Structure of renal corpuscle

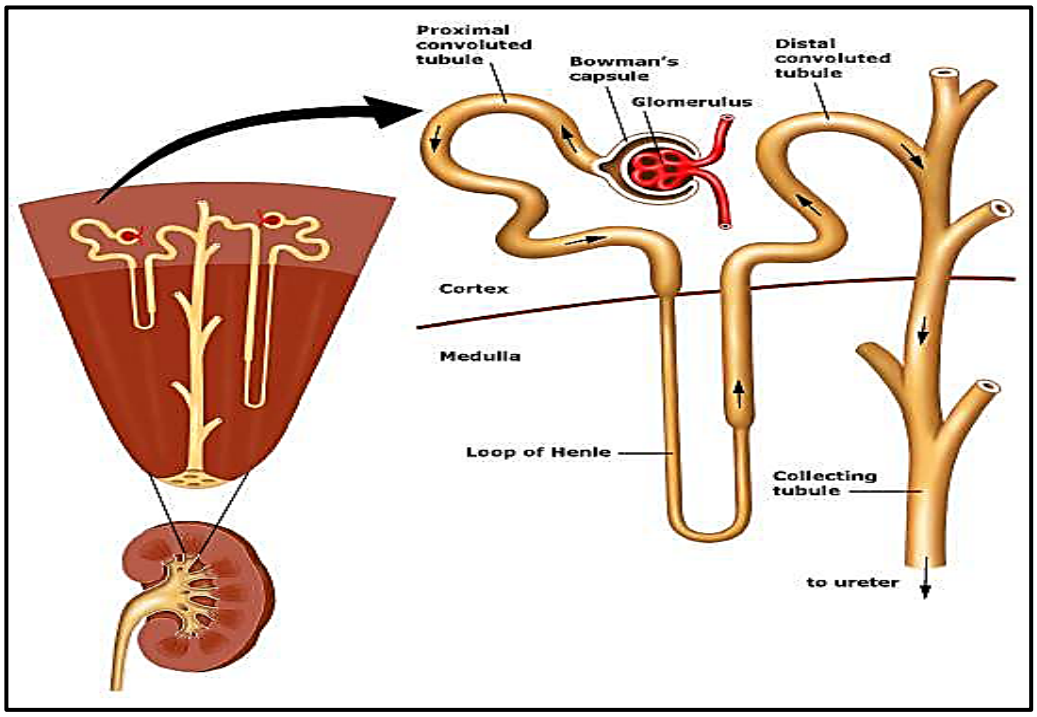
The renal corpuscle is formed by two portions:

1. ***Glomerulus***: It is a cluster of branching capillaries enclosed by Bowman's capsule.
2. ***Bowman's capsule:*** The structure of Bowman's capsule is like a funnel with filter paper, encloses the glomerulus.

Tubular portion of nephron

This portion is the continuation of Bowman's capsule. It is made up of three parts:

1. The proximal convoluted tubule.
2. The distal convoluted tubule.
3. Loop of Henle.



- **Proximal convoluted tubule**

  It is the coiled portion arising from Bowman's capsule. It is situated in the cortex. It is continued as descending limb of loop of Henle.

- **Loop of Henle**

  Loop of Henle consists of:

i. Descending Limb

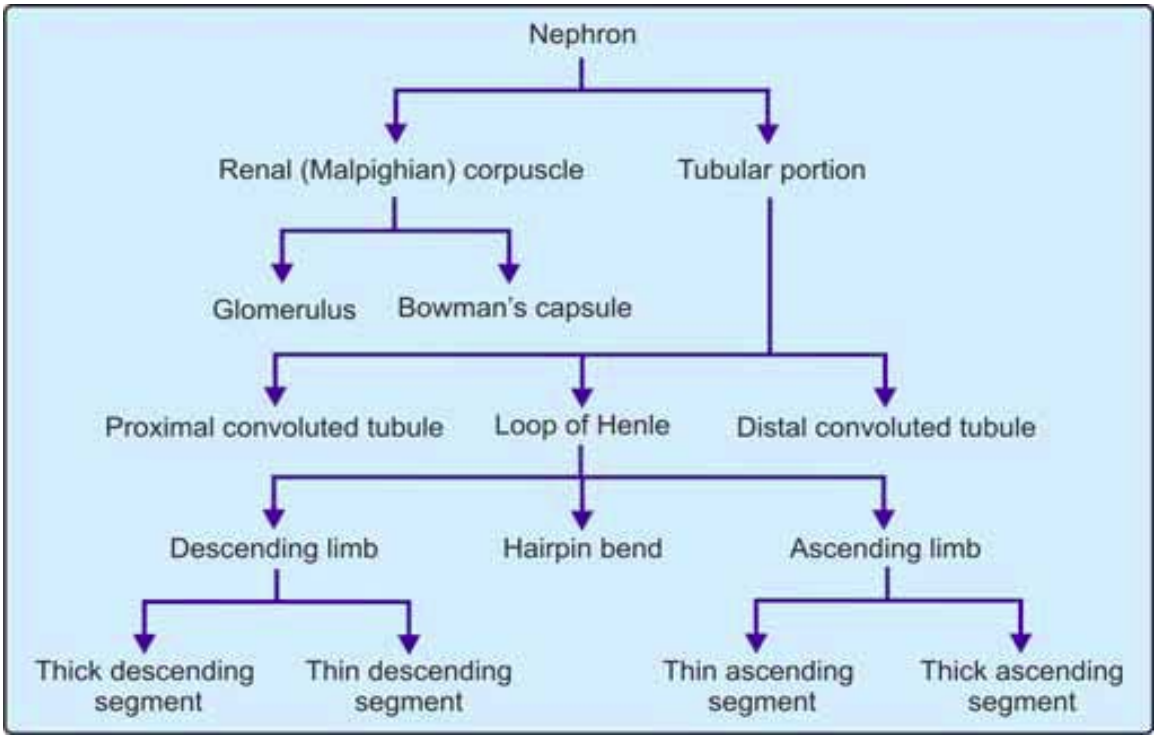
Descending limb of loop of Henle is made up of thick descending segment and thin descending segment. The thick descending segment is the direct continuation of the proximal convoluted tubule. It descends down into medulla. The thick descending segment is continued as thin descending segment.

ii. Hairpin Bend

The thin descending segment is continued as hairpin bend of the loop. The hairpin bend is continued as the ascending segment of loop of Henle.

iii. Ascending Limb

Ascending limb of Henle's loop has two parts, thin ascending segment and thick ascending segment. Thin ascending segment is the continuation of hairpin bend. The thin ascending segment is continued as thick ascending segment. Thick ascending segment ascends to the cortex and continues as distal convoluted tubule.



Collecting duct

The distal convoluted tubule continues as the initial or arched collecting duct, which is in cortex. The lower part of the collecting duct lies in medulla. Seven to ten initial collecting ducts unite to form the straight collecting duct, which passes through medulla.

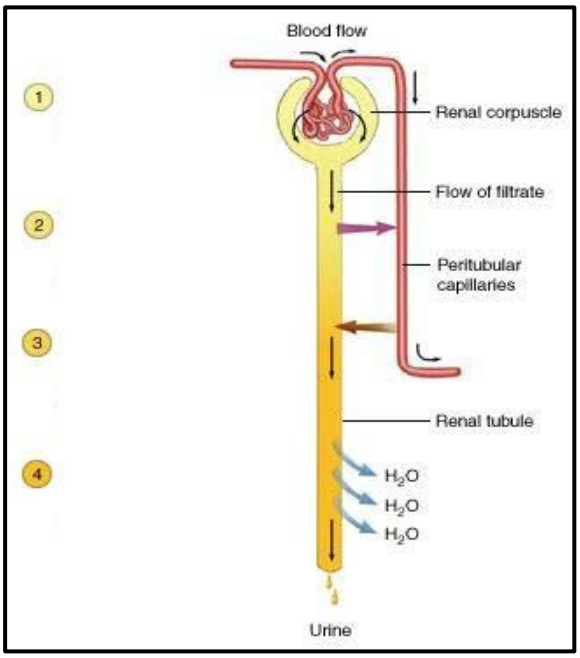
Urine formation

Urine formation is a blood cleansing function. Normally, about 26% of cardiac output enters the kidneys to get rid of unwanted substances. Kidneys excrete the unwanted substances in urine. Normally, about 1 to 1.5 L of urine is formed every day.

The mechanism of urine formation includes the following processes:

1. Glomerulus filtration.
2. Tubular reabsorption.
3. Tubular secretion.

Then **water conservation** and finally **Excretion**.



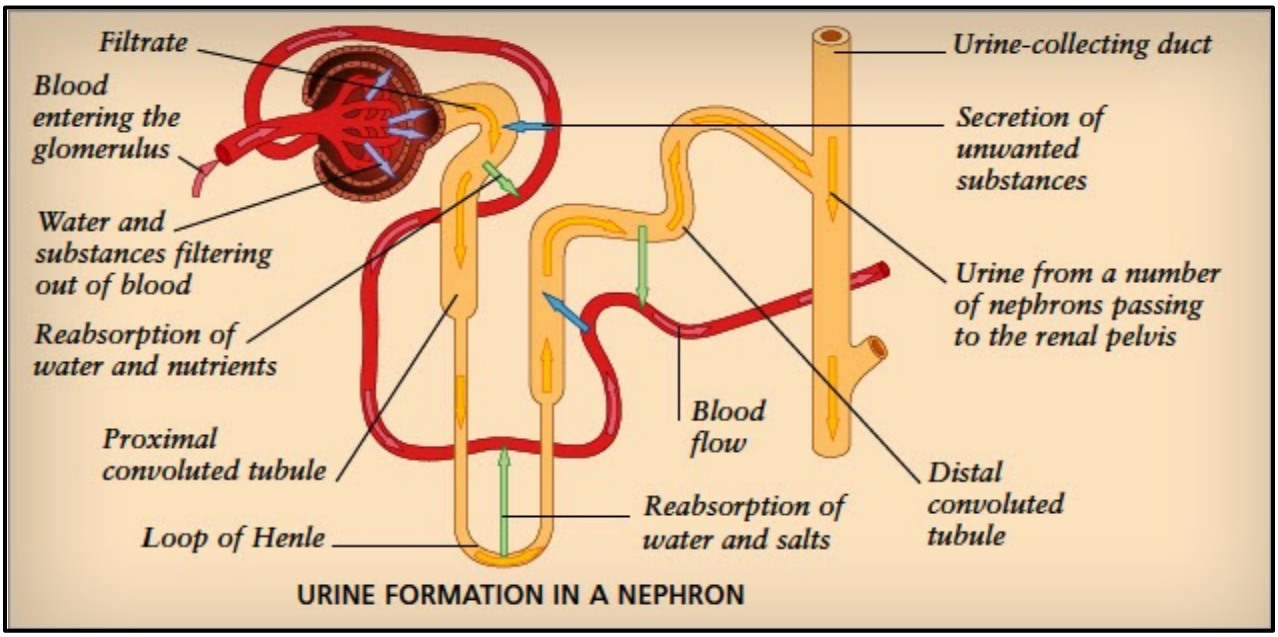
Glomerular Filtration

A process by which the blood passes through the glomerular capillaries, much of its fluid, containing both useful chemicals and dissolve waste materials, filtered through the filtration membrane where it is filtered and then flows into Bowman's capsule.

Glomerular Filtration Rate: It is the amount of fluid filtered from the blood into the capsule each minute.

Factors governing the filtration rate at the capillary beds are:

1. Total surface area available for filtration.
2. Filtration membrane permeability.
3. Net filtration pressure.



Pressure determining filtration

The pressures, which determine the glomerular filtration rate (GFR), are:

1. *Glomerular Capillary Pressure*

It is the pressure exerted by the blood in glomerular capillaries. It is about 60 mm Hg and, varies between 45 and 70 mm Hg. Glomerular capillary pressure is the highest capillary pressure in the body.

2. *Colloidal Osmotic Pressure in the glomeruli*

It is exerted by plasma proteins in the glomeruli. The plasma proteins are not filtered through the glomerular capillaries and remain in the glomerular capillaries. These proteins develop the colloidal osmotic pressure which is about 25 mm Hg. It opposes glomerular filtration.

3. *Hydrostatic Pressure in Bowman's capsule*

It is the pressure exerted by the filtrate in Bowman's capsule. It is also called capsular pressure. It is about 15 mm Hg. It also opposes glomerular filtration.

Net Filtration Pressure

Net filtration pressure is the balance between pressure favoring filtration and pressures opposing filtration. It is otherwise known as effective filtration pressure or essential filtration pressure.

The net filtration pressure **=** 60 – (25 + 15) = 20 mm Hg.
=***Glomerular capillary pressure – {Colloidal osmotic pressure + Hydrostatic pressure in Bowman's capsule}***

*** Normal net filtration pressure is about 20 mm Hg, and, it varies between 15 and 20 mm Hg.

Tubular Reabsorption

It is the process by which water and other substances are transported from renal tubules back to the blood. Large quantity of water (more than 99%), electrolytes and other substances are reabsorbed by the tubular epithelial cells.

The reabsorbed substances move into the interstitial fluid of renal medulla, then move into the blood in peritubular capillaries. Tubular reabsorbtion mainly occurs in the proximal tubule and the Loop of Henele.

Selective reabsorption

Tubular reabsorption is known as selective reabsorption because the tubular cells reabsorb only the substances necessary for the body. Essential substances such as glucose, amino acids and vitamins are completely reabsorbed from renal tubule. Whereas the unwanted substances like metabolic waste products are excreted through urine.

Mechanism of reabsorption

The basic transport mechanisms involved in tubular reabsorption are of two types:

1. *Active Reabsorption*

Active reabsorption is the movement of molecules against the electrochemical gradient. It needs liberation of energy which is derived from ATP. **By using Na+, K+ ATP pumps.** The substances reabsorbed actively from the renal tubule are sodium, calcium, potassium, phosphates, sulfates, bicarbonates, glucose, amino acids, ascorbic acid, uric acid and ketone bodies.

2. *Passive Reabsorption*

Passive reabsorption is the movement of molecules along the electrochemical gradient. This process does not need energy. The substances reabsorbed by passively are chloride, urea and water. **By using:**

- Na+ symporters (glucose, amino acid, etc.).
- Na+ antiporters (H^+).
- Ion channels.
- Osmosis.

Regulation of tubular reabsorption

Tubular reabsorption is regulated by three factors:

1. Glomerulotubular balance.
2. Hormonal factors.
3. Nervous factors.

1. Glomerulotubular Balance

It is the balance between the filtration and reabsorption of solutes and water in kidney. This process helps in the constant reabsorption of solute particularly sodium and water from renal tubule.

Mechanism of Glomerulotubular Balance

Glomerulotubular balance occurs because of osmotic pressure in the peritubular capillaries. When GFR increases, more amount of plasma proteins accumulate in the glomerulus. Consequently, the osmotic pressure increases in the blood, by the time it reaches efferent arteriole and peritubular capillaries. The elevated osmotic pressure in the peritubular capillaries increases reabsorption of sodium and water from the tubule into the capillary blood.

2. *Hormonal Factors*

The hormones which regulate GFR are: Aldosterone, Angiotensin II, Antidiuretic hormone, Parathormone and Calcitonin.

3. *Nervous Factor*

Activation of sympathetic nervous system increases the tubular reabsorption (particularly of sodium) from renal tubules. It also increases the tubular reabsorption indirectly by stimulating secretion of renin from juxtaglomerular cell. Renin causes formation of angiotensin II which increases the sodium reabsorption.

Tubular secretion

Tubular secretion is the process by which the substances are transported from blood into renal tubules. It is also called tubular excretion.

Substances secreted in different segments of renal tubules are:

1. *Potassium* is secreted actively by sodium-potassium pump in proximal and distal convoluted tubules and collecting ducts.
2. *Ammonia* is secreted in the proximal convoluted tubule.
3. *Hydrogen ions* are secreted in the proximal and distal convoluted tubules. Maximum hydrogen ion secretion occurs in proximal tubule.

*** Thus, urine is formed in the nephron by the processes of glomerular filtration, selective reabsorption and tubular secretion.