

# **Excretory System**

**B.Sc Second year Zoology (Honours) Paper - 4**

**Dr. Mirza Imteyaz Baig**

**Assistant Professor**

**Department of Zoology**

**Raja Singh College, Siwan.**

**Mobile no: 09538245814**

**E- mail: bmirza7@gmail.com**

## *The Excretory System*

- The urinary system is the organ system of the body that plays a major role in maintaining the salt, water, and pH homeostasis of the blood.
- Collectively, these organs carry out the process of **excretion**, or the removal of metabolic waste from the body.
- These metabolic waste materials are the by-products of the normal activities of the cells and tissues.
- Excretion in humans is performed by the formation and discharge of urine from the body.

## *Functions of the Urinary System*

- As the kidneys produce urine, they carry out the following functions that contribute to homeostasis.

## *Excretion of Metabolic Wastes*

- The kidneys excrete metabolic wastes, notably nitrogenous wastes.

- Urea is the primary nitrogenous end product of metabolism in human beings, but humans also excrete some ammonium, creatinine, and uric acid.
- Urea is a by-product of amino acid metabolism.
- The breakdown of amino acids in the liver releases ammonia, a compound that is very toxic to cells.
- The liver rapidly combines the ammonia with carbon dioxide to produce urea, which is much less harmful.
- Creatine phosphate is a high-energy phosphate reserve molecule in muscles. The metabolic breakdown of creatine phosphate results in creatinine.
- The breakdown of nucleotides, such as those containing adenine and thymine, produces uric acid.

## ***Maintenance of Water–Salt Balance***

- A principal function of the kidneys is to maintain the appropriate water–salt balance of the blood.
- Blood volume is intimately associated with the salt balance of the body.
- Salts, such as NaCl, have the ability to cause osmosis—the diffusion of water, in this case, into the blood.
- The more salts there are in the blood, the greater the blood volume and the greater the blood pressure.
- In this way, the kidneys are involved in regulating blood pressure.
- The kidneys also maintain the appropriate level of other ions, such as potassium ions ( $K^+$ ), bicarbonate ions ( $HCO_3^-$ ), and calcium ions ( $Ca^{2+}$ ), in the blood.

## ***Maintenance of Acid–Base Balance***

- The kidneys regulate the acid–base balance of the blood.

- For a person to remain healthy, the blood pH should be just about 7.4.
- The kidneys monitor and help control blood pH, mainly by excreting hydrogen ions ( $H^+$ ) and reabsorbing the bicarbonate ions ( $HCO_3^-$ ) as needed to keep blood pH at 7.4.
- Urine usually has a pH of 6 or lower because our diet often contains acidic foods.

### *Secretion of Hormones*

- The kidneys assist the endocrine system in hormone secretion. The kidneys release renin, an enzyme that leads to **aldosterone** secretion.
- Aldosterone is a hormone produced by the adrenal glands, which lie atop the kidneys. Aldosterone is involved in regulating the water–salt balance of the blood.
- **Erythropoietin (EPO)** is a hormone secreted by the kidneys.

- When blood oxygen decreases, EPO increases red blood cell synthesis by stem cells in the bone marrow.

### ***Additional Functions of the Kidneys***

- The kidneys also reabsorb filtered nutrients and synthesize vitamin D. Vitamin D is a molecule that promotes calcium ion ( $\text{Ca}^{2+}$ ) absorption from the digestive tract.

### **Organs of the Urinary System**

- The urinary system consists of the kidneys, ureters, urinary bladder, and urethra.

### ***Kidneys***

- The kidneys are paired organs located near the back on either side of the vertebral column.
- The kidneys are bean shaped and reddish-brown in color. The fist-sized organs are covered by a tough capsule of fibrous connective tissue, called a renal capsule.

- The concave side of a kidney has a depression where a renal artery enters and a renal vein and a ureter exit the kidney.
- The renal artery transports blood to be filtered to the kidneys, and the renal vein carries filtered blood away from the kidneys.

### ***Ureters***

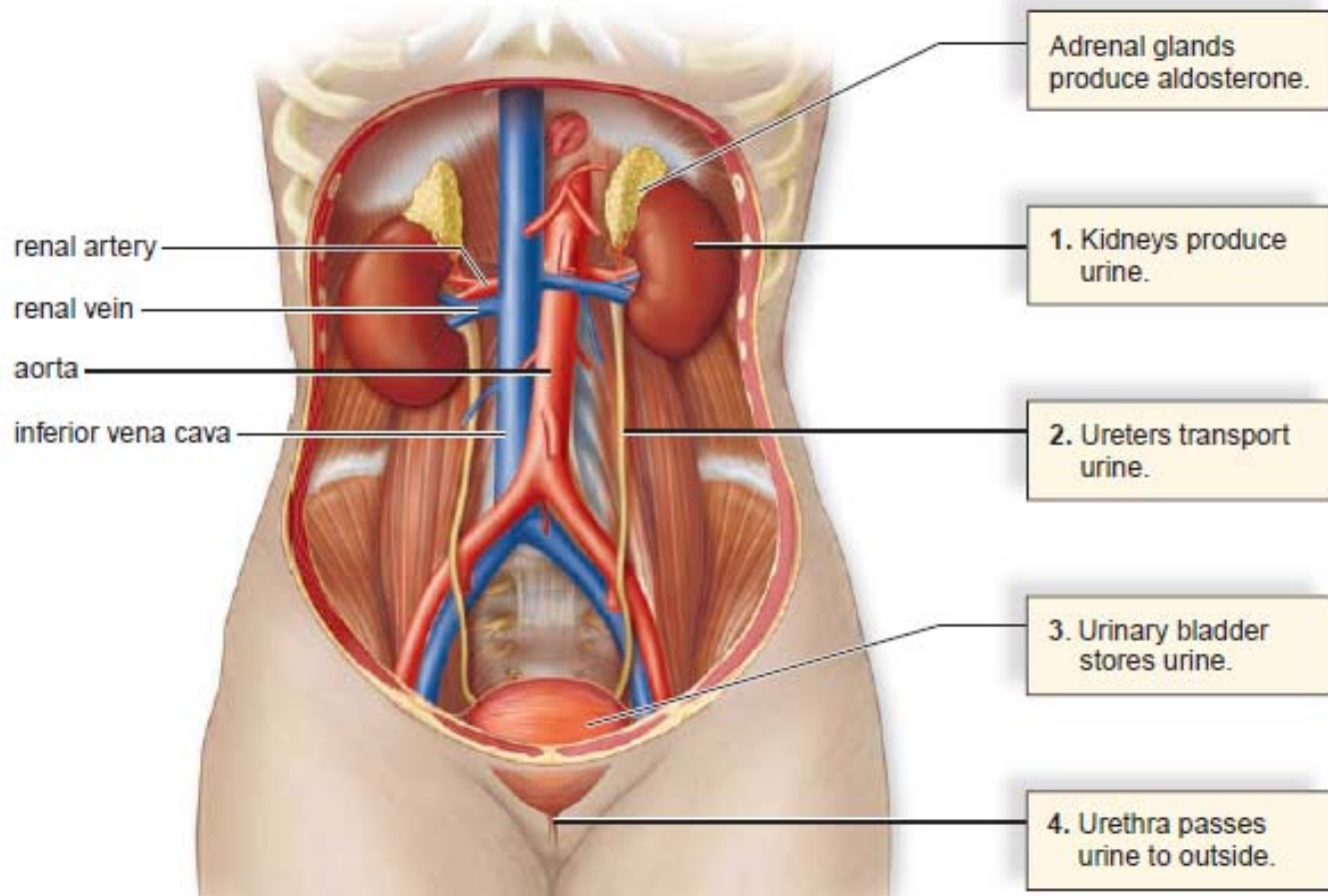
- The ureters conduct urine from the kidneys to the bladder.
- They are small, muscular tubes about 25 cm long and 5 mm in diameter. The wall of a ureter has three layers: an inner mucosa, a smooth muscle layer, and an outer fibrous coat of connective tissue.
- Peristaltic contractions cause urine to enter the bladder even if a person is lying down. Urine enters the bladder in spurts that occur at the rate of one to five per minute.

### ***Urinary Bladder***

- The urinary bladder stores urine until it is expelled from the body.

- The bladder has three openings: two for the ureters and one for the urethra, which drains the bladder.
- The bladder wall is expandable because it contains a middle layer of circular fibers of smooth muscle and two layers of longitudinal smooth muscle.
- A layer of transitional epithelium enables the bladder to stretch and contain an increased volume of urine.
- Two sphincters in close proximity are found where the urethra exits the bladder.
- The internal sphincter occurs around the opening to the urethra.
- It is composed of smooth muscle and is involuntarily controlled.
- An external sphincter is composed of skeletal muscle that can be voluntarily controlled.





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- When the urinary bladder fills to about 250 ml with urine, stretch receptors are activated by the enlargement of the bladder.
- These receptors send sensory nerve signals to the spinal cord.
- Subsequently, motor nerve impulses from the spinal cord cause the urinary bladder to contract and the sphincters to relax so that urination, also called **micturition**, is possible.

### **Urethra**

- The **urethra** is a small tube that extends from the urinary bladder to an external opening. Therefore, its function is to remove urine from the body.
- The urethra has a different length in females and in males. In females, the urethra is only about 4 cm long.
- The short length of the female urethra makes bacterial invasion of the urinary tract easier.