UNIT – HUMAN PHYSIOLOGY

Chapter 17

EXCRETION

The metabolism in animals result in formation of some waste substances or excretory substance. Carbohydrates and lipid contains carbon, hydrogen and oxygen whereas protein and nucleic acid contains carbon, hydrogen, oxygen & nitrogen. Metabolism of carbohydrates and lipids results in the formation of CO₂ and H₂O. The Metabolism of nitrogenous compounds like proteins and nucleic acids results in formation of NH₃, uric acid, urea etc... The accumulation of these excretory substances alters the pH and the homeostasis. This may result in slowing down the metabolism and cell poisoning - ultimately death of the organism. So these metabolic wastes have to be thrown out of the body by the process called excretion.

The elimination of CO₂ and H₂O takes place through respiratory system and skin. The elimination of nitrogenous waste materials through mainly kidney in human beings.

**NOTE:** Removal of undigested food material is called defecation or egestion.

17.1 Definition: “Essentially removal of nitrogenous waste material from body is defined as excretion.”

17.2 Based on excretory product animals can be grouped into 3 major groups:

1. **Ammonotelic animals**: The organisms whose principle excreta is ammonia are called ammonotelic animals and the process of elimination of ammonia is called ammonotelism.
   Ammonia is highly toxic, cannot be stored in body for long time. It is readily soluble in water hence it is principle excreta in aquatic crustaceous, annelidans, molluscs, echinoderms, bony fishes and larval form of amphibians.

2. **Uricotelic animals**: Organisms whose principle excreta is uric acid are called uricotelic animals and the process of elimination of uric acid is called uricotelism.
   Uric acid is least toxic, a least soluble in water. Hence it is principle excreta in those organisms which conserve water. Eg:- Insects, land snail, reptiles and birds.

1. **Ureotielic animals**: Animals whose principle excreta is urea are called ureotielic animals and the process of elimination of urea is called ureotelism.
   Urea is less toxic than ammonia and more toxic than uric acid. In ornithine cycle ammonia reacts with CO₂ to form urea in liver. Ureotoelic animals are cartilaginous fishes, adult amphibians and all mammals.
Extra Reading:

a) **Aminotelic organism**: Some molluscs and echinoderms excrete excess of amino acids such animals are called aminotelic animals. Elimination of nitrogenous waste in the form of amino acids are called aminotelism

b) **Guanotelism**: Elimination of guanine in the nitrogenous waste is called guanotelism. Animals which follow this process are called guanotelic animals.

   Eg: Spiders.

### 17.3 Some excretory organs in various animals:

<table>
<thead>
<tr>
<th>Excretory organs</th>
<th>Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractile vacuole</td>
<td>Protozoans</td>
</tr>
<tr>
<td>Flame cells</td>
<td>Platyhelminthes</td>
</tr>
<tr>
<td>Nephridia</td>
<td>Annelidans</td>
</tr>
<tr>
<td>Green glands &amp; Antenary glands</td>
<td>Crustaceans</td>
</tr>
<tr>
<td>Malpighian tubules</td>
<td>Insects</td>
</tr>
<tr>
<td>Kidney</td>
<td>All vertebrates</td>
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</tbody>
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Figure 17.1 a  Contractile vacuole in ameoba

Figure 17.1 b Flame cells in Platyhelminthes
The excretory organ – kidney is a major excretory organ. Apart from this, skin is also excretory organ (sweat glands and lacrymal gland).

Humans have a pair of bean shaped kidneys. They are found on either side of the vertebral column at posterior abdominal region. Right kidney is slightly lower than left kidney.

17.4 Internal structure of the kidney:

Longitudinal section of kidney reveals two distinct regions-outer renal cortex and inner renal medulla. The medulla has renal pyramids. Each pyramid has narrow renal papilla towards the pelvis and broad base towards the cortex. Each renal papilla projects into the cavity of a minor calyx. These minor calyces join together to form 2 to 3 major calyces, which open into wide funnel like structure called renal pelvis which in turn opens into the ureter.

Each kidney has about a million nephrons. Nephron is the structural and functional unit of kidney. Nephron is also called uriniferous tubule.

It has Bowman’s capsule, glomerulus, Proximal convoluted tubule (PCT), Henle’s loop, Distal convoluted tubule (DCT), collecting tubule. Urine formation takes place in nephron.
Figure 17.3 (a,b,c)
17.5 Flow chart of urine formation

Dissolved substances of blood like, urea, glucose, amino acids mineral salts etc filtered out in Bowman’s capsule under high filtration pressure. Glomerular filtrate is called primary urine.

Filtrate passes the PCT which reabsorbs useful substances from primary urine

Partial absorption of water and Na\(^+\) ions takes place from Henle’s loop

Na\(^+\) and H\(_2\)O reabsorbed under the influence of hormone in DCT

Urea, uric acid creatine hippuric secreted by tubule

Urine is formed.

17.6 Micturition: The act of expulsion of urine from body is called micturition or urination. It is controlled by autonomous nervous system.

17.7 Urine:

a) Volume – about 1\(\frac{1}{2}\) lt to 2 lt/day
b) Colour- colourless to amber. Colour is due to urochrome
c) pH value 6 to 8
d) Odour (1) Fresh urine has no odour
   (2) Stagnant urine produces pungent smell of ammonia
e) Taste- Saltish
f) Sp. Gravity 1.025
17.7.1 Chemical composition of urine:

Urine

- Water 95%
- 5% dissolved substance
  - Organic
    - Urea
    - Uric acid
    - Creatinine
    - Para amino
    - Hippuric acid (PAH)
  - Inorganic
    - Sulphates, chlorides
    - Phosphates of Na, K, Ca, Mg, NH₄, drugs, Pigments

Extra Reading:

Hormonal control of urine formation

Urine formation is under the control of two hormones—aldosterone and antidiuretic hormone (ADH).

- Antidiuretic hormone (ADH) released from the posterior lobe of pituitary gland, increases the permeability of the renal tubule to water. When the blood plasma is concentrated, more ADH is secreted and more water is reabsorbed in the urinary tubules. Hence, urine passed out from body is concentrated. When the blood plasma is diluted, less ADH is secreted and less water is reabsorbed in the urinary tubule. In this case, dilute urine is passed out of the body.

- Aldosterone, a hormone released from the adrenal cortex, influences reabsorption of sodium and potassium. This hormone regulates the amount of sodium and potassium that is to be retained in the blood and that which is to be excreted.

Summary:

- The removal of metabolic waste products from the body is termed as excretion.
Egestion is the process of passing out undigested food material from the body and it is the part of the digestive system.

The three main nitrogenous waste products excreted by animals are NH₃, urea & uric acid.

Ammonotelism is the elimination of nitrogenous waste chiefly in the form of ammonia. Animals excreting ammonia as the major nitrogenous wastes are called ammonotelic animals.

Uricotelism is the elimination of nitrogenous waste chiefly in the form of uric acid. Animals excreting uric acid as the major nitrogenous wastes are called uricotelic animals.

Ureotelism is the elimination of nitrogenous waste chiefly in the form of urea. Animals excreting urea as the major nitrogenous wastes are called ureotelic animals.

In Platyhelminthes, the excretion takes place through flame cells.

In annelidians, the excretory organs are coiled tubules called nephridia.

The excretory organs in arthropodans are malpighian tubules.

The excretory organs in crustaceans (arthropodans) are green glands.

Each kidney in LS. shows two distinct regions – an outer cortex and inner medulla.

Nephron is the structural and functional unit of a kidney.

Each nephron consists of Bowman's capsule, glomerulus, Proximal convoluted tubule (PCT), Henle’s loop, Distal convoluted tubule (DCT), collecting tubule.

Yellow colour of the urine is due to urochrome.

ANSWER THE FOLLOWING

1) What are the three types of nitrogenous waste products?
2) Classify the animals on the basis of their excretory wastes.
3) What is the principle nitrogenous waste in bony fishes and birds?
4) Name the excretory product in rat and horse.
5) Which is the principle nitrogenous waste in mammals?
6) How does the skin help in excretion?
7) What is urochrome?
8) What is the approximate number of nephrons in each kidney of a human being?