Physiology of Excretion

B.Sc Second year Zoology (Subsidiary) Paper - 2

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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 carryout 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 (Ca^{2+}) absorption from the digestive tract.