ANATOMY OF KIDNEY

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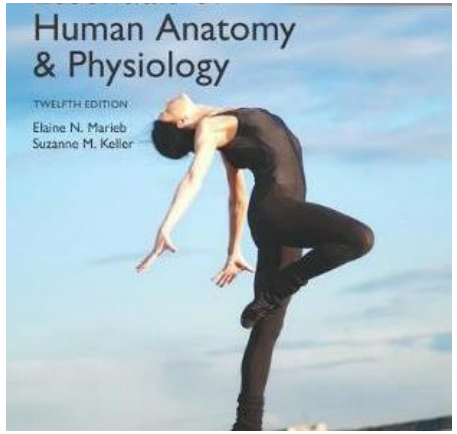
RESOURCES



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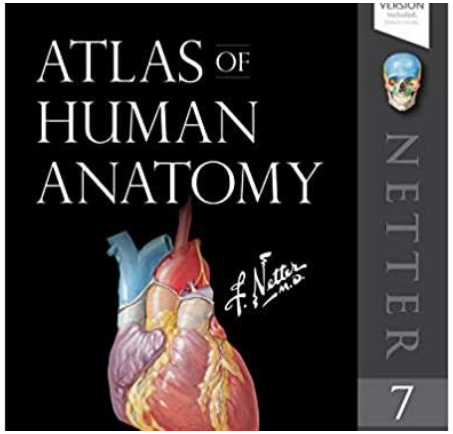
By Elaine Marieb and Suzanne Keller



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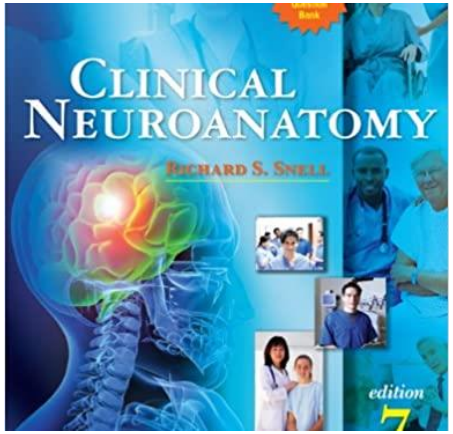
By Frank Netter



Clinical Neuroanatomy

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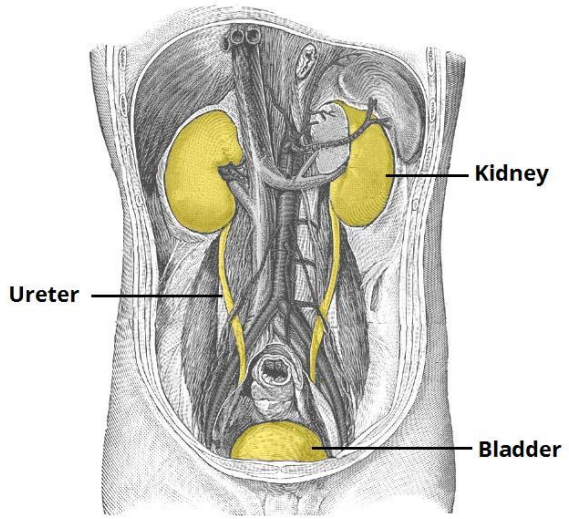
INTRODUCTION

- The human body has two kidneys, each around the size of a fist.
- They are located at the back of the abdominal cavity just below the rib cage on each side of the spine.
- Every day, each kidney filters liters of fluid from the bloodstream.
- Although the lungs and the skin also play roles in excretion, the kidneys bear the major responsibility for eliminating nitrogenous (nitrogen-containing) wastes, toxins, and drugs from the body.

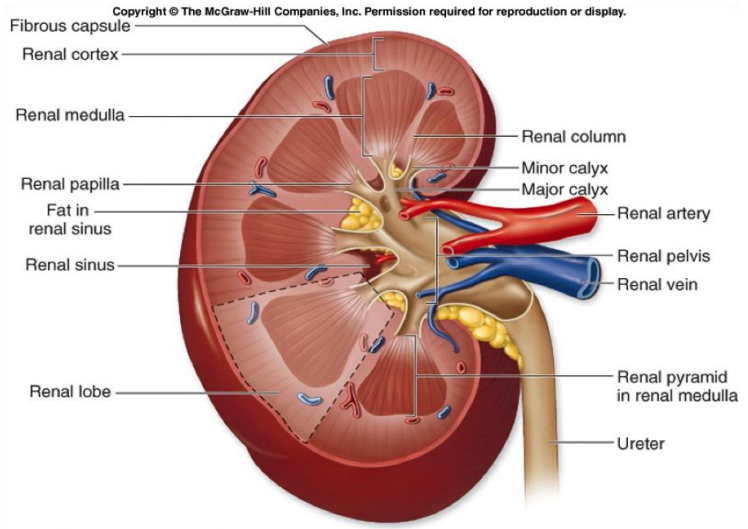
FUNCTIONS

- Excretes most of the waste products of metabolism.
- Controls water & electrolyte balance of the body.
- Maintain acid-base balance of the blood.
- Erythropoietin hormone stimulates bone marrow for RBCs formation.
- Rennin enzyme regulates the blood pressure.
- Converts vitamin D to its active form.



STRUCTURE

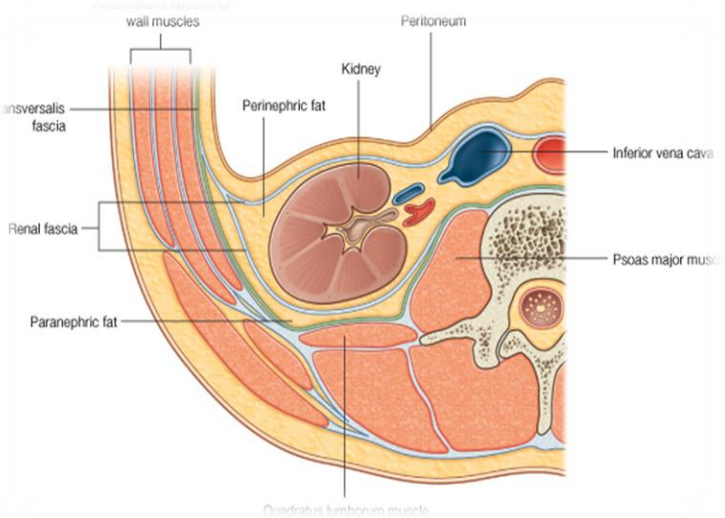
- Kidneys are reddish brown in color.
- They lie behind the peritoneum on the posterior abdominal wall on either side of the vertebral column.
- They are largely under cover of the costal margin.
- The right kidney lies slightly lower than the left due to the large size of the right lobe of the liver.
- The upper border of the right kidney is at the level of 11^{th} intercostal space while the left kidney is at the level of 11^{th} rib.
- With contraction of the diaphragm, the kidney moves downward as much as 2.5 cm.
- The lateral border is convex, while the medial border is convex at both ends but its middle pat shows a vertical slit called the hilum.
- The hilum extends into a large cavity called the renal sinus.
- The hilum transmits the renal vein, two branches of renal artery, ureter, and the third branch of renal artery from the front backward (V.A.U.A.)



Right kidney, coronal section

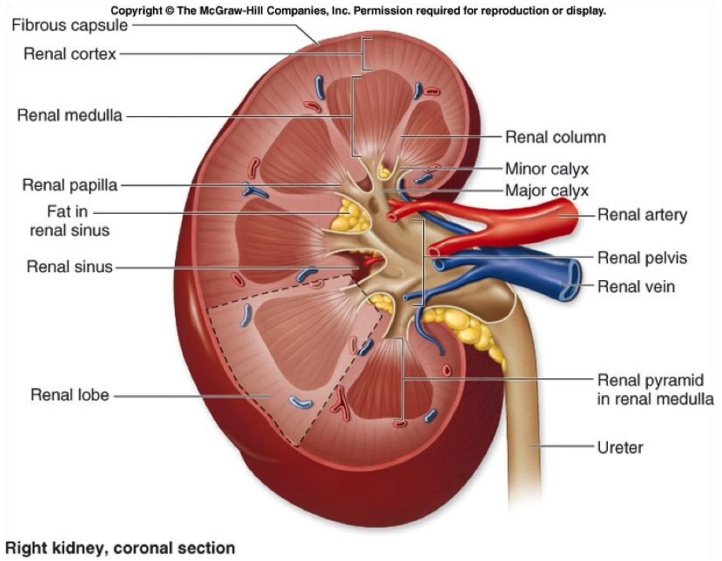
COVERINGS

- **Fibrous capsule** that surrounds the kidney.
- **Perirenal** (perinephric) fat that covers the fibrous capsule.
- **Renal fascia** that encloses the kidneys and suprarenal glands.
- **Pararenal** (paranephric) fat that lies external to the renal fascia, and forms part of the retroperitoneal fat.
- **N.B.** The last 3 structures support the kidney in position.



RENAL STRUCTURE

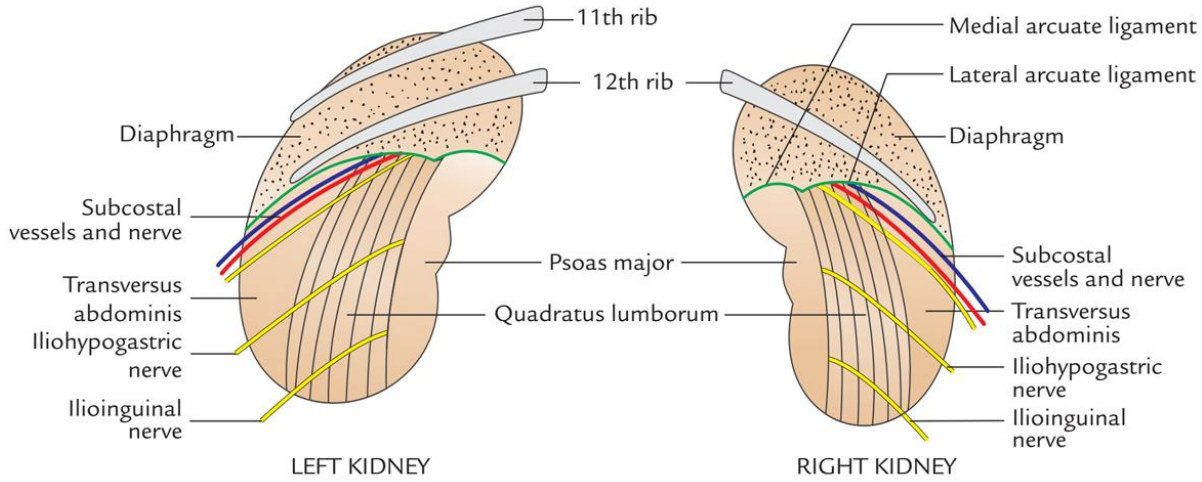
- Each kidney has an outer cortex and an inner medulla.
- Medulla is composed of about 12 renal pyramids.
- The base of each pyramid is directed toward the cortex and its apex (the renal papilla) is projecting medially.
- The cortex extends into the medulla between adjacent pyramids as the renal column.
- Extending from the bases of the renal pyramids into the cortex are striations known as medullary rays.
- The renal sinus within the hilum, contains the upper expanded end of the ureter, the renal pelvis.
- Renal pelvis divides into two or three major calyces, which divides into two or three minor calyces.



Right kidney, coronal section

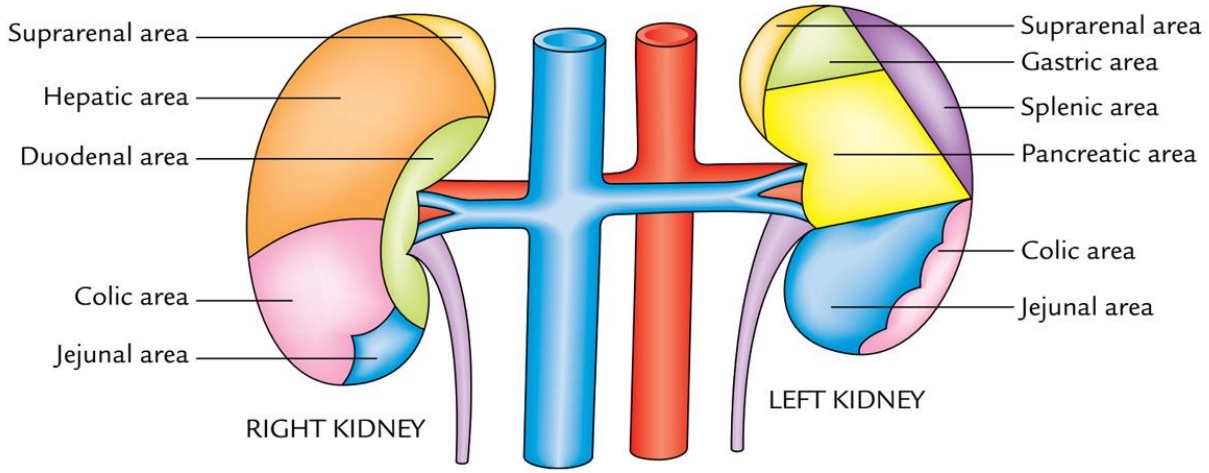
POSTERIOR RELATION

- Twelfth rib.
- Costodiaphragmatic pleural recess.
- Four muscles:
  - Diaphragm.
  - Psoas major.
  - Quadratus lamborum.
  - Transversus abdominis.
- Three Nerves:
  - Subcostal nerve (T12).
  - Iliohypogastric (L1) nerve.
  - Ilioinguinal (L1) nerve.



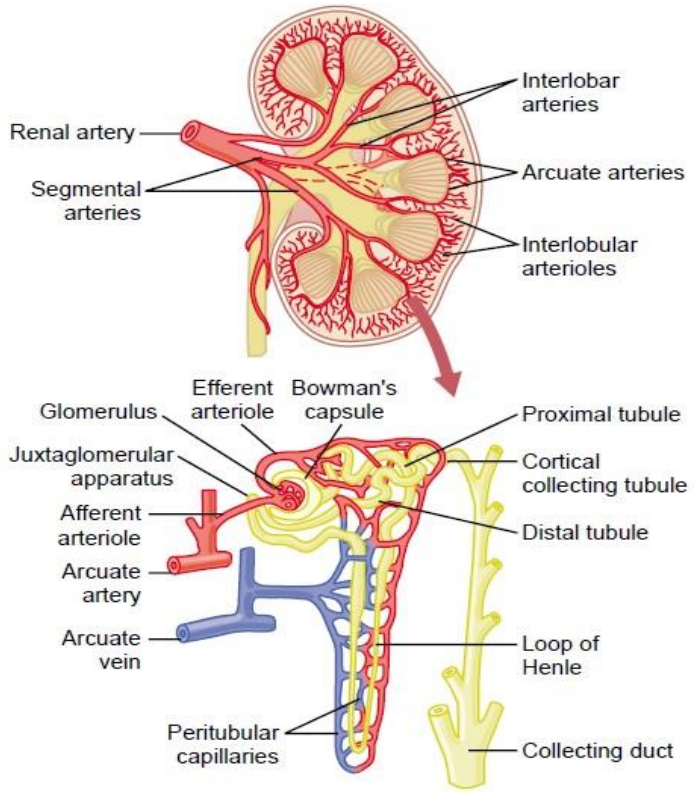
ANTERIOR RELATION

- **Right Kidney**
  - Right suprarenal gland
  - Liver
  - Second part of the duodenum
  - Right colic flexure
  - Coils of small intestine
- **Left Kidney**
  - Left suprarenal gland,
  - Stomach
  - Spleen
  - Pancreas
  - Left colic flexure
  - Descending colon
  - Coils of jejunum



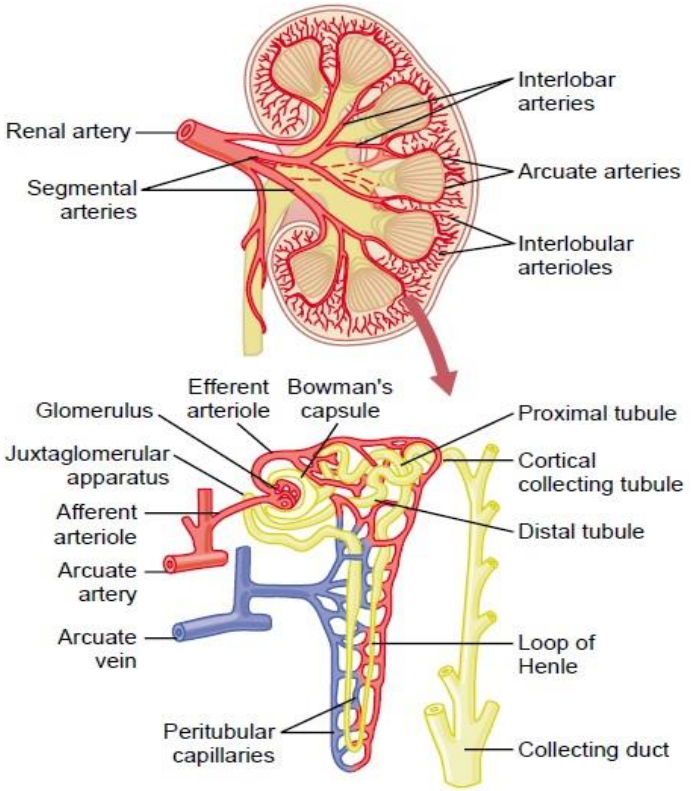
BLOOD SUPPLY

- The **renal artery** arises from the aorta at the level of the second lumbar vertebra.
- Each renal artery divides into **five** segmental arteries that enter the hilum of the kidney, **four** in front and **one** behind the renal pelvis.
- They are distributed to different segments of the kidney.
- **Lobar artery** arises from each segmental artery, one for each renal pyramid.
- Each lobar artery gives off 2 or 3 **interlobar arteries**.
- The interlobar arteries run toward the cortex on each side of the renal pyramid.
- Interlobar arteries give off the **arcuate arteries** at the junction of the cortex and medulla.
- The arcuate arteries give off several **interlobular arteries**.
- Interlobular artery gives off **afferent glomerular arterioles** .



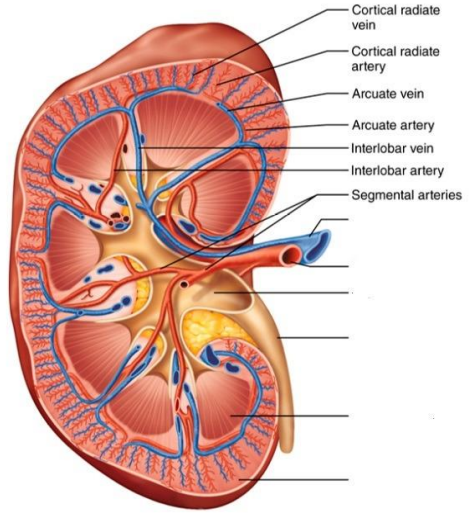
NEPHRON

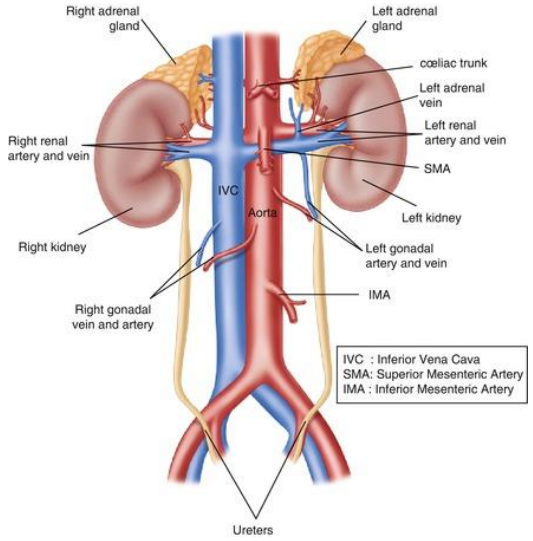
- Each nephron is associated with two capillary beds:
  - The glomerulus
  - The peritubular capillary bed.
- The glomerulus is both fed and drained by **arterioles**.
  - The **afferent arteriole**, which arises from an interlobular artery, is the feeder vessel.
  - The **efferent arteriole** receives blood that has passed through the glomerulus.



BLOOD DRAINAGE

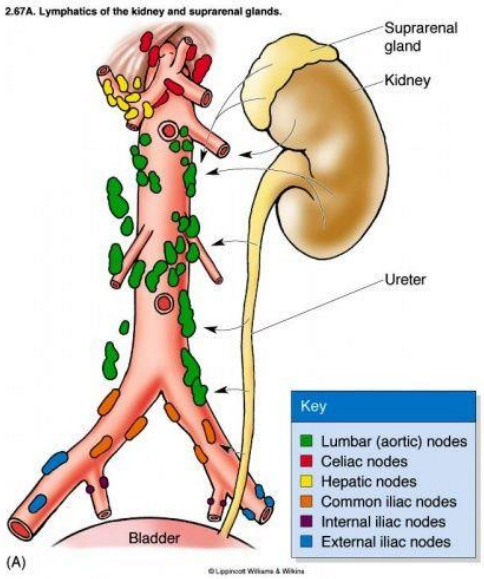
- Kidneys are drained through **interlobular veins** and **interlobar veins** until these converge from across the kidney to form the **renal vein**.
- **Renal vein** emerges from the hilum in front of the renal artery and drains into the IVC.
- The left renal vein is longer than the right renal vein.
- The left renal vein receives **left gonadal** and **left suprarenal** veins.





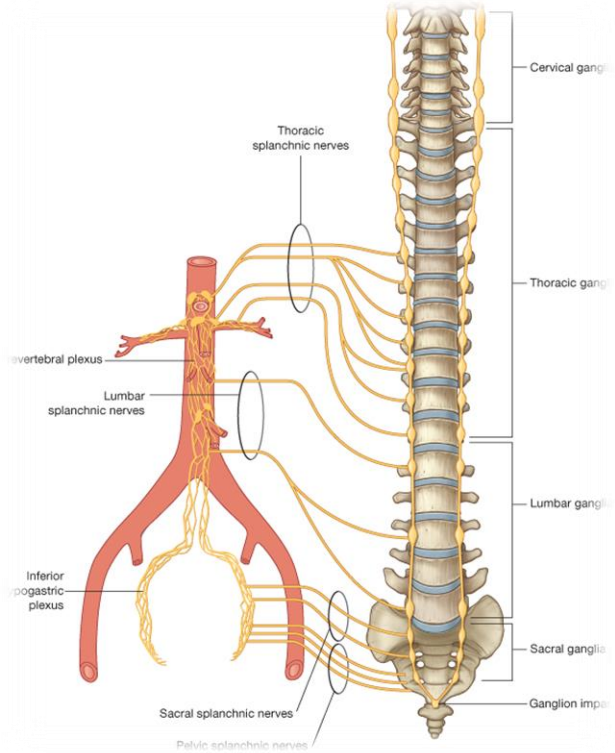
LYMPH DRAINAGE

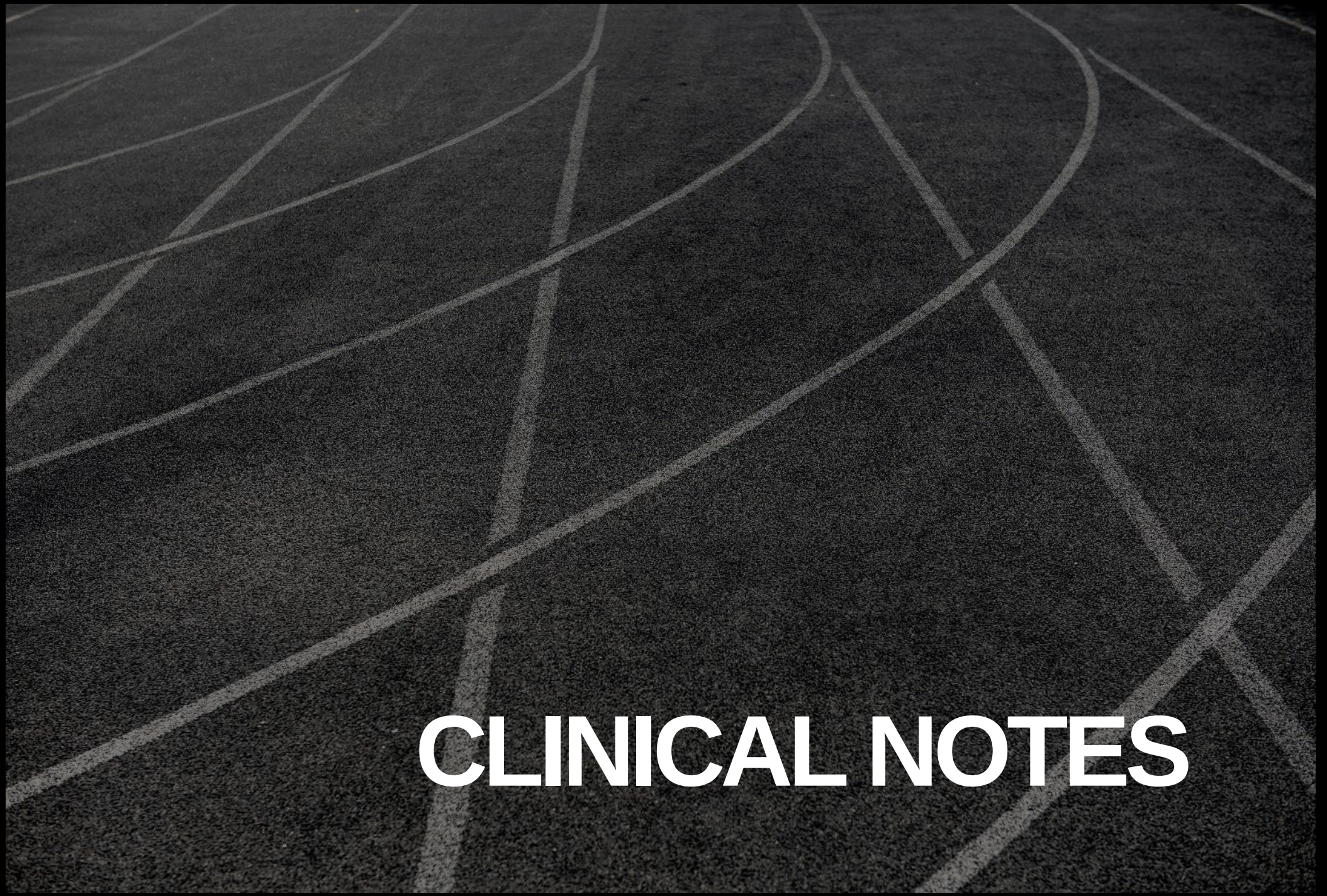
- Lateral aortic lymph nodes around the origin of the renal artery.



INNERVATION

- Renal sympathetic plexus.
- The afferent fibers that travel through the renal plexus enter the spinal cord in the 10^{th}, 11^{th}, and 12^{th} thoracic nerves.

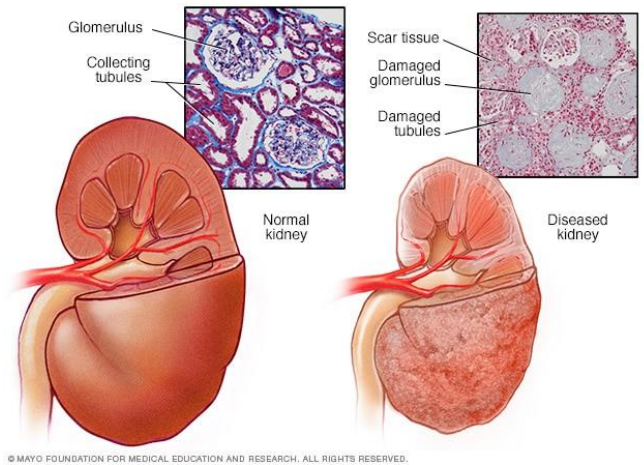




CLINICAL NOTES

CHRONIC KIDNEY DISEASE

- It is the preferred terminology for chronic renal failure.
- CKD is diagnosed by blood test for creatinine to determine the patient's glomerular filtration rate.
- High levels of creatinine means the glomerular filtration rate is falling which means that the kidney's ability to filter and excrete waste products is inhibited.
- In the early stages of CKD, creatinine levels may be normal, but urinalysis demonstrates a loss of protein or red blood cells into the urine.
- There are five stages of CKD categorized according to the level of reduced kidney function and evidence of kidney damage, such as blood or protein in the urine.
- The most severe stage is end-stage kidney disease (ESKD), also called end-stage renal disease and CKD stage 5, which is diagnosed when kidney function deteriorates to the extent that irreversible kidney failure occurs, requiring kidney dialysis or kidney transplant.

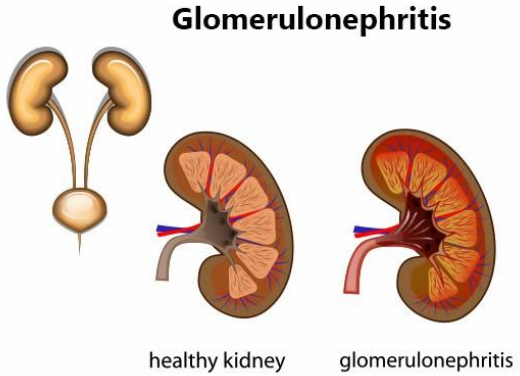


RENAL FAILURE

- It refers to inability of the kidneys to maintain proper filtration function, excrete wastes appropriately and to maintain electrolyte balance.
- There are three main stages: acute, chronic (now called chronic kidney disease as discussed above) and end-stage.
- Acute renal failure (ARF) is the sudden loss of the ability of the kidneys to remove waste and concentrate urine.
- It is usually initiated by an underlying cause, such as severe dehydration, infection, trauma to the Kidney or the chronic use of painkillers.
- ARF is often reversible with no lasting damage.
- ARF is also known as acute kidney injury (AKI).
- End-stage renal disease (ESRD) is the complete failure of the kidneys to function, or where chronic kidney disease has worsened to the point at which kidney function is less than 10% of normal.
- See chronic kidney disease above.
- ESRF is also called chronic kidney disease (CKD) stage 5.

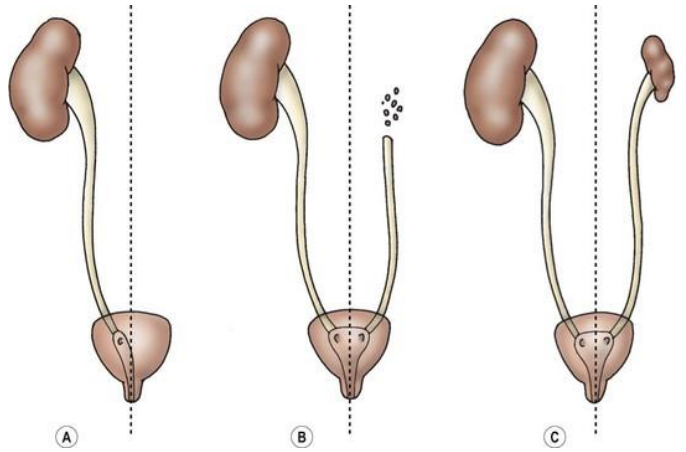
GLOMERULONEPHRITIS

- It is a kidney disease in which the glomeruli – the parts of the kidneys responsible for filtering waste and fluids from the blood - become inflamed.
- This causes blood and protein to be lost in the urine.
- Glomerulonephritis may be caused by specific problems with the body's immune system but often the cause is unknown.
- Glomerulonephritis can be acute (a sudden attack of inflammation) - or chronic (beginning gradually).
- In some patients there is no history of kidney disease and the disorder first manifests as chronic renal failure.



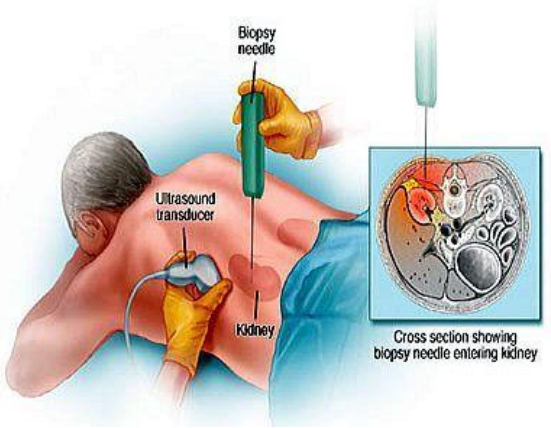
KIDNEY (RENAL) AGENESIS

- It occurs when the kidneys do not form during fetal development.
- Renal agenesis can be unilateral, with one kidney present, or bilateral, with no kidneys or very little kidney tissue present (dysgenesis).
- If the agenesis is unilateral, the other kidney will usually hypertrophy to recover for the missing kidney.
- Unilateral agenesis is often asymptomatic and is often discovered later in life.



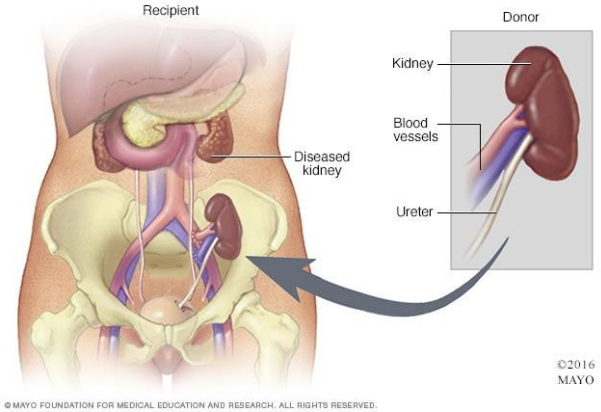
RENAL BIOPSY

- It involves taking a sample of kidney tissue for laboratory examination.
- It can be performed as an open procedure or percutaneously, using a biopsy needle (generally under ultrasound guidance).



RENAL TRANSPLANTATION

- Renal transplantation is a surgical procedure that involves the removal of a diseased kidney and replacement with a donor organ (either from a living donor or a cadaver).
- Living donor kidneys can be either from an identical twin (isograft) or other individual (allograft), preferably from a close relative.



QUESTIONS?

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