The Excretory System

Excretion

Excretion is the removal of harmful and unwanted substances, especially nitrogenous wastes from the body.

Substances to Rid Off

Carbon Dioxide and Water	• Carbon dioxide is eliminated through the lungs. • Water becomes part of the rest of the water in the body.
Nitrogenous Metabolic Wastes	• Urea is excreted through the kidneys.
Excess Salts	• Salts are excreted through the kidneys.
Water	• The excess quantity of water is removed through the kidneys.
Bile Pigments	• Some of the bile pigments are excreted in the urine.

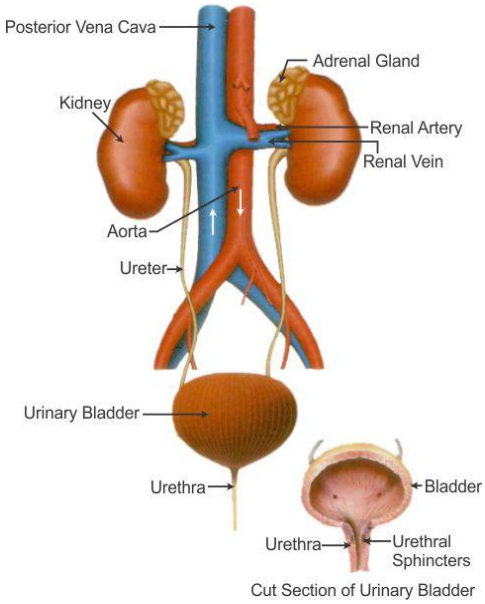
The Excretory Organs

1. The Kidneys	• Primary excretory organ.
2. Sweat Glands	• Excrete sweat which contains nitrogenous waste. • Sweat is excreted only when required, i.e. for cooling the body.
3. The Lungs	• Carbon dioxide is expired by the lungs.

The Urinary System

The human urinary system consists of

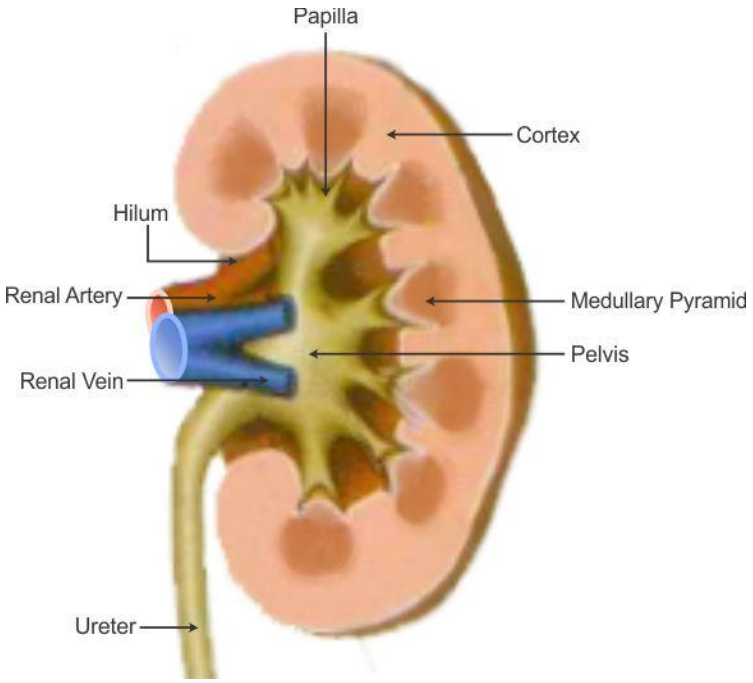
1. A pair of kidneys
2. A pair of ureters
3. Urinary bladder
4. Urethra



Human Urinary System

A Pair of Kidneys	• Dark red, bean shape, 10 cm long, 6 cm wide. • The right kidney is slightly lower in position due to the presence of the liver. • The renal artery supplies oxygenated blood to the kidneys. • The renal veins take away deoxygenated blood from the kidneys.
A Pair of Ureters	• Ureters are tube-like structures which arise from the notch, i.e. the **hilum** of each kidney. • The ureters connect behind with the urinary bladder. • The ureters carry the urine produced to the urinary bladder.
Urinary Bladder	• Muscular sac-like structure. • It stores urine temporarily.
Urethra	• Short muscular tube which expels urine out of the body. • It is long in males and very short in females. • The opening is guarded by sphincters which open at the time of urination.

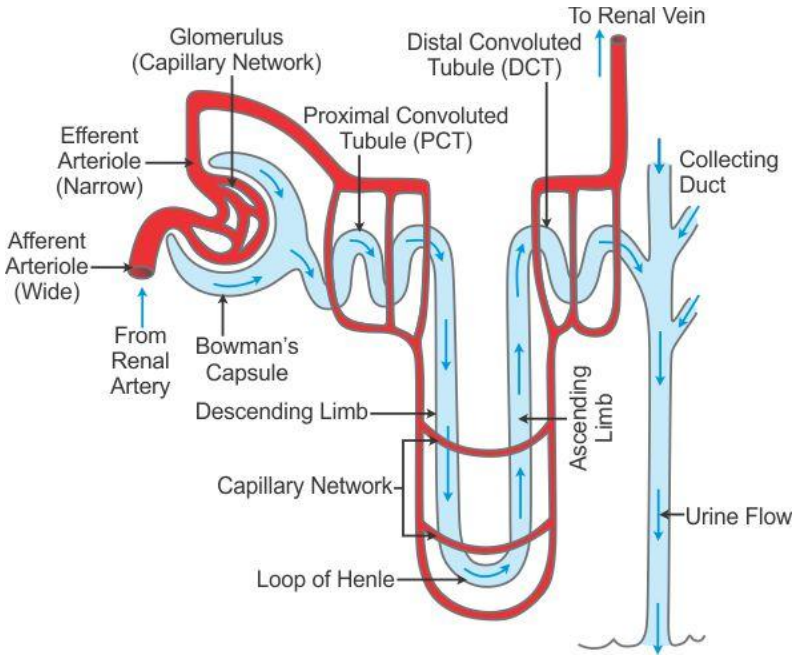
Internal Structure of the Kidneys



L.S. of Kidney

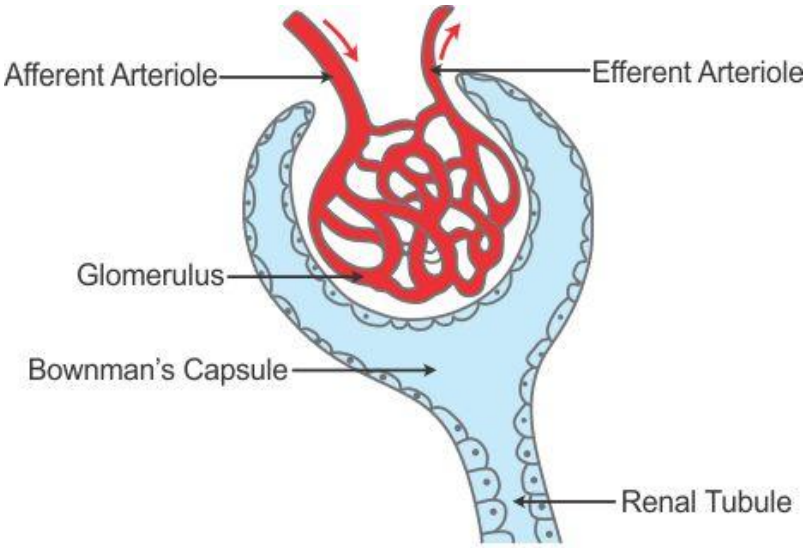
- The longitudinal section of the kidneys shows two regions—an outer dark cortex and an inner lighter medulla.
- The medulla is composed of conical pyramids.
- The apex of each pyramid, i.e. papilla, projects into the pelvis.

Uriniferous Tubule



Uriniferous Tubule

The kidneys have an enormous number of uriniferous tubules.
They are also known as **nephrons**, **renal tubules** or **kidney tubules**.
Uriniferous tubules are the structural and functional units of the kidneys.



Malpighian Tubule

Bowman's Capsule	Proximal Convoluted Tubule (PCT)	Loop of Henle	Distal Convoluted Tubule (DCT)
• It is a thin-walled, cup-like depression. • A knot-like mass of blood capillaries called **glomerulus** is located in the concave depression of the Bowman's capsule. • The Bowman's capsule and the glomerulus together are called **Malpighian tubule** or **renal tubule**.	• It is also known as the **first convoluted tubule**. • It is the first part of the convoluted region of the tubule. • PCT lies in the cortex.	• It is the U-shaped middle part of the tubule.	• It is the end part of the kidney tubule. • It opens into the collecting duct.

Blood Supply to the Kidneys

Dorsal aorta → renal artery → afferent arteriole → glomerulus → efferent arteriole → secondary capillary network (vasa recta) → renal vein → posterior vena cava

Formation of Urine

The process of urine formation occurs in two major steps:

Ultrafiltration	Reabsorption
• Due to the hydrostatic pressure built in the glomerulus, the liquid part of the blood filters out from the glomerulus and passes into the Bowman's capsule. • This filtration under extraordinary force is called **ultrafiltration**. • The filtrate is known as **glomerular filtrate**.	• The glomerular filtrate passes down the tubule; water and other substances required by the body are reabsorbed. • This entire process is called **selective reabsorption**. • Potassium ions and certain substances such as penicillin are passed into the urine through the distal convoluted tubule. • The cells of the walls of DCT are involved in bringing back into the renal tubule potassium ions and other substances; hence, this process is known as **tubular secretion**.
Part of the Renal Tubule	**Activity**
Glomerulus	Ultrafiltration
Bowman's Capsule	Receives glomerular filtrate
Proximal Convoluted Tubule (PCT)	Reabsorbs water, glucose, sodium and chloride ions
Loop of Henle	Absorption of water and sodium ions
Distal Convoluted Tubule (DCT)	Reabsorption of chloride ions and water

Urine Excretion

- The filtrate left after reabsorption and tubular secretion is called **urine**.
- The urine passes from the collecting duct to the pelvis of the kidneys. From there, it is sent to the urinary bladder through the ureters.
- By relaxing the sphincters present at the opening of the urethra, the urine is expelled from the body. This process is known as **micturition** or **urination**.

Physical Properties of Urine

- Colour: Yellow. It is due to urochrome.
- Volume: 1 to 1.5 litres. However, the volume can vary depending on the liquid intake of the person.
- pH: 5 to 8. Slightly acidic.
- Odour: Faint smell. It is ammonia-like due to bacterial activity.
- Specific gravity: 3 to 1.035
- Urine is made of 95% of water and 5% of solid wastes.

Abnormal Constituents in Urine

1. Haematuria: Due to infection in the urinary tract, kidney stone or tumour, blood passes out with urine.
2. Glycosuria: Excess glucose passes out with urine due to diabetes mellitus.
3. Due to anaemia, hepatitis or liver cirrhosis, bile is passed out in the urine.

Regulation of Urine Output

The water content in urine is controlled by **Anti-diuretic Hormone (ADH)**.
Reduction in the secretion of ADH results in more production of urine. This condition is called **diuresis**.
Substances which increase the production of urine are called **diuretics**.

Osmoregulation

While removing urea from the blood, the kidneys also regulate the composition of blood, i.e. the water and salt concentration in the blood. This function is called **osmoregulation**.
Drinking enough water helps the kidneys to function properly.
In summer, we lose a considerable amount of water through perspiration which makes the urine thicker and concentrated. Hence, the kidneys have to reabsorb more water from the urine.

Artificial Kidney

- If one kidney is damaged or removed, the other kidney alone is capable of fulfilling the excretory needs of the patient.
- However, the failure of both kidneys would lead to death.
- Such a patient undergoes dialysis. The dialysis machine is an artificial kidney in which the patient's blood is led from the radial artery through the machine where excess salts and urea are removed.
- The purified blood returns to a vein in the same arm.