Chapter 32 - Excretion

Excretion is the getting rid of waste products of metabolism.

The main excretory organs are:

- lungs (water and carbon dioxide)
- skin (water and salts)
- kidneys (water, salts, and urea)
Epidermis
The outer layer is dead, cornified, and full of waterproof keratin. The inner layer has living, granular cells. The Malpighian layer makes new cells and contains cells with melanin.

Dermis
These cells contain a strong protein called collagen and has many blood vessels, sweat glands, hairs, sebaceous glands, and nerve receptors.

Temperature Regulation
The skin cools the body with open pores and sweat and keeps the body warm by erecting hairs to close the pores (goosebumps).
Functions of the Skin

The functions of skin are:

- **protection:**
  - epidermis protects against damage, water loss, and the entry of pathogens
  - melanin protects against UV radiation
  - sebum (oil) keeps the epidermis intact

- **vitamin production** (vitamin D is made in the skin)
- **food store** (fat stores energy)
- **sense organ** (the skin is an organ of touch, e.g. it senses touch and temperature)
- **excretion** (sweat removes water and salts from the body)

- **temperature regulation:**
  - Cold conditions cause
    - hairs to stand up to keep skin warm
    - blood vessels narrow (constrict) to retain heat
    - shivering
  - Warm conditions cause
    - sweating, which cools the body due to evaporation
    - blood vessels to widen (dilate) to lose heat
The Urinary System

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

The kidneys make urine in the following way:
- blood (containing waste) enters the kidneys through the renal arteries
- the kidneys filter waste and useful materials from the blood
- useful materials are reabsorbed from the kidneys back into the blood
- some materials are secreted from the blood into the kidneys
- urine formed in the kidneys flows to the bladder through the ureters
- blood (low in waste) leaves the kidneys in the renal veins

The bladder stores urine.

Urine is excreted through the urethra.

The functions of the kidneys are:
- excretion of water, salts, and urea
- osmoregulation:
  - control the water content of the blood (and body fluids)
  - control the salt concentration of the blood (and body fluids)
- control the pH of the blood (and body fluids)
**Nephrons - Higher Level**

These carry out the functions of the kidneys and are located in the cortex and medulla of the kidney.

A nephron makes urine as follows:

- **filtration:**
  - blood enters the nephron in the afferent arteriole
  - this forms many capillaries called the glomerulus
  - high pressure in the glomerulus forces water and small molecules out of the blood
  - glomerular filtrate is a dilute solution of waste and useful molecules
Reabsorption

Water is reabsorbed by **Osmosis**. Salt is reabsorbed by **diffusion** and **active transport**.

<table>
<thead>
<tr>
<th>Functions of the regions of a nephron</th>
<th>Amount of water reabsorbed</th>
<th>Salts reabsorbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal tubule</td>
<td>Most</td>
<td>Most (as well as glucose, amino acids and vitamins)</td>
</tr>
<tr>
<td>Descending limb of loop of Henle</td>
<td>A little</td>
<td>None</td>
</tr>
<tr>
<td>Ascending limb of loop of Henle</td>
<td>None</td>
<td>Some</td>
</tr>
<tr>
<td>Distal tubule</td>
<td>Some</td>
<td>Some</td>
</tr>
<tr>
<td>Collecting duct</td>
<td>A little</td>
<td>None</td>
</tr>
</tbody>
</table>
Urine Volume Control

**ADH (Anti-Diuretic Hormone)**: is released from the pituitary gland and controls the volume of urine formed.

Lack of water in the **blood plasma** stimulates ADH.
It causes water to be reabsorbed and less urine is made.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Effect on blood</th>
<th>ADH</th>
<th>Distal tubule &amp; collecting duct</th>
<th>Urine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thirsty or Salty diet or Hot day or Exercise</td>
<td>Low water content and high salt concentration</td>
<td>Produced</td>
<td>More permeable to water</td>
<td>Low volume of water; Higher salt concentration (i.e. a low volume of concentrated urine)</td>
</tr>
<tr>
<td>Excessive water intake or Very low salt diet</td>
<td>High water content and low salt concentration</td>
<td>Not produced</td>
<td>Less permeable to water</td>
<td>High volume of water; Lower salt concentration (i.e. a high volume of dilute urine)</td>
</tr>
<tr>
<td>High protein diet</td>
<td>Normal water content and increased concentration of urea</td>
<td>No effect</td>
<td>No effect</td>
<td>Same volume of water; Increased urea concentration (i.e. the same volume of concentrated urine)</td>
</tr>
</tbody>
</table>