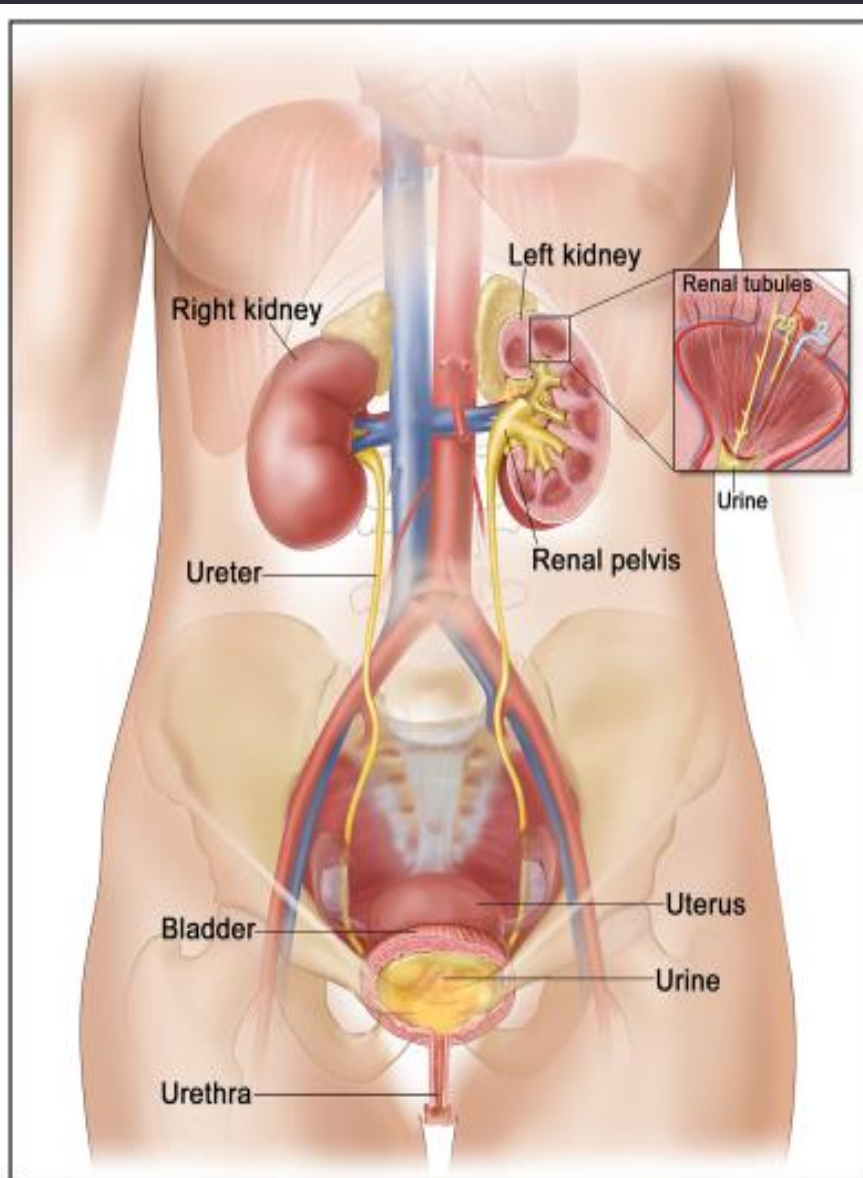
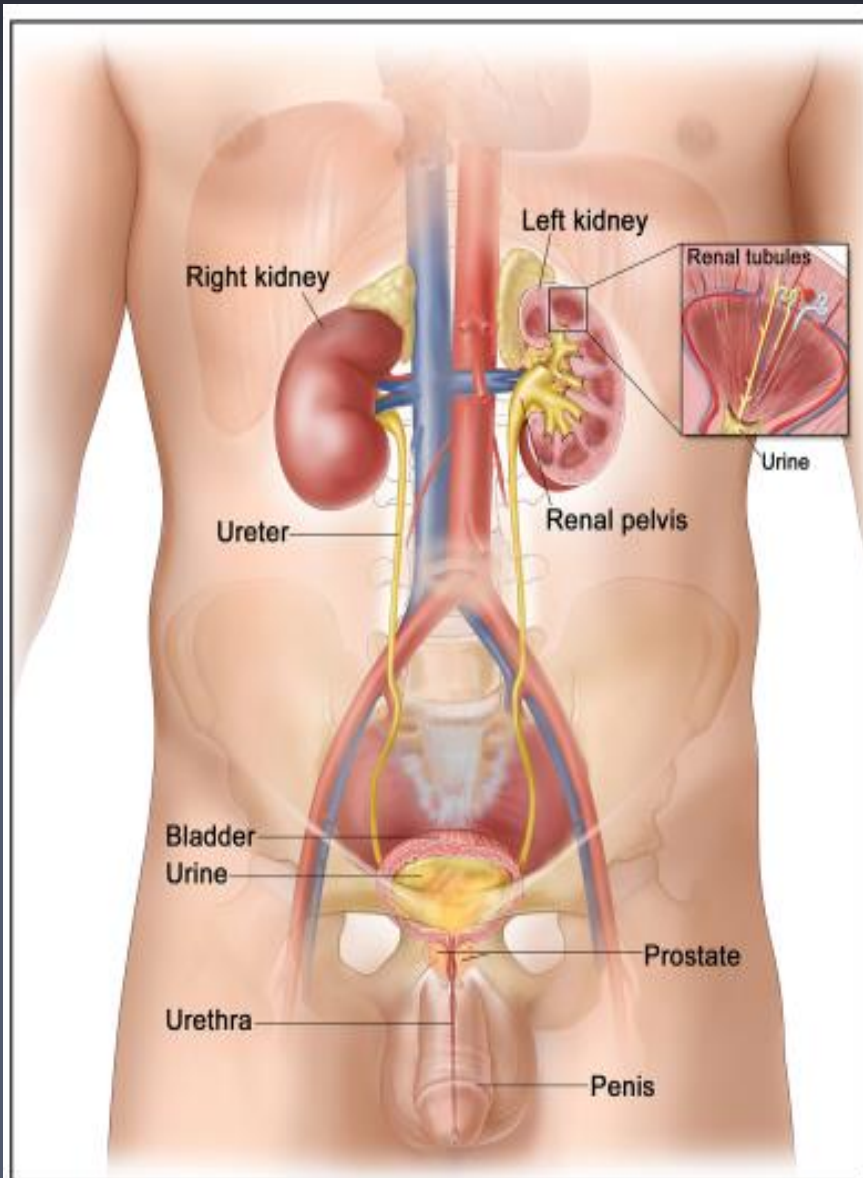


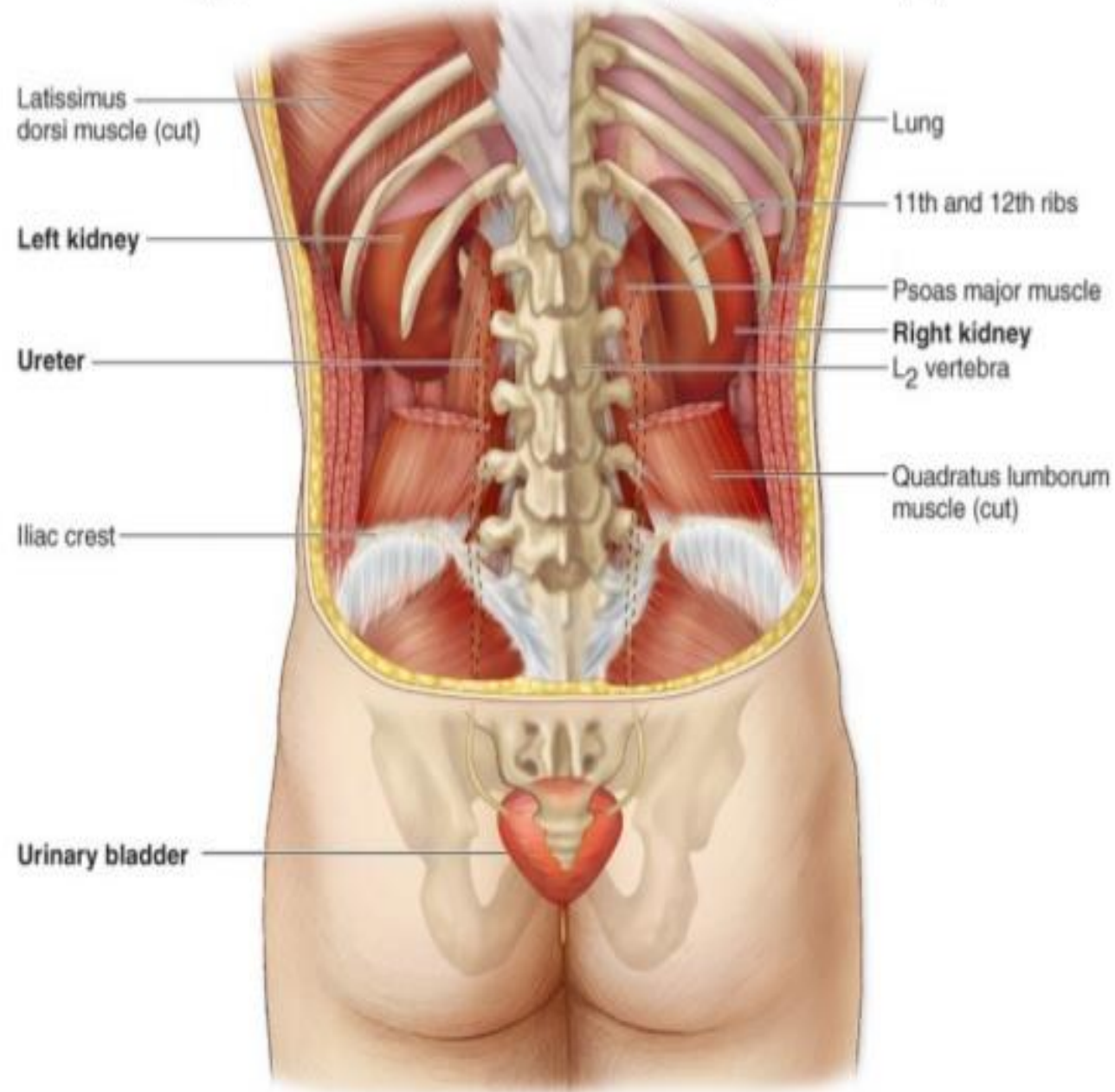
Acute glomerulonephritis  
Chronic glomerulonephritis  
Nephrotic syndrome  
Acute and chronic pyelonephritis  
Nephrolithiasis. Kidney colic  
Acute renal failure  
Chronic kidney failure  
Nephrogenic high blood pressure



Rodica Bugai, dr. șt. med., conf. univ.

# Urinary system



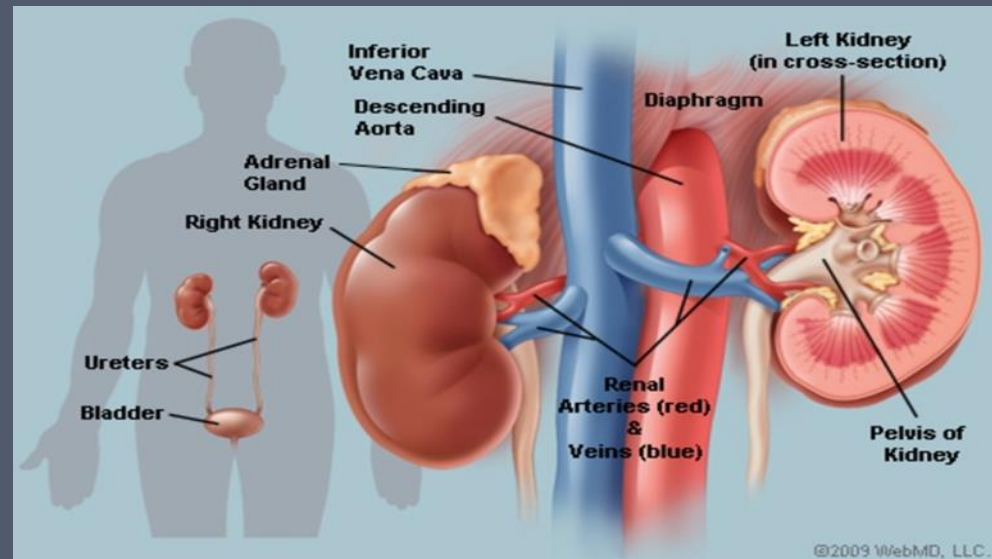


(b) Posterior view

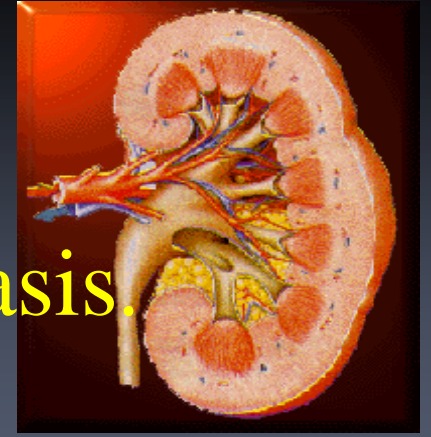
# Kidneys

**The kidneys are some of the most important organs**

- The right kidney is generally slightly smaller and lower than the left, to make space for the liver.
- Each kidney weighs 125–170 grams (g) in males and 115–155 g in females.



# Functions of the kidneys



The main role of the kidneys is **maintaining homeostasis**.

1. **Waste excretion**
  2. **Reabsorption of nutrients**
  3. **Maintaining pH**
  4. **Osmolarity regulation**
  5. **Regulating blood pressure**
  6. **Secretion of active compounds**
  7. **Maintain electrolyte, fluid balance of blood**
- ...

# Waste excretion

- The kidneys remove a number of waste products and get rid of them in the urine.
- Two major compounds that the kidneys remove are:
  - ✓ **urea**, which results from the breakdown of proteins
  - ✓ **uric acid** from the breakdown of nucleic acids

# Reabsorption of nutrients

- **The kidneys reabsorb nutrients from the blood and transport them to where they would best support health.**
- **They also reabsorb other products to help maintain homeostasis.**
- **Reabsorbed products include:**
  - ✓ glucose
  - ✓ amino acids
  - ✓ bicarbonate
  - ✓ sodium
  - ✓ water
  - ✓ phosphate
  - ✓ chloride, sodium, magnesium, and potassium ions

# Maintaining pH

- In humans, the acceptable pH level is **7.38 -7.42**. Below this boundary, the body enters a state of **acidemia**, and above it, **alkalemia**.
- Outside this range, proteins and enzymes break down and can no longer function. In extreme cases, this can be fatal.
- The kidneys and lungs help keep a stable pH within the human body. The lungs achieve this by moderating the concentration of carbon dioxide.
- The kidneys manage the pH through two processes:
  - ✓ **Reabsorbing and regenerating bicarbonate from urine:** Bicarbonate helps neutralize acids. The kidneys can either retain it if the pH is tolerable or release it if acid levels rise.
  - ✓ **Excreting hydrogen ions and fixed acids:** Fixed or nonvolatile acids are any acids that do not occur as a result of carbon dioxide. They result from the incomplete metabolism of carbohydrates, fats, and proteins. They include lactic acid, sulfuric acid, and phosphoric acid.



# Osmolality regulation

- **Osmolality** is a measure of the body's electrolyte-water balance, or the ratio between fluid and minerals in the body. Dehydration is a primary cause of electrolyte imbalance.
- If osmolality rises in the blood plasma, the **hypothalamus** in the brain responds by passing a message to the **pituitary gland**. This, in turn, releases **antidiuretic hormone (ADH)**
- In response to ADH, the kidney makes a number of changes, including:
  - ✓ increasing urine concentration
  - ✓ increasing water reabsorption
  - ✓ reopening portions of the collecting duct that water cannot normally enter, allowing water back into the body
  - ✓ retaining urea in the medulla of the kidney rather than excreting it, as it draws in water

# Regulating blood pressure

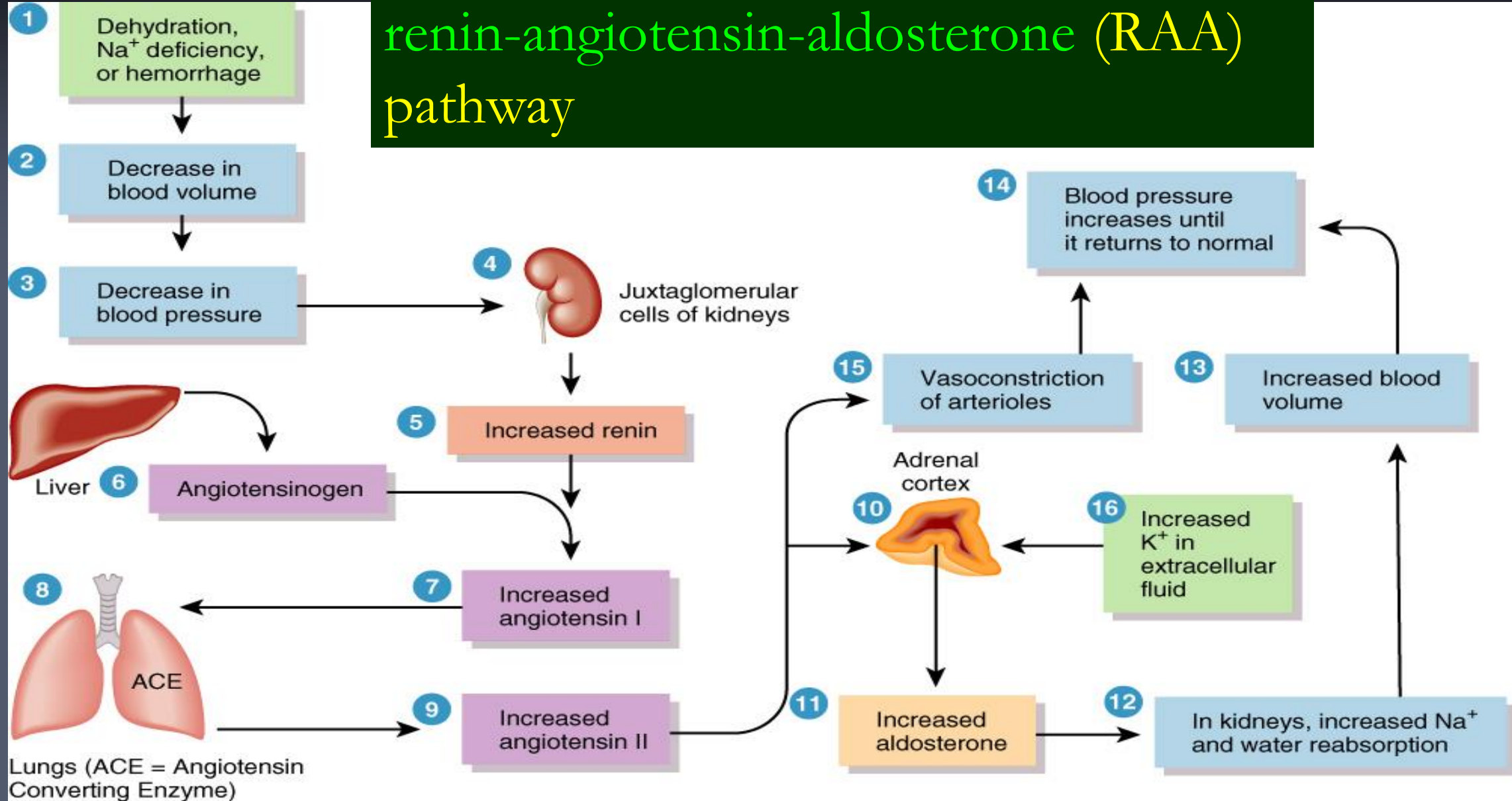
- The kidneys regulate **blood pressure** when necessary, but they are responsible for slower adjustments.
- They adjust long-term pressure in the arteries by causing changes in the fluid outside of cells. The medical term for this fluid is extracellular fluid.
- These fluid changes occur after the release of a vasoconstrictor called **angiotensin II**. Vasoconstrictors are hormones that cause blood vessels to narrow.
- They work with other functions to increase the kidneys' absorption of sodium chloride, or salt. This effectively increases the size of the extracellular fluid compartment and raises blood pressure.
- **Anything that alters blood pressure can damage the kidneys over time, including excessive alcohol consumption, smoking, and obesity.**

# Secretion of active compounds

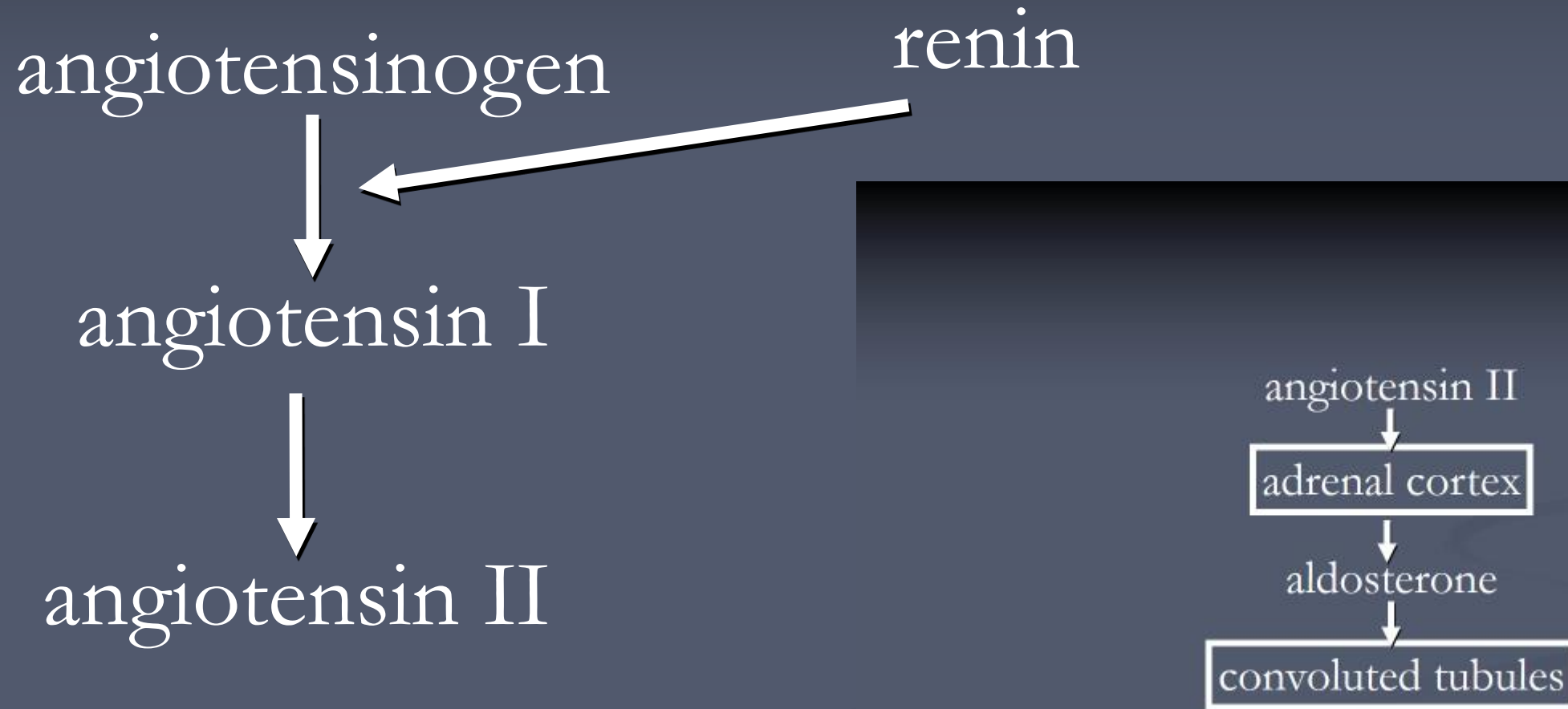
The kidneys release a number of important compounds, including:

- **Erythropoietin:** This controls erythropoiesis, or the production of red blood cells. The liver also produces erythropoietin, but the kidneys are its main producers in adults.
- **Renin:** This helps manage the expansion of arteries and the volume of blood plasma, lymph, and interstitial fluid. Lymph is a fluid that contains white blood cells, which support immune activity, and interstitial fluid is the main component of extracellular fluid.
- **Calcitriol:** This is the hormonally active metabolite of **vitamin D**. It increases both the amount of **calcium** that the intestines can absorb and the reabsorption of phosphate in the kidney.

# Regulation of Aldosterone secretion by renin-angiotensin-aldosterone (RAA) pathway



# Hormonal Control of Kidney Function



# Formation of Calcitriol

7-Dehydrocholesterol (in skin)

UV rays

Diet

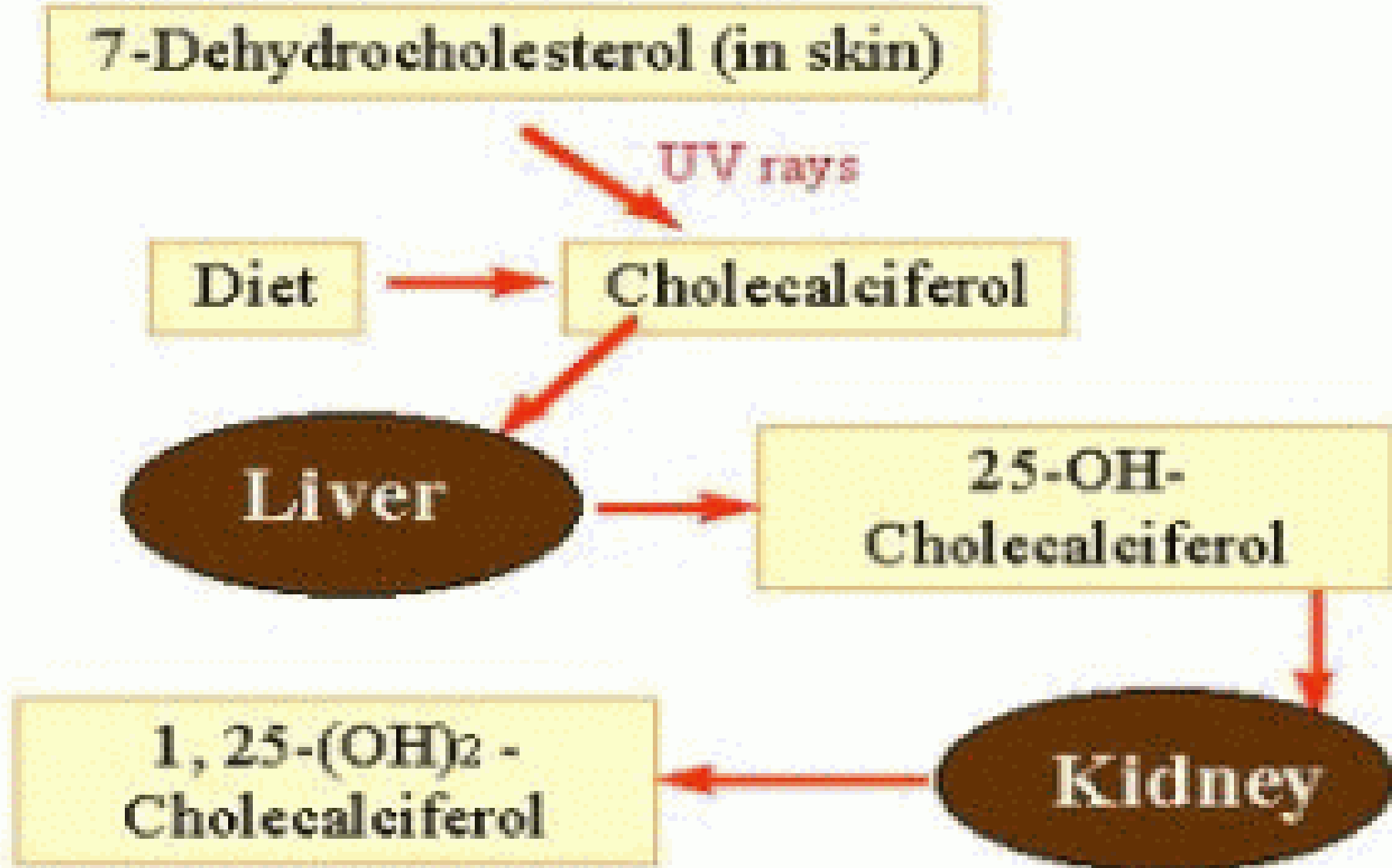
Cholecalciferol

Liver

25-OH-  
Cholecalciferol

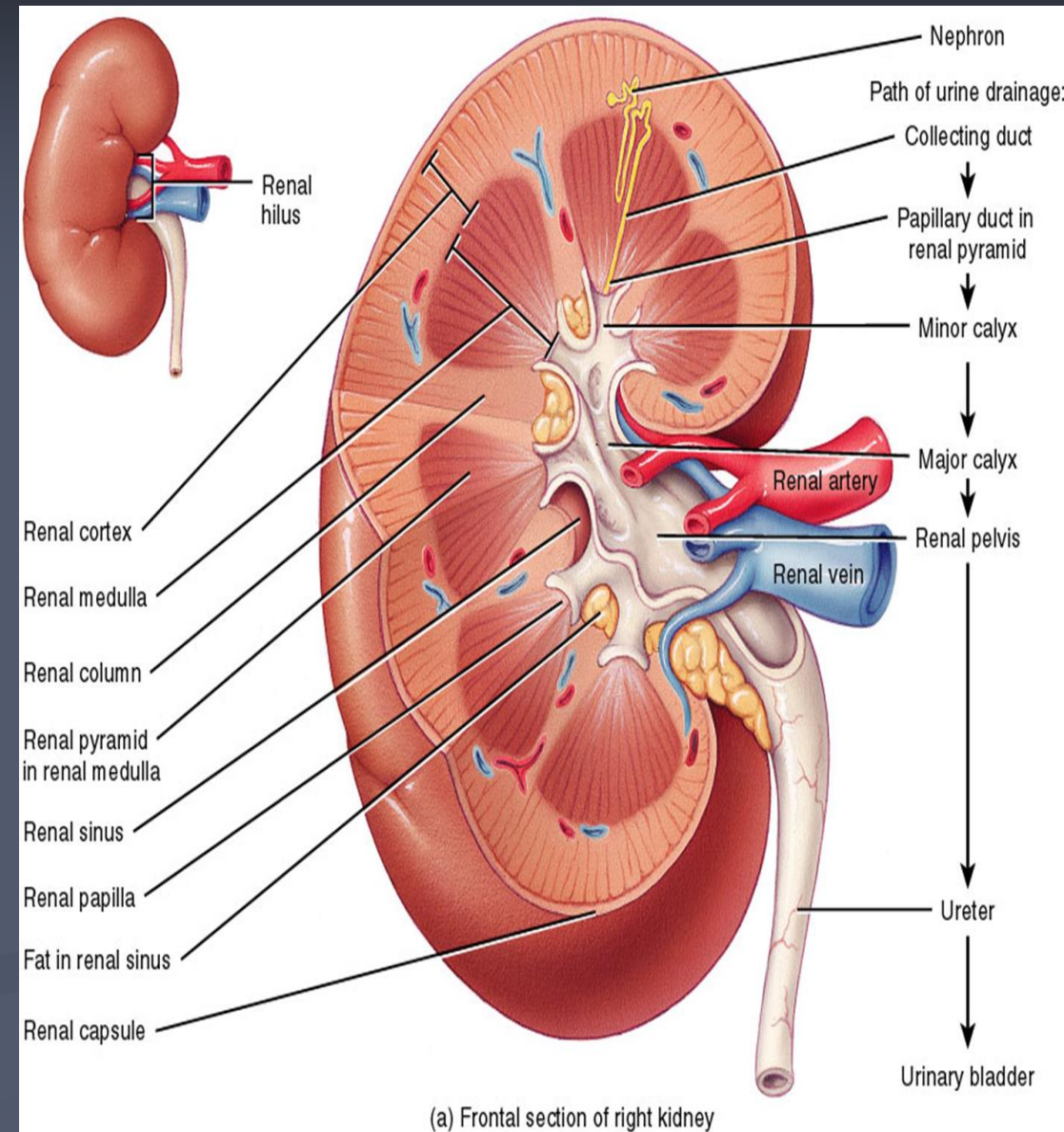
1, 25-(OH)<sub>2</sub> -  
Cholecalciferol

Kidney

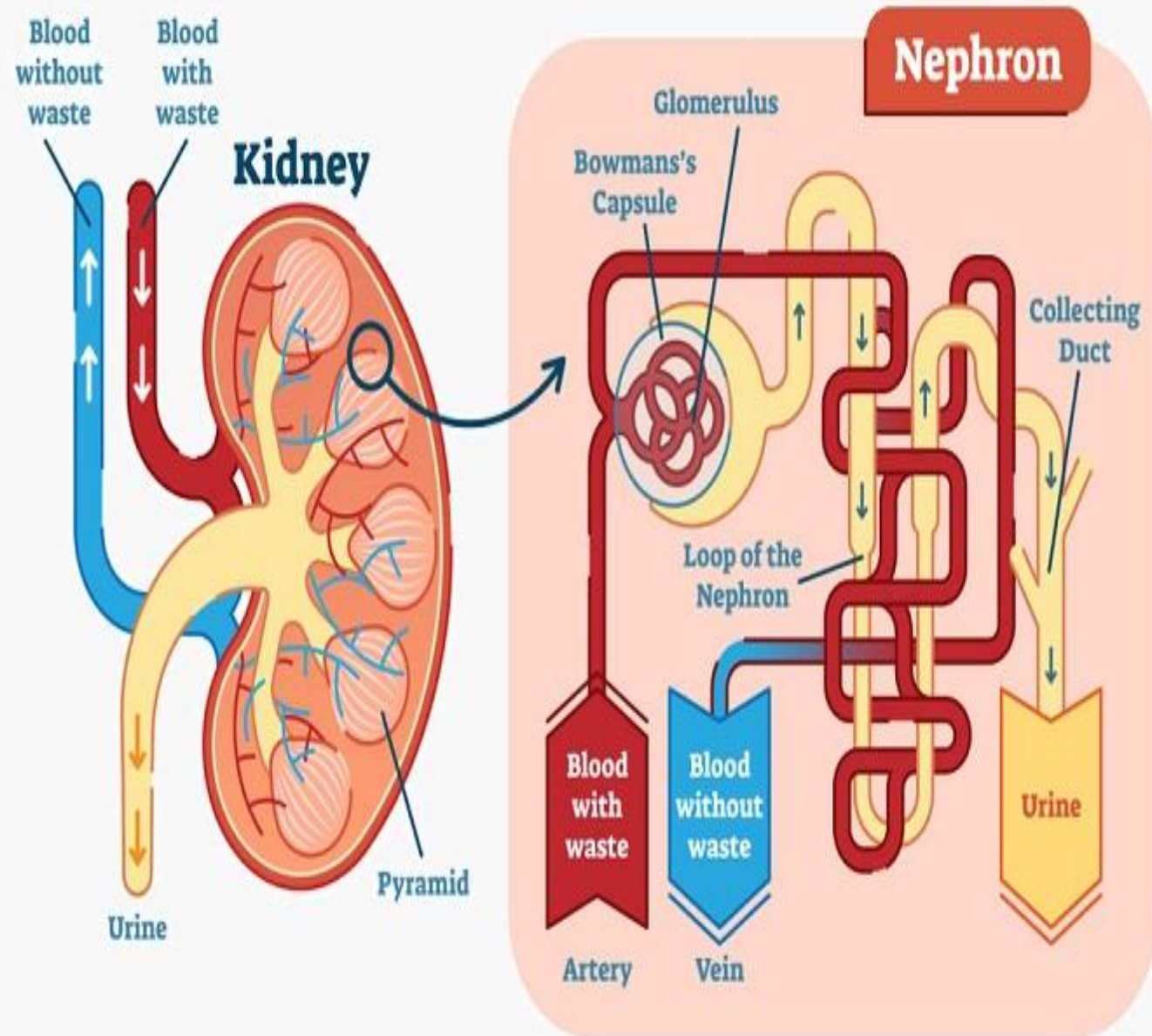


# Nephron

- consist of a long tubule & a ball of capillaries called a **glomerulus**
- the end of the tubule that surrounds the glomerulus is called **Bowman's capsule**
- the remaining parts of the tubule are called the:
  - **proximal tubule**
  - **loop of Henle**
  - **distal tubule**
- the tubule empties into a **collecting duct** that leads to the **renal pelvis**
- the renal pelvis opens to the **ureter**

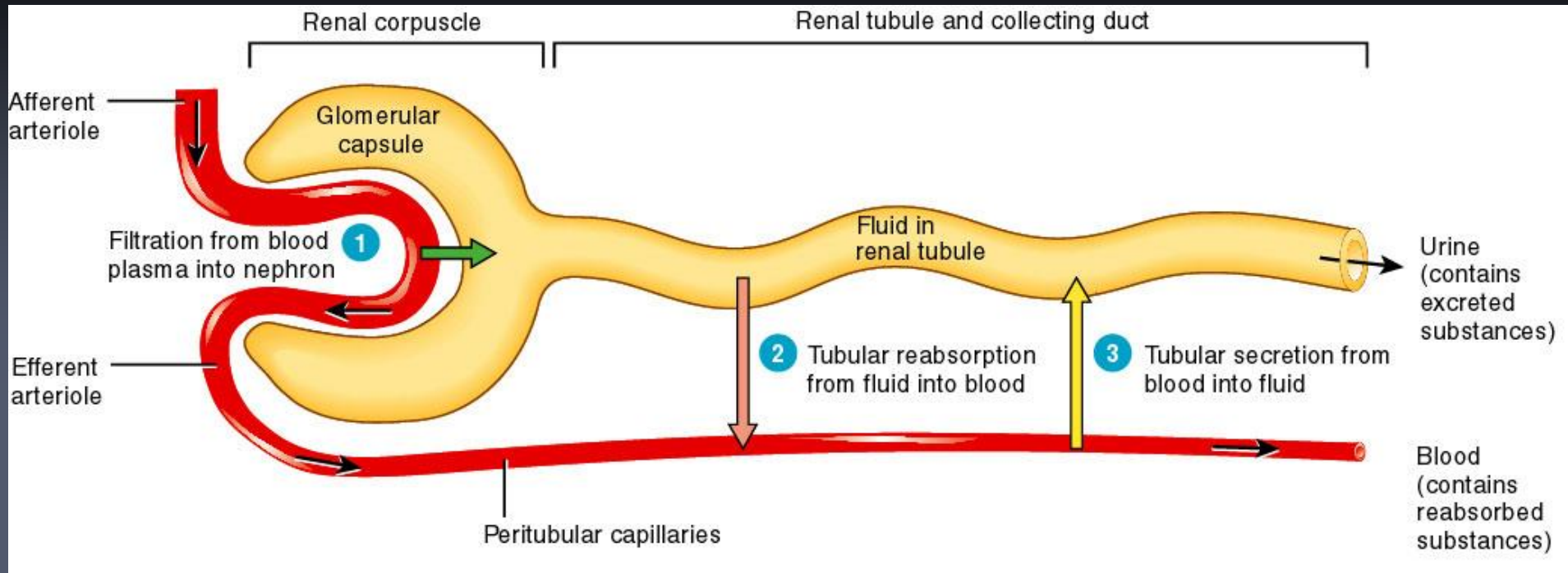


# Nephron



Each kidney contains over 1 million nephrons and thousands of collecting ducts

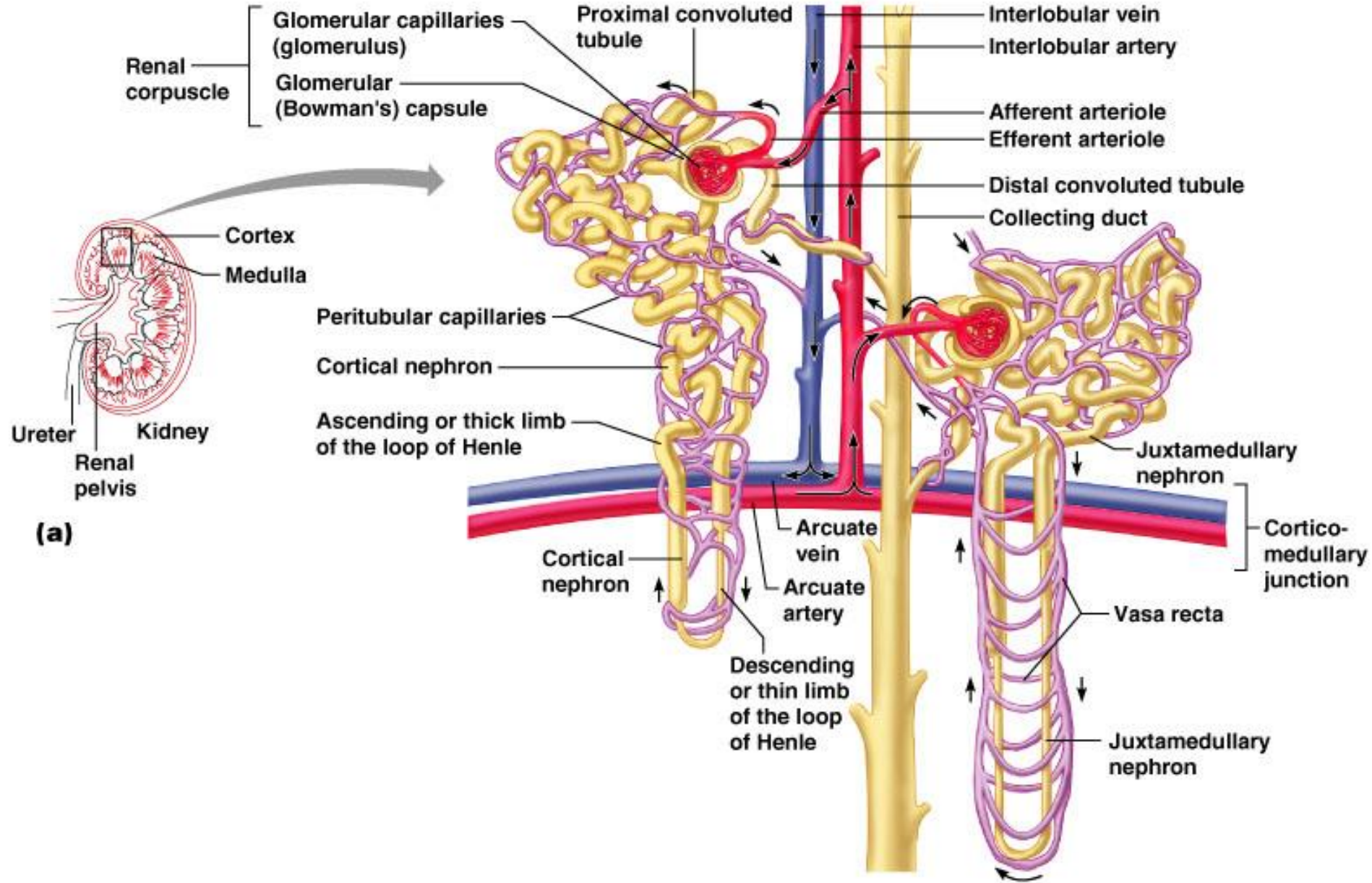




## Nephron's functions:

1. glomerular filtration
2. tubular reabsorption
3. tubular secretion

# Nephron



# Nephron

## Boman's Capsule

- filtration occurs as blood pressure in the capillaries of the glomerulus forces filtrate into Bowman's capsule
  - the process is passive (diffusion)
  - the filtrate includes:
    - ✓ water, salts, bicarbonate ( $\text{HCO}_3^-$ ),  $\text{H}^+$ , urea, glucose, amino acids
- ## Proximal Convoluted Tubule

## Proximal Convoluted Tubule

Reabsorbs: water, glucose, amino acids, and sodium.

65% of  $\text{Na}^+$  is reabsorbed

65% of  $\text{H}_2\text{O}$  is reabsorbed

90% of filtered bicarbonate ( $\text{HCO}_3^-$ )

50% of  $\text{Cl}^-$  and  $\text{K}^+$

## Loop of Henle

Creates a gradient of increasing sodium ion concentration towards the end of the loop within the interstitial fluid of the renal pyramid.

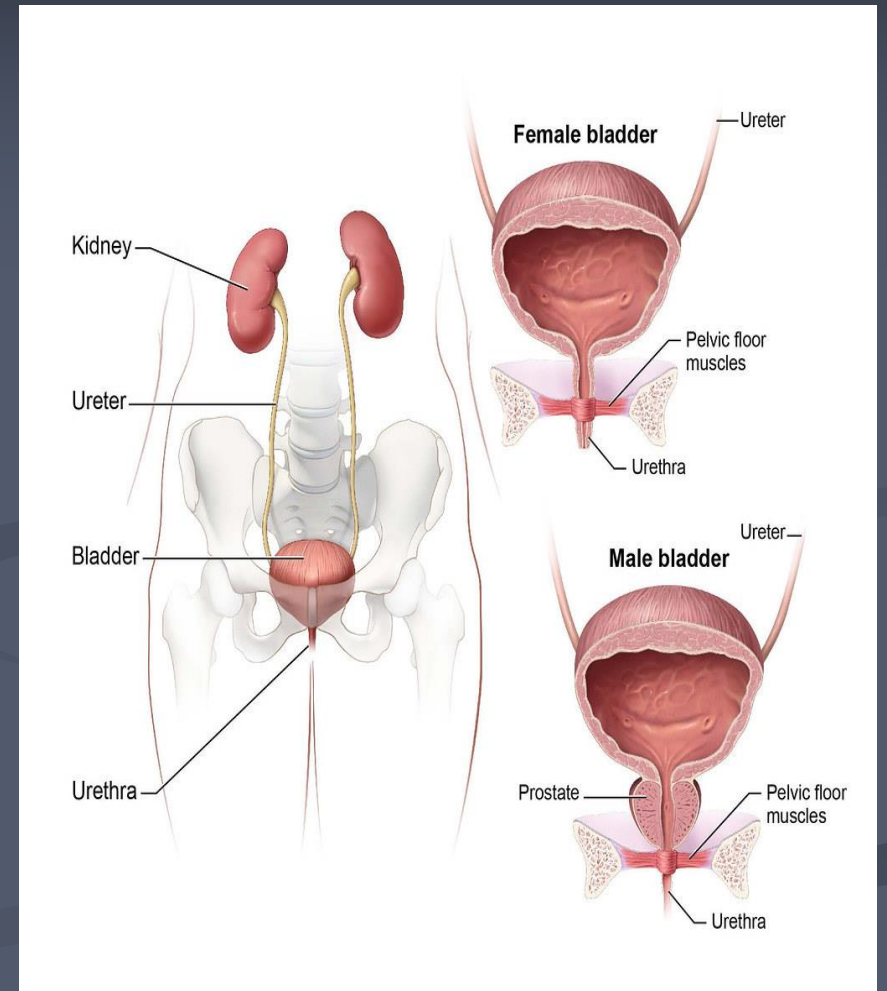
➤ 25%  $\text{Na}^+$  is reabsorbed in the loop

➤ 15% water is reabsorbed in the loop

➤ 40%  $\text{K}$  is reabsorbed in the loop

# Bladder

1. Mucosa (transitional epithelium)
2. Muscular layer (detrusor muscle): 3 layers of smooth muscle
3. Fibrous adventitia
4. Internal urethral sphincter muscle
5. External Urethral sphincter



# Assessment of the urinary system diseases

Most diagnosis can be reached by a complete history, and a thorough physical examination

- Make the patient feel comfortable
  - calm, caring, and competent image
  - Family member
- Time
  - sufficient to express their problems and the reasons for seeking your care
- Listen carefully
  - without distractions in order to obtain and interpret the clinical information provided by the patient

# Pain

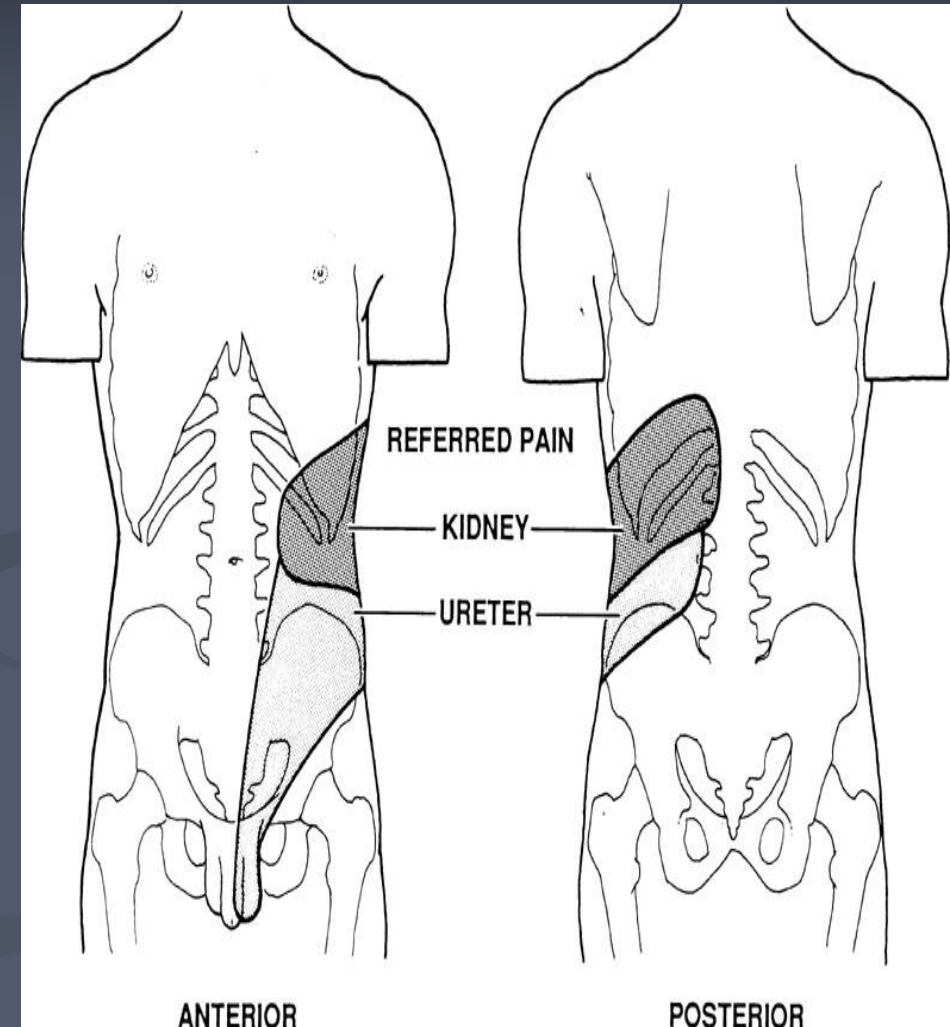
- **Can be severe in the case of:**
  - urinary tract obstruction
  - inflammation
- **Inflammation of the Ur. tract is most severe when it involves the parenchyma of a Ur. organ**
  - Pyelonephritis
  - Prostatitis
  - Epididymitis
- **Inflammation of the mucosa of a hollow viscus may produce from discomfort-till severe burning pain**
  - Cystitis
  - Urethritis

**In case of tumors Tumors:** No pain unless

- obstruction
- extend beyond the primary organ to involve adjacent nerves

# Renal Pain

- **Renal Pain**- as a result of acute distention of the renal capsule
  - **Site:** ipsilateral costovertebral angle just lateral to the sacrospinalis muscle and beneath the 12th rib
  - Renal pain may also be confused with pain resulting from irritation of the costal nerves, most commonly T10–T12 which is:
    - not colicky in nature.
    - severity of radicular pain may be altered by changing position
  - **Associated symptoms** (Nausea, Vomiting, Ileus, fever, chills...)



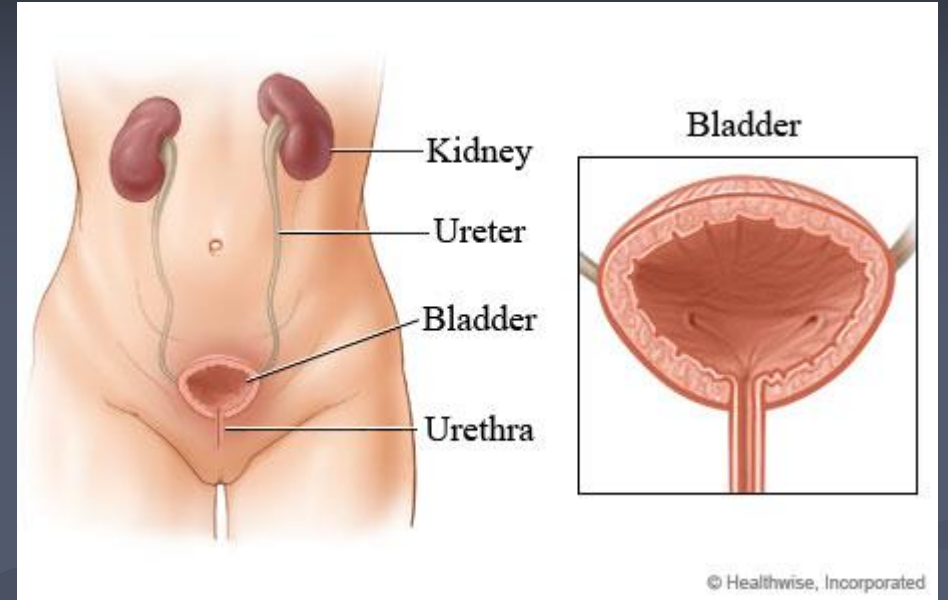
# Ureteral pain

- Usually is acute and secondary to obstruction
  - **Midureter ( Rt side)**: referred to the right lower quadrant (McBurney's point) and simulate appendicitis
  - **Midureter (Lt side)** :referred over the left lower quadrant and resembles diverticulitis.
  - Scrotum in the male or the labium in the female.
  - Lower ureteral obstruction frequently produces symptoms of bladder irritability ( frequency, urgency, and suprapubic discomfort)



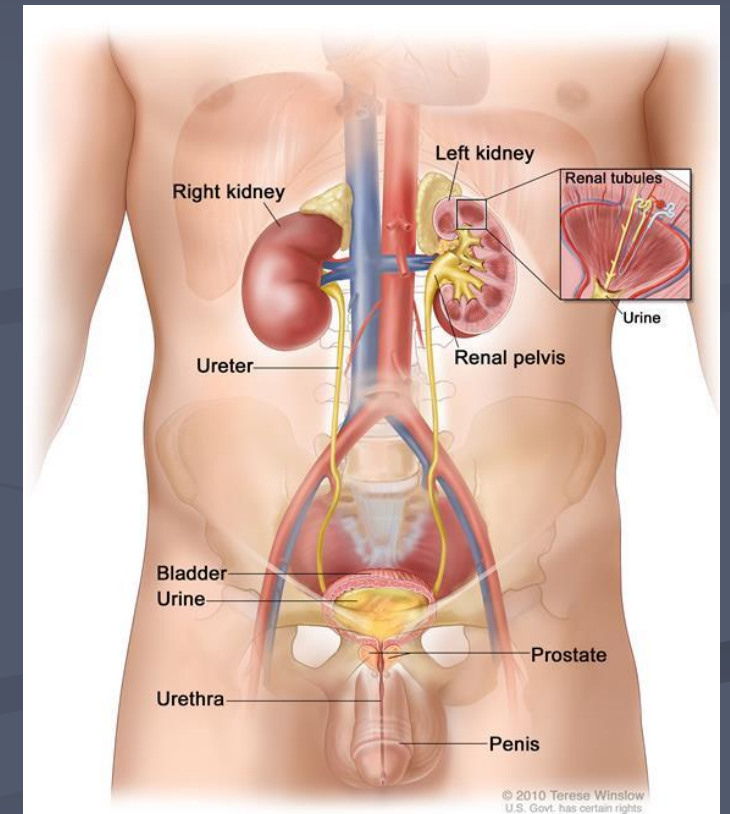
# Bladder Pain

- Vesical pain is due
  - Overdistention
  - Inflammation
- localization-in the suprapubic region
- from discomfort-till severe burning pain



# Prostatic Pain

- **Inflammation with secondary edema and distention of the prostatic capsule**
- poorly localized
  - lower abdominal
  - Inguinal
  - Perineal
  - Lumbosacral
  - rectal pain.
  - irritative urinary symptoms ( frequency and dysuria)
  - acute urinary retention.



# Hematuria

## ■ Hematuria : the presence of blood in the urine

????????????????

- Is the hematuria gross or microscopic?
- Timing: (beginning or end of stream or during entire stream)?
- Is it associated with pain?
- Is the patient passing clots?
- If the patient is passing clots, do the clots have a specific shape?

## ■ Initial hematuria:

- usually arises from the urethra
- least common
- usually secondary to inflammation.

## ■ Total hematuria

- most common
- bladder or upper urinary tracts.

## ■ Terminal hematuria

- the end of micturition
- secondary to inflammation bladder neck or prostatic urethra.

# Urinary symptoms

- ❑ Quantity of the urine during 24 hours (polyuria, oliguria, anuria)
- ❑ Urinary frequency
- ❑ Nicturia
- ❑ Dysuria: painful urination
- ❑ Incontinence
- ❑ Decreased force of urination
- ❑ Urinary hesitancy
- ❑ Intermittency
- ❑ Post void dribbling
- ❑ Straining

# Enuresis

- Urinary incontinence that occurs during sleep
- Mostly in children up to 5 years

# Fever and Chills

- Usually in
  - Pyelonephritis
  - Glomerulonephritis
  - Prostatitis
  - Bladder's inflammation

# Past Medical History

Systemic diseases that may affect the Urinary system

- **diabetes mellitus**
- **multiple sclerosis**
- **TB**
- **right Cardiac failure**
- **liver failure**
- **atherosclerosis...**

## Family History

- **prostate cancer**
- **stones**
- **renal tumors (some types)**

## Anamnesis

### Cigarette smoking

- urothelial carcinoma, mostly bladder - cancer
- erectile dysfunction.

### Chronic alcoholism

- impaired urinary function
- sexual dysfunction.
- testicular atrophy, and decreased libido.

# Urinary system (physical assessment)

## Inspection:

- **Skin**- pallor, yellow-gray, excoriations, changes in turgor, bruises, texture (e.g. rough, dry skin)
- **Mouth**: stomatitis, ammonia breath.
- **Face & extremities**- generalized edema, peripheral edema, bladder distention, masses, enlarged kidney.
- **Abdomen**-abdominal contour for midline mass in lower abdomen (may indicate urinary retention) or unilateral mass.
- **Weight**: weight gain 2<sup>nd</sup> to edema, weight loss & muscle wasting in renal failure.

## Urinary system (physical assessment)

- **General state of health-** fatigue, lethargy, & diminished alertness.
- **Palpation-** No costovertebral angle tenderness, nonpalpable kidney & bladder, no palpable masses.
- **Percussion:** Tenderness in the flank may be detected by fist percussion. If CVA tenderness & pain are present, indicate a kidney infection or polycystic kidney disease.
- **Auscultation:** The abdominal aorta & renal arteries are auscultated for a bruit, which indicates impaired blood flow to the kidneys



# Kidneys

## ■ Palpation of the kidneys

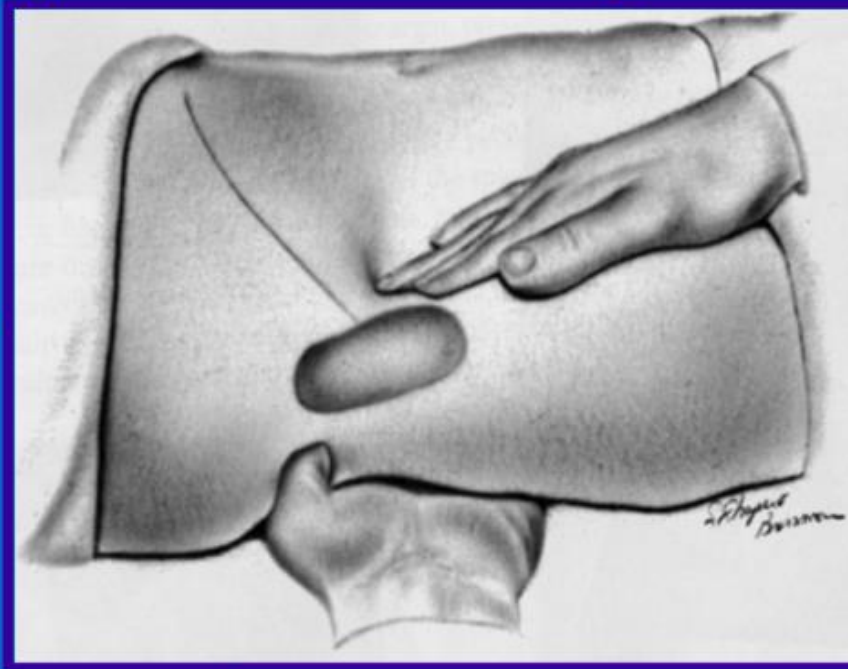
- supine position
- **The kidney is lifted from behind with one hand in the costovertebral angle**
- **In neonates, palpating of the flank between the thumb anteriorly and the fingers over the costovertebral angle posteriorly**
- Place left hand posteriorly just below the right 12th rib. Lift upwards.
- Palpate deeply with right hand on anterior abdominal wall.
- Feel lower pole of kidney and try to capture it between your hands



# Examination of Kidney

## Palpation of the kidney

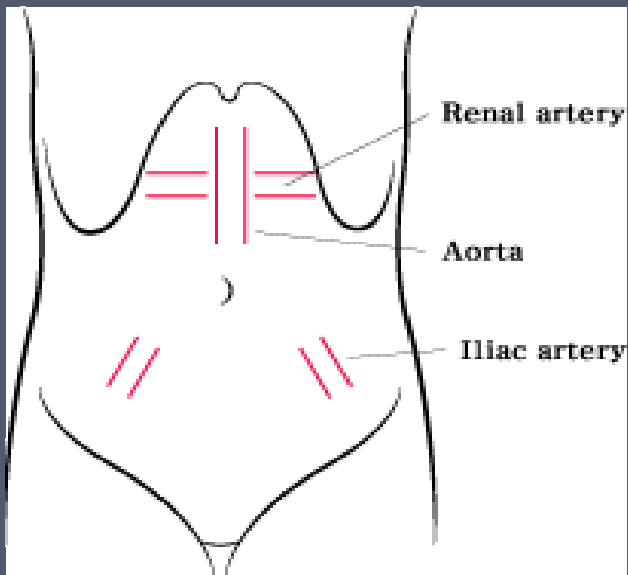
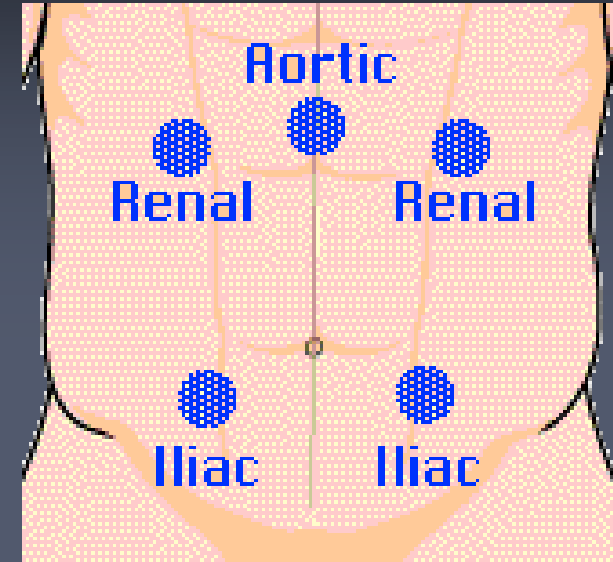
- Normal kidneys are not usually palpable.



- Right kidney may be felt to slip between hands during exhalation

# Kidney Auscultation

- epigastrium for bruit
  - renal artery stenosis
  - aneurysm.
  - renal arteriovenous fistula.



Bruits **confined to systole** do not necessarily **indicate disease**.

- When listening for bruits, you will need to **press down quite firmly** as the **renal arteries** are **retroperitoneal** structures.

# Urine

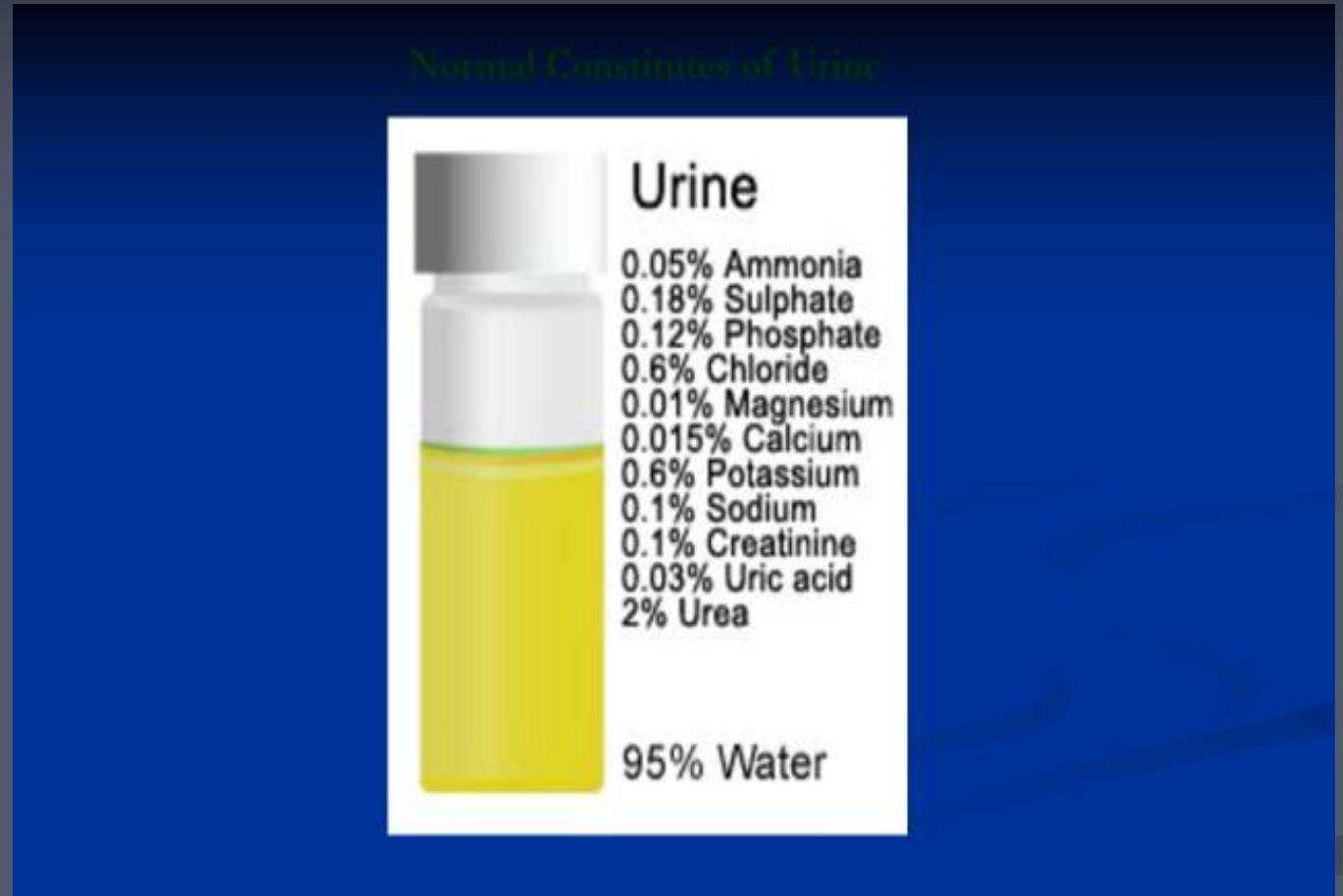
**Water**- 95%

**Nitrogenous waste:**

- urea
- uric acid
- creatinine

**Ions:**

- sodium
- potassium
- sulfate
- phosphate



From the original 1800 g NaCl, only 10 g appears in the urine

# Urine

- **smell**- normal is ammonia-like

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

**diabetes insipidus**- yucky asparagus

- **pH**- 4.5-8, ave 6.0
- **specific gravity**– more than 1.0; ~1.001-1.030
- **color**- affected by what we eat: salty foods, vitamins

**vegetarian diet**- urine is alkaline

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

# Urine

**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**



# Urine

## Specific Gravity (SG)

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



# Urine

## 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**

**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, glomerulonephritis, amyloidosis, nephrotic syndrom**



# Urine

## Abnormal Constitutes of Urine

**Ketone bodies**- not normal in urine

**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

**Bile pigments**-

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

**WBC**-

**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

# Urine

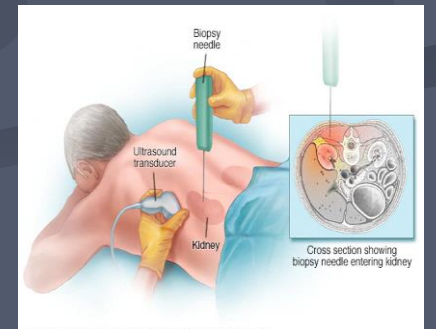
- **A decrease in SG** (less conc. urine) occurs with increased fluid intake, diuretic administration, diabetes insipidus.
- **An increase SG** (more conc. urine) occurs with insufficient fluid intake, decreased renal perfusion, or the presence of ADH.
- **Urine Culture & Sensitivity**- identifies the presence of microorganisms & determines the specific abx. that will treat the existing microorganisms.

# Urinary system (Diagnosis test)

- **Creatinine clearance test-** A blood & timed urine specimen that evaluates kidney function. Blood is drawn at the start of the test & the AM of the day that the 24-hour urine specimen collection is complete.
- **Uric acid-** A 24-hour collection to diagnose gout & kidney disease.

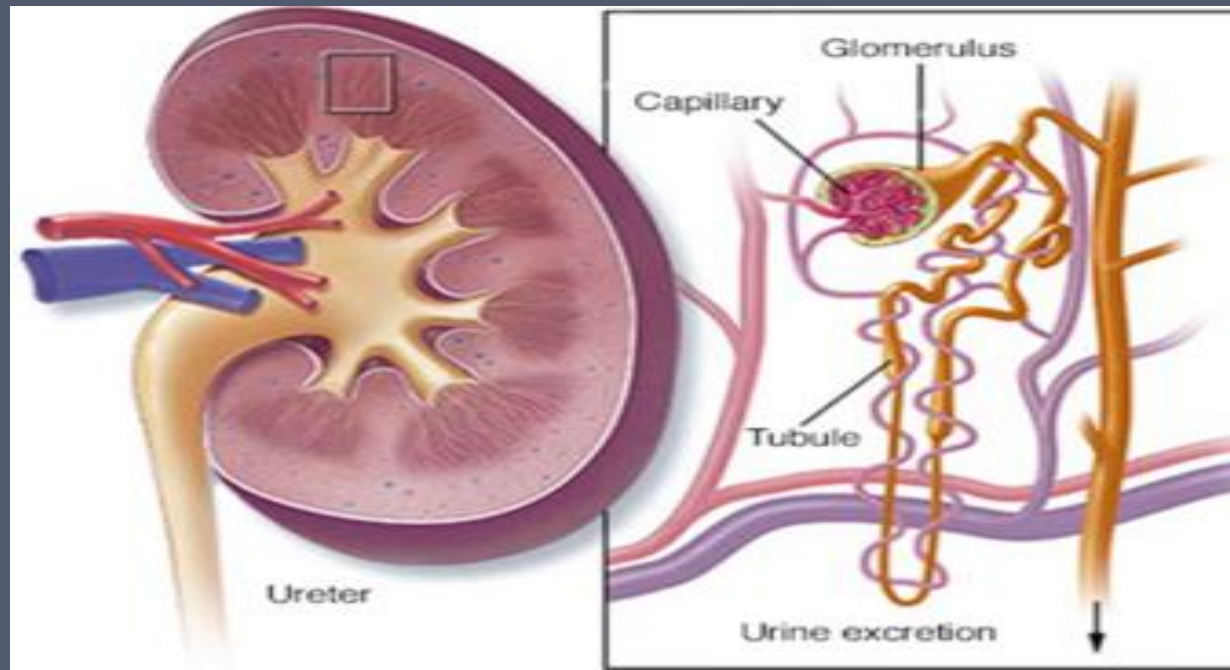
# Urinary System (Diagnostic test)

- **KUB (Kidney, ureters, bladder) radiograph**-An x-ray film that views the urinary system & adjacent structures; used to detect urinary calculi.
- **Bladder ultrasonography**-A noninvasive method of measuring the volume of urine in the bladder
- **Computed tomography (CT) & MRI**- provide cross-sectional views of the kidney & urinary tract.
- **Intravenous pyelogram (IVP)**- the injection of a radiopaque dye that outlines the renal system. Performed to identify abnormalities in the system.
- **Renal angiography**- the injection of a radiopaque dye through a catheter for examination of the renal arterial supply. Assess the client for allergies to iodine, seafood & radiopaque dyes.
- **Renal Scan**- An IV injection of a radiopaque for visual imaging of renal blood flow.
- **Cystometrogram (CMG)**- A graphic recording of the pressures exerted at varying phases of the bladder.
- **Cystoscopy & Biopsy**- the bladder mucosa is examined for inflammation, calculi or tumors by means of a cystoscope, a biopsy may be obtained.
- **Renal biopsy**- insertion of a needle into the kidney to obtain a sample of tissue for exam.



# Glomerulonephritis

- Glomerulonephritis is the inflammation of the glomeruli of the kidney.

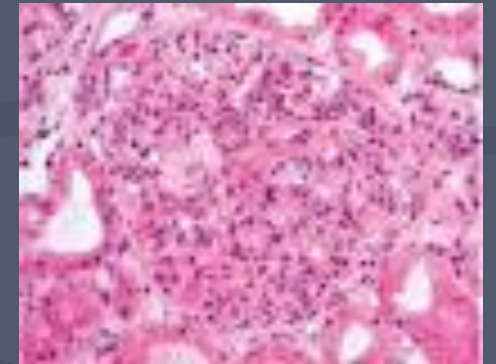


# Acute glomerulonephritis

- Acute glomerulonephritis is the **inflammation of the glomeruli** which causes the kidneys to malfunction
- It is also called **Acute Nephritis, Glomerulonephritis** and **Post-Streptococcal Glomerulonephritis**
- Predominantly affects children from ages 2 to 12
- Incubation period is 2 to 3 weeks

## *Classification:*

- **Acute** – days, weeks. Spontaneous recovery common
- **Subacute** – weeks months, irreversible renal failure
- **Chronic** – months, years.



# Acute glomerulonephritis

Etiology:



- **Infection**
  - Post-streptococcal glomerulonephritis
  - Bacterial endocarditis
  - Viral infection
- **Immune diseases**
  - Lupus – chronic inflammatory disease
  - Goodpasture’s syndrome – a rare immunological lung disorder.
  - IgA nephropathy – blood in the urine.
- **Vasculitis**
  - Polyarteritis - affects small and medium blood vessels.
- **High blood pressure**
- **Diabetic kidney disease**
- **Focal segmental glomerulosclerosis – scarring of some of the glomeruli.**
- **High use of non-steroidal anti-inflammatory drugs.**

# Acute glomerulonephritis

## Signs and Symptoms

- **Hematuria:** dark brown or smoky urine
- **Oliguria:** urine output is  $< 400$  ml/day or **anuria**
- **Edema:** starts in the eye lids and face then the lower and upper limbs then becomes generalized; may be migratory
- **Hypertension:** usually mild to moderate



# Acute glomerulonephritis

## General Symptoms

- Fever
- Headache
- Malaise
- Anorexia
- Nausea and vomiting
- High blood pressure
- Pallor due to edema and/or anemia
- Confusion
- Lethargy
- Loss of muscle tissue
- Enlargement of the liver

# Acute glomerulonephritis

## Complications

- Acute kidney failure
- Chronic kidney failure
- High blood pressure
- Nephrotic syndrome
- Pulmonary edema
- Pericarditis
- Hypertensive encephalopathy, heart failure and acute pulmonary edema may occur in severe cases
- Acute renal necrosis due to injury of capillary or capillary thrombosis

# Acute glomerulonephritis

## *Diagnosis:*

- **Urine test** - to check creatinine clearance, total protein in the urine, concentration, red blood cells, osmolarity.
- **Blood test** – abnormal albumin levels, abnormal blood urea nitrogen, high creatinine level, anemia.
- **Streptozyme tests** – to confirm recent infection
- **CT**
- **Ultrasound**
- **Intravenous pyelogram**

# Acute glomerulonephritis

## Prevention

- proper hygiene
- prompt medical assessment for necessary antibiotic therapy should be sought when infection is suspected
- prophylactic immunizations

# Acute glomerulonephritis

## Treatment:

- Diet
- Bed rest
- Antibiotics
- Vasodilators
- Antihypertensive drugs
- Diuretics
- Treatment of complications



# Chronic glomerulonephritis

Develops over several years, with or without symptoms.

## Etiology:

### Infection

- Post-streptococcal
- Bacterial endocarditis
- Viral infection

### Immune diseases

- Lupus – chronic inflammatory disease
- Goodpasture's syndrome – a rare immunological lung disorder.
- IgA nephropathy – blood in the urine.

### Vasculitis

- Polyarteritis - affects small and medium blood vessels.

### High blood pressure

### Diabetic kidney disease

Focal segmental glomerulosclerosis – scarring of some of the glomeruli.

High use of non-steroidal anti-inflammatory drugs.

# Chronic glomerulonephritis

## Simptoms

- Hematuria - or excess protein in the urine (and foamy urine)
- High blood pressure
- Periorbital edema
- Frequent nighttime urination
- Abdominal pain
- Oliguria
- Muscle twitching

# Chronic glomerulonephritis

## Diagnosis:

- Blood test – hematocrit, urea, creatinine, protein, albumin, cholesterol
- Urine test
- Biopsy
- CT, ultrasound
- Intravenous pyelogram



# Chronic glomerulonephritis

## Treatment:

- Antihypertensive drugs
- Diuretics
- Corticosteroids
- Dietary restrictions – like low protein, low salt and iron or vitamin supplements
- Dialysis
- Kidney transplant

# Nephrotic Syndrome

- The nephrotic syndrome is not a disease, it is a group of signs and symptoms commonly seen in pts with glomerular diseases characterized by **massive proteinuria, hypoalbuminemia and edema.**
- There is a marked increase in capillary wall permeability to serum proteins rather than glomerular inflammatory changes.
- The primary abnormality in NS is the excretion amounts (**greater than 3.5 grams per day**) of protein in the urine

# Nephrotic Syndrome

## Etiology

- The nephrotic syndrome is the result of diffuse injury to the glomerulus's.
- The injury may occur in the course of poststreptococcal GN or in association with amyloid infiltration of the glomeruli, diabetic intercapillary glomerulosclerosis or SLE.
- It is occasionally in allergic reactions
  - The reduction circulating volume that occurs may results in **increased renal retention of salt and water** through normal compensatory mechanisms more than 50% of pts with the NS. Have normal or increased plasma volume and normal or low levels of plasma rennin during sodium retention, suggesting a primary renal contribution to salt retention in the NS

# Nephrotic Syndrome

## Complications:

- Hypercoagulability
- Acute renal failure
- Hyperparathyroidism

## Treatment

Diet

Prednisolone

Cyclophosphamide

NSAID

Heparin

# AMYLOIDOSIS

AA amyloid – systemic disease

AL amyloid – multiple myeloma

Deposits of amyloid – glomeruli (mesangial)

- arterioles

- tubular BM

Nonselective proteinuria – nephrotic syndrome (60%) → renal failure (with large kidneys!)

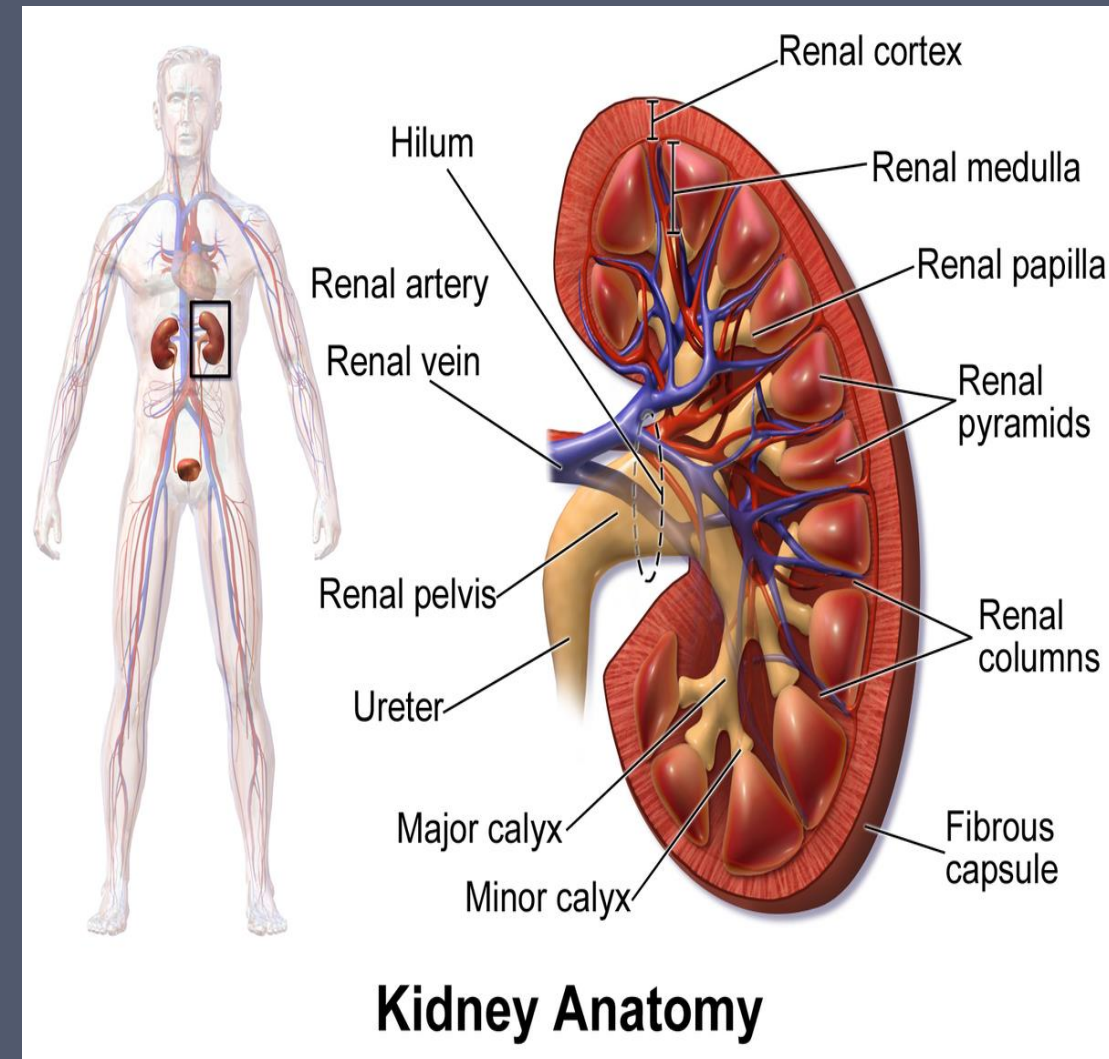
# Pyelonephritis



# Pyelonephritis

## Inflammation of kidney parenchyma

- Bacterial infection reaches kidneys:
  - Blood or lymph
  - Through ureters from lower urinary tract
- More common in women
- May cause systemic infection



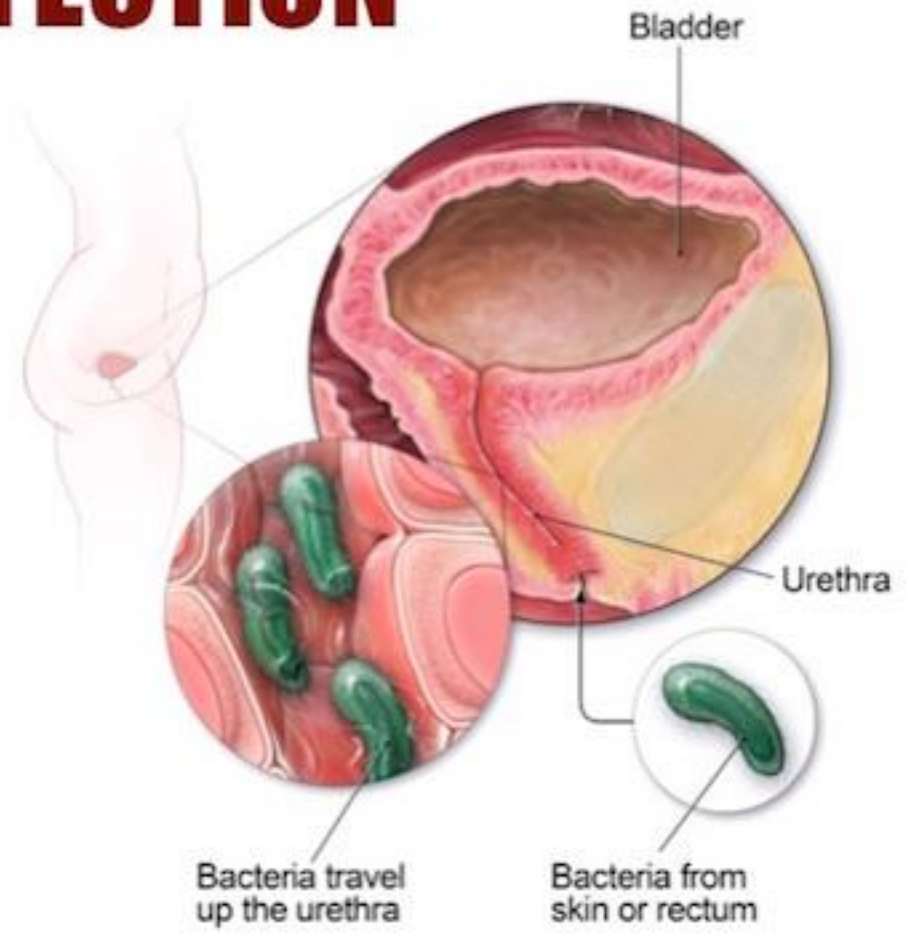
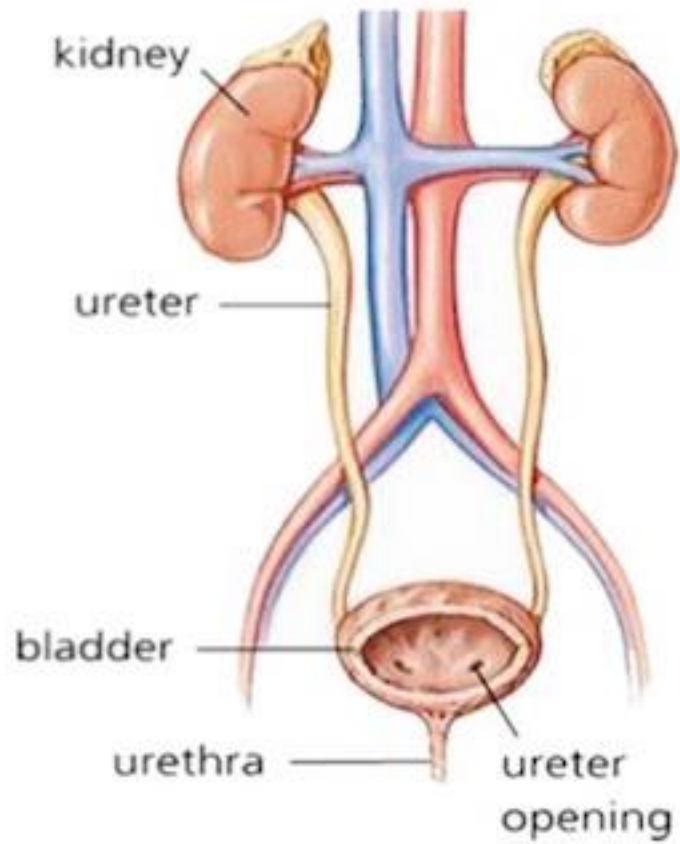
# PYELONEPHRITIS

## Predisposing Conditions

- Urinary stones
- Hydronephrosis
- Cystitis
- Prostatic hyperplasia
- Tumors
- Pregnancy
- Vesico-ureteric reflux
- External ureteric compression (e.g. fibrosis)



# URINARY TRACT INFECTION



# PYELONEPHRITIS

## Predisposition to pyelonephritis

(Mnemonic *URINE*)

**U** Urolithiasis

**R** Reflux (vesico-ureteric)

**I** Infections of lower UT

**N** Neoplasms (e.g. ureteric, vesical, prostatic)

**E** External compression (e.g.) pregnancy

retroperitoneal fibrosis

# ACUTE PYELONEPHRITIS

Is a sudden and severe kidney infection. It causes the kidney to swell and may permanently damage them

## Etiology

Bacterial infection (E. coli 80%) -Lower UTI precedes renal infection  
urinary tract infection (UTI), E. coli – infection spreading from the renal pelvis onto the kidney tissue.

Ascending > hematogenous

Sepsis

Typhoid fever

Acute tonsillitis

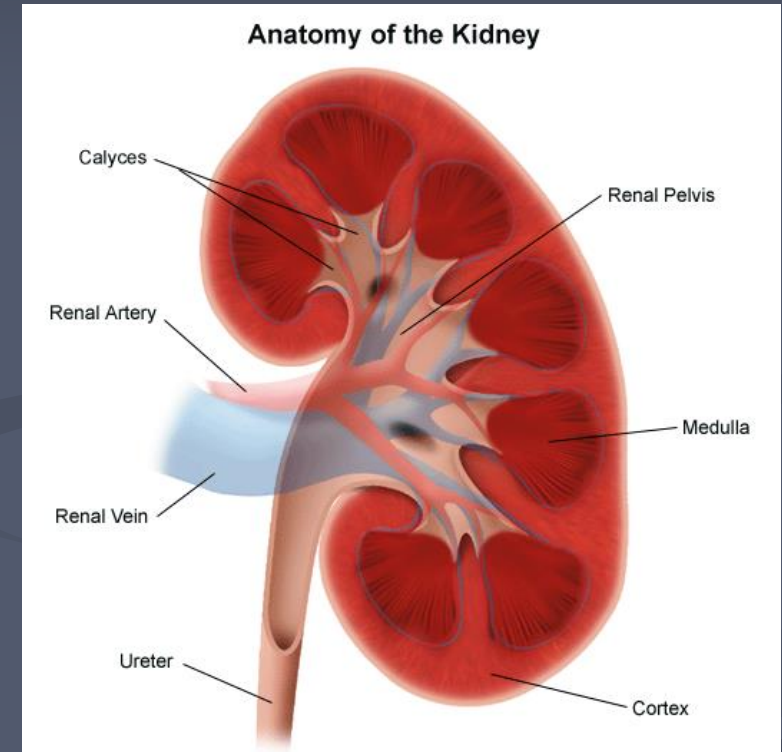
Kidney stones

HIV infection

# ACUTE PYELONEPHRITIS

## Pathology

- Unilateral > bilateral
- Focal
- PMNs in tubules → interstitium



# ACUTE PYELONEPHRITIS

## Complications

Acute pyelonephritis can sometimes cause:

- an abscess (pus-filled area) in your kidney
- inflammation (swelling) of the kidney
- blood poisoning (septicaemia), which can occur if bacteria causing the pyelonephritis gets into your blood stream

# CHRONIC PYELONEPHRITIS

## Pathology

Destruction of renal tissue and fibrosis

- Cortical scars
- Loss of papillae
- Ectasia of calices
- Hydronephrosis

→ Irregularly shrunken small kidney

**Histology:** Chronic inflammatory infiltrates

- Tubular atrophy with casts  
 (“thyroidization”)

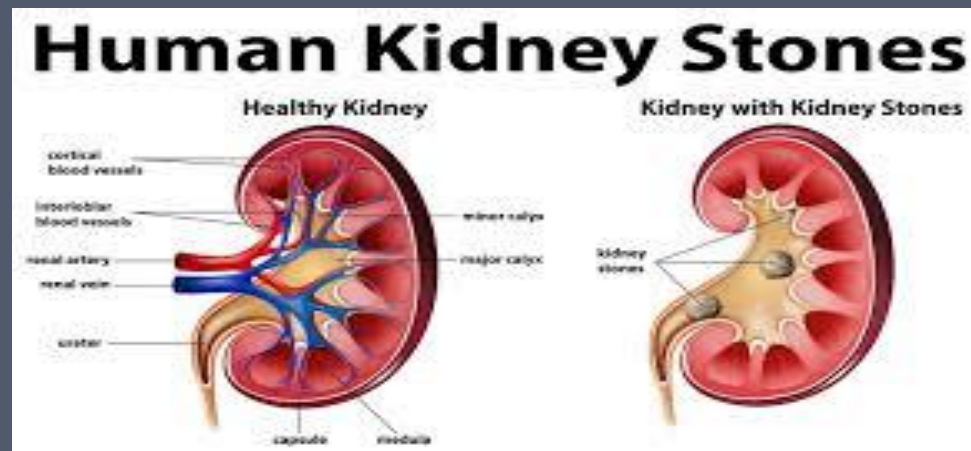
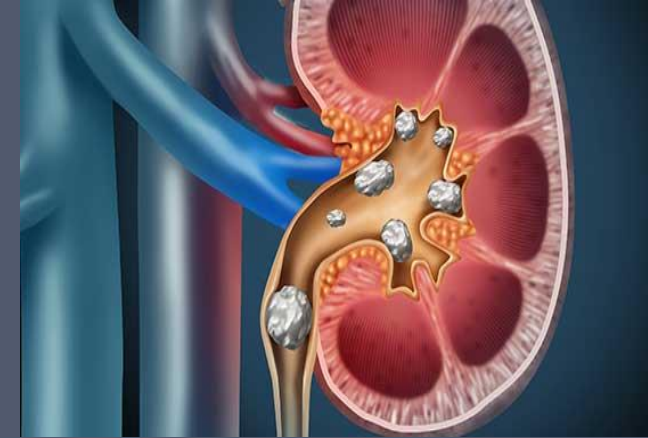
# Pyelonephritis

## Signs and symptoms

- Fever (high –in acute pielonefritis- and subferile one in chronic pyelonephritis)
  - Chills
  - Flank pain, pain in the abdomen, back, side
  - Nausea
  - Vomiting
  - painful and burning urination
  - pus or blood in the urine
  - urgent or frequent urination fishy-smelling urine
  - nicturia
  - fatigue
- 
- Can progress to sepsis and result in renal failure

# Kidney Stones

- Pathological concretions originate in renal pelvis
- Supersaturation of urine with insoluble salts:
  - Calcium oxalate and uric acid
  - Common in 20-40 y/o
  - Recurrent
  - More common in men





# Kidney Stones

1. Calcium oxalate (75%)
2. Uric acid (15%)
3. Struvite (magnesium ammonium phosphate)
4. calcium phosphate (8%)
5. Cystine (1%)



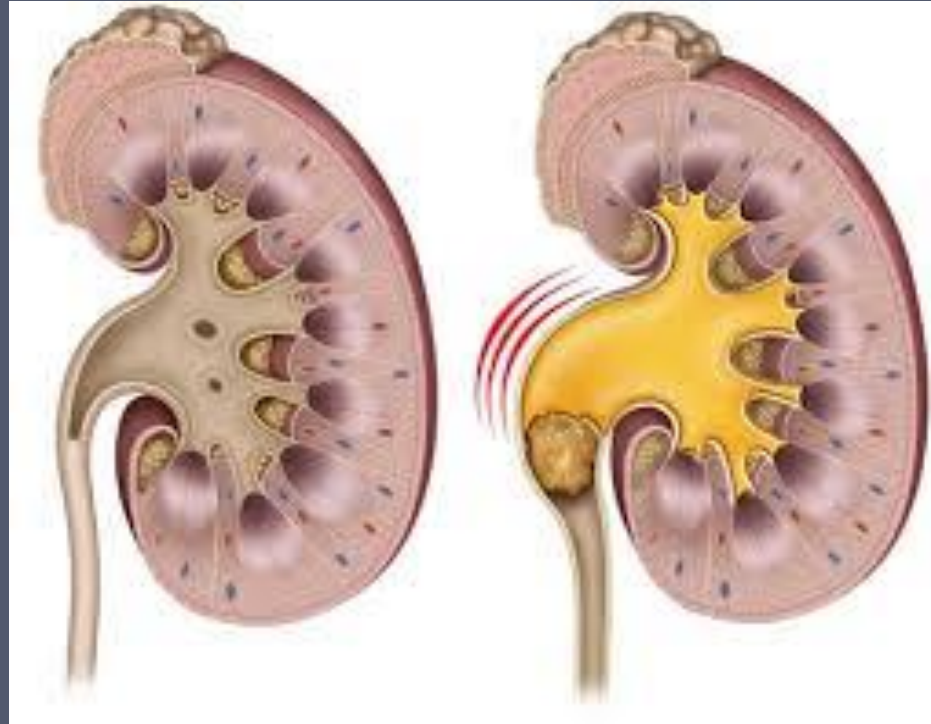
# Kidney Stones

## ■ Risk factors

- Dehydration
- CNS disorders
- Drug use
- Surgery

## ■ Signs and symptoms

- Vary
- Severe pain



# Kidney Stones-symptoms

For a long period of time can be asymptomatic

- Pain, severe one, that may radiate
- Restlessness
- Nausea and vomiting
- Urinary urgency/frequency
- Diaphoresis
- Low-grade fever
- Hematuria
- Dysuria
- Definitive care

# Renal colic

- **Renal colic** is pain that occurs due to a stone in the urinary tract.
- Stones can develop anywhere in the urinary tract, and they can vary significantly in size.
- The symptoms of renal colic vary depending on the size of the stone and its location in the urinary tract. Some small stones cause mild renal colic, and a person can pass them in the urine without much discomfort.
- Larger stones can cause severe pain, especially if they become stuck and block any small passages in the urinary tract. Susceptible areas include the ureters, which are the tubes through which the urine passes between the kidney and the bladder.
- The most common presentation of renal colic is pain on the affected side of the body between the lower ribs and hip. This pain tends to radiate to the lower abdomen and groin.
- The pain typically comes in waves that each last 20–60 minutes before subsiding.

# Renal colic

Renal colic is just one of the symptoms that urinary stones can cause. Other symptoms that commonly occur alongside renal colic include:

- pain or difficulty urinating
- blood in the urine, which may make it appear pink, red, or brown
- urine that smells unusual
- nausea
- vomiting
- small particles in the urine
- feeling a constant urgent need to urinate cloudy urine
- urinating more or less frequently than usually

# Renal colic

Stones develop due to a few different risk factors, including:

- extra calcium in the urine
- diseases of the gastrointestinal (GI) tract, such as Crohn's disease or ulcerative colitis
- gout, which occurs due to an excess of uric acid
- certain medications
- cystinuria, in which stones develop from an amino acid called cysteine
- obesity
- surgeries of the GI tract, such as a gastric bypass
- dehydration
- a family history of urolithiasis

# Renal colic

- People can pass most small stones in the urine.
- recommend **hydration, pain relieving medications** to help a person deal with the pain and monitor until the stone passes.

**A range of procedures can help a person remove larger stones and relieve renal colic.**

These include:

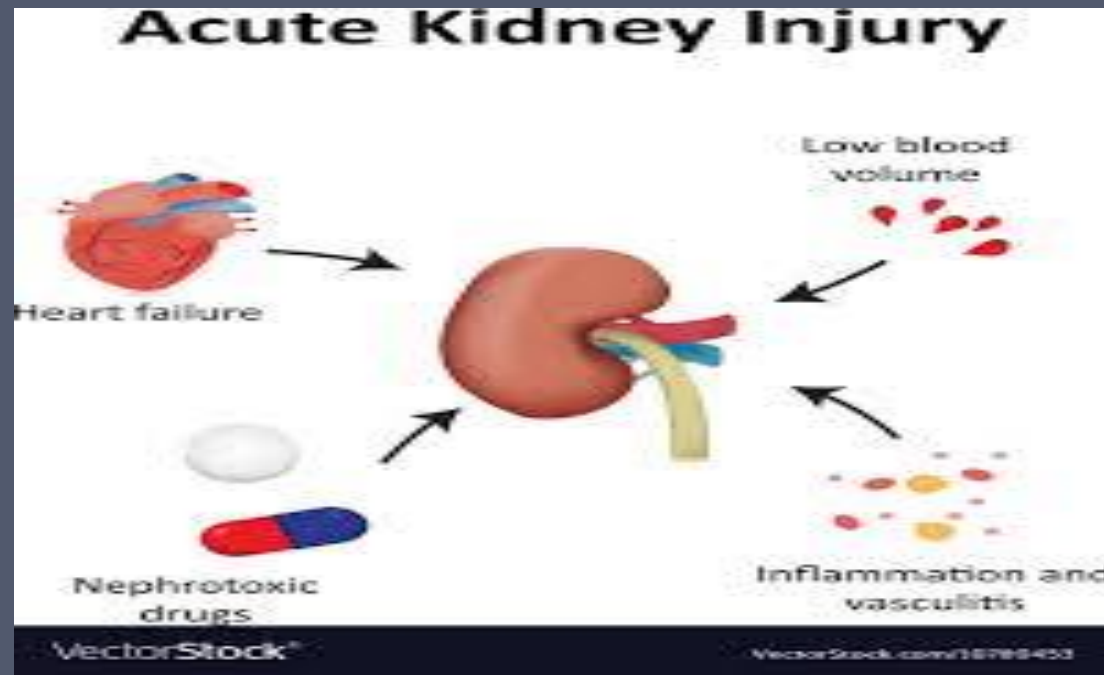
- *Ureteroscopy guided stone extraction*
- *Extracorporeal shock wave lithotripsy (ESWL)*
- *Percutaneous nephrolithotomy*
- *Stent placement*
- *Open surgery*

# Acute Renal Failure

Sudden decrease in glomerular filtration

Acute kidney failure — also called acute renal failure or acute kidney injury — develops rapidly, usually in less than a few days.

Acute kidney failure is most common in people who are already hospitalized, particularly in critically ill people who need intensive care.





# Acute Renal Failure

## Causes:

- a condition that slows blood flow to the kidneys (*prerenal*)
- direct damage of the kidneys (*intrinsic*)
- the kidneys' urine drainage tubes (ureters) become blocked and wastes can't leave the body through the urine (*postrenal*)

# Acute Renal Failure

## Impaired blood flow to the kidneys (prerenal):

Diseases and conditions that may slow blood flow to the kidneys and lead to kidney injury include:

- Blood or fluid loss
- Blood pressure medications
- Heart attack
- Heart disease
- Infection
- Liver failure
- Use of aspirin, ibuprofen (Advil, Motrin IB, others), naproxen sodium (Aleve, others) or related drugs
- Severe allergic reaction (anaphylaxis)
- Severe burns
- Severe dehydration

# Acute Renal Failure

## Damage to the kidneys (*intrinsic*) :

These diseases, conditions and agents may damage the kidneys and lead to acute kidney failure:

- Blood clots in the veins and arteries in and around the kidneys
- Cholesterol deposits that block blood flow in the kidneys
- Glomerulonephritis
- Hemolytic uremic syndrome, a condition that results from premature destruction of red blood cells
- Infection
- Lupus, an immune system disorder causing glomerulonephritis
- Medications, such as certain chemotherapy drugs, antibiotics and dyes used during imaging tests
- Scleroderma, a group of rare diseases affecting the skin and connective tissues
- Thrombotic thrombocytopenic purpura, a rare blood disorder
- Toxins, such as alcohol, heavy metals and cocaine
- Muscle tissue breakdown (rhabdomyolysis) that leads to kidney damage caused by toxins from muscle tissue destruction
- Breakdown of tumor cells (tumor lysis syndrome), which leads to the release of toxins that can cause kidney injury

# Acute Renal Failure

Urine blockage in the kidneys (*postrenal*):

Diseases and conditions that block the passage of urine out of the body (urinary obstructions) and can lead to acute kidney injury include:

- Bladder cancer
- Blood clots in the urinary tract
- Cervical cancer
- Colon cancer
- Enlarged prostate
- Kidney stones
- Nerve damage involving the nerves that control the bladder
- Prostate cancer

# Acute Renal Failure

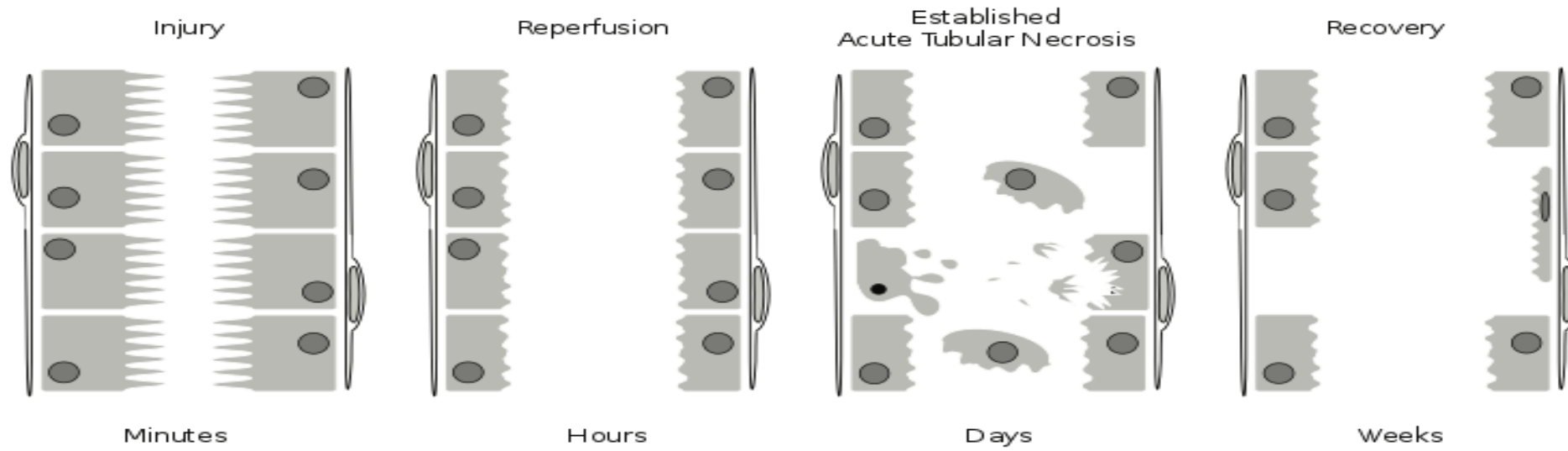
## Risk factors

Acute kidney failure almost always occurs in connection with another medical condition or event. Conditions that can increase your risk of acute kidney failure include:

- Being hospitalized, especially for a serious condition that requires intensive care
- Advanced age
- Blockages in the blood vessels in your arms or legs (peripheral artery disease)
- Diabetes
- High blood pressure
- Heart failure
- Kidney diseases
- Liver diseases
- Certain cancers and their treatments

# Acute Renal Failure

## *Pathophysiology of acute kidney injury in the proximal renal tubule*



# Acute Renal Failure

## Complications

Potential complications of acute kidney failure include:

- **Fluid buildup.** Acute kidney failure may lead to a buildup of fluid in your lungs, which can cause shortness of breath.
- **Chest pain.** If the lining that covers your heart (pericardium) becomes inflamed, you may experience chest pain.
- **Muscle weakness.** When your body's fluids and electrolytes — your body's blood chemistry — are out of balance, muscle weakness can result.
- **Permanent kidney damage.** Occasionally, acute kidney failure causes permanent loss of kidney function, or end-stage renal disease. People with end-stage renal disease require either permanent dialysis — a mechanical filtration process used to remove toxins and wastes from the body — or a kidney transplant to survive.
- **Death.** Acute kidney failure can lead to loss of kidney function and, ultimately, death.

# Acute Renal Failure

Signs and symptoms of acute kidney failure may include:

- Decreased urine output, although occasionally urine output remains normal
- Fluid retention, causing swelling in your legs, ankles or feet
- Shortness of breath
- Fatigue
- Confusion
- Nausea
- Weakness
- Irregular heartbeat
- Chest pain or pressure
- Seizures or coma in severe cases
- Sometimes acute kidney failure causes no signs or symptoms and is detected through lab tests done for another reason.



# Acute Renal Failure

## Diagnosis

### KDIGO (2012) specific criteria:

*ARF can be diagnosed if any one of the following is present:*

- Increase in SCr by  $\geq 0.3$  mg/dl ( $\geq 26.5$   $\mu\text{mol/l}$ ) within 48 hours;  
or
- Increase in SCr to  $\geq 1.5$  times baseline, which has occurred within the prior 7 days; or
- Urine volume  $< 0.5$  ml/kg/h for 6 hours.

# Acute Renal Failure

## Staging

The **RIFLE** criteria, proposed by the Acute Dialysis Quality Initiative (ADQI) group, aid in assessment of the severity of a person's acute kidney injury:

- **Risk:** 1.5-fold increase in the serum creatinine, or glomerular filtration rate (GFR) decrease by 25 percent, or urine output  $<0.5$  mL/kg per hour for six hours.
- **Injury:** Two-fold increase in the serum creatinine, or GFR decrease by 50 percent, or urine output  $<0.5$  mL/kg per hour for 12 hours
- **Failure:** Three-fold increase in the serum creatinine, or GFR decrease by 75 percent, or urine output of  $<0.3$  mL/kg per hour for 24 hours, or no urine output (anuria) for 12 hours
- **Loss:** Complete loss of kidney function (e.g., need for renal replacement therapy) for more than four weeks
- **End-stage kidney disease:** Complete loss of kidney function (e.g., need for renal replacement therapy) for more than three months

# Acute Renal Failure

## Evaluation

- blood tests : urea and creatinine.
- the ratio of BUN to creatinine.
- a bladder scan or a post void residual to rule out urinary retention ( 50–100 ml suggests neurogenic bladder dysfunction.)
- urine sediment analysis,
- renal ultrasound
- and/or kidney biopsy

Indications for kidney biopsy in the setting of ARF include the following:

- Unexplained ARF, in a patient with two non-obstructed normal sized kidneys
- ARF in the presence of the [nephritic syndrome](#)
- Systemic disease associated with ARF
- Kidney transplant dysfunction

# Acute Renal Failure

**Treatment** for acute kidney failure involves identifying the illness or injury that originally damaged kidneys, treatment options depend on what's causing kidney failure.

## ❑ **Treatments to balance the amount of fluids in the blood**

- If acute kidney failure is caused by a lack of fluids in the blood, intravenous (IV) fluids may recommend
- In the case of edema-diuretics

## ❑ **Medications to control blood potassium**

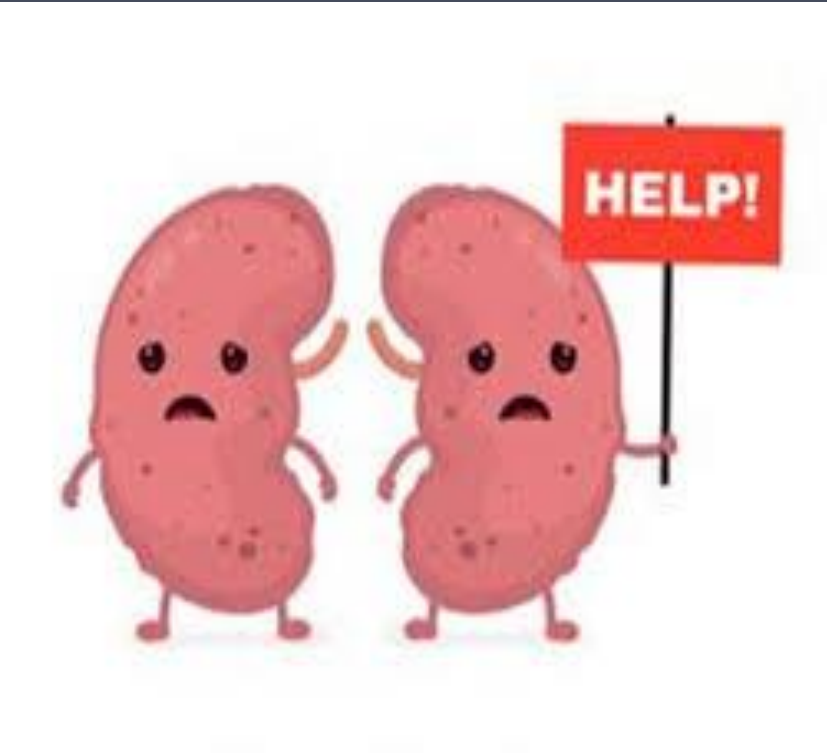
-calcium, glucose or sodium polystyrene sulfonate (Kionex) to prevent the accumulation of high levels of potassium in the blood. Too much potassium in the blood can cause dangerous irregular heartbeats (arrhythmias) and muscle weakness.

## ❑ **Medications to restore blood calcium levels**

-an infusion of calcium.

## ❑ **Dialysis to remove toxins from the blood.** excess fluids , excess potassium from the body.

# Chronic kidney disease



## Alternative Names

Kidney failure - chronic

Renal failure - chronic

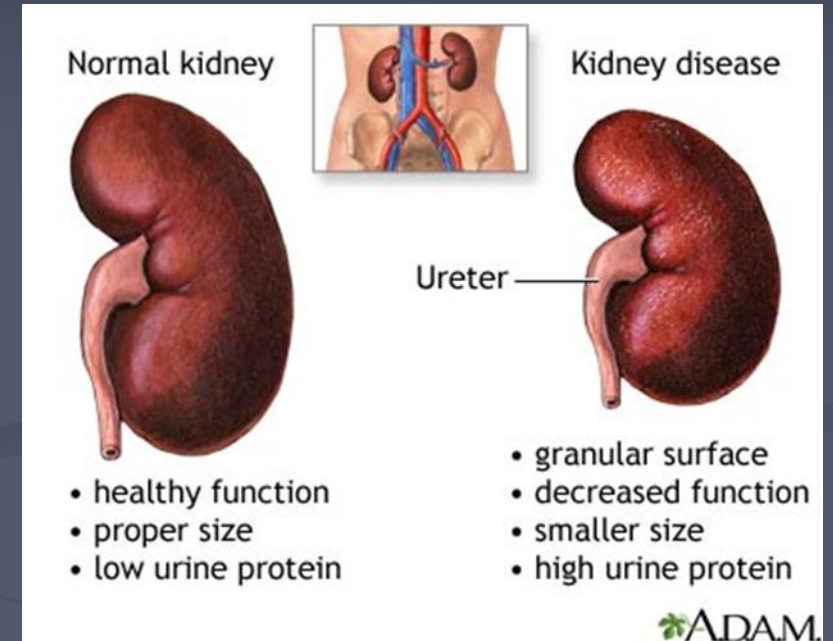
Chronic renal insufficiency

Chronic kidney failure

Chronic kidney disease

# Chronic kidney disease

- Chronic renal failure is a functional diagnosis characterized by a progressive and generally irreversible decline in glomerular filtration rate.
- The clinical constellation of signs and symptoms of the end/stage renal failure is known as the “**uremic syndrome**”



# Chronic kidney disease

Diseases and conditions that cause chronic kidney disease include:

- Type 1 or type 2 diabetes
- High blood pressure
- Glomerulonephritis
- Interstitial nephritis an inflammation of the kidney's tubules and surrounding structures
- Polycystic kidney disease
- Prolonged obstruction of the urinary tract, from conditions such as enlarged prostate, kidney stones and some cancers
- Vesicoureteral reflux, a condition that causes urine to back up into your kidneys
- Recurrent kidney infection, also called pyelonephritis

# Chronic kidney disease

## Risk factors:

- Diabetes
- High blood pressure
- Heart and blood vessel (cardiovascular) disease
- Smoking
- Obesity
- Being African-American, Native American or Asian-American
- Family history of kidney disease
- Abnormal kidney structure
- Older age

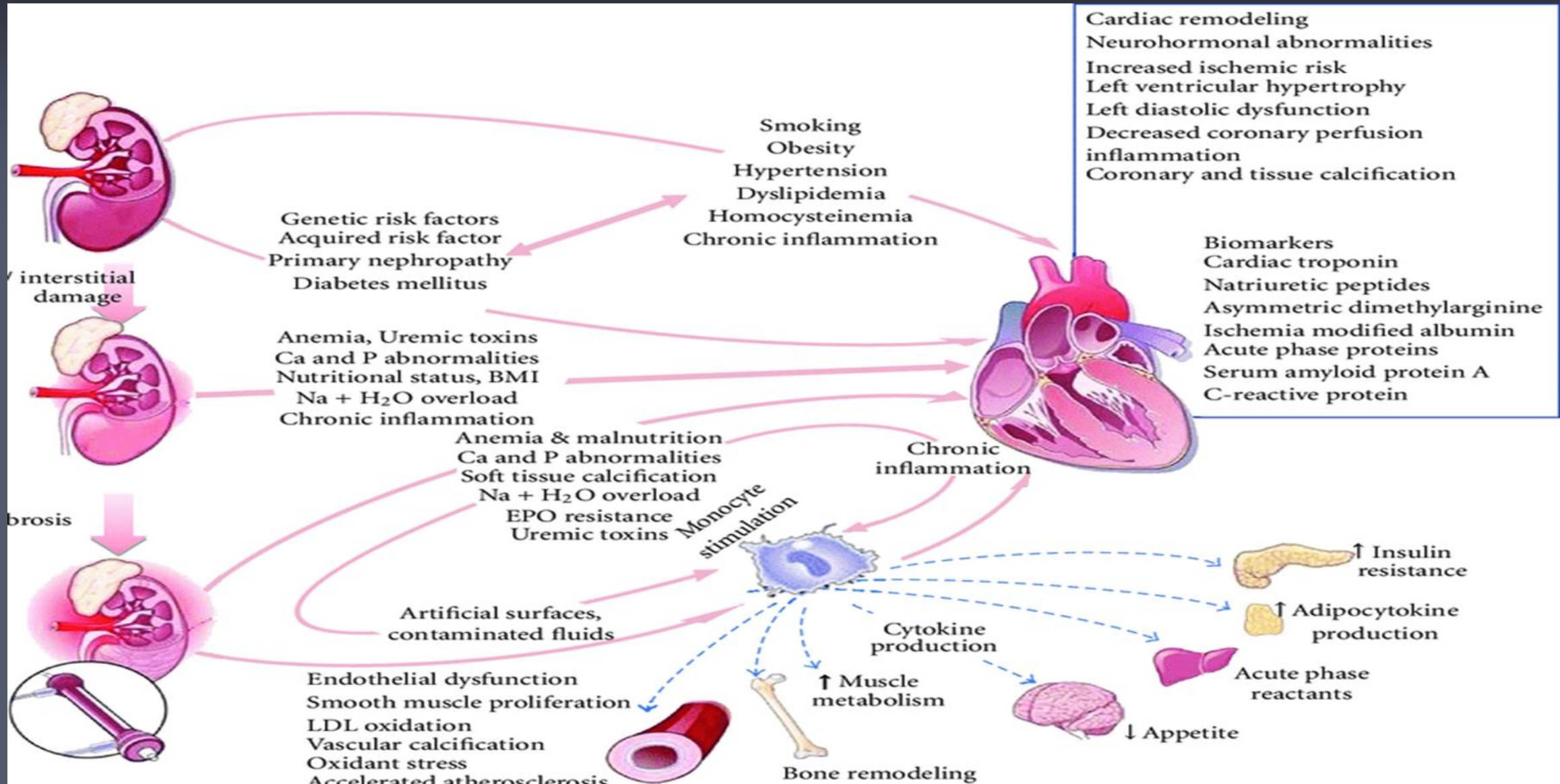


# Chronic kidney disease

## Complications

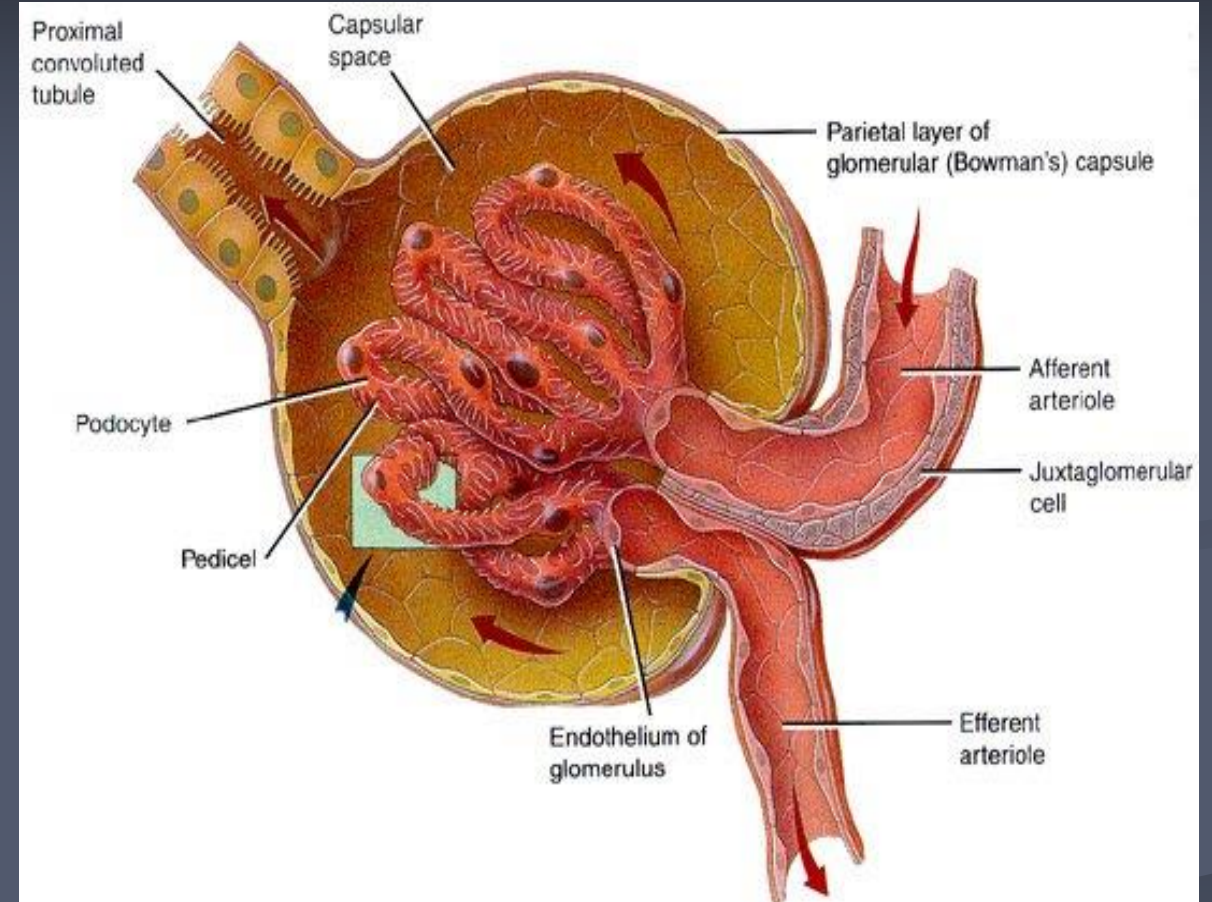
- Fluid retention, which could lead to swelling in the arms and legs, high blood pressure, or pulmonary edema
- A sudden rise in potassium levels in the blood (hyperkalemia)
- Heart and blood vessel (cardiovascular) disease
- Weak bones and an increased risk of bone fractures
- Anemia
- Decreased sex drive, erectile dysfunction or reduced fertility
- Damage to the central nervous system, which can cause difficulty concentrating, personality changes or seizures
- Decreased immune response
- Pericarditis
- Pregnancy complications that carry risks for the mother and the developing fetus
- Irreversible damage to the kidneys (end-stage kidney disease)

# CHRONIC KIDNEY DISEASE



# Chronic Kidney Disease

**Glomerular filtration rate (GFR)** is the volume of fluid filtered from the renal (kidney) glomerular capillaries into the Bowman's capsule per unit time. Clinically, this is often measured to determine renal function.



# NORMAL RANGES of GFR

The normal ranges of **GFR**, adjusted for body surface area, are:

Males:  $70 \pm 14$  mL/min/m<sup>2</sup>

Females:  $60 \pm 10$  mL/min/m<sup>2</sup>

**(125ml/mt)**

- ✓ GFR can increase due to hypoproteinemia because of the reduction in plasma oncotic pressure.
- ✓ GFR can also increase due to constriction of the efferent arteriole but decreases due to constriction of the afferent arteriole.

# STAGES OF CHRONIC KIDNEY DISEASE

- Stage 1 with normal or high **GFR** ( $\text{GFR} > 90$  ml/min)
- Stage 2 Mild CKD (**GFR** = 60-89 ml/min)
- Stage 3 Moderate CKD (**GFR** = 30-59 ml/min)
- Stage 4 Severe CKD (**GFR** = 15-29 ml/min)
- Stage 5 End Stage CKD (**GFR** <15 ml/min)

# KIDNEY FUNCTION REMAINING

## Stage I & II



> 90%    90 - 60%

### *Decreased Kidney Function*

- No symptoms observed
- Urea and creatinine are normal

## Stage III



60% - 30%

### *Kidney Insufficiency*

- More symptoms occurred
- Rising creatinine level, excess urea, anemia

## Stage IV



30% - 15%

### *End-Stage Renal Disease*

- Renal function severely impaired
- Elevated urea and creatinine

## Stage V



< 15%

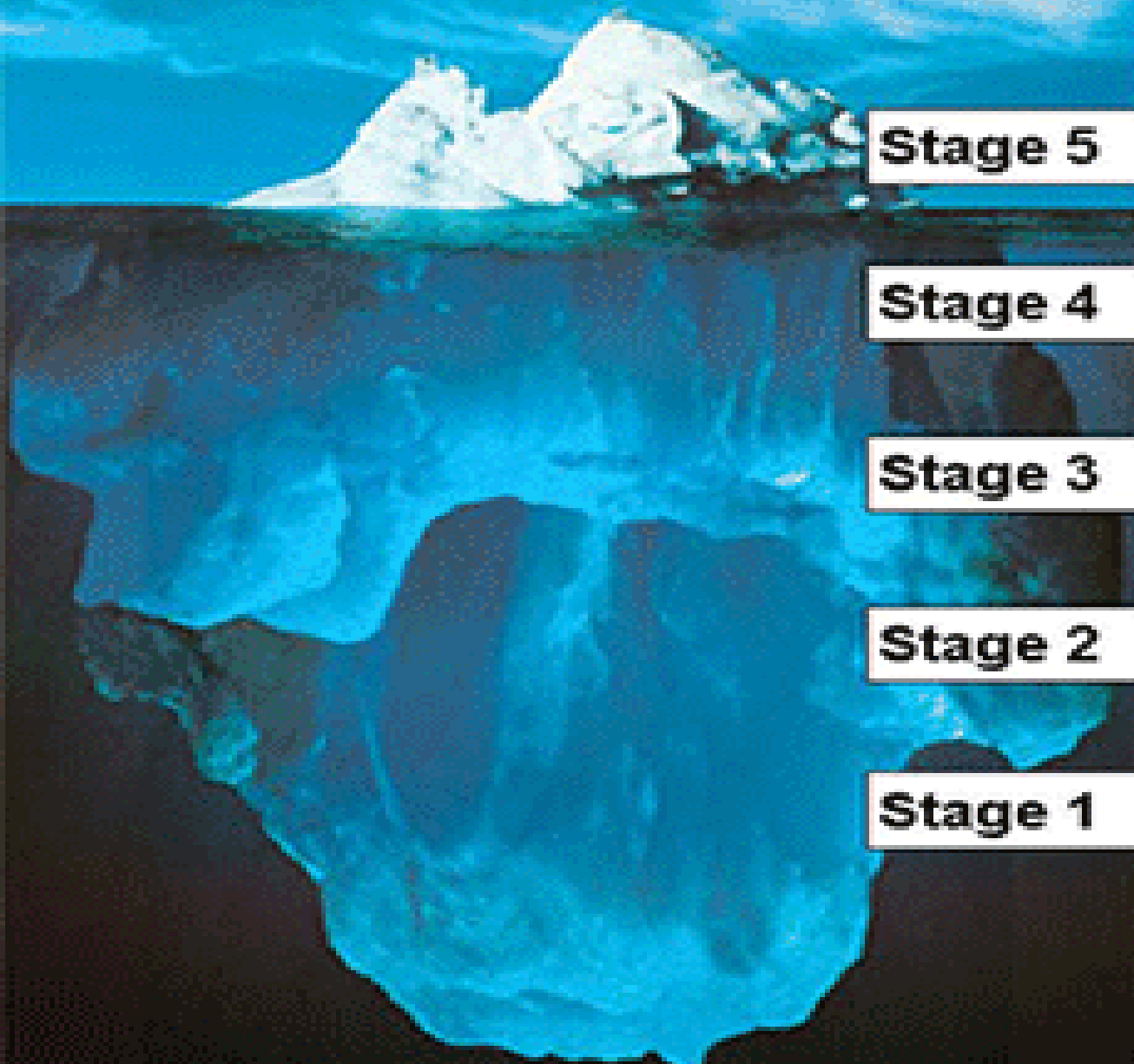
# Stages of Chronic Kidney Disease –NKF-K/DOQI

Stage	Description	GFR (ml/min/1.73 m <sup>2</sup> )
<p><b>1</b> KIDNEY DAMAGE WITH NML OR INCREASED GFR</p> <p>GFR <math>\geq 90</math></p> <p>DX/RX OF UNDERLYING CONDITION AND COMORBIDITIES</p>	<p><b>2</b> MILD</p> <p>GFR 60 TO 89</p> <p>ESTIMATE THE RATE OF PROGRESSION</p>	<p><b>3</b> MODERATE</p> <p>GFR 30 TO 59</p> <p>EVALUATE AND TREAT COMPLICATIONS</p>
	<p><b>4</b> SEVERE</p> <p>GFR 15 TO 29</p> <p>PREPARE FOR RENAL REPLACEMENT THERAPY</p>	<p><b>5</b> KIDNEY FAILURE</p> <p>GFR <math>&lt; 15</math> OR DIALYSIS</p> <p>DIALYSIS OR TRANSPLANTATION IF UREMIC</p>

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# Kidney Failure is the Tip of the Iceberg...



## Prevalence of Chronic Kidney Disease (CKD):

Kidney Failure/End-stage kidney disease (GFR <15): 400,000

Stage 5

GFR 15–29:  
300,000

Stage 4

GFR 30–59:  
7,400,000

Stage 3

Kidney damage & GFR 60–89:  
5,700,000

Stage 2

Kidney damage & GFR >90:  
5,600,000

Stage 1

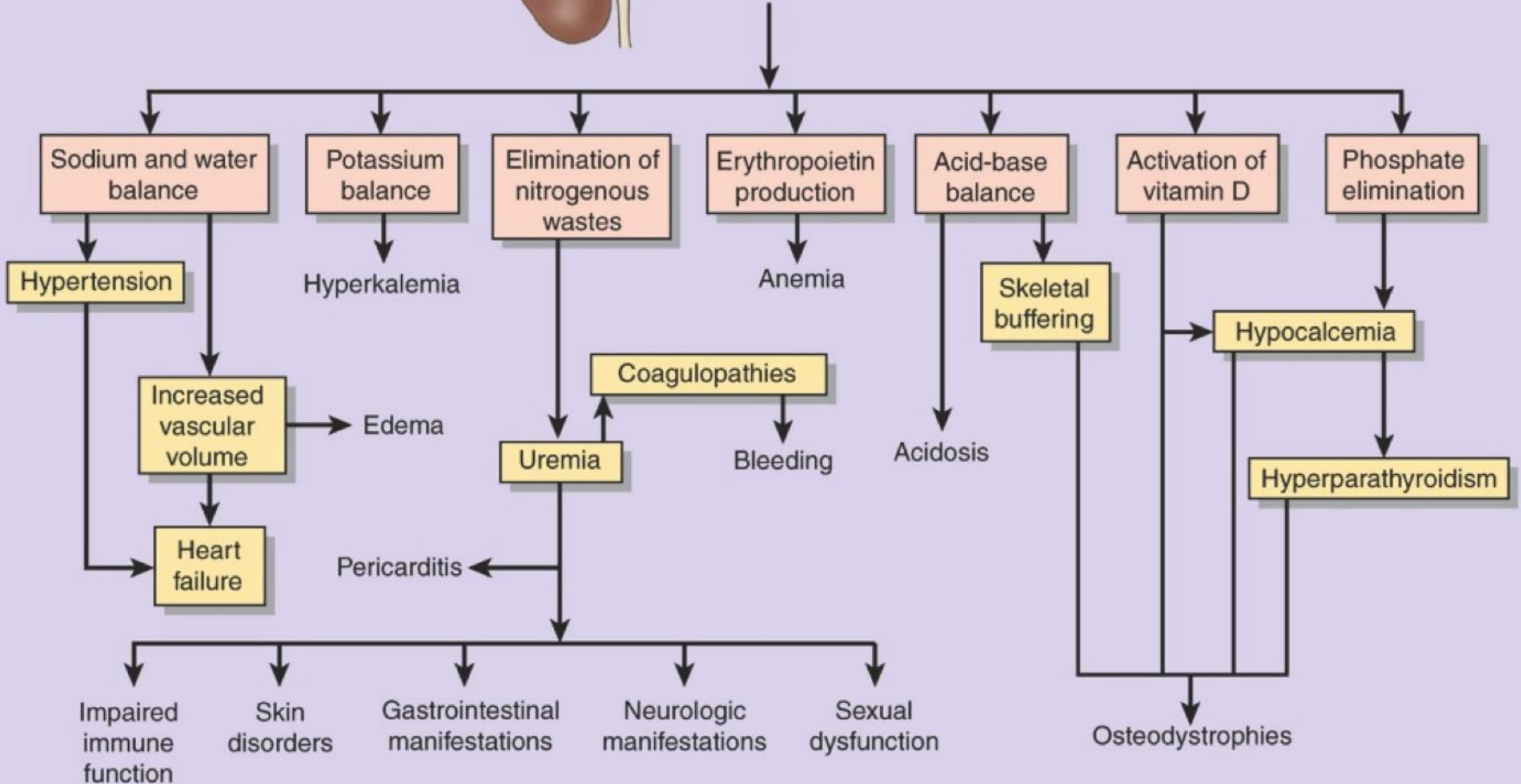
**19 million Americans with CKD**

**8 million Americans with GFR <60**





# Chronic kidney disease



# Chronic kidney disease-symptoms

## Electrolytes

Edema,

Hyponatremia

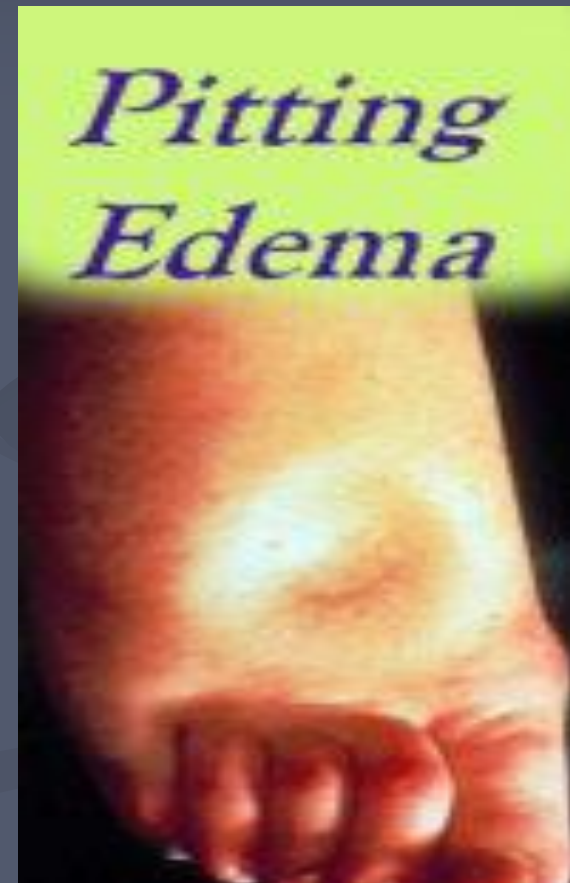
Hyperkalemia

Metabolic acidosis

Hyperuricemia

Hyperphosphatemia

Hypocalcemia

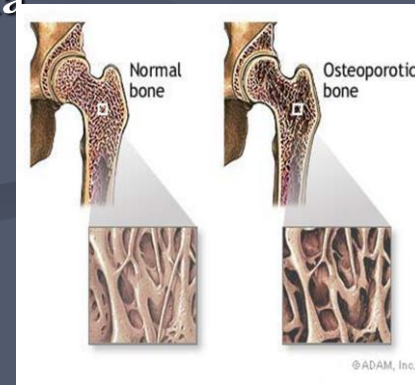


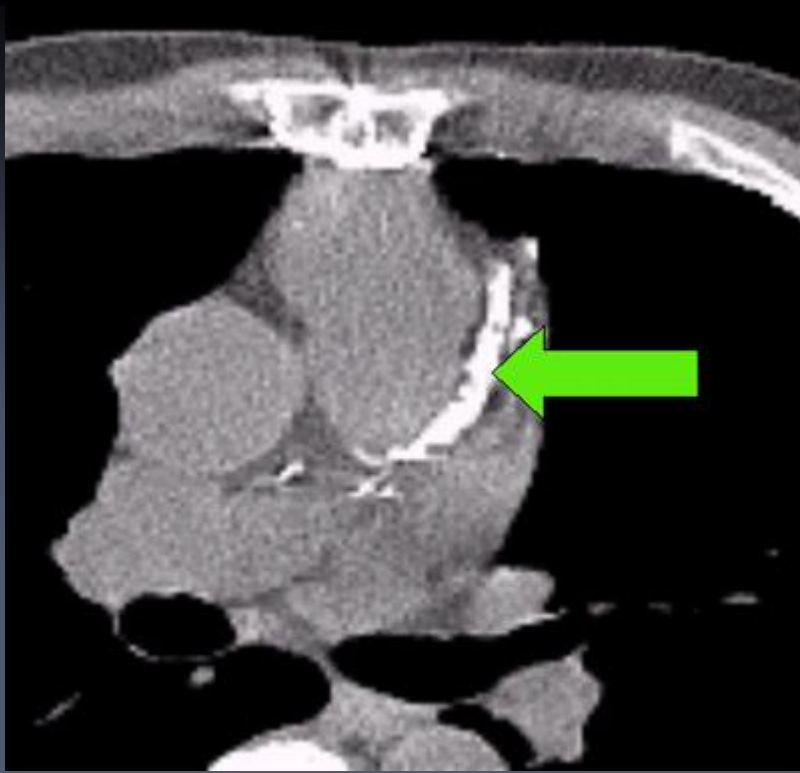
# Chronic kidney disease-symptoms

- **CNS:** confusion, inability to concentrate, fatigue, asterixis, restless leg syndrome, sensory and motor neuropathy
- **CVS:** CHF, hypertension with target organ damage left ventricular hypertrophy, retinopathy
- **GI:** nausea, vomiting, anorexia, upper GI hemorrhage, constipation

# Chronic kidney disease --symptoms

- **SKIN:** pruritus, purpura, skin pigmentation or “sallow color”, edema
- **Endocrine:** hyperlipidemia, decreased sex hormone levels, decreased sex drive, menstrual irregularities
- **Hematological:** normocytic anemia, bleeding, impaired cellular immunity
- **MSK:** nocturnal muscle cramping, Renal osteodystrophy, muscle weakness, growth retardation in children, amyloid arthropathy caused by beta2-microglobulin deposition
- **Bones-** Hyperphosphatemia, hypocalcemia and secondary hyperparathyroidism, decreased vitamin D production Renal osteodystrophy, osteitis fibrosa cystica and osteomalacia





Calcification of the left coronary artery in a patient with chronic kidney disease receiving dialysis as seen on a computerized tomography (CT) scan. The extensive deposition of mineral (arrowed) results in a radio-opaque vessel with a density similar to that of bone

**Looser zone (arrow) in the distal fibula  
of a child with renal osteodystrophy**



# Formation of Calcitriol

7-Dehydrocholesterol (in skin)

UV rays

Diet

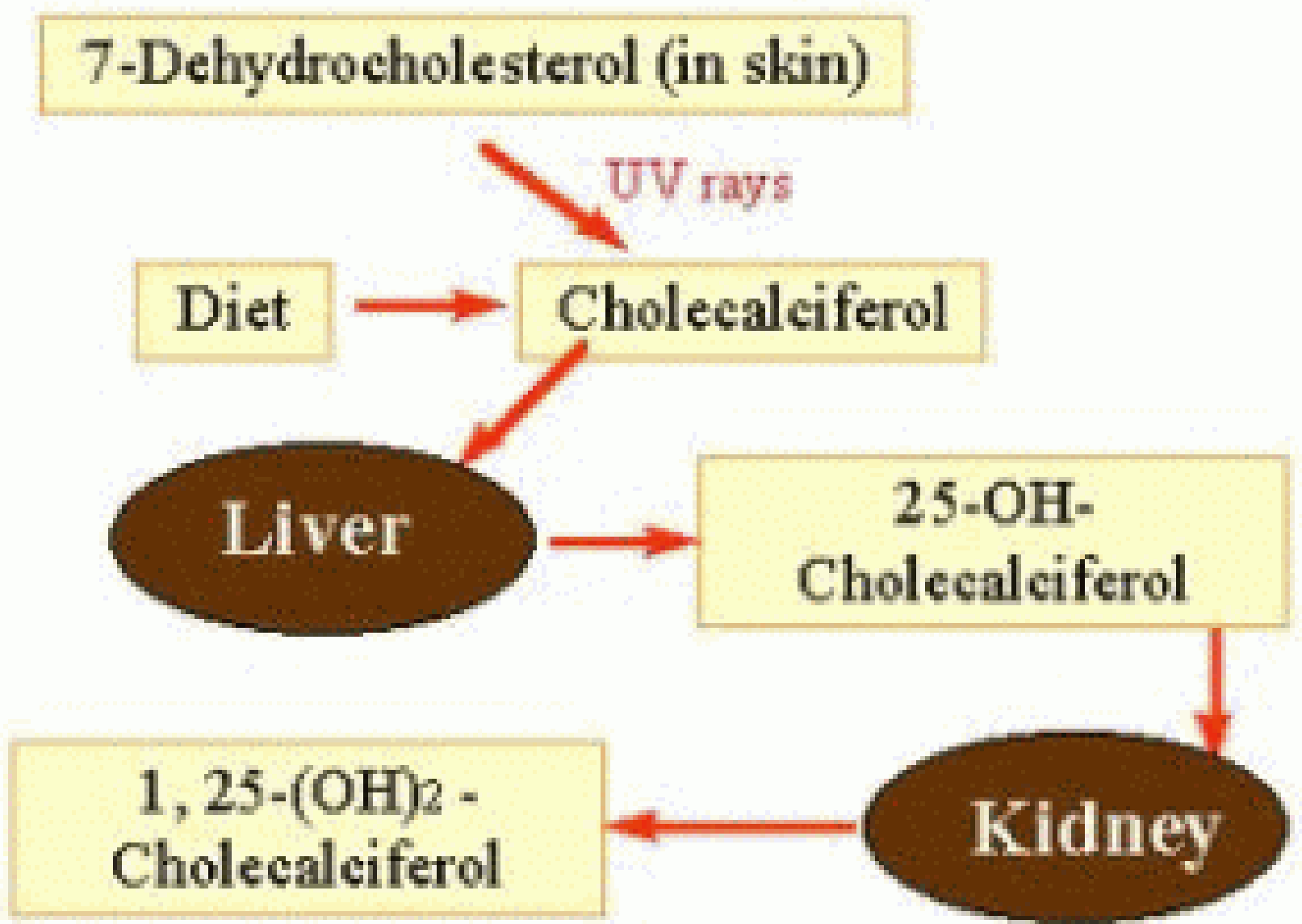
Cholecalciferol

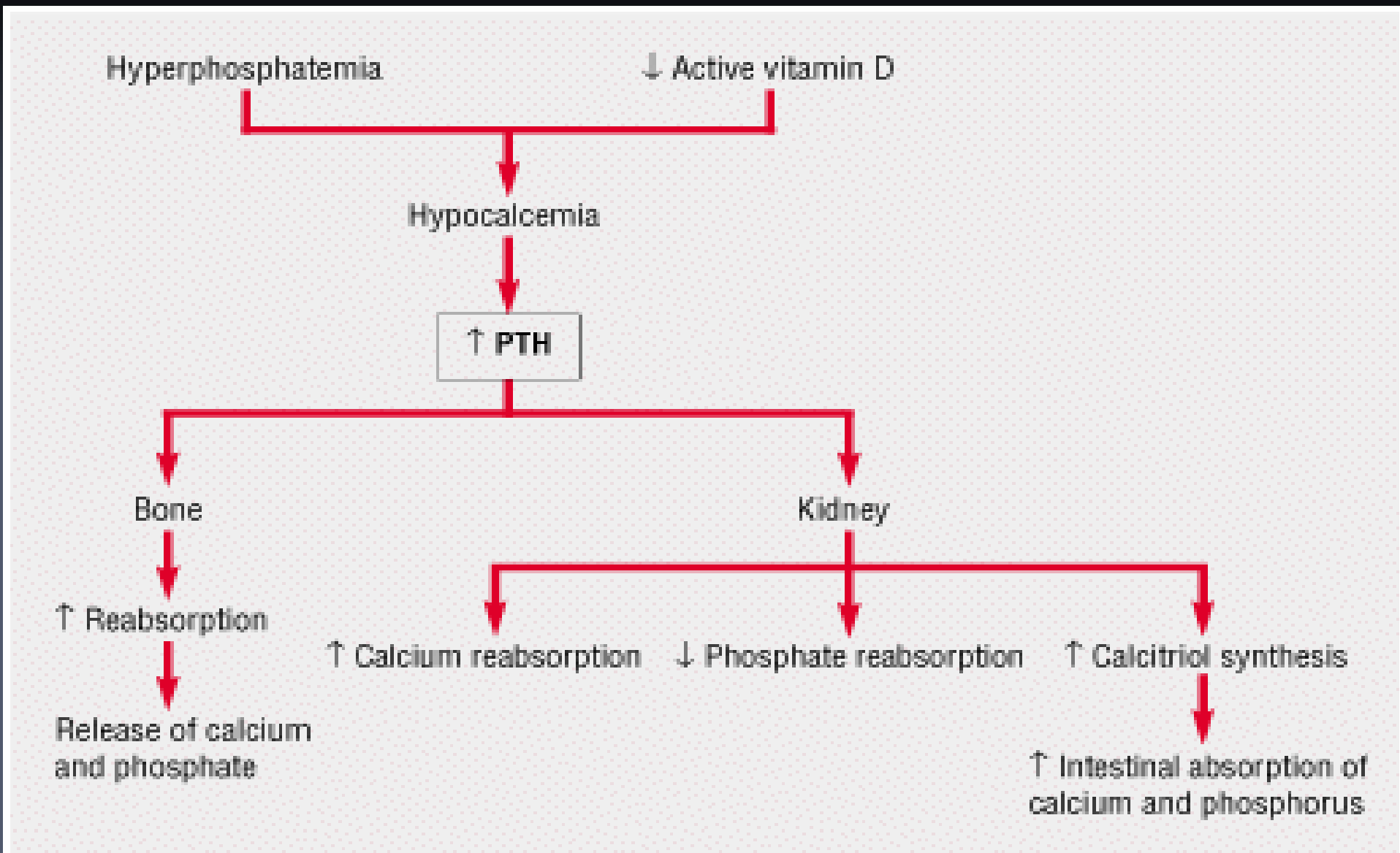
Liver

25-OH-Cholecalciferol

1, 25-(OH)<sub>2</sub> - Cholecalciferol

Kidney



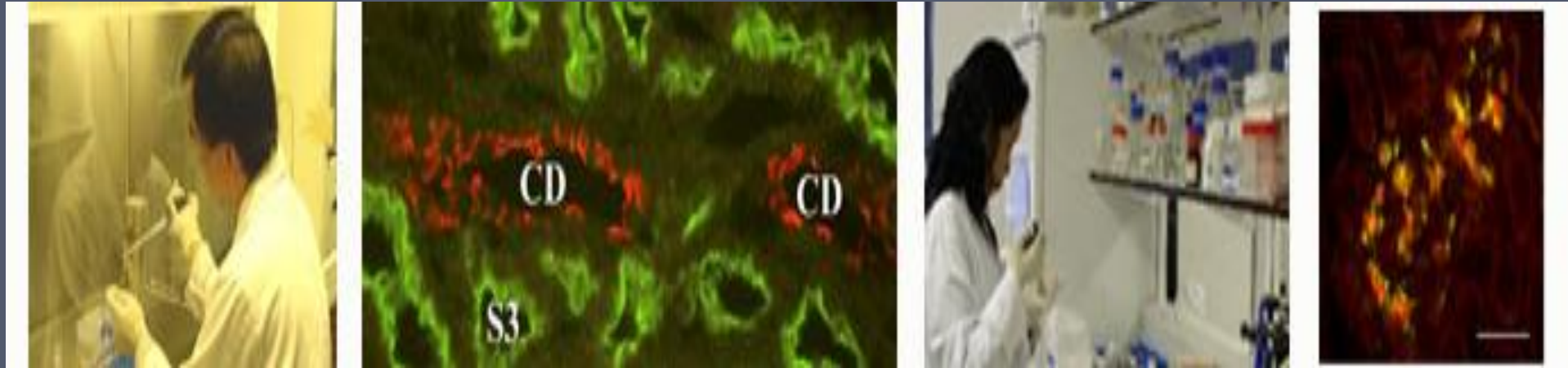


**Figure 1. Abnormalities in metabolism of calcium and phosphorus in patients with chronic kidney disease. PTH, parathyroid hormone.**



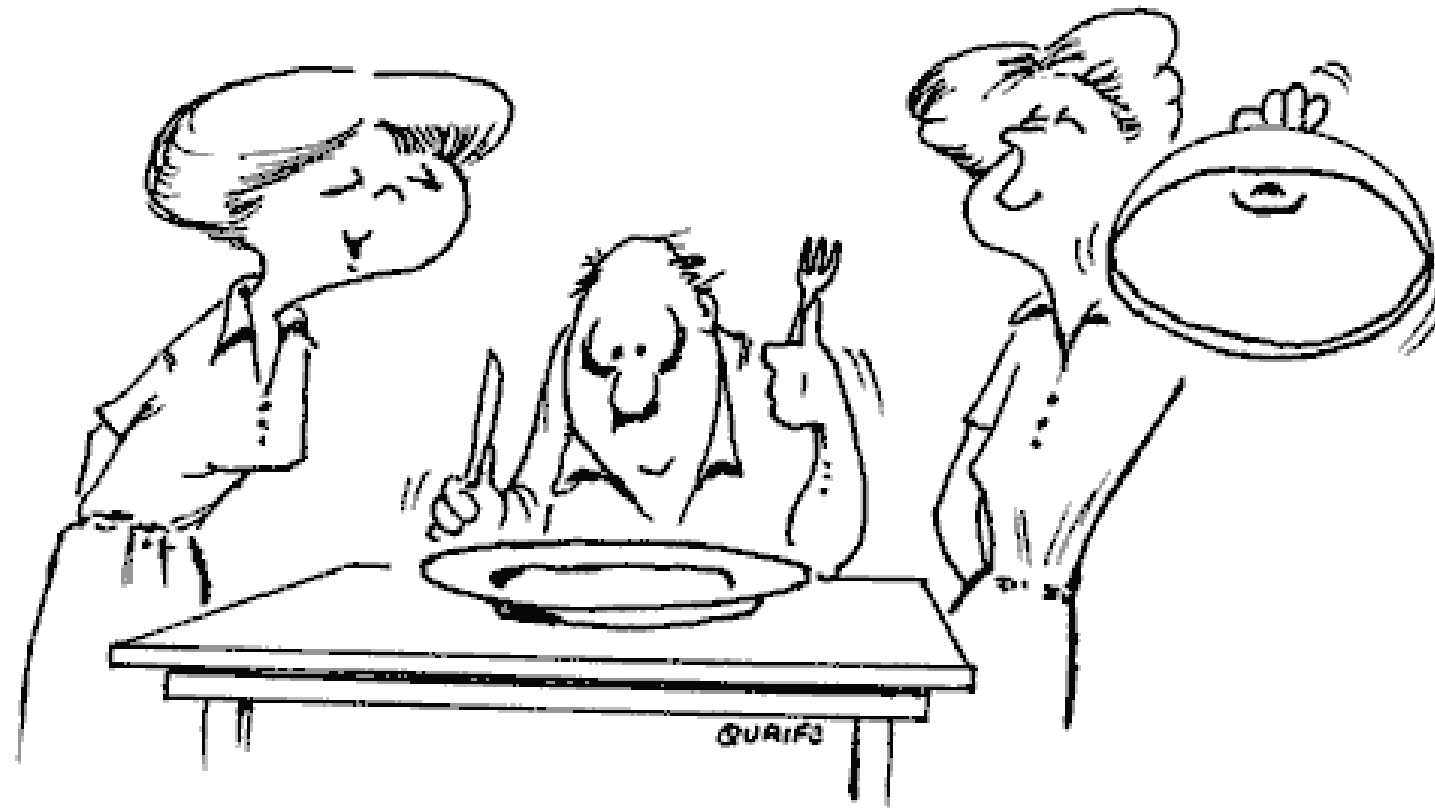
# Exams and Tests

- Urinalysis
  - Creatinine levels progressively increase.
  - BUN is progressively increased.
  - Creatinine clearance progressively decreases.
- Potassium test
  - Arterial blood gas
  - blood chemistry
  - Abdominal CT scan
  - Abdominal MRI

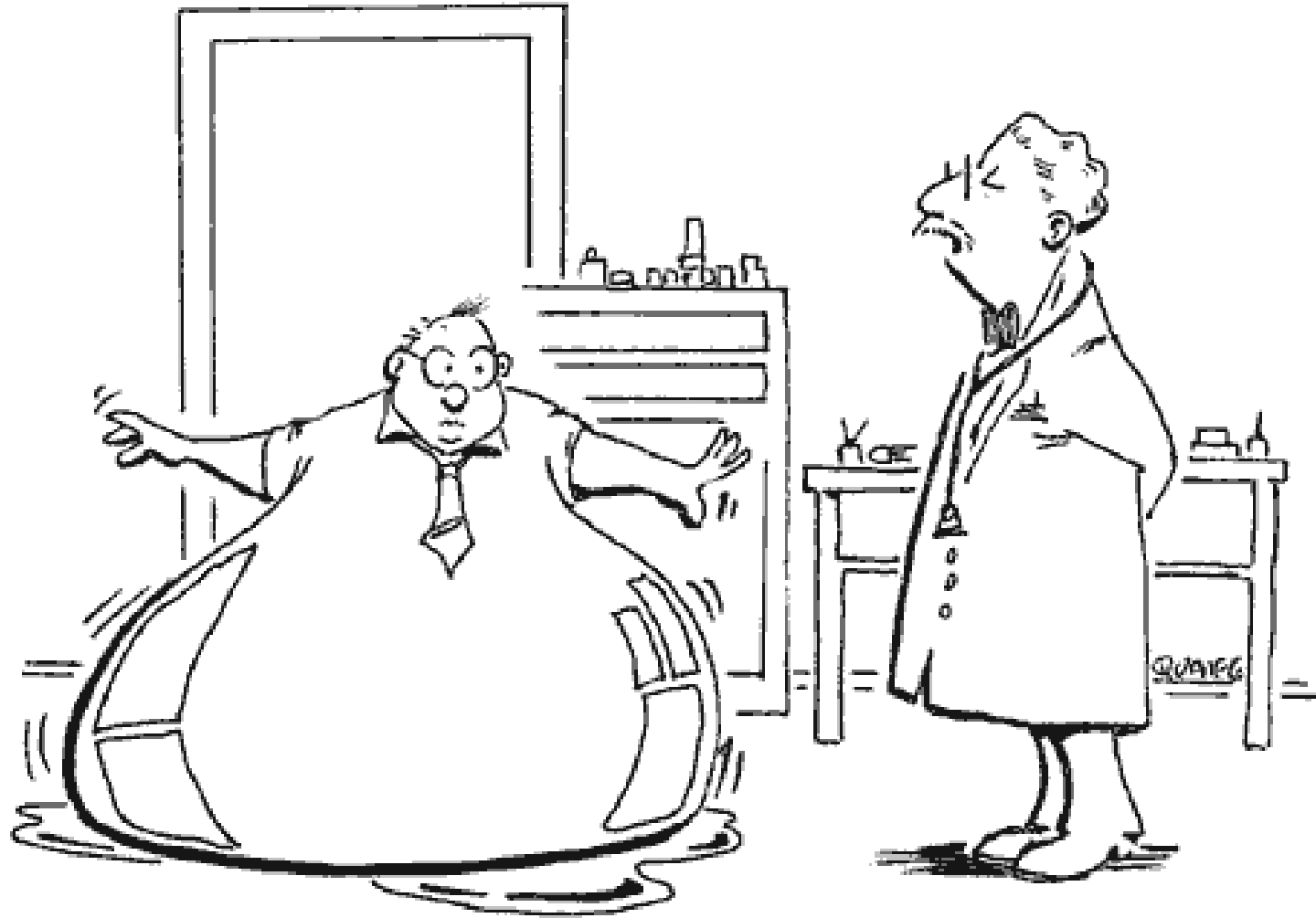


# MANAGEMENT

- Potassium balance:
- Sodium balance:
- Water balance:
- Metabolic acidosis:
- Gastrointestinal complications
- Cardiovascular complications
- Hematologic complications
- Bone disease
- Hyperphosphatemia
- PTH suppression
- Neurologic complications



...and this dish is totally potassium-free!



Your tests reveal that  
you are retaining fluids!

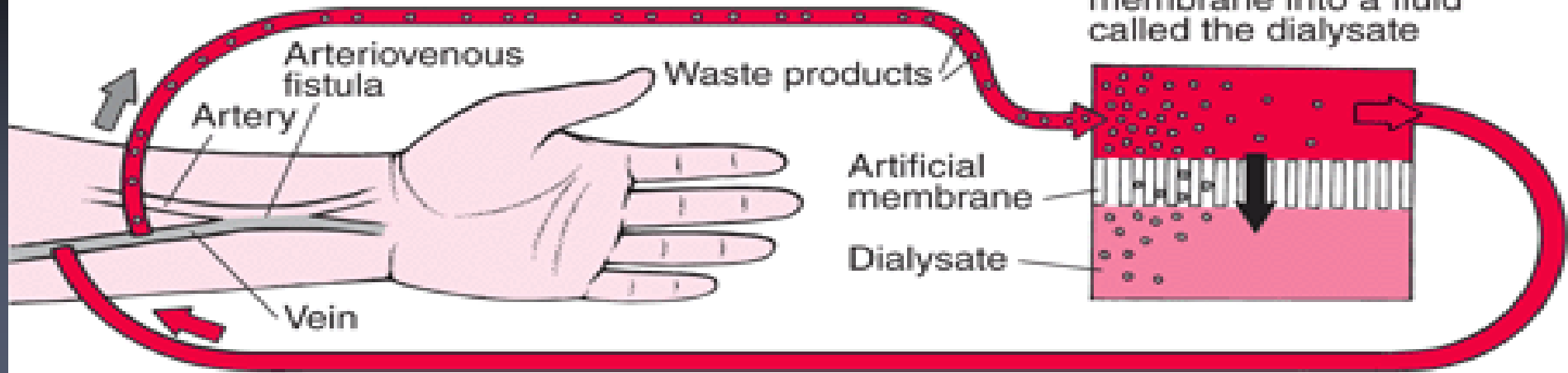


I really feel that you should  
start dialysis immediately!

# HEMODIALYSIS



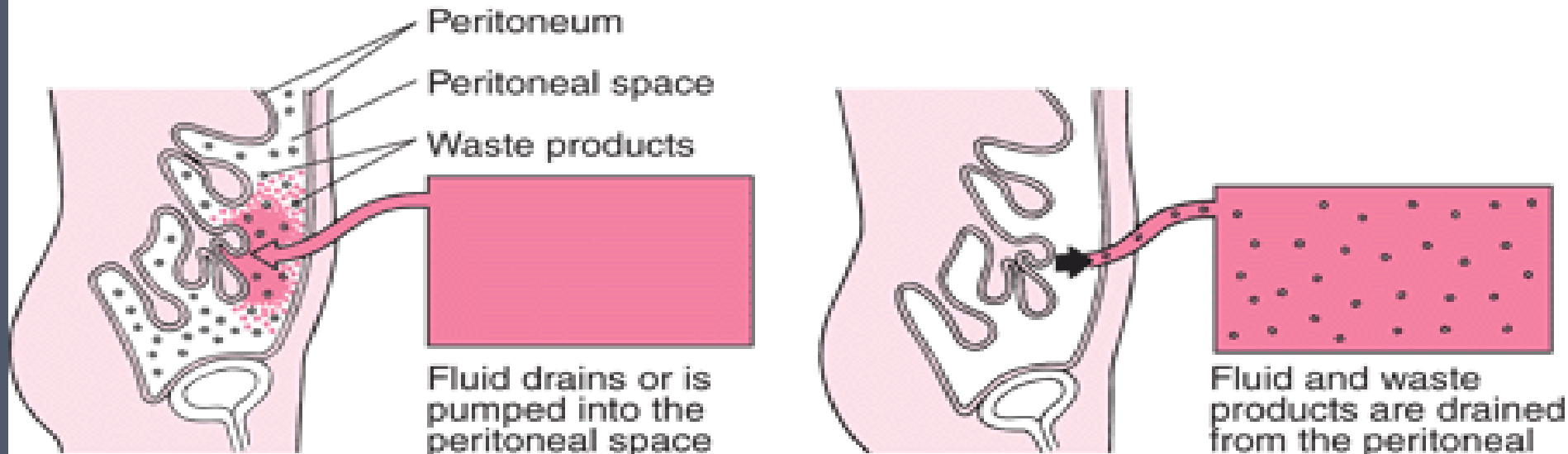
Blood is pumped from the arteriovenous fistula into a dialyzer



In the dialyzer, waste products filter from the blood through an artificial membrane into a fluid called the dialysate

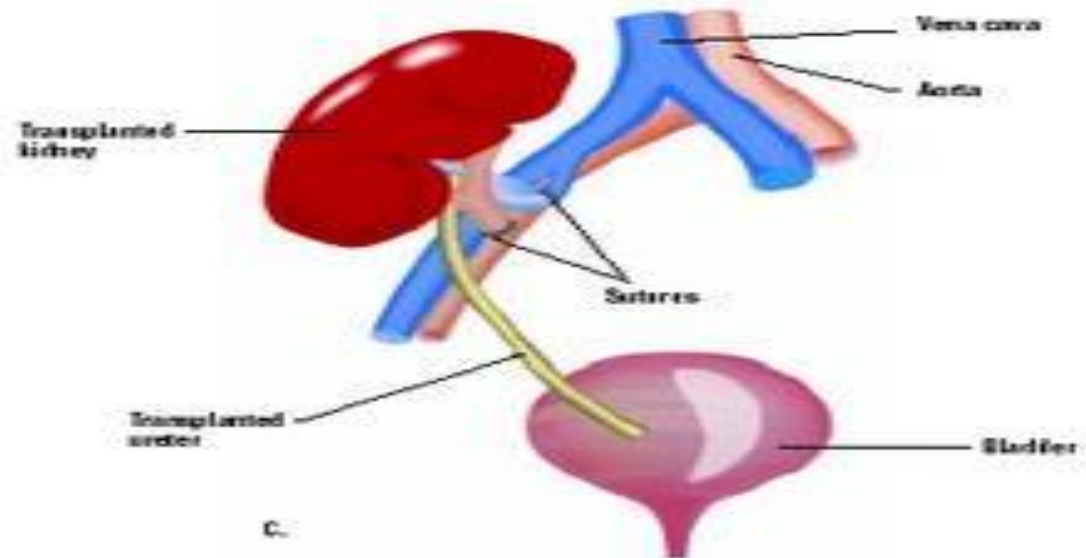
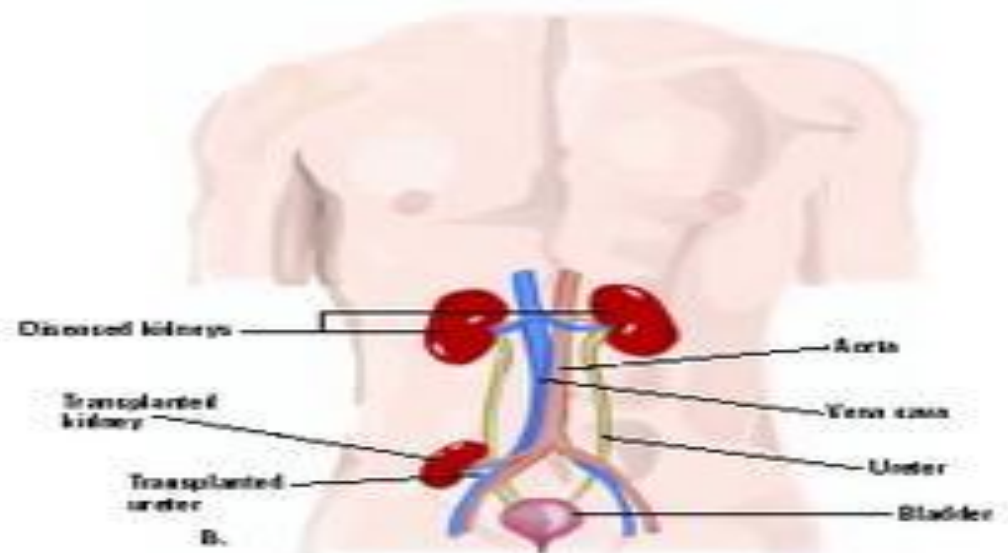
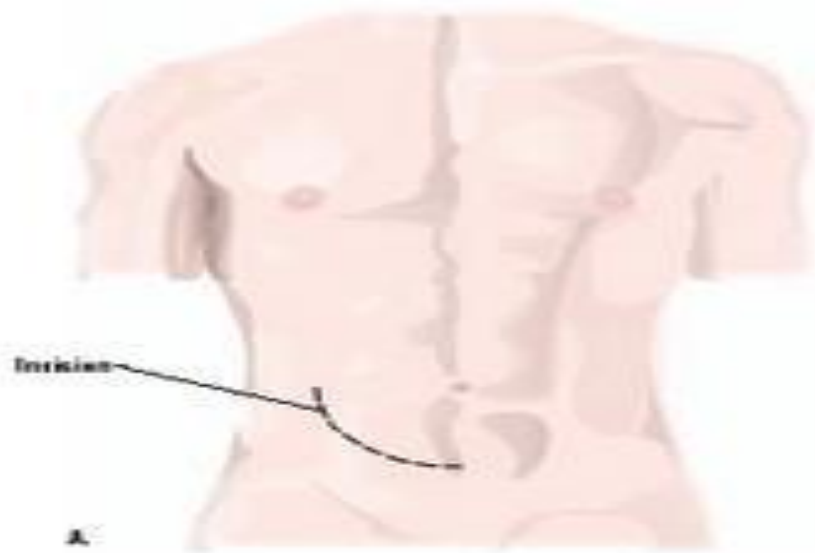
Purified blood is pumped from the dialyzer into the arteriovenous fistula

### Hemodialysis



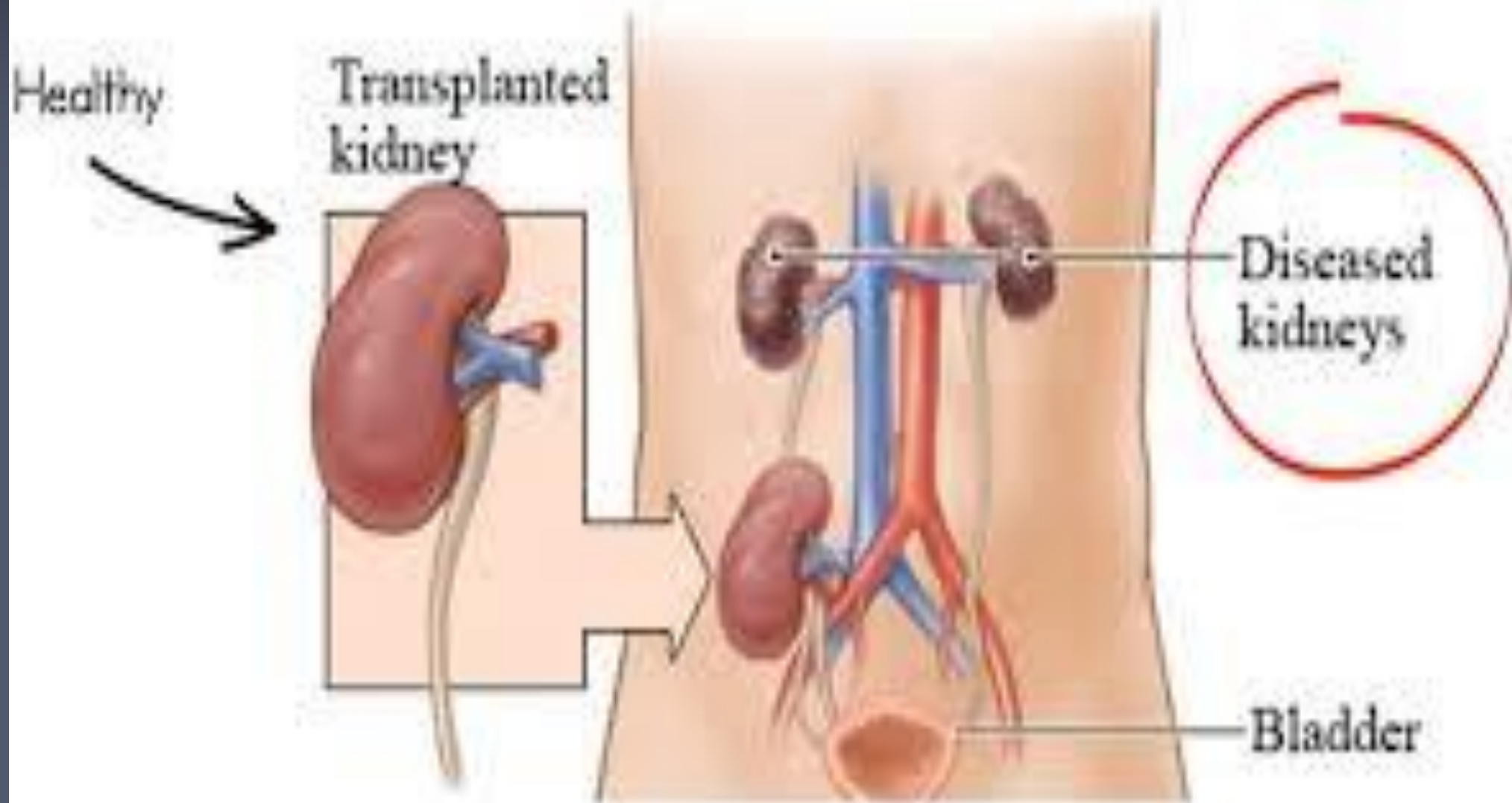
### Peritoneal Dialysis

# Kidney transplantation





# Kidney Transplantation



# Nephrogenic high blood pressure

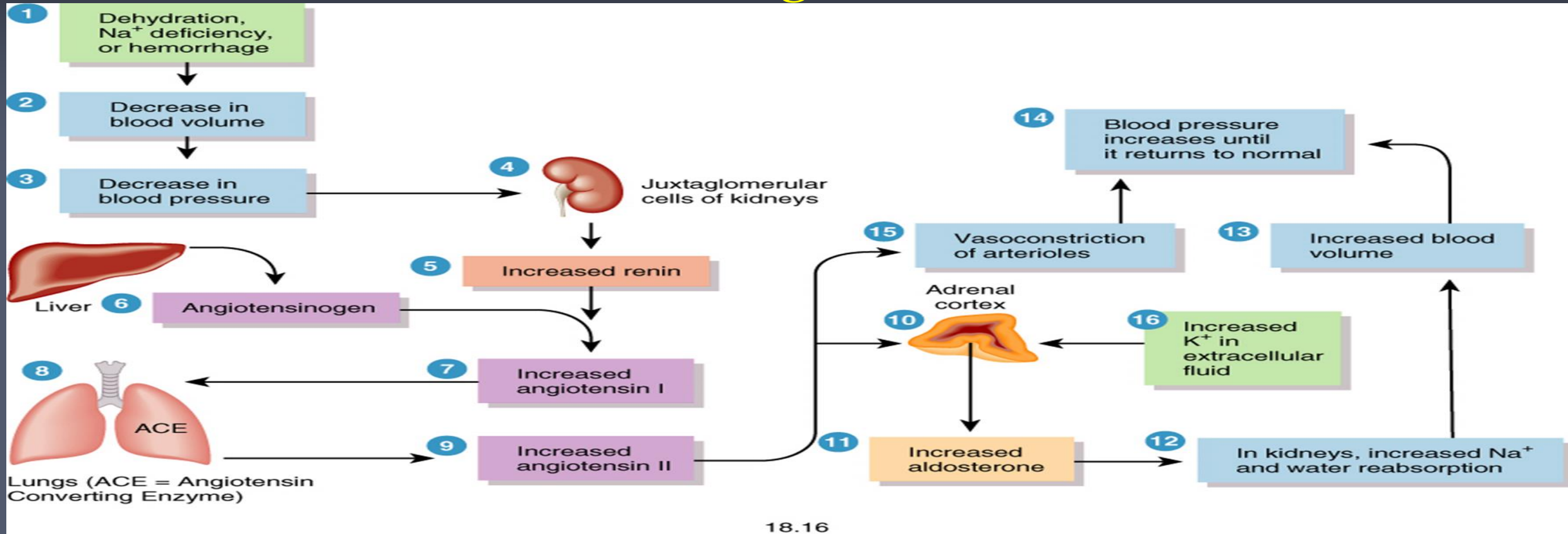
Is hypertension caused by the affection of the kidney or renal vessels

## *Etiology:*

- Renal artery stenosis
- Dehydration
- Atherosclerosis
- Embolism
- Kidney stones
- cancer
- Acute or chronic glomerulonephritis
- Acute or chronic pielonephritis

# Nephrogenic high blood pressure

## Pathogenesis:



18.16

Stenosis of renal vessel → increase renin → increase angiotensin II → vasoconstriction → aldosterone → increase blood volume

Renal hypertension can cause **chronic kidney disease**

# Nephrogenic high blood pressure

## Symptoms

- headache
- confusion
- double vision
- vomiting
- **High** and **persistent** hypertension affects the heart
- Heart pain like angina pectoris
- Cardiac asthma
- Lung edema
- Clinical signs of kidney disease that caused hypertension

# Nephrogenic high blood pressure

## Diagnosis:

- Xray
- Blood test
- Urine test
- biopsy
- CT
- Angiography
- Electrocardiographically -  
deviation of the heart's electrical axis to the left, a certain increase in the R1 wave, and later descent of the ST1 segment below the zero line, and the negative or two phase T1,2 wave
-

# Nephrogenic high blood pressure-treatment

Medications are used first to try to control high blood pressure in renal hypertension. The most important blood pressure medications to treat renal hypertension include:

- **ACE inhibitors** (angiotensin converting enzyme inhibitors)-[ramipril](#), [benazepril](#), [captopril](#), [lisinopril](#)...
- **ARBs** (angiotensin II receptor blockers). Examples include [candesartan](#), [losartan](#), [olmesartan](#), [valsartan](#).

In some people with renal hypertension due to narrowing of the renal artery, even taking three or more medications every day may not adequately control blood pressure. In these situations, a procedure to improve blood flow to the kidneys may help. Possible procedures include:

- **Angioplasty.** A doctor threads a catheter through a large artery in the groin and advances it into the renal artery. A balloon is then inflated for a few moments. This widens the artery and improves blood flow.
- **Stenting.** During angioplasty, a wire-mesh stent can be expanded inside the renal artery. The stent stays in place. This keeps the artery open after the balloon is removed. Research, however, has not shown that stenting is more effective than medication for renal hypertension.

# Clinical situation

Your patient is 64 years old and complains of weakness, dyspnea, and fatigue. She has a history of renal failure but missed dialysis this week. Her face, hands, and feet are swollen. Her blood pressure is 190/110 mm Hg, pulse is irregular; there are moist crackles in the bases of the lungs; and her ECG shows peaked T waves.

# Discussion

- What is the most likely explanation for this patient's symptoms?
- Discuss whether furosemide would or would not be appropriate to give her.
- Which electrolyte imbalances do you anticipate in this patient?
- What should you consider if she experiences a cardiac arrest?



THANK YOU

