

Formation of Urine

Urine is the excretory fluid eliminated by the kidney. Formation of urine is a highly sensitive and complex process. It involves three steps. They are,

1. *Ultrafiltration*
2. *Reabsorption* and
3. *Secretion*

1. Ultrafiltration

The straining of blood by the Malpighian corpuscle for minute particles is called ultrafiltration. It is the first step in urine formation.

Malpighian corpuscle functions as the **filtering apparatus**. The Bowman capsule is like a **funnel with filter paper**. The **glomerulus** provides the **blood** for filtering.

The blood and the capsular space of the Bowman capsule are separated by capillary **endothelium**, a **basement membrane** and capsular **epithelium**. Arterial blood flows in the glomerulus. This blood is filtered by the Bowman capsule and it enters the capsular space. The fluid present in the capsular space is called **glomerular filtrate**.

The glomerular filtrate exactly resembles a **cell free** and **protein free** blood. The constituents of glomerular filtrate remain in the same ratio as those of the blood.

In 24 hours, **180 litres** of glomerular filtrate is formed. ie. **125ml/ minute**.

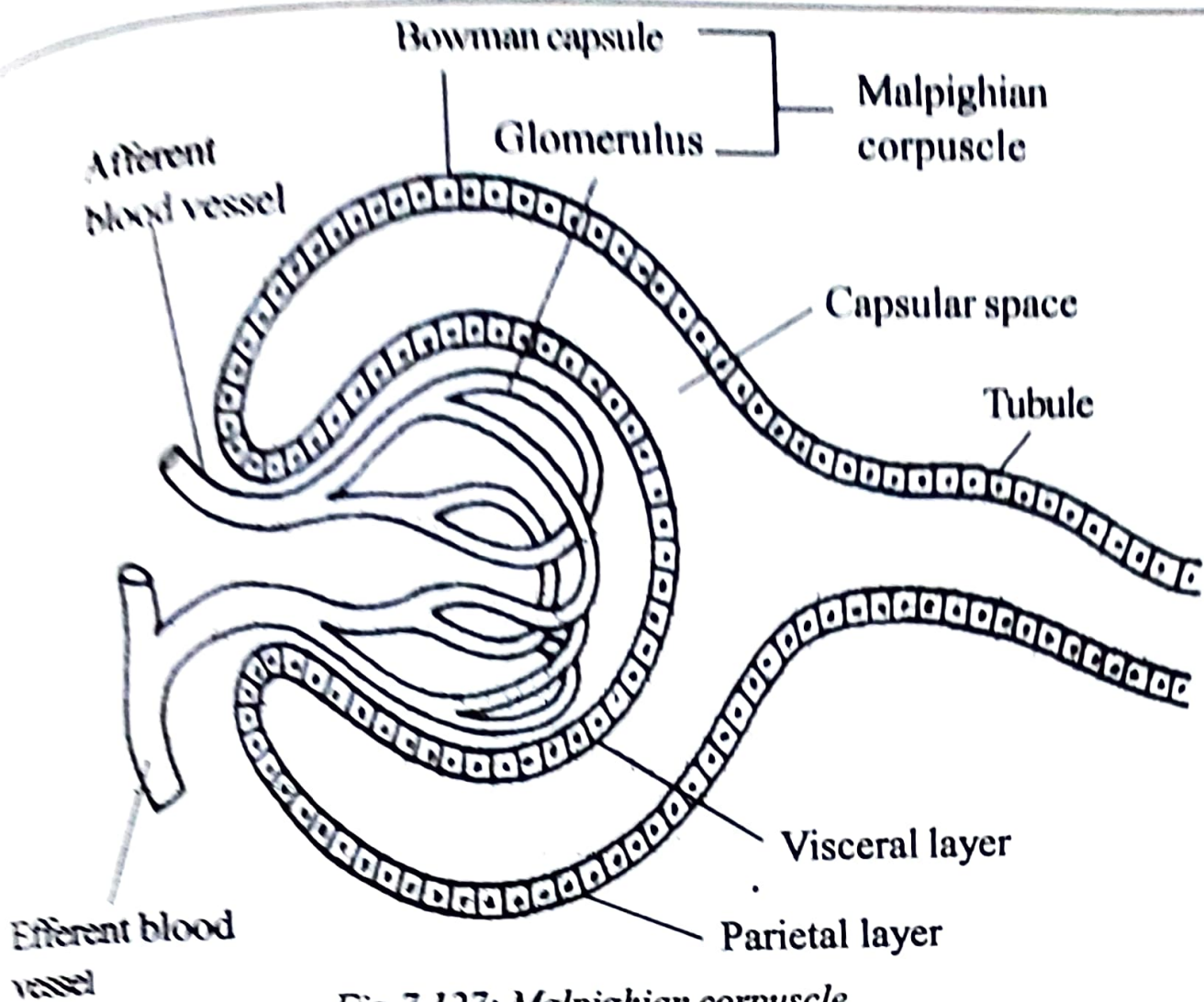


Fig.7.127: Malpighian corpuscle.

Ultrafiltration is facilitated by the following factors :

- Pores present in the Malpighian corpuscles.
- Blood pressure.
- Renal blood flow.
- Osmotic pressure.
- Hydrostatic pressure.
- Constriction of glomerular arterioles.
- Sympathetic stimulation.
- Hormonal factors.

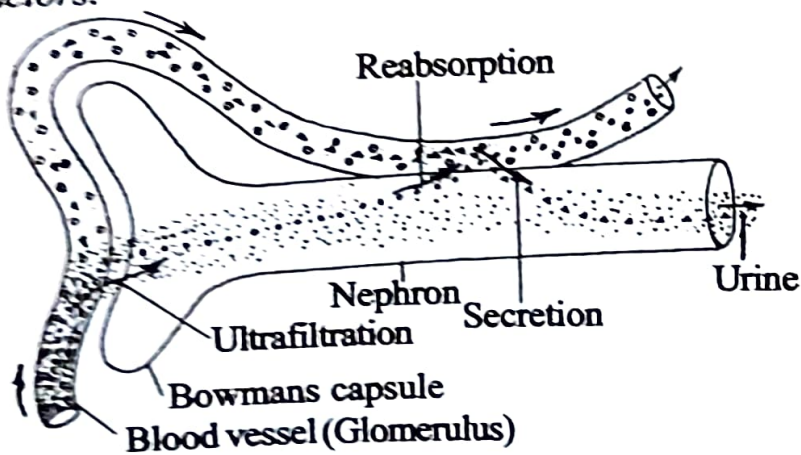


Fig.7.128: Mechanism of urine formation showing ultrafiltration, reabsorption and secretion.

2. Reabsorption

Reabsorption is the intake of useful substances into the blood from the glomerular filtrate. Every day about 180 litres of glomerular filtrate are formed. But a normal man excretes only 1 to 1.5 litres of urine, i.e about 1% of the glomerular filtrate.

The remaining bulk i.e 99% of glomerular filtrate is reabsorbed into the blood.

Reabsorption is *selective reabsorption* because useful substances are reabsorbed and the wastes are retained in the glomerular filtrate.

The useful substances of glomerular filtrate are reabsorbed into the blood by the way of the capillary network enveloping the uriniferous tubule.

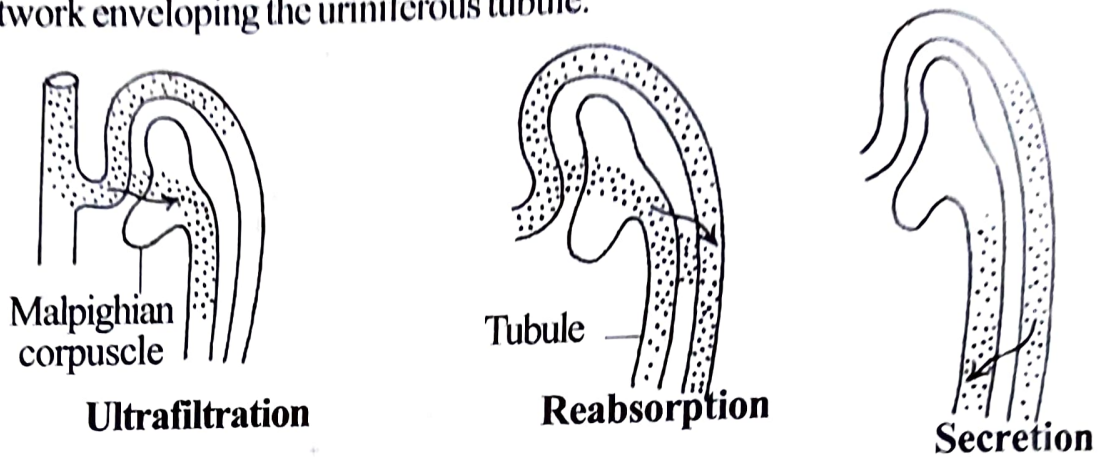


Fig.7.129: Formation of urine.

Reabsorption is the function of the renal tubule.

The following substances are reabsorbed from the glomerular filtrate of the uriniferous tubule:

1. The **amino acids, glucose, protein** and **phosphate** are reabsorbed in the first part of the proximal tubule.

2. **Sodium chloride** and **bicarbonates** are absorbed along the proximal tubule and the distal tubule.

3. **Potassium** is reabsorbed in the proximal tubule.

4. **Water** is reabsorbed from the distal tubules and collecting duct.

5. **Sodium** is reabsorbed from the ascending limb.

The rate of reabsorption varies from 100% to negligible amounts.

1. The reabsorption of glucose is 100%.

2. The reabsorption of water and sodium is 99%.

3. **Urea, uric acid, creatine**, etc. are reabsorbed in negligible amount.

As the renal fluid moves into the collecting duct, the renal fluid is called **urine**.

At the end of the duct, the urine is more concentrated than the original glomerular filtrate and is also **hypertonic** to plasma.

Thus out of the 180 litres of glomerular filtrate about 179 litres are reabsorbed.

Water reabsorption occurs by osmosis which is a **passive** and non-energy requiring process. But the absorption of glucose, amino acids and vitamins is an **active process**.

The cleaning of the blood by the kidney can be compared to the housewife who wants to clean up a dirty room. To get a clear wash she empties the room of all its portable furniture (table, chairs, pictures and so on) as well as the waste materials. Once the waste has been disposed off all the furnitures are returned to the room again.

3. Secretion

Secretion is the release of unwanted materials from the blood into the nephron. The concentration of certain substances in the final urine is higher than that present in the glomerular filtrate. Again urine contains certain additional substances which are not present in the glomerular filtrate. This shows that the urinary epithelium secretes some substances into the lumen of the urinary tubule.

This secretion mainly occurs in the convoluted tubules.

Aminohippuric acid, an excretory product is secreted into the proximal convoluted tubule.

K^+ and H^+ ions are secreted by the distal convoluted tubules.

Potassium, ammonia, urea are also secreted into the tubules.

Creatinine and *phosphates* are other substances secreted.

Moreover, a number of foreign substances introduced into the body for therapeutic or diagnostic purposes are also removed from the plasma mainly by the tubular epithelium. Such substances include *penicillin, phenolsulphonaphthalein*, etc.

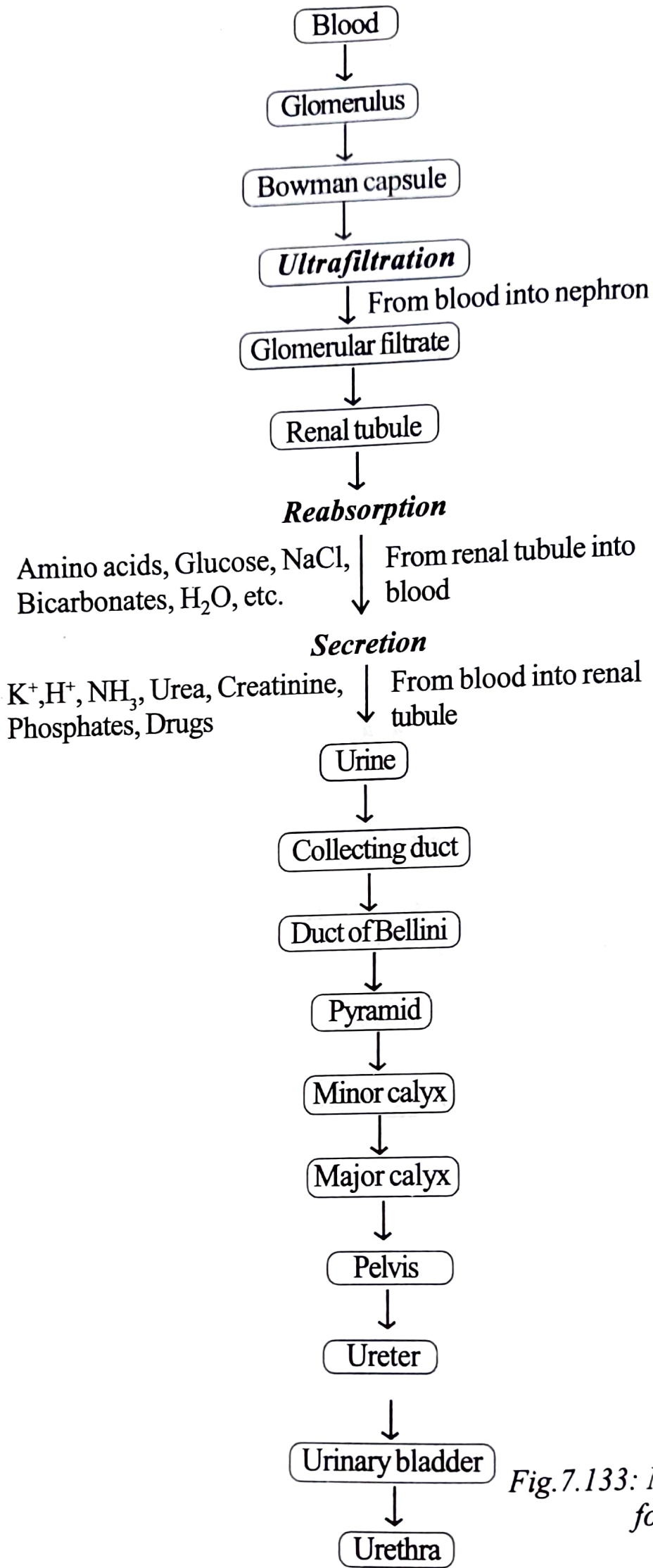


Fig.7.133: Mechanism of urine formation.

- The glomerular filtrate is similar to the blood except the absence of blood cells and proteins.
- **Reabsorption** is the intake of useful substances into the **blood** by the renal tubule from the glomerular filtrate.
- The substances reabsorbed include
 - Amino acids*
 - Glucose*
 - Sodium chloride*
 - Bicarbonate*
 - Water, etc.*
- **Secretion** is the extraction of unwanted materials by the renal tubule from the blood and pouring them into the renal tubule.
- The following substances are secreted into the renal tubule :
 - K⁺ ions*
 - H⁺ ions*
 - Ammonia*
 - Urea*
 - Creatinine*
 - Phosphates*
 - Drugs like penicillin.*
- The urine is **hypertonic**.
- The urine is passed out from the nephron through the following route:

