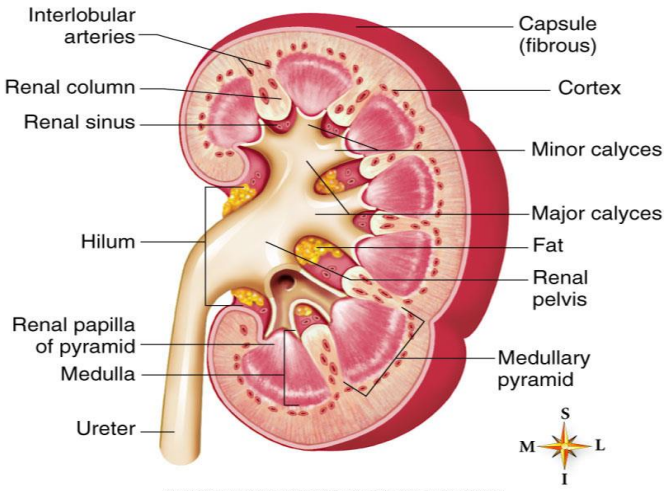
BIOS 2015 … CHAPTER 18- Urinary Systems Disorders

Page **Note**

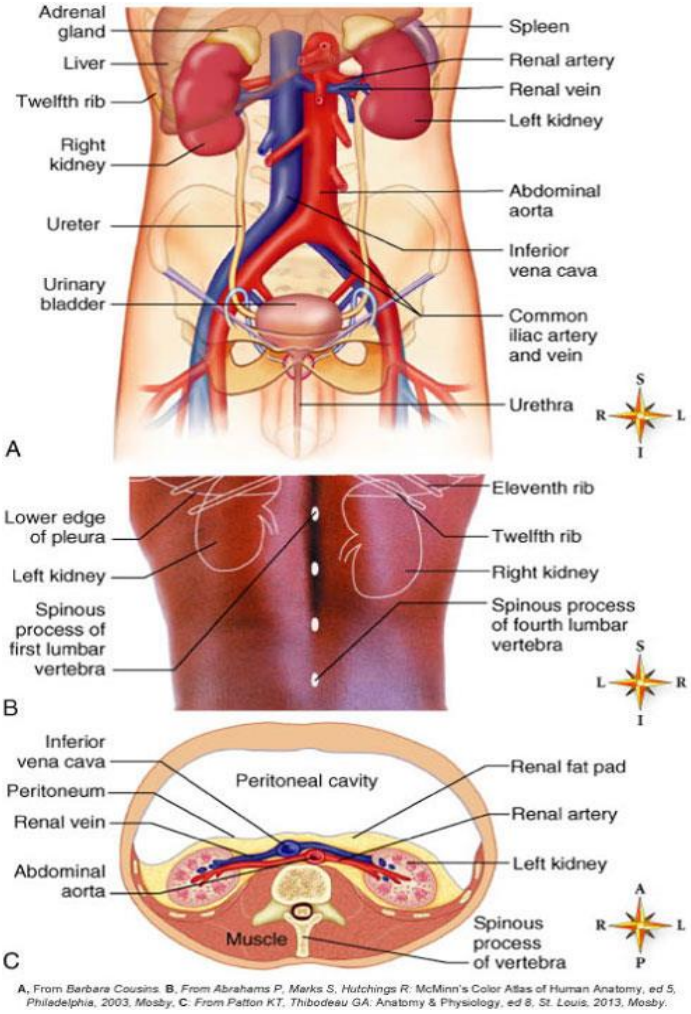
Composed of: Kidneys > Ureters > Bladder > and Urethra

SYSTEM FUNCTIONS:
- Removes metabolic wastes
- Removes hormones from the body
- Removes drugs other foreign material from body
- Regulates water, electrolyte, acid-base balance
- Secretes erythropoietin
- Activates vitamin D
- Regulate blood pressure through the renin-angiotensin-aldosterone system

Anatomy of Kidney:



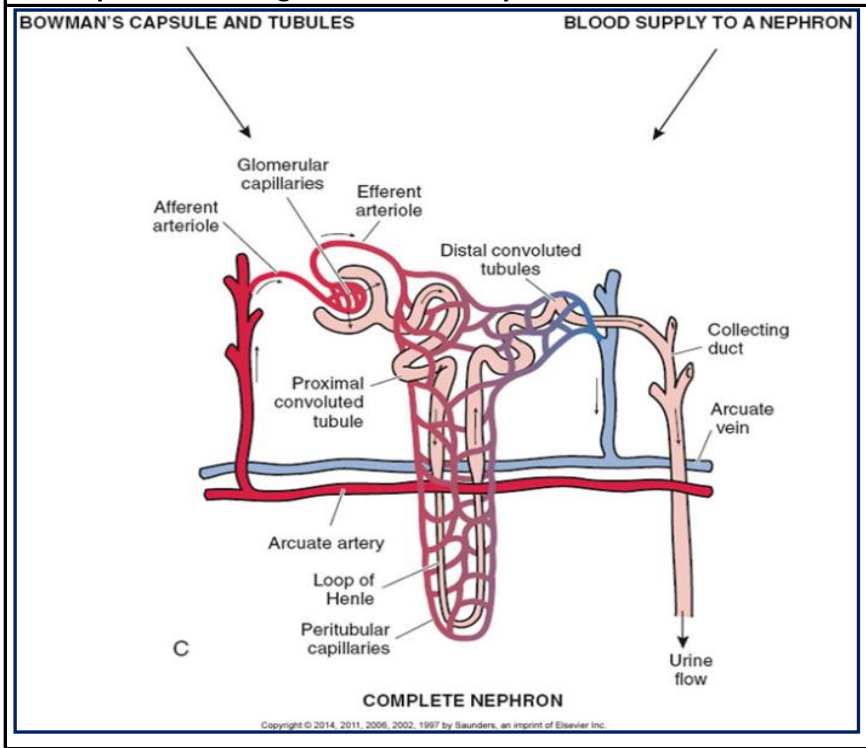
Adapted from Brundage DJ: Renal Disorders. Mosby's Clinical Nursing Series, St. Louis, 1992, Mosby.

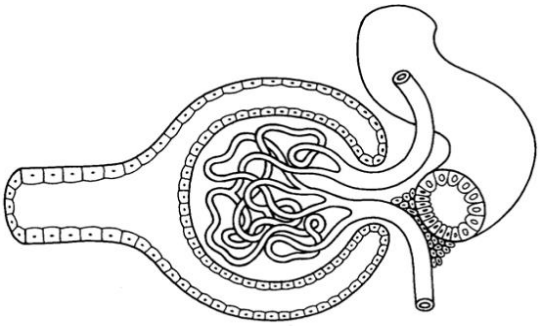


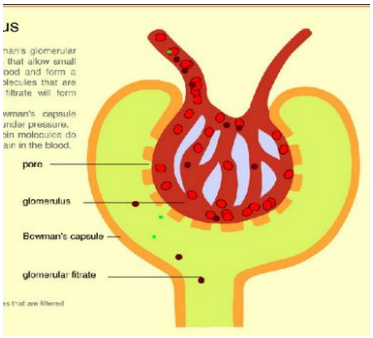
A, From Barbara Cousins. B, From Abrahams P, Marks S, Hutchings R: McMinn's Color Atlas of Human Anatomy, ed 5, Philadelphia, 2003, Mosby. C: From Patton KT, Thibodeau GA: Anatomy & Physiology, ed 8, St. Louis, 2013, Mosby.

The Nephron - working unit of the kidney

Glomerulus - tuft of capillaries that filters.







How the nephron works:

1. Blood, composed of protein rich fluid and cells, is filtered in the glomerulus.

2. Cells and proteins are retained in the vascular system, but fluid, electrolytes, and glucose exit the glomerular capillaries , enter Bowman's capsule and enter the tubular system that leads to the bladder.

3. As the filtrate passes through the tubular system, electrolytes, glucose, and other metabolites may be "Reabsorbed" from the tubules back into the blood. Conversely, metabolites and waste in the blood can be "Secreted" into the tubules.

The table below shows that all the glucose and water in the blood is filtered (into the filtrate), but then all of the glucose and most of te water is reabsorbed .

Substance	Blood	Filtrate	Urine
Water (L)	180	180	1.4
Cells	Yes	No	No
Glucose (mg/L)	1000	1000	0
Protein (mg/L)	40,000	0-trace	0-trace
Urea (mg/L)	260	260	18,000
Na^+ (mEq/L)	142	142	128
K^+ (mEq/L)	5	5	60
HCO_3^- (mEq/L)	28	28	14

Hormones Involved in Reabsorption

Antidiuretic hormone (ADH)
- Secreted by the posterior pituitary
- Reabsorption of water in distal convoluted tubules and collecting ducts

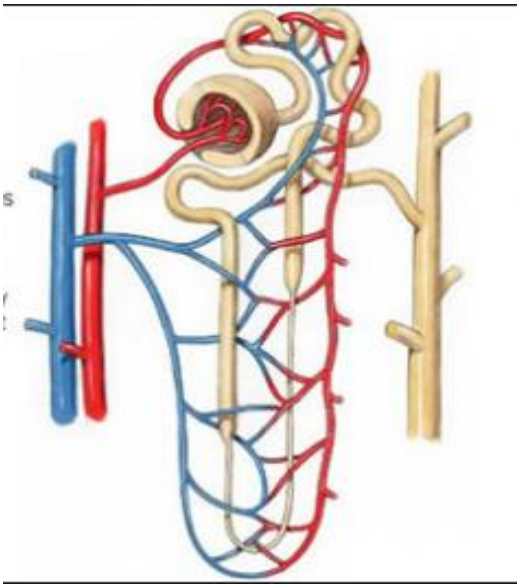
Aldosterone
- Secreted by adrenal cortex
- Sodium reabsorption in exchange for potassium or hydrogen

Atrial natriuretic hormone
- Hormone from the heart
- Reduces sodium and fluid reabsorption

Glomerular Filtration:
The picture to the left highlights that the glomerular capillary tuft is situated in an arteriole circuit unlike most capillary beds that are located between arteriole and venule.

There is thus an afferent arteriole (going to the glomerulus) and efferent arteriole (exiting the glomerulus). Both of these have smooth muscle that can relax or contract to alter blood flow through the glomerulus.

The following occur:
Autoregulation and hormones control pressure in the glomerular capillaries by:
1. Vasoconstriction of afferent arteriole
Decreased glomerular pressure—decreased filtrate
2. Dilation of afferent arteriole
Increased pressure in glomerulus—increased filtrate
3. Vasoconstriction of efferent arteriole



Controls on arteriolar constriction:

1. Autoregulation

2. Sympathetic nervous system - vasoconstriction.

3. Renin - secreted by the juxtaglomerular cells when blood flow in the aferent arteriole is low triggers the Renin - angiotensin mehanism.

REABSORPTION

Mechanisms of reabsorption include: Active transport, Co-Transport, and Osmosis.

Proximal Convoluted Tubule:

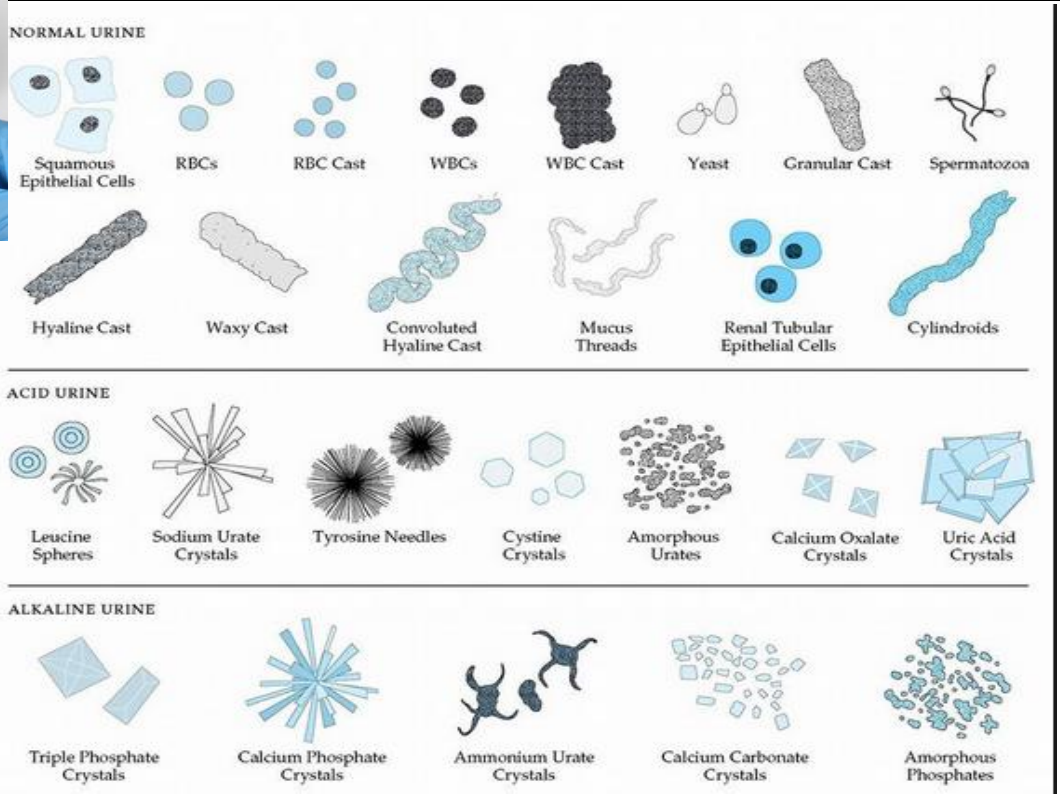
- Most of the water reabsorption.
- Glucose reabsorption.
- Nutrient and electrolyte reabsorption.

Incontinence and Retention

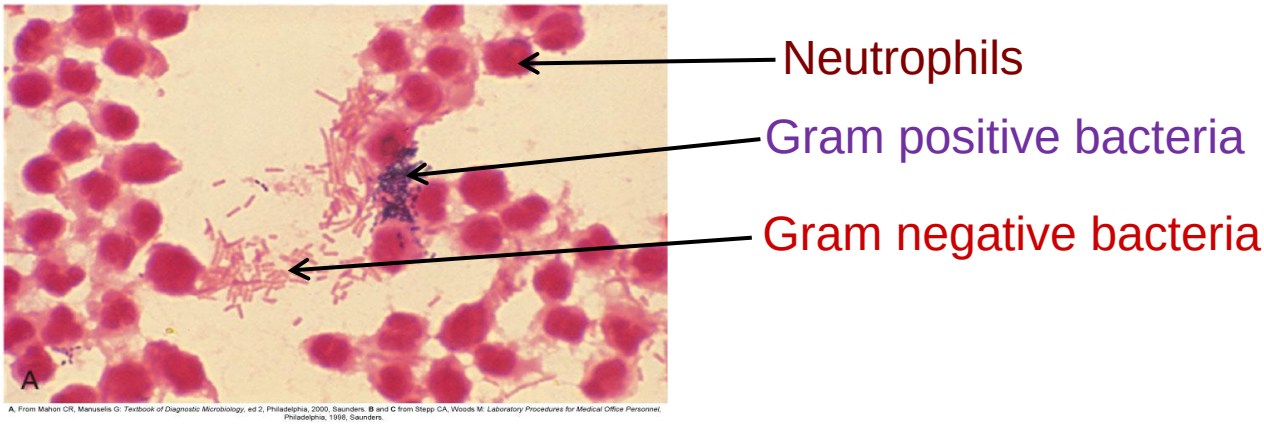
Incontinence
Loss of voluntary control of the bladder
Enuresis
- Involuntary urination by child age older than 4 years
- Often related to developmental delay, sleep pattern, psychosocial aspect (**bed wetting**).
Stress incontinence (more common in women)
- Increased intra-abdominal pressure (Coughing, lifting, laughing) forces urine through sphincter.
- Seen with multiple pregnancies .
Overflow incontinence
- Incompetent bladder sphincter in older adults.
- Weakened detrusor muscle may prevent complete emptying of bladder.
Spinal cord injuries or brain damage
- Neurogenic bladder, may be spastic or flaccid
- Interference with CNS and ANS voluntary controls of the bladder
Retention
- Inability to empty bladder
- May be accompanied by overflow incontinence
- Spinal cord injury at sacral level blocks micturition reflex
- May follow anesthesia (general or spinal)

Diagnostic Tests

Urinalysis: **a test strip and a microscopic examination** that assesses urine color, pH, specific gravity, osmolarity, protein, glucose,ketones, bilirubin, inflammatory cells, red blood cells, bacteria, and crystals.



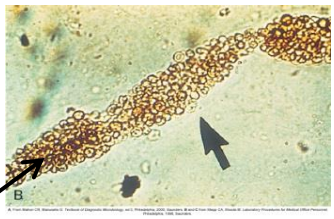
Urinary Tract Infection: picture below with heavy purulence and presence of gram-negative and gram-positive organisms



Blood (hematuria)
- Small amounts in infection, inflammation, or tumors in urinary tract
- Large amounts in increased glomerular permeability or hemorrhage

Elevated protein level (proteinuria, albuminuria)
- Leakage of albumin or mixed plasma proteins into filtrate

Bacteria (bacteriuria)
- Infection in urinary tract

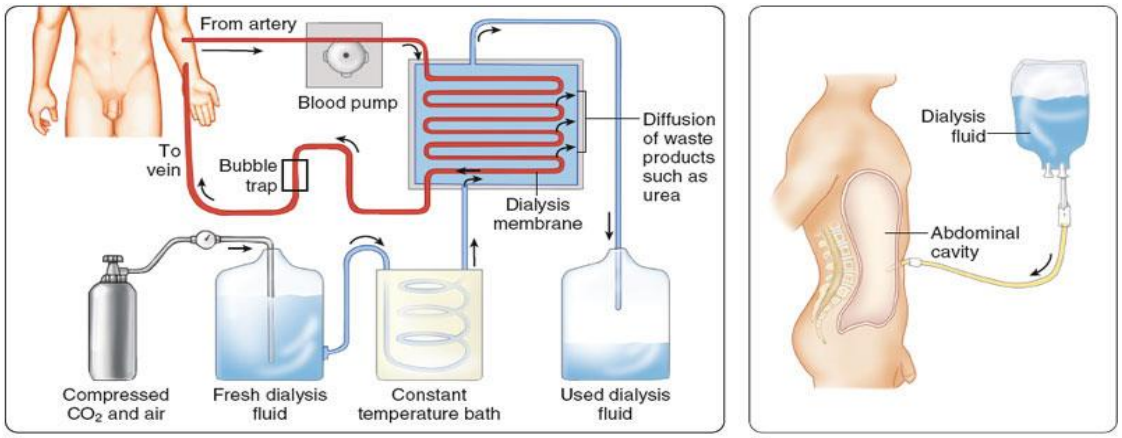


Urinary casts - indigat inflammation in the tubules. A red blood cell cest

Specific Gravity (SG)- indicates the tubules ability to concentrate urine

- Low SG = dilute urine; High SG = concentrated urine

Glucose and Keones - evidence of diabetes mellitus, not well controlled.

	Blood Tests
	Serum Urea, more commoly referred to as **Blood Urea Nitrogen or BUN:**
	- elevated when the kidney is failing to eliminate waste.
	Creatinine:
	- also elevated when the kidney is failing to eliminate waste.
	Metabolic acidosis -Indicates decreased GFR, Failure of tubules to control acid-base balance
	Anemia - Indicates decreased erythropoietin secretion and/or bone marrow depression
	Electrolytes - this may reflect the kidney's ability to retain or loose electrolytes to maintain homeostasis.
	Serology- Abtibody levels can assist in the diagnosis of autoimmune diseases. Antistreptokinase (ASO) is elevated in poststreptococcal glomerulonephritis.
	Renin - Elevated renin maeks the kidney as the casue of hypertension.
	Renin > Aldosterone > Na retention > elevation in blood pressure.
	Culture and Sensitivity - to identify the casue and cure of a bacterial infection.
	Radiologic tests Radionuclide imaging, angiography, ultrasound, CT, MRI, intravenous pyelography Used to visualize structures and possible abnormalities, flow patterns, and filtration rates
	Clearance tests Examples: creatinine or inulin clearance - **Used to assess GFR** **Cystoscopy** - Visualizes lower urinary tract - May be used to perform biopsy or remove kidney stones **Biopsy** - Used to acquire tissue specimens
	Diuretics - drugs that cause the kidneys to loose water and electrolytes.
	Dialysis - a technique using semipermeable membranes to remove waste from the blood of a person in renal failure. **Hemodialysis** - pumps the blood through dialysis tubing. **Peritoneal Dialysis** - circulates dialysis fluid through the peritoeal cavity and uses the preritoneal lining as the dialysis membrane.
	 A and B From Patton KT, Thibodeau GA: *Anatomy & Physiology*, ed 8, St. Louis, 2013, Mosby
	Urinary Tract Infections
	Urethra - Urethritis; Bladder - Cystitis; Kidney - Pyelonephritis; Prostate - Prostatitis
	Escherichia coli (E coli) is a common cause
	More common in women because of: Shortness of urethra and Proximity to anus Older men: Prostatic hypertrophy and Urine retention Congenital abnormalities in children Other common predisposing factors: Incontinence, Retention of urine, Direct contamination with fecal material

	Cystitis and Urethritis
	Bladder wall (cystitis) and urethra (urethritis) are inflamed. Hyperactive bladder and reduced capacity Pain is common in pelvic area Dysuria, urgency, frequency, and nocturia Systemic signs may be present. Fever, malaise, nausea, leukocytosis Urine often cloudy, with unusual odor Urinalysis indicates bacteriuria, pyuria, microscopic hematuria
	Pyelonephritis
	One or both kidneys involved From ureter into kidney Purulent exudate fills pelvis and calyces **Recurrent or chronic infection can lead to scar tissue formation.** Loss of tubule function **Obstruction and collection of filtrate → hydronephrosis** **Eventual chronic renal failure if untreated**
	Signs of cystitis plus pain associated with renal disease **Dull, aching pain in lower back or flank area** Systemic signs include high temperature Urinalysis Similar to cystitis **Urinary casts are present.** Reflection of renal tubule involvement Treatment with antibacterials
	Inflammatory Disorders: Glomerulonephritis (GN)
	Many types with a variety of etiologies. Example: **Post Steptococcal GN occurs after a streptococcal infection.** **Blood test shows antistreptococcal (ASO) antibodies** **Formation of an antigen-antibody complex that deposits in glomerulus** **Activates complement system and damages glomerulus.** Inflammatory response in glomeruli Increased capillary permeability—leakage of some protein and large numbers of erythrocytes Can lead to decreased urinary output and hypertension
	Blood tests - **Elevated BUN and creatinine levels** - **Elevation** of anti-DNase B, streptococcal antibodies, antistreptolysin, **antistreptokinase** - Complement levels decreased (use in renal inflammation) **Metabolic acidosis** **Urinalysis** **- Proteinuria, hematuria, erythrocyte casts** **- No evidence of infection**
	Treatment **Sodium restriction** possible (to treat hypertension). Protein and fluid intake decreased in severe cases **Drug treatment** **- Glucocorticoids to reduce inflammation** **- Antihypertensives**
	Nephrotic Syndrome

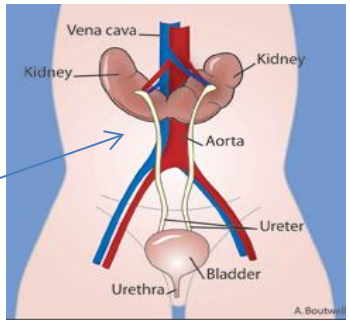
	Abnormality in glomerular capillaries, increased permeability, **large amounts of plasma proteins escape into filtrate** **Low serum protein leads to edema and low blood pressure.** May be idiopathic, autoimmune (like lupus), from exposure to nephrotoxins or drugs
	Urolithiasis
	- stones (also called calculi) can be located anywhere in the urinary tract.A81
	Renal pain (called "renal colic") caused by obstruction of the ureter **Intense spasms of pain in flank area** **Radiating into groin area** **Lasts until stone passes or is removed** Possible nausea and vomiting, cool moist skin, rapid pulse **Radiological examination confirms location of calculi.**
	Treatment - Small stones will be passed eventually. - Extracorporeal shock wave lithotripsy (ESWL) - Laser lithotripsy - Drugs may be used to dissolve stones partially. - Surgery **Prevention** - Treatment of underlying condition - Adjustment of urine pH through dietary modifications - Consistent increased fluid intake
	Cancer
	Renal cell carcinoma:
	Primary tumor arising from the tubule epithelium **Tends to be symptomatic in early stages** **Often has metastasized to liver, lung, bone, or central nervous system at time of diagnosis** Occurs more frequently in men and smokers Treatment is removal of kidney. Immunotherapy may be used in some cases. **Tumor is radioresistant, and chemotherapy is not used in most cases.**
	Wilms Tumor - a pediatric renal tumor sometimes associated with congenial anomlaies.
	Bladder Cancer:
	Most bladder tumors are malignant and commonly arise from transitional epithelium of the bladder. Often develops as multiple tumors Diagnosed by urine cytology and biopsy Early signs Hematuria, dysuria Infection common Tumor is invasive through wall to adjacent structures. Metastasizes to pelvic lymph nodes, liver, and bone
	Predisposing factors Working with chemicals in laboratories and industry, Particularly **aniline dyes**, rubber, aluminum **Cigarette smoking** **Recurrent infections** Heavy intake of analgesics **Treatment** - Surgical resection of tumor, Chemotherapy and radiation, Photoradiation in some early cases

Vascular Disorders: Nephrosclerosis

Involves vascular changes in the kidney
Some occur normally with aging.
Thickening and hardening of the walls of arterioles and small arteries
Narrowing of the blood vessel lumen
Reduction of blood supply to kidney
Stimulation of renin
Increased blood pressure
Continued ischemia
Destruction of renal tissue
Chronic renal failure

Congenital Disorders (disorders present at birth).

Vesicoureteral reflux (urine in bladder backs up into ureters).
Agenesis
-Failure of one kidney to develop
Hypoplasia
-Failure to develop to normal size
Ectopic kidney
-Kidney and ureter displaced out of normal position
"Horseshoe" kidney
-Fusion of the two kidneys

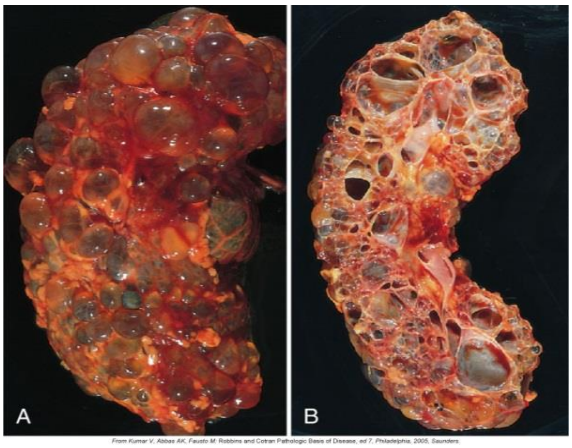


Adult Polycystic Kidney

Autosomal dominant gene on chromosome 16

No indications in child and young adults
First manifestations usually around age 40 years

Multiple cysts develop in both kidneys.
- Enlargement of kidneys
- **Compression and destruction of kidney tissue**
- **Chronic renal failure**
- Diagnosis by CT or MRI



Renal Failure

Acute Renal Failure: Sudden onset, elevated BUN and creatinine, identify casue and remove harmful condition.
Causes include kidney disease, shock, nephrotoxins (drugs, chemicals, toxins), and obstructive disease like stones or tumors.

Chronic Renal Failure:

Gradual irreversible destruction of the kidneys over a long period of time
Asymptomatic in early stages
May result from
- Chronic kidney disease
- Congenital polycystic kidney disease
- Systemic disorders
- Low-level exposure to nephrotoxins over sustained period of time

	End Stage Renal Failure:
	Negligible GFR **Fluid, electrolytes, and wastes retained in body** **Azotemia, anemia, and acidosis (three As)** - Azotemia is high BUN and creatinine. - Anemia from decreased erythropoietin. - Acidosis from inability to dump acid (H+). **Marked oliguria or anuria** Regular dialysis or kidney transplantation - To maintain patient's life