

EXCRETION/URINE FORMATION IN MAMMALS

Excretion is the separation of metabolic wastes inside the body, then their elimination to outside of body. During elimination certain useful substances are reabsorbed.

Metanephric kidneys are excretory organs of mammals. They are located on either side of the vertebral column. The two kidneys are asymmetrical in position. The right kidney is slightly lower than the left.

The functional unit of kidney is nephron or uriniferous tubule. Each kidney of man has about one million of nephrons. Each nephron is a coiled tube having a length of 3 cm.

STRUCTURE OF NEPHRONS:

A nephron is a twisted tubule, closed at one end and open at the other end. One end of nephron is formed of cup shaped Bowman's capsule. It is double walled. The space between two walls is called capsular space. The cavity of the cup contains a network of capillaries called glomerulus.

The glomerulus receives blood from afferent vessels and comes out from glomerulus through efferent vessels. The Bowman's capsule together with glomerulus are called Malpighian corpuscles.

The Bowman's capsule leads into many coils called proximal convoluted tubule (PCT). The PCT leads into 'U' shaped Henle's loop. It has three regions, a proximal descending limb, a middle thin segment and descending ascending limb. The ascending limb leads into another coil portion called distal convoluted tubule (DCT). It opens into collecting tubule or collecting duct.

(Signature)

The collecting duct receive several nephron.
 The collecting duct open into pyramids.

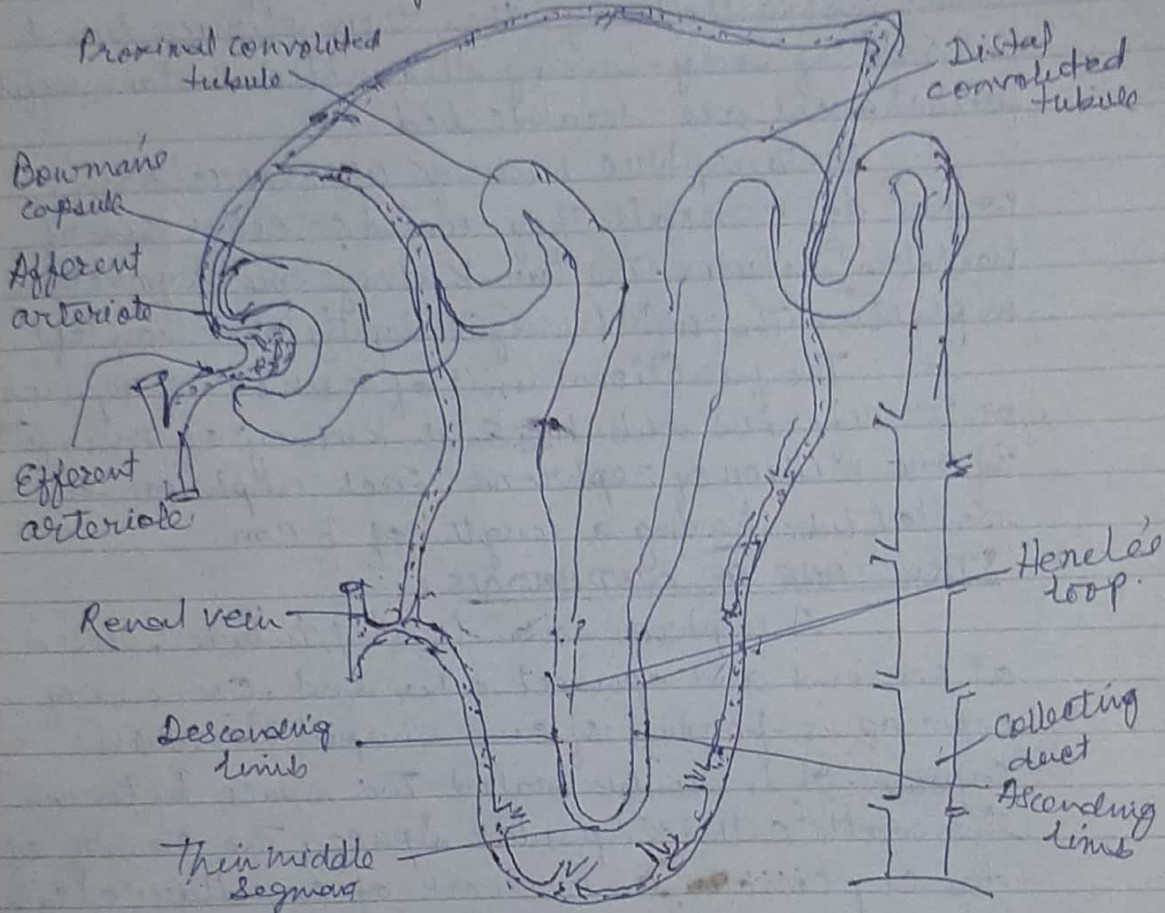


Fig - A Nephron of mammal.

URINE FORMATION:

Urine is the excretory ^{fluid} products eliminated by the kidney. Formation of urine is a highly complex and sensitive process. It involve three steps. They are

1. Ultrafiltration or glomerular filtration.
2. Selective reabsorption
3. Tubular Secretion (Augmentation).

1. Ultrafiltration :

The straining of blood by Malpighian corpuscle is called ultrafiltration. It is the first

Step in urine formation

In glomerular capillaries of Bowman's capsul, the blood pressure is about twice as that in other capillary network. Ultrafiltration is an entirely passive process.

Blood enter the glomerulus at a hydrostatic pressure (P_b) of 60 mmHg (Guyton 1996) which is tend to filter out some fine components of blood. But is resisted by three pressures:

① Osmotic pressure of plasma protein in the glomerular capillaries. $P_o = 30$ mmHg.

② Hydrostatic pressure of the fluid present in the renal tubule. $P_c = 10$ mmHg.

③ Hydrostatic pressure of interstitial fluid around the renal tubule. $P_i = 10$ mmHg.

So, net driving force responsible for ultrafiltration is difference between the blood enter the glomerulus and the sum of those pressure which resist the hydrostatic pressure and is called glomerular filtration rate (GFR).

$$\begin{aligned} \text{GFR} &= P_b - (P_o + P_c + P_i) \\ &= 60 - (30 + 10 + 10) \\ &= 60 - 50 \end{aligned}$$

$$\text{GFR} = 10 \text{ mmHg}$$

The GFR is responsible for filtering of large amount of water, glucose (120mg/minute), amino acids, vit C, Na^+ (575 gm/day) etc. and a number of harmful substances like urea, uric acid, creatinine, ammonium salts, pigments, K^+ etc. The protein complex carbohydrates, fats etc. are not filtered.

In 24 hours 180 litres of glomerular filtrate is formed.

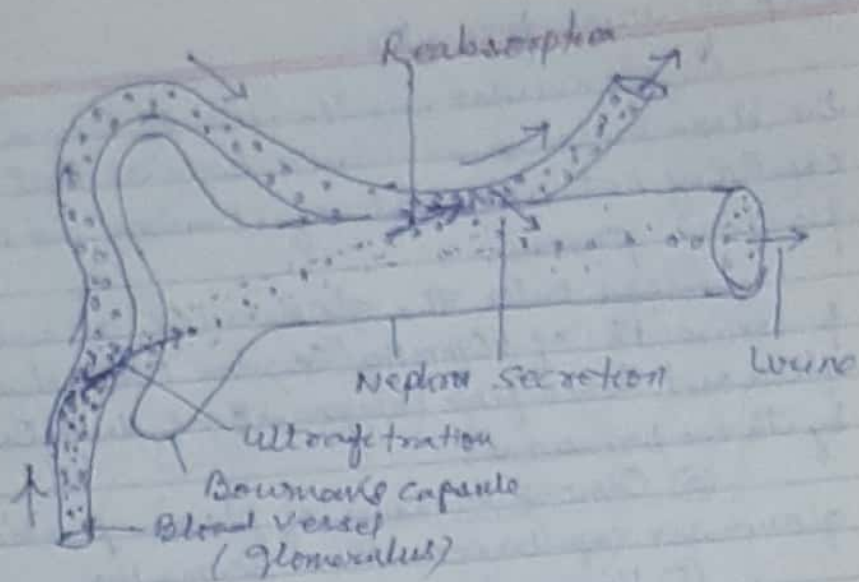


Fig. Mechanism of Urine formation showing Ultrafiltration, Reabsorption and Secretion.

② Selective reabsorption

Reabsorption is the intake of useful substances into the blood from the glomerular filtrate. The substances are divided into three categories on the basis of their amount of reabsorption.

① High threshold substances: Those substances which are ~~totally~~ totally or mostly reabsorb from nephric filtrate into blood capillaries are called high threshold substances. Ex. Water, glucose, amino acids, vit C, Na^+ etc.

② Low threshold substances: A small amount of substances are reabsorbed. Ex. Urea, Uric acid etc.

③ Non threshold substances: These are the substances which are not absorbed at all and include creatinine, hippuric acid etc.

Two mechanisms are involved in the selective reabsorption.

(i) Back diffusion: It is a physical process and operates along the concentration gradient.