CHAPTER NO: 15

EXCRETION AND OSMOREGULATION

❖ **Osmoregulation :** The maintenance of an optimal concentration of water and salts in the tissues and body fluids is called as osmoregulation.

Functions:

1. Maintenance of internal osmotic concentration which is different from the surrounding medium.
2. Homeostasis
3. Regulation of water and internal ionic concentration.
4. Low body fluid concentration causes swelling of cells and

- **Osmosis:** Special type of diffusion in which movement of solvent(water) from lower concentration to higher concentration through semipermeable membrane
- **Osmotic pressure:** The pressure which is sufficient to stop the flow of solvents from lower concentration to higher concentration through semi permeable membrane
- Excretory organs play an important role in maintenance of constant internal environment of the body called homeostasis. It requires osmoregulation, the process of controlling solute concentrations and water balance. Composition of blood (and internal environment) is determined by by what excretory organs retain not by what mouth ingests .
- **Salt glands:** Marine birds like Albatross spend their life on the sea. That means water, they drink salty water. They have special glands called salt glands near nostrils. These are capable of secreting salts by active transport and help to manage osmotic balance. Many marine organisms like sea turtles and marine iguanas also have such salt excreting glands.
- Animals can either be isoosmotic to the surrounding (osmoconformers) or control internal environment independent of external environment (osmoregulators).

- **Osmoconformers :** Marine organisms mostly are osmocomformers because their body fluids and external environment are iso osmotic in nature.
- **Osmoregulators :** Fresh water forms and terrestrial organisms are osmoregulators.
- **Stenohaline organisms:** conformers or regulators, most organisms can tolerate only narrow range of salt concentrations. Such organisms are called stenohaline organisms. (steno : narrow)
- **Euryhaline organisms :** Those who are capable of handling wide changes in salinity are called euryhaline organisms ex. barnacles, clams etc.
- Unicellular forms have contractile vacuoles which collect and discharge waste products outside the cell.
- Excretion in sponges takes place by diffusion of waste material in water which is discharged through osculum.
- True organs of excretion are found in those animals that show bilateral symmetry.
- Most common type is simple or branching tube that opens to exterior through pores called nephridiopores.

❖ Types of nephridia :

1. **Protonephridia :** These are network of dead end tubes called flame cells. These are found mostly in animals that lack true body cavity e.g.Platyhelminthes. Protonephridia are also found in rotifers, some annelids and *Amphioxus*.
2. **Metanephridia :** These are unbranched coiled tubes that connect to body cavity through funnel like structures called nephrostomes. Body fluid enters the nephridium through nephrostome and gets discharged through nephridiopore. eg. Earthworms.

In most of the insects, excretion takes place by set of blind ended tubules called malpighian tubules.

Crustaceans have green glands as excretory organs. Members of phylum Echinodermata do not have any specialized excretory organs.

Waste materials directly diffuse into water or are excreted through tube feet. Mammalian kidneys are a collection of functional units called nephrons, which are well designed to extract metabolic waste

❖ **Excretion:** The separation ,collection and elimination of nitrogenous waste products from the body is called as excretion

- **Types of Excretion: 1. Ammonotelism 2. Ureotelism 3. Uricotelism 4. Guanotelism**

Points	Ammono -telism	Ureotelism	Uricotelism	Guano-telism
1.Defⁿ	Elimination of nitrogenous waste products in the form of ammonia	Elimination of nitrogenous waste products in the form of urea	Elimination of nitrogenous waste products in the form of uric acid	Elimination of nitrogenous waste products in the form of guanine
2.Basic nitrogenous product	Ammonia	Urea	Uric acid (Excess deposition of uric acids in joints causes painful arthritis c/a gout.	Guanine
3. Animals	Ammono-telic	Ureotelic	Uricotelic	guanotelic
4.pH	High	Moderate	less	Less
5.Toxicity	Highly toxic	Moderatly toxic	Least toxic	Least toxic
6.Water solubility	Highly water soluble	Water soluble	Least soluble	Least soluble
7.Place of synthesis	Liver	Liver	Liver	Liver
8.Process required for synthesis	Simple diffusion (through gills, skin , kidneys)	Ornithine cycle	Ionosinic pathway [Uric acid formed by breakdown of purine nitrogen base]	Ionosinic pathway
9.Water requirement for elimination	Large quantity of water	Moderate quantity of water	Negligible amount of water [Uric acid eliminated in the form of solid pellets/thick paste]	Negligible amount of water
10.Quantity of water for elimination	300-500 ml water /gram of ammonia	50 ml water/gram of urea	10ml water/gram of uric acid	1ml water / gram of guanine
11.Example	Aquatic invertebrates, Bony fishes, Tadpole larva of frog	Adult Frog, Turtles, Toads, mammals, Marine fishes	Land, Snails, Reptiles, Birds, Terrestrial insects, Lizards ,Snakes	Arachnids like Spider, Scorpions, Penguins

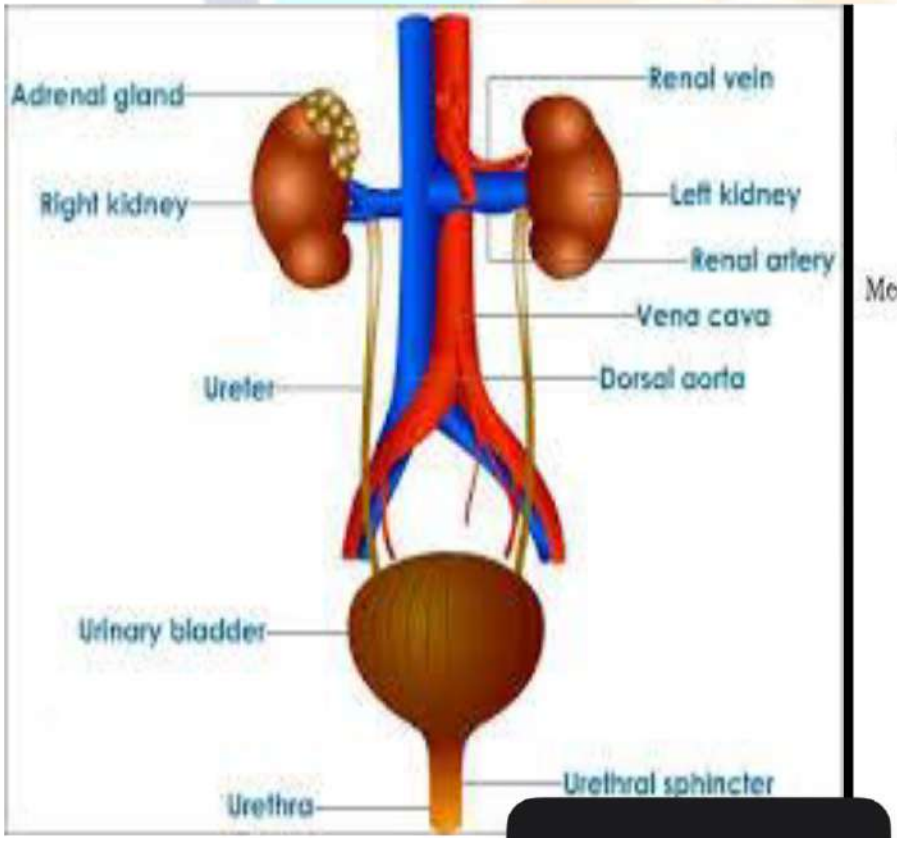
❖ Excretory Products :

- Excretory products: The products formed by catabolism of glucose, amino acids, glycerol and fatty acids called as excretory products.
- The excretory products are
  1. Carbon dioxide and Water
  2. Bile pigments [bilirubin & biliverdin]
  3. Non nitrogenous waste [Ammonia ,Urea, Uric acid, Guanine, creatinine]
  4. Inorganic salts ,Hormones and Vitamins
- **Deamination:** The conversion of excess amino acids in liver into ammonia is called as deamination.
- **Detoxification:** Conversion of highly toxic ammonia into moderate toxic urea or least toxic uric acid is known as detoxification.

  Liver helps in deamination and detoxification.
- Plasma Creatinine is produced from catabolism of creatinine phosphate during skeletal muscle contraction. It provides ready source of high energy phosphate. Normally blood creatinine levels remain steady because the rate of production matches it's excretion in urine. Hence, level above normal is an indication of poor renal function.

❖ Excretory system of Man:

1. Kidneys
2. Urinary bladder
3. Ureters
4. Urethra



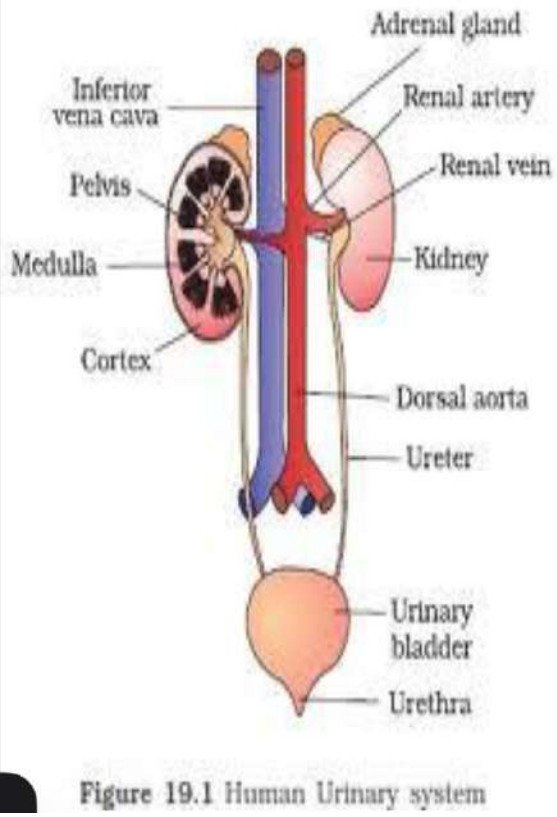


Figure 19.1 Human Urinary system

1. Kidneys:

- **Nature:** Major or principal excretory organ.
- **Shape:** Bean shaped **Color:** Dark red
- **Size:** 10 cm long X 5 cm wide X 4 cm thick
- **Numbers:** 2 in numbers or 1 pair
- **Position:** Right kidney is slightly lower in position than left kidney.
- **Location:** Attached to dorsal body wall at the level of 12^{th} thoracic to 3^{rd} lumbar vertebrae in the abdominal cavity.
- **Retro-peritoneal:** The peritoneal covering present on anterior surface.
- **Margins/Surfaces:** **a. Lateral margin:** convex
  b.Medial margin : concave
- **Hilum:** A notch present on the medial margin of kidney is hilum.
- **Suprarenal/Adrenal gland:** A cap like gland present on the top of kidney is adrenal gland.
- **Adipose Tissue Capsule:** It is semi solid fatty tissue covering.
- **Functions:**

1. Maintenance of constant internal environment and delicate balance (Homeostasis)
2. Adjustment of Na^+, K^+& Cl^- ion concentration.
3. Extraction of non nitrogenous waste products
4. Regulation of water salt balance [Osmoregulation]
5. Regulation of acid base balance.
6. Removal of excess foreign substances [Drugs, Pigments ,Toxins and Dyes]

2. Ureters :

- **Nature:** A pair of thin, narrow, muscular tubes arising from hilus of kidney.
- **Size:** 25-30 cm long
- **Connections:** The ureter running up to urinary bladder and opens into it by lateral angle.

a. Functions :

1. Carry urine from kidneys to urinary bladder
2. Peristaltic contraction

3. Urinary bladder:

- **Nature:** The thick walled hollow muscular sac/bag like structure.
- **Shape:** Pear shaped
- **Internal linings:** Transitional epithelium [For Expansion]
- **Detrusor muscles:** The thick layer of smooth muscles

- **Location:** Lying in pelvic cavity

b. Functions:

1. Temporarily storage of urine(500-1000 ml)
2. Expulsion of urine at intervals through urethra.
3. Serve as reservoir of water during dryness condition.

4. Urethra:

- **Nature:** Urethra is thin walled, narrow short (female) or long (male) duct.
- **Location:** Starts from lower part of urinary bladder and opens exterior.
- **Sphincter muscles:** The opening of urethra guarded by sphincter muscles also known as urethral sphincters. Urethral sphincter is under voluntary control results in micturition./Urination and emptying of the bladder
- **Length: a. Male:** 20 cm [Urethra passes through penis]
  b. Female: 4 cm [Urethra opens in front of vaginal opening vestibule]
- **Functions:** It carries only urine in female & both urine and semen in male

❖ Histology/T.S. of Kidney:

1. Adipose tissue : Each kidney covered by semi liquid fatty tissue covering known as adipose capsule.The outer covering of capsule is made up of tough fibrous C.T. called as renal fascia.

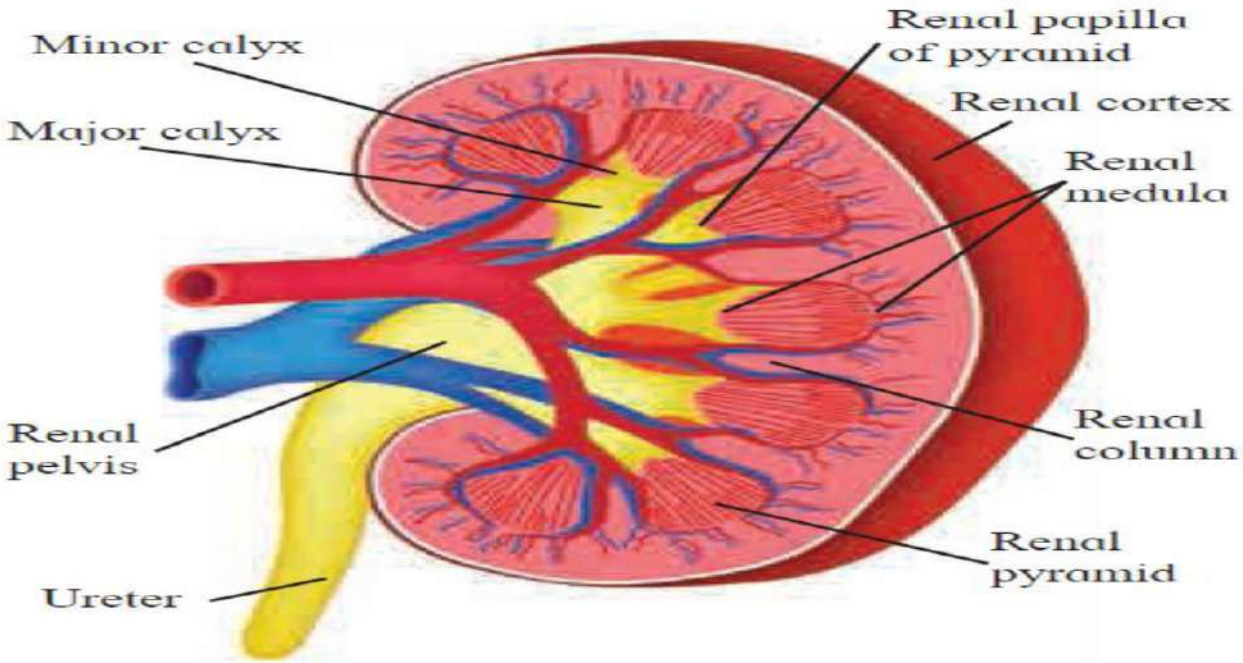
2. Cortex: It is outer peripheral region .It is red in color and granular in appearance.Cortex consist of Malpighian body, PCT, DCT ; therefore granular or spotted in appearance.It is region of urine formation .

3. Medulla: It is inner region lighter than cortex. Medulla consists of Loop of Henle's and collecting tubule therefore striated in appearance. It also contains blood capillary network and connective tissue.

a. Renal pyramids: Medulla consists of conical shaped structure with wide base and narrow cortex. The wide base attached to cortex and narrow apex attached to medulla. Or directed towards an inner space of medulla. Medulla contains 6-20 renal pyramids

b. Renal papilla : The inner space of medulla which contains narrow apex of renal pyramids known as renal papilla.

c. Columns of Bertini : The part of cortex continued inside the medulla between renal pyramids called as columns of Bertini.



4. **Renal pelvis/Sinus:** The large funnel shaped space on the innerside of kidney is renal pelvis. The ureter is connected to pelvis.Renal pelvis is hollow region of kidney fill with urine in the normal state.
5. **Calyx:** The edges of pelvis contains cup like extensions towards medullar end is called as calyx.
    - Minor calyx: Minor calyx receives urine from collecting duct
    - Major calyx : Major calyx receives urine from minor calyx
6. **Duct of Bellini:** 7-8 collecting ducts joins to form a structure towards papilla of pyramid called as duct of Bellini.

❖ Structure of Nephron:

- **Def^{n}:** Nephron in a microscopic structural and functional units of kidney produce urine.
- **Uriniferous tubule:** A nephron along with collecting tubule is known as uriniferous tubule.
- **Numbers:**1.2 million **Length:** 40-60 mm
- **Nature :** Nephron is thin walled coiled duct lined by single layer of epithelial cells. Nephron is long coiled duct in which coiling takes place in definite manner.
- **Regions:**

a. Proximal region: It lies in cortex and blind sac
b. Middle region: It lies in medulla
c. Distal end: It also lies in cortex. It opens in collecting tubule.

- **Parts:**

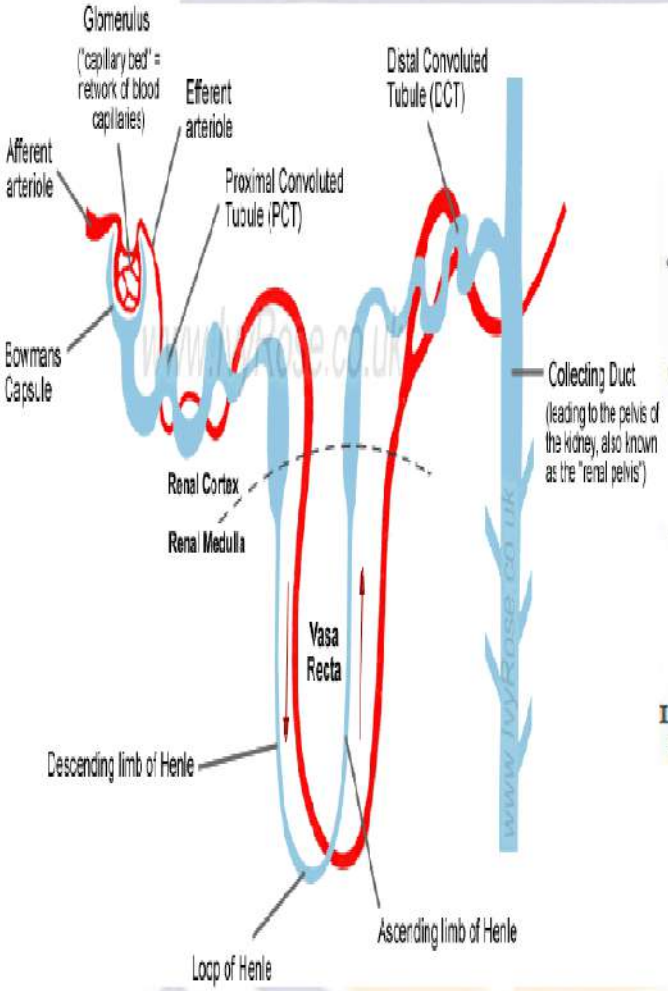
A. Malpighian body/Renal corpuscles:

1. Bowman's capsule:

2. Glomerulus
    a. Efferent arterioles
    b. Afferent arterioles

B. Renal tubule:

1. Proximal convulated tubule(PCT)
2. Loop of Henle :
    a) Descending loop
    b) Ascending loop
3. Distal convulated tubule
4. Collecting duct.



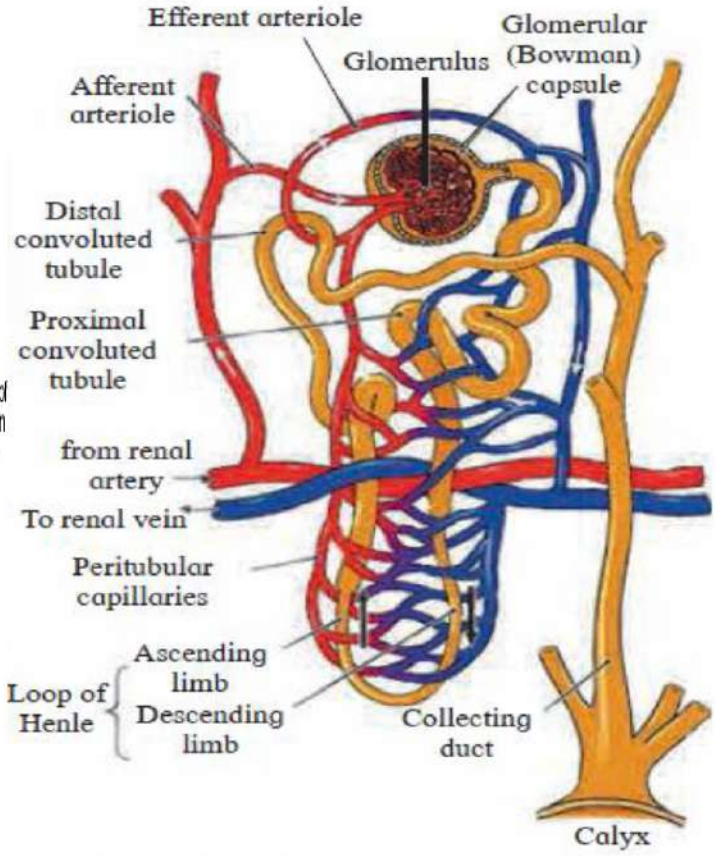


Fig. 15.7 Nephron and peritubular capillaries network

A. Malpighian body/Renal corpuscles:

- The anterior most part of nephron lies in the cortex is called as malpighian body.
- Ultrafiltration of blood to form primary urine is principal function of malpighian body.

1. **Bowman's capsule /Renal capsule :**The proximal widest blind end of nephron is called as Bowman's capsule.
    - **Shape:** Cup shaped **Width:** 1.2 mm
    - **Epithelial tissue:** It is double walled structure made up of squmous epithelim.
    - **Continuation:** Continuous into renal tubule

- **Layers:** 2 layers i.e. parietal and visceral.
  a. Parietal layer: Outer layer
  b. Visceral layer Inner layer contains podocytes
- **Podocytes:** The specialized cells with foot like processes present on visceral layer is known as podocytes.
- **Filtration slits:** The gaps present between foot like processes of podocytes called as filtration slits. It forms glomerular filtrate.
- **Capsular/Urinary space**: The space present between parietal and visceral layer is called as capsular space.

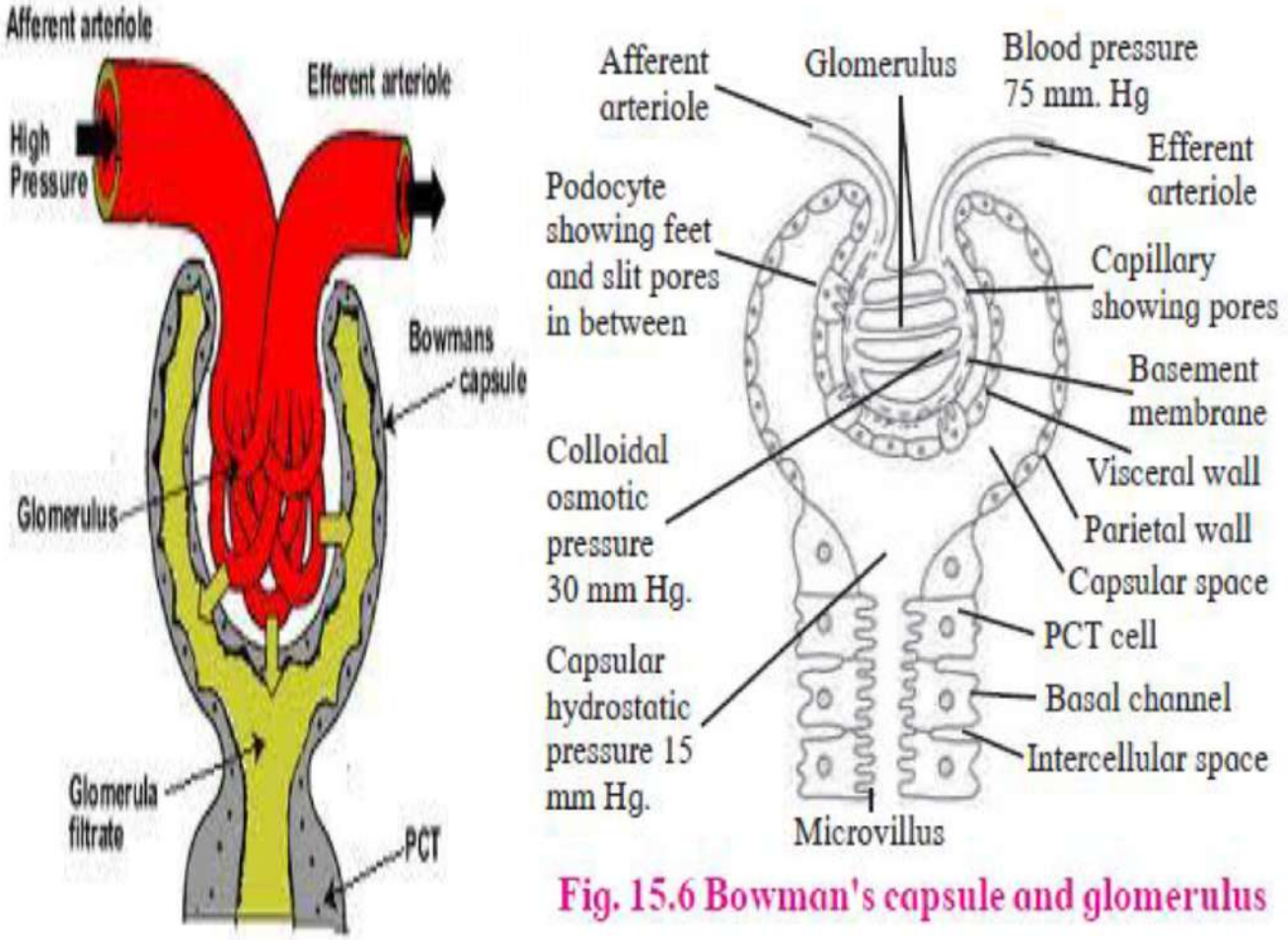


Fig. 15.6 Bowman's capsule and glomerulus

2. Glomerulus:

- Globular network of capillaries forms knot like structure in cup shaped cavity known as glomerulous.
- Glomerulous made up of efferent and afferent arterioles.
- Glomerulous has an intimate connection with visceral layer of Bowman's capsule.

a) **Efferent arterioles:** A slightly thinner arteriole carries blood away from glomerulous is efferent arteriole.

b) **Afferent arterioles:** A thin wider branch of renal artery which supplies blood to glomerulous.

B. Renal tubule: It is long, coiled, tubular and posterior part of nephron.

It consist of

1. Neck :

- It is short narrow tube arising from the base of Bowman's capsule.
- It is internally lined by ciliated and cuboidal epithelium.
- Beating of cilia draws filtrate from Bowman's capsule into lumen of renal tubule.
- It is present in cortex.

2. Proximal convulated tubule(PCT):

- It is highly coiled part present just near the neck
- It is present in cortex
- Lumen of PCT is narrow
- PCT internally lined by cuboidal and ciliated epithelium.
- PCT shows cells with brush borders (Brush borders formed from microvilli which increases area of reabsorption
- PCT helps in absorption of amino acids,glucose,Na,Ca and water from renal filtrate.

3. Loop of Henle :

- PCT leads to U shaped region and takes hair pin turn known as loop of Henle
- It lies partly in cortex and partly in medulla
- It consists of two limbs i.e. Descending and Ascending limb.

a. **Descending loop:** It is thin walled permeable to water and internally lined by epithelial cells.

b. **Ascending loop:**It is thick walled and impermeable to water.It helps in concentration of urine.

4. Distal convulated tubule :

- The posterior less colied part of renal tubule is known as DCT.
- It is internally lined by cudoidal epithelium.
- Microvilli absent in DCT.
- DCT is close to glomerulous of nephron and forms complex structure known as Juxta glomerular apparatus (JGA)
- JGA secrtes rennin enxyme which controls BP of Kidney.
- DCT opens in collecting duct.

5. Collecting duct :

- It is short and straight part of renal tubule.
- About 7-8 collecting ducts joins to form duct of bellini .It opens into calyx at the apex of pyramid.

- All terminal ducts of nephron opens into common collecting duct (CCD) also known as Duct of bellini.
- The ducts passes through medulla and enter the renal pelvis.
- The pelvis opens finally into the ureter.

6. Peritubular capillaries:

- The efferent arteriole leaves the glomerulous and forms network of capillaries on renal tubule known as peritubular capillaries.
- The peritubular capillaries unite to form venule (Vasa recta)
- The vasa recta joins to form renal vein

❖ Mechanism of Urine formation:

A. Ultrafiltration :

- **Definition :** The filtration of blood under pressure is called as ultrafilration.
- **Place of occurance:** Malpighian body
- **Filtration units:** Glomerulus and Bowman's Capsule of malpighian body acts as filtration units.
- **Glomerular filtration**:The ultrafilration takes palce in glomerulus so known as glomerular filtration
- **Role of glomerulus:**

1. The globular network of capillaries forms knot like structure in the cup shaped space of malpighian body known as glomerulus.
2. The diameter of afferent arteriole is larger than efferent arteriole. Due to this, blood enters faster in glomeerulis than it leaves it . This create a hydrostatic pressure within the glomerulus, This pressure helps in formation of glomerular fitrate

- **Effective filtration pressure (EFP):** The hydrostatic pressure with in the glomerulus is called as EFP. EFP formed by

a.Glomerular hydrostatic pressure: The blood pressure in the glomerular capillaries is GHP.**GHP is 55mmHg**.

b.Osmotic pressure: The presense of plasma proteins creates a pressure on the walls of blood capillaries is OP. The OP opposes a GHP .**The OP is 30mmHg**

c.Filtrate hydrostatic pressure: The force created by filtrate that reaches into urinary space of Bowman's capsule is called as FHP.**FHP is 15mmHg**

- **Net filtration pressure:**

  = Capillary hydrostatic – { Osmotic pressure + Filtrate hydrostatic }
  Pressure Pressure

  = CHP – { OP+FHP }

  = 55-{30+15}

  = 55-45

  = 10mmHg

- **Formation of primary urine:** Due to ultrafiltration, glomerular filtrate formed and stored in Bowman's capsule known as primary urine. Primary urine contains useful as well as harmful substances. The composition of urine is more or less similar to the body fulids.
- Useful substances:Deproteinized plasma,Glucose,Amino acids,Salts, Iron ,Water, Hormones,Vitamins and Minerals
- Harmful substances: Urea,Uric acid ,Creatinine,Pigments,Drugs and Bacteria
- Glomerular filtration rate: The rate of formation of filtrate /min is called as glomerular filtration rate.
- GFR is 125ml filtrate /min or 180-200 liters /Day
- The time required to pass entire blood through glomerulus is only 4 minutes. The Kidney receives 600-650 ml blood/minute for filtration (1200ml)

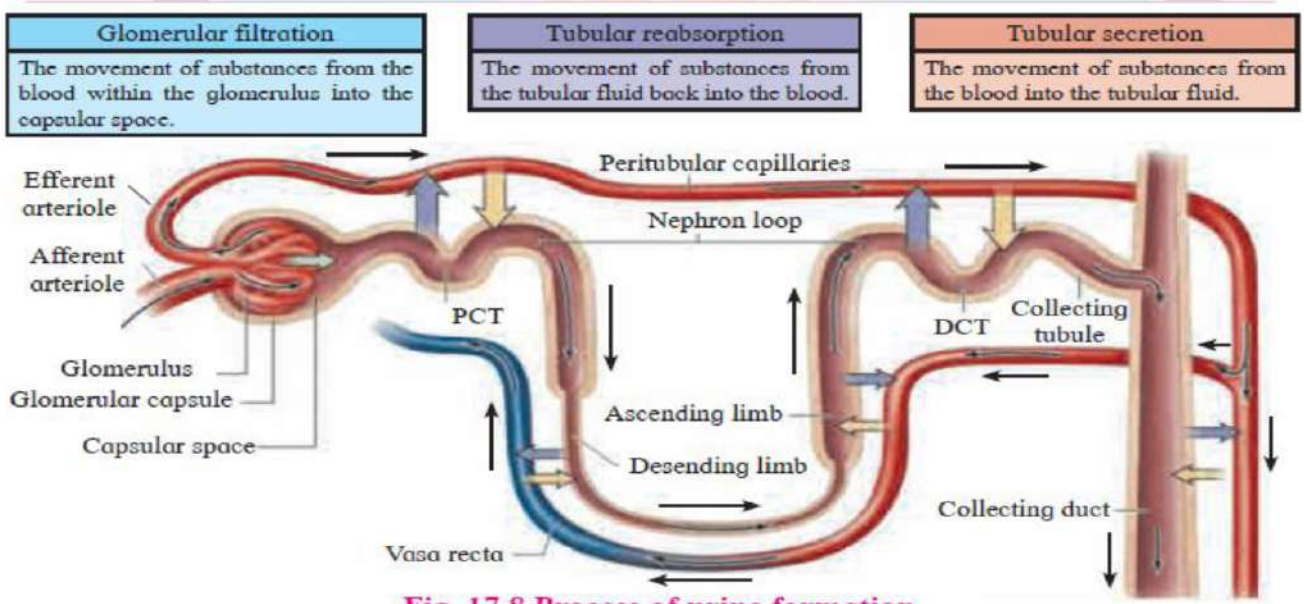


Fig. 17.8 Process of urine formation

B. Selective reabsorption: The process by which only useful substances from the filtrate are reabsorbed by renal tubule and put back into capillaries for filtration is called as selective reabsorbtion.

The 99 % filtrate is reabsorbed. The reabsorption carried out by two ways:

a. **Active reabsorption/transport:** The absorption from higher concentration to lower concentration by using ATP molecules and against concentration gradient.

b. **Passive reabsorption /transport:** The absorption from lower concentration to higher concentration along with concentration gradient.

- **Mechanism:** As filtrate moves through renal tubule ,it comes in contact with blood of peritubular capillaries. So exchange occurs in between blood and filtrate. High threshold substance are completely reabsorbed and low threshold substances reabsorbed negligibly.

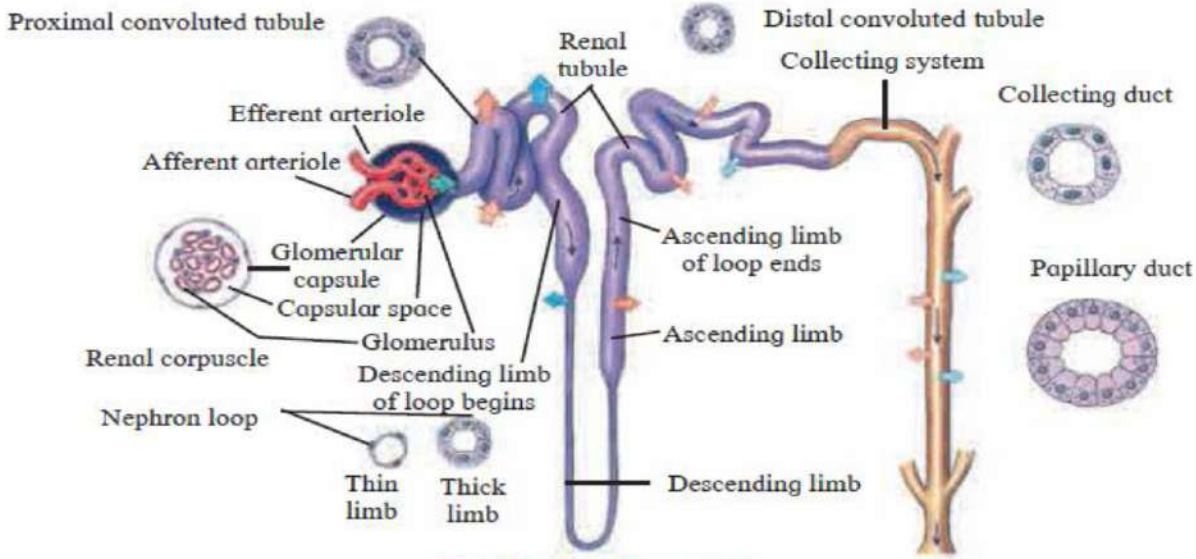


Fig. 15.9 Reabsorption

Sr. No.	Parts	Active Transport	Passive transport	Remark
1	**PCT**	70 % Na , K Large amount of Calcium,Vitamin C ,100 % Glucose & amino acids	75 % water and Chloride	No glucose left in urine
2	**Loop of Henle's**			
	a) Descending loop		5 % water	Filtrate becomes hypertonic
	b)Ascending loop	Salts & Na	K & Cl	Filtrate becomes hypotonic
3	**DCT**	Na	H_2O and Cl	Filtrate becomes isotonic

- **Factors responsible for reabsorption:**
  1. **Aldosterone:** Maintains sodium ion concentration
  2. **Calcitonin and Parathrome hormone:** Maintains calcium ion concentration.
  3. **ADH/Vasopressin:** Regulates reabsorption of water

C. Tubular secretion :

- The separation and secretion of unwanted substances from peritubular capillaries network into tubular fluid is called as tubular secretion.
- The large sized unwanted substances which are not filtrate during ultra-filtration escape through efferent arteriole.
- The unwanted substances are actively separated by the cells of renal tubule and come in the lumen of renal tubule.
- The unwanted substances are K^+ ions, H^+ ions ,Creatinine, uric acid, Urea ,Ammonia and penicillin.
- The secretion/separation of hydrogen iom takes place in DCT and collecting duct.

❖ Composition/Characters of urine:

- **Nature:** Transparent
- **Color:** Yellow due to urochrome pigment
- **Aroma:** Pungent due to urinode
- **Production per day :** 1.2-1.5 liters /Day
- **Composition:**

Constituents	Water	Urea	Salts	Uric acid	Creatinine	Ammonia
Percentage	95 %	2.5 %	1%	Traces	Traces	Traces

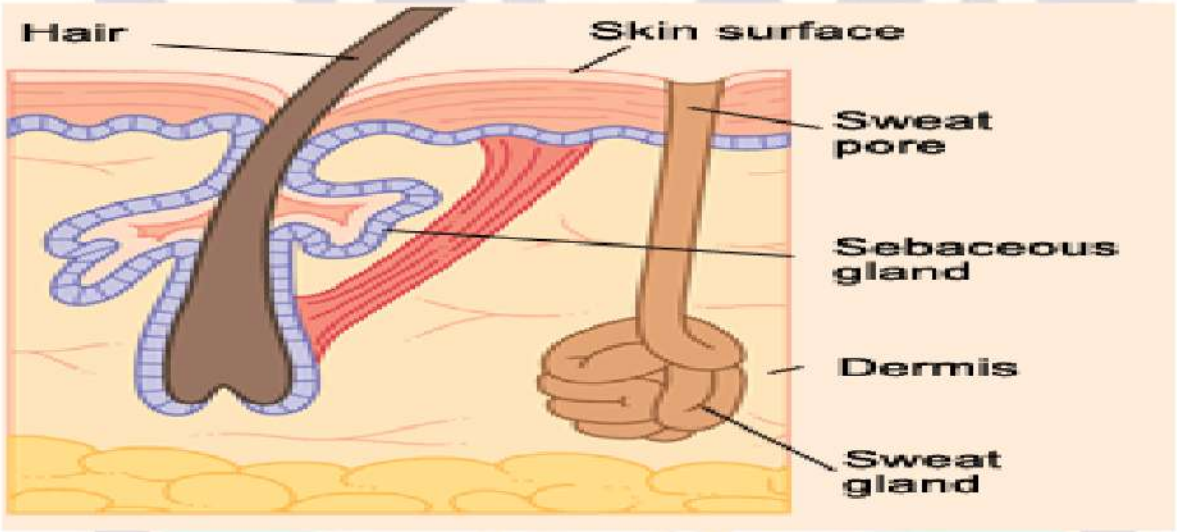
❖ Osmoregulation in kidneys/Concentration of Urine :

1. **Reabsorption of water:** Renal tubule helps in reabsorption of water to prevent dehydration. Reabsorption is important to maintain the water balance of blood and body fluids.
2. **Anti-diuretic hormone:** The ADH hormone secreted when water content of body fluid is less than normal.ADH helps to increase the permeability of water of DCT & collecting duct. Due to this,

large amount of water reabsorbed and retained. Higher amount of water in blood suppresses the activity of ADH. Due to this, water is not reabsorbed and body fluid tends to their regular level of concentration.

3. **Facultative absorption:** The urine produced may be hypertonic or hypotonic according to need of body so the absorption is called as facultative absorption.
4. **Diabetes insipidus:** Low secretion of ADH causes diabetes insipidus .In this condition, person feels thirsty and very diluted urine excreted.

❖ Role of skin in excretion:



In man, skin is thick and impermeable .It acts as organ of excretion with the help of two glands present in dermis of skin.

1. **Sweat glands:**
   - The simple, unbranched tubular gland present in dermis of skin is known as sweat gland.
   - The sweat glands distributed evenly all over the body.
   - They are abundant on palm, facia parts, armpits and sole.
   - The sweat glands secretes aqueous fluid containing glucose,
   - NaCl, water, Urea and lactic acid known as sweat.
   - The sweat helps in thermoregulation.
2. **Sebaceous glands:**
   - The glands present near the hair follicles in dermis of skin are known as sebaceous glands.
   - They secrete oily substances/wax known as sebum.
   - Sebum mixes with sweat on the surface of skin.
   - Sebum makes skin softer and lubricates hairs.
   - Sebum contains lipids, fatty acids, steroids and hydrocarbons.
   - It Protects skin from any injury and infection.

❖ Role of lungs in Excretion:

- Lungs act as both organ of respiration and excretion.
- It helps in excretion of volatile substances like CO_2 and water vapour during respiration.
- In anaerobic respiration, oxidation of glucose takes place and there is production of H_2O & CO_2. H_2O & CO_2 diffuse into alveoli and passed out into the blood.
- The most of water is used for metabolic processes and excess thrown out in the form of water vapour.
- The water vapour and CO_2 expelled out from the lungs along with expired air.

$$C_6H_{12}O_6 + 6CO_2 \text{----------} 6CO_2 + 6H_2O + 38\ ATP$$

❖ Disorders and Diseases:

Excessive albumin in urine (albuminuria) indicates injury to endothelial capsular membrane as a result of increased blood pressure, injury or irritation of kidney cells by substances such as toxins or heavy metals.

Presence of excessive quantities of ketone bodies in urine may be caused due to diabetes mellitus, starvation or too little carbohydrates in diet.

Presence of leucocytes in urine indicate possibility of infection of kidney or other urinary organs.

1. Renal Kidney failure/Renal insufficiency:

- **Definition:** A medical condition in which kidney fails to filter toxins and waste products from the body
- **Detection test:** Serum creatinine level
- **Symptoms:**
  1. Abnormal body fluid level
  2. Disturbance in acid base balance [Abnormal K, Ca and P level]
  3. Anaemia Haematuria(blood in urine) ,Proteinuria (Protein in urine)
- **Types:**

1. Acute kidney failure/Injury(AKF/AKI): Rapid progressive loss of renal function characterized by oligourea (decrease urine production).

Symptoms:

- Adults: Less than 400 ml urine production/day
- Children: less than 0.5 ml urine prod^{n} /kg/hr.

- Infants: Less than 1 ml urine prod^{n}/kg/hr.

RX:

- Dialysis
- Kidney /Renal trans placentation

2. Chronic kidney failure/Disease (CKF/CKD): CKF shows slow progressive loss of renal function.

❖ Haemodialysis:

- Derived from Greek word : dialusis/Disolution
- **Meaning:** Dia: Through Lysis: Loosening
- **Definition :** Dialysis is an artificial technique of removing toxins and waste products from the blood.

  When renal function falls below 5 to 7%, accumulation of harmful substances in blood begins. In such a condition, the person has to go for artificial means of filtration of blood.
- Dialysis acts as artificial kidneys helps in filtration of toxins and waste products from the body.
- **Mechanism:**
  1. The stream of blood taken from an artery is circulated on one side of semi permeable membrane while circulates solution of similar electrolytic compounds to the patient's blood on the other side.
  2. Waste products, toxins and water from patients blood filter through semi permeable membrane
  3. The semi permeable membrane contains too small pores to allow passage of blood cells and proteins
  4. The purified blood then returned to patient's body through vein.

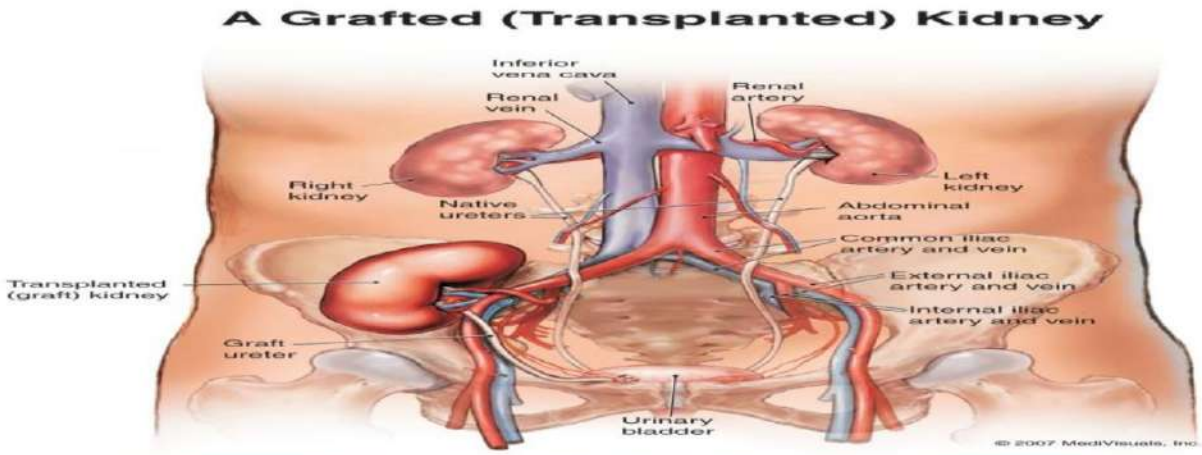
❖ Peritoneal dialysis :

- In this method, the dialyzing fluid is introduced in abdominal cavity or peritoneal cavity.
- The peritoneal membrane acts as semipermeable dialyzing membrane.
- Toxic wastes and extra solutes pass into the fluid. This fluid is drained out after prescribed period of time.
- Peritoneal dialysis can be repeated as per the need of the patient.
- It can be carried out at home at work or while travelling. But it is not as efficient as haemodialysis.
- Kidneys are associated with secretion of erythropoietin, renin and calcitriol which is not possible using dialysis machine

❖ **<u>Erythropoietin:</u>** Production of blood cells.

❖ Kidney Transplantation:

- Implantation of kidney from donar to recipients is called as kidney transplantation
- **Recipient:** The patients with end stage renal disease.
- **Donar:** The healthy person who donates kidney to the recipient
- **Types:**
  1. **Diseased Donor transplantation/Cadaveric**
  2. **Living donor transplantation**
     a) Genetically related living donor
     b) Genetically unrelated living donor
- Transplacentation depends on the degree of compatibility between donar and graft/Receipients



2.Nephrites/Glomerulonephritis/Bright's disease:

- Inflammation of kidney or nephron is known as nephritis.
- Antigen-antibody reaction localize in the kidney causes inflammation of kidney and glomeruli.
- Nephritis is characterized by haematuria, proteinuria, hypertension, oedema and oligouria.
- Cause: Streptococcal throat infection
- Prone/Susseptability: 6-16 years childrens.

3.Uraemia:

- Increase in level of urea in blood is called as uraemia.
- Normal Blood urea : 0.01-0.03 %
- In uraemia : Above 0.05%

4.Kidney stones/Ureterolithiasis:

Presence of calculi in the kidney /ureter/kidney passage

- Stones are solid concretion or crystal aggregation formed from dissolved urinary minerals.
- **Nephrolithiasis:** Stones in nephron

- **Ureolithiasis:** Stones in urinary passage
- **Ureterolithiasis:** Stones in ureter
- **Types of stones:** Depending on composition they are classified into

1. **Calcium stones :** Usually are calcium oxalate stones or calcium phosphate ones.
2. **Struvite stones :** These are formed in response to bacterial infection caused by urea splitting bacteria. These grow quickly and become quite large.
3. **Uric acid stones :** In people who don't drink enough water or consume high protein diet can suffer from this type of stones. [Due to metabolic abnormalities]
4. **Cystine stones :** It is a genetic disorder that causes kidney to excrete too much of certain amino acid.[Due to metabolic abnormalities]

- **Symptoms :** Intermittent pain below rib cage in back and side ways. Hazy, brownish/reddish/ pinkish urine. Frequent urge to pass urine. Pain during micturition.
- **Diagnosis :**
  1.Uric acid content of blood,
  2.Colour of urine
  3. kidney X-ray
  4.Sonography

❖ Regulation of Kidney functions:

1. Antidiuretic hormone /ADH:

- Osmoreceptors stimulates hypothalamus to release ADH
- ADH increases permeability of renal tubule for absorption of water and prevents excess loss of water.
- ADH also constricts blood vessels and increases blood pressure in kidney.
- ADH also increases glomerular filtration rate.

2. Renin:

- Juxta glomerular apparatus secretes rennin enzyme.
- Renin converts angiotensinogen of blood to angiotensin.
- Angiotensin converting enzyme (lungs) converts angiotensin I into angiotensin II

3. Angiotensin II :

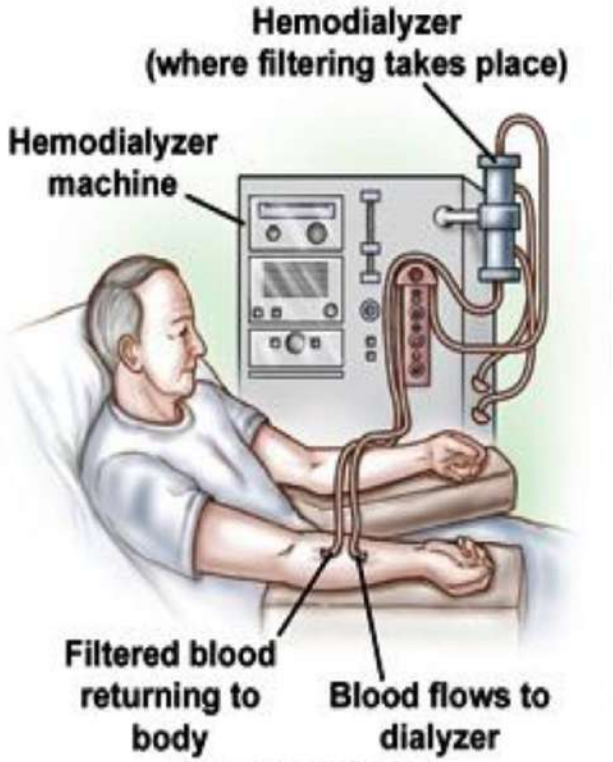
- Angiotensin II acts as vaso constrictors
- It stimulates adrenal cortex to secrete aldosterone

4. Aldosterone:

- Aldosterone increases blood pressure of kidney and GFR
- Increased Sodium excretion declines aldosterone secretion.

5. Atrial natriuretic hormone/factor [ANH/ANF]:

- Atria of heart produces ANF .
- ANF decreases blood pressure and blood volume by promoting salt and water excretion in urine.
- ANF promotes Sodium and water excretion in urine.
- ANF helps in natriuresis[Increase in excretion of Sodium in the urine]



Blood Supply to Kidney

Renal artery
↓
Renal arteriole
↓
Afferent arteriole
↓
Glomerular capillary
↓
Efferent arteriole
↓
Peritubular capillaries network
↓
Renal veinule
↓
Renal vein

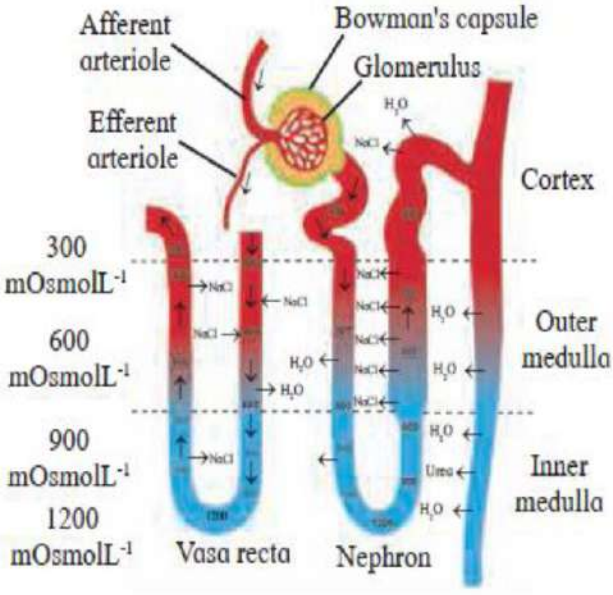


Fig. 15.10 Concentration of urine

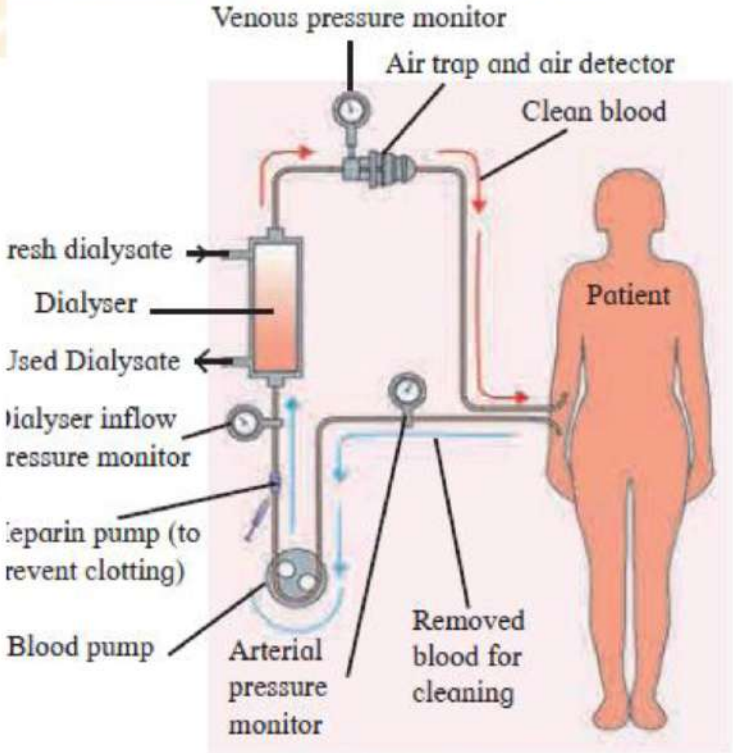


Fig. 15.12 Haemodialysis