

The Urinary System



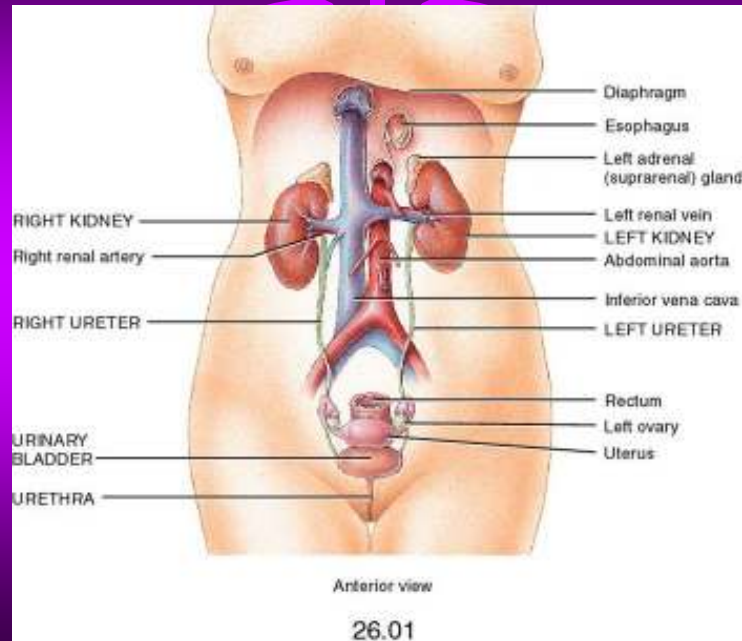
Functions of the Urinary System

- Maintains homeostasis of blood
 - Remove waste products
 - Restore selected amounts of water and solutes
- Maintains blood pressure
 - Controls blood plasma volume
- Helps regulate the body's pH
- Stimulates red blood cell production
 - Erythropoietin (EPO)
- Helps in many metabolic processes

Components of the Urinary System

- Kidneys (2)
- Ureters (2)
- Bladder
- Urethra

Urinary System



Kidneys



- The paired kidneys are located retroperitoneal and are found in the abdominal cavity.
- They function to filter blood, regulate blood volume and composition, and form urine.

The Ureters



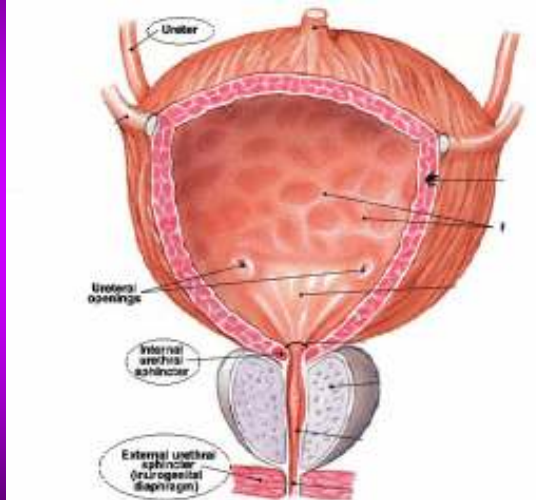
- Tubes that carry urine from the kidneys to the urinary bladder
- Actually an extension of the renal pelvis
 - 25 to 30 cm long (10 to 12 inches)
- Primary function is to transport urine
 - gravity
 - hydrostatic pressure
 - peristaltic action by muscularis layer

The Urinary Bladder



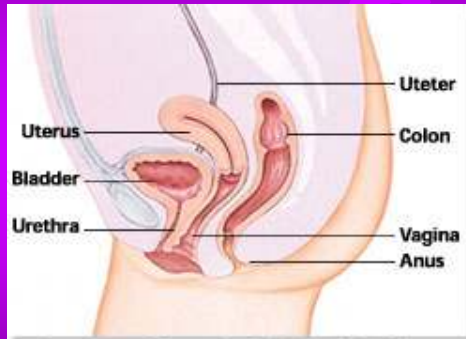
- A hollow muscular organ that stores urine until excretion
- Shape is dependent upon how much urine is present at any given time
- When filled with urine it is somewhat pear shaped
- Trigone - a small triangular shaped area formed by the openings of the ureters and the urethra

Bladder- structure of

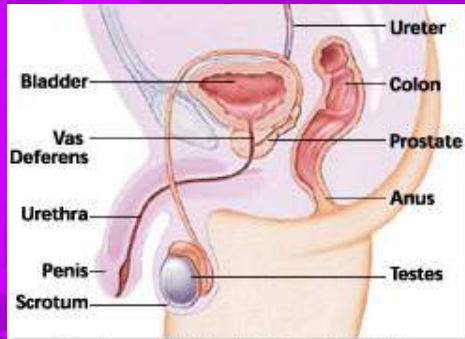


- 3 layers
 - Outer layer
 - Loose connective tissue
 - Middle layer
 - Smooth muscle and elastic fibres
 - Inner layer
 - Lined with transitional epithelium

Bladder



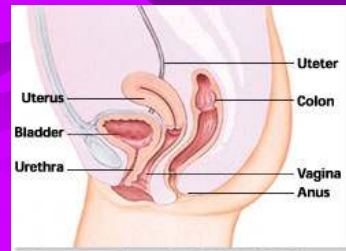
Interior of Female Pelvis - Side View



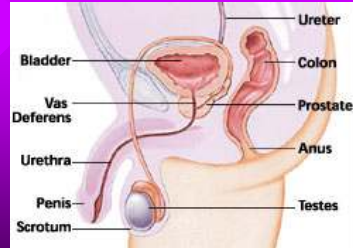
Interior of Male Pelvis - Side View

Urethra

- Extends from the base of the bladder to the outside world.
- Anatomical differences mean that male and female urethras are different.
 - Female: 4cm long
 - Male: 14cm long



Interior of Female Pelvis - Side View



Interior of Male Pelvis - Side View

Histology of the Bladder

- Comprised of four tissue layers
- Mucosa - inner layer made up of transitional epithelium
- Submucosa
- Detrusor - third layer of tissue consists of three layers of smooth muscle
 - inner layer - longitudinally arranged
 - middle layer - circular arrangement
 - outer layer - longitudinally arranged
- Serous Coat - outermost layer

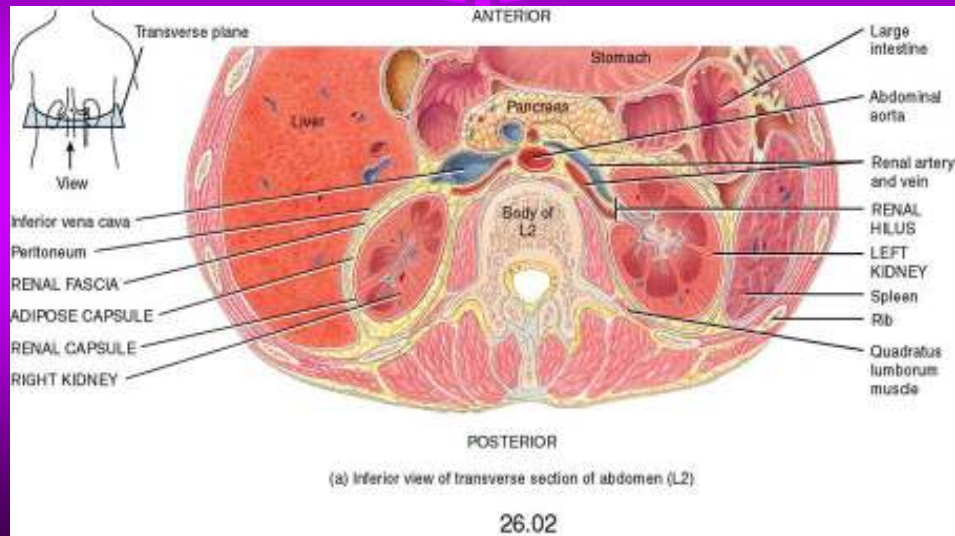
The Urethra

- A small tube leading from the floor of the urinary bladder to the exterior of the body
- The terminal portion of the urinary system that serves as the passageway by which to discharge urine from the body
- Urethral Orifice - the opening of the urethra to the exterior
- External Urethral Sphincter - sphincter muscle controlling urination

The Kidneys

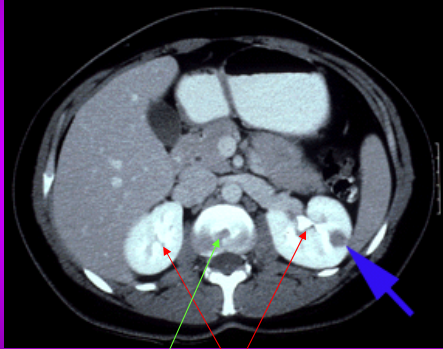
- Paired reddish organs shaped like a bean
- Located just above the waist between the parietal peritoneum and the posterior wall of the abdomen (retroperitoneal)
- About 10-12 cm long, 5 to 7.5 cm wide, and 2.5 cm thick
- Concave border faces medially
- Convex surface faces laterally
- About the size of your fist

Position of Kidneys

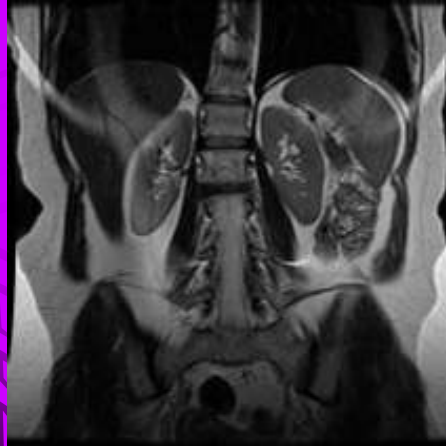


Position of the Kidneys

CT abdomen with contrast



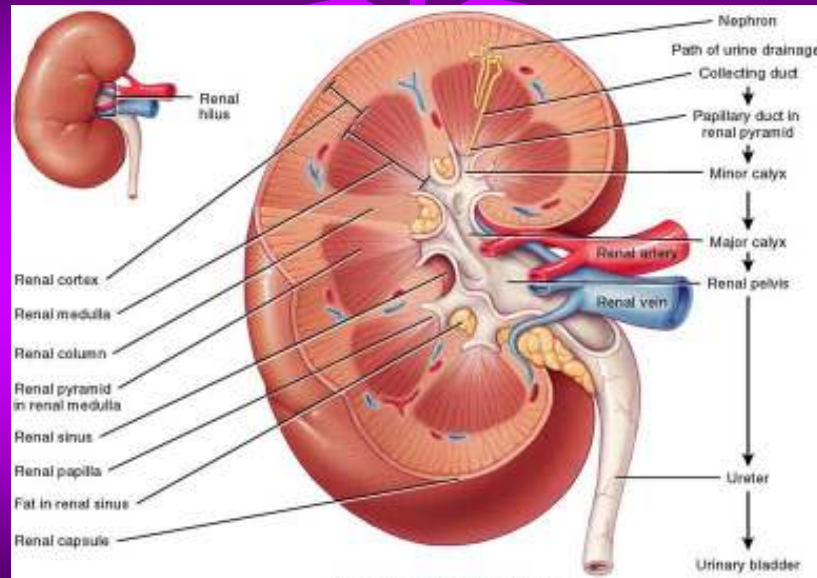
MRI coronal abdomen



Internal Anatomy of the Kidney

- Cortex - outer reddish area of the kidney
- Medulla - inner brownish area of the kidney
- Renal (Medullary) Pyramids - 8 to 18 triangular structures located within the medulla of each kidney
- Renal Pelvis - a large cavity within the renal sinus that serves as an area to collect urine from the renal pyramids
 - Calyces - channels into the renal pelvis

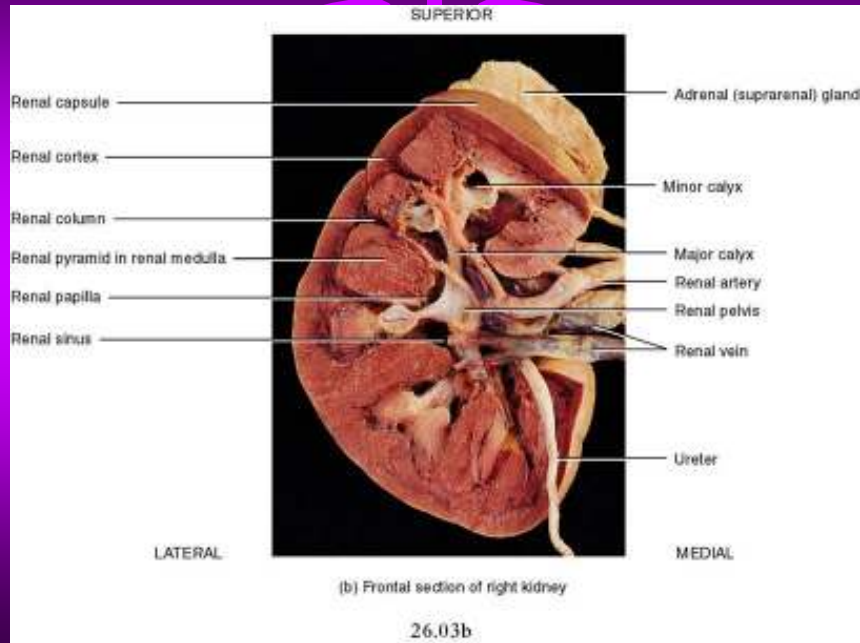
Kidney Structures



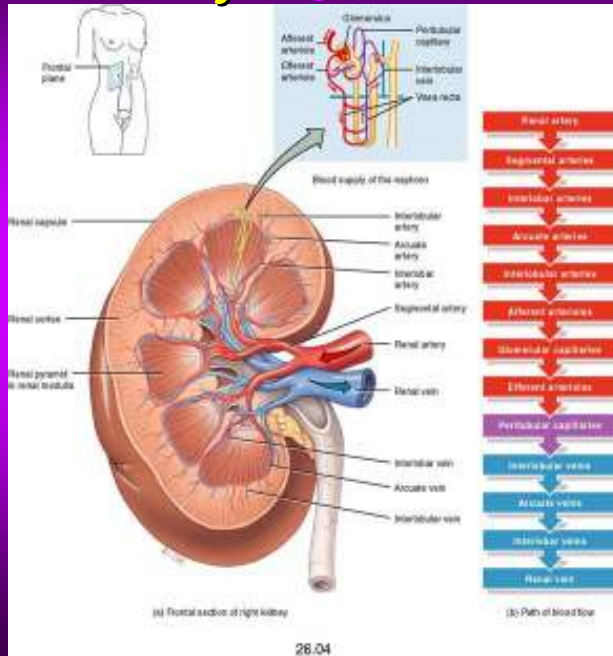
(a) Frontal section of right kidney

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Kidney Structures



Kidney Vasculature

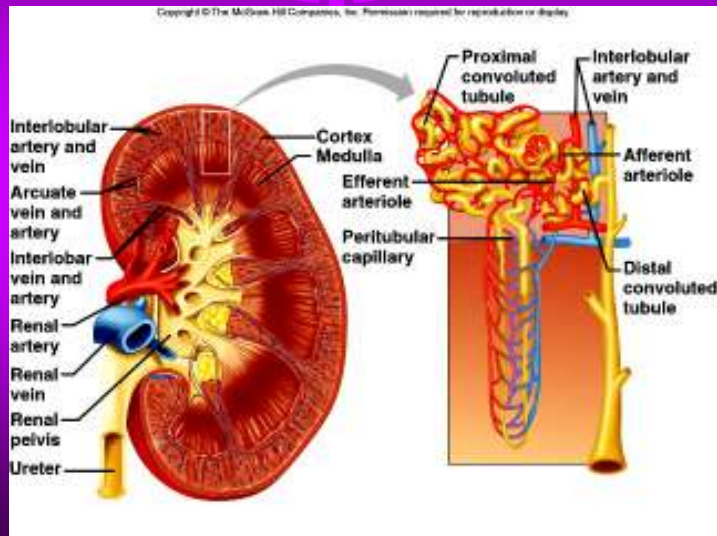


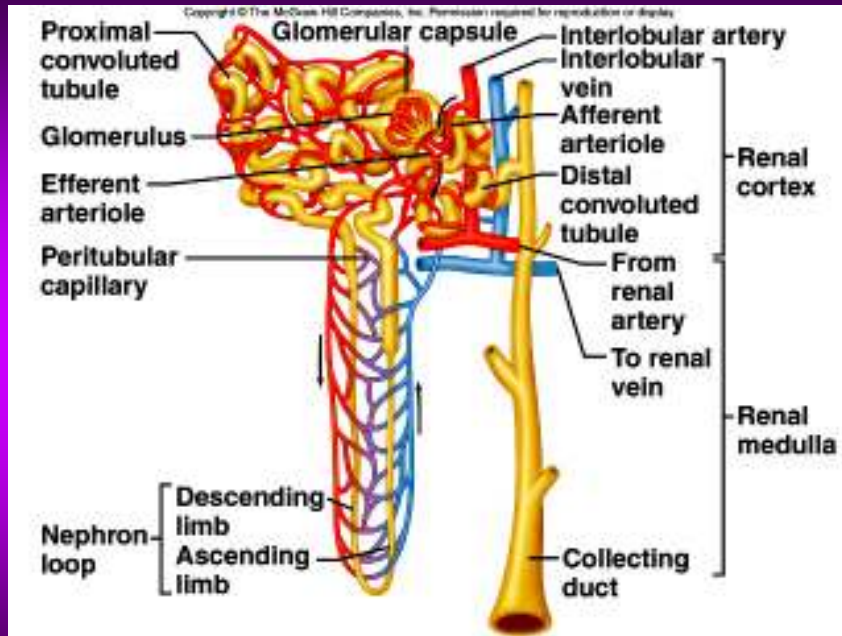
Nephrons

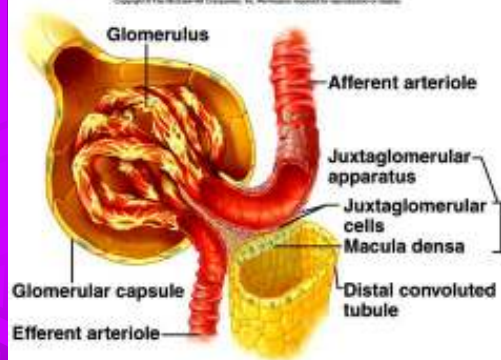
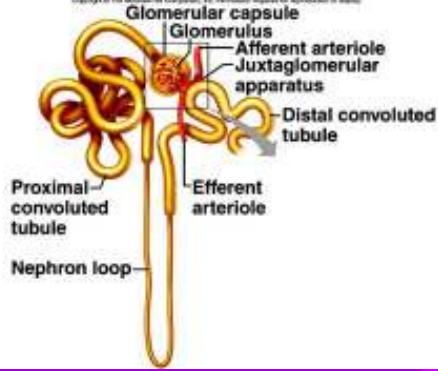


- The functional units of the kidney
 - Filters blood by removing waste products
 - Forms urine
- Portions of the nephron are located in both the cortex and medulla areas of the kidney
- Generally - blood and urine flow from the outside area (cortex) to the inner regions (medulla) of the kidney

3. Venous blood is returned through a series of vessels that generally correspond to the arterial pathways.

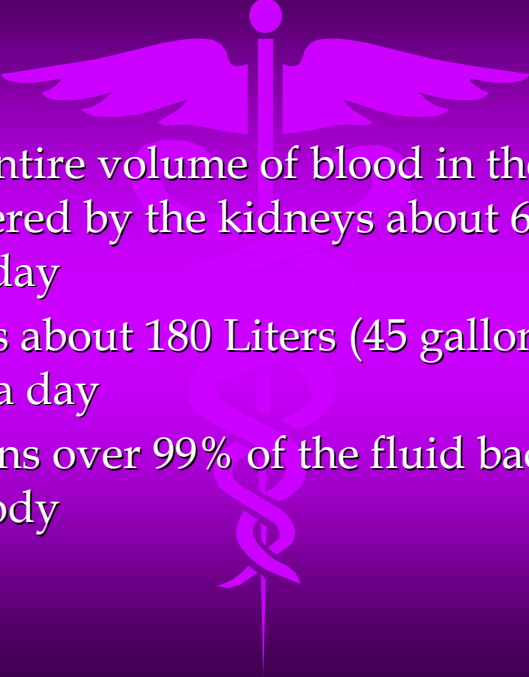






Functions of the Nephrons

- Responsible for removing wastes from blood and regulating blood fluid and electrolyte balance
 - Controls blood concentration and volume
 - Regulates blood pH
 - Removes toxic wastes from the blood
- Produces urine
 - The fluid and solutes removed from the blood

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- The entire volume of blood in the body is filtered by the kidneys about 60 times each day
 - Filters about 180 Liters (45 gallons) of fluid a day
 - Returns over 99% of the fluid back to the body

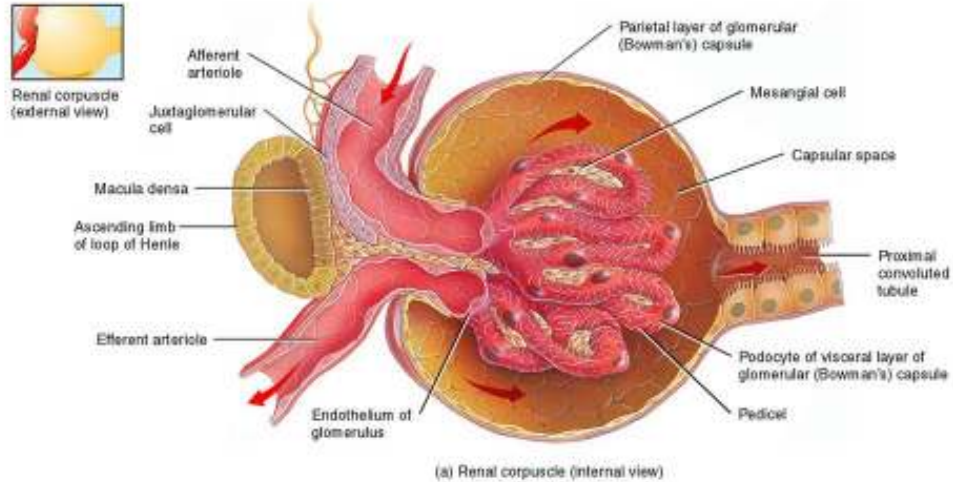
Components of each Nephron

- Renal Corpuscle - an expanded bulb-like end of the nephron located in the cortex of the kidney
 - Contains the glomerulus and glomerular (Bowman's) capsule
- Renal Tubules - thin twisting ducts of tubes
 - Portions of the renal tubule are located within both the renal cortex and medulla

The Renal Corpuscle

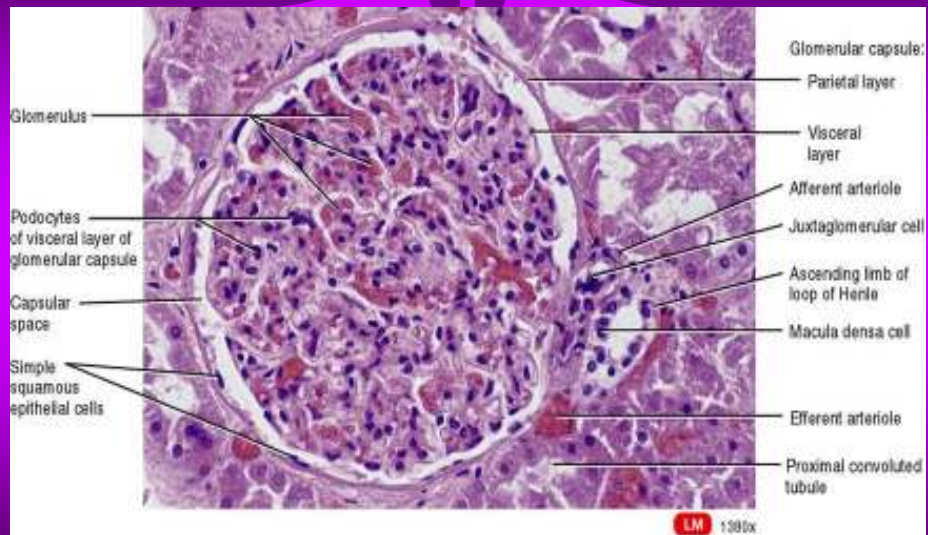
- Glomerulus - a microscopic tuft or knot of blood vessels located in the renal cortex
 - Where filtration of the blood takes place
 - Contains holes or pores (fenestrae) where small particles can filter out of the blood
 - Podocytes - cells surrounding the glomerular capillaries
 - afferent arterioles -efferent arterioles
- Glomerular (Bowman's) Capsule - sac-like structure that surrounds the glomerulus
 - The beginning of the renal tubules

Renal Corpuscle



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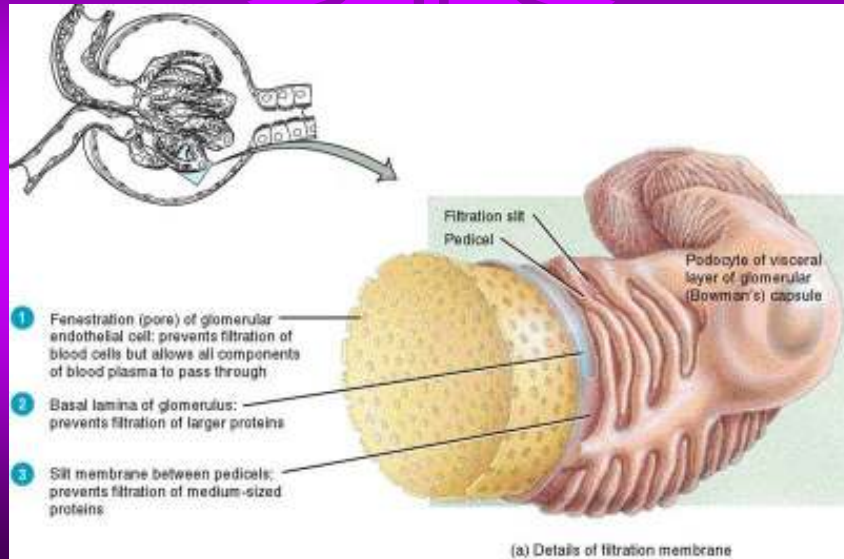
Renal Corpuscle



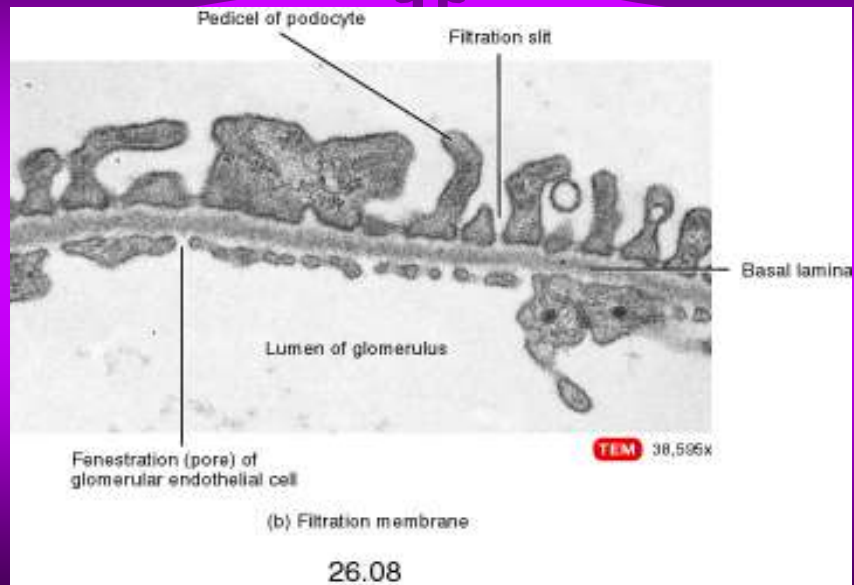
(b) Renal corpuscle

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Filtration Structures



Filtration Structures

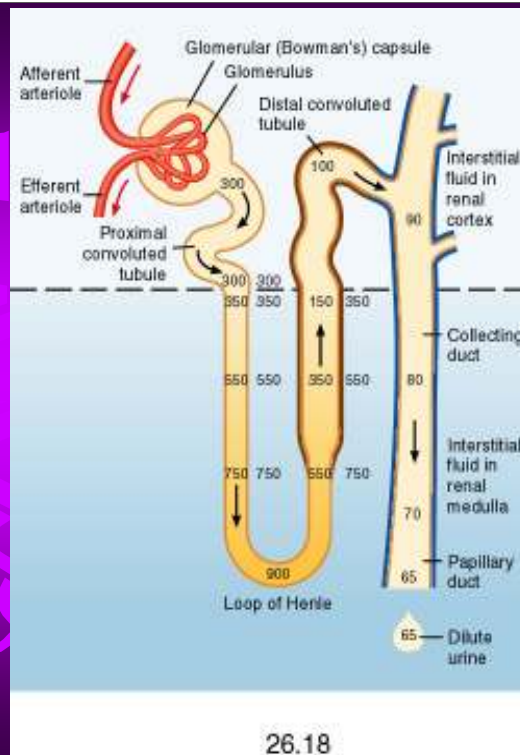


The Renal Tubules

- Folding, twisting length of tubes where waste products are passed into the urine and water and salts are reabsorbed by the body
- Composed of three main sections
 - Proximal Convoluted Tubule
 - Loop of Henle (Nephron Loop)
 - Distal Convoluted Tubule
- The entire length of the renal tubules surrounded by peritubular capillaries
 - Reabsorption of fluid back into the blood
 - Secretion of excess ions into urine

Renal Tubules

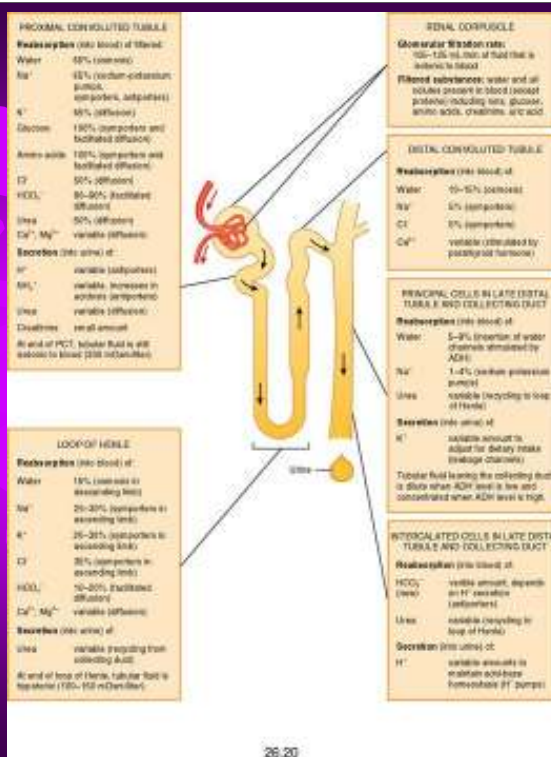
- Tubular Secretion
- Tubular Reabsorption



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Renal Tubules

- Tubular Secretion
- Tubular Reabsorption

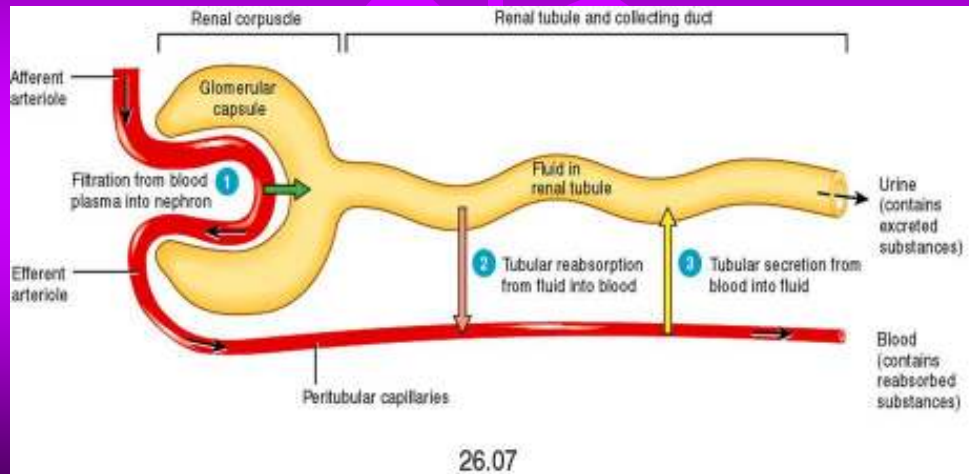


Urine Production



- 3 process involved in urine production
- all of these processes occurs in the n
nephrons of the kidneys
- 1. Glomerular filtration
- 2. Tubular reabsorption
- 3. Tubular secretion

Kidney Processes



Urine



- The by product of the activity of the kidneys
- Urinalysis - the analysis of the volume, physical, chemical, and microscopic properties of urine

Urine Volume



- Normally about 1000 ml to 2000 ml (one to three quarts) per day
- Influenced by:
 - Blood Pressure
 - Blood Concentration
 - Temperature
 - Diuretics
 - Emotions
 - Hormones

Physical Characteristics of Urine

- Color - yellow or amber
 - Can vary considerably with diet
- Turbidity - clear when freshly voided but becomes turbid upon standing
- Odor - usually odorless but may become ammonia like upon standing
- pH - average is about 6.0 but can vary with diet (4.8 - 8.0)
- Specific Gravity - dependent upon amount of material in solution
 - 1.001 to 1.035

Chemical Composition of Urine

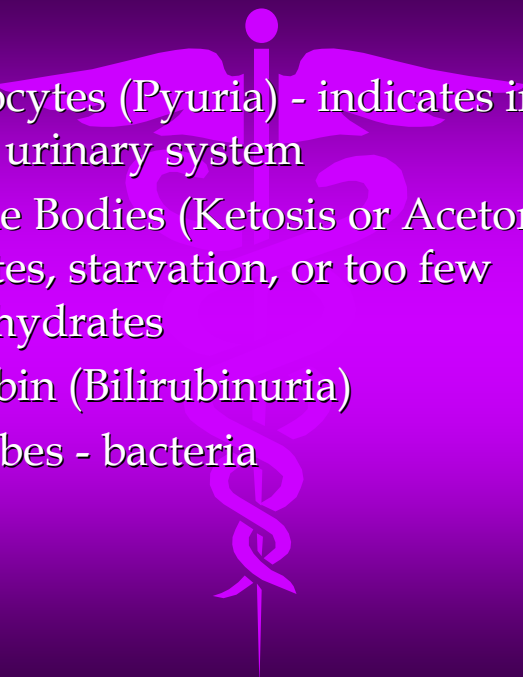


- Water - 95% of total urine volume
- 5% solutes from cellular metabolism or other outside sources such as drugs
- Organic Components of Urine
 - Urea - Uric Acid - Creatine
 - Hippuric Acid - Ketone Bodies - Others
- Inorganic Components of Urine
 - NaCl - Ca⁺⁺ - NH₄⁺
 - Mg⁺⁺ - PO₄ (3-) - SO₄ (2-)

Abnormal Constituents of Urine



- Glucose (Glucosuria or Glycosuria)
 - diabetes or liver disease
- Erythrocytes (Hematuria) - acute inflammation of urinary organs
 - kidney stones
 - trauma
 - tumors
 - kidney disease

- 
- Leukocytes (Pyuria) - indicates infection in the urinary system
 - Ketone Bodies (Ketosis or Acetonuria) - diabetes, starvation, or too few carbohydrates
 - Bilirubin (Bilirubinuria)
 - Microbes - bacteria

Fluid Intake



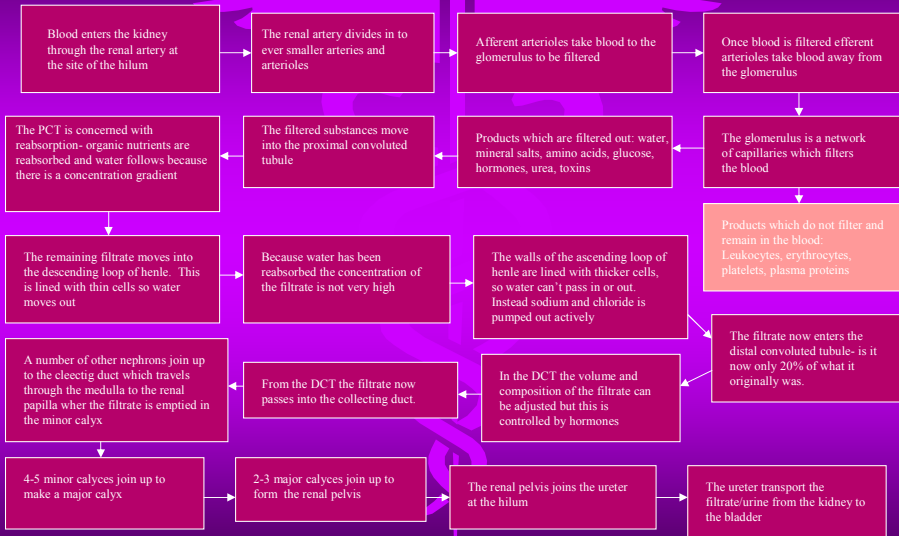
- Oral – liquid and solid – ingestion of fluid by mouth
- Intravenous – the introduction of fluids into the vein
- Metabolic – the formation of water as a waste product of cellular respiration

Output



- Micturition - urination
- Voiding - another name for urination
- Sweat
- Feces
- Exhaled Vapor

Summary.....





**URINARY SYSTEM
DISORDERS**



Cystitis

- An inflammation of the urinary bladder
- Usually involves the mucosa and submucosa layers of tissue
- Can be caused by injury, infection, or chemicals
- Symptoms include burning sensation upon urination, painful urination, frequent urination, urgency, low back pain and possibly bed wetting

Diabetes Insipidus (DI)



- A diabetic condition characterized by excretion of large volumes of urine
 - polyuria
 - 5 to 15 L/day of extremely dilute urine
- Caused by an ADH production disorder
 - hyposecretion of ADH
- Patients exhibit extreme thirst (polydipsia)

Glomerulonephritis (Bright's Disease)

- Inflammation of the glomeruli of the kidneys
- Can be caused by an allergic reaction to toxins given off by bacteria that have infected another part of the body
- Can result in kidney failure

Incontinence



- Inability to retain, urine, feces, or semen through the loss of sphincter control or because of cerebral or spinal lesions

Kidney Stones



- Calculus or crystalline masses present in the pelvis of the kidney composed primarily of oxalates, phosphates, and carbonates of varying size

Renal Failure

- A decrease or cessation of glomerular filtration (less than 10% of function)
- Acute Renal Failure (ARF)
 - sudden worsening of renal function
 - may follow a case of hypovolemic shock
- Chronic Renal Failure (CRF)
 - progressive, irreversible decline in function
 - can be caused by chronic glomerulonephritis, pyelonephritis, congenital polycystic disease, and traumatic loss of kidney tissue

Urinary Tract Infections (UTI's)



- A term used to describe an infection of a part of the urinary system or a abnormally large number of microbes present in the urine
- Much more common in females
- Individuals at risk include:
 - pregnant women
 - renal disease
 - hypertension
 - diabetes
- Symptoms include burning or painful urination, pubic and back pain, chills, fever, nausea, vomiting, etc.

Urinalysis

Why do doctors ask for a urine sample?

characteristics:

- **smell-** ammonia-like
- **pH-** 4.5-8, ave 6.0
- **specific gravity**– more than 1.0; ~1.001-1.003
- **color-** affected by what we eat: salty foods, vitamins

Odor

odor- normal is ammonia-like

diabetes mellitus- smells fruity or acetone like due to elevated ketone levels

diabetes insipidus- yucky asparagus---

pH- range 4.5-8 avg 6.0

vegetarian diet- urine is alkaline

**protein rich and wheat diet- urine
is acidic**



Color



Color- pigment is **urochrome**

Yellow color due to metabolic breakdown of hemoglobin (by bile or bile pigments)

Beets or rhubarb- might give a urine pink or smoky color

Vitamins- vitamin C- bright yellow

Infection- cloudy

Specific Gravity



Water: s.g. = 1g/liter;

Urine: s.g. ~ 1.001 to 1.030

Pyelonephritis- urine has high s.g.;
form kidney stones

Diabetes insipidus- urine has low s.g.;
drinks excessive water; injury or tumor
in pituitary

Abnormal Constitutes of Urine

Glucose- when present in urine condition called *glycosuria* (nonpathological) [glucose not normally found in urine]

Indicative of:

- Excessive carbohydrate intake
- Stress
- Diabetes mellitus

Abnormal Constitutes of Urine

Albumin-abnormal in urine; it's a very large molecule, too large to pass through glomerular membrane > abnormal increase in permeability of membrane

Albuminuria- nonpathological conditions- excessive exertion, pregnancy, overabundant protein intake-- leads to physiologic albuminuria

Pathological condition- kidney trauma due to blows, heavy metals, bacterial toxin

Abnormal Constitutes of Urine

Ketone bodies- normal in urine but in small-amts

Ketonuria- find during starvation, using fat stores

Ketonuria is couples w/a finding of glycosuria-- which is usually diagnosed as diabetes mellitus

RBC-hematuria

Hemoglobin-

Hemoglobinuria- due to fragmentation or hemolysis of RBC; conditions: hemolytic anemia, transfusion reaction, burns or renal disease

Abnormal Constitutes of Urine

Bile pigments-

Bilirubinuria (bile pigment in urine)- liver pathology such as hepatitis or cirrhosis

WBC-Sign of infection.

Pyuria- urinary tract infection; indicates inflammation of urinary tract

Casts- hardened cell fragments, cylindrical, flushed out of urinary tract

WBC casts- pyelonephritis

RBC casts- glomerulonephritis

Fatty casts- renal damage

INQUIRY

1. List several functions of the kidneys.
2. What does the glomerulus do?
3. What are several constituents you should not find in urine?
4. What is specific gravity?
5. What two hormones effect fluid volume and sodium concentration in the urine?
6. Where are the pyramids located in the kidney?
7. What vessel directs blood into the glomerulus?
8. Where does most selective reabsorption occur in the nephron?