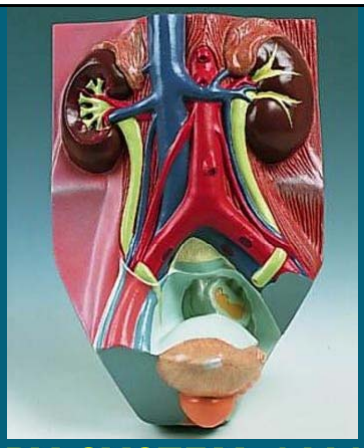
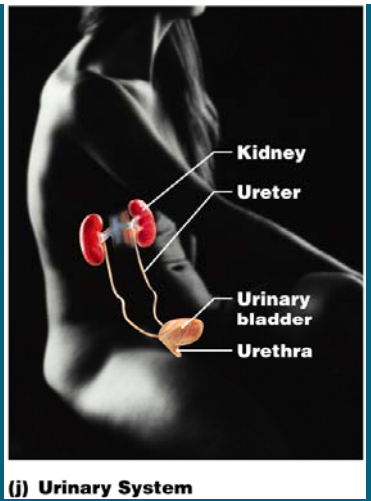


URINARY SYSTEM ANATOMY
PART 1

DANIL HAMMOUDI.MD

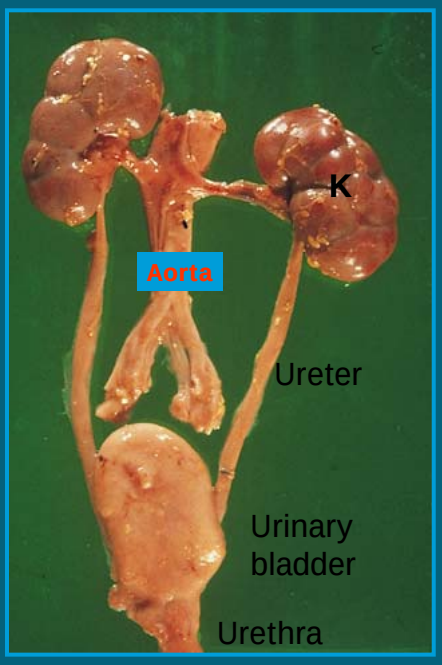
Urinary System

- Composed of
  - kidneys,
  - ureters,
  - urinary bladder,
  - and urethra
- Eliminates nitrogenous wastes from the body
- Regulates water, electrolyte, and pH balance of the blood



(j) Urinary System

Figure 1.3j



Components of the Urinary System

Kidneys **Ureters**

Urinary Bladder

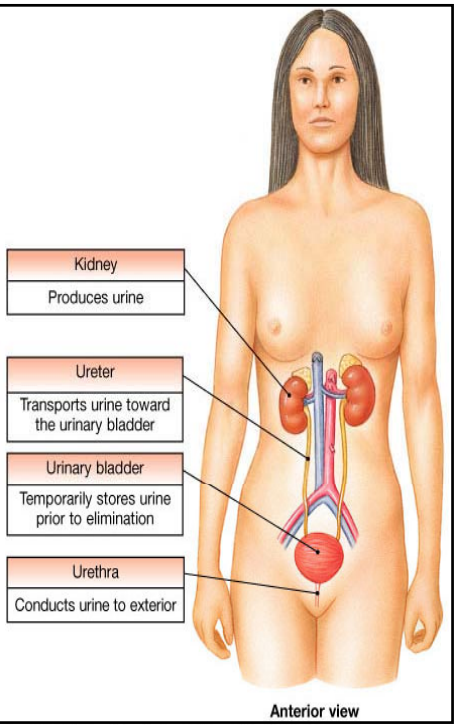
Urethra

Kidney Anatomy External

The **renal artery, renal vein** and **ureter** enter the kidney via the **hilus.** The kidney and it's vessels are embedded in a mass of fatty tissue called the **perirenal fat** which extends into a central cavity, the **renal sinus.**

Functions of the urinary system

- Excretion
  - The removal of organic waste products from body fluids
- Elimination
  - The discharge of waste products into the environment
- Homeostatic regulation of blood plasma
  - Regulating blood volume and pressure
  - Regulating plasma ion concentrations
  - Stabilizing blood pH
  - Conserving nutrients



Functions of the Urinary System

- Elimination - urine & toxic metabolites from the blood
- Conservation - salts, glucose, proteins & H_2O
- Regulation - blood pressure, hemodynamics & acid-base balance
- Endocrine - produces renin, erythropoietin and prostaglandins

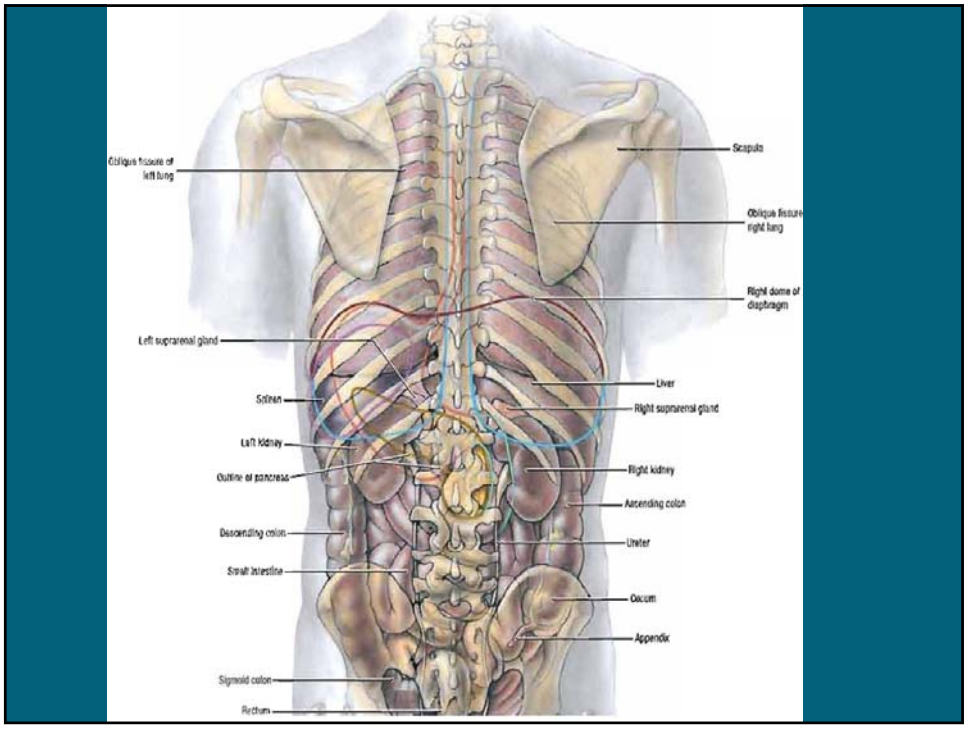
Function

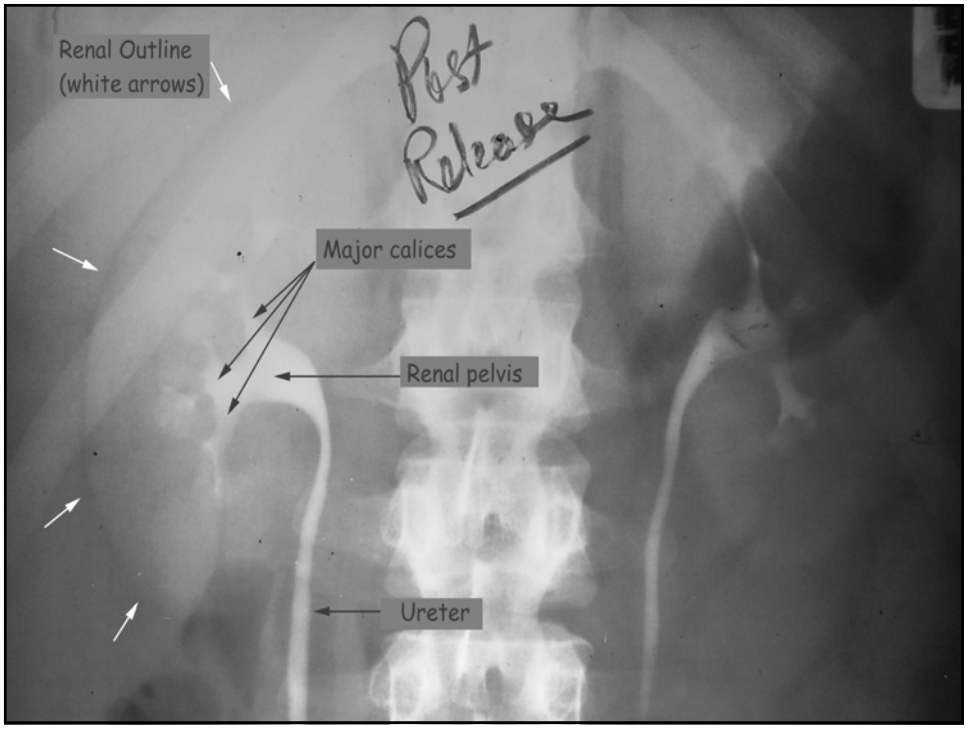
- Regulating blood ionic composition
- Regulating blood pH
- Regulating blood volume
- Regulating blood pressure
- Produce calcitrol and erythropoietin
- Regulating blood glucose
- Excreting wastes

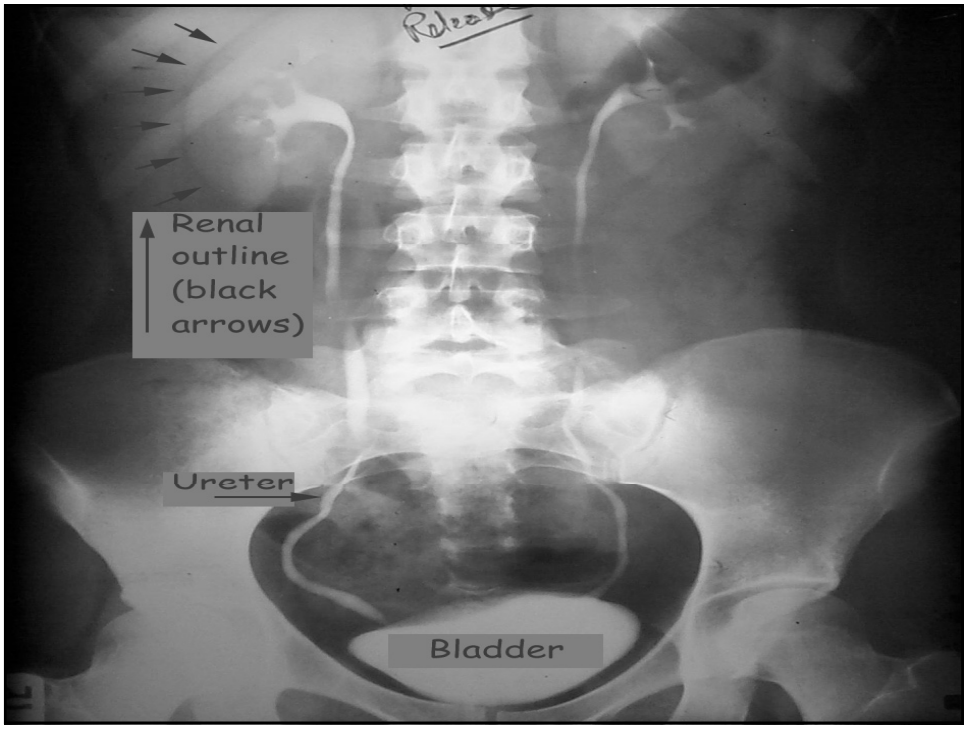
Kidney Functions

- Filter 200 liters of blood daily, allowing toxins, metabolic wastes, and excess ions to leave the body in urine
- Regulate volume and chemical makeup of the blood
- Maintain the proper balance between water and salts, and acids and bases
- Gluconeogenesis during prolonged fasting
- Production of rennin to help regulate blood pressure and erythropoietin to stimulate RBC production
- Activation of vitamin D

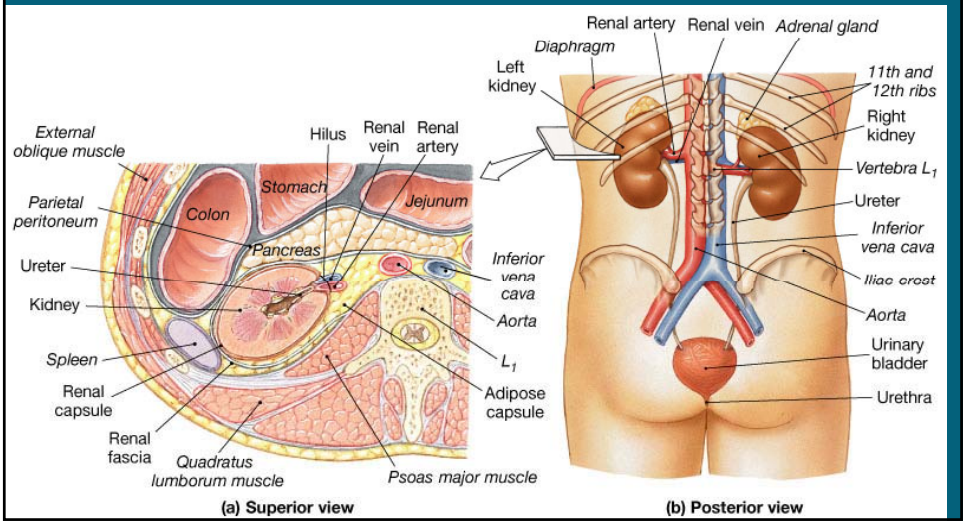
- Urinary bladder - provides a temporary storage reservoir for urine
- Paired ureters - transport urine from the kidneys to the bladder
- Urethra - transports urine from the bladder out of the body


Oblique fissure of left lung
Scapula
Oblique fissure right lung
Right dome of diaphragm
Left suprarenal gland
Liver
Spleen
Right suprarenal gland
Left kidney
Outline of pancreas
Right kidney
Ascending colon
Descending colon
Ureter
Small intestine
Caecum
Appendix
Sigmoid colon
Rectum


Renal Outline (white arrows)
Post Release
Major calices
Renal pelvis
Ureter



The Position of the Kidneys



Move as much as 1 inch during respiration

- The kidneys lie in a retroperitoneal position on the posterior abdominal wall in the superior lumbar region T11-T2
- The right kidney is lower than the left
- The lateral surface is convex; the medial surface

is concave - **hilum**

- Renal vein, 2 branches of the renal artery, the ureter, another branch of renal artery (VAUA)
- Lymph vessels and sympathetic fibres also pass

through hilum

Location and Relations – Right Kidney

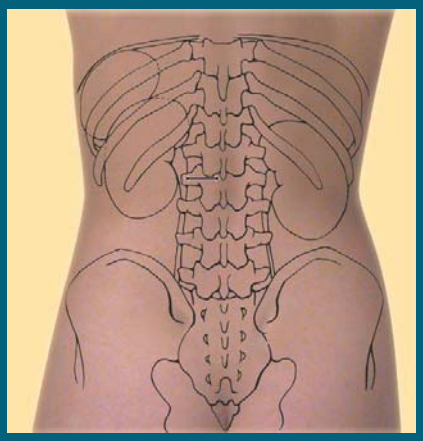
- **Anteriorly**

– Adrenal gland, the liver, 2nd duodenum, right colic flexure

- **Posteriorly**

– Diaphragm (and costodiaphragmatic recess), 12th rib, psoas,

- – subcostal (T12) iliohypogastric and ilioinguinal nerves (L1) run downwards and laterally



Location and Relations – Left Kidney

• Anteriorly

– Adrenal, spleen, stomach, pancreas, left colic flexure

• Posteriorly

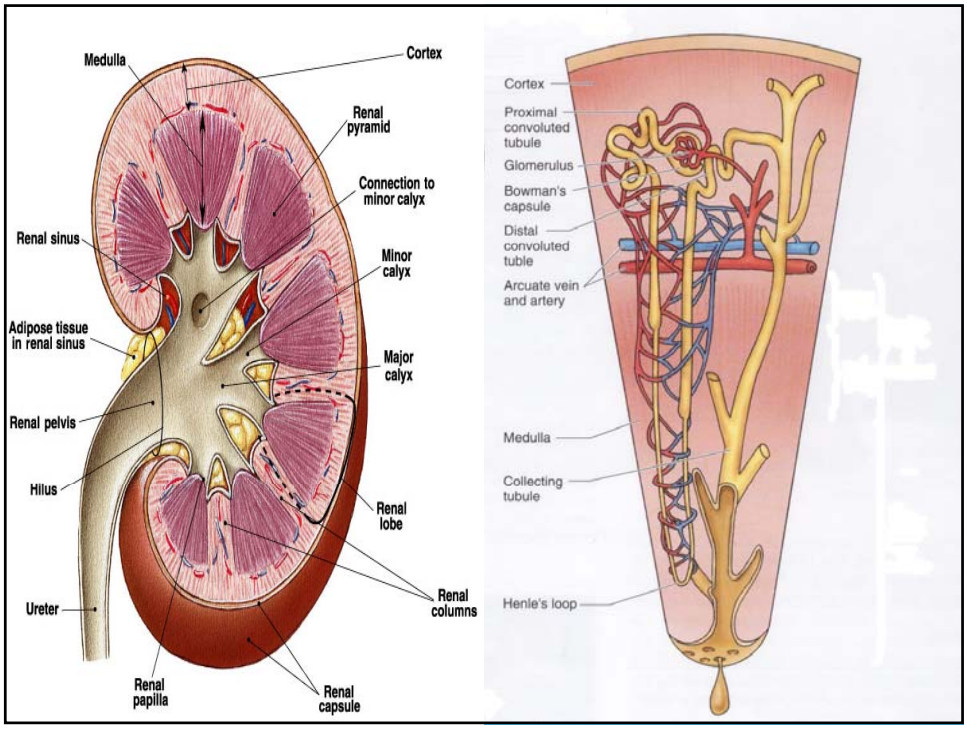
– **Diaphragm (and costodiaphragmatic recess),** 11th and 12th rib, psoas,

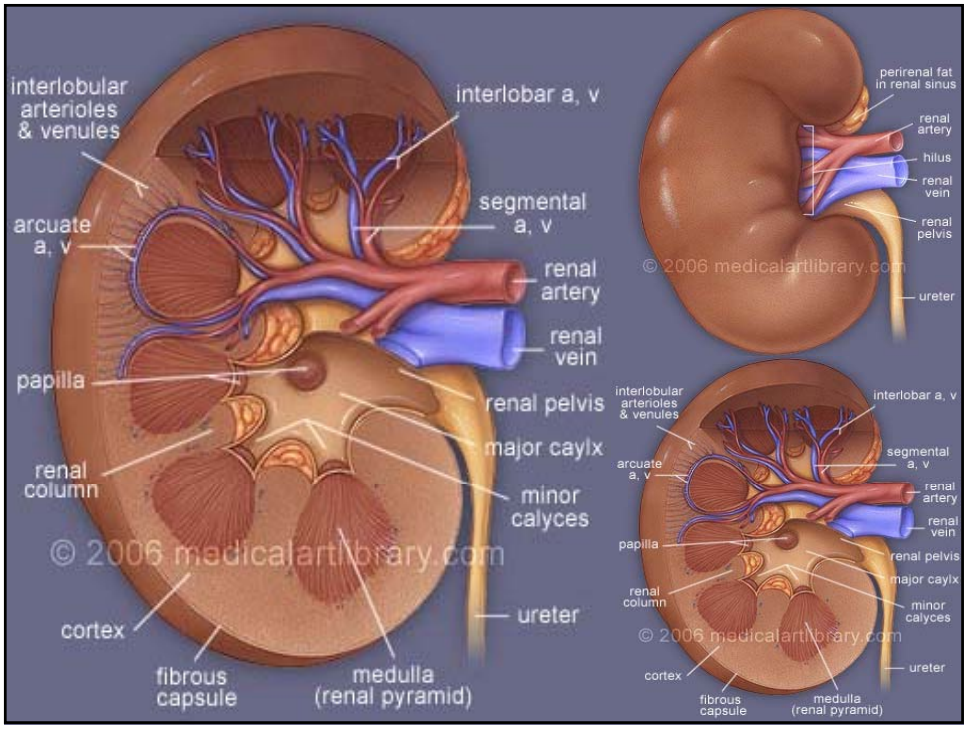
– subcostal (T12) iliohypogastric and ilioinguinal nerves (L1) run downwards and laterally

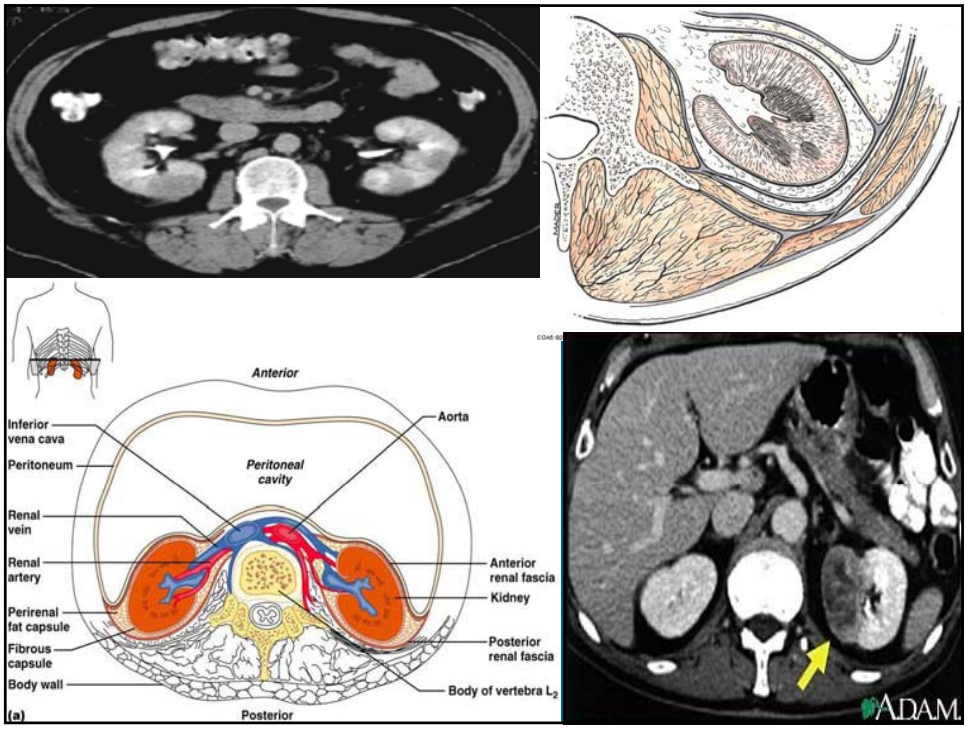
Coverings of the Kidneys

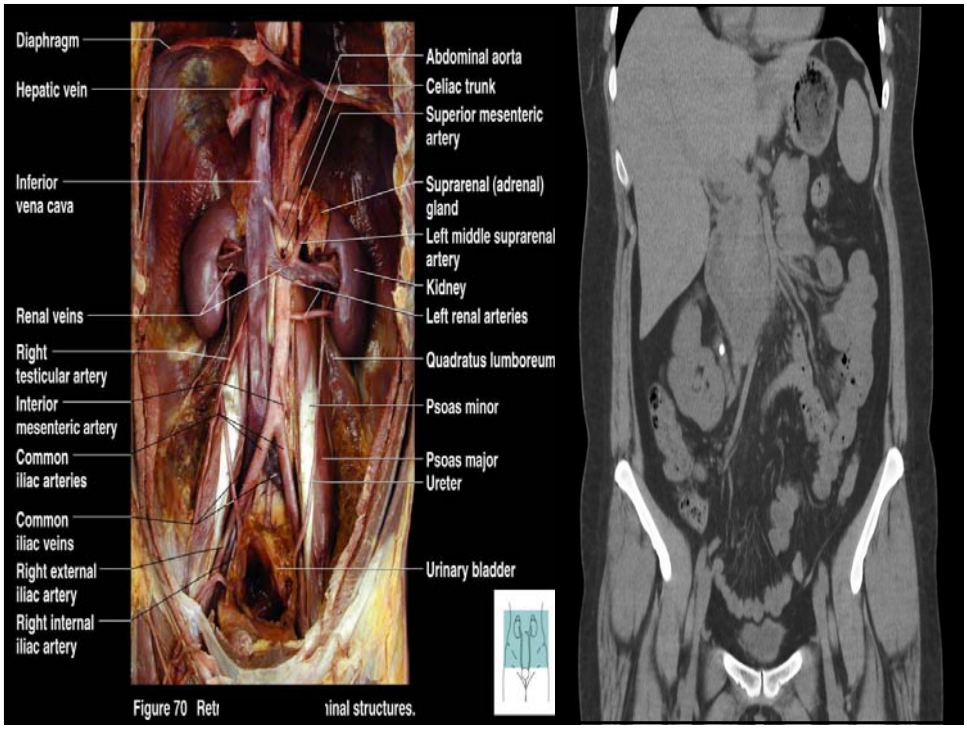
- **Renal / fibrous capsule** - that prevents kidney infection
- **Perirenal fat** – fatty mass that cushions the kidney and helps attach it to the body wall
- **Renal fascia** – outer layer of dense fibrous connective tissue that anchors the kidney
- **Pararenal fat** – external to the renal fascia

Perirenal Fat	A layer of adipose tissue (fat) partially surrounds the kidney. It is usually a radilogy finding but occassional a tumor can arise from it.
Renal Capsule	The thin but tough covering of the kidney. It helps protect the kidney. During a kidney biopsy, may feel a "pop" as the needle goes through the renal capsule
Renal Cortex	The outer shell of the kidney between the renal capsule and the renal medulla. The renal cortex contains the renal corpuscles (particularly the glomeruli) and most of the renal tubules (except for the loop of Henle). It is about 1 centimeter thick and also goes down between the renal pyramids. Many kidney diseases affect the glomeruli so the goal of a kidney biopsy is to sample this area.
Renal Medulla	The innermost area of the kidney. It is separated into 8 to 18 cone-shaped sections called the medullary pyramids. If the biopsy needle goes in too far, you may only get medulla and the biopsy will likely have to be repeated.
Medullary Pyramid	An important part of the inner kidney. It consists primarily of collecting tubules as well as loops of Henle. The base of the medullary pyramid is next to the cortex and it tapers to form the renal papillae. There are between 8 to 18 medulla pyramids in each kidney.
Calyx	An extension of the renal pelvis that surrounds the renal papillae. It collects urine from the papillary ducts. Several minor calyces drain into a major calyx and then onto the renal pelvis.
Renal Pelvis	The area where the urine collects before entering the ureters. Two or three major calices come together to enter the renal pelvis. Cancers and kidney stones can form in renal pelvis and cause blood to be lost in the urine.
Renal Sinus	A cavity in the kidney that contains the calices and the renal pelvis. It also contains the blood vessels, nerves, and fat.

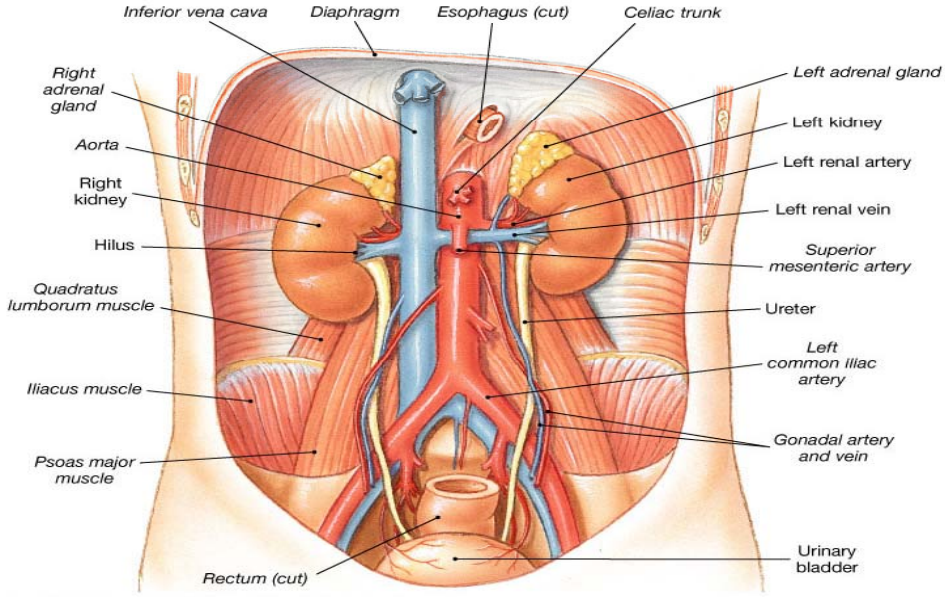

Medulla
Cortex
Renal pyramid
Connection to minor calyx
Renal sinus
Minor calyx
Adipose tissue in renal sinus
Major calyx
Renal pelvis
Hilus
Renal lobe
Ureter
Renal columns
Renal papilla
Renal capsule
Cortex
Proximal convoluted tubule
Glomerulus
Bowman's capsule
Distal convoluted tuble
Arcuate vein and artery
Medulla
Collecting tubule
Henle's loop


interlobular arterioles & venules
interlobar a, v
arcuate a, v
segmental a, v
renal artery
renal vein
papilla
renal pelvis
major caylx
renal column
minor calyces
ureter
cortex
fibrous capsule
medulla (renal pyramid)
© 2006 medicalartlibrary.com
perirenal fat in renal sinus
renal artery
hilus
renal vein
renal pelvis
ureter
© 2006 medicalartlibrary.com
interlobular arterioles & venules
interlobar a, v
segmental a, v
arcuate a, v
renal artery
renal vein
papilla
renal pelvis
major caylx
renal column
minor calyces
© 2006 medicalartlibrary.com
cortex
ureter
fibrous capsule
medulla (renal pyramid)


Anterior
Inferior vena cava
Peritoneum
Peritoneal cavity
Aorta
Renal vein
Renal artery
Anterior renal fascia
Kidney
Perirenal fat capsule
Fibrous capsule
Posterior renal fascia
Body wall
Body of vertebra L_2
(a)
Posterior
A.D.A.M.


Diaphragm
Hepatic vein
Inferior vena cava
Renal veins
Right testicular artery
Interior mesenteric artery
Common iliac arteries
Common iliac veins
Right external iliac artery
Right internal iliac artery
Abdominal aorta
Celiac trunk
Superior mesenteric artery
Suprarenal (adrenal) gland
Left middle suprarenal artery
Kidney
Left renal arteries
Quadratus lumboreum
Psoas minor
Psoas major
Ureter
Urinary bladder

The Urinary System in Gross Dissection



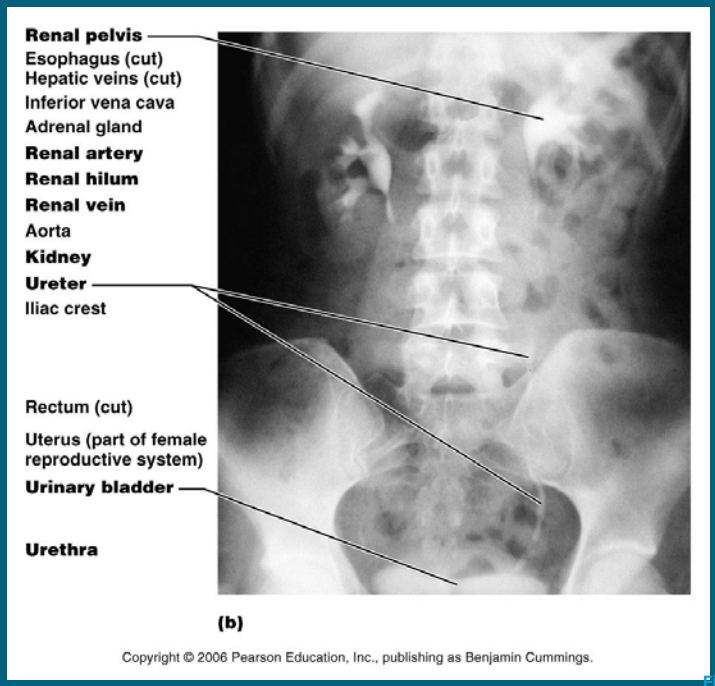


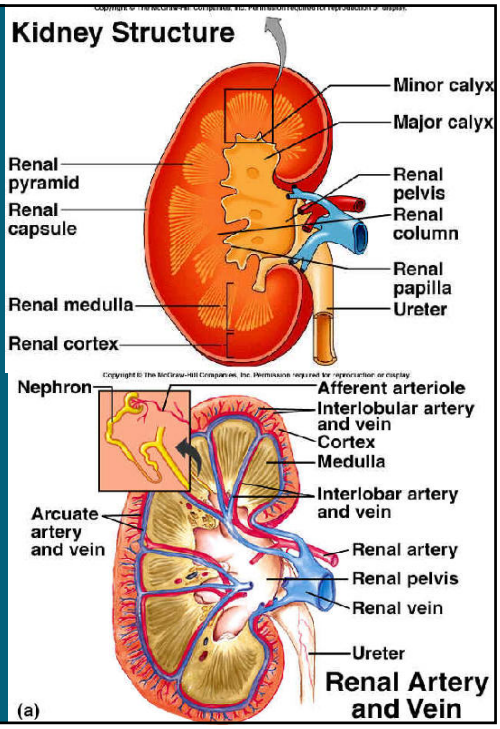
Figure 25.1b

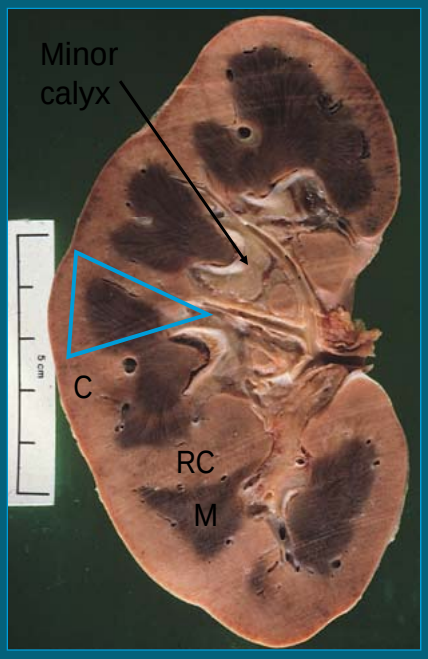
KIDNEY
- Basic structural unit = nephron (renal tubule or kidney tubule)

Hilum = depression thru which urine exits and blood vessels enter (and exit) the kidney

Renal Pelvis = expansion of upper part of ureter within the hilum, divided into large and small cups (major and minor calyces).

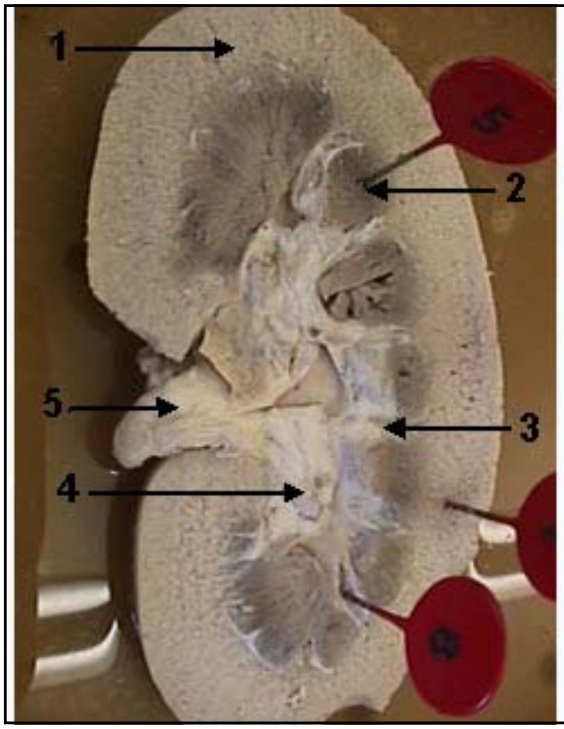
Collecting Ducts = empty into calyces, these are structures into which renal tubules drain





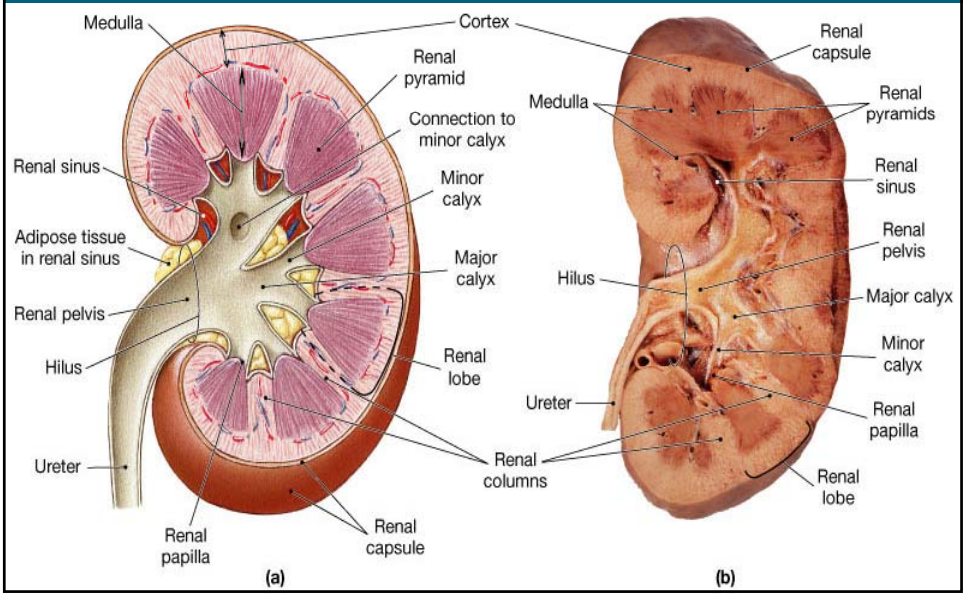
Cortex
- **renal columns**

Medulla
- **medullary pyramids**
- **minor calyx**
- **medullary rays**

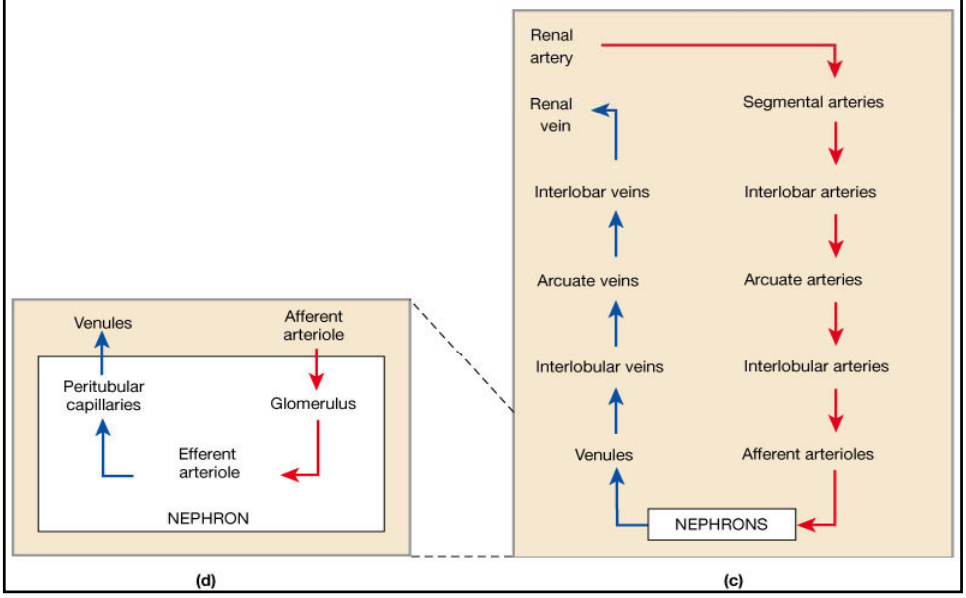


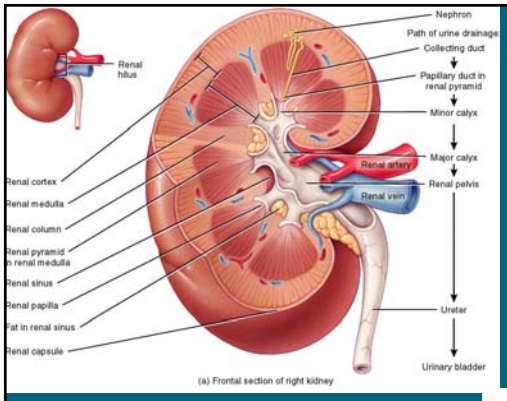
1renal cortex
2renal pyramid
3renal column
4renal pelvis
5ureter

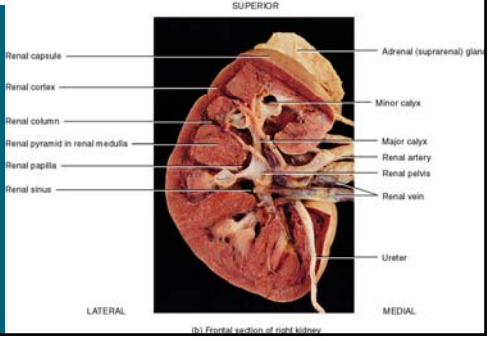
The Structure of the Kidney

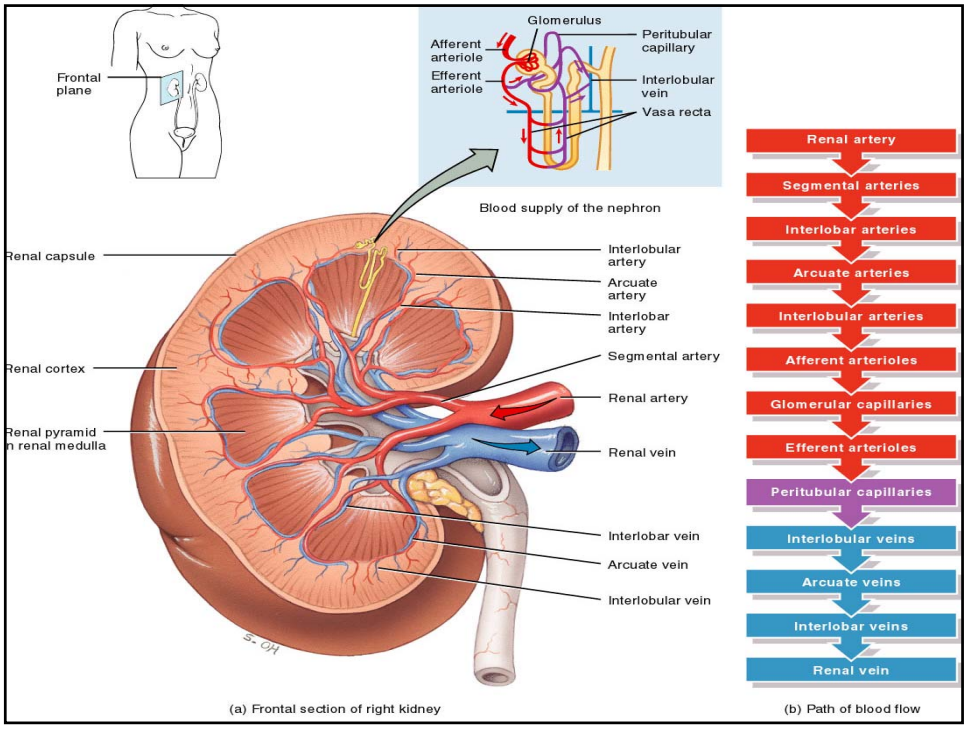


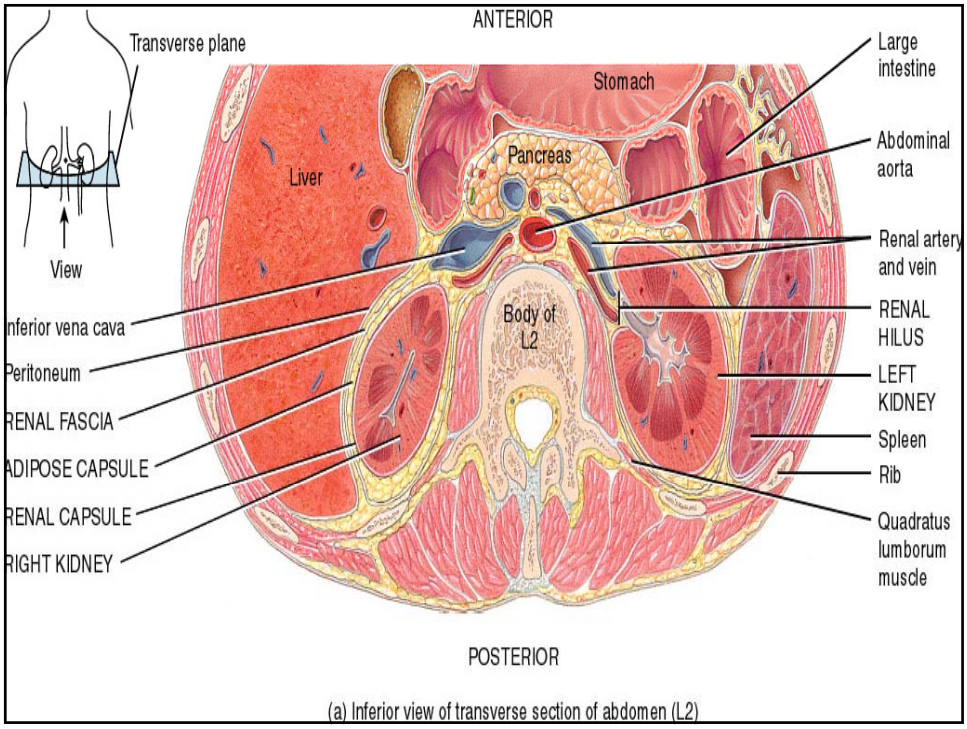
The Blood Supply to the Kidneys

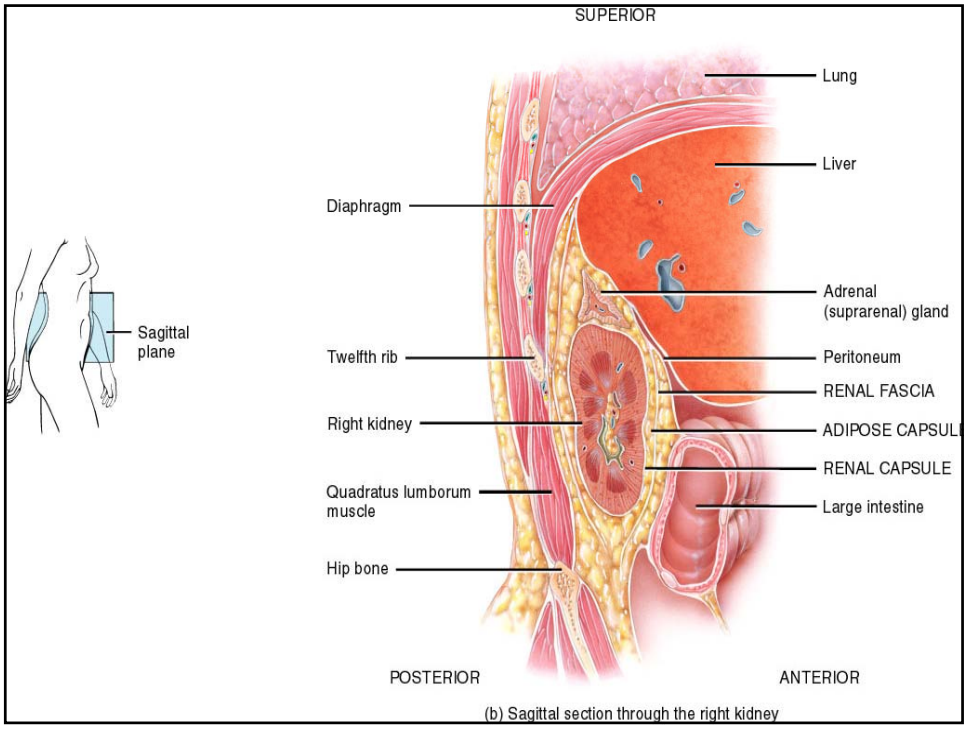


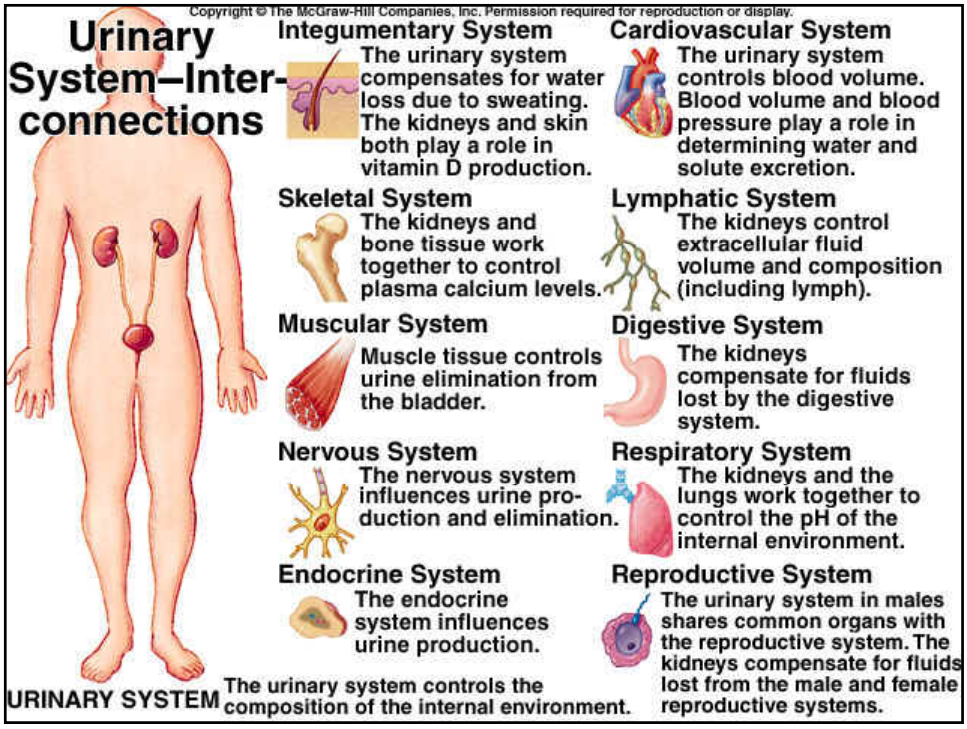





Frontal plane
Glomerulus
Afferent arteriole
Efferent arteriole
Peritubular capillary
Interlobular vein
Vasa recta
Blood supply of the nephron
Renal capsule
Renal cortex
Renal pyramid in renal medulla
Interlobular artery
Arcuate artery
Interlobar artery
Segmental artery
Renal artery
Renal vein
Interlobar vein
Arcuate vein
Interlobular vein
(a) Frontal section of right kidney
Renal artery
Segmental arteries
Interlobar arteries
Arcuate arteries
Interlobular arteries
Afferent arterioles
Glomerular capillaries
Efferent arterioles
Peritubular capillaries
Interlobular veins
Arcuate veins
Interlobar veins
Renal vein
(b) Path of blood flow


ANTERIOR
Transverse plane
View
Stomach
Liver
Pancreas
Large intestine
Abdominal aorta
Renal artery and vein
RENAL HILUS
LEFT KIDNEY
Spleen
Rib
Quadratus lumborum muscle
Body of L2
nferior vena cava
Peritoneum
RENAL FASCIA
ADIPOSE CAPSULE
RENAL CAPSULE
RIGHT KIDNEY
POSTERIOR
(a) Inferior view of transverse section of abdomen (L2)


SUPERIOR
Lung
Liver
Diaphragm
Adrenal (suprarenal) gland
Sagittal plane
Twelfth rib
Peritoneum
RENAL FASCIA
Right kidney
ADIPOSE CAPSULE
RENAL CAPSULE
Quadratus lumborum muscle
Large intestine
Hip bone
POSTERIOR
ANTERIOR
(b) Sagittal section through the right kidney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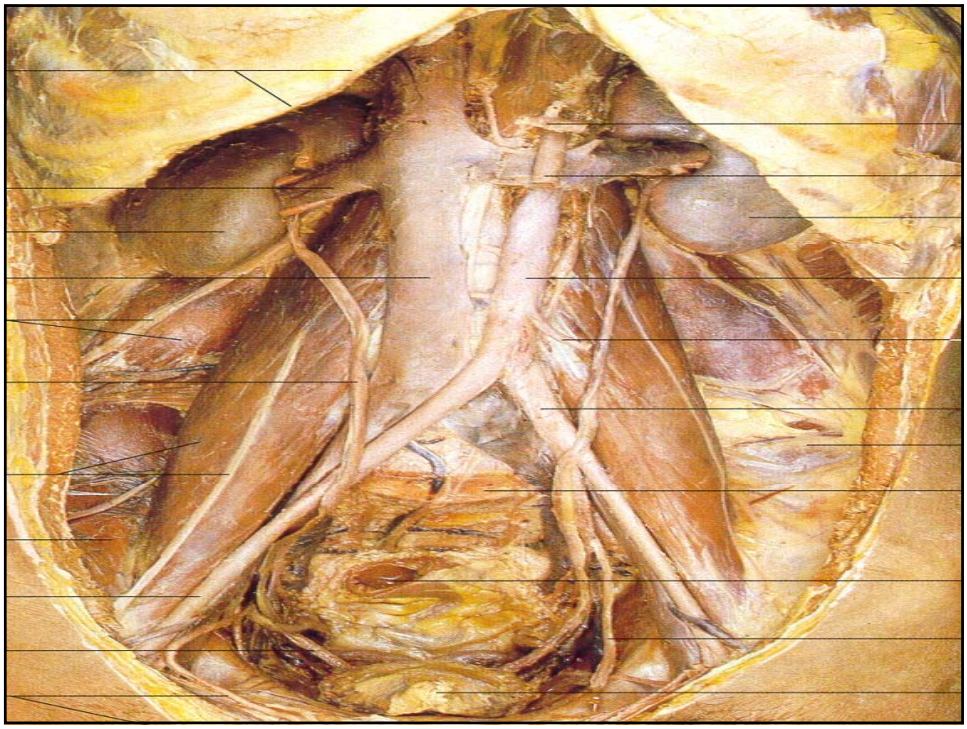
Urinary System–Inter-connections
Integumentary System
The urinary system compensates for water loss due to sweating. The kidneys and skin both play a role in vitamin D production.
Cardiovascular System
The urinary system controls blood volume. Blood volume and blood pressure play a role in determining water and solute excretion.
Skeletal System
The kidneys and bone tissue work together to control plasma calcium levels.
Lymphatic System
The kidneys control extracellular fluid volume and composition (including lymph).
Muscular System
Muscle tissue controls urine elimination from the bladder.
Digestive System
The kidneys compensate for fluids lost by the digestive system.
Nervous System
The nervous system influences urine production and elimination.
Respiratory System
The kidneys and the lungs work together to control the pH of the internal environment.
Endocrine System
The endocrine system influences urine production.
Reproductive System
The urinary system in males shares common organs with the reproductive system. The kidneys compensate for fluids lost from the male and female reproductive systems.
URINARY SYSTEM
The urinary system controls the composition of the internal environment.



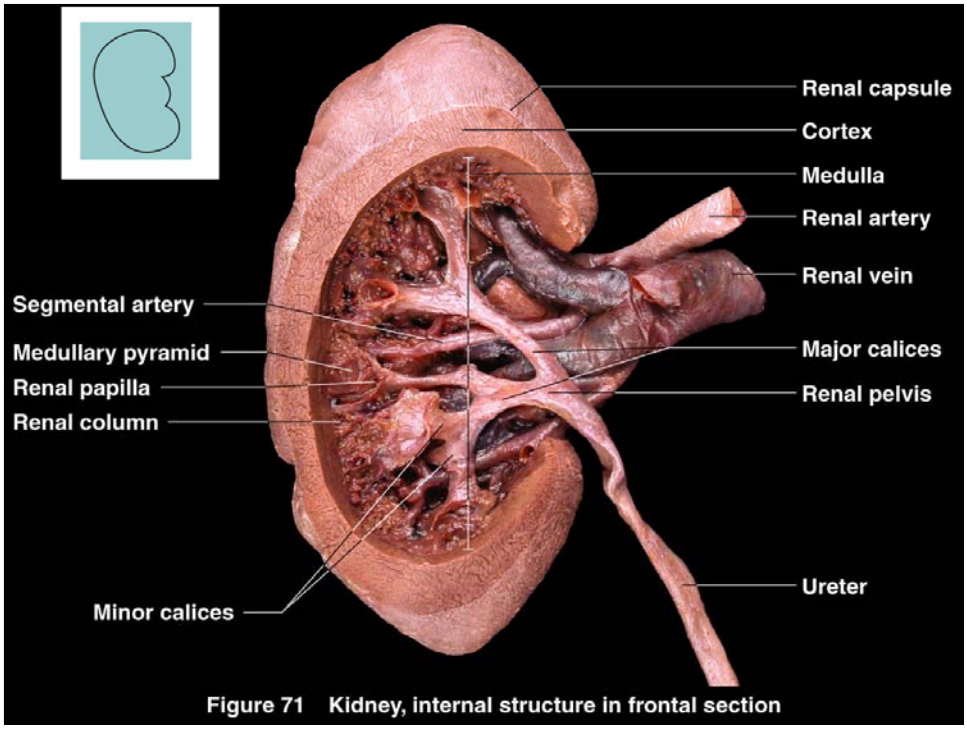
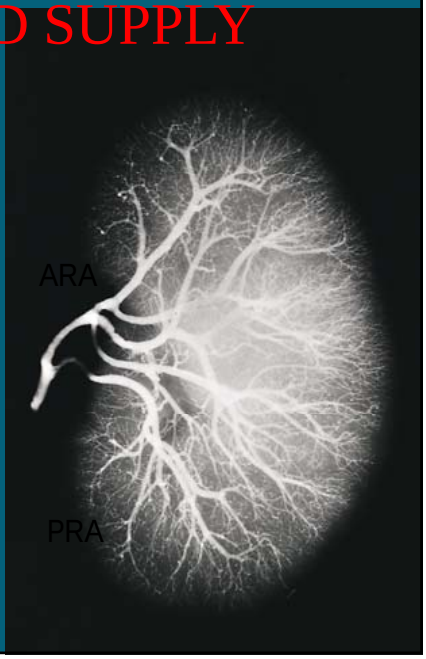


Figure 71 Kidney, internal structure in frontal section

KIDNEY: BLOOD SUPPLY

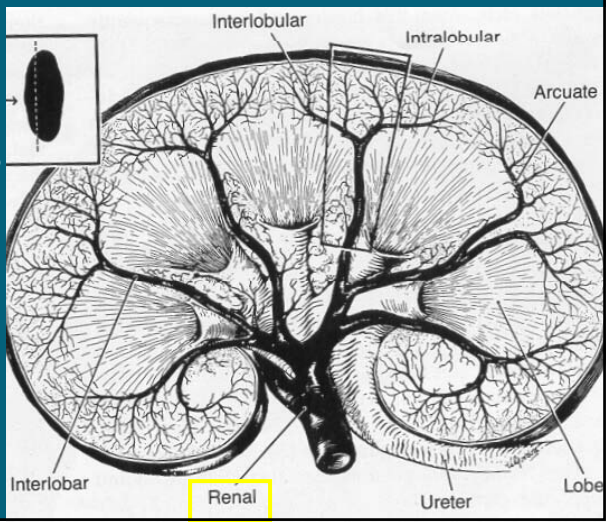
•AS A BLOOD-FILTERING ORGAN, THE KIDNEY'S BLOOD SUPPLY IS CRUCIAL TO ITS FUNCTION...

Renal artery



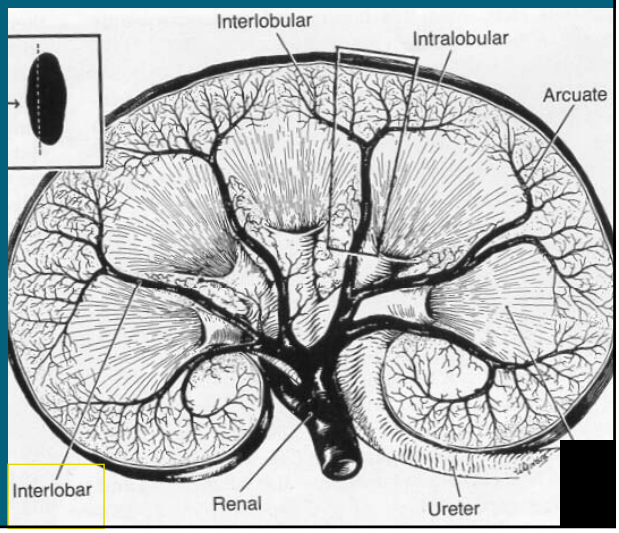
RENAL BLOOD SUPPLY

- **RENAL ARTERY** SUPPLIES EACH KIDNEY
- RENAL A. BRANCHES INTO **ANT. & POST. BRANCHES** NEAR HILUM



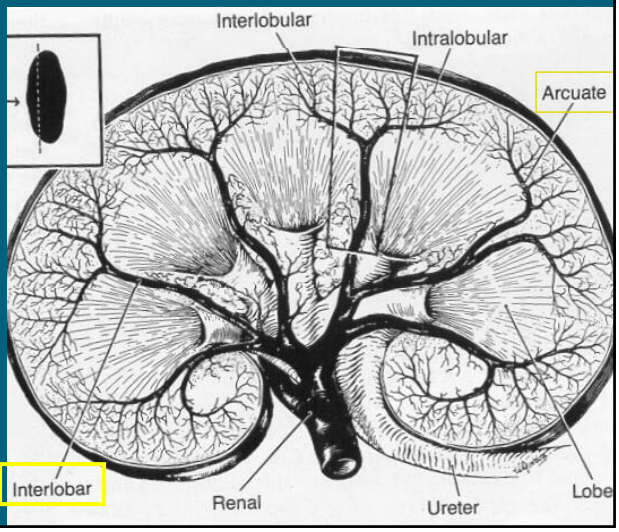
RENAL BLOOD SUPPLY

- **ANTERIOR AND ANT. & POST. RENAL BRANCHES** GIVE RISE TO **INTERLOBAR ARTERIES** (PENETRATE MEDULLA BETWEEN MEDULLARY PYRAMIDS)



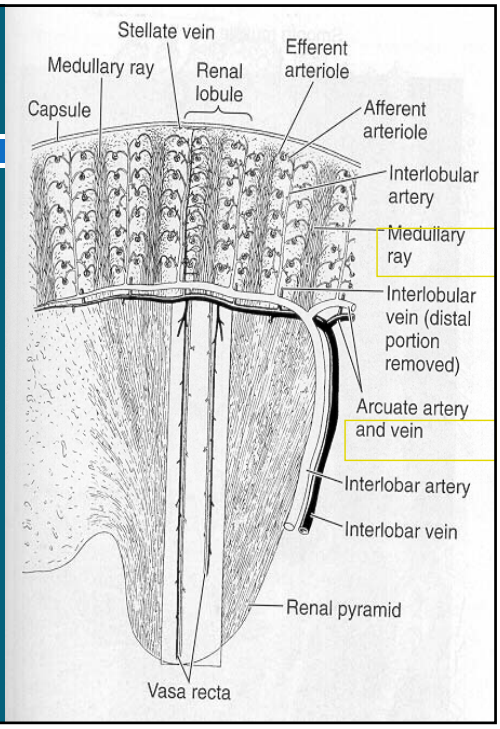
RENAL BLOOD SUPPLY

- **INTERLOBAR ARTERIES** GIVE RISE TO **ARCUATE A.A.** (COURSE ALONG CORTICO-MEDULLARY BORDER)



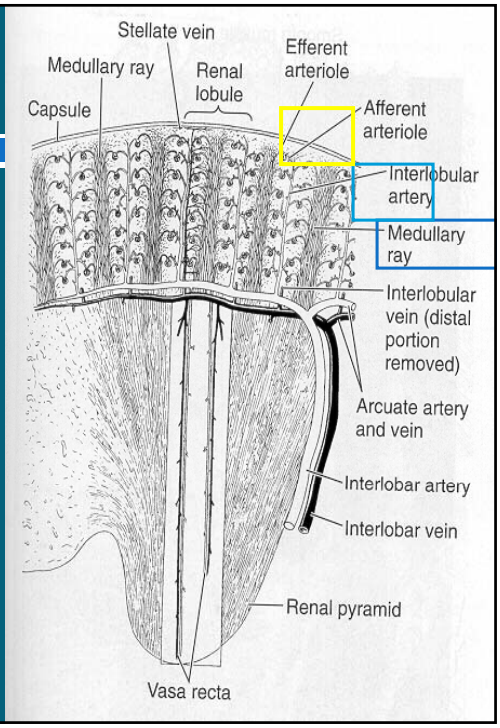
RENAL BLOOD SUPPLY

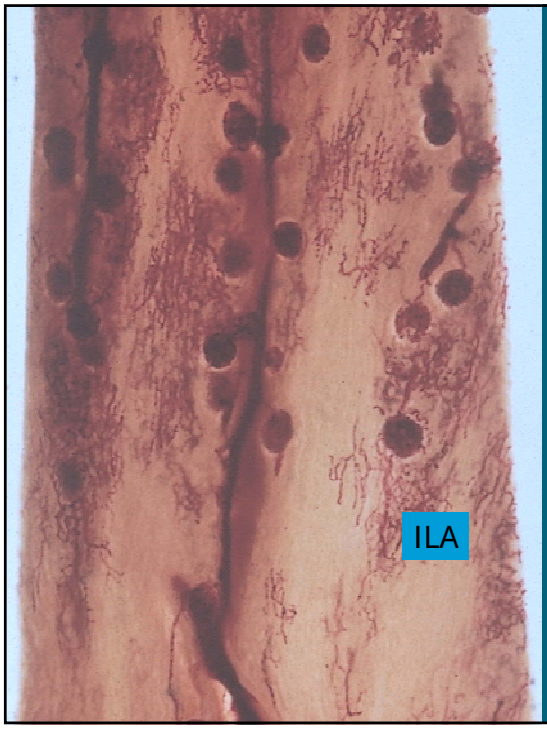
- **ARCUATE A.A.** GIVE RISE TO **INTERLOBULAR A.A.** (PENETRATE CORTEX BETWEEN MEDULLARY RAYS; LIE BETWEEN RENAL LOBULES)



RENAL BLOOD SUPPLY

- **INTERLOBULAR A.A.** GIVE RISE TO **AFFERENT ARTERIOLES** (SUPPLY GLOMERULI.)
- **GLOMERULI** ARE DRAINED BY **EFFERENT ARTERIOLES**…



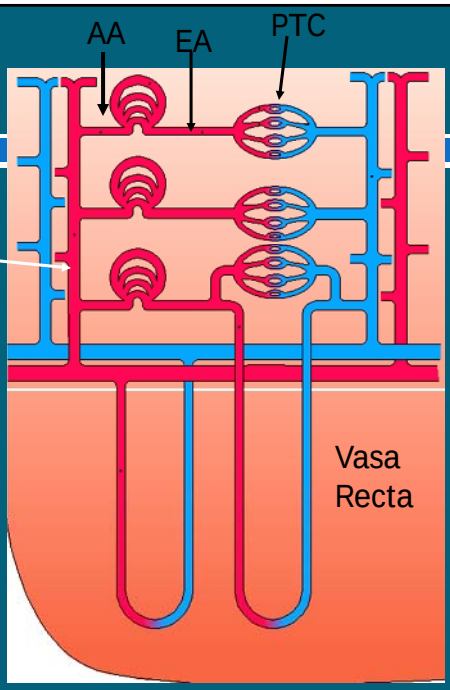


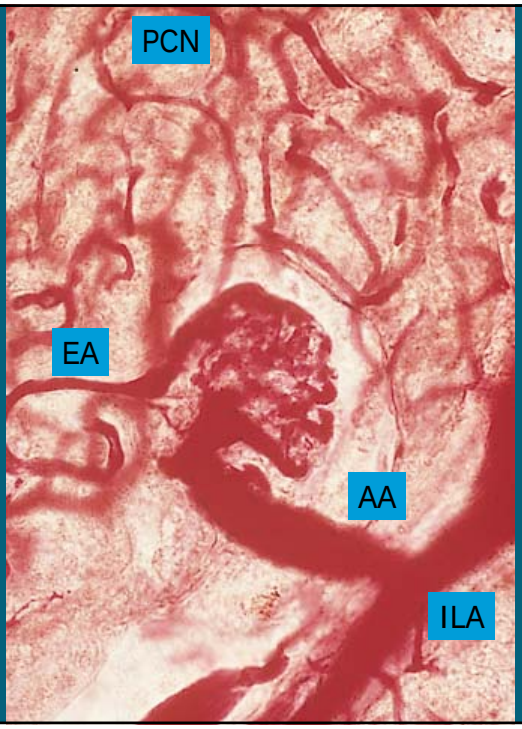
ILA - Interlobular Artery

Branches supply the glomerulus as Afferent arterioles

KIDNEY: BLOOD SUPPLY

- Efferent arterioles drain the glomeruli & form capillary networks
- Drain cortical nephrons and form peritubular capillary network (take up substances resorbed by tubular epithelium)
- Drain juxtamedullary nephrons and form vasa recta (countercurrent exchange system)

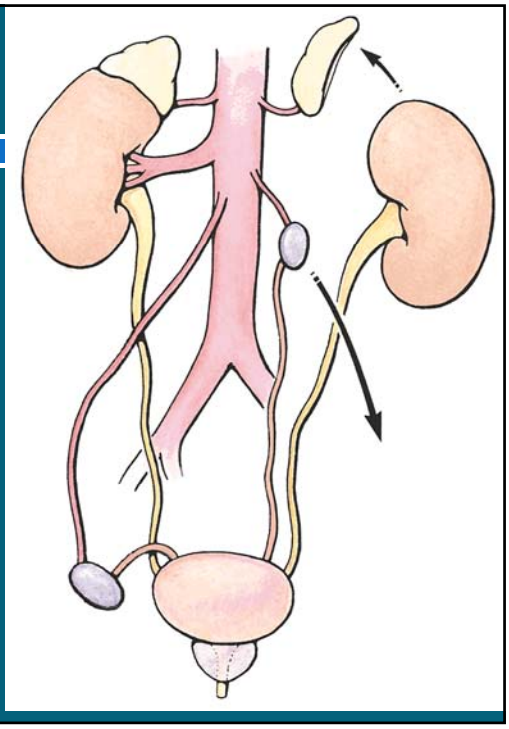


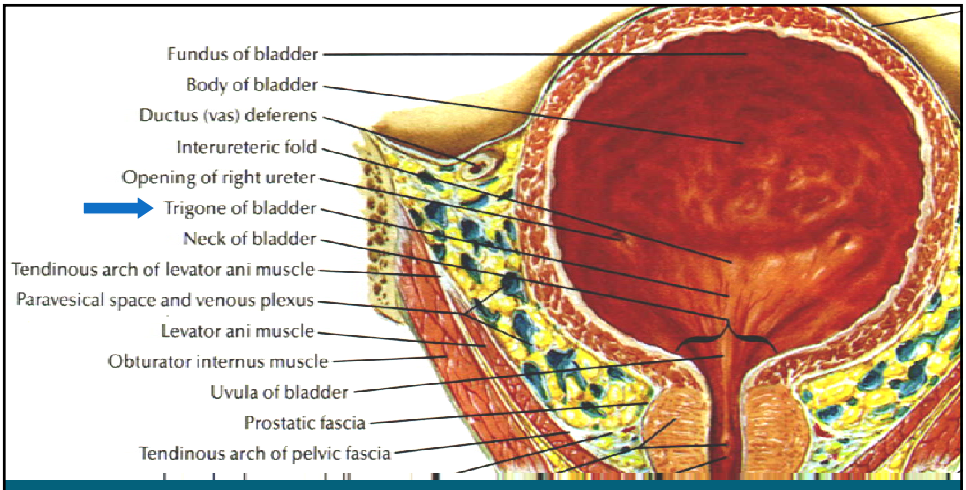


URETERS

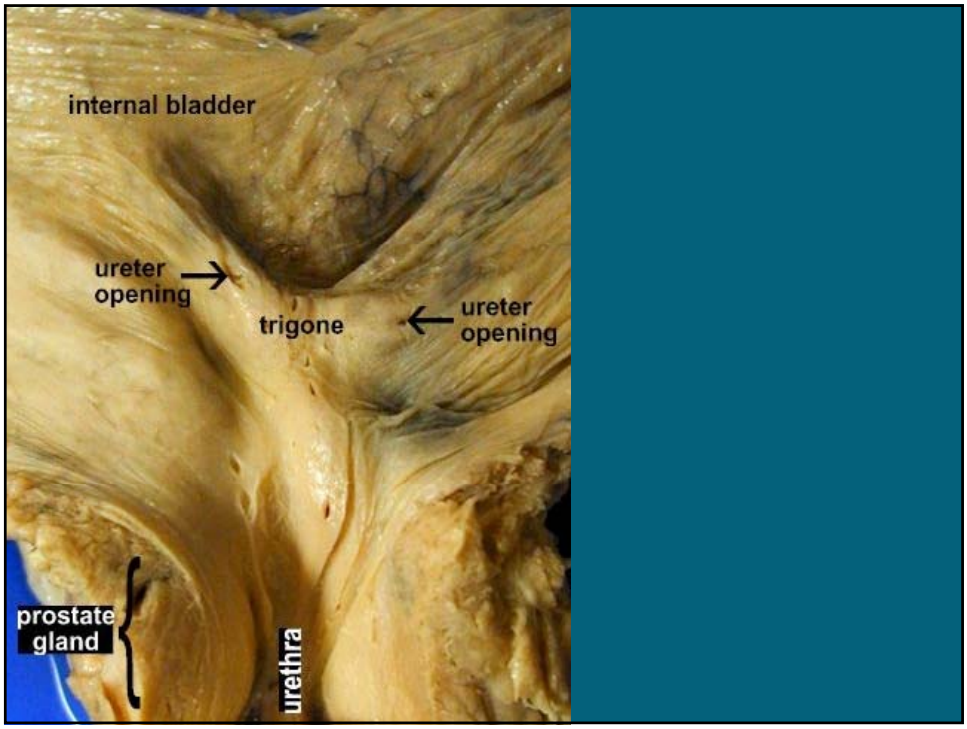
URETERS

- Run anterior to psoas and bifurcation of common iliac arteries to enter pelvis.
- Run retroperitoneally along posterolateral wall, anterior to the internal iliac artery.





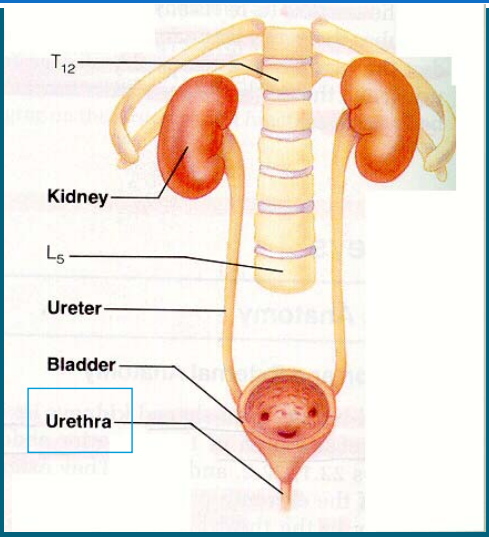
Lined by transitional epithelium over a dense lamina propria. Walls composed of detrusor muscles. Inner circular layer forms the internal urethral sphincter. Also external sphincters


internal bladder
ureter opening
trigone
ureter opening
prostate gland
urethra

URETHRA

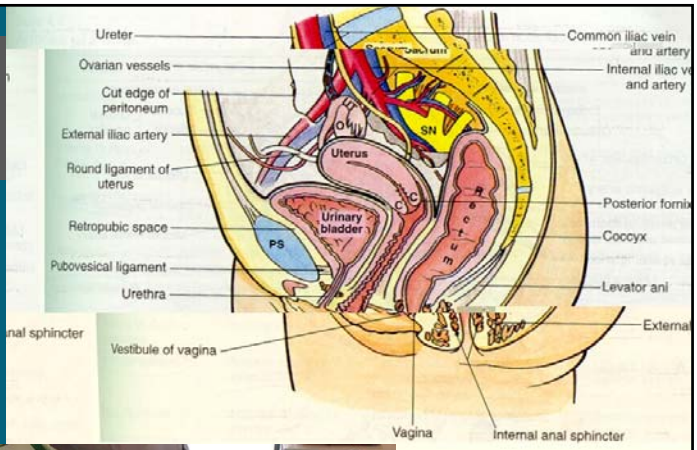
URETHRA

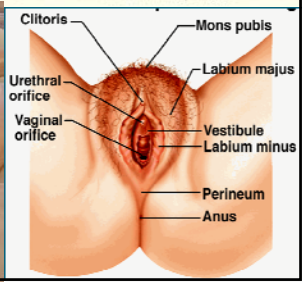
- DIFFERS IN LENGTH, EPITHELIUM, AND FUNCTION IN MALES AND FEMALES…

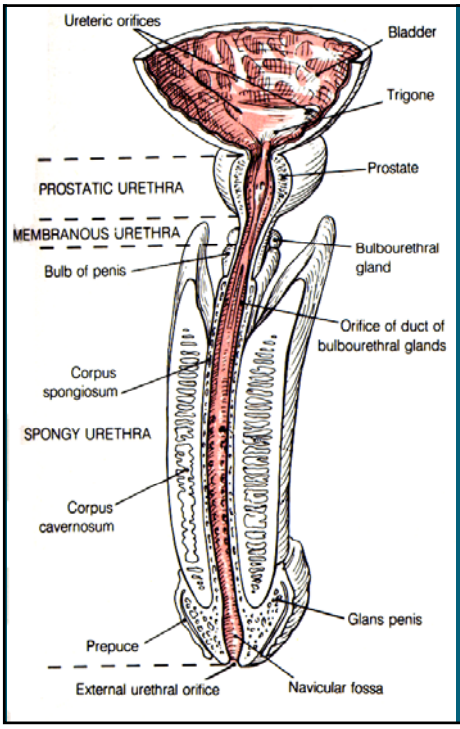


FEMALE URETHRA

- 4-5 CM
- STRATIFIED SQUAMOUS (AREAS OF PSEUDO-STRATIFIED COLUMNAR)





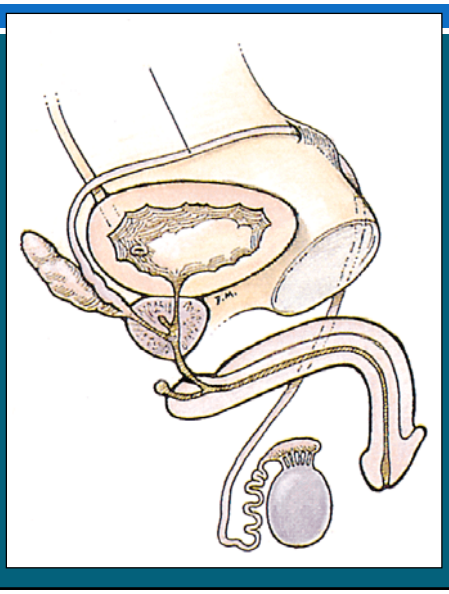


Male urethra conducts both urine and seminal fluid and consists of three parts:

Prostatic
Membranous
Spongy (penile, cavernous)

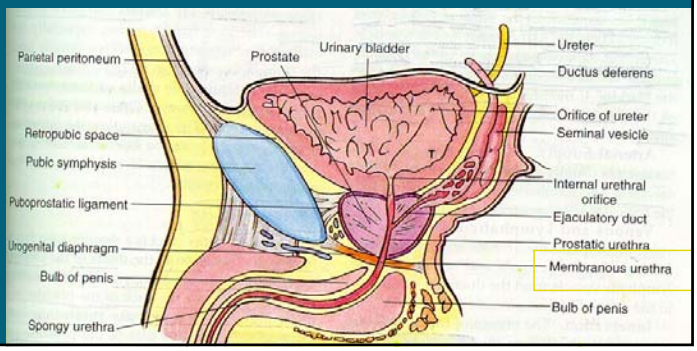
MALE URETHRA: PROSTATIC

- SURROUNDED BY PROSTATE GLAND
- LINED BY TRANSITIONAL EPITHELIUM



MALE URETHRA: MEMBRANOUS

- MEMBRANOUS PART IS SHORTEST SEGMENT
- LINED BY PSEUDOSTRATIFIED COLUMNAR EPITHELIUM



MALE URETHRA: Spongy

- EPITHELIAL LINING CHANGES IN THE GLANS FROM PSEUDOSTRATIFIED COLUMNAR TO STRATIFIED SQUAMOUS
- MUCOUS GLANDS OF LITTRE IN CAVERNOUS PORTION