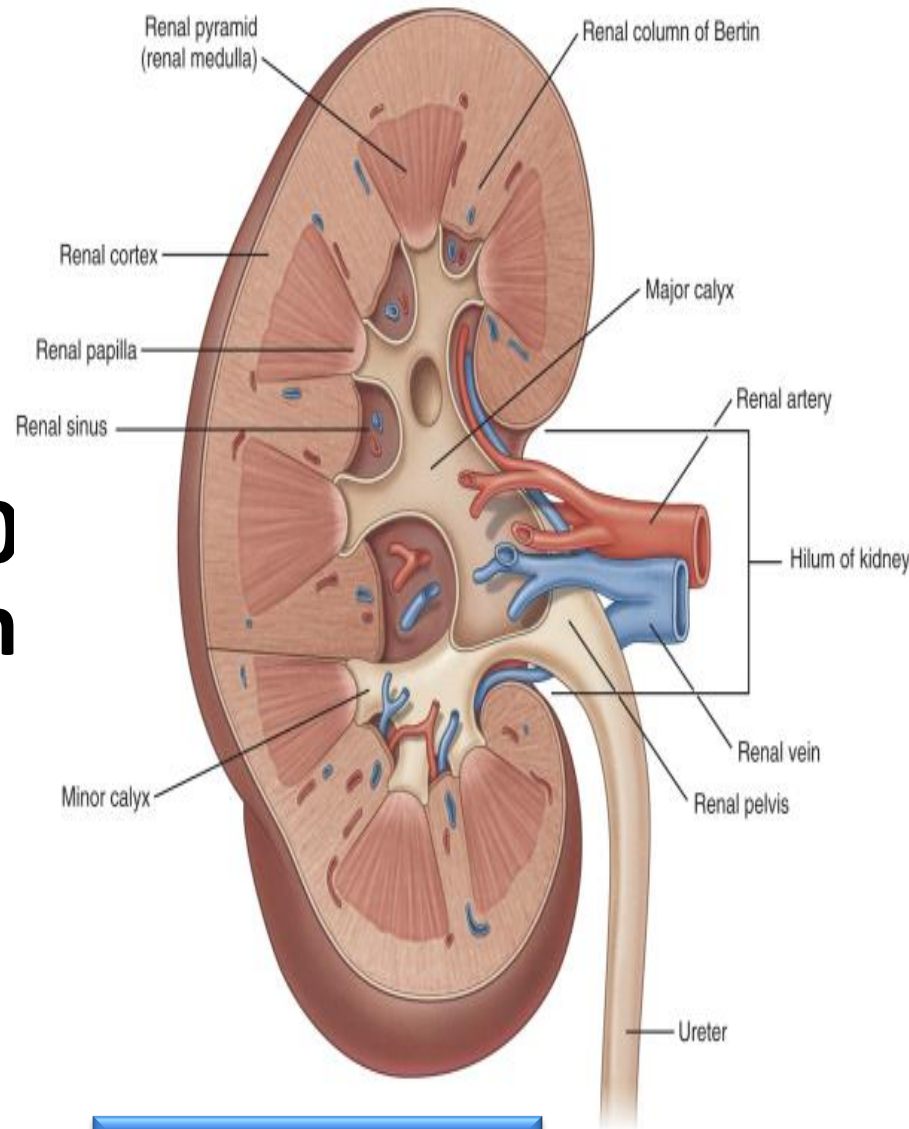
- ***1- the activity of the macula densa cells which react to changes in fluid passing them in the distal tubules;***

2- pressure in glomerular arterioles affecting the secretory activity of their granule cells;

- *stimulation by sympathetic fibers ending near juxtaglomerular cells.*

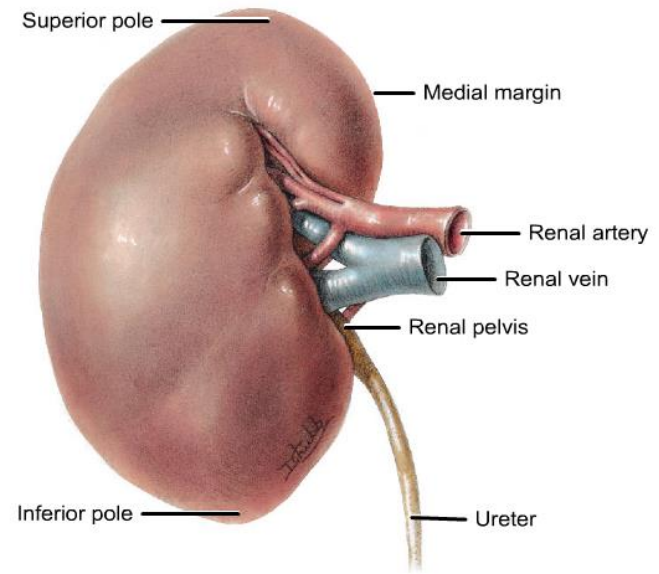
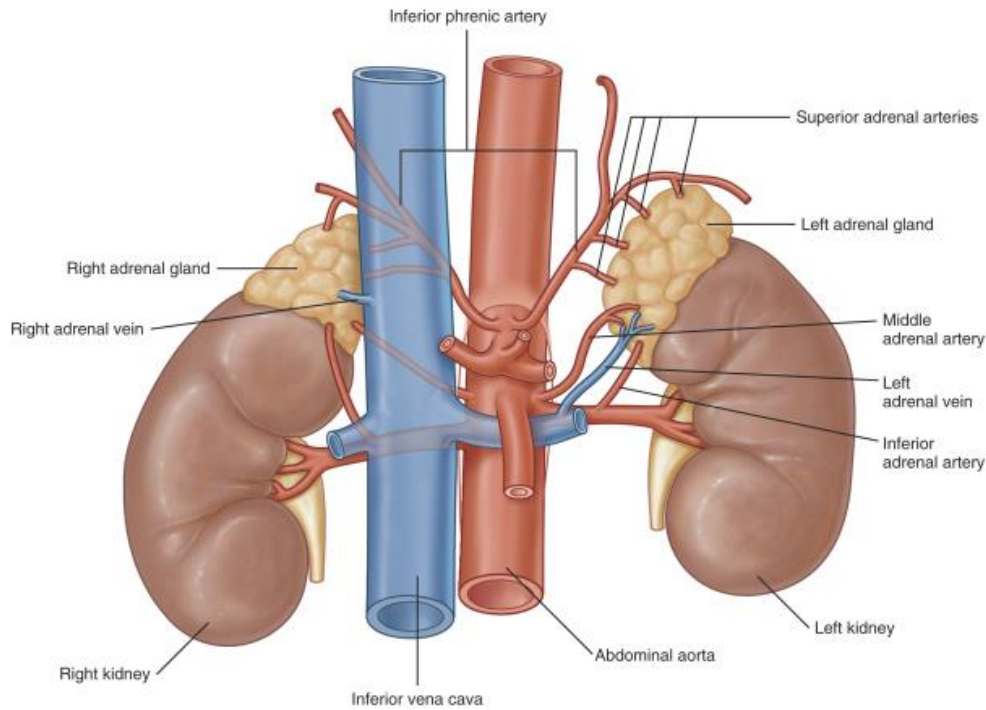
GROSSLY

- The kidney are bilaterally paired **reddish brown organs** ,bean shape .
- Each kidney weighs **150 gm** in male & **135 gm** in female.
- The kidney generally measured **10-12 cm** vertically ,**5-7 cm** transversely,& **3cm** in antero-posterior dimension.

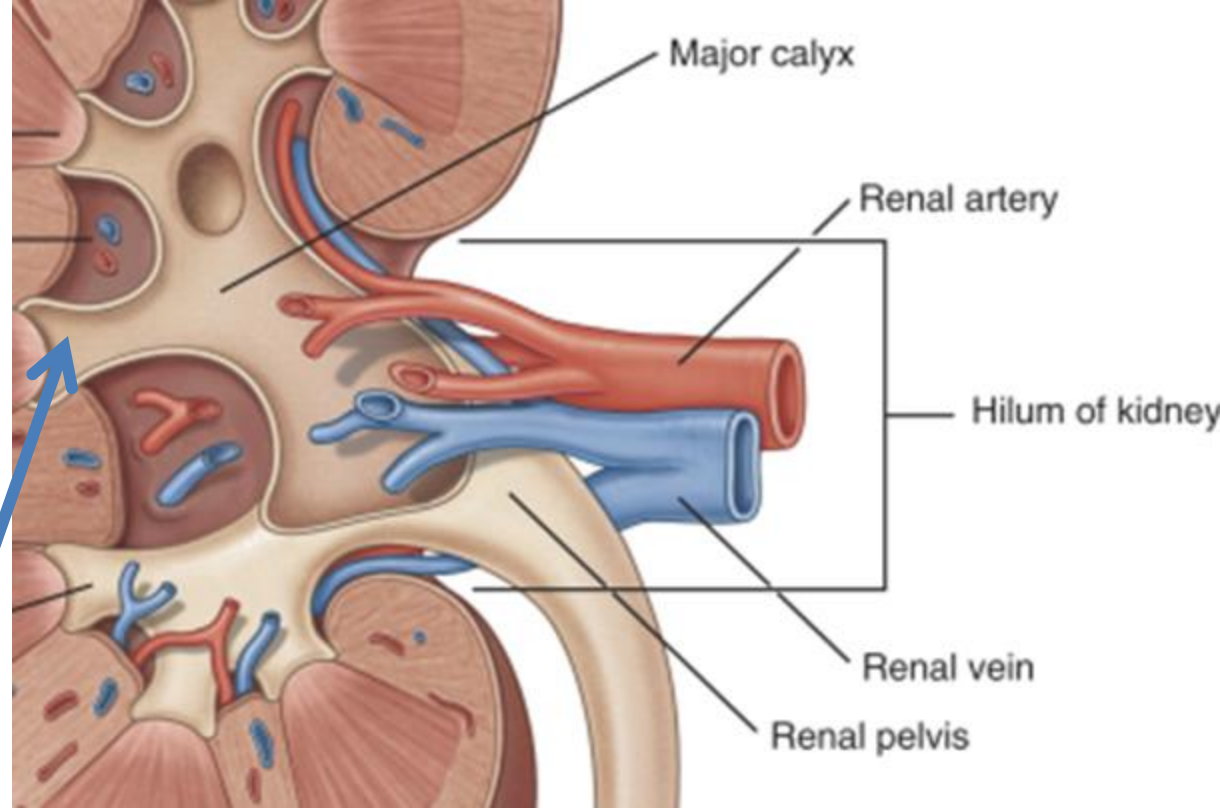


cm 3-6-12
2.5-5-10

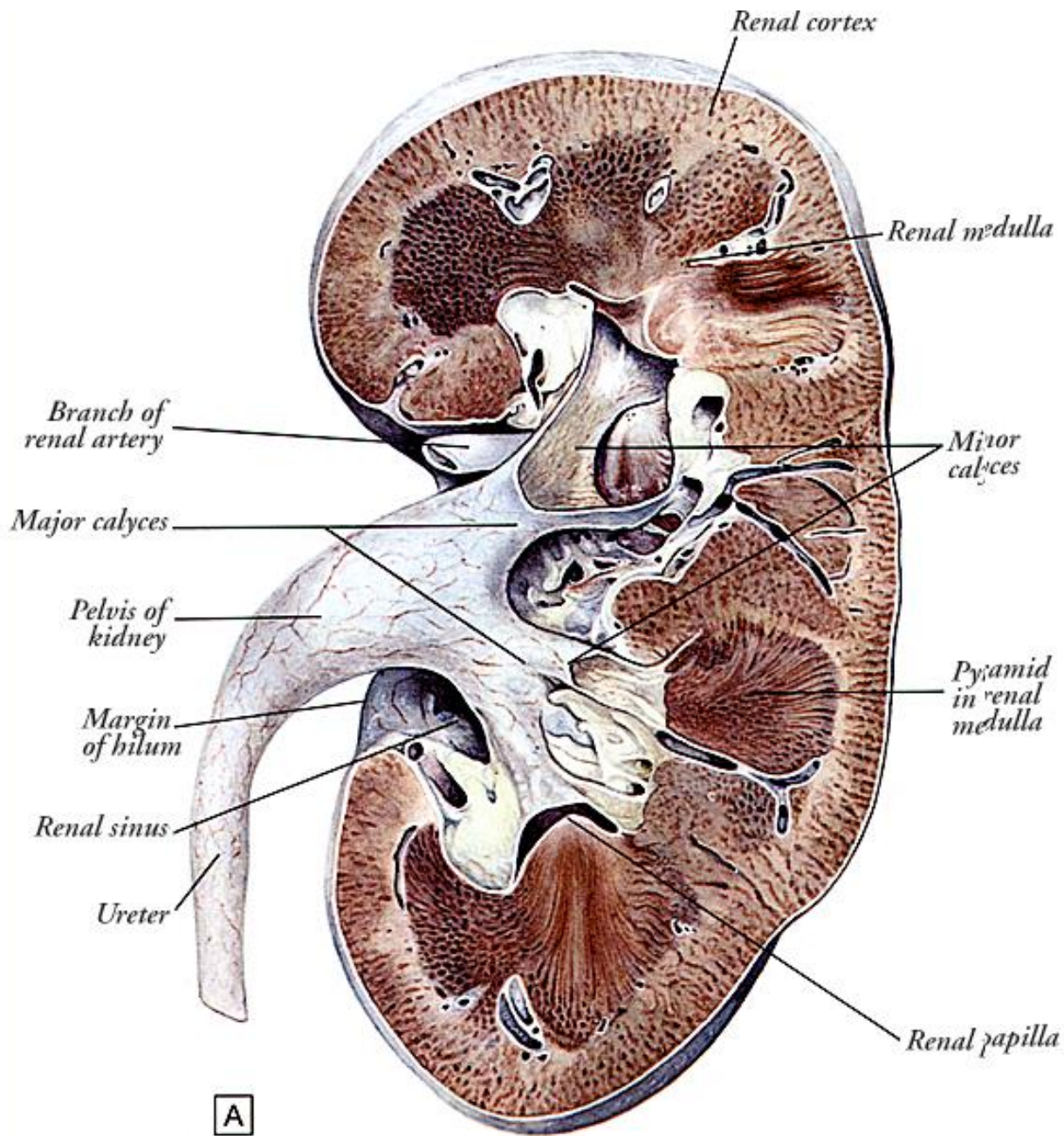
- Because of compression by the liver, the right kidney shorter & wider.
- In children, the kidneys relatively larger & possess more prominent fetal **lobation**, which disappear by **first year of life**, occasionally persist into adulthood.



Renal sinuses:
space in hilum
contain renal
pelvices (2-3
major calyces
then each form
2-3 minor cal.)
minor calyx
receive one
papilla.

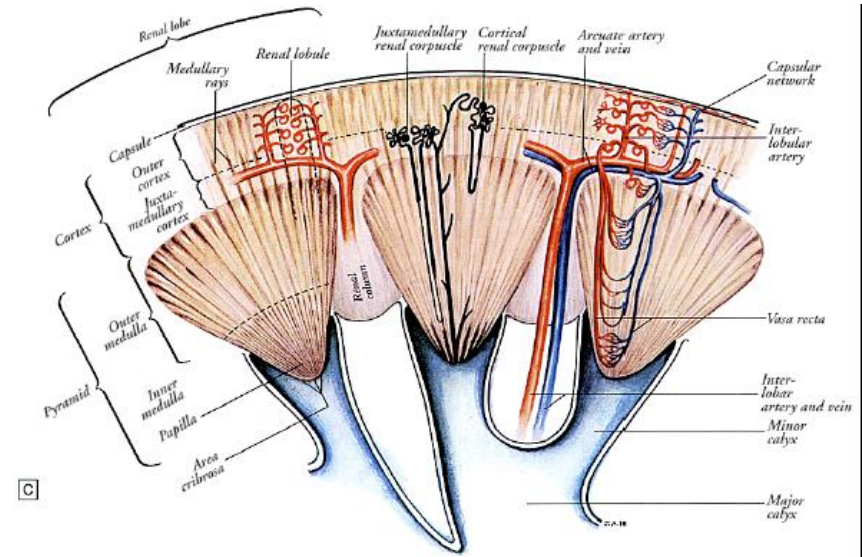


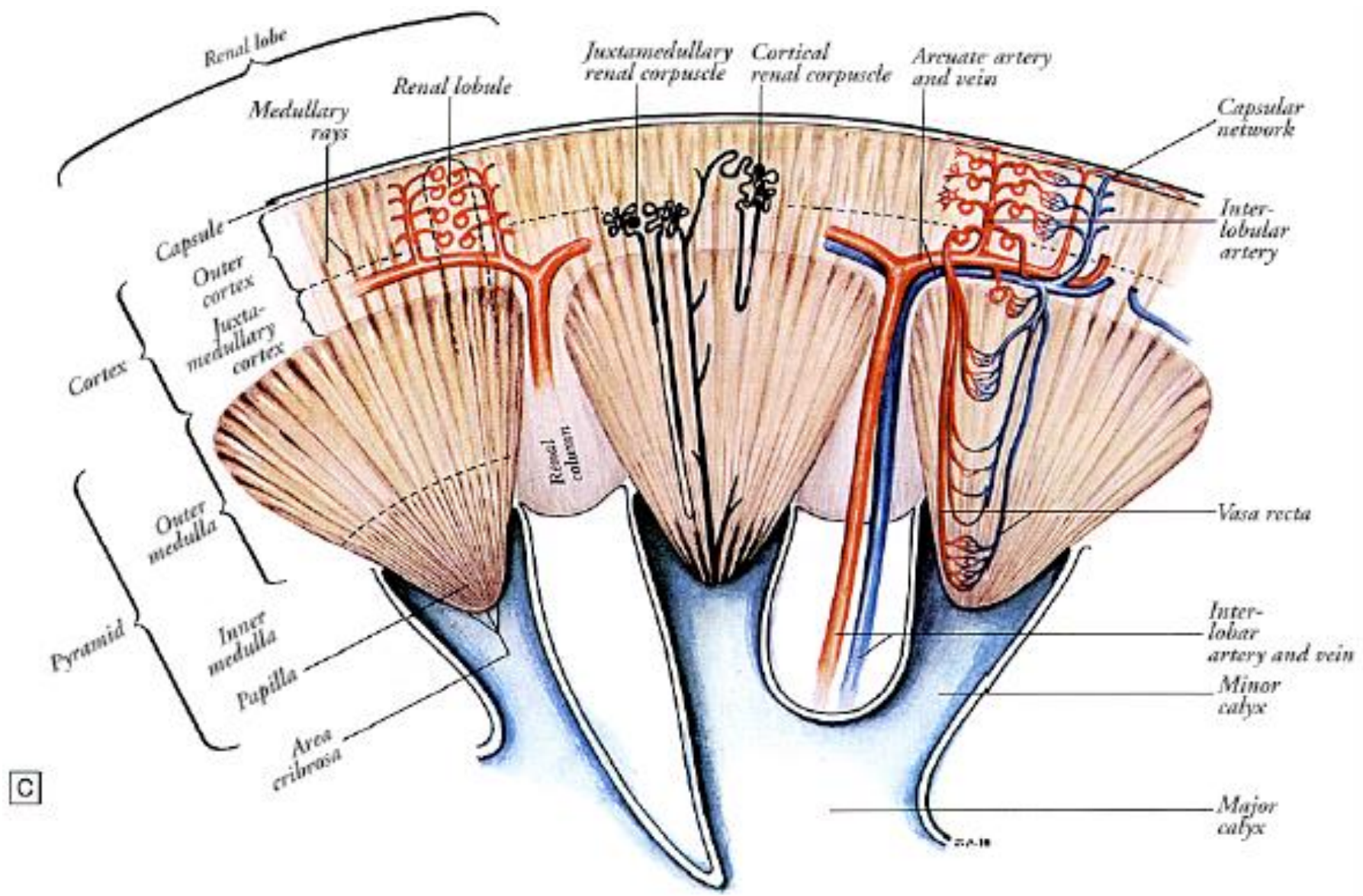
- Renal pyramid dozen in no (<12).



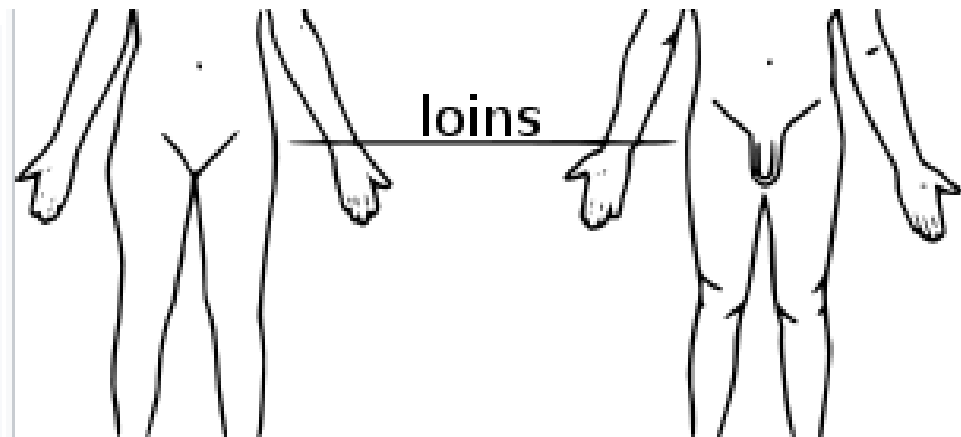
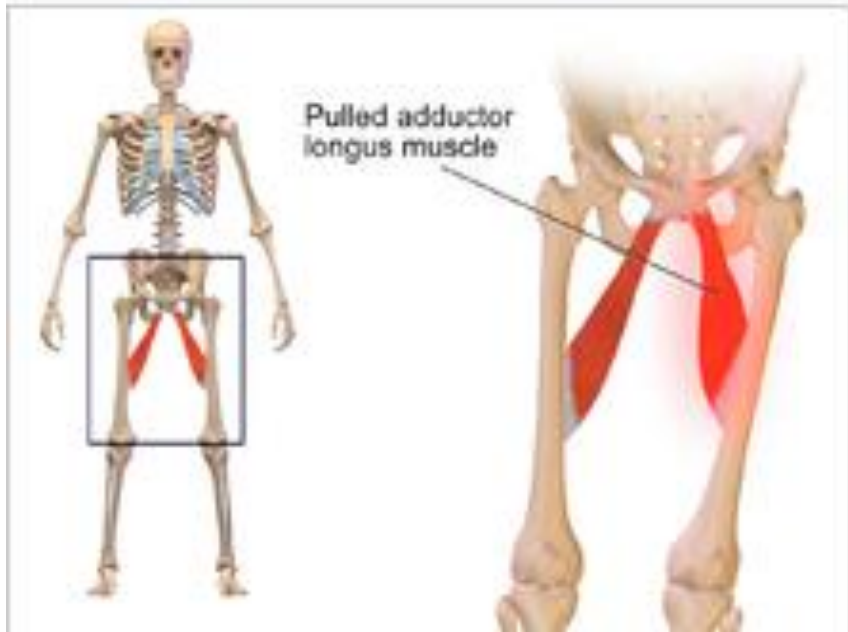
The kidney divided into cortex & medulla


- the medullary areas are pyramidal, more centrally located & separated by sections of cortex the segments of cortex called **columns of Bertin**.
- The renal medullas are multiple, distinct, conically shaped areas, darker than cortex.
- The same structures also called **pyramids**.
- .





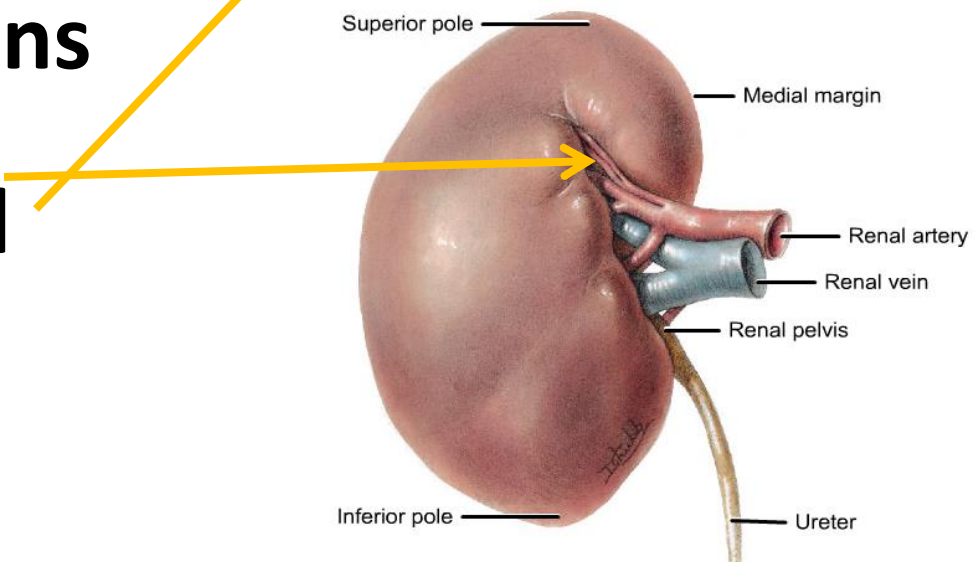
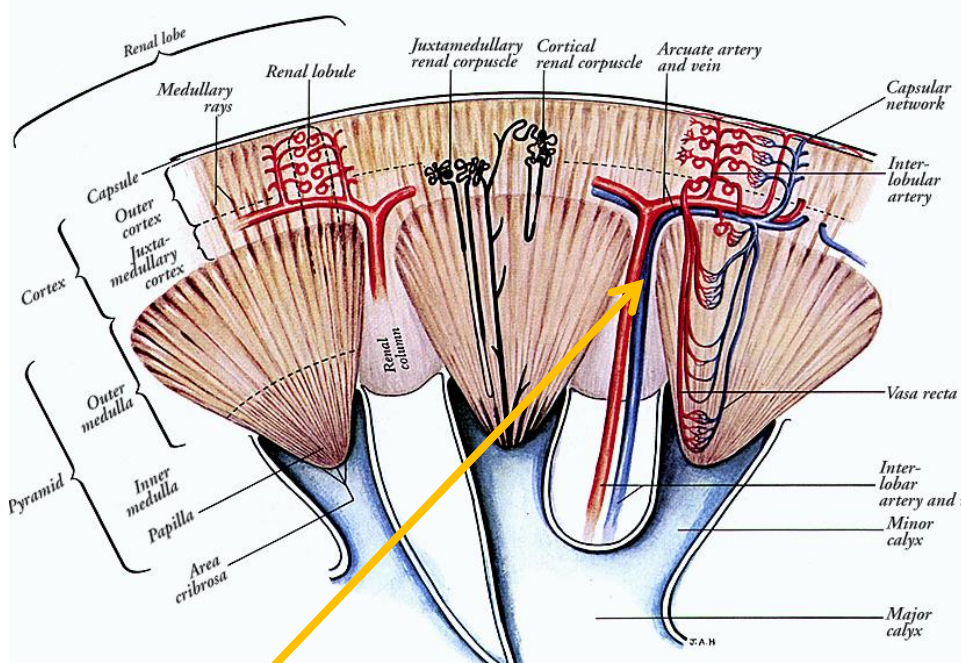
The pain, spasmodic and agonizing, is referred to cutaneous areas innervated from spinal segments which supply the ureter, mainly T11–L2. It shoots down and forwards from the loin (side of the human body below the rib cage to just above the pelvis) to the groin (between the abdomen and the thigh) and scrotum or labium majus and may extend into the proximal anterior aspect of the thigh (ilioinguinal) and projection to the genitofemoral nerve (L1, 2); the cremaster (which has the same innervation) may reflexly retract the testis.

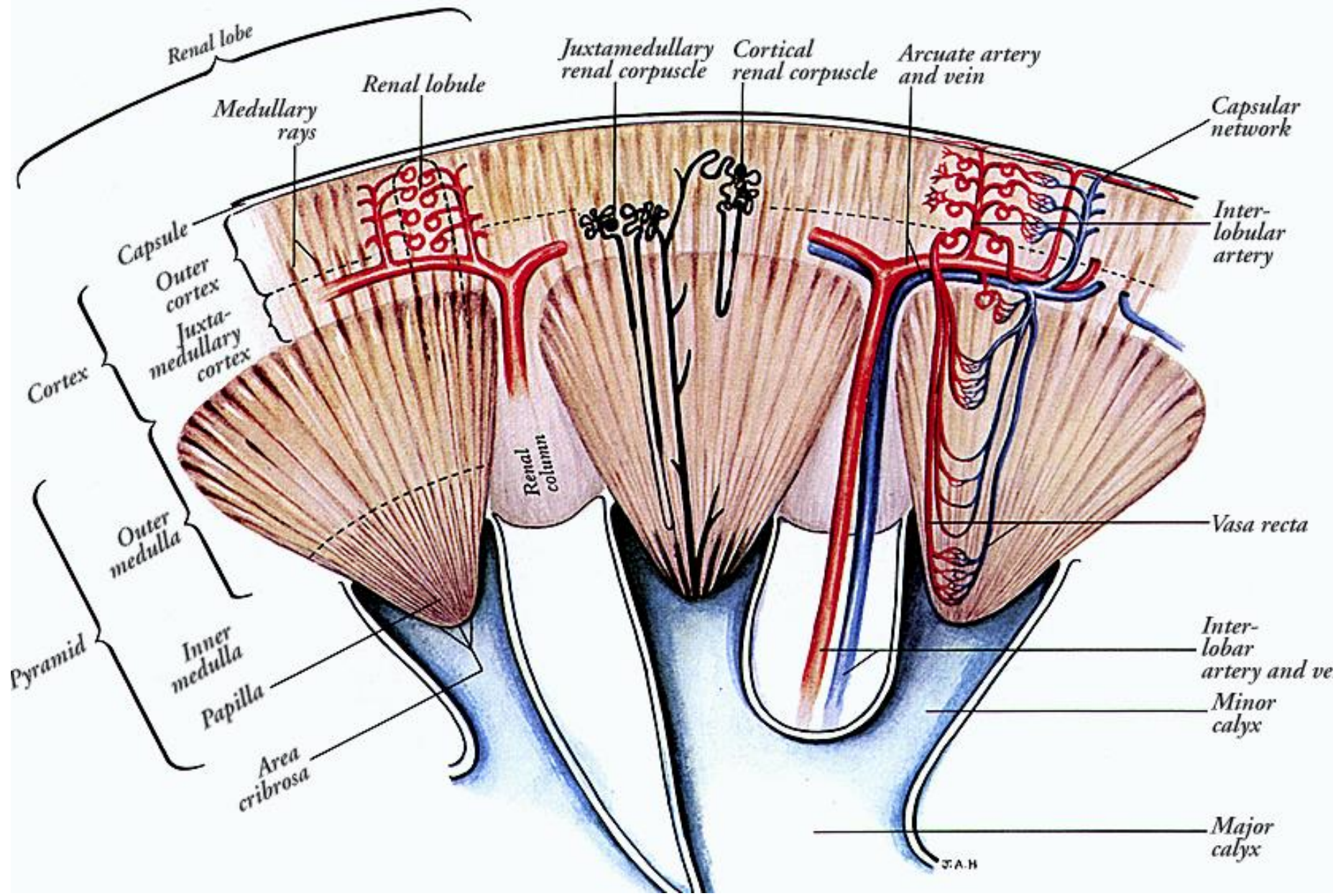


Human loins, on the side of the rib cage and pelvis 

- **RENAL CORTEX: is** lighter in color than the medulla & not only cover the renal pyramid peripherally but also extends between pyramids (**columns of BERTIN**) themselves .

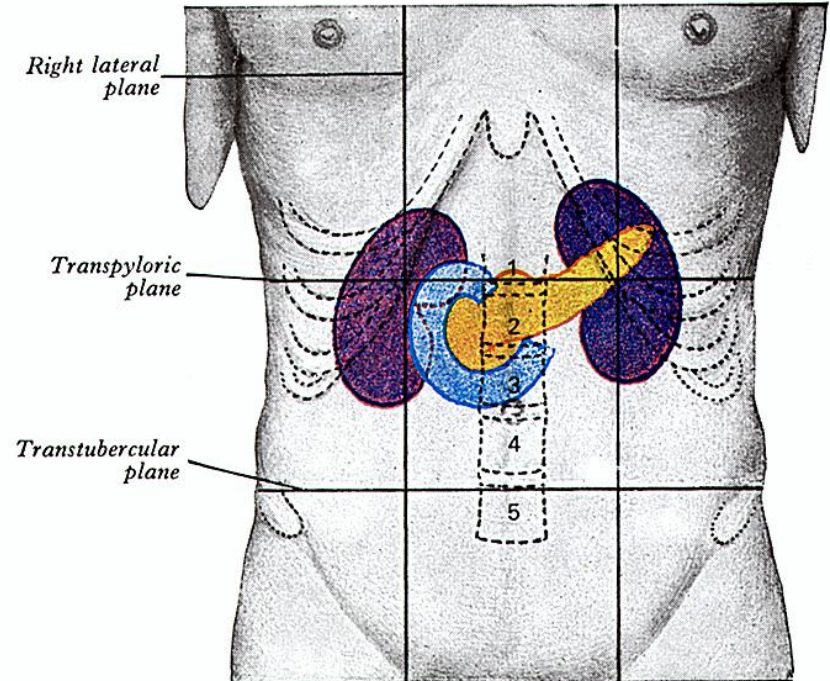
through these columns the renal vessels traverse from renal sinus to peripheral cortex



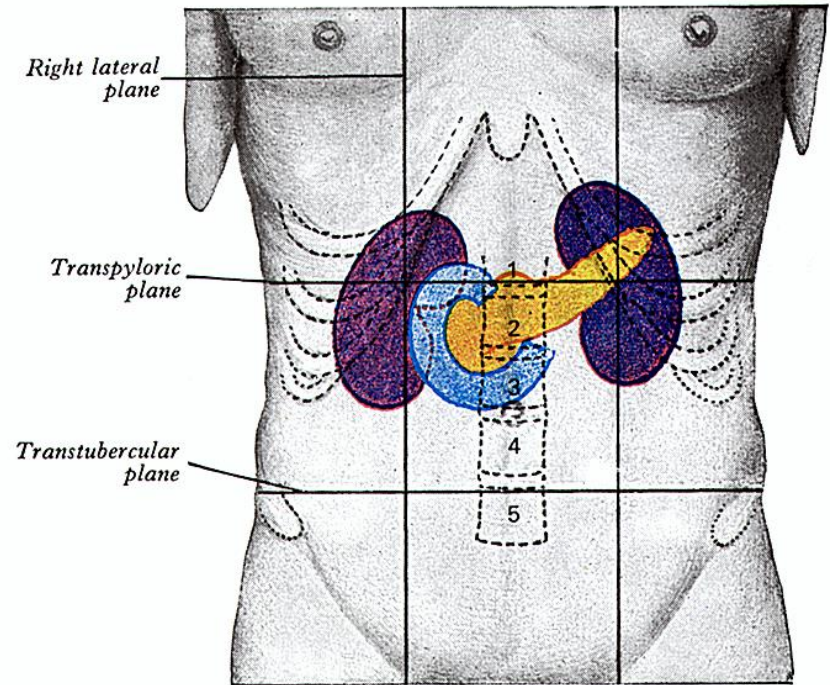


Renal surface projects

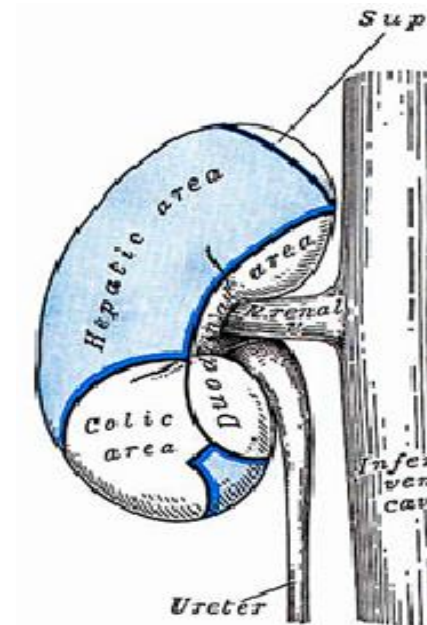
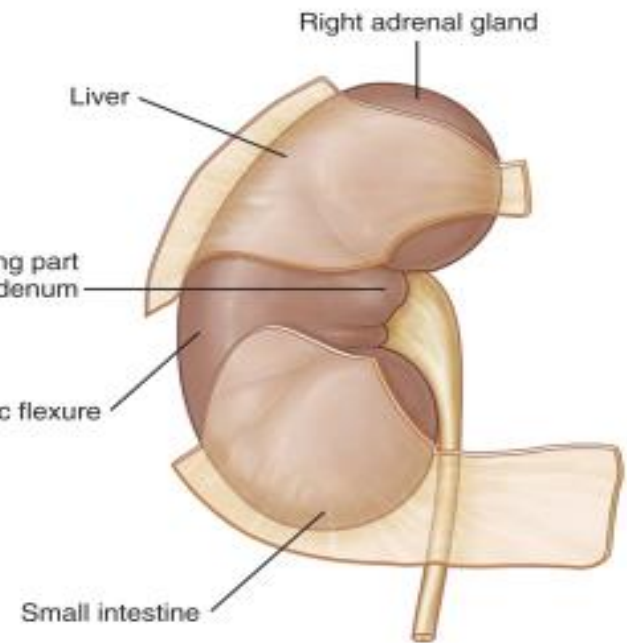
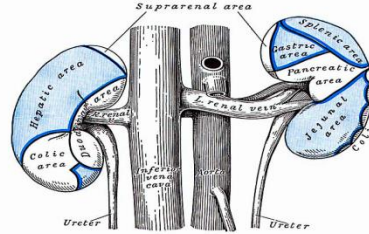
- **Anterior surface**: hilar centre at transpyloric plane, medial to tip of 9th costal cartilage (left hilar just above the plane & right just below)
- **Posterior surface**: the hilar centre opposite the lower border of spinous process of L1



- The kidneys are 2.5cm lower in standing than recumbent position
- They ascend & descend a little with respiration
- **Right kidney 1.25 cm lower than left because right lobe of liver**

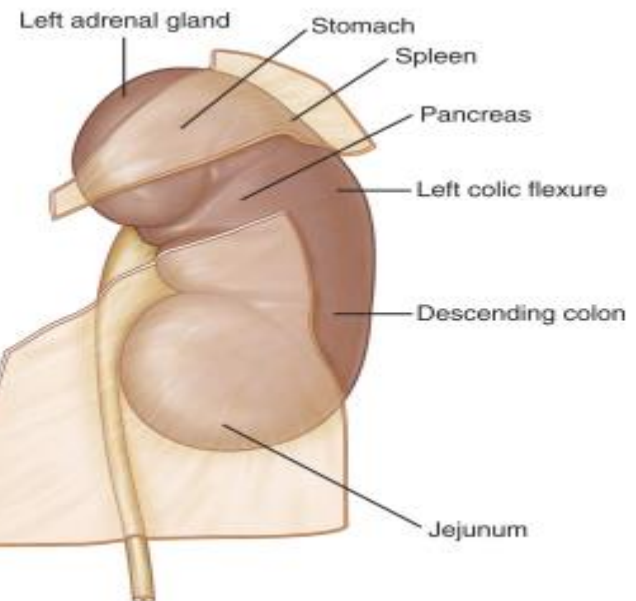
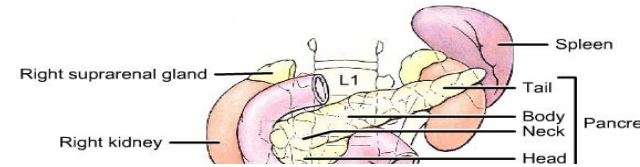
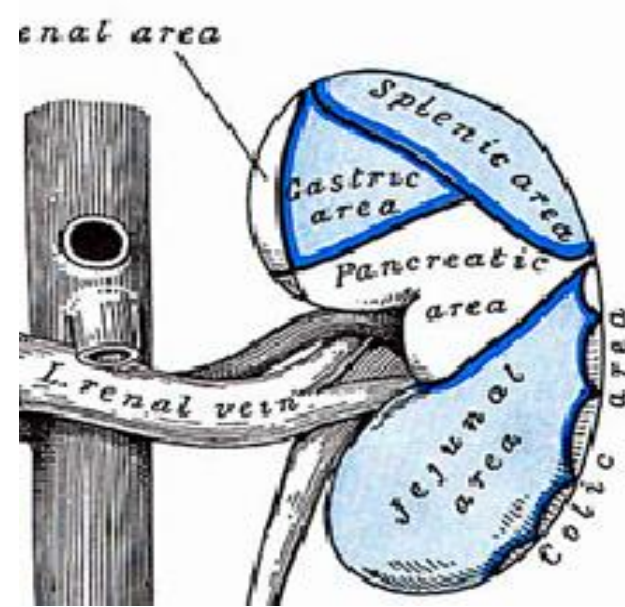


Renal relations



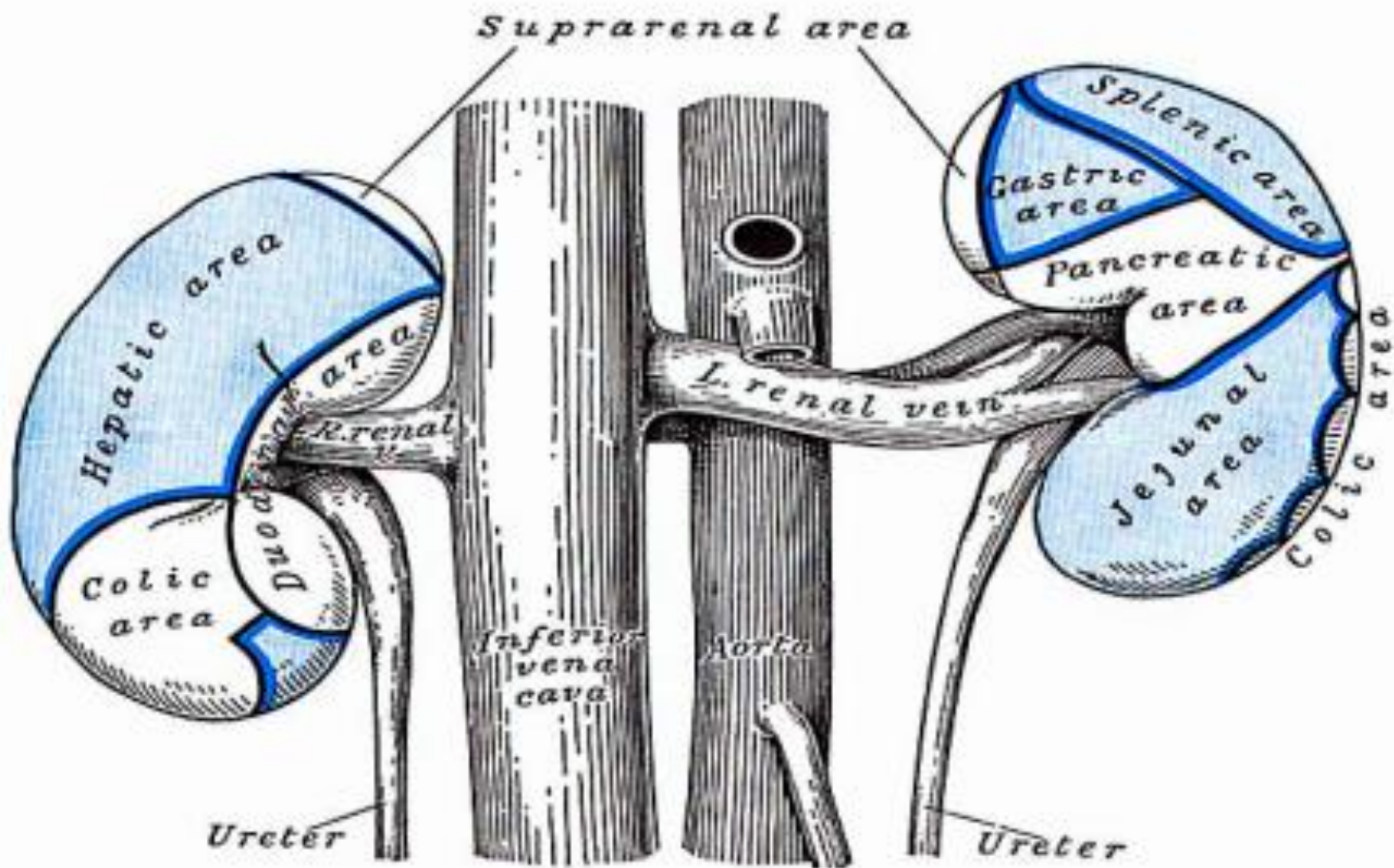
- **Anterior surface of right kidney:**
 - Superior pole:- contacts the suprarenal gland ,large area belc this ;right lobe of live
 - Medial area: 2nd part of duodenum.
 - Inferiorly contact with right colic flexure laterally & small intestine medially,
- The area of contact with liver & small intestine cover by peritoneum, but suprarenal duod. & colic area devoid peritoneum.

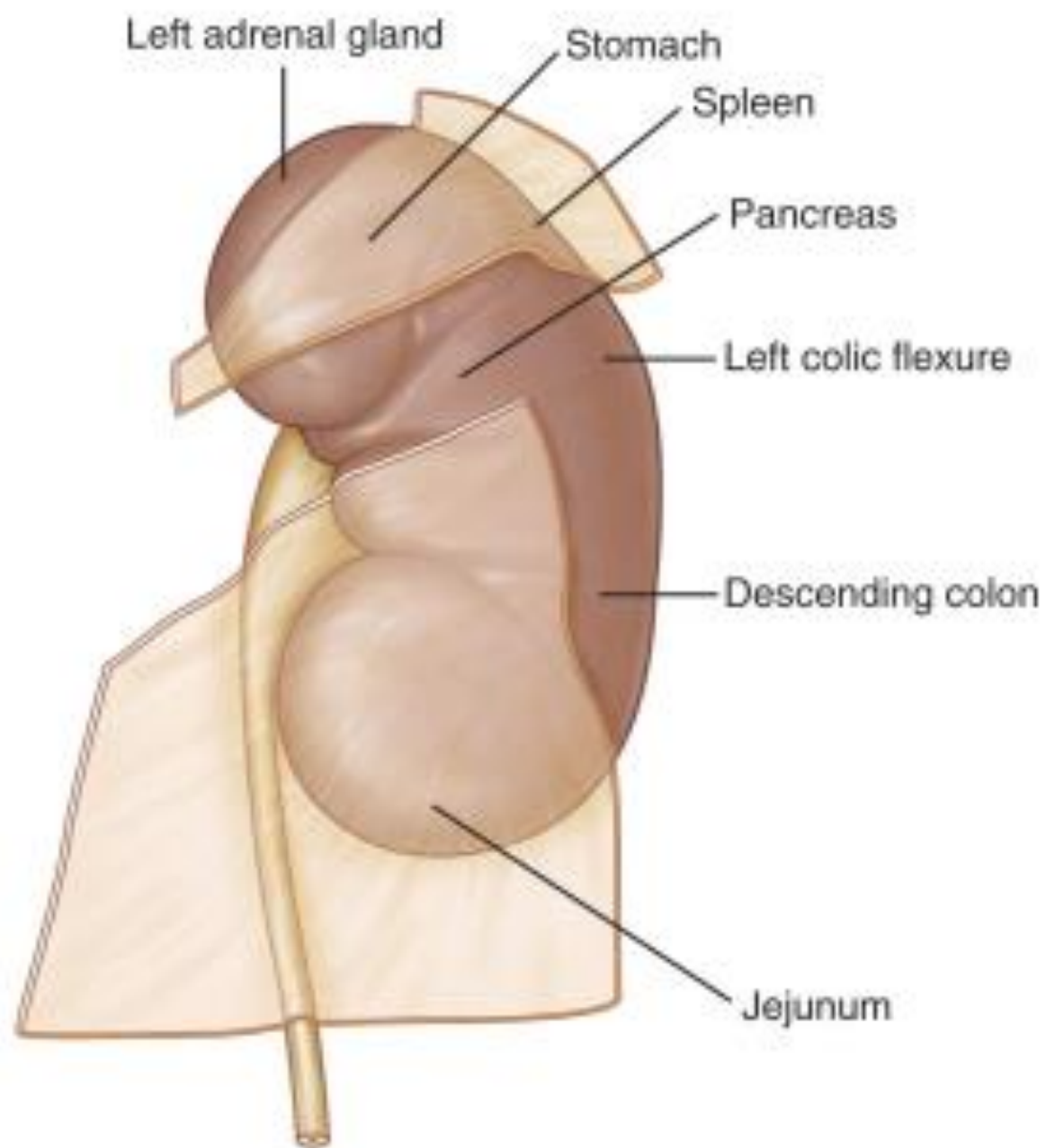
- **Anterior surface of left :**
- superior pole: **L. SUPRARENAL GLAND,**
- lateral half related to spleen,
- central area: **pancreatic body & splenic vessels, stomach,**
- lateral region: **L. colic flexure & beginning of descending colon,**
- Medial :**coils of jejunum.**



The gastric area, spleen & jejunal area are cover with peritoneum.

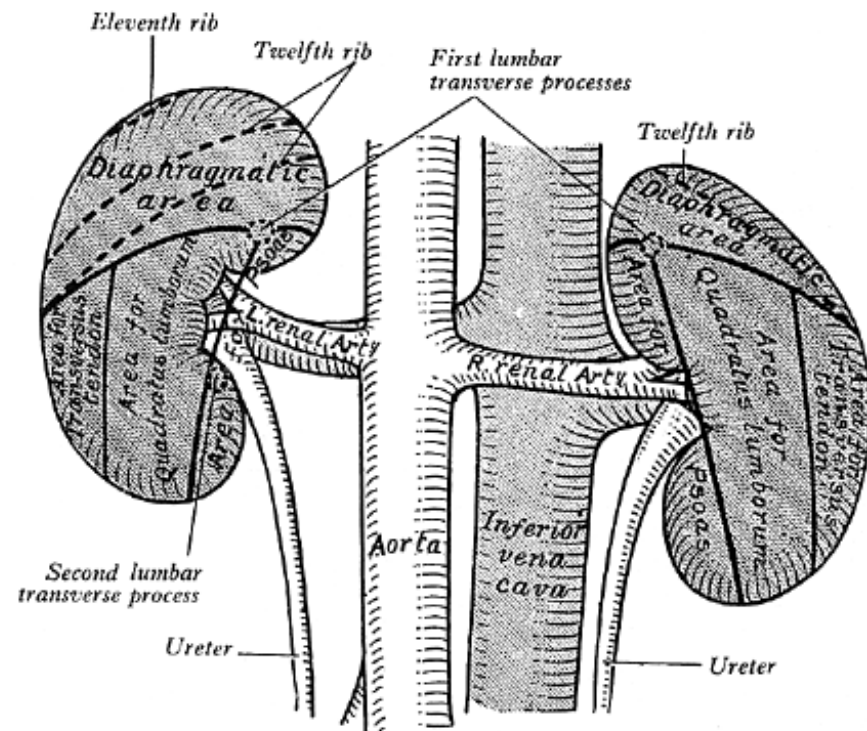
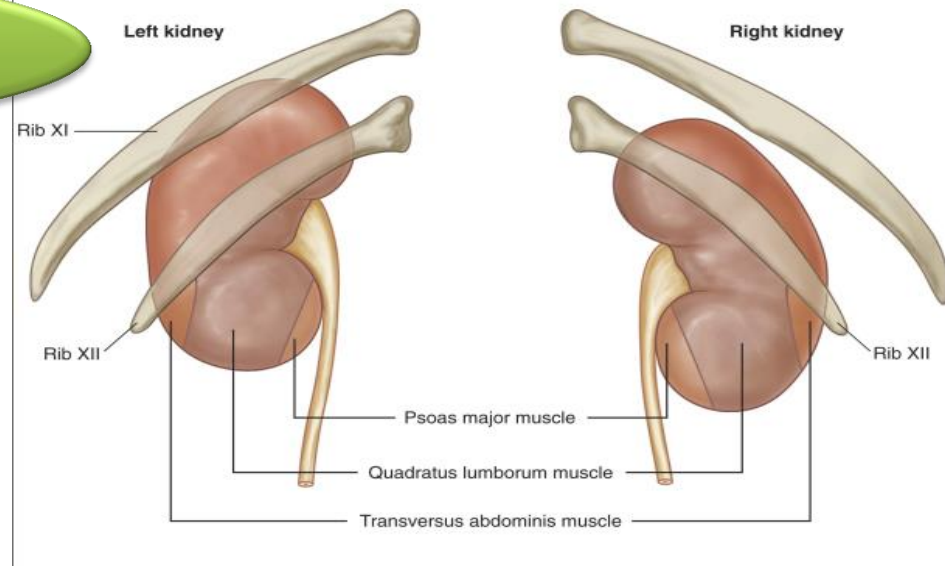
The suprarenal ,pancreatic & colic area are devoid of peritoneum.





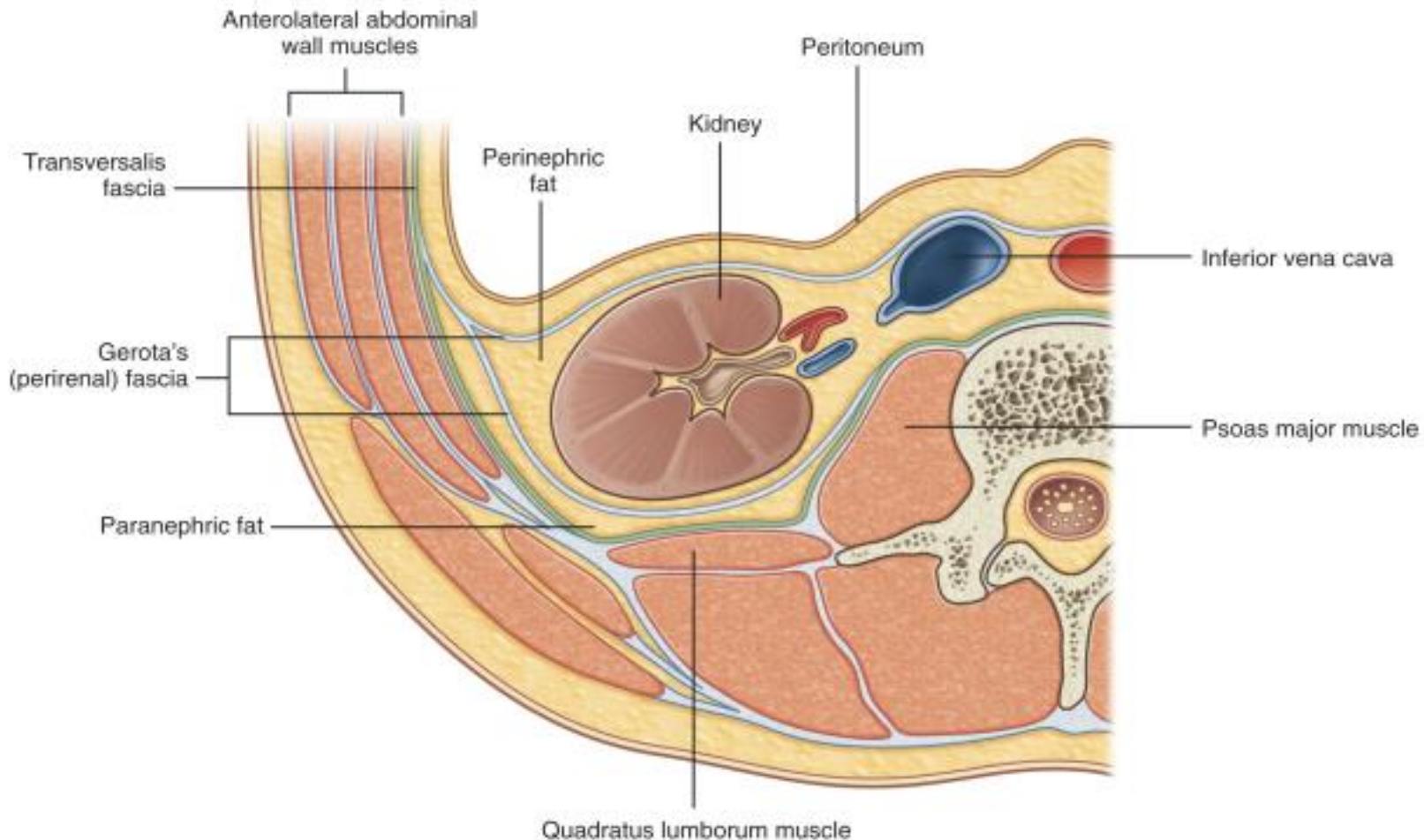
Posterior surface

- Posteromedial is embedded in fat & devoid of peritoneum.
- It is Anterior to diaphragms & to the medial & lateral arcuate ligament ,psoas major ,quadratus lumborum & aponeurotic tendon of transversus abdominis ,to subcostal vessels & subcostal. iliohypogastric & ilioinguinal nerve .
- The upper pole of R. kidney is level with 12th rib ,that of L. kidney with 11th & 12th ribs.

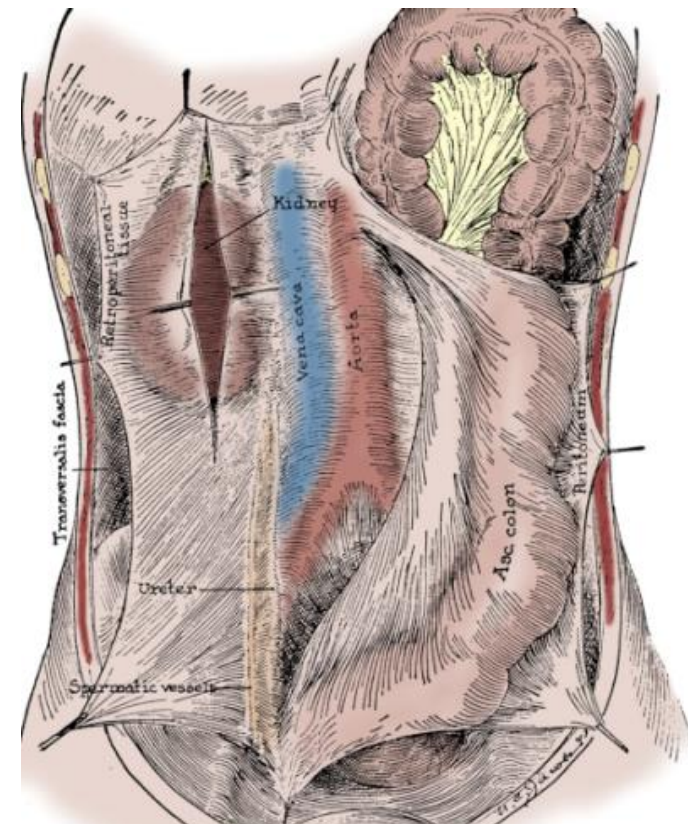


Covering of kidney

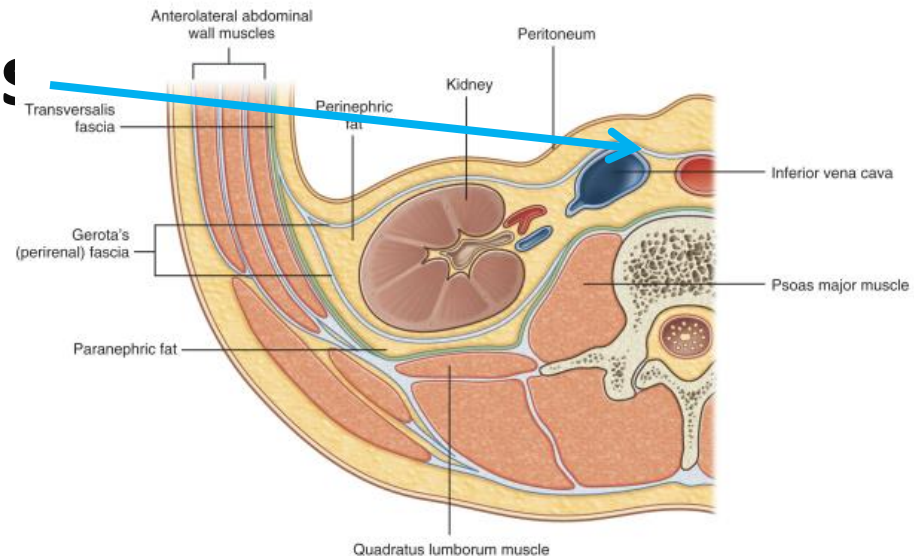
1. Fibrous capsule : closely attached to outer surface.
2. Perirenal fat : around the renal capsule .



3. perirenal fascia (**gerotas fascia**): enclose kidney & suprarenal gland & continuous laterally with fascia transversalis, the fascia enclose kidney on 3 sides: Superiorly, medially & laterally.



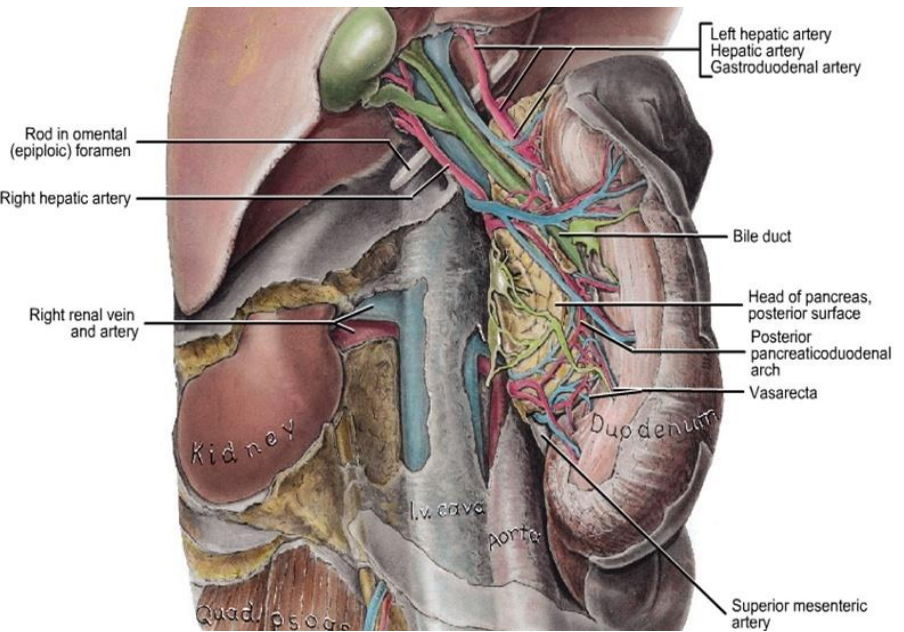
Medially it extend across midline to fuse with contra lateral side.



**Inferiorly not closed
& remain an open
potential space.**

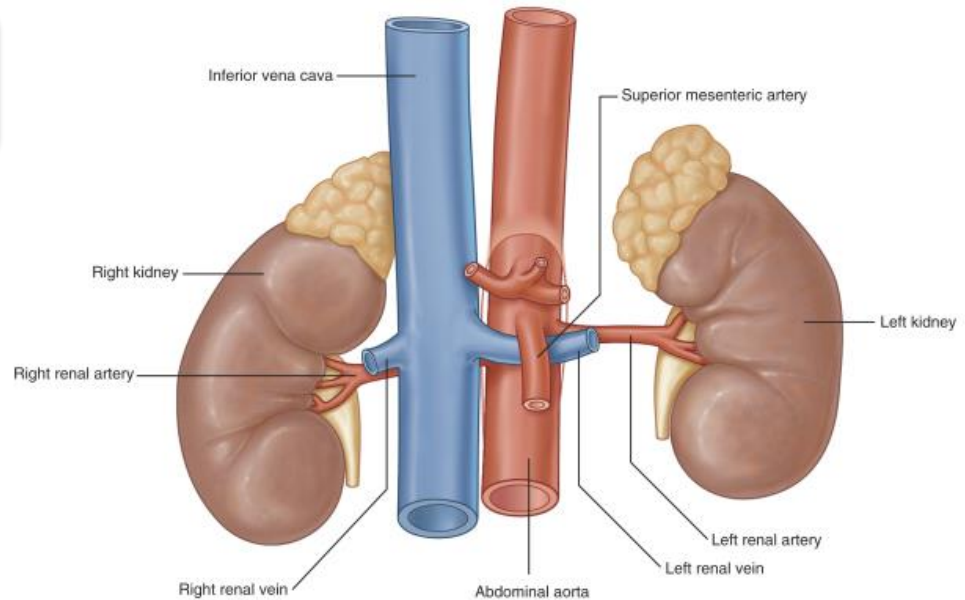
**Gerotas fascia serves
as an anatomical
barrier to spread
of malignancy.**

**4. Pararenal fat
:continuous with
retro peritoneal
fat (extra
peritoneal fat.**



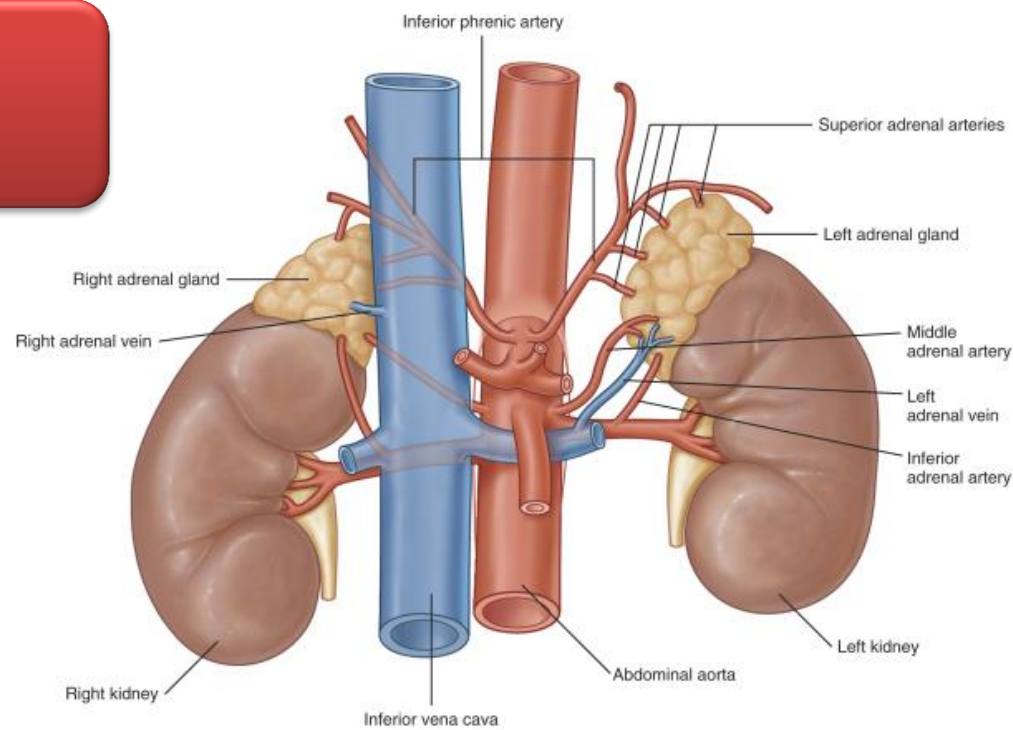
Renal vasculature

- Classically consist of single artery & single vein that enter the kidney via the renal hilum.
- The artery & vein are branch from aorta & IVC, just below Superior mesenteric artery at level of L2.
- The vein anterior to artery , renal pelvis & ureter located posterior to vascular structure



Renal artery

- **Right renal artery:** leaves aorta & progresses with caudal slope under IVC toward the R. kidneys.
- **Left renal artery:** courses directly laterally to the L. kidney.
- **Both renal artery move posteriorly as they enter kidneys**
- **Both artery have branches to respective (adrenal gland, renal pelvis & ureter).**



- The renal artery splits into 4–5, these are renal segmental artery.
- The 1st & most constant branch is posterior segmental branch, which separate from renal artery before enters renal hilum.
- Typical 4 anterior branch from superior to inferior are (apical, upper, middle, lower)

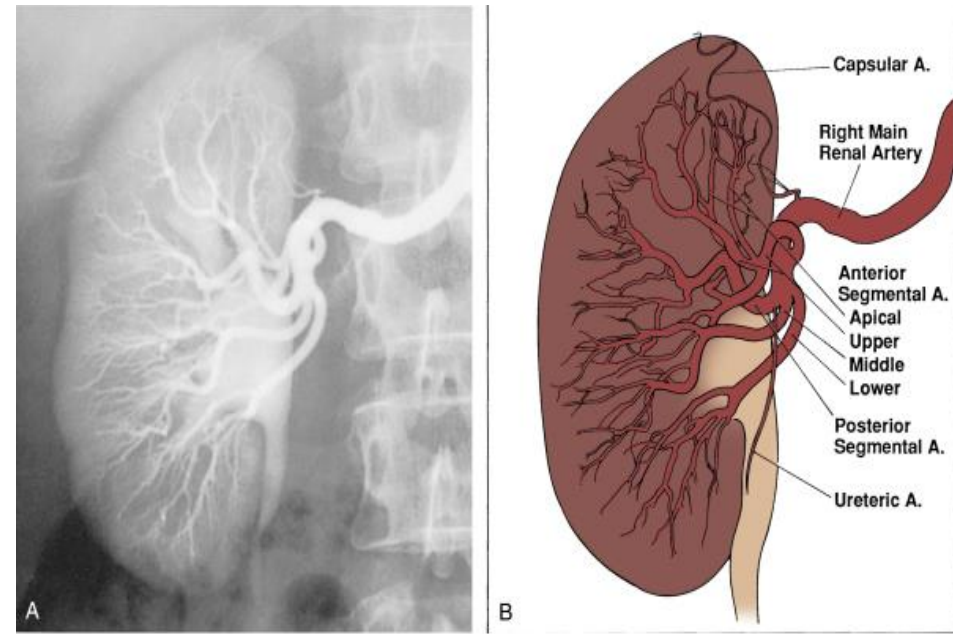
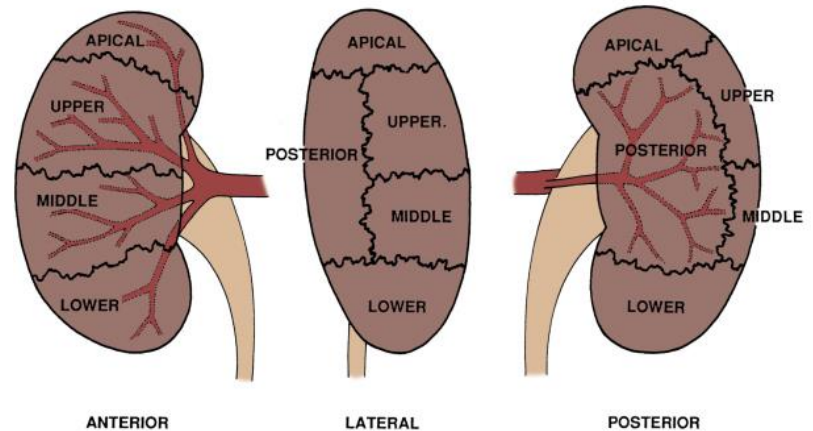


Figure 1-29 A and B, Segmental branches of the right renal artery demonstrated by renal angiogram.



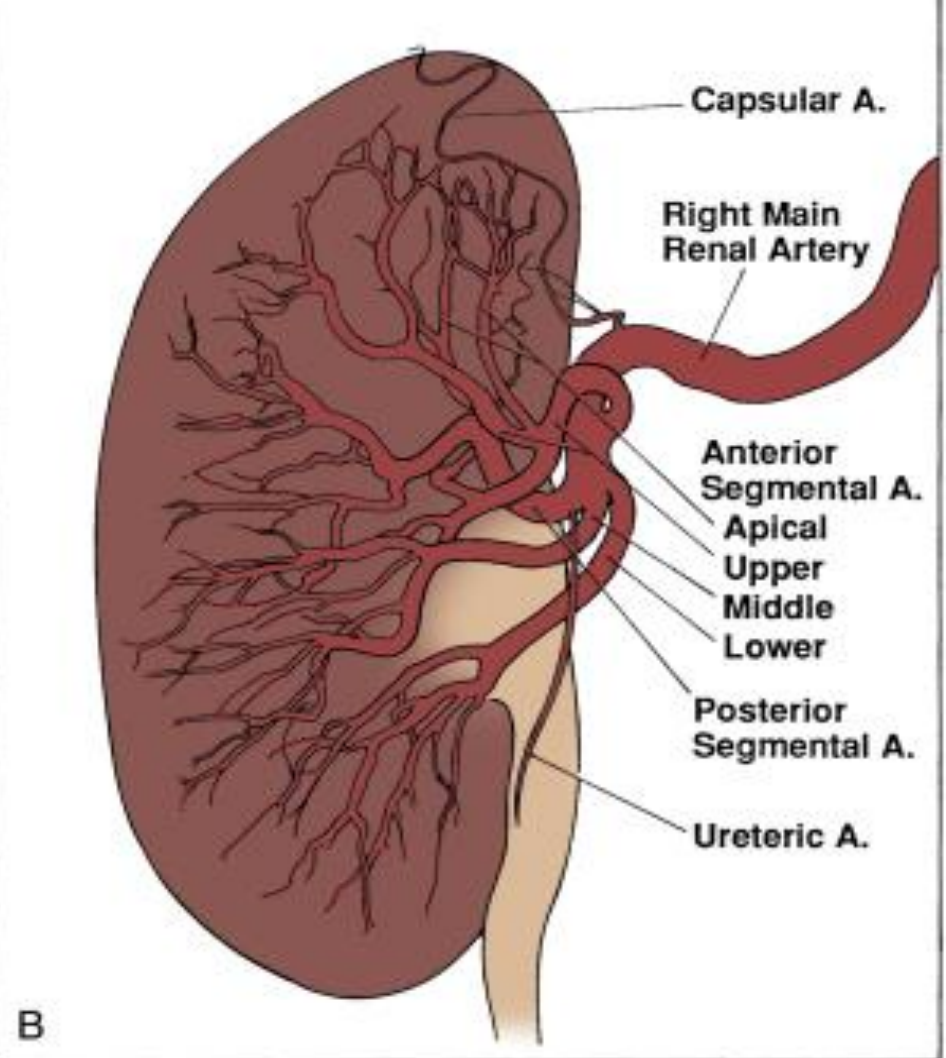


Figure 1-29 A and B, Segmental branches of the right renal artery demonstrated by renal angiogram.

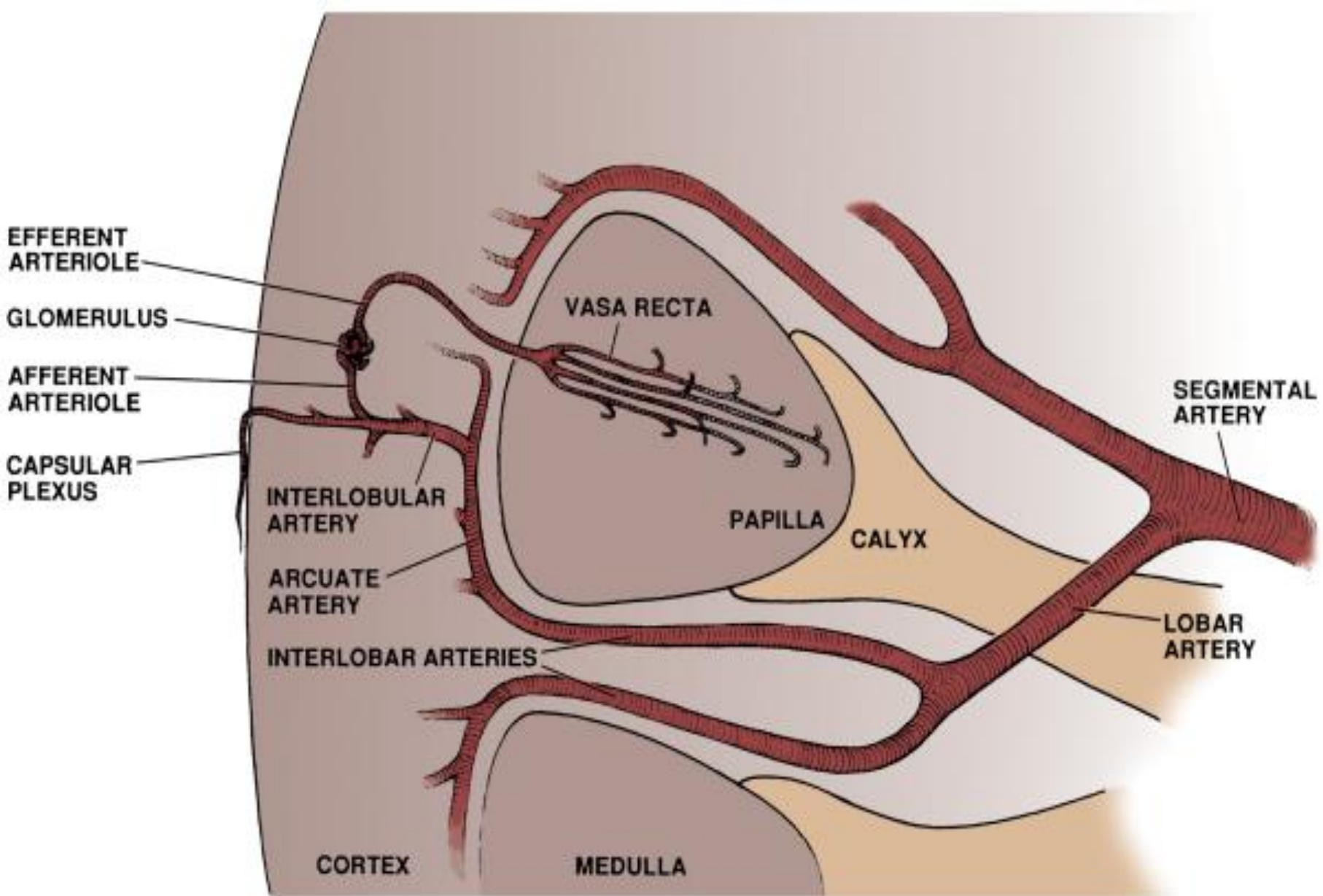
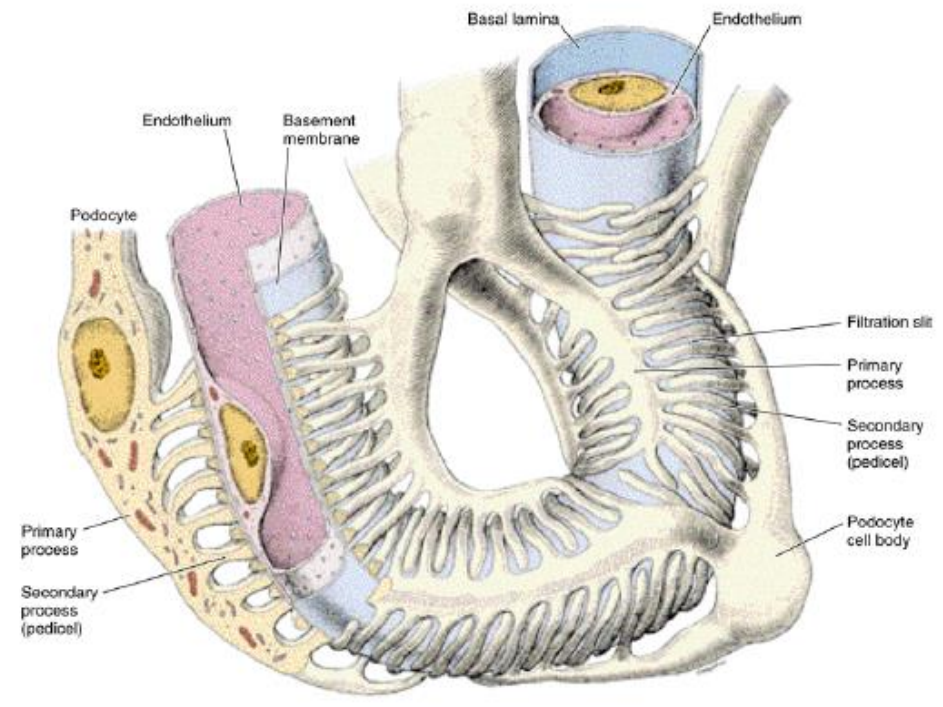
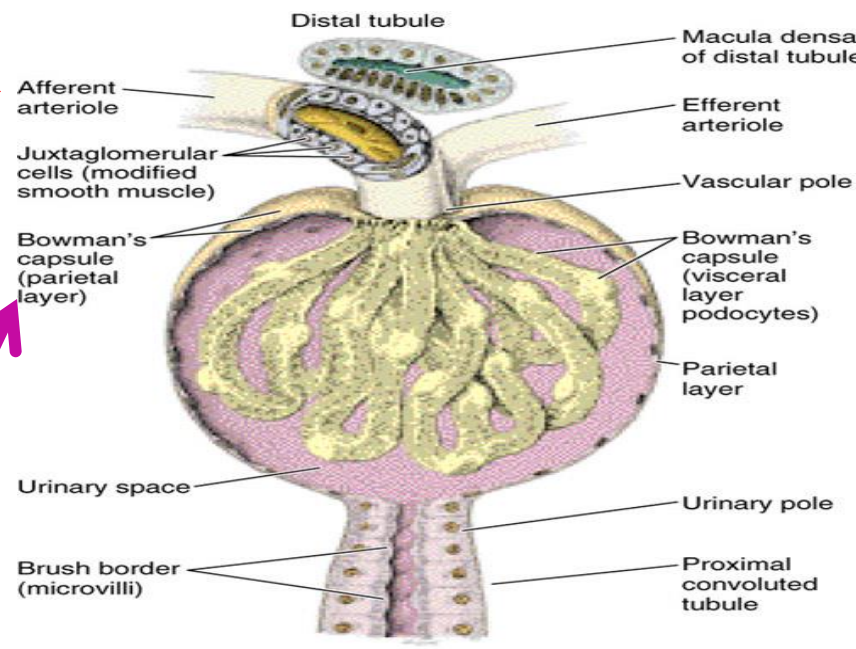


Figure 1-31 Intrarenal arterial anatomy.

2 million glomeruli

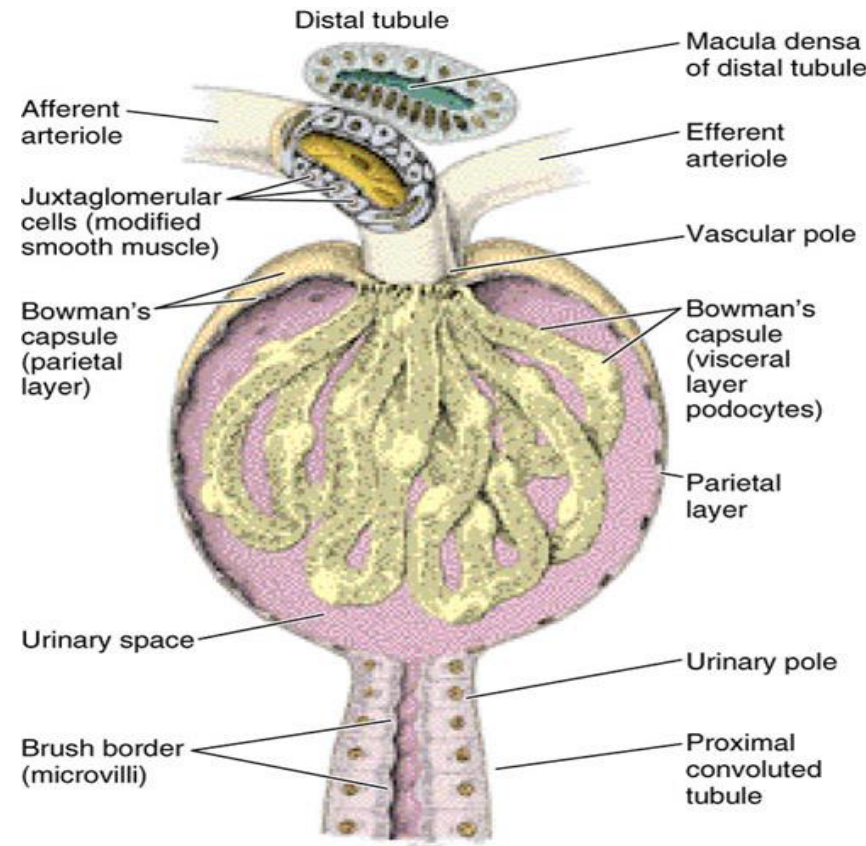
Each is fed by an afferent arteriole

The urine filtrates leaves arterial system & collected in glomerular (bowman's) capsule



Glomerulus

- Double wall capsule parietal layer of simple Squamous cells epithelium
- Visceral podocytes covering capillary network to form glomerulus's
- Between two layer capsular space
- Capsule with its glomerulus's form renal corpuscle

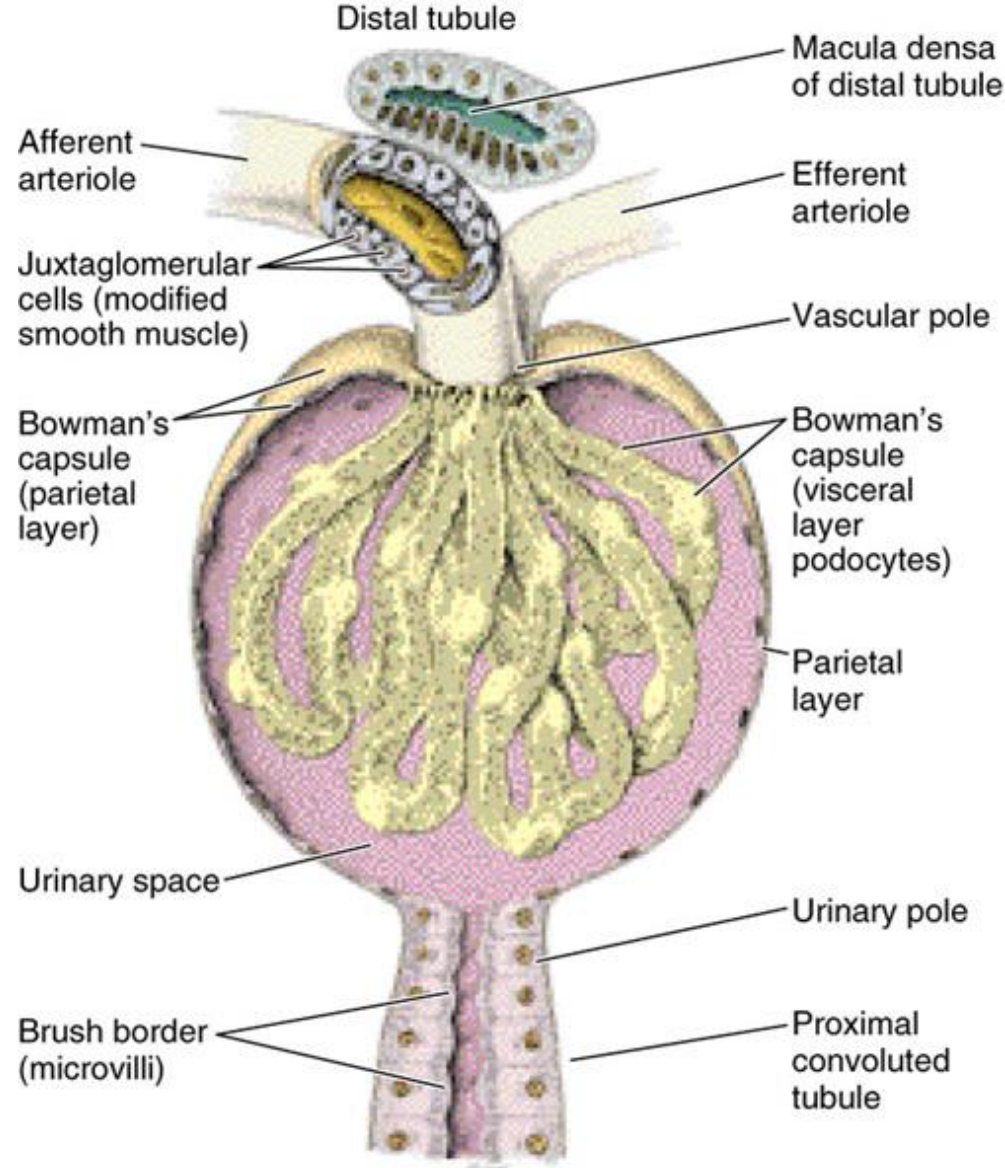


Histology

**Blood flow leave glom.
capillary via (efferent
arteriole) & continues
to one of two
location:**

***2ndry capillary network
around urinary
tubules in cortex, or***

***Descending into renal
medulla as the (vasa
recta).***

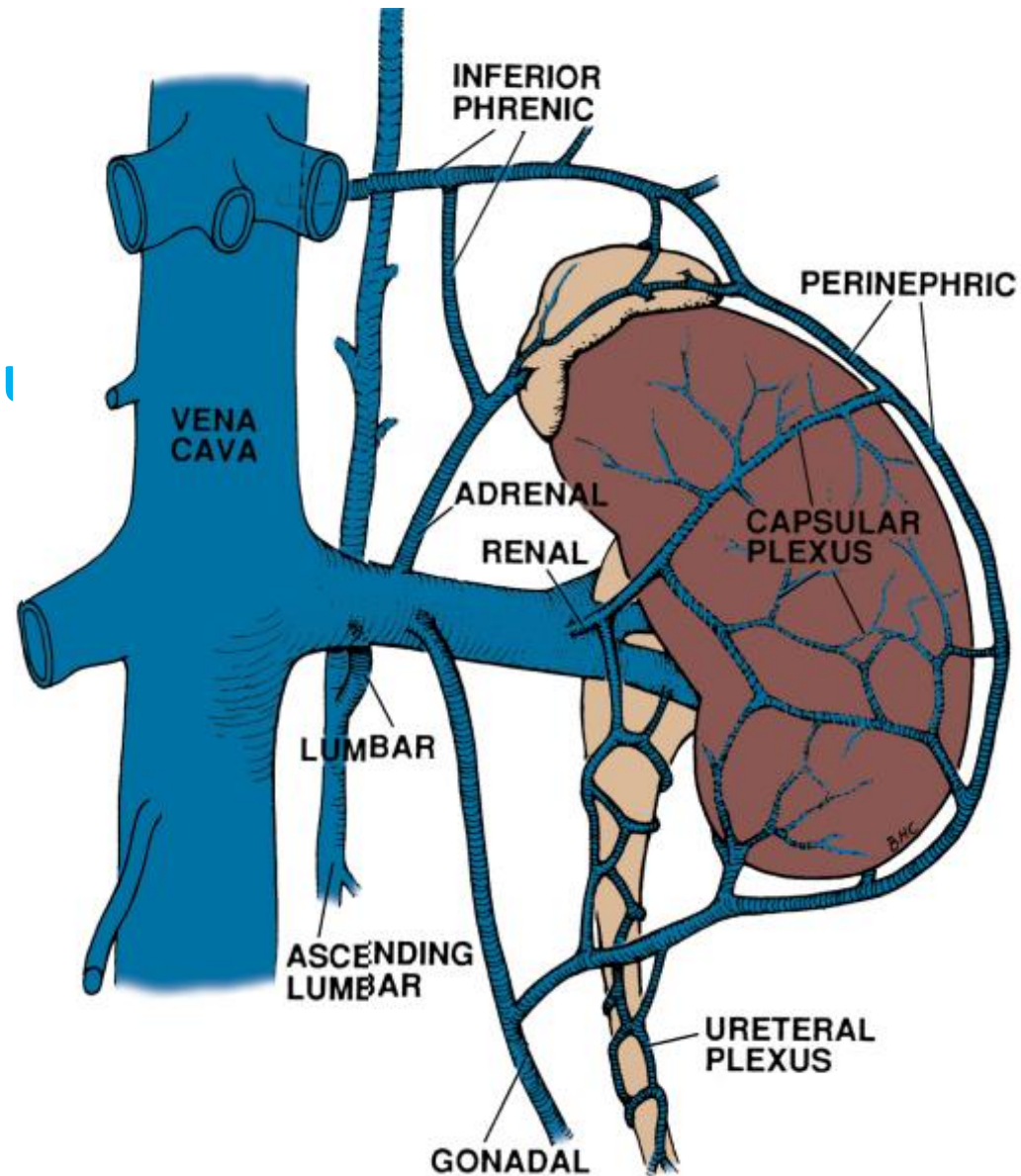


Renal vein

Renal venous drainage correlates closely with arterial supply.

Unlike arterial supply, venous drainage communicates freely through venous collars around the infundibulum, providing extensive collateral circulation.

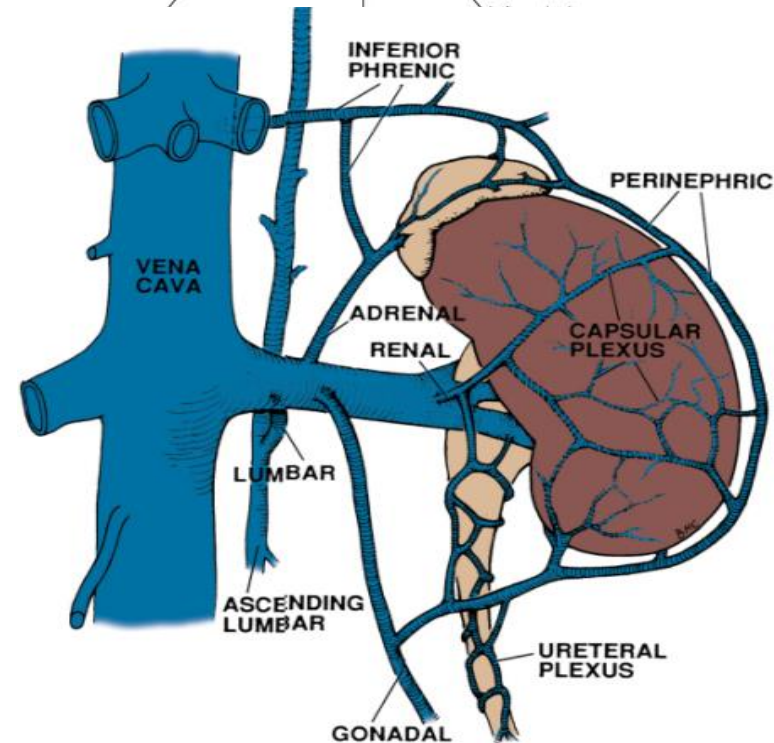
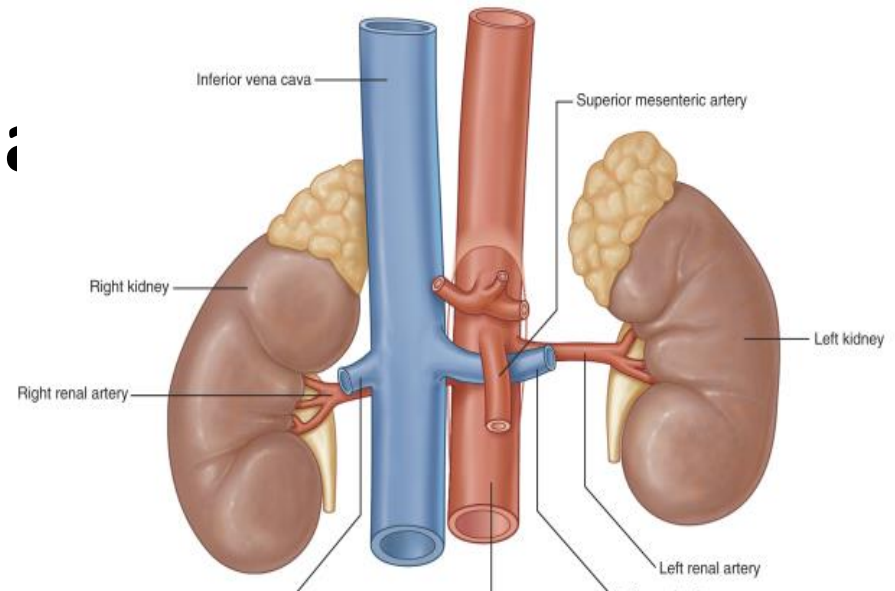
Surgically, this is important because unlike arterial supply, the segmental venous branch has little effect on venous out flow.



Renal vein is located directly anterior to renal art. ,this position can vary up to 1-2 cm cranially or caudally relative to artery.

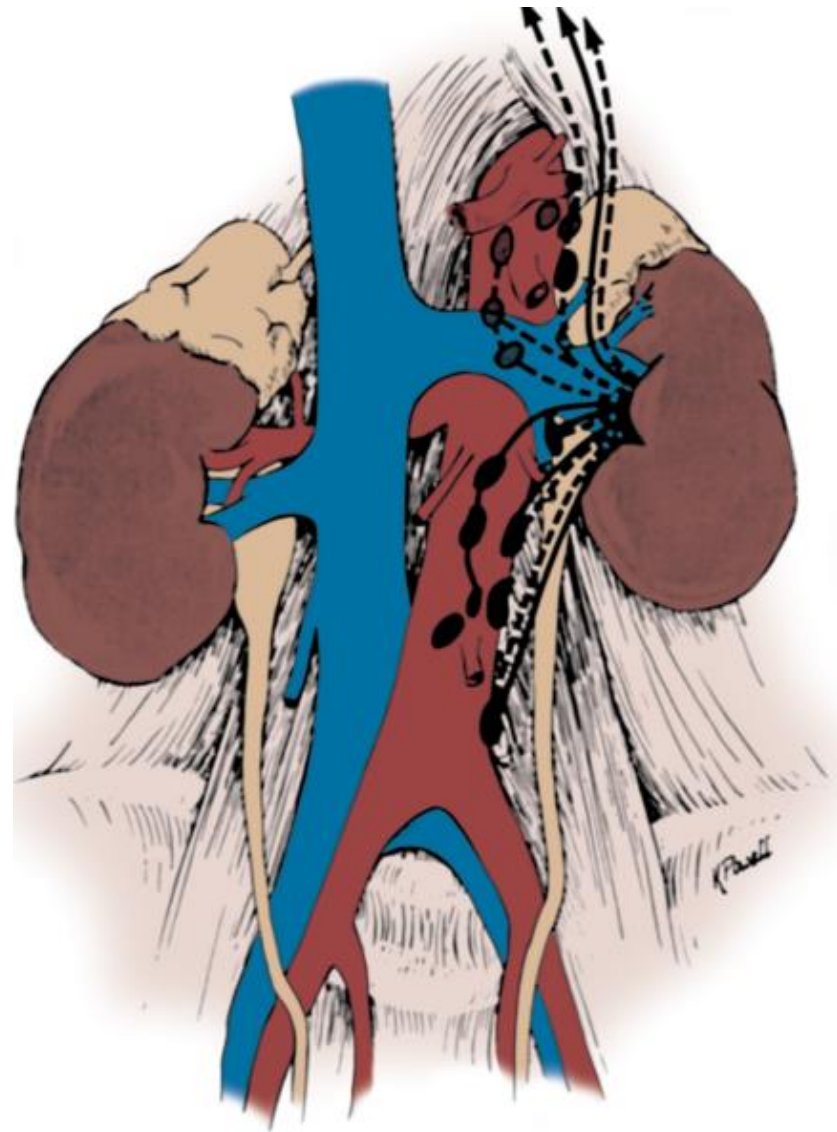
Additionally, left renal vein received the *left adrenal vein superiorly, lumbar vein posteriorly & left gonadal vein inferiorly*

R. renal vein typically dose not receive any branches.

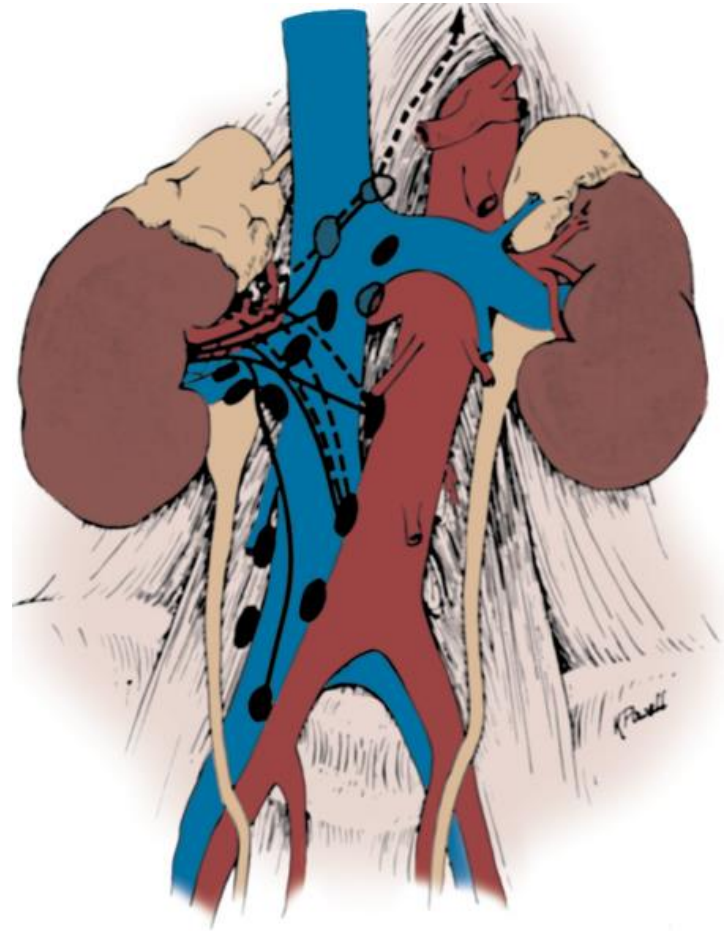


Renal lymphatic's

- On the left: primary lymphatic drainage is into L.lateral para-aortic L.N.including node anterior & posterior to the aorta between inferior mesenteric artery & the diaphragm.
- Occasionally ,there will be additional drainage from left kidney in to retrocrural nodes or directly into thoracic duct above diaphragm.

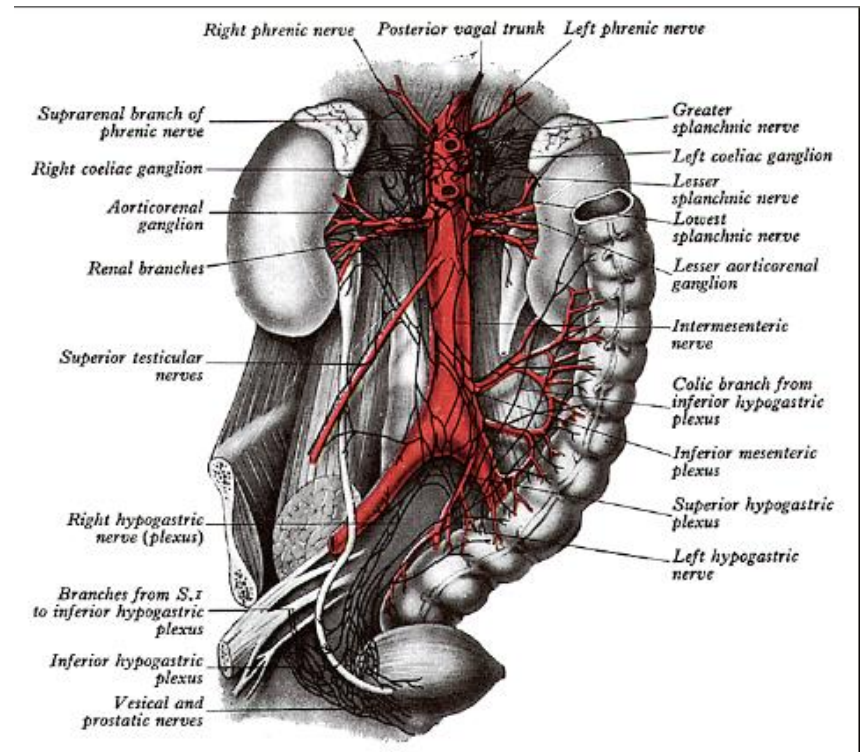


- On right: drainage is into (interaortalcaval) & right (paracaval) L.N.

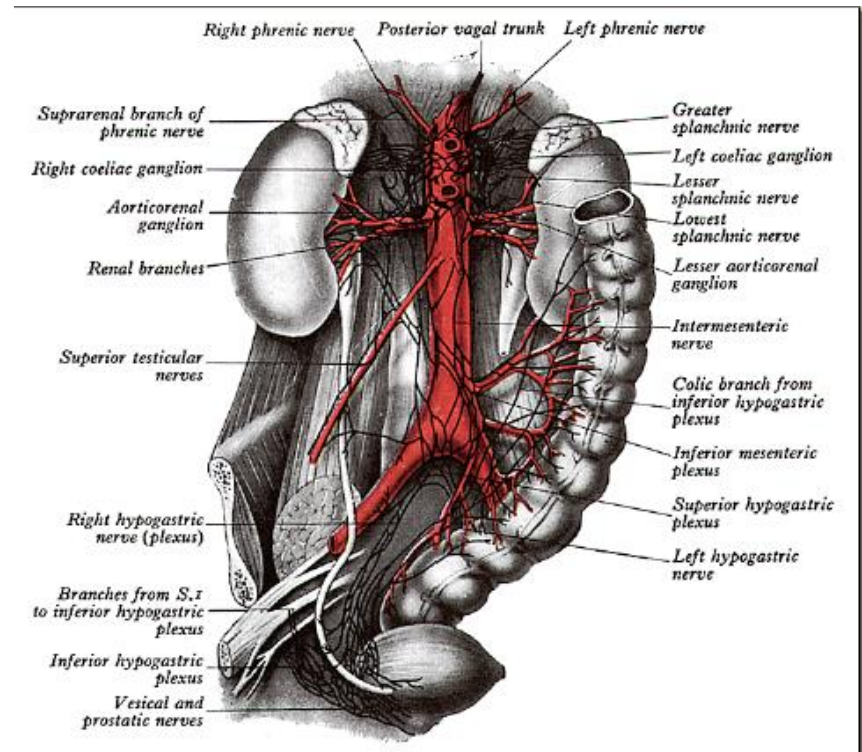


RENAL INNERVATION

- Sympth.prgang.nerve originate from 8th thora.through 1st lumber spinal segment & then travel to celiac & aortic gangl.
- Symp.postgang.fiber travel to kidn.via autonomic plexus surrounding renal artery



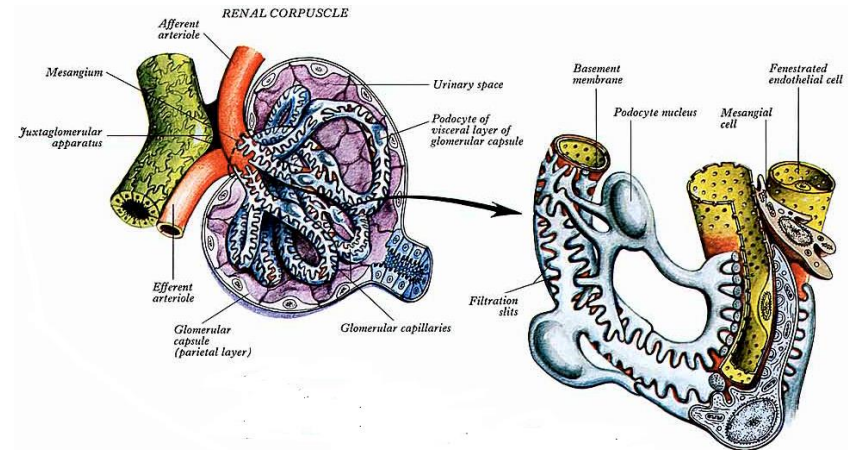
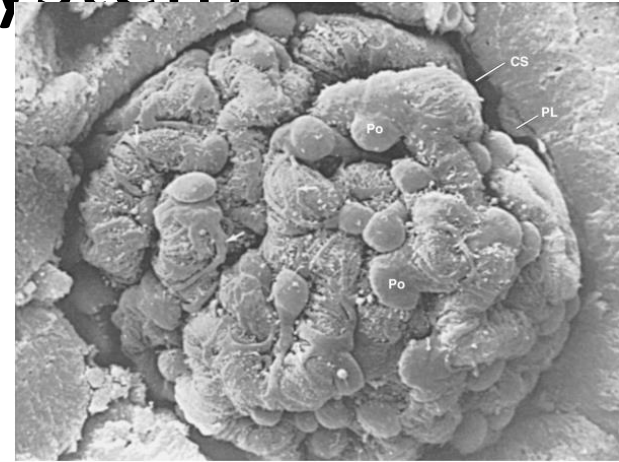
- Parasympathetic fibers originate from the vagus nerve and travel with sympathetic fibers along the renal artery.

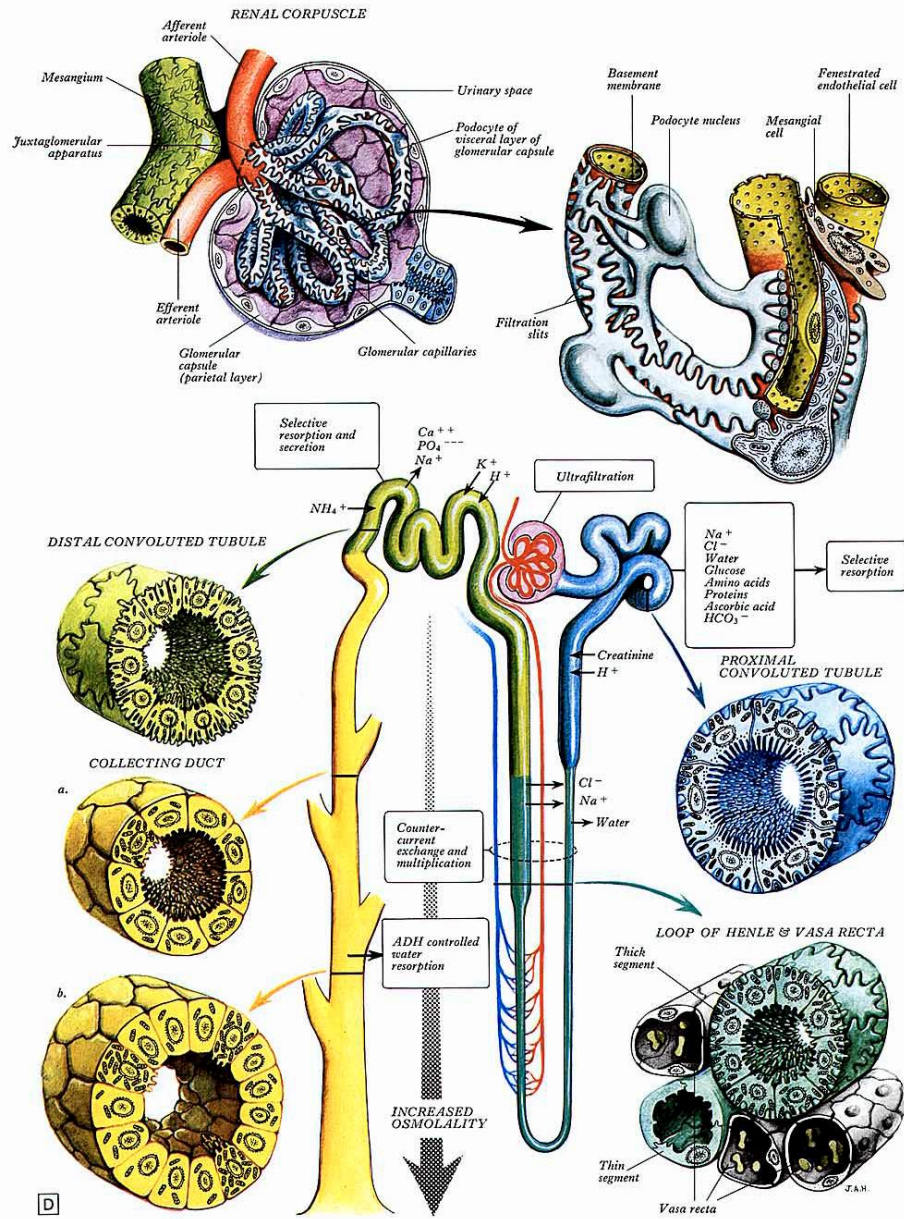


Renal collecting system

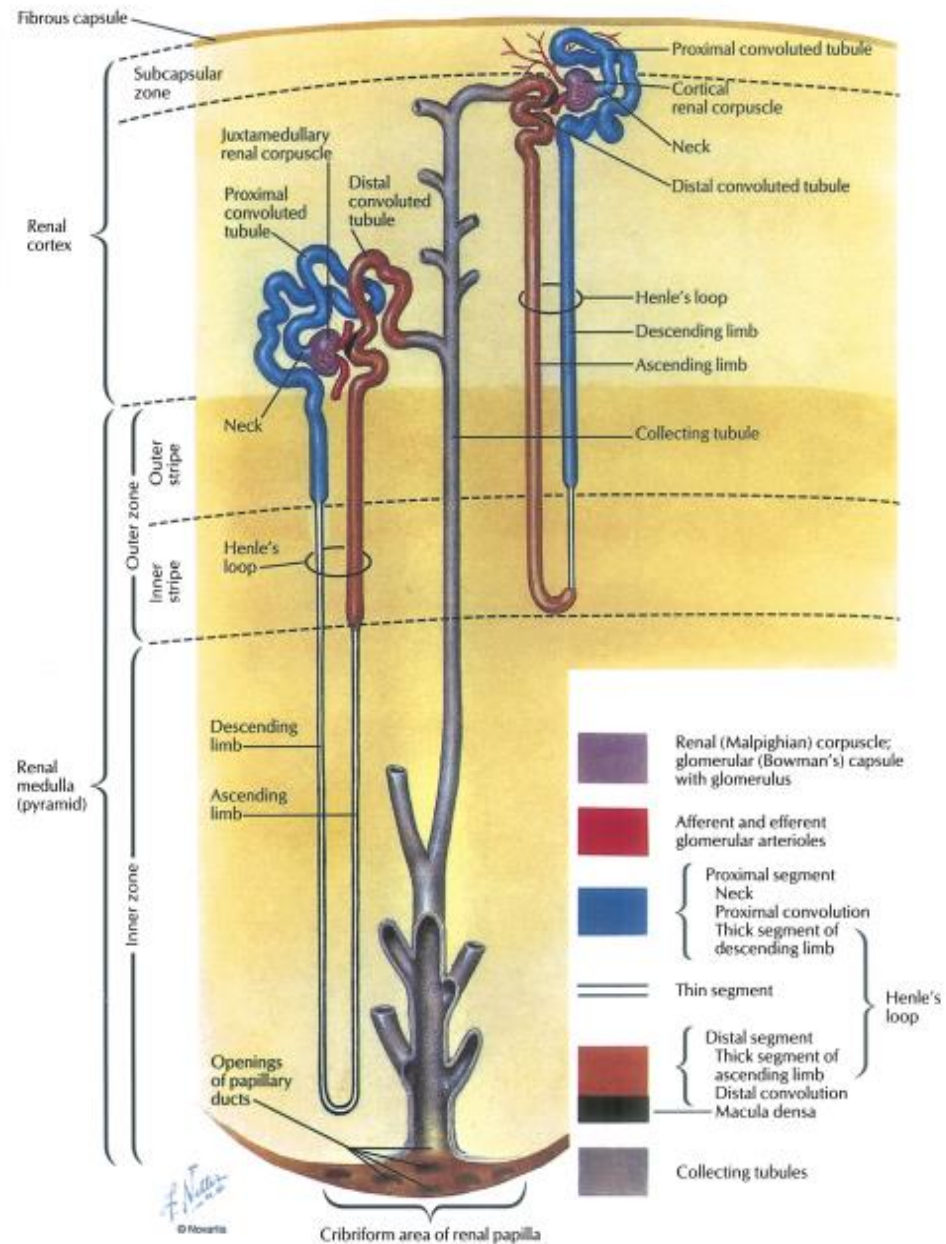
microscop.anatomy from glomerulus to collecting system

- Microscopically ,originates in renal cortex at (glomerulus) as filtrate enter into (bowman's capsule).
- Bowm.caps. & glomerular capillary network form (renal corpuscle)or called (malpighian corpuscle)
- Glom.cap.netw.is cover by specialized epith.cell called (podocytes),which form barrier across urinary filtrate.

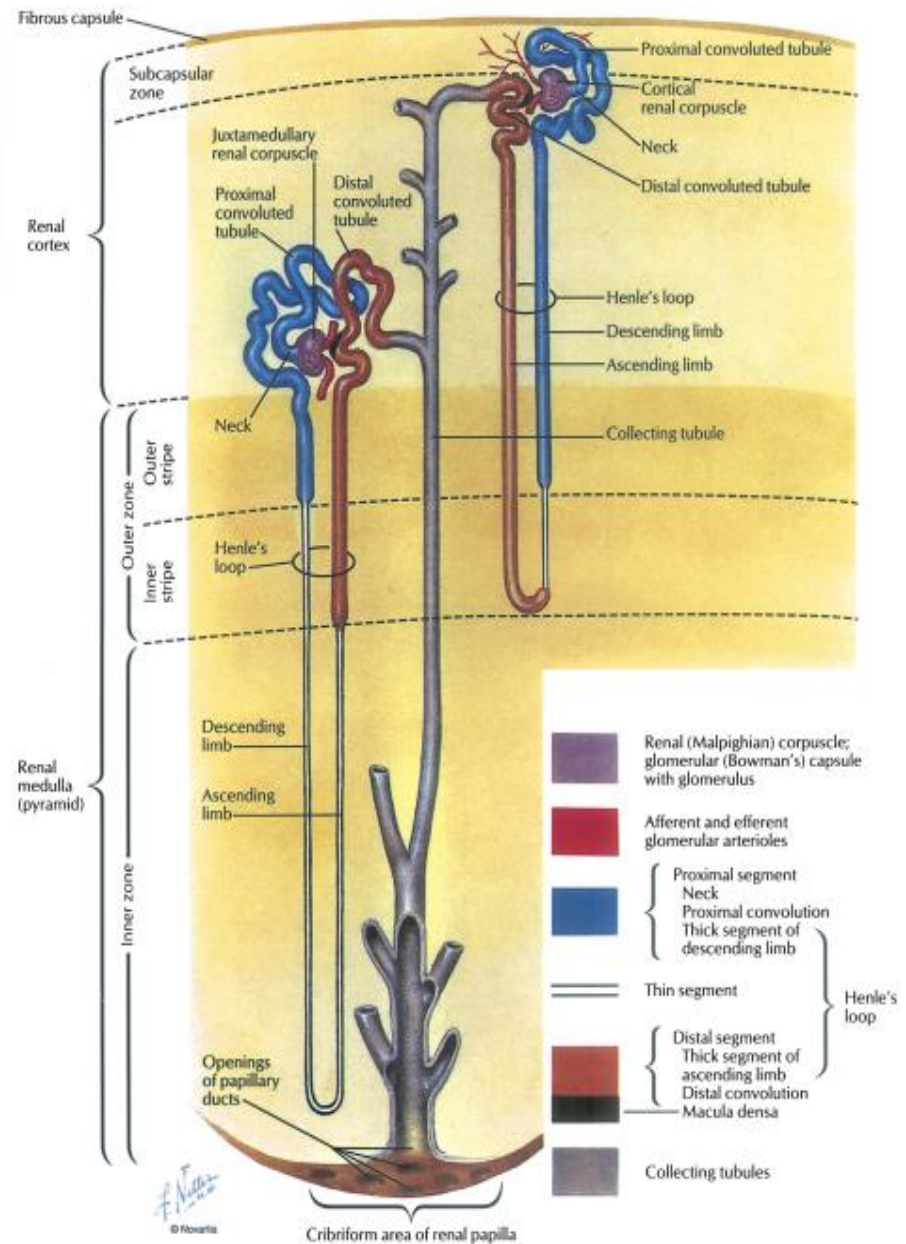




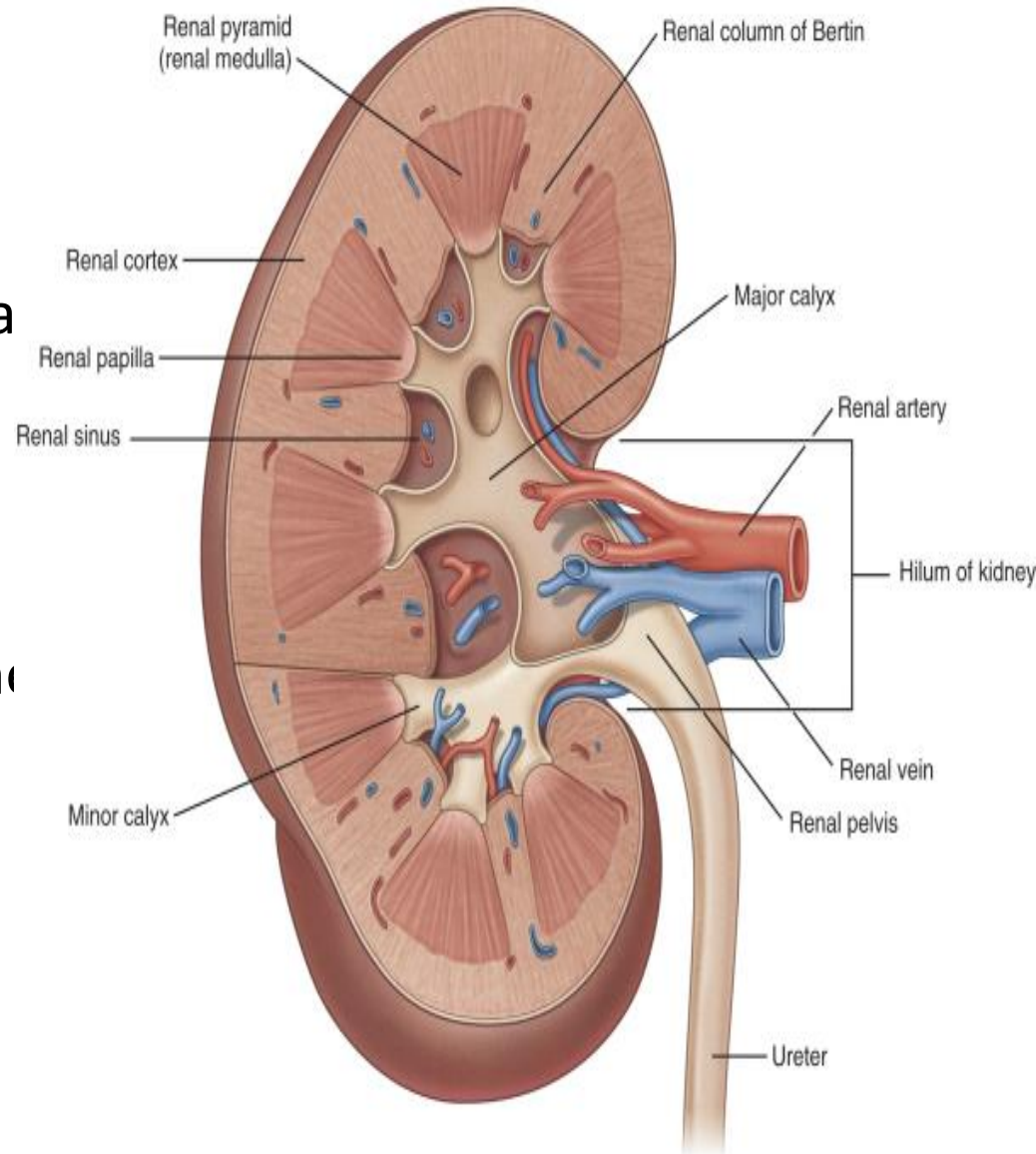
- The filtrate is initially collected in Bowman's cap. & then move to (proximal convoluted tubule)
- Pro.con.tub., composed of thick (cuboidal) epith. Covered by dense microvilli.
- Microvilli, increase surface area of pro.tub., which allowing large portion of urinary filtrate to be reabsorbed in this section of nephron.



- Pro.tubu.continues deeper into cortical tiss.to become the (loop of henle),which extend variable distance into renal medulla ,which then reveres course & move back toward periphery of kid.,which became thickens &form (distal convoluted tubule).

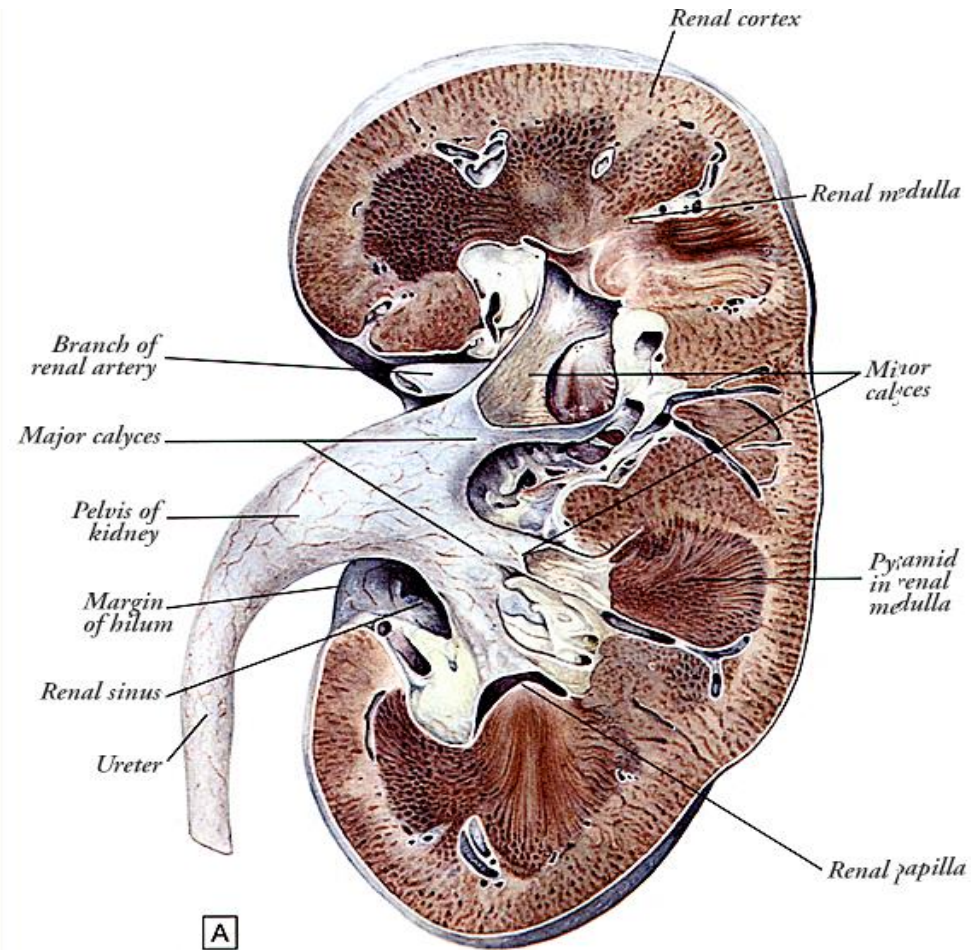


- Distal tubule ,return to position adjacent to original glomerulus & proximal convoluted tubule, which form (collecting tubule).
- Collecting tubule ,form multiple nephrons ,combine into (collecting duct),which extend in width through renal medulla, which empties into apex of medullary pyramid, the renal papilla.



Renal papilla ,calyces, pelvis

- Renal papillae are the tip of medullary pyramid & consist the 1st gross stricture of renal colle.syst.
- Typically there are 7-9 papillae per kidney.
- Each of these papillae cupped by a(minor calyx) each minor calyx narrows to an (infundibulum)



- Infundi.combine to form 2 or 3 (major calyceal) branches which termed (upper, middle, lower pole calyces), which intern combine to form (renal pelvis).
- Renal pelvis, itself can vary greatly in size ,ranging from small intrarenal pelvis to large extra renal pelvis.
- Pelvis narrows to form (ureteropelvic junction), which beginning of (ureter).

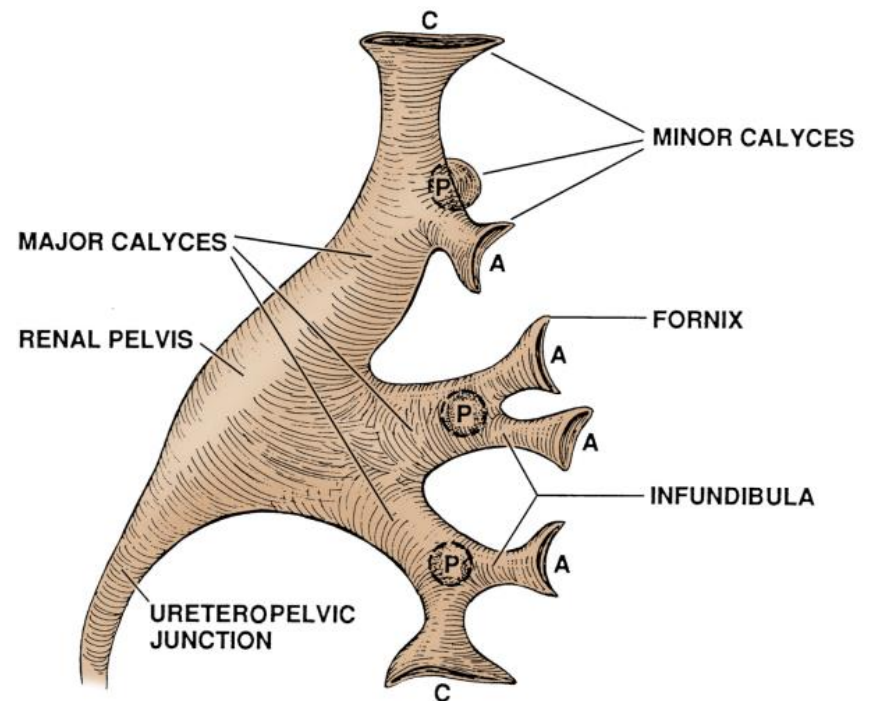




Figure 1-41 Significant variation between two normal renal pelvises, demonstrated by excretory urography. **A**, Large, extrarenal pelvis. **B**, Narrow, completely intrarenal pelvis.

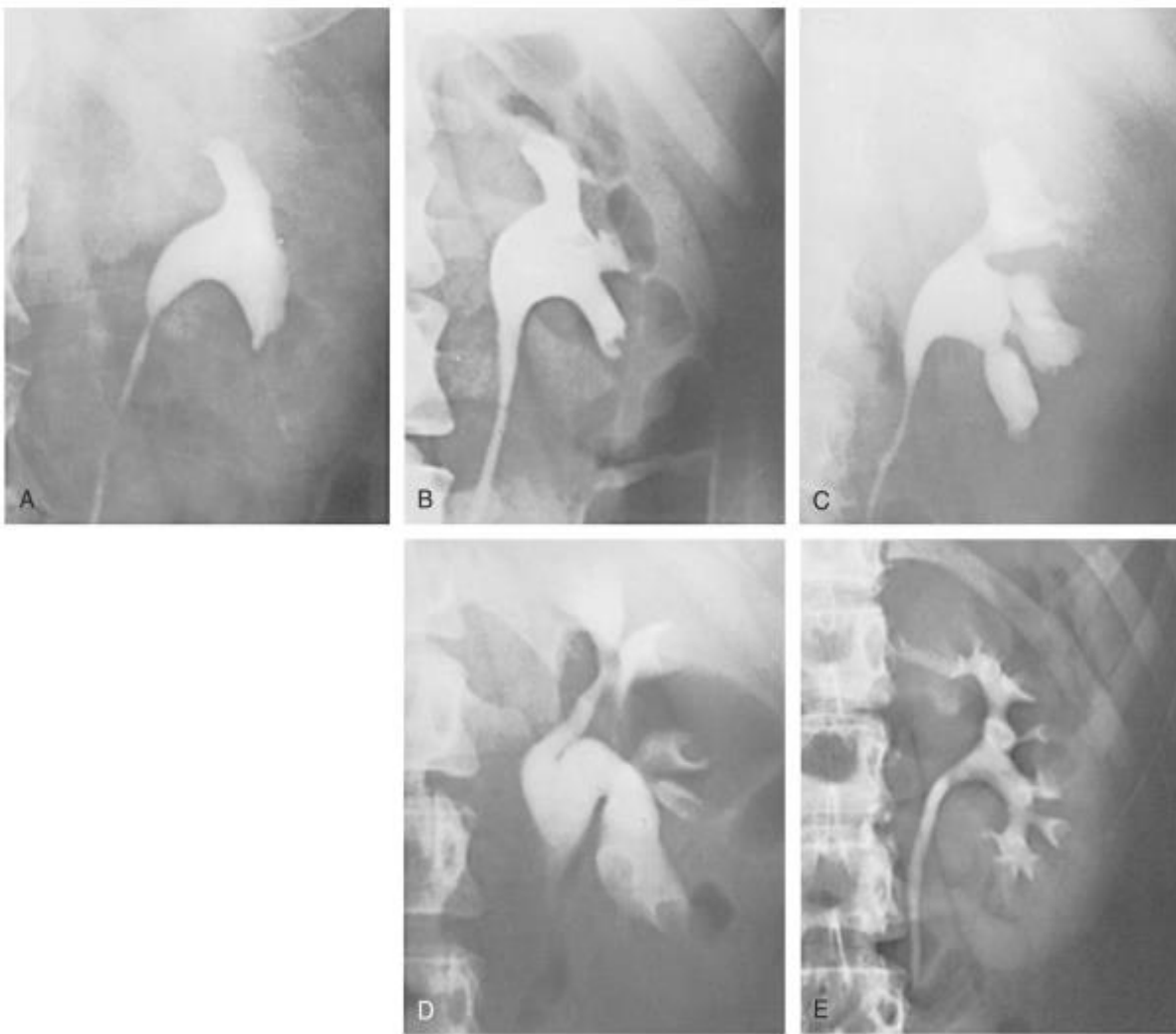
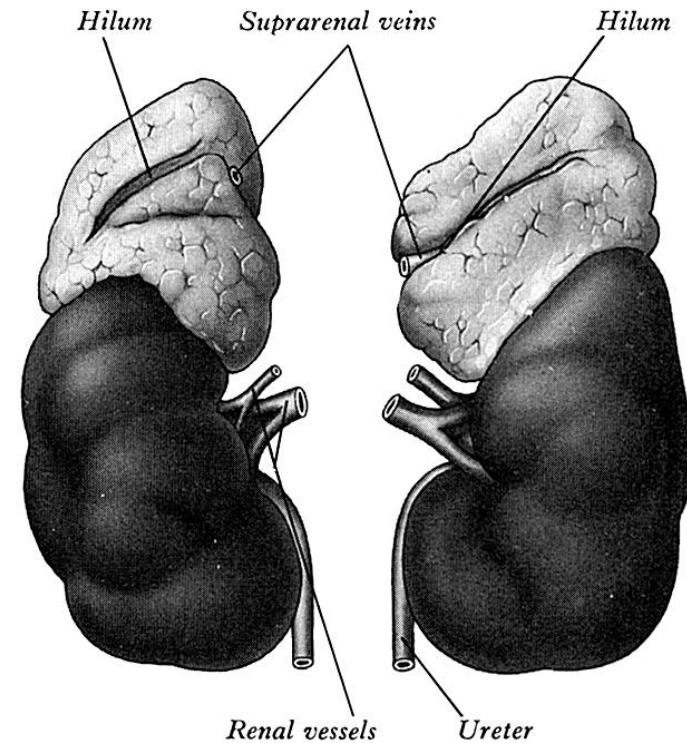
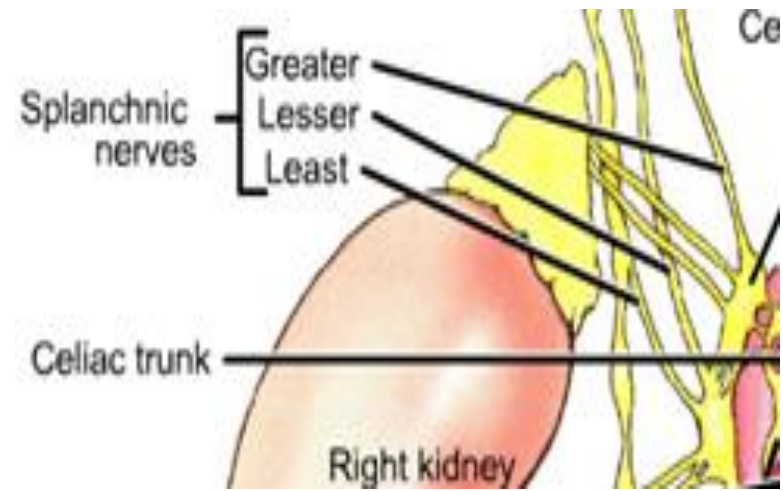
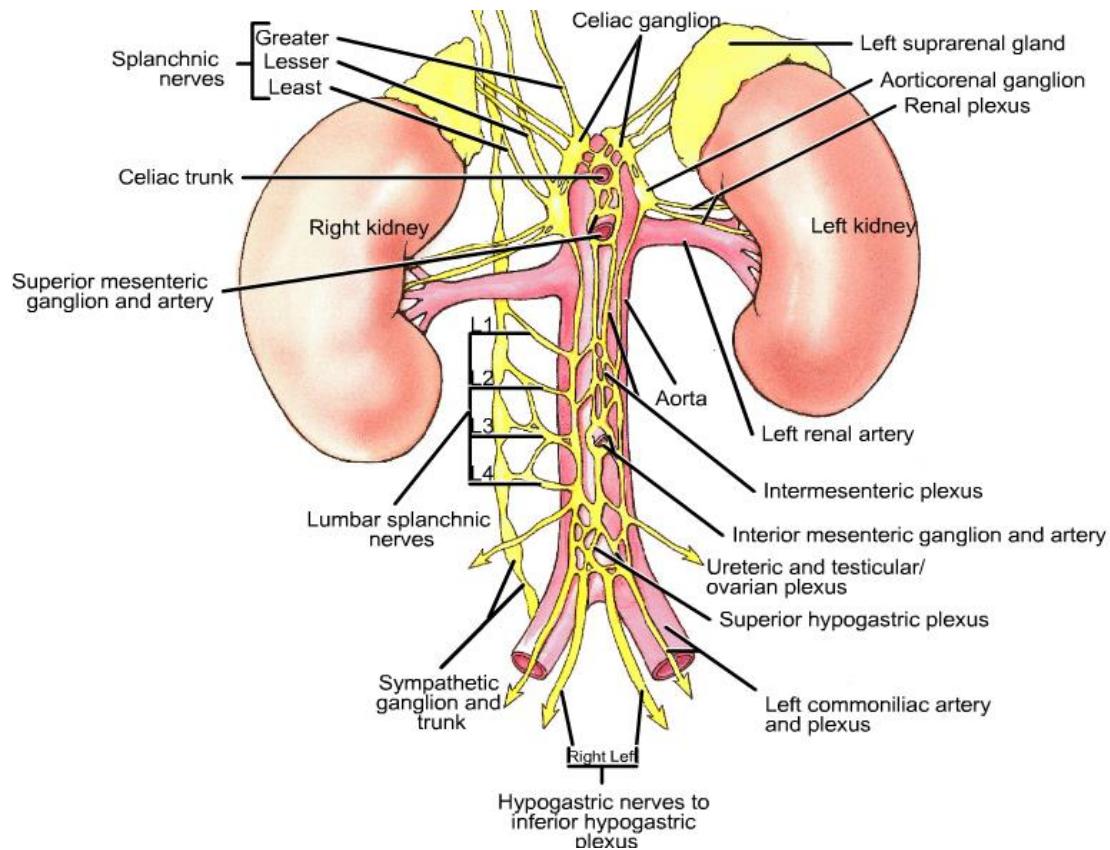


Figure 1-42 Examples of normal variations in the architecture of the renal collecting system, demonstrated by excretory urography. **A**, Absence of calyces. **B**, Minor calyces arising directly from the renal pelvis. **C**, Megacalyces. **D**, "Orchid" calyces. **E**, Multiple minor calyces and nearly absent renal pelvis.

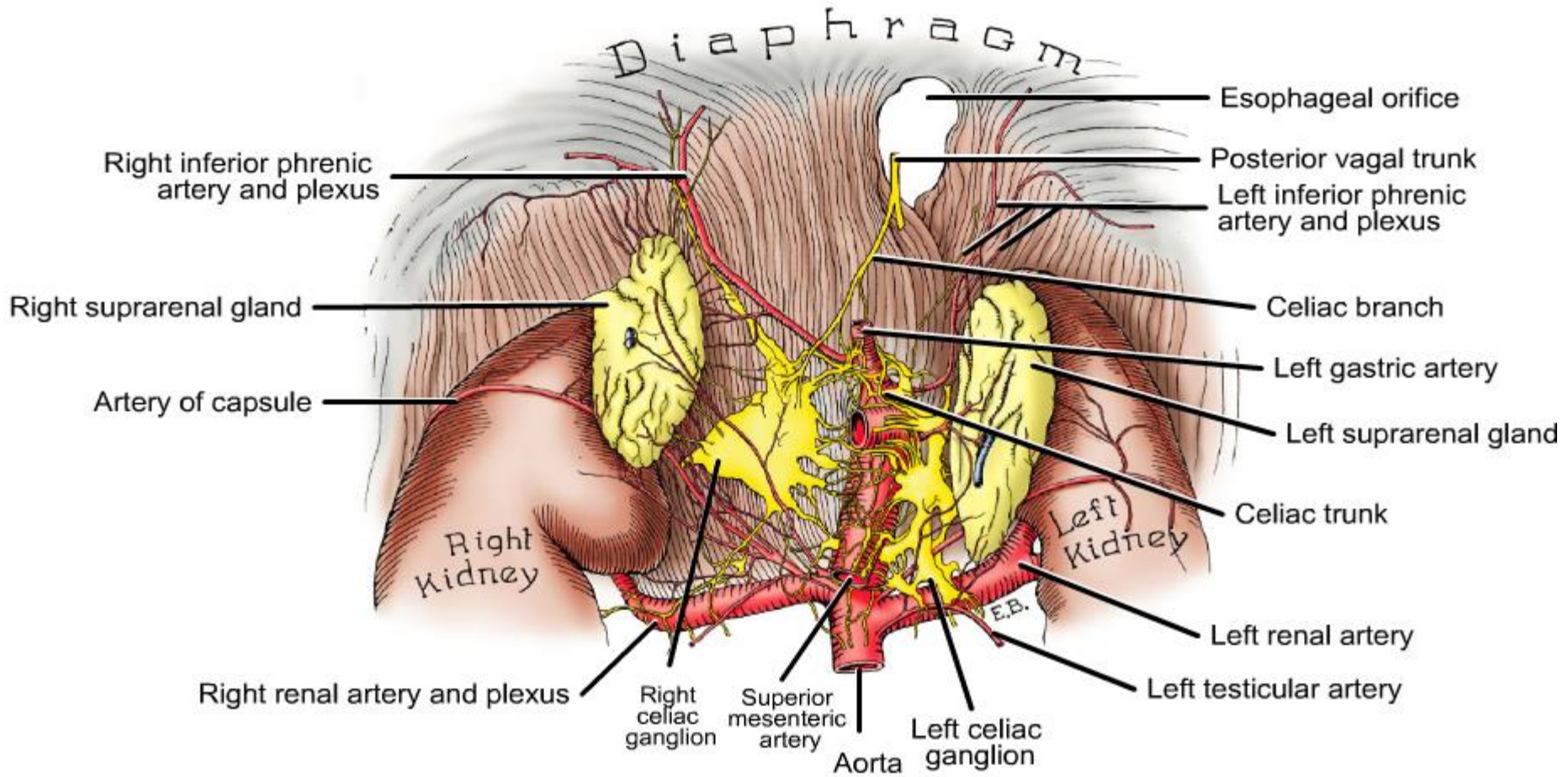
Suprarenal gland:

- ***Location : between medial side of upper pole of each kidney and vertebral column***
- ***Surrounded by perirenal fat and renal fascia***
- ***Function : produces***
 - ***cortex : gluco corticoids h. mineralo-corticoides h. & sex hormones***
 - ***medulla : epinephrine & nor epinephrine***



The greater splanchnic nerve is formed by fibers from the **5th to 10th** thoracic ganglia, and the lesser splanchnic nerve receives fibers from the **10th and 11th** thoracic ganglia. Both nerves contain preganglionic and visceral afferent fibers(sensory);

- Shape : r: hat (or pyramidal, L: semilunar
- Blood supply : suprarenal ,
- inferior phrenic
- renal artery
- Vein: R: inferior vena cava
- left : renal vein
- Lymphatic to par aortic L.n.
- Nerve : medulla pre ganglionic nerve fiber from great (5-10th ganglia)sympathetic splanchnic nerves to chromaphine cells to produce **epinephrine and nor epinephrine**



- The **cortex** under the control of the **ACTH** by the pituitary gland
- ***Structure:***
- **Medulla:** completely invested by the cortex
- **O**void or polyhedral cells in clumps or cords surrounded by venules or capillaries
- **S**tained brown by potassium bichromate so called chromaffin cells (catecholamine)
- **G**anglionic cells

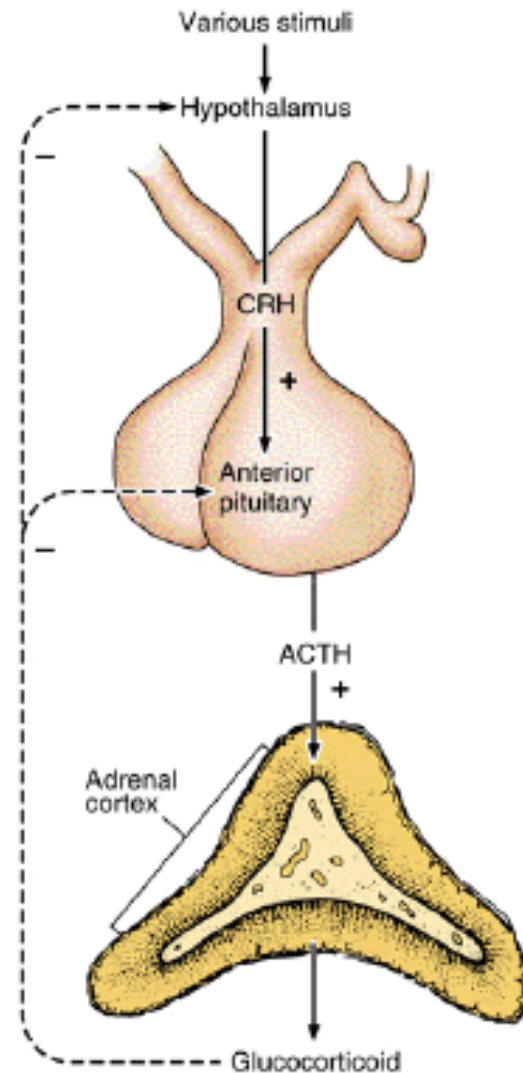
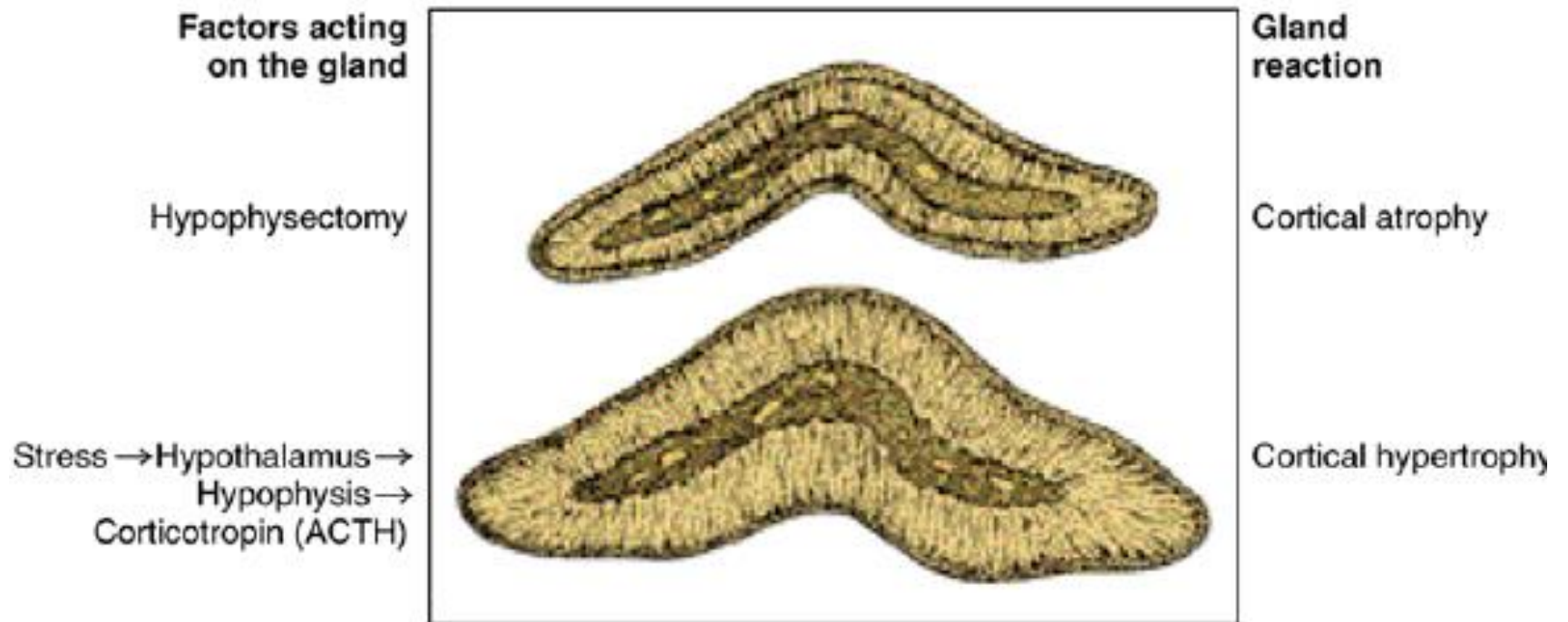
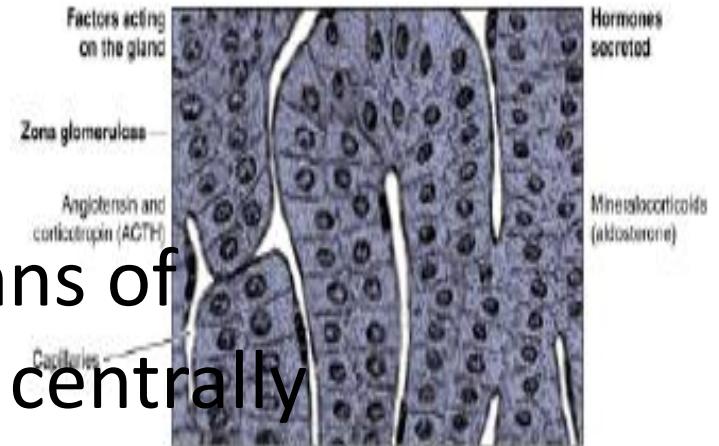


Figure 21—6. Feedback mechanism of ACTH and glucocorticoid secretion. Solid arrows indicate stimulation; dashed arrows, inhibition. CRH, corticotropin-releasing hormone, ACTH, corticotropin.

Figure 21—7. Effects of decreased or increased stimulation on the structure of the adrenal cortex.



- **Cortex:** three concentric regions
- **Zona glomerulosa**
- Below the capsule
- Closely packed arched columns of columnar or pyramidal cells, centrally spherical nucleus.
- **Controlled by ACTH to produce mineralocorticoids (aldosterone) stimulate distal convoluted tubule to reabsorb water and sodium and excrete potassium.**



Histology

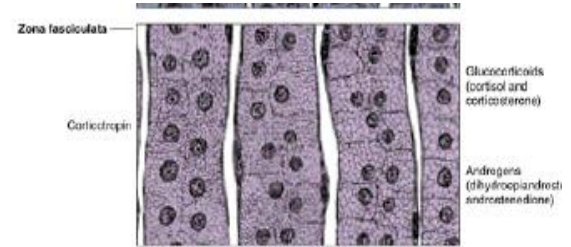
- ***Zona fasciculata***

- Most of the cortex

- Cells polyhedral (spongiocytes)filled with lipids

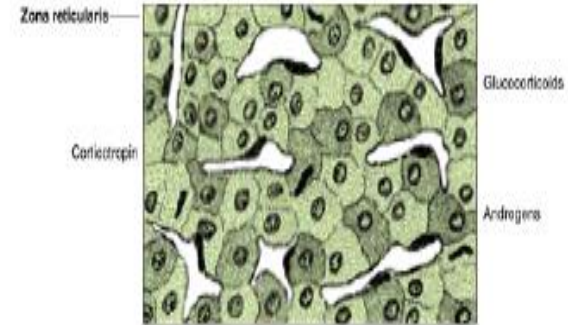
- Arranged in one or two layer thick perpendicular to the capsule with sinusoids in between columns

- ***Produce androgens and corticosteroid (cortizole) in response to ACTH to increases retention of water and increases blood glucose***



Histology

Zona reticularis



Histology

- Deepest of cortex
- Anastomosing cords of small cells
- Dark and light staining cells according to amount of lipofusine granules
- **Release glucocorticoids and androgens in response to ACTH**

- Supra renal gland

Histology

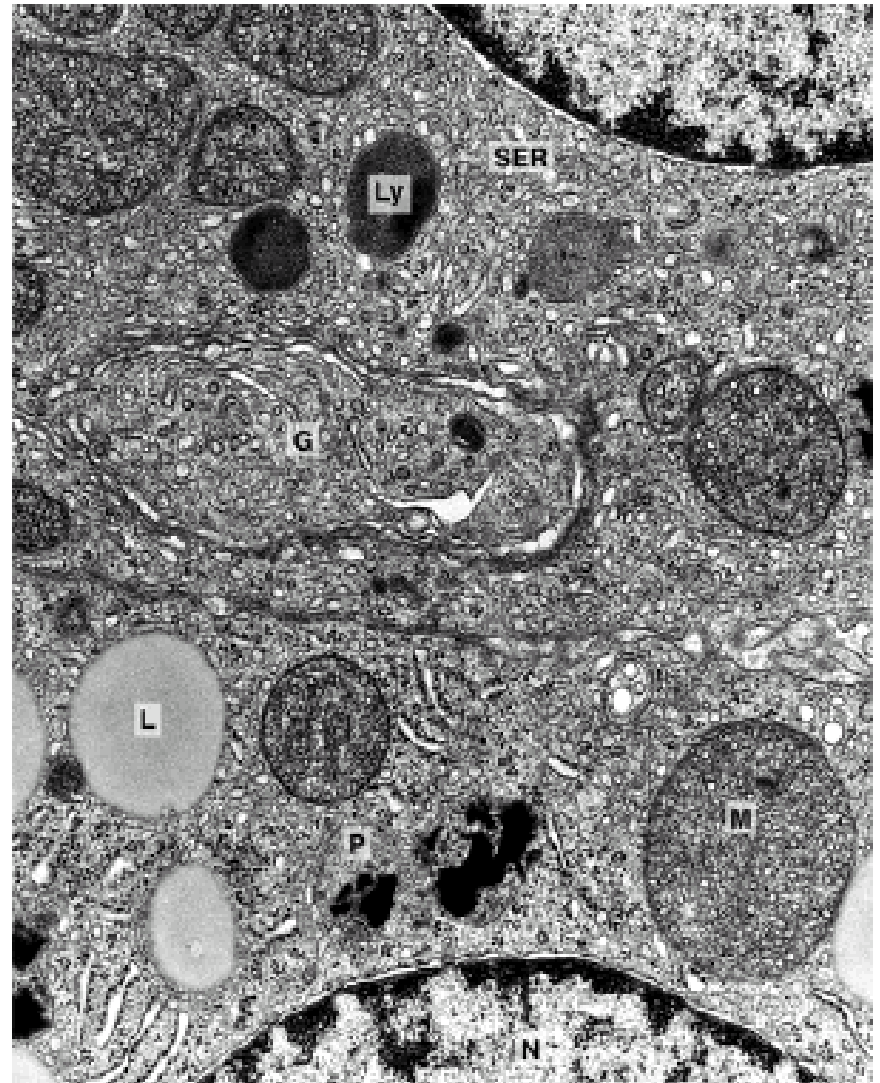
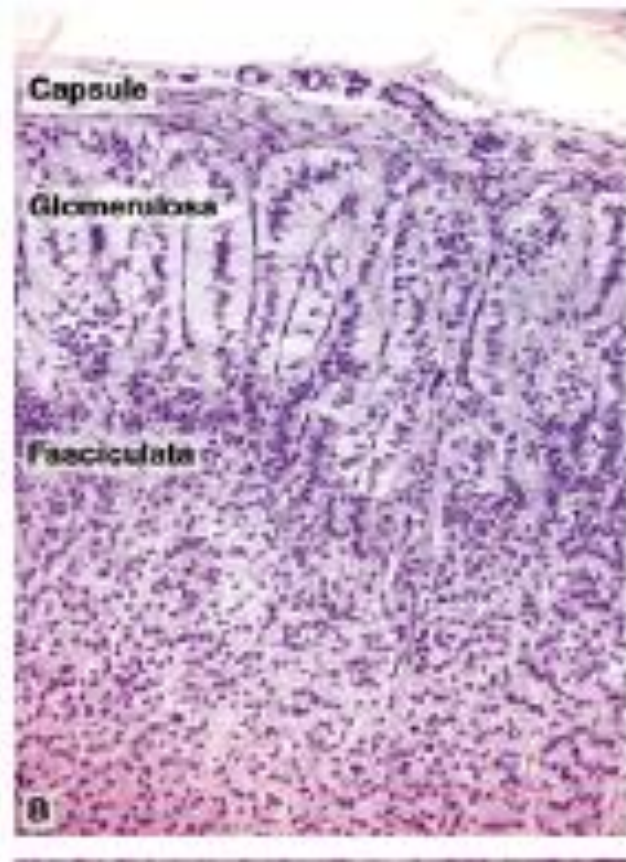
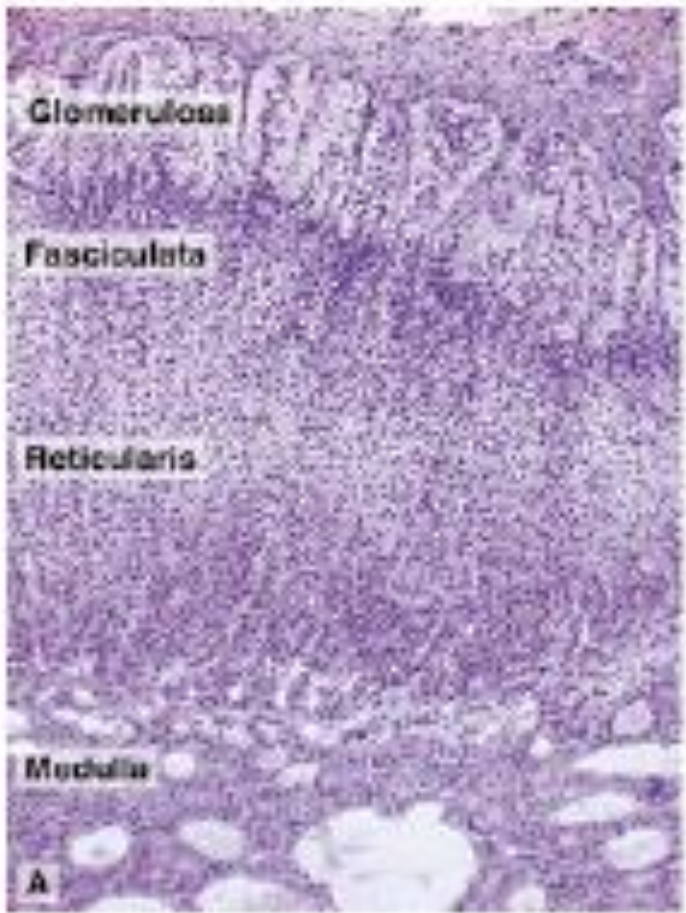
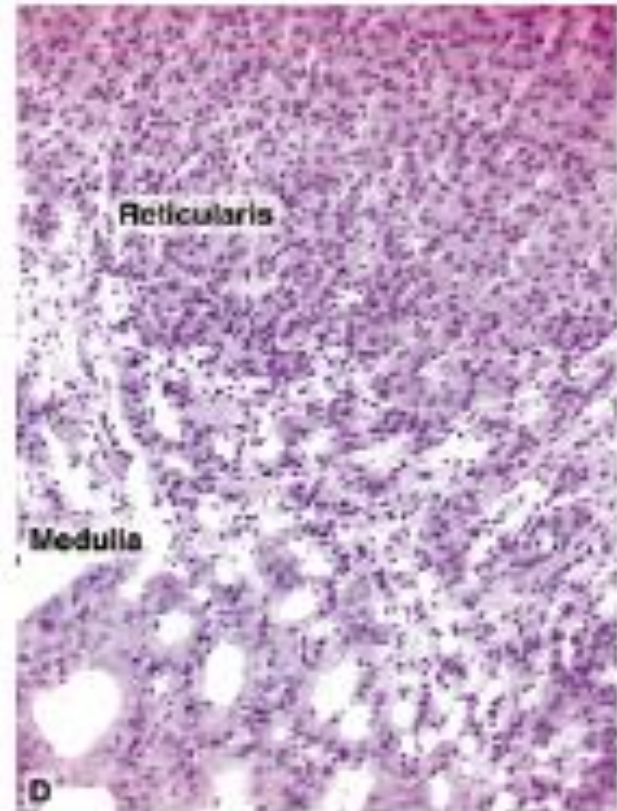
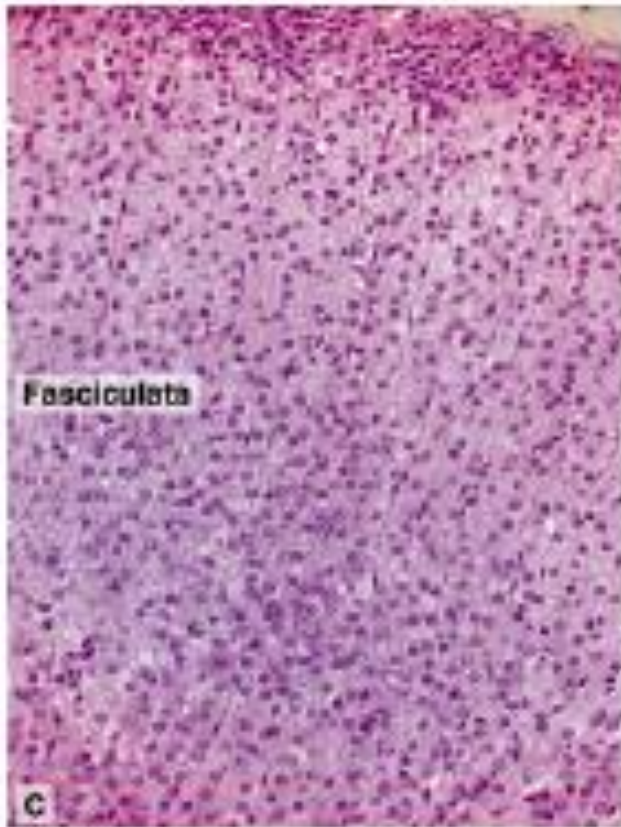


Figure 21—4. Fine structure of 2 steroid-secreting cells from the zona fasciculata of the human adrenal cortex. The lipid droplets (L) contain



Histology



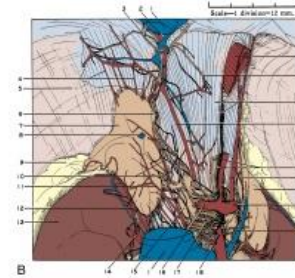


Histology

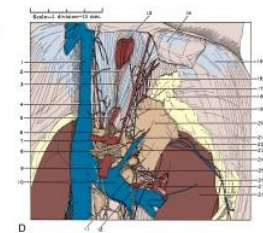
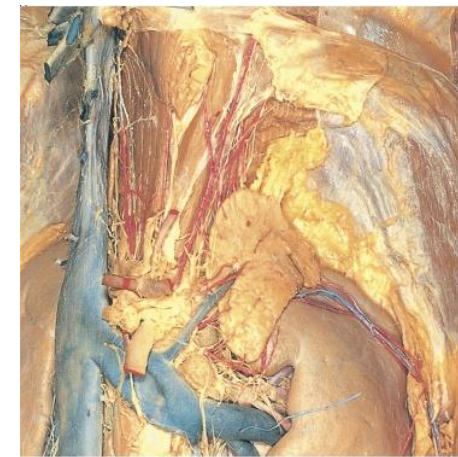
Adrenal glands

- Anatomical relationships:
- Adult adrenal glands are 3 – 5 cm in greatest transverse dimension & weigh approx. 5 gm.
- Grossly, yellow organ , enclosed with gerotas fascia & separated from upper pole of kidney by layer of connective tiss.

- Right gland : is pyramidal ,surrounding structure include (liver) anterolaterally,(duodenum) anteromedially &(IVC) medially.

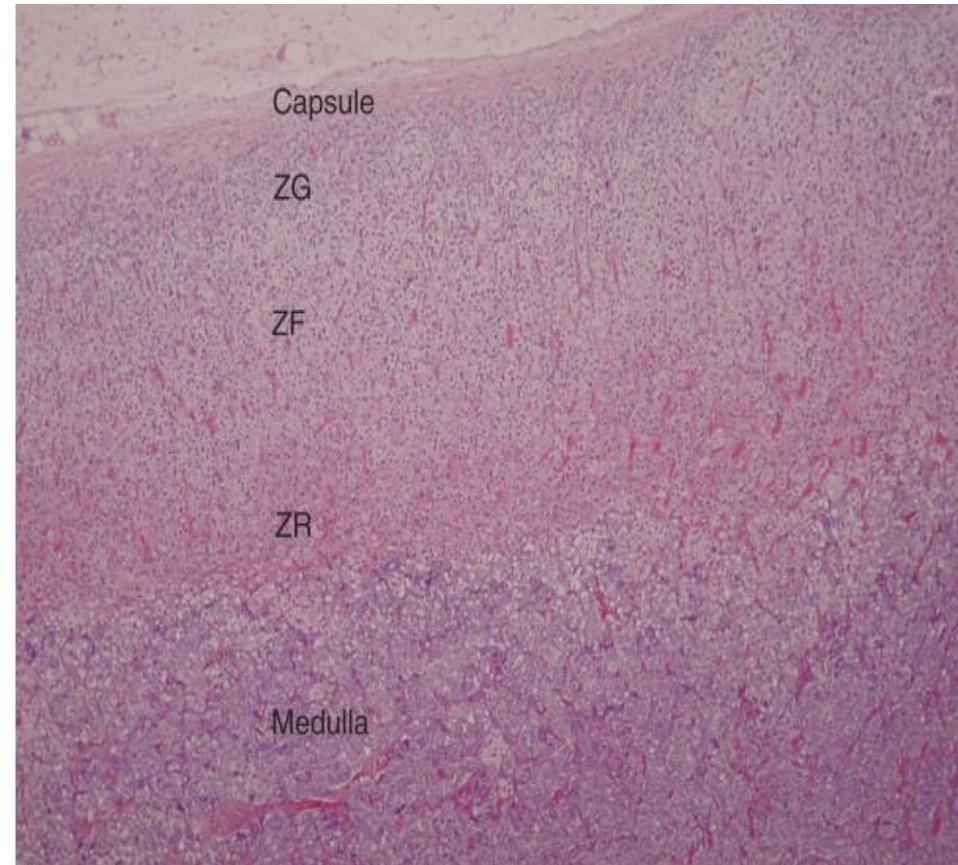


- Left gland :crescentic ,upper & anterior aspects are related to (stomach), tail of pancreas) &(splenic vessels).

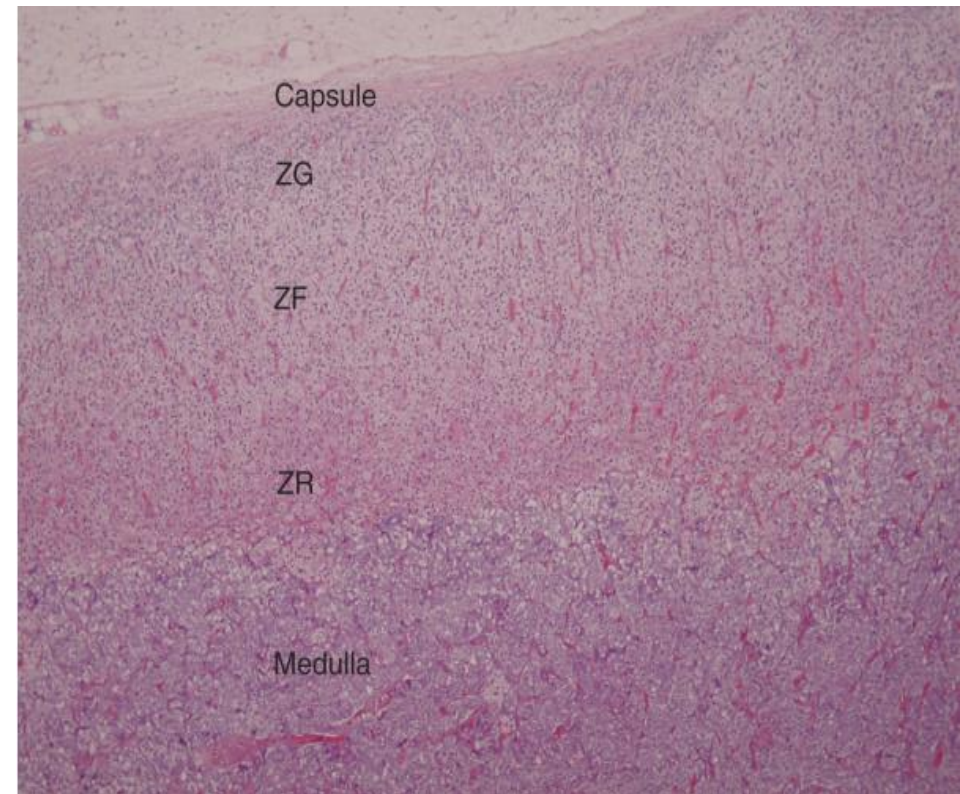


Composition

- Embryologically: adrenal gland is distinct from the kidney, so in renal entopy the adrenal gland is not affected.
- Histologically, adrenal is divided into two components:
 - The centrally located medulla.
 - The peripherally located cortex.
- The medulla itself is composed of (chromaffin cells) which are innervated by presynaptic sympathetic fibers.
- Secretion of catecholamines by the medulla is under sympathetic control.
-



- Adrenal cortex :mesodermal origin &make approx. 90 % of adrenal mass.
- It composed of 3 layer ,from external to internal (zona glomerulosa ,zona fasciculata & zona reticularis)
- Glomerulosa,producing mineralo corticoid (eg.aldosterone)
- Fasciculata producing (glucocrtecoids)eg. Cortisol.
- Reticularis ,synthesizing sex steroids (androgen).



- The end

- ***Thank you***