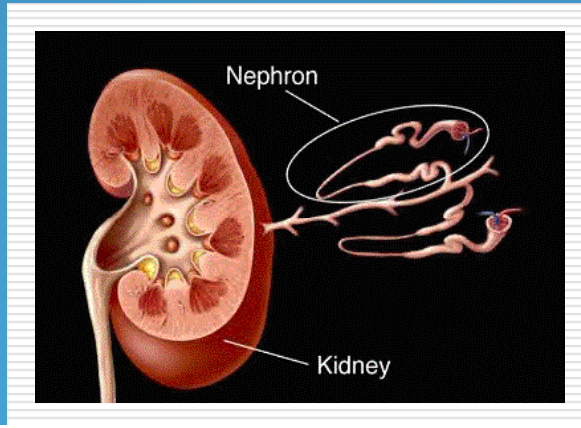
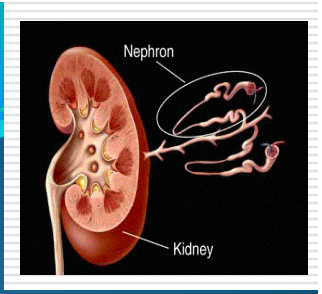
RENAL FUNCTION TESTS
&
RENAL FAILURE CASE STUDY

Mrs. Purva P. Naik
DEPARTMENT OF BIOCHEMISTRY
TMH



Kidneys



Kidneys are the principal organs of the urinary system.

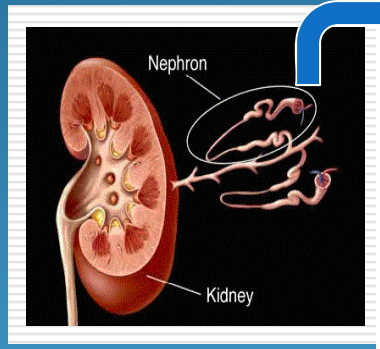
Primary functions are:

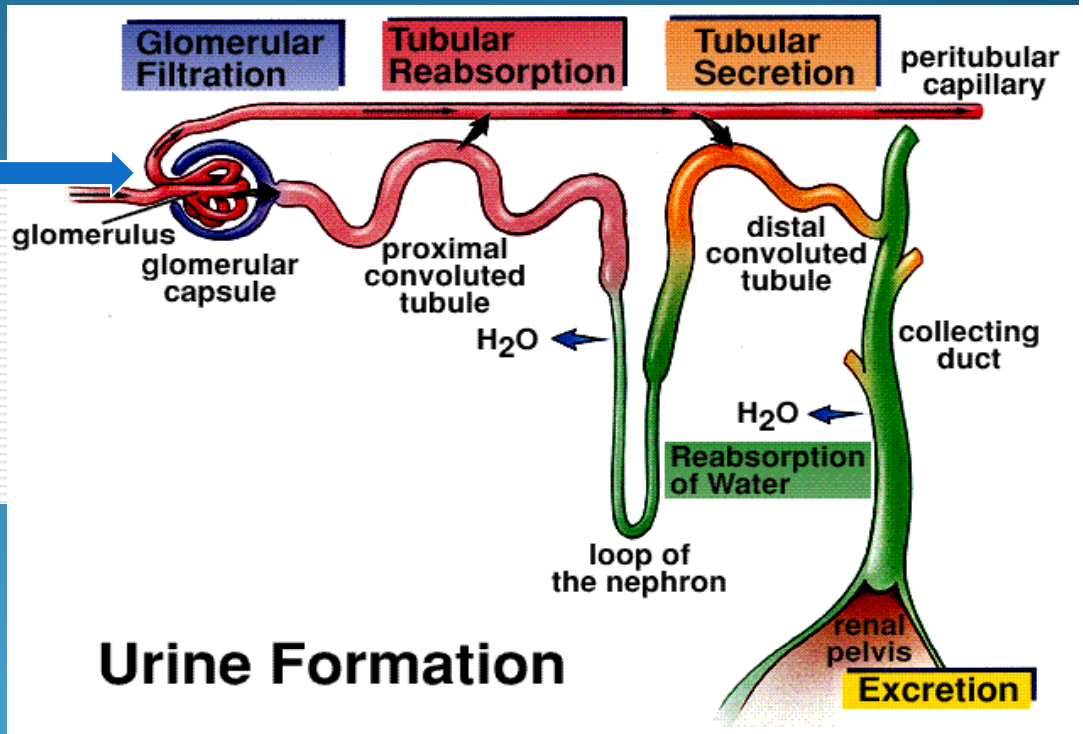
1. Regulate the volume and composition of extracellular fluid (ECF)
2. Excrete waste products from the body- detoxify blood.
3. Increase calcium absorption (activation of vitamin D).
4. Stimulate RBC production by producing erythropoietin.
5. Regulate acid base balance.
6. Secretion of renin and angiotensin to regulate blood pressure and
7. Electrolyte balance.

Urine formation

Outcome of multistep process of
Glomerular filtration,
Tubular reabsorption,
Tubular secretion,
&

excretion of
- water,
- electrolytes, &
- metabolic waste products.





Urine is the result of the above process, but primary function is to filter the blood and maintain the body's internal homeostasis.

Urine formation

Glomerular filtration:

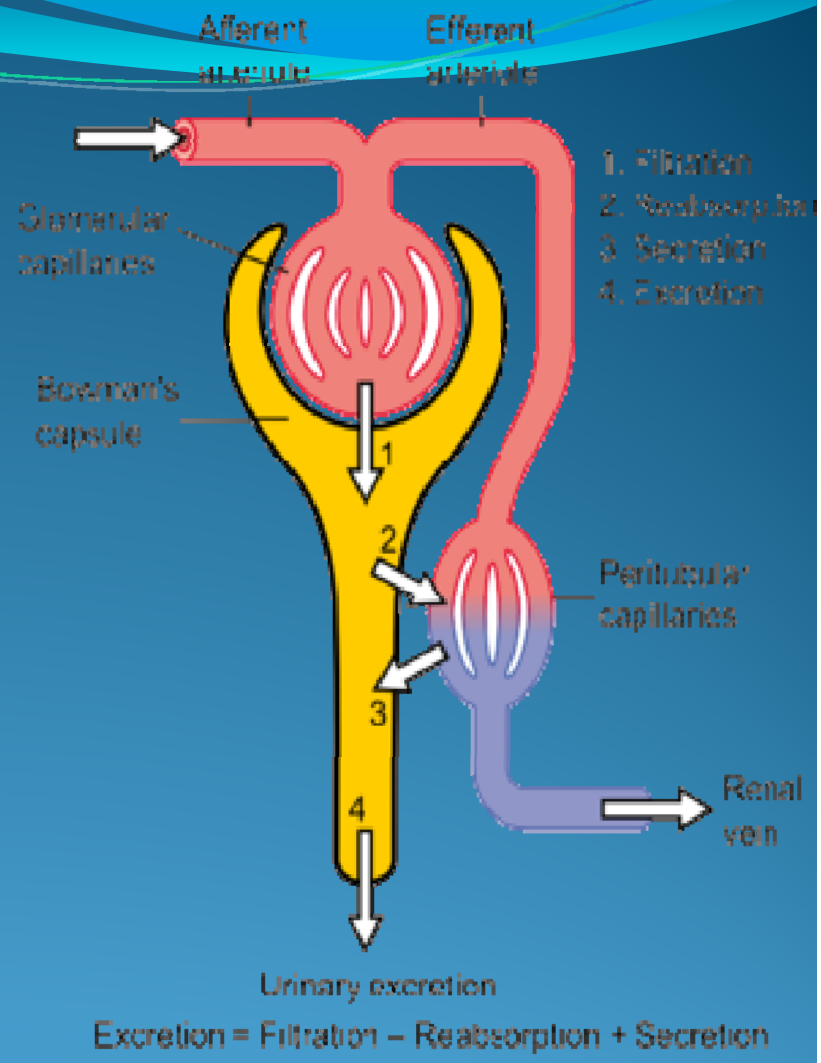
- The amount of blood filtered by the glomeruli in a given time is termed the glomerular filtration rate (GFR).
- Normal GFR = 125 ml/min.

Tubular reabsorption:

- 99% glomerular fitrate is reabsorbed into the blood while it passes through the renal tubules and ducts.

Tubular secretion:

- This removes excessive quantities of certain dissolved substances from the body, and also maintains the blood at a normal healthy pH (pH 7.35 to pH 7.45).



Terms related to the phases of renal failure

Oliguria- diminished urine output related to inadequate perfusion of kidney. UOP <400ml/day.

Uremia- condition in which renal function declines and symptoms develop. Accumulation of metabolic byproducts (uric acid and creatinine) that are normally excreted by the kidneys.

Azotemia - an excess of urea or other nitrogenous wastes in the blood as a result of kidney insufficiency

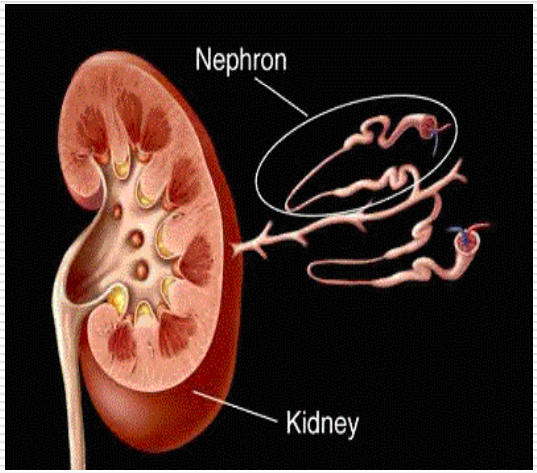
Anuria- absence of urine formation.

Polyuria- large volumes of urine

Hematuria- blood in urine

Anemia- hemoglobin (Hb) <13 g/dL,

Pruritis- itching or burning skin.



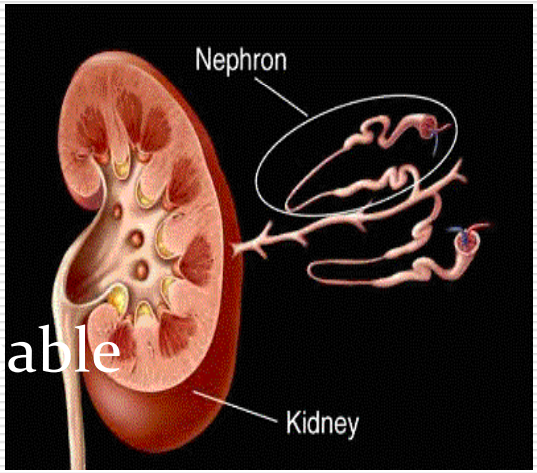
Chronic and acute kidney disease

Occurs when kidneys are no longer able to clean toxins and waste from blood.

Symptoms of kidney failure: changes in urination, edema, weakness, fatigue, ammonia breath, flank pain & itching.

Acute renal failure (ARF)
- sudden onset
- rapid reduction in urine output
- Usually reversible
- Tubular cell death and regeneration

Chronic renal failure (CRF)
- Progressive
- Not reversible
- Nephron loss
- 75% of function can be lost before it is noticeable

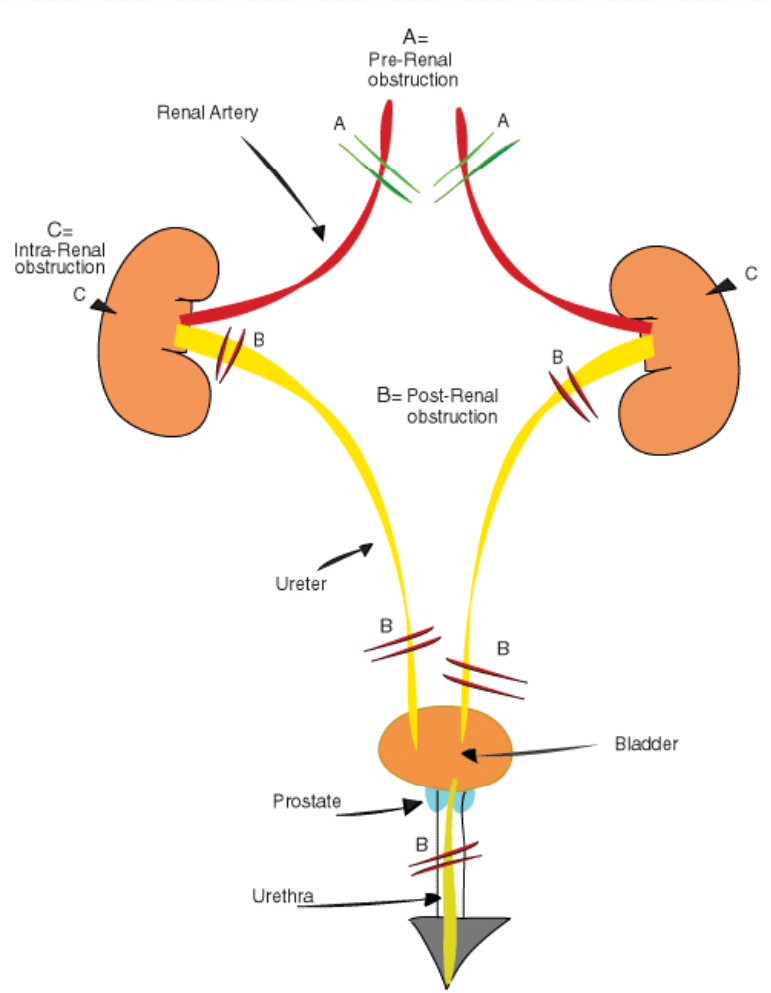


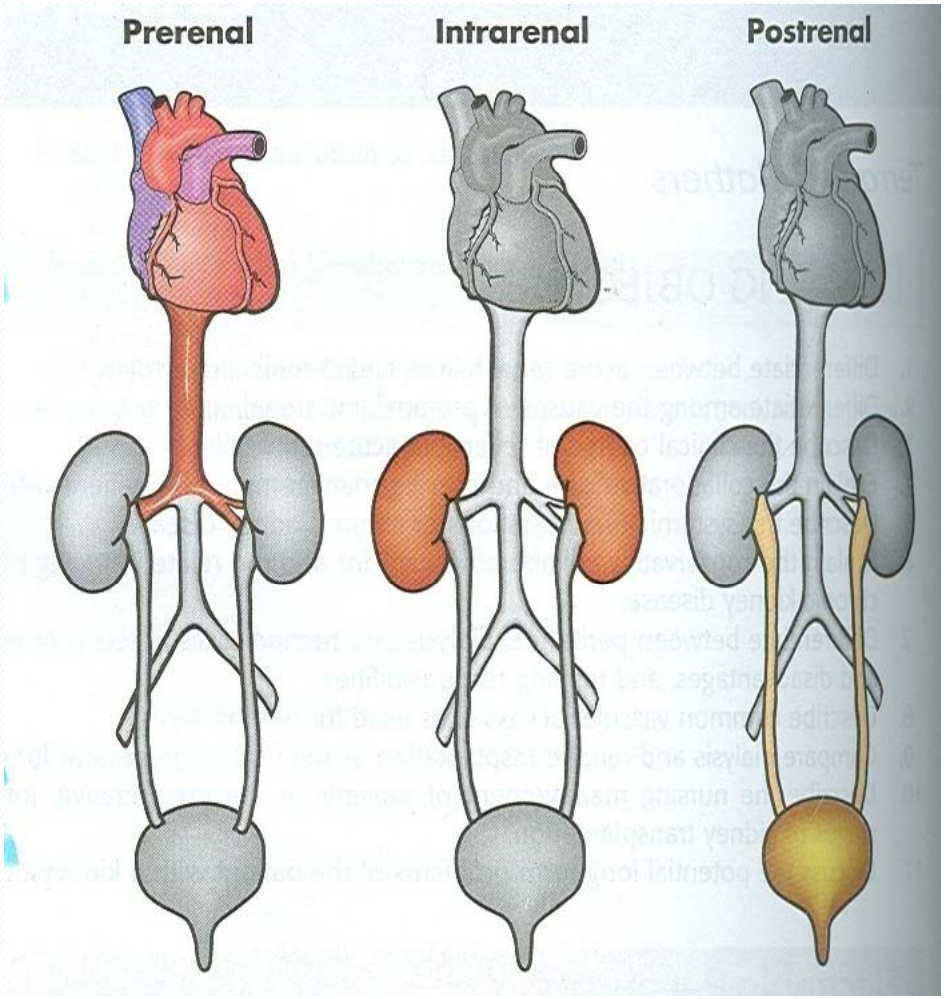
ARF

Pre-renal = 55%

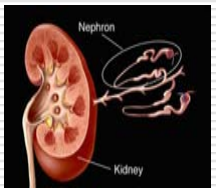
Renal (intrinsic)= 40%

Post-renal = 5-15%





Causes of ARF



Causes	Agents
PRERENAL	
Hypovolemia	Trauma, burns, surgery
Decreased effective plasma volume	Nephrotic syndrome, sepsis, shock
Decreased cardiac output	Congestive cardiac failure, pulmonary embolism
Renovascular obstruction	Atherosclerosis, stenoses
RENAL	
Glomerular & small vessel disease	Aggressive glomerulonephritis
Interstitial nephritis	Infection, infilteration, drugs / toxins
Tubular lesions	Post eschemic, nephrotoxins, hypercalcemia
POSTRENAL	
Bladder outflow obstruction	Prostatism, neurogenic bladder
Ureteric obstruction	Stones, blood clots, tumors.

Symptoms of ARF

- Decrease urine output (70 %)

Edema, esp. lower extremity

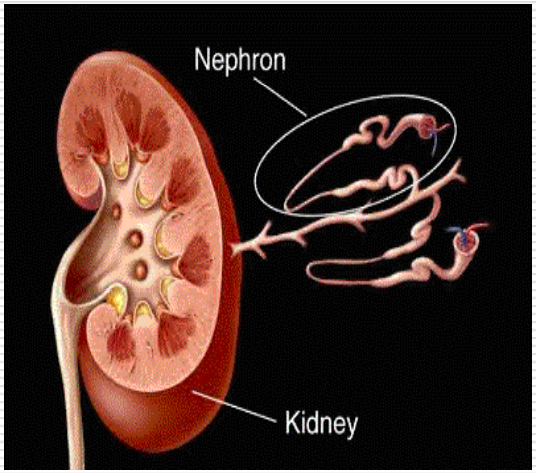
Mental changes

Nausea, vomiting

Pruritus

Anemia

Cool, pale, moist skin



ARF

Stages

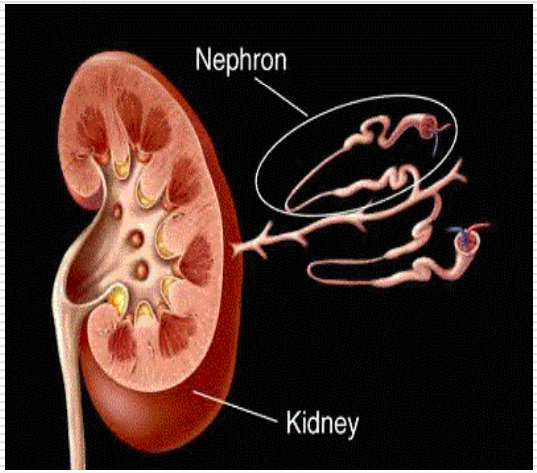
Onset – 1-3 days with increased blood urea nitrogen (BUN) and creatinine and possible decreased urine output (UOP)

Oliguria – UOP < 400 mL/day, elevated BUN, Creat, Phos, K levels and may last up to 14 days.

Diuretic (drugs) – UOP as much as 4000 mL/day but no waste products, at end of this stage may begin to see improvement

Recovery – things go back to normal

or may remain insufficient and become chronic.



CRF

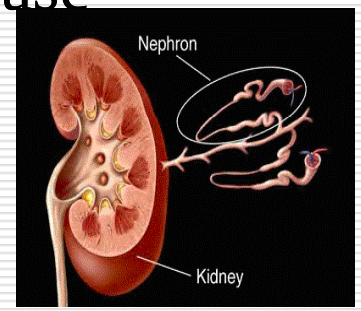
- Progressive, irreversible damage to the nephrons and glomeruli
- Recurrent kidney infections, vascular changes (diabetes/hypertension) etc.

- Regardless of the cause:

  Decreased: gfr, tubular function & tubular reabsorption capabilities.

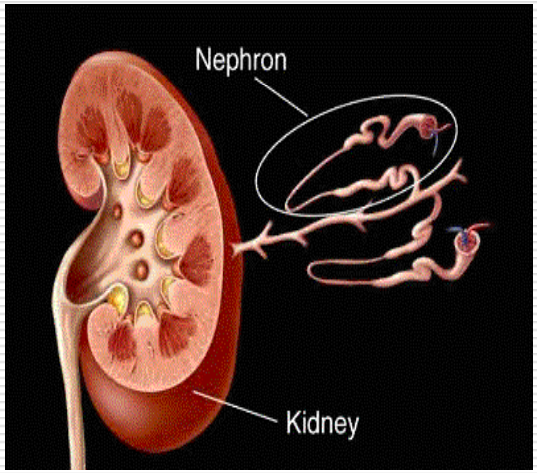
  Dysfunction fluids & electrolytes, acid base disturbances.

- Systemic problems develops end-stage renal disease (esrd) occurs when gfr <15 ml/min



CRF Causes

- Diabetic Nephropathy
- Hypertension
- Glomerulonephritis
- HIV nephropathy
- Reflux nephropathy in children
- Polycystic kidney disease
- Kidney infections & obstructions



Renal function tests

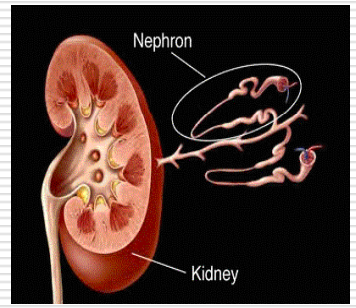
Tests	Biological reference interval
BUN	6-20 mg/dL
Creatinine	Male: 0.7 – 1.3 mg/dL Female : 0.6 – 1.1 mg/dL
Uric acid	Male: 3.5 – 7.2 mg/dL Female : 2.6 – 6.0 mg/dL
Potassium	3.5 – 5.1 mmol/L
24hrs. Creatinine clearance test	Male 94-140 ml/min Female 72-110 ml/min

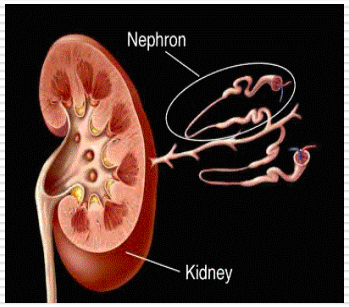
Hyperkalemia may cause cardiac arrest

Dialysis

- A process for removing waste and excess water from the blood,
- It is used primarily as an artificial replacement for lost kidney function in people with renal failure.

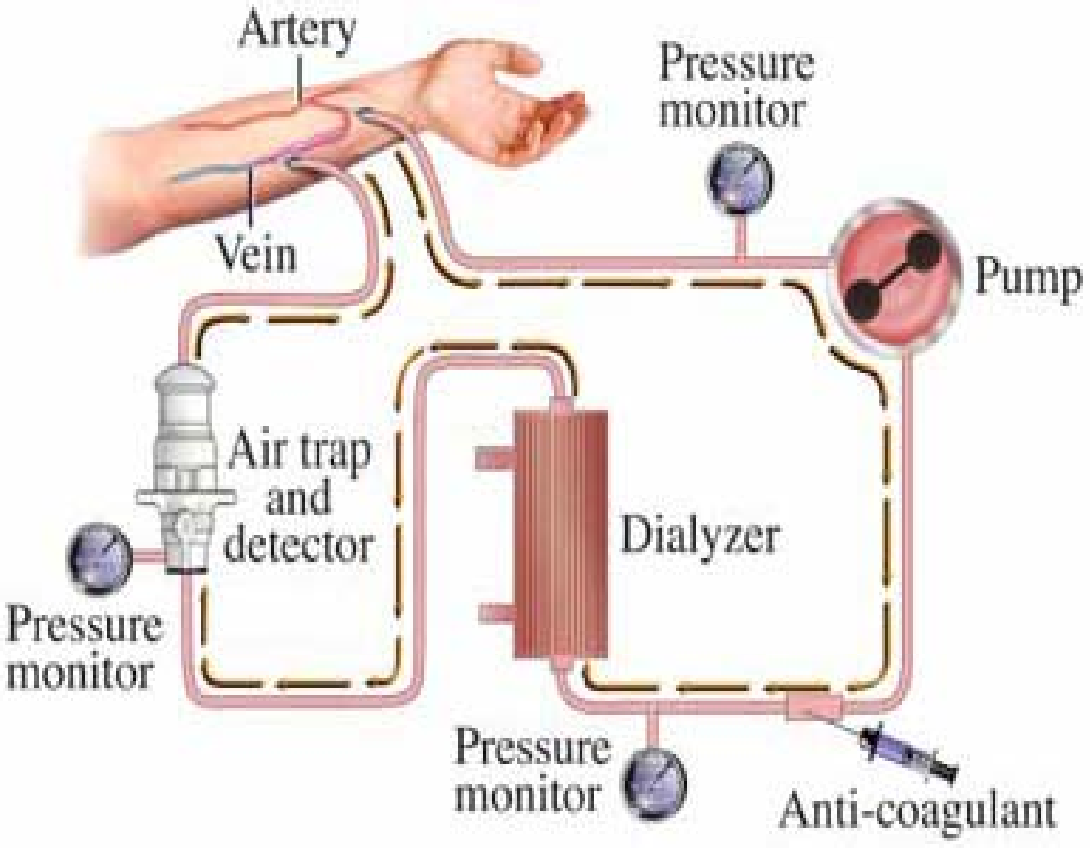
- ½ of patients with CRF eventually require dialysis:
- Dialysis
  - Diffuse harmful waste out of body
  - Control BP
  - Keep safe level of chemicals in body
  - 2 types
    - Hemodialysis
    - Peritoneal dialysis

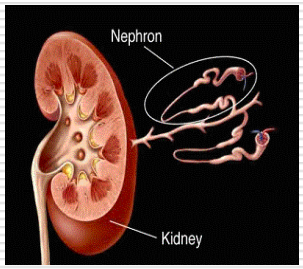




dialysis

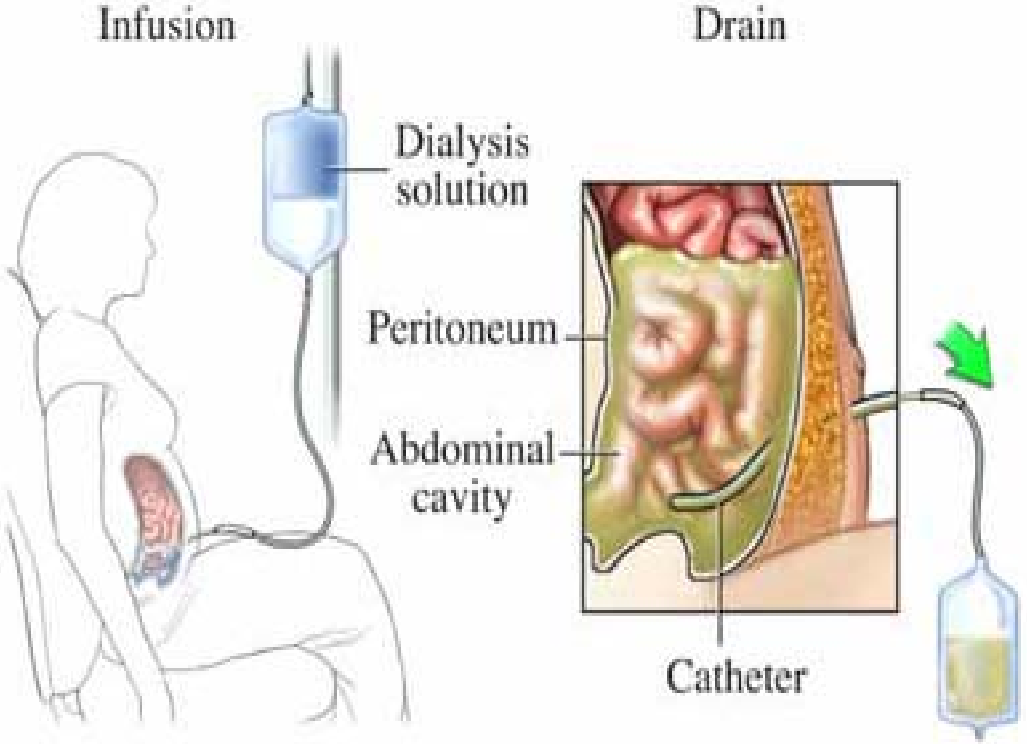
- Machine filters blood and returns it to body.
- 3-4 times a week.
- Takes 2-4 hours.



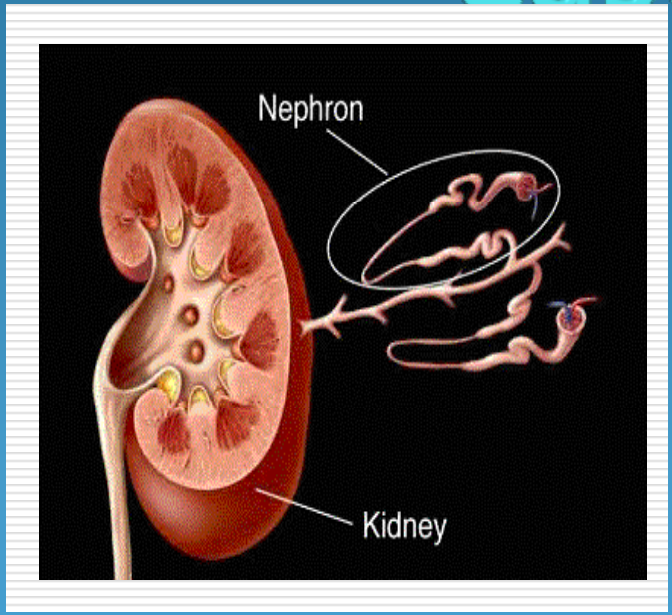


itoneal Dialysis

- Peritoneal dialysis works by using the lining of the abdomen (peritoneum) as a filter.
- It is used as an alternative to hemodialysis.
- There are three stages to a dialysis cycle
- FILL
- DWELL
- DRAIN

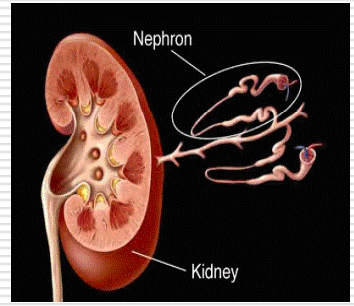


Case Study



Case Study - 1

- A 53 years old patient complains of frequent thirst and urination, lethargy, weakness, and blurred vision.
- A medical work-up reveals the following:
- Blood pressure: 164/93 mm Hg
- Fasting blood glucose: 210 mg/dL
- HbA1c: 9.4%
- BUN: 83 mg/dL
- Serum creatinine: 3.4 mg/dL
- Serum cholesterol: 230 mg/dL
- LDL: 163 mg/dL
- HDL : 25 mg/dL



Questions

Lab findings
- Blood pressure: 164/93 mm Hg
- Fasting blood glucose: 210 mg/dL
- HbA1c: 9.4%
- BUN: 83 mg/dL
- Serum creatinine: 3.4 mg/dL
- Serum cholesterol: 230 mg/dL
- LDL: 163 mg/dL
- HDL : 25 mg/dL

- Is this a renal failure case?
- Yes
- What is this condition known as?
- Diabetic nephropathy
- What may be the cause?
- Uncontrolled diabetes leads to renal failure.
- What is the cause for high total cholesterol and LDL cholesterol and Low HDL cholesterol?
- Uncontrolled diabetes.

Case study 2

- 5 year old boy seen by a pediatrician for case of pneumonia, he has had during the 3 month period.
- Physical examination shows moderate to severe swelling of ankles and face.

Lab findings are

- Spot urine protein 4+ by dipstick
- 24 hr urine protein 8 g/24 hrs
- Serum albumin 1.4 g/dL
- Serum cholesterol 285 mg/dL
- BUN 11 mg/dL
- Serum creatinine 1.1 mg/dL
- CCT 63 mL/min

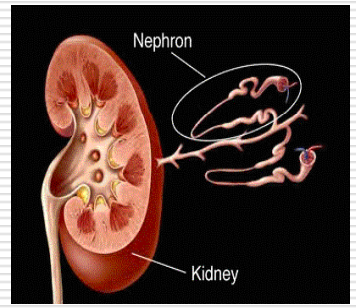
Questions

Lab findings	
Spot urine protein	4+
24 hr urine protein	8 g/24 hrs
Serum albumin	1.4 g/dL
Serum cholesterol	285 mg/dL
BUN	11 mg/dL
Serum creatinine	1.1 mg/dL
CCT	63 mL/min

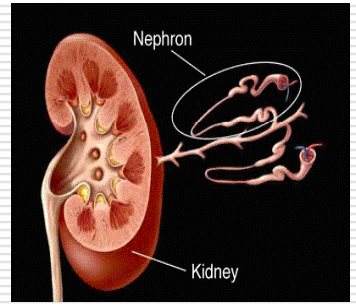
- What is the diagnosis?
- Patient has nephrotic syndrome.
- What is the relationship between Pneumonia and renal disease?
- Chronic protein loss through the kidneys has caused hypo-gammaglobulinemia resulting in decreased immune response to infections.
- Does the child have azotemia?
- No, neither BUN nor creatinine is elevated.
- How can CCT be decreased when serum urea and creatinine conc. are within normal limits?
- CCT is considerably more sensitive to mild decreases in renal function than BUN or creatinine concentration.

Case study 3

- 75year old Male with h/o prostate cancer diagnosed in 2006.
- It was metastatic to his ribs at the time, so prostatectomy was not done.
- He has done well since then on hormone therapy, but presents to clinic today c/o abdominal pain and decreased urine output over the last 5 days, as well as irritability and back pain.
- His creatinine is 8.5 mg/dL



Questions



- Is this renal failure?
  - Yes
- What type is it most likely to be?
  - Post-renal, from prostatic obstruction
- What tests clinician might order?
  - Bladder scan or post-void residual; renal ultrasound
- How would clinician manage this?
- Giving fluids, following UOP and monitoring creatinine level.


Thank you!

Questions

1. The normal urinary system consists of:

A. two kidneys, two ureters, one urethra
B. two kidneys, one ureter, one bladder, one urethra
C. one kidney, two ureters, one bladder, one urethra
D. two kidneys, two ureters, one bladder, one urethra

D

9. Which of the following could potentially cause renal failure:

A. Hypovolemic shock
B. Chemical exposure
C. Obstruction by kidney stone
D. All of these

D

BUN

- BUN is indicator of glomerular filtration rate.
- Liver breaks down proteins (regulated by rate of kidney excretion) and produces ammonia — which contains nitrogen.
- The nitrogen combines with other elements, such as carbon, hydrogen and oxygen, to form urea.
- Urea then circulates in the blood in the form of urea nitrogen. In healthy people, most urea nitrogen is filtered out by the kidneys and leaves the body through the urine.

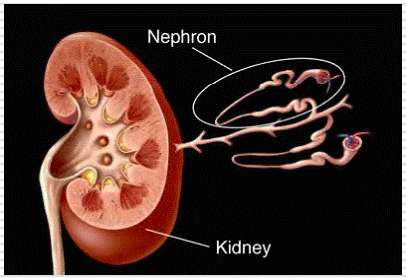
Creatinine

- It is a better indicator of kidney function.
- It is a breakdown product of creatine.
- Creatine is synthesized primarily in the liver from the methylation of glycocyamine.

  (synthesized from the arginine and glycine in the kidney).
- It is then transported through blood to the other organs, muscle, and brain.
- where, through phosphorylation it becomes phosphocreatine.
- During the reaction, creatine and phosphocreatine are catalyzed by creatine kinase, and a spontaneously converted to creatinine.

Uric acid

- Uric acid is the relatively water-insoluble end product of purine nucleotide metabolism.
- Three forms of kidney disease have been attributed to excess uric acid: acute uric acid nephropathy, chronic urate nephropathy, and uric acid nephrolithiasis.
- 2/3 rd uric acid is discharged from kidneys and 1/3 rd is discharged from intestinal tract.
- Amount of uric acid produced and excreted each day is almost same, hence if the production of uric acid is stable, than the high uric acid is due to hindered excretion from the kidneys and GI tract.



#######

- Diabetes and hypertension are the leading cause of ESRD
- Chronic renal disease is accompanied by characteristic abnormalities of lipid metabolism
- hypercholesterolemia accelerates the rate of progression of kidney disease