STRUCTURE OF KIDNEY AND ITS FUNCTIONAL UNIT

The gross anatomy of the mammalian kidney. Each individual normally has two kidneys, one located on each side against the dorsal inner surface of the lower back, outside the peritoneum. In view of their small size (about 1 % of total body weight in humans), the kidneys receive a remarkably large blood flow, equivalent to about 20%-25% of the total cardiac output.
The kidney filters the equivalent of the blood volume every 4-5 minutes.
The outer functional layer, the cortex, is covered by a tough capsule of connective tissue.
The inner functional layer, the medulla, sends papillae projecting into the pelvis.
The pelvis gives rise to the ureters, which empty into the urinary bladder.
The urine leaves the bladder during micturition (urination) via the urethra, which leads to the end of the penis in males and into the vulva in females.
Human adults produce about a liter of slightly acidic (pH approximately 6.0) urine each day.

Q.Is there any variation in urine production rate?

Urine production rates vary diurnally, being high during the day and low at night, reflecting the time course of water intake and production of metabolic water. Urine contains water and other by-products of metabolism, such as urea, as well as NaC1, KCl, phosphates, and other substances that are present at concentrations in excess of the body's requirements. The objective is to maintain a more-or-less constant body composition,hence the volume and composition of urine reflects the volume of fluid taken in and the amount and composition of ingested food.

Q.Mention possible determining factor of urine volume?

i)The actual volume of urine produced is determined by the volume of water ingested plus the water produced during metabolism minus evaporative water loss via the lungs and sweating and, to a *lesser extent, that lost with the feces*.

ii)When voided, urine is normally clear and transparent, but after a rich meal the urine may become alkaline and slightly turbid.

Iii)The smell and colour of urine is determined by the diet. For example, consumption of methylene blue will give urine, which typically is yellow, a distinctive blue colour, and consumption of asparagus will completely change the more usual, slightly aromatic odor of urine.

Q.How release of urine is accomplished?

i)The release of urine is accomplished by the simultaneous contraction of the smooth muscle of the bladder wall and the relaxation of the skeletal muscle sphincter around the opening of the bladder.

ii)As the bladder wall is stretched by gradual filling of the bladder, stretch receptors in the wall of the bladder generate nerve impulses that are carried by sensory neurons to the spinal cord and brain, producing the "associated" sensation of fullness.

iii)The sphincter can then be relaxed by inhibition of motor impulses, allowing the smooth muscle of the bladder wall to contract under autonomic control and empty the contents.

iv)The presence of a bladder allows the controlled release of stored urine rather than a continual dribble paralleling the flow of urine from the kidney into the bladder. Such controlled release is used by some animals to mark out their territory.

Q.What is the functional unit of mammalian kidney? Make a brief note on its structure.

i)The functional unit of the mammalian kidney is the nephron (Figure 2), an intricate epithelial tube that is closed at its beginning but open at its distal end.

ii)Each kidney contains numerous nephrons, which empty into collecting ducts.

iii)These ducts combine to form papillary ducts, which eventually empty into the renal pelvis.

iv)At the closed end, the nephron is expanded-somewhat like a balloon that has been pushed in from one end toward its neck-to form the **cup-shaped Bowman's capsule**.

v)The lumen of the capsule is continuous with the narrow lumen that extends through the renal tubule.

Q.How ultrafiltration is related to glomerulus and bowman's capsule?

i)A tuft of capillaries forms the renal glomerulus inside Bowman's capsule. This remarkable structure is responsible for the first step in urine formation.

ii)An ultrafiltrate of the blood passes through the single-cell layer of the capillary walls, through a basement membrane, and finally through another single-cell layer of epithelium that forms the wall of Bowman's capsule.

iii)The ultrafiltrate accumulates in the lumen of the capsule to begin its trip through the various segments of the renal tubule, finally descending the collecting duct and eventually into the renal pelvis.

iv)The wall of the renal tubule is one cell layer thick; this epithelium separates the lumen, which contains the ultrafiltrate, from the interstitial fluid.

Q.State the modification found in nephron in relation to urine formation.

v)In some portions of the nephron, these epithelial cells are morphologically specialized for transport, bearing a dense pile of microvilli on their luminal, or apical, surfaces and deep infoldings of their basal membranes (Figure 3).

The epithelial cells are tied together by leaky **tight junctions,** which permit limited paracellular diffusion between the lumen and interstitial space surrounding the renal tubule.