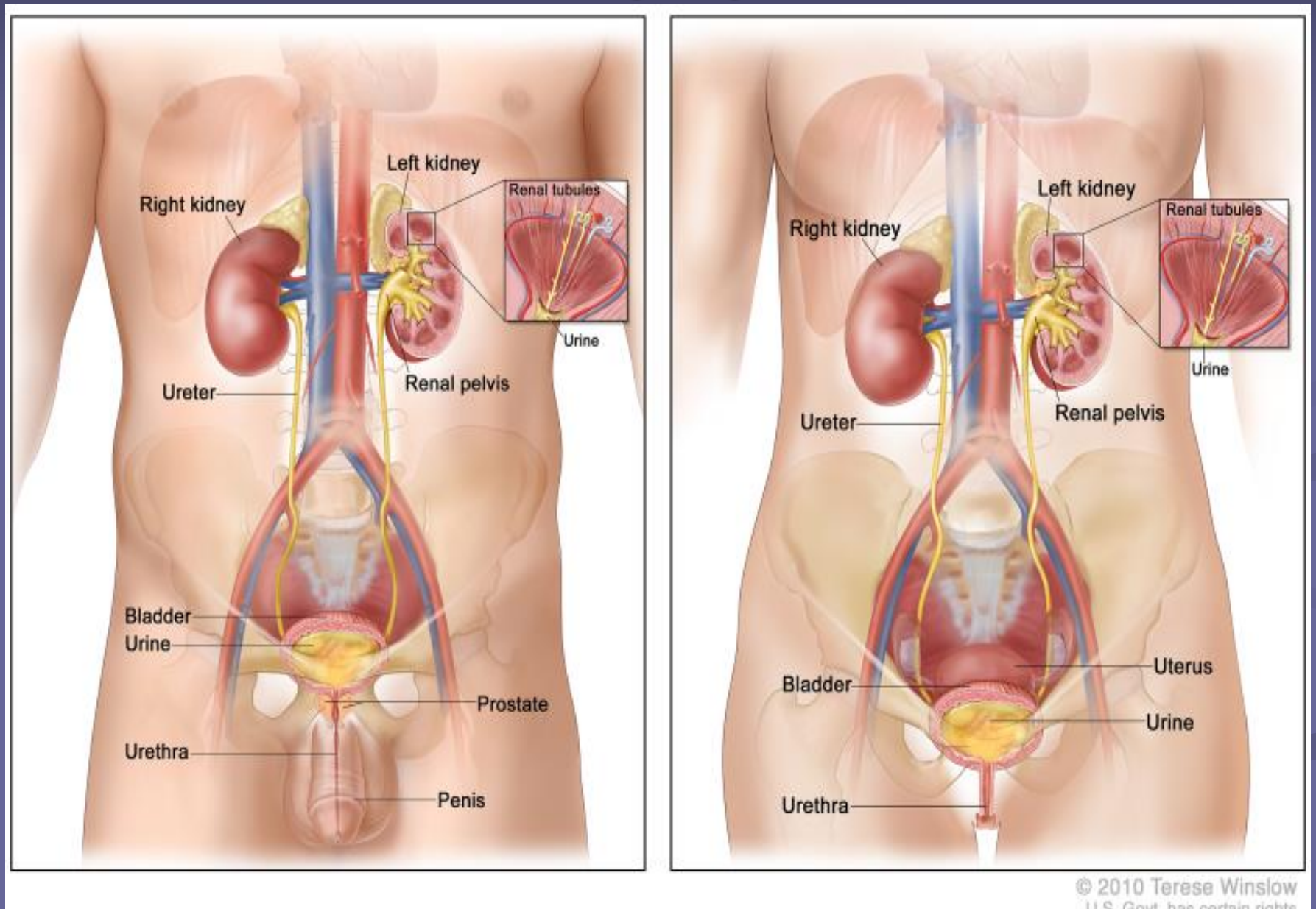
Clinical and paraclinical methods for the examination of patients with kidney and urinary tract disorders

Urinary system



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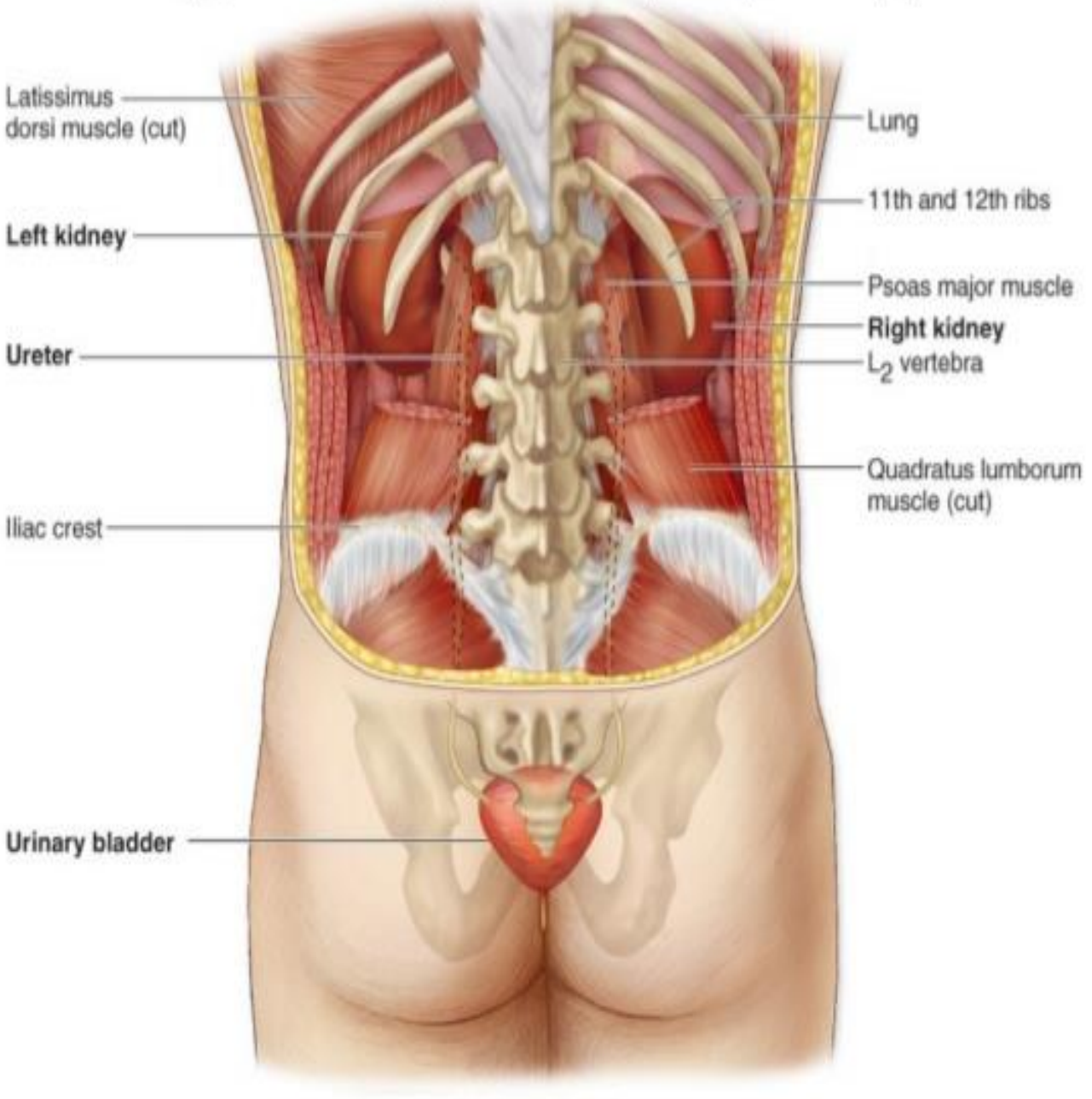
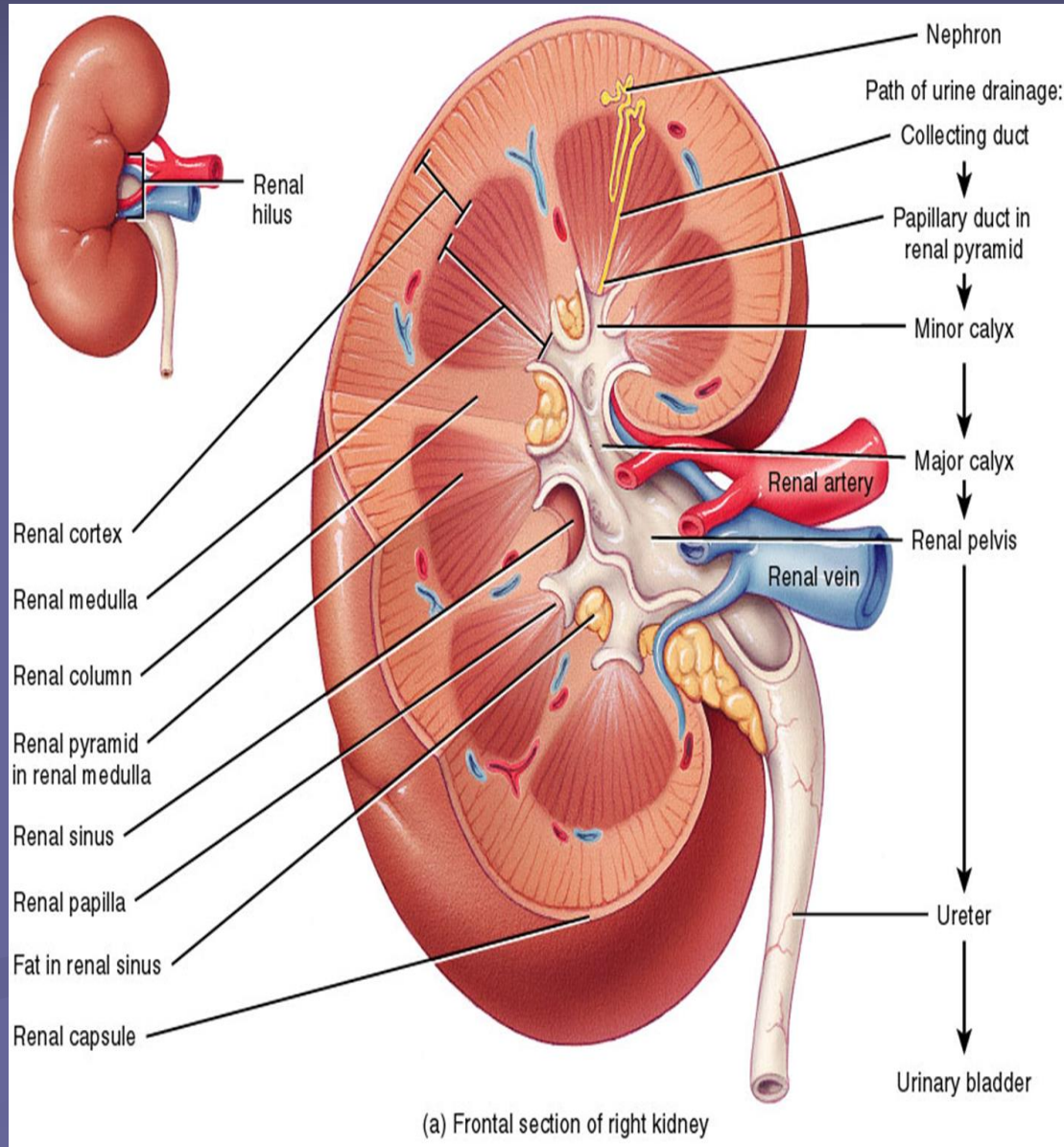


(b) Posterior view

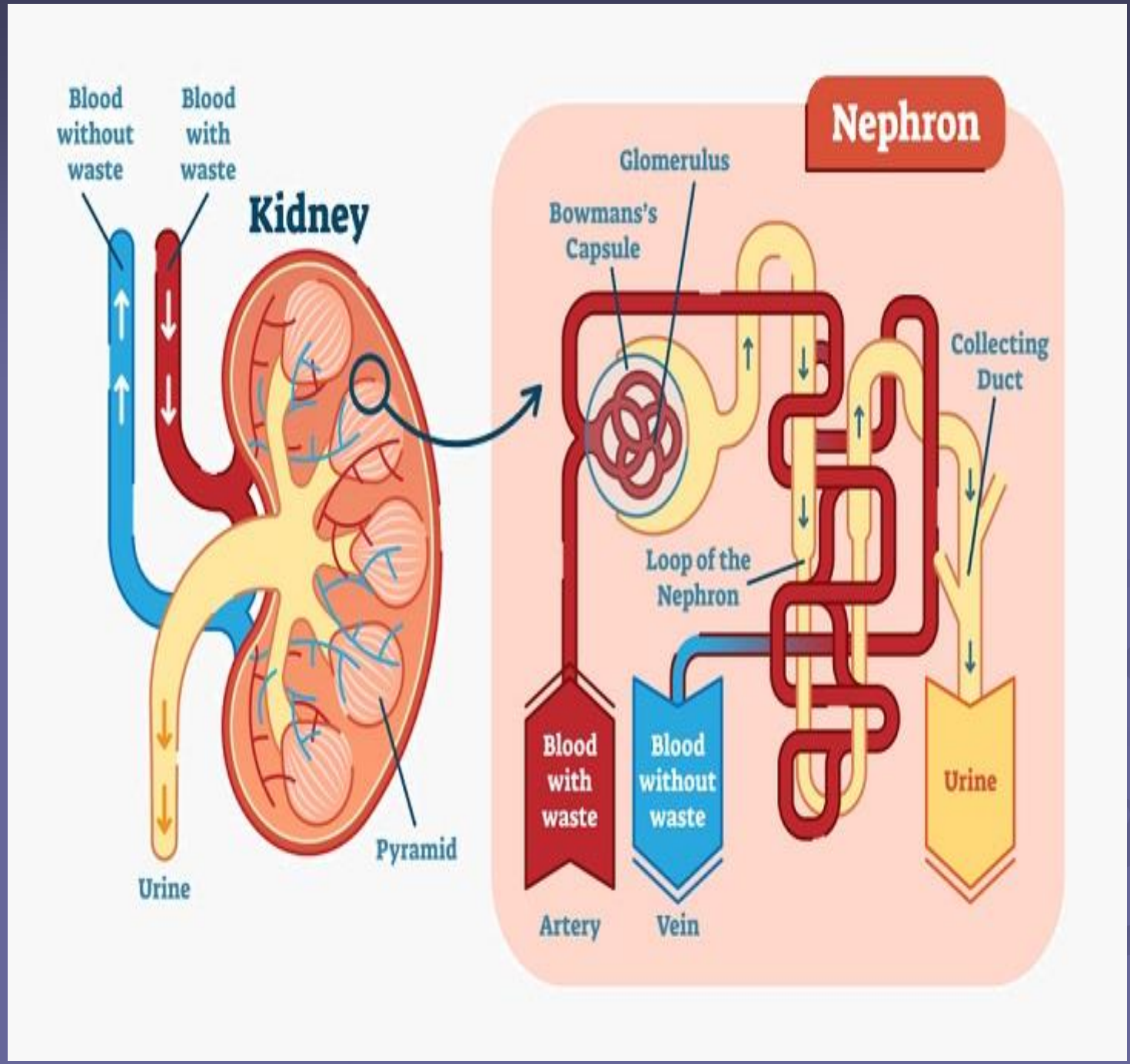
Nephron

- 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**

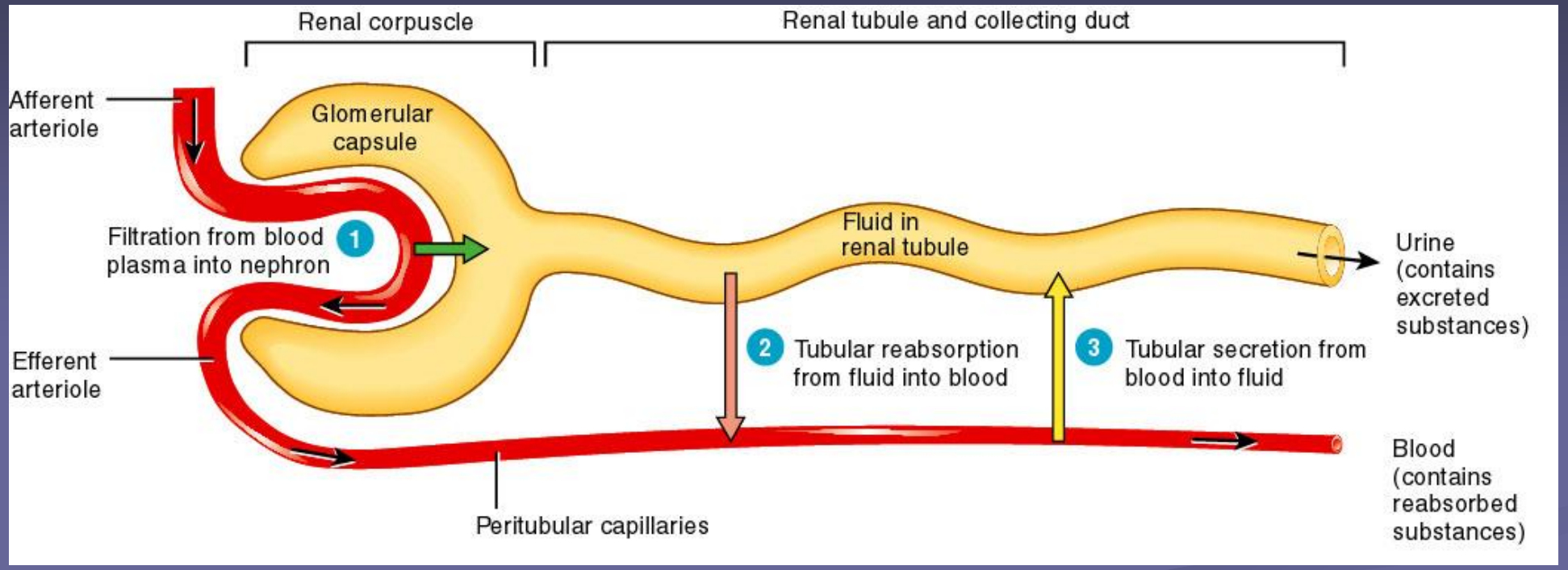


(a) Frontal section of right kidney

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

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 (HCO_3^-), H^+, urea, glucose, amino acidsProximal Convoluted Tubule

Proximal Convoluted Tubule

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

65% of Na+ is reabsorbed
65% of H2O is reabsorbed
90% of filtered bicarbonate (HCO3-)
50% of Cl- and K+

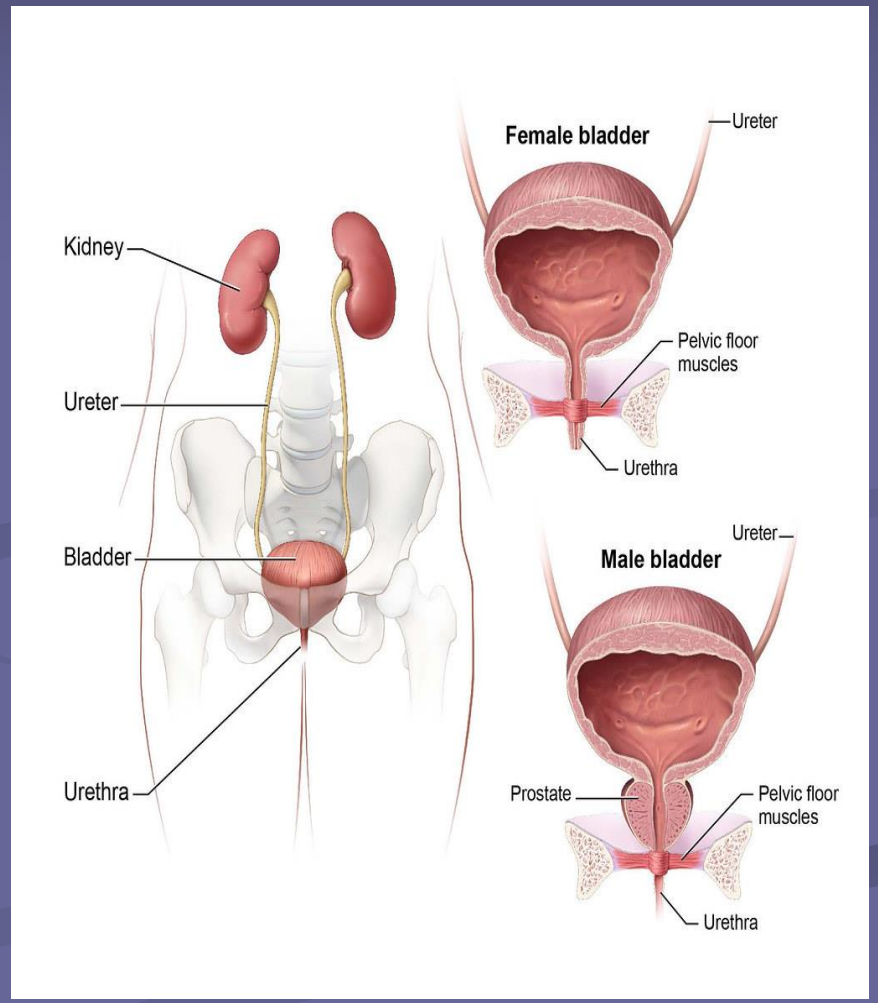
Loop of Henle

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

- ➢25% Na+ is reabsorbed in the loop
- ➢15% water is reabsorbed in the loop
- ➢40% K is reabsorbed in the loop

Bladder

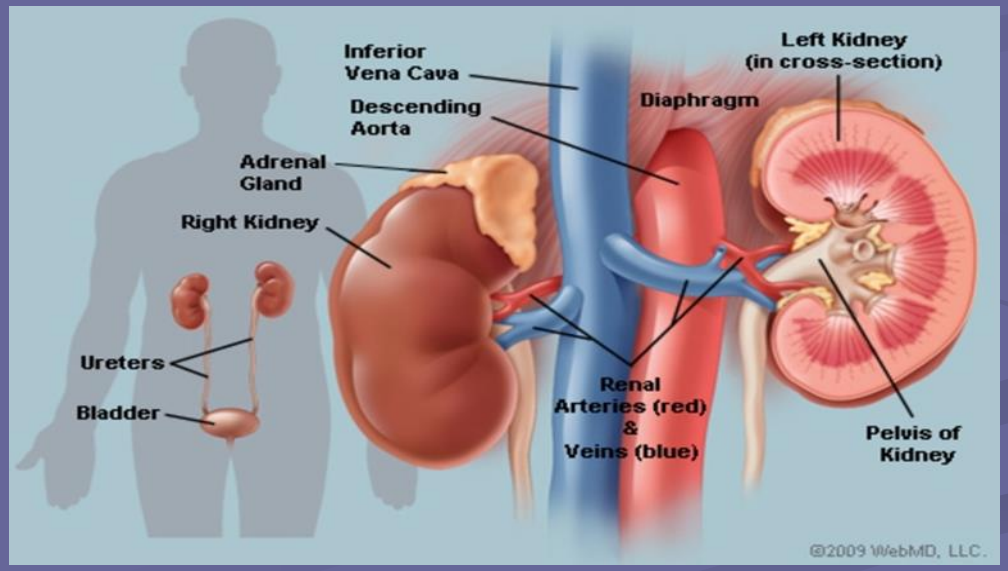
1. Mucosa (transitional epithelium)
2. Muscular layer (detrusor muscle): 3 layers of smooth
3. Fibrous adventia
4. Internal urethral sphinctermuscle
5. External Urethral sphincter



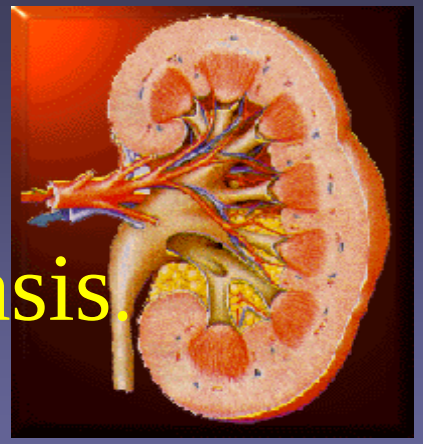
Kidneys

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

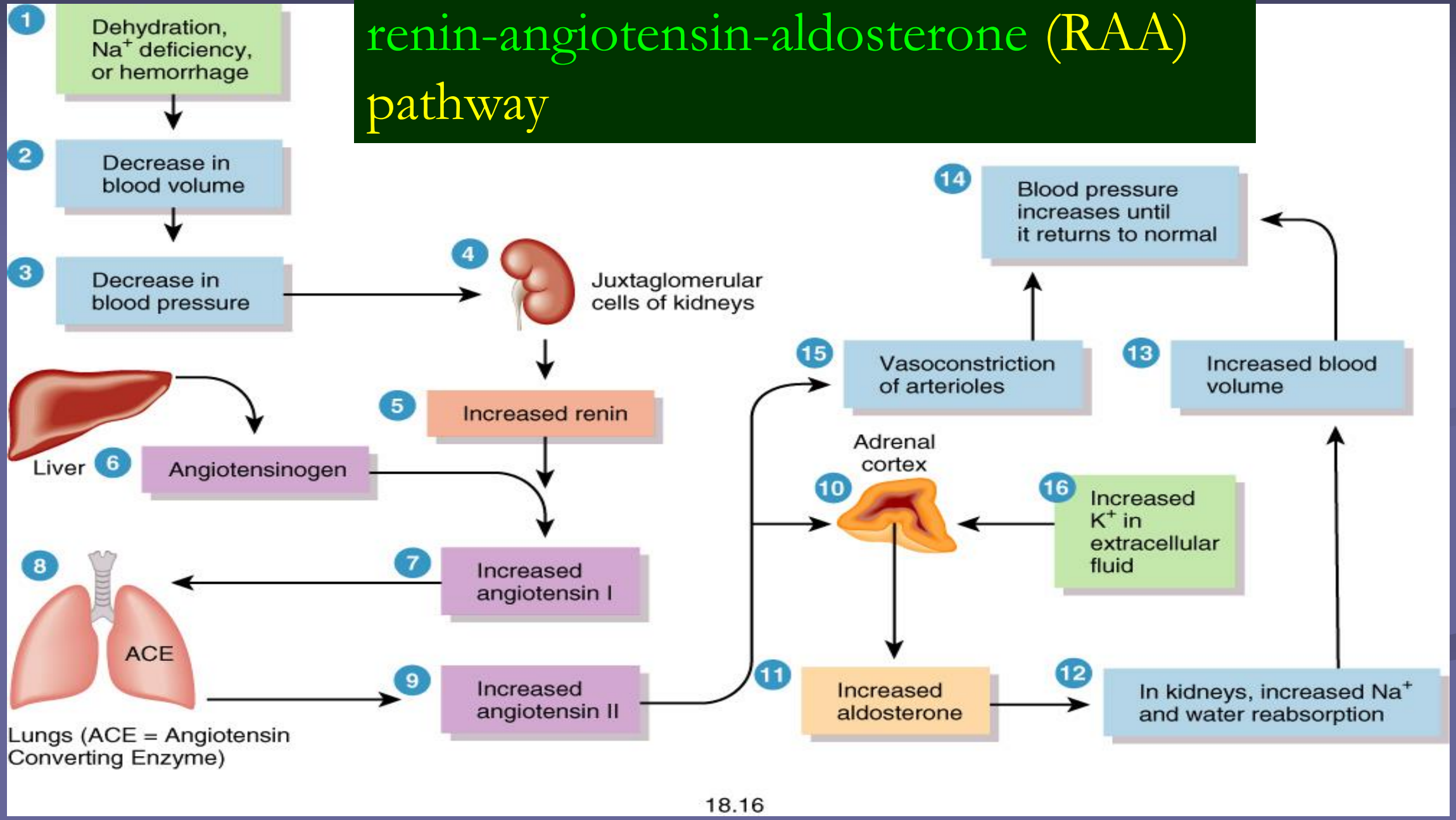
✓ reopening portions of the collecting duct that water cannot normally enter, allowing water back into the body

✓ 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.

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



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Secretion of active compounds

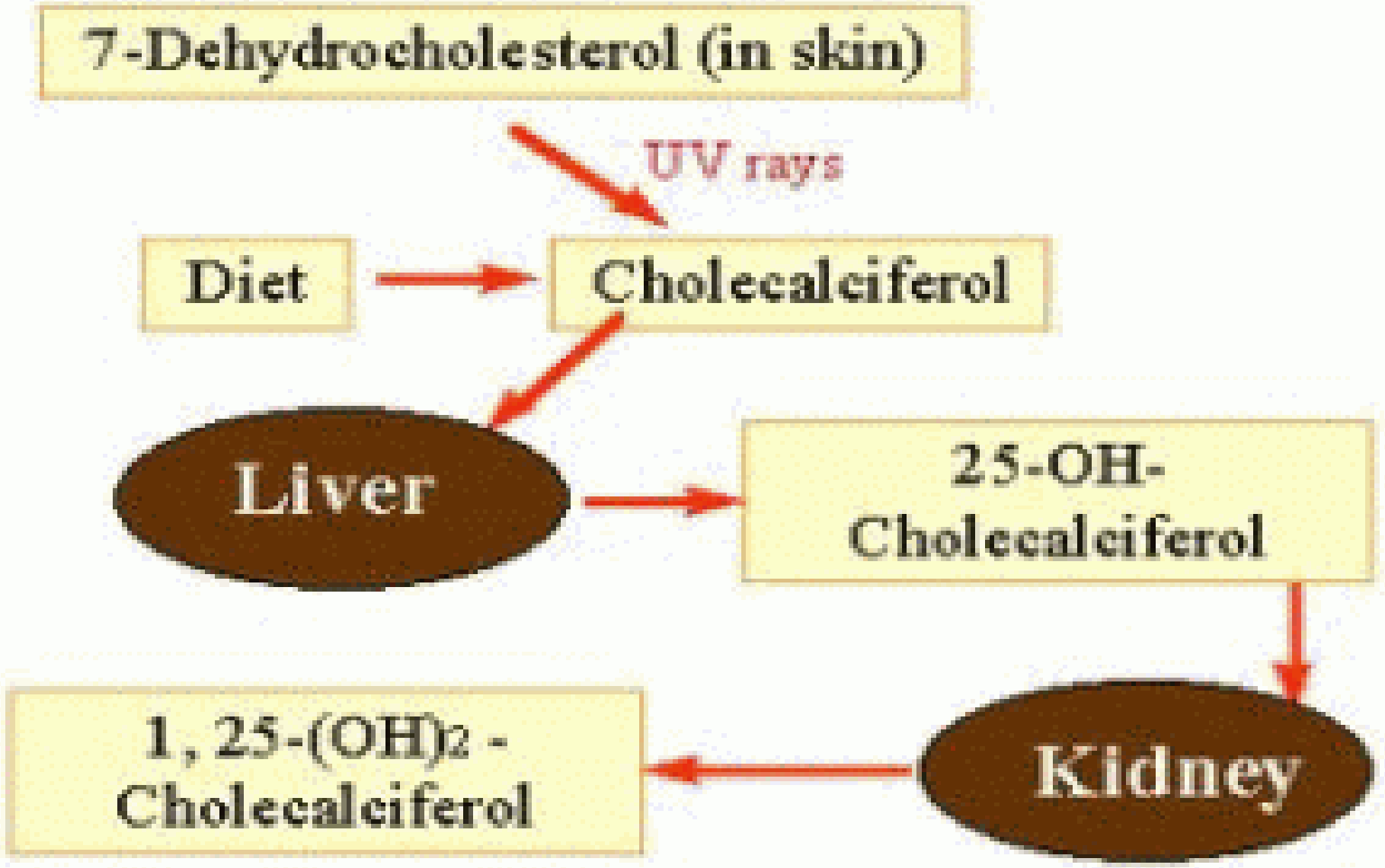
The kidneys release a number of important compounds, including:

- **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.

Formation of Calcitriol



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
- 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

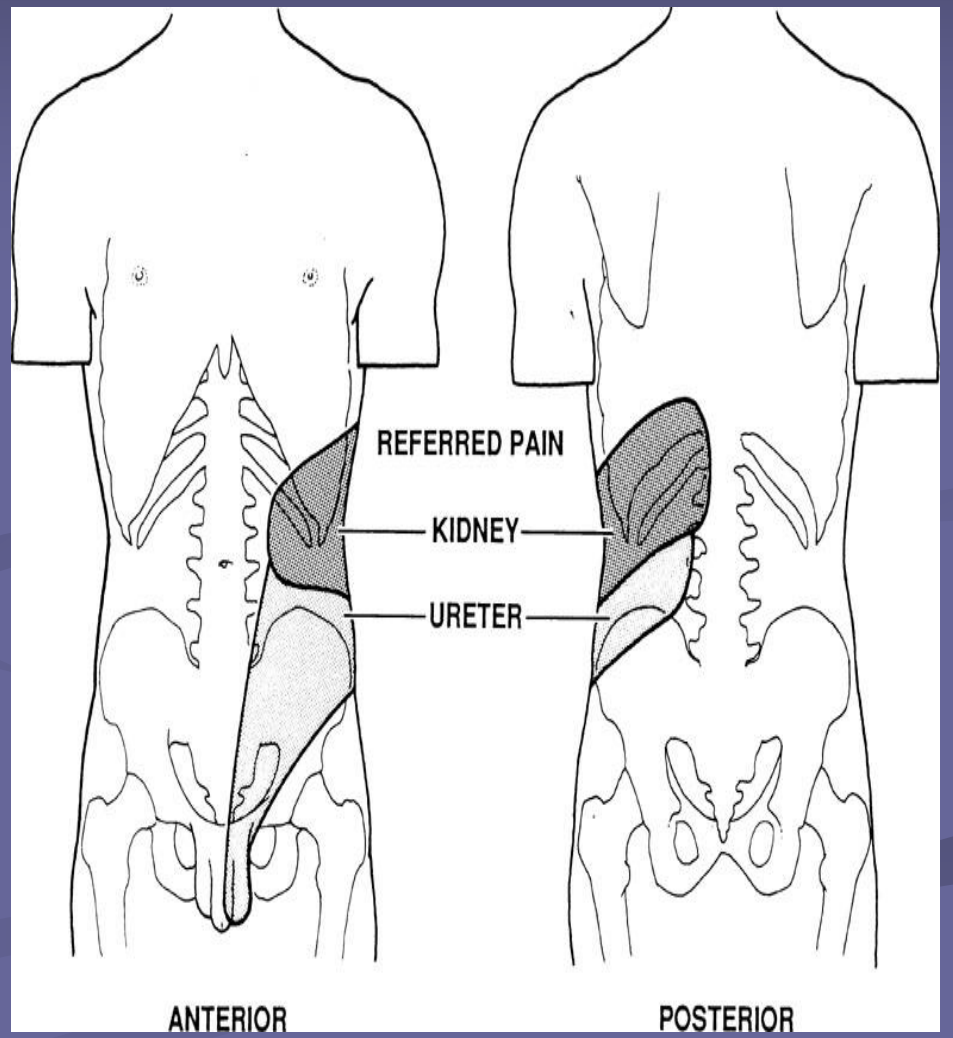
- ***Renal Pain- as a result of*** acute distention of the renal capsule

  - ***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, feverm chills...



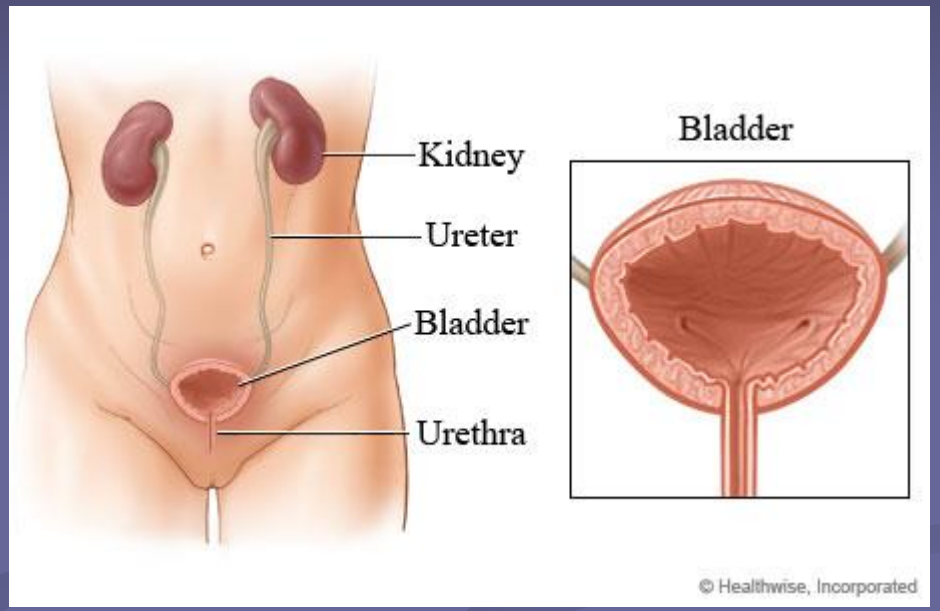
Ureteral pain

- 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

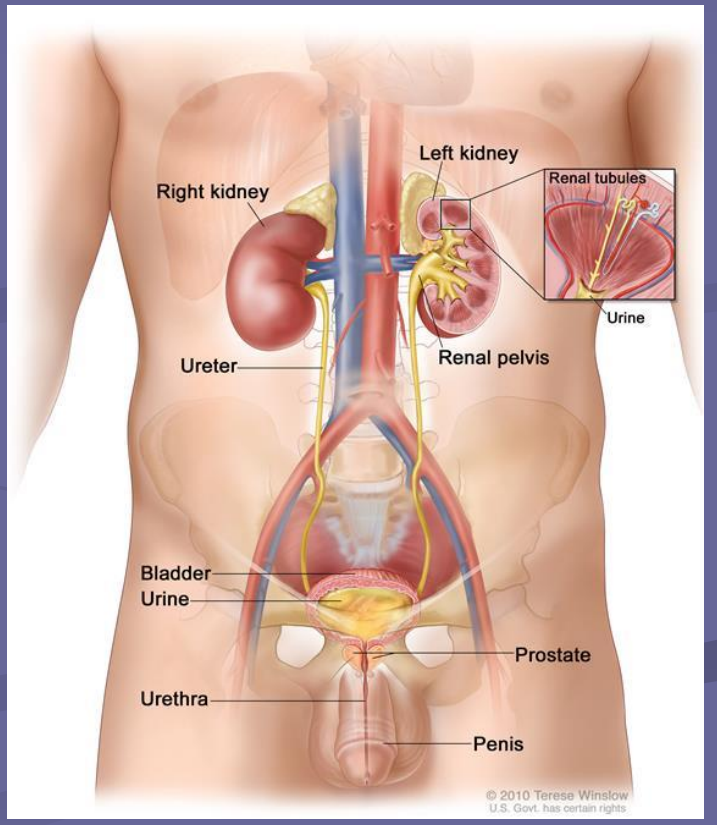
- Vesical pain is due
  - Overdistention
  - Inflammation



  - localization-in the suprapubian 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.



Urinary simptoms (complaints)

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

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.

Complaints

- ***Diuresis*** --- secretion of urine during a certain period of time

- Diuresis can be:

- **positive** (the amount of urine excreted exceeds the volume of liquid taken)- occurs in resolution of oedema, after administration of diuretics ...
- negative (the reverse ratio)-in cases of liquid retention in the body or its excess excretion through the skin, by the lungs (e.g. in dry and hot weather).

Complaints

- ***Dysuria-*** deranged excretion of urine
- ***Polyuria -*** increased amount of excreted urine. It can be of renal and extrarenal aetiology:

- in persons who take much liquid, during resolution of oedema (cardiac or renal), and after taking diuretics.

-longstanding polyuria with a high relative density of urine is characteristic of DM (due to a deranged resorption of water in renal tubules because of increased osmotic pressure of the urine rich in glucose).

- in diabetes incipidus (insufficient supply of antidiuretic hormone secreted into blood by the posterior pituitary.

- in the absence of sensitivity of the tubules to the ADH, in affected interstice of the renal medulla of various nature, in hypokaliaemia, and hypercalcaemia.

Complaints

- **Hyposthenuria-** persistent polyuria with low specific density of urine, is usually a symptom of a severe renal disease (e.g. chronic nephritis, chronic pyelonephritis, renal arteriolosclerosis, etc.

-Polyuria in such cases indicates the presence of a neglected disease with renal insufficiency and decreased reabsorption in renal tubules.

Complaints

- **Oliguria-**Decreased amount of excreted urine (< 500 ml/day)

-Extrarenal oliguria --it can be due to limited intake of liquid, during staying in a hot and dry room, in excessive sweating, intense vomiting, profuse diarrhoea, and during decompensation in cardiac patients.

-Renal oliguria -- in acute nephritis, acute dystrophy of the kidneys in poisoning with corrosive sublimate, etc.

Complaints

- ***Anuria -*** a complete absence of urine secretion and excretion, or < 200 ml/day

-Anuria persisting for several days threatens with possible development of uraemia and fatal outcome.

-Anuria may be caused by the deranged secretion of urine by the kidneys (secretory anuria) which occurs in severe form of acute nephritis, nephronecrosis (poisoning with sublimate or other nephrotoxic substances), transfusion of incompatible blood, and also some general diseases and conditions such as severe heart failure, shock, or profuse blood loss.

Complaints

- **Excretory Anuria--**In certain cases the secretion of urine is normal but its excretion is obstructed mechanically (obstruction of the ureters or the urethra by a calculus, inflammatory oedema of the mucosa, proliferation of a malignant tumour)

+It is usually attended by strong pain in the loin and the ureters due to distension of the renal pelves and the ureters. Exctretory anuria is often attended by renal colic.

- **Secretory (Renal) anuria** can be of reflex origin, e.g. in severe pain (contusion, fractures of the extremities, etc).

- ***Ischuria*** **-** the urine is retained in the bladder and the patient is unable to evacuate it. (this occurs in compression or other affection of the spinal cord, and in loss of consciousness)

Complaints

- ***Pollakiuria*** (frequent micturitions). A healthy person urinates from 4 to 7 times a day. The amount of excreted urine during one micturition is from 200 to 300 ml (1000-2000 ml/day).

-Frequency of micturition may vary within wider range under certain conditions: it may decrease in limited intake of liquid, after eating much salted food, in excessive sweating, in fever, and the like, or the frequency may increase (polyuria) if the person takes much liquid, in getting cold, and the like circumstances.

-Frequent desire to urinate with excretion of meagre quantity of urine is the sign of cystitis. A desire to urinate during night sleep does not arise more than once. In the presence of pollakiuria the patient feels the desire to urinate during both day and night.

In the presence of chronic renal insufficiency and if the kidneys are unable to control the amount and concentration of excreted urine in accordance with the amount of liquid taken, physical exertion, the ambient temperature, or other factors important for the liquid balance in the body, the patient urinates at about equal intervals with evacuation of about equal portions of urine. This condition is called *isuria.*

Complaints

- ***Nycturia-*** the amount of urine excreted during night often exceeds the amount of daily urine

-Nocturnal enuresis (nycturia) and oliguria during day time occur in cardiac decompensation and are explained by a better renal function at night, i.e. at rest (cardiac nycturia).

-Nycturia may concur with polyuria in renal dysfunction, at the final stage of chronic glomerulonephritis, chronic pyelitis, vascular nephrosclerosis, and other chronic renal diseases (renal nycturia).

Complaints

- Some diseases of the bladder and the urethra are attended by difficult and painful urination.
- The patient would complain of:

- change in the colour of the urine,
- its cloudiness,
- and traces of blood.

Complaints

- *Oedema* - in acute and chronic diffuse glomerulonephritis, nephrotic syndrome, amyloidosis, and acute renal excretory dysfunction
- It is important to ask the patient about the site that was the first

to be attacked by oedema, the sequence of oedema spreading, and the rate of intensification of this phenomenon

Complaints

- ***Isosthenuria -***the specific density of the urine is monotonous (in the presence of isuria and nycturia of renal origin, which arise due to the loss by the kidneys of their concentrating ability)
- ***Hyposthenuria -***the specific density of urine is decreased (the specific density of urine varies from 1.009 to 1.011, i.e. approaches the specific gravity of primary urine (plasma ultrafiltrate) in patients with pronounced nephrosclerosis, which is the final stage of many chronic renal diseases)

Complaints

Enuresis

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

Fever and Chills

- Usually in
  - Pyelonephritis
  - Glomerulonephritis
  - Prostatitis
  - Bladder’s inflamation

Complaints

- *Headache, dizziness,* and *heart pain* may result from kidney affections.

-These symptoms occur in those renal diseases which are attended by considerable increase in the arterial pressure, e.g. in acute and chronic glomerulonephritis or vascular nephrosclerosis.

A pronounced and persistent increase in the arterial pressure can be among the causes of deranged vision (neuroretinitis).

Complaints

- Patients with diseases of the kidneys can complain of weakness, indisposition, impaired memory and work capacity and deranged sleep. Vision may be deranged along with skin itching and unpleasant breath.
- **Dyspeptic disorders** sometimes join in: loss of appetite, dryness and unpleasant taste in the mouth, nausea, vomiting, and diarrhoea.

-All these phenomena are associated with retention in the body of protein decomposition products due to renal insufficiency which develops at the final stage of many chronic renal diseases, and sometimes in acute diseases attended by retention of urine during several days.

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 2nd to edema, weight loss & muscle wasting in renal failure.

Urinary system (physical assessment)

- **General state of health- fatigue, lethargy, & diminished alertness.**
- **Palpation-presence of the pain or masses in the region of the kydney**
- **Percussion: Presence of the pain may 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**

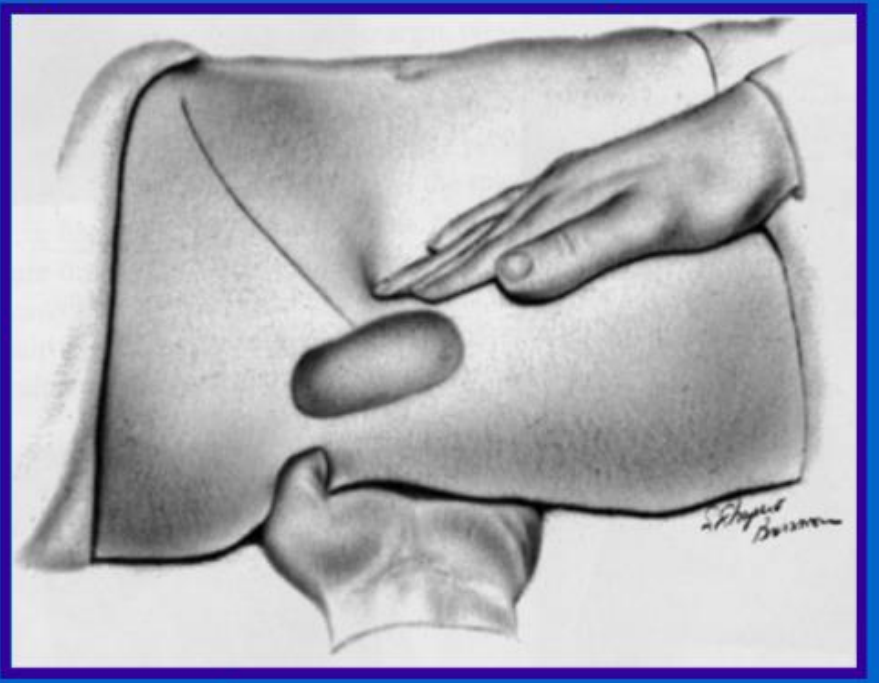
Kidneys

- 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

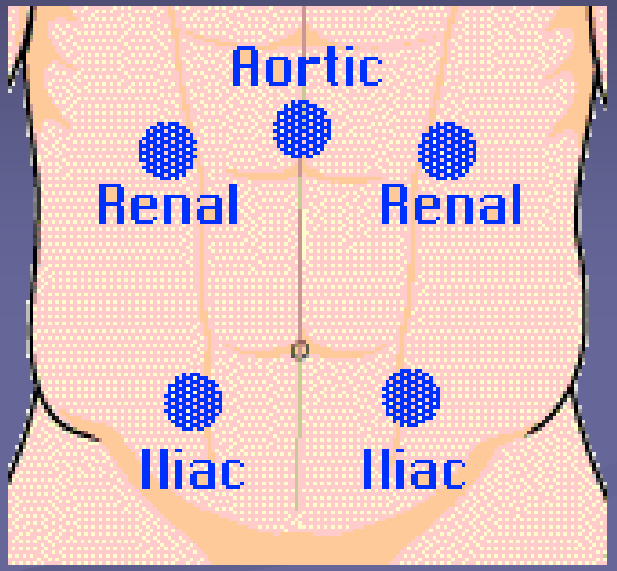
- Normal kidneys are not usually palpable.

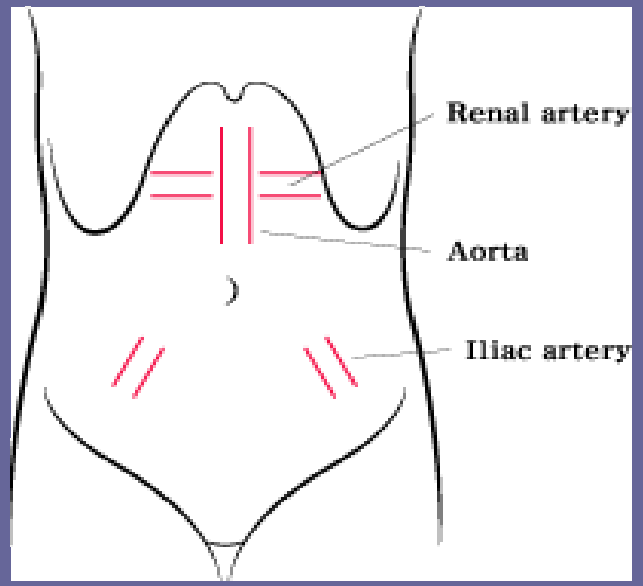


Kidney percussion

Kidney **Auscultation**

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





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

Urine

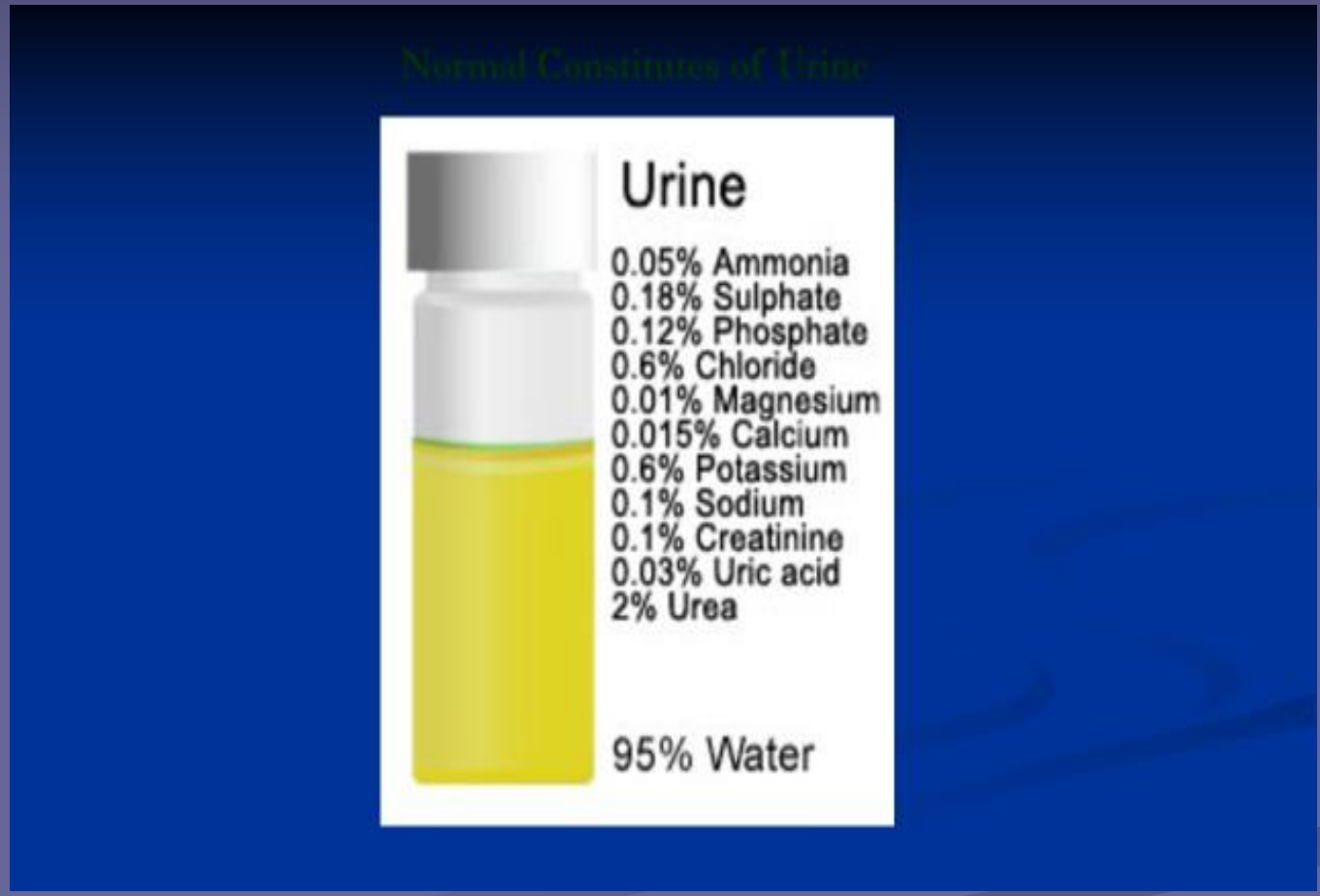
Water- 95%

Nitrogenous waste:

- urea
- uric acid
- creatinine

Ions:

- sodium
- potassium
- sulfate
- phosphate



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 density**– 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 Density (SD)

Water: s.g. = 1g/liter;
Urine: s.g. ~ 1.001 to 1.030

Pyelonephritus- 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, nefrotic sindrom

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- pyelonephritus

RBC casts- glomerulonephritus

Fatty casts- renal damage

Urine

- A decrease in SD (less conc. urine) occurs with increased fluid intake, diuretic administration, diabetes insipidus.
- An increase SD (more conc. urine) occurs with insufficient fluid intake, decreased renal perfusion, or the presence of ADH.

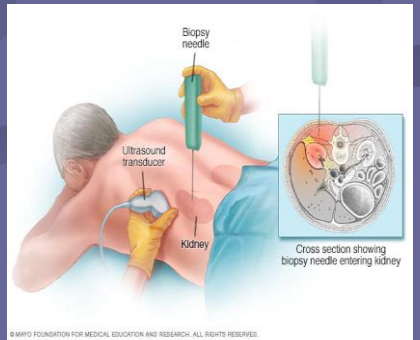
- **Urine Culture & Sensitivity-** identifies the presence of microorganisms & determines the specific antibiotix. that will treat the existing microorganisms.

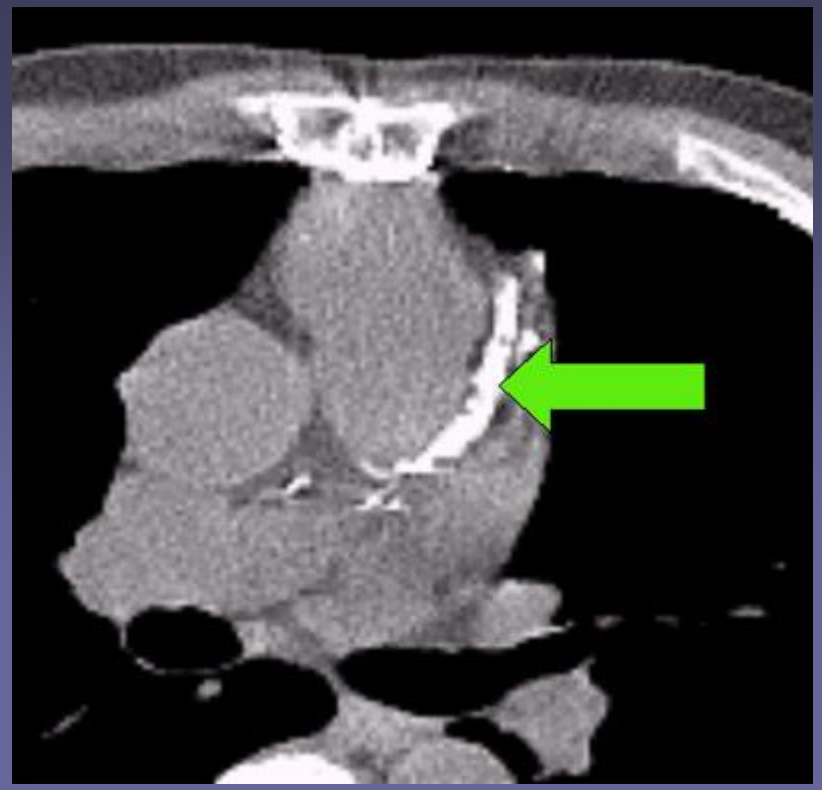
Urinary system (Diagnosis test)

- 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.**





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

THANK YOU

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