# 8 The Excretory System [Elimination of Body Wastes]

***Syllabus :*** *Excretory System : Elementary treatment of the structure and function of the kidneys; the kidneys treated as comprising cortex and medulla and consisting of a branched system of tubules well supplied with blood vessels leading to the ureter (details of the courses of the tubules and their blood vessels not required).*

***Scope of Syllabus :*** External and internal structure of the kidney; parts of the excretory system along with the blood vessels entering and leaving it should be taught with the help of charts or models. Students should be able to draw the diagrams with correct labelling and know the functions of various parts. A general idea of the structure of a kidney tubule nephron should be given. A brief idea of ultra filtration, selective reabsorption and tubular secretion in relation to the composition of blood plasma and urine formed.

A large number of waste products are formed during metabolic activities in the body.

- Large amounts of $CO_2$ and $H_2O$ are produced by metabolism of carbohydrates, fats and proteins.
- Nitrogenous wastes such as ammonia, urea, uric acid, etc., are formed from proteins and other complex nitrogenous compounds.
- These nitrogenous products become toxic or harmful if retained inside and hence are sent out with the help of the excretory system.

## 8.1 EXCRETION (*ex* : out, *crete:* flow)

The process of removal of chemical wastes (mainly nitrogenous) from the body is known as 'excretion'. Excretion plays an important role in maintaining the homeostatic (steady state) condition of the body.

Organs which are concerned with the formation, storage, and elimination of urine constitute the 'Excretory system'.

**Excretory system or Urinary system ?**

Excretion should not be confused with defaecation (meaning passing out faeces, *i.e.* the undigested food from the intestine).

Similarly, passing out $CO_2$ through the lungs is a part of respiration and not excretion.

In humans, the term ***urinary system*** is more appropriate than the excretory system.

## 8.2 SUBSTANCES TO BE GOT RID OFF

There are a number of chemical substances which are regularly formed in our body or which are absorbed through the food that must be got rid of—otherwise they become harmful. Some such substances are : (1) Carbon dioxide and water (respiratory products) (2) Nitrogenous metabolic wastes (3) Excess salts and vitamins (4) Water (5) Bile pigments.

(1) **Carbon dioxide** and **water :** Every living cell liberates energy by oxidizing glucose with the production of carbon dioxide and water.

- Carbon dioxide is eliminated through the lungs.
- The water becomes a part of the rest of the water in the body.

(2) **Nitrogenous metabolic wastes :** These include urea, uric acid and ammonia. These are produced mainly in the liver from the dead protein–remains of the other tissues that are brought to it. Any extra amino acids (digestion products of protein) cannot be stored in the body. They are broken down in the liver to produce usable (also storable) glucose, and the urea that has to be excreted out. ***Urea is highly poisonous; if allowed to accumulate in the blood to a certain level, it causes death.***

- Urea is excreted out through the kidneys.

(3) **Excess salts** such as common salt (NaCl) and even some ***excess water-soluble vitamins*** (B & C) need to be eliminated.

- Salts are mainly given out by the kidneys.

(4) **Water** is taken in with food and beverages, in large quantities.

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➢ The excess quantity of water is removed which, incidentally, also serves a useful purpose of dissolving the harmful materials to carry them out.

(5) **Bile pigments** (chiefly yellow bilirubin) are the breakdown products of the haemoglobin of the dead RBCs. The liver cells extract it from the circulation and secrete it into the bile juice poured into the duodenum through the common bile duct. These pigments are modified in the intestine to pigments that give faeces their yellowish brown colour. Some of these pigments are excreted in urine.

***Excretion** is the removal of all **harmful** and **unwanted** products from the body, especially the nitrogenous wastes.*

## 8.3 THE EXCRETORY ORGANS

Excretion in humans (mammals) is brought about by the following organs :

1. **Kidneys :** These are the primary excretory organs throwing out excretory products (chiefly **urea**) in the form of urine.
2. **Sweat glands :** Excretion by sweat glands is incidental. These glands are primarily concerned with cooling (thermoregulation). The sweat secreted carries with it small amounts of nitrogenous wastes. Sweat glands pass out sweat only when required for cooling, so truly they are not excretory.
3. **Lungs :** Excretion by lungs in the form of *carbon dioxide* released in the expired air.

### PROGRESS CHECK

1. Given below is a list of substances – select the ones that need to be got rid off from the body.
   *Glucose, excess water, amino acids, urea, carbon dioxide, excess common salt, glycogen, uric acid.*
2. (i) Undigested and unabsorbed food which passes out is termed as excreta in popular language. Is it a kind of excretion ? Yes/No
   (ii) Give reason in support of your answer.

## 8.4 KIDNEYS (URINARY SYSTEM)

The **kidneys** (Fig. 8.1) are two bean-shaped organs about 10 cm long and 6 cm wide, located on either side of the backbone and protected by the last two ribs. The right side kidney is at a slightly lower level than the left one. A tube, the **ureter,** arises from the notch (**hilum**) in the median surface of each kidney and connects behind with the **urinary bladder** in the lower part of the abdomen. The front end of the ureter is somewhat expanded into the kidney and is called the **pelvis** (Fig. 8.2) (Lat. **pelvis** : basin/cup). The urine produced in the kidneys constantly flows through the ureters and collects in

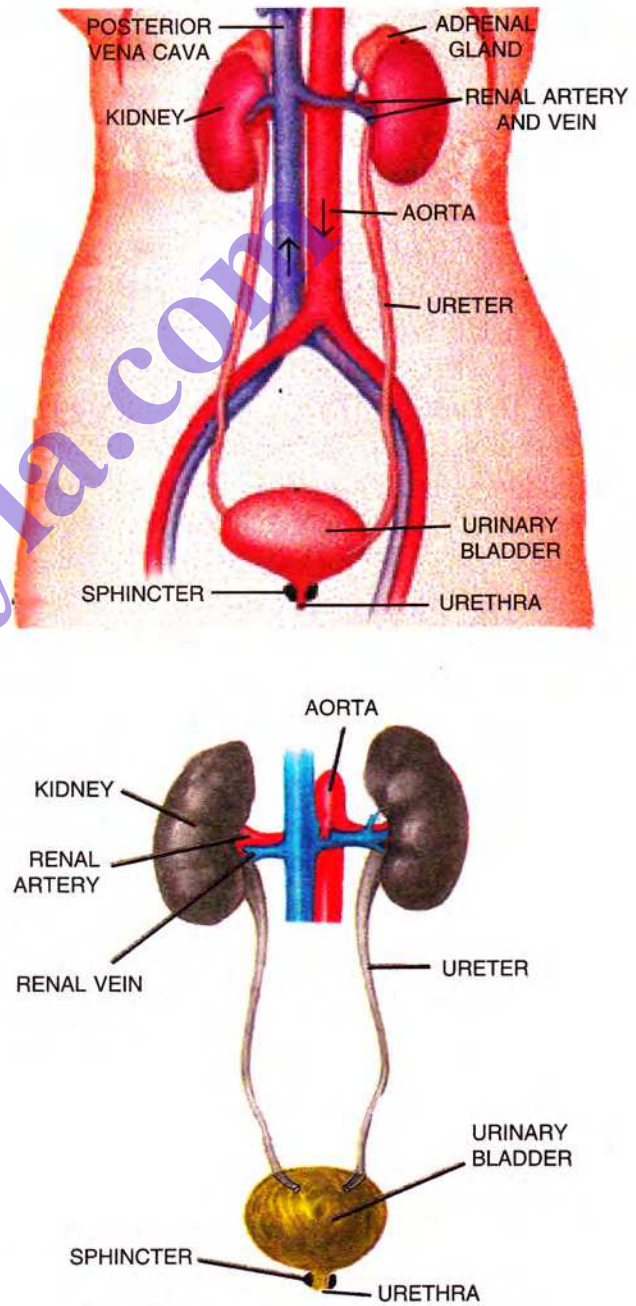


**Fig. 8.1 : Upper – The urinary system, Lower – The urinary system (diagrammatic)**

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the urinary bladder. The urine is intermittently emptied from the urinary bladder to the outside of the body through the urethra. The openings of the ureters (into the bladder) are somewhat projecting and act like valves to prevent the backflow of urine when the bladder contracts to pass out the urine. A sphincter (circular muscle) guards the opening of the bladder into the urethra and relaxes only at the time of *urination (micturition)* under an impulse from the brain.

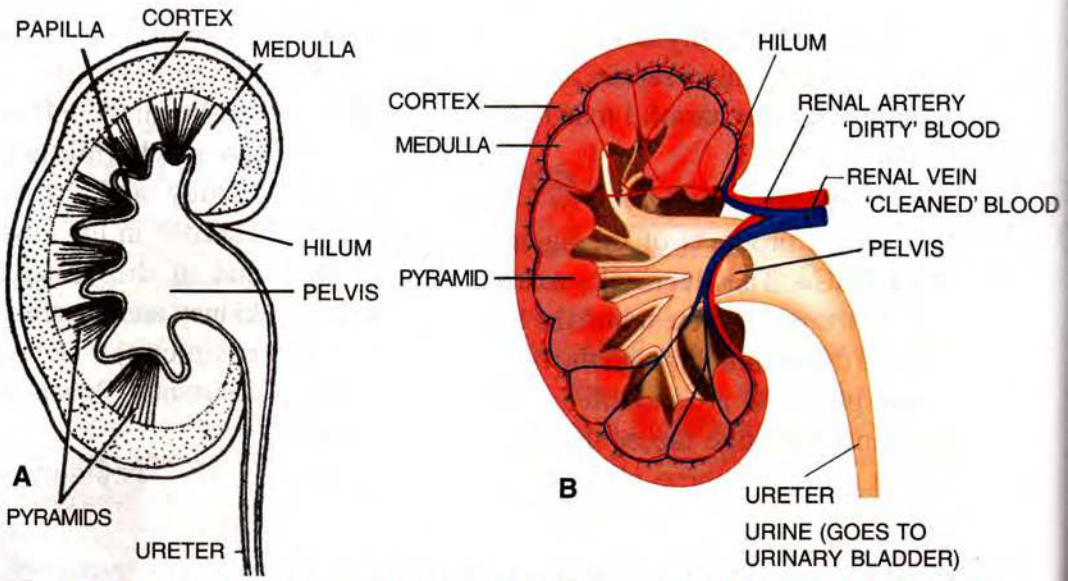


**Fig. 8.2 : A kidney in longitudinal section : A–simplified, B–along with blood supply**

### 8.4.1 Internal Structure of the kidney

A longitudinal section of the kidney (Fig. 8.2) shows two main regions—an outer dark **cortex** and an inner lighter **medulla**. The medulla is composed of a finely striped substance arranged in several **conical pyramids**. The apex of each pyramid **(papilla)** projects into the pelvis of the kidney.

The kidney is composed of an enormous number of minute tubules called **uriniferous tubules** or **nephrons** or **renal tubules** or just **kidney tubules**. These are the structural as well as functional units of the kidney.

### 8.4.2 Structure of a Kidney tubule

Each kidney tubule (Fig. 8.3) has the following parts :

**Bowman's capsule :** It is a thin-walled (single-cell thick epithelium) cup, something like a hollow ball pressed deep on one side. Its hollow internal space continues into the tubule. The outer concavity of the cup lodges a knot-like mass of blood capillaries, called **glomerulus.** The **Bowman's capsule and the glomerulus together** are called ***Malpighian capsule* or just *renal capsule*.**

**Proximal** or **first convoluted tubule (PCT)** is the starting convoluted region of the tubule ("proximal" means nearer, *i.e.* nearer to the Bowman's capsule).

**Both the Bowman's capsule and the proximal convoluted part lie in the cortex** giving it a dotted appearance in sectional view (Fig. 8.2A).

**Middle U-shaped part (Loop of Henle)** is shaped like a hair-pin; it is not convoluted. It runs in medulla to turn back and to re-enter the cortex to continue into the next convoluted region of the tubule.

**Distal convoluted tubule (DCT)** (again lying in the cortex) is the end part of the kidney tubule ("distal" means farther, i.e. farther or away from the Bowman's capsule). It opens into a **collecting duct**. The collecting duct receives the contents of many kidney tubules and pours it as urine in the pelvis of the kidney.

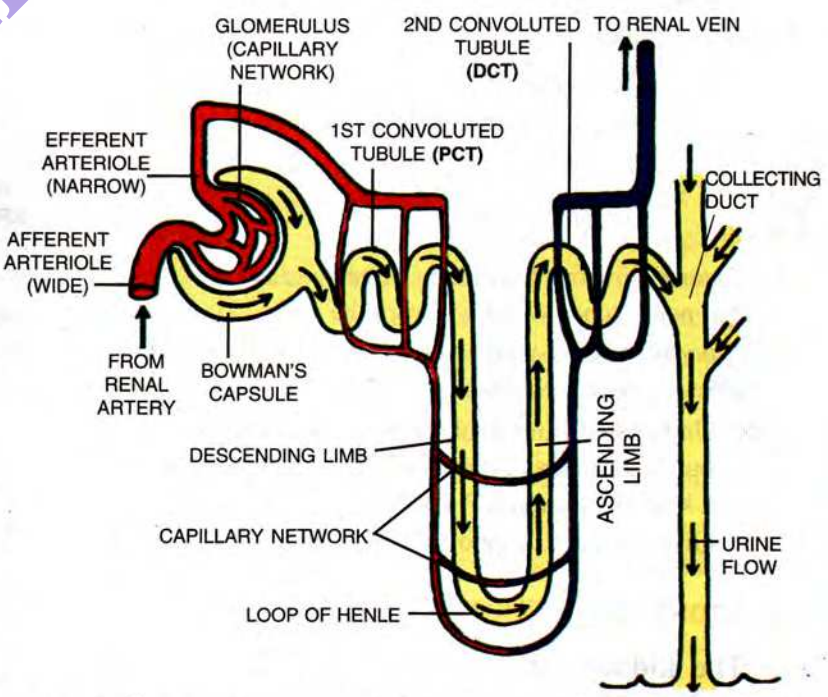


**Fig. 8.3 : A single renal (uriniferous) tubule, highly diagrammatic**

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**URINIFEROUS TUBULES**

*Tiny, so many, and for so much!*

- *Total number in both kidneys : Approximately* ***2 million***
- *Each single tubule :* ***4–5 cm long***
- *Total length of all tubules together : more than* ***60 km***

This great length provides a huge surface for reabsorption of usable substances specially water, as the contents move through them.

- *Blood flowing through kidneys* ***per minute = 1 litre***
- *Glomerular filtrate produced in* ***24 hours = 160 litres***
- *Urine produced from glomerular filtrate after reabsorption* ***per day = 1.2 litre***

## BLOOD SUPPLY TO THE KIDNEY TUBULES

A pair of renal arteries branch off from the dorsal aorta to enter the respective kidneys (Fig. 8.1). Each renal artery branches and rebranches several times to give rise to arterioles; each such arteriole enters a Bowman's capsule under the name of **afferent arteriole** (*afferent* : to bring to). This afferent arteriole breaks into a number of capillaries which form a knot-like mass **(glomerulus)** closely fitting inside the Bowman's capsule (Fig. 8.4). The reuniting capillaries of the glomerulus form the **efferent arteriole** (*efferent* : to carry away). The efferent arteriole after emerging from the Bowman's capsule runs a short distance and breaks up into a **secondary capillary network** (vasa recta) which surrounds the renal tubule, and rejoins to form a vein (Fig. 8.3) By uniting again and again with other veins of the kidney it ultimately forms the renal vein which leaves the kidney at the median surface to pour the blood into the posterior vena cava.

**350 times a day through kidneys!**

***All the body blood passes through the kidneys 350-400 times a day at the rate of 1–2 litres per minute.***

### PROGRESS CHECK

1. Name the following :
   (i) The tube arising from the notch of the kidney on the median side and connecting behind with the urinary bladder.
   (ii) The tube that passes the urine to the outside of the body.
   (iii) The inner lighter coloured region of the kidney.
   (iv) Knot-like mass of blood capillary inside Bowman's capsule.
   (v) The structural and functional unit of the kidney.
   (vi) The blood vessel which :
   (a) enters malpighian capsule.
   (b) leaves malpighian capsule
2. Given is a jumbled list of the parts of a certain body structure — Loop of Henle, Bowman's capsule, distal convoluted tubule, glomerulus, proximal convoluted tubule.
   (i) Name the structure to which the listed parts belong.
   (ii) Rearrange the parts in their proper sequence from the starting point to where they end.

### 8.4.3 Function of the Kidney–Formation of urine

The formation of urine occurs in *two* major steps; (I) **ultrafiltration** and (II) **reabsorption**.

#### (I) ULTRAFILTRATION

The blood flows through the glomerulus **under great pressure** which is much greater than in the capillaries elsewhere. The reason for this greater pressure is that the **efferent (outgoing) arteriole is narrower** than the afferent (incoming) arteriole. This high pressure (hydrostatic pressure) causes the liquid part of the blood to **filter out** from the glomerulus into the renal tubule. This filtration under extraordinary force is called **ultrafiltration**. During ultrafiltration almost all the liquid part of the blood (plasma along with most of its organic and inorganic substances including urea, glucose, amino acids, etc.) comes out of the glomerulus and passes into the funnel-shaped cavity of the Bowman's capsule (Fig. 8.4). The fluid entering the renal tubule is called the **glomerular filtrate**. The glomerular filtrate consists of water, urea, salts, glucose and other plasma solutes. The thicker part of the blood left behind in the glomerulus after ultrafiltration, namely,

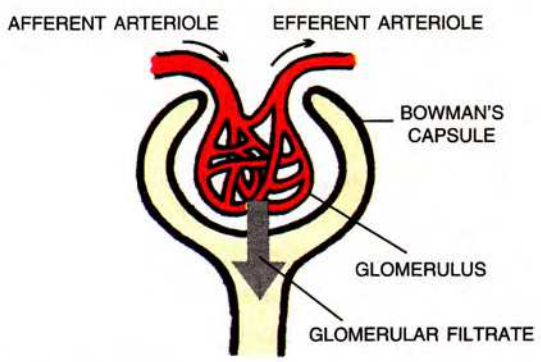


**Fig. 8.4 : Diagrammatic sketch of one malpighian capsule (Bowman's capsule + glomerulus)**

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the two kinds of corpuscles, proteins, and other large molecules are carried forward through the efferent arteriole. Thus, the blood proceeding away from the glomerulus is relatively thick.

### (II) REABSORPTION

The glomerular filtrate entering the renal tubule is not urine. It is an extremely dilute solution containing a lot of usable materials including **glucose** and some salts such as those of **sodium**. As the filtrate passes down the tubule, much of the water is reabsorbed together with the usable substances. But their reabsorption is only to the extent that the normal concentration of the blood is not disturbed. This is called ***selective absorption***.

Certain substances like potassium ($K^+$) in the normal course, and a large number of foreign chemicals including drugs like penicillin are passed into the forming urine in the distal convoluted tubule. This passage involves the activity of the cells of the tubular wall, and hence it is called ***tubular secretion***.

The filtrate left after reabsorption and tubular secretion is called ***urine***.

**Table 8.1 Steps in Urine Formation**

| Part of renal tubule | Activity |
|---|---|
| 1. GLOMERULUS | – Ultrafiltration |
| 2. BOWMAN'S CAPSULE | – Receives glomerular filtrate |
| 3. PROXIMAL CONVOLUTED TUBULE | – Reabsorbs most water (about two-thirds), and much of glucose and sodium and chloride ions |
| 4. LOOP OF HENLE | – Some absorption of water and sodium ions |
| 5. DISTAL CONVOLUTED TUBULE | – Reabsorption of remaining chlorides and some water.<br>– Walls secrete potassium and foreign chemicals such as penicillin and other drugs into the forming urine |

**Urine excretion** – Final urine passes into collecting ducts to the pelvis and through the ureter into the urinary bladder by ureteral peristalsis (waves of constriction in the ureters) and due to gravity. Urine is expelled from the urinary bladder through the urethra (in the penis in males, and directly in females) by relaxation of the sphincter muscles located at the opening of the urinary bladder into the urethra under impulse from the nervous system. Such a process is called ***micturition***.

All these functions involved in urine formation require energy, hence the oxygen demand of the kidneys is 6 to 7 times higher than what is required by muscles.

### Physical properties of urine

- **Colour :** Clear yellow (due to pigment urochrome). Colour varies with the diet.
- **Volume :** 1 to 1.5 litres per day but varies.
- **pH :** 5 to 8 i.e., usually it is slightly acidic (pH = 6). Protein diet makes it more acidic while vegetable diet makes it alkaline.
- **Odour :** On standing, the smell of urine becomes strong, ammonia-like due to bacterial activity, otherwise faint smell.
- **Specific gravity :** 1.003 to 1.035

## 8.5 CONSTITUENTS OF URINE

The normal human urine consists of about 95% of *water* and 5% of *solid wastes* dissolved in it. The percentage of the solid wastes may slightly vary according to the food taken and according to the time after taking food but usually these are approximately (in grams per litre of urine) as follows :

**Table 8.2 Constituents of Urine**

| *Organic in (g/L)* | | *Inorganic in (g/L)* | |
|---|---|---|---|
| Urea | 2·3 | Sodium chloride | 9·0 |
| Creatinine | 1·5 | Potassium chloride | 2·5 |
| Uric acid | 0·7 | Ammonia | 0·6 |
| Others | 2·6 | Others | 2·5 |

Besides the normal constituents, the urine may pass out certain hormones and also certain medicines like the antibiotics and the excess vitamins.

### *Abnormal constituents in urine*

(i) **Blood cells / Haematuria** — in this, the blood passes with urine, due to infection in urinary tract, kidney stone or tumour.

(ii) **Glucose / Glycosuria** — excess glucose passes with urine, due to ***diabetes mellitus*** (sugar diabetes).

### TASTE OF URINE ?

It may sound awkward to talk about the taste of urine. However —

- Normally, it is **saltish**.
- When **sweetish**, the condition may be due to

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sugar diabetes, urine containing the sugar glucose (due to insufficient insulin), and ants gather to lick the urine of a diabetic person.

- When **tasteless**, it is due to much water in the urine, a condition called ***diabetes insipidus*** (due to insufficient ADH hormone) ("insipid" means tasteless).

(iii) **Albumin** — Due to high blood pressure, OR due to increased permeability of the Bowman's capsule membrane on account of bacterial infection.

(iv) **Bile pigments** — anaemia, hepatitis (jaundice) or due to liver cirrhosis.

## 8.6 REGULATION OF URINE OUTPUT

**The pituitary gland** and **Diuresis** (increased production of urine) – Concentration of the urine by water reabsorption is controlled by antidiuretic hormone (ADH) secreted by the posterior lobe of the pituitary gland (Page 140). If ADH secretion is reduced, there is an **increased production of urine**, this is called 'diuresis'. Substances that increase the formation of urine are called 'diuretics', *e.g.*, liquid diets, tea, coffee, alcohol, etc.

### GOUT AND KIDNEY STONES

**Uric acid is relatively less soluble in water and may crystallize and get deposited in the joints causing gout. Excessive uric acid and certain salts like calcium oxalate may be the source of kidney stones, when the kidneys are not working fully normally.**

### PROGRESS CHECK

1. State if the following statements are ***true*** or ***false***.
   (i) The blood flows through glomerulus under great pressure.
   (ii) Glomerular filtrate consists of many substances such as water, salts, glucose and white blood corpuscles.
   (iii) Sodium chloride contained in glomerular filtrate is fully reabsorbed in the renal tubule.
   (iv) Besides the normal constituents, the urine may pass out excess vitamins but not the antibiotics.
   (v) Excessive uric acid and urine may produce kidney stones.

## 8.7 OSMOREGULATION

The kidney while removing wastes like urea from the blood also regulates its composition, *i.e.*, the percentage of water and salts. This function is called **osmoregulation** — it implies ***the regulation of osmotic pressure of the blood.***

*Drinking enough water directly or through food helps the kidneys in their proper working.* In tropical climates, as in our own country, we drink a lot of water during summer. Yet **we urinate fewer times in summer than in winter and the urine passed is generally thicker.** The reason is that in summer, we lose a considerable part of water through perspiration and the kidneys have to reabsorb more water from the urine making it more concentrated.

In **cholera**, the patient suffers from vomiting and watery bowels. His intestines are unable to absorb water into the blood. The result is that his kidneys reabsorb almost all the water from the urine in the renal tubules and with it even the urea. Ultimately the patient may die due to poisoning by the accumulation of high quantities of urea in his body (uremia). The immediate treatment is to replenish water in the blood by glucose-saline drip or by giving oral rehydration solution (ORS) through the mouth.

### *The water balance in human body*

The adult human body contains nearly 40 litres of water which forms 60% of the body weight.

Average daily loss and gain of water in an adult human male in good health at rest in temperate climate :-

| | Loss | mL | % |
|---|---|---|---|
| 1. | *In urine (by kidneys)* | *1500* | *(60%)* |
| 2. | *In sweat (by skin)* | *500* | *(20%)* |
| 3. | *In breath (by lungs)* | *400* | *(16%)* |
| 4. | *In faeces* | *100* | *(4%)* |
| | | ***Total = 2500*** | |
| | **Gain** | | |
| 1. | *In drink (as water or in beverages)* | *1500* | *(60%)* |
| 2. | *In food* | *700* | *(25%)* |
| 3. | *Metabolic water (product of cellular respiration)* | *300* | *(12%)* |
| | | ***Total = 2500*** | |

(The intake and output of water would slightly vary according to the climate and the lifestyle of a person)

## 8.8 MISCELLANEOUS INFORMATION

**Artificial Kidney :** If one kidney is damaged or removed for some reason, the other kidney alone is sufficient for excretory needs and the person can lead a normal life. But failure of both the kidneys would lead to death. Artificial kidney is a **dialysis**

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**Table 8.3 A Summary of Excretion in Humans**

| Excretory substances | Excretory organs | Remarks |
|---|---|---|
| Carbon dioxide | Lungs | As a gas in expired air |
| Minerals salts, Nitrogenous waste products : 1. Mainly urea 2. Creatinine 3. Uric acid | Kidneys | As constituents of urine |
| | Skin | As constituents of sweat, though sweat contains only small quantities of nitrogenous products |
| Water | Kidneys | Excess water excreted out as the main constituent of urine |
| | Skin | Water lost as the main constituent of sweat |
| | Lungs | Water lost as water vapour in expired air. |
| Bile pigments (from haemoglobin breakdown) | Liver | Through the intestines (via bile juice poured into duodenum). |

**machine**. The patient's blood is led from the radial artery in his arm through the machine where the urea and excess salts are removed and the purified blood is returned to a vein in the same arm. In cases of permanent damage to the kidneys, dialysis is to be repeated for about twelve hours twice a week

## *REVIEW QUESTIONS*

### A. MULTIPLE CHOICE TYPE

*(Select the most appropriate option in each case)*

1. Excretion primarily involves
   (a) removal of all byproducts during catabolism.
   (b) removal of byproducts during anabolism.
   (c) removal of nitrogenous wastes.
   (d) throwing out excess water
2. Maximum amount of water from the glomerular filtrate is reabsorbed in
   (a) proximal convoluted tubule
   (b) descending limbs of loop of Henle.
   (c) ascending limb of loop of Henle.
   (d) distal convoluted tubule.
3. Which one of the following in real sense is NOT an excretory activity ?
   (a) Giving out carbon dioxide
   (b) Passing out faecal matter
   (c) Sweating
   (d) Removal of urea.
4. In humans, urea is formed in
   (a) ureter (b) liver
   (c) spleen (d) kidney

### B. VERY SHORT ANSWER TYPE

1. Name the following :
   (a) The organ which produces urea.
   (b) The outer region of kidney containing the Bowman's capsule.
   (c) The tuft of capillaries inside the Bowman's capsule.
   (d) The part of kidney tubules where the term urine is first used for the fluid in it.
   (e) The vein in which urea concentration is maximum.
2. Given below are two sets (a and b) of five terms each. **Rewrite** the terms in their correct order so as to be in logical sequence.
   (a) Afferent arteriole, renal vein, capillary network, glomerulus, efferent arteriole.
   (b) Renal artery, urethra, ureter, kidney, urinary bladder.
3. In each one of the following sets of body parts or substances or processes, **pick out** the one item which overall includes the remaining four
   (a) Glomerular filtrate, Bowman's capsule, ultrafiltration, glomerulus, blood plasma.
   (b) Skin, liver, lungs, kidneys, excretion.
   (c) ADH, water, pituitary, osmoregulation, urine.
   (d) $CO_2$, bile pigments, water, excretion, urea.

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## C. SHORT ANSWER TYPE

1. **Write down** the functional activity of the following parts,
   (a) Glomerulus .....
   (b) Henle's loop .....
   (c) Ureter .....
   (d) Renal artery .....
   (e) Urethra .....
2. **Why** is excretion necessary ? Name the common excretory substances in our body.
3. **What** is a uriniferous tubule? How does it function?
4. **Why** is it necessary to maintain a normal osmotic concentration of the blood?
5. If you donate one kidney to a needy patient, **would** it cause any harm to you? Give reason.
6. In summer the urine is slightly thicker than in winter. **Explain** the reason.
7. **Differentiate** between the following pairs of terms :
   (a) Bowman's capsule *and* malpighian capsule.
   (b) Renal cortex *and* renal medulla.
   (c) Renal pelvis *and* renal papilla.
   (d) Urea *and* urine.
   (e) Excretion *and* katabolism.
8. **Name** the main nitrogenous metabolic waste excreted out by mammals including humans.
9. **Match** the items in **Column I** with those in **Column II** and write down the matching pairs.

| Column I | Column II |
|---|---|
| (a) Bowman's capsule | (i) Renal artery |
| (b) Contains more $CO_2$ and less urea | (ii) Regulates amount of water excreted |
| (c) Antidiuretic hormone | (iii) Renal vein |
| (d) Contains more urea | (iv) Glomerulus |

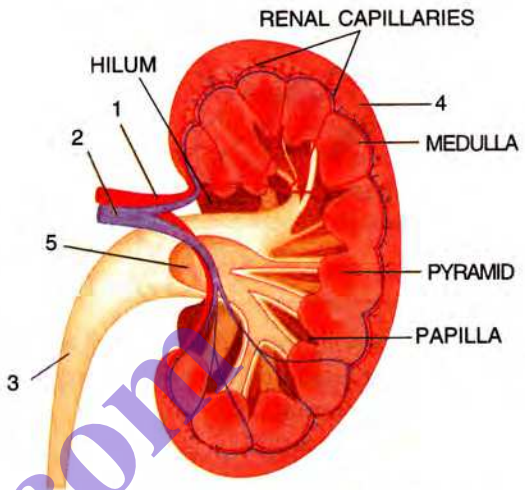
10. **Fill** in the blanks in the following passage to make it a meaningful description.
    In a nephron, the ..... flows through the ..... under great pressure. The reason for this great pressure is that the ..... (outgoing) ..... is narrower than the ..... (incoming). This high pressure causes the ..... part of the blood to filter out from the ..... into the..... capsule.

## D. LONG ANSWER TYPE

1. **Define** the following terms :
   (a) Ultrafiltration
   (b) Micturition
   (c) Renal pelvis
   (d) Urea
   (e) Osmoregulation
2. **Explain** the terms ultrafiltration and selective absorption.
3. **What** is dialysis ? Under what condition is it carried out ?

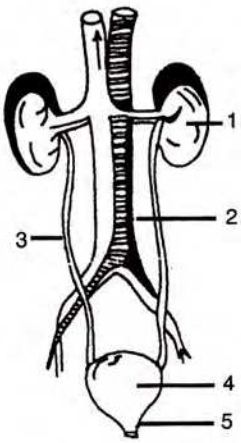
## E. STRUCTURED/APPLICATION/SKILL TYPE

1. Look at the figure given below. It is a section of human kidney as seen from the front.




   (a) **Is** it the left kidney or the right one ? Give reason in support of your answer.
   (b) **Is** it a longitudinal section or a cross-section?
   (c) **Name** the parts numbered 1-5.
   (d) **Which** area/part (give its name and the number given on the diagram) contains the following respectively :
      (i) Malpighian capsule
      (ii) The pyramids
      (iii) Freshly collected urine

2. Given alongside is the figure of certain organs and associated parts in the human body. Study the same and answer the questions that follow :
   (a) **Name** all the organ-systems shown completely or even partially.
   (b) **Name** the parts numbered 1 to 5.
   (c) **Name** the structural and functional unit of the part marked '1'.
   (d) **Name** the two main organic constituents of the fluid that flows down the part labelled '3'.
   (e) **Name** the two major steps involved in the formation of the fluid that passes down the part labelled '3'.

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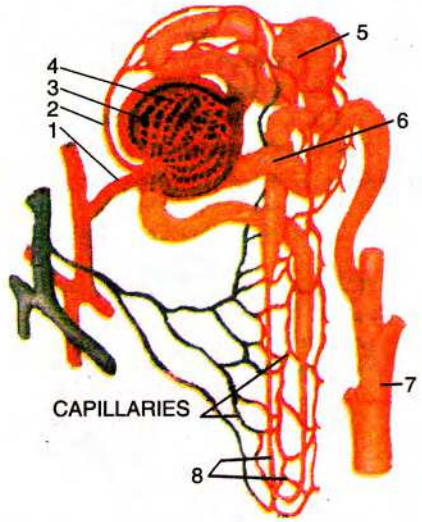
3. The following diagram represents a mammalian kidney tubule (nephron) and its blood supply.



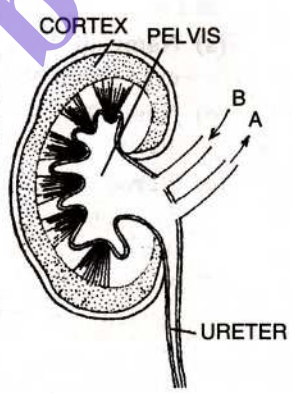

Parts indicated by the guidelines 1 to 8 are as follows :

1. Afferent arteriole from renal artery;
2. Efferent arteriole
3. Bowman's capsule,
4. Glomerulus;
5. Proximal convoluted tubule with blood capillaries;
6. Distal convoluted tubule with blood capillaries;
7. Collecting tubule;
8. U-shaped loop of Henle.

**Study the diagram and answer the questions** that follow:

(a) Where does ultrafiltration take place ?
(b) Which structure contains the lowest concentration of urea ?
(c) Which structure contains the highest concentration of urea ?
(d) Which structure (normally) contains the lowest concentration of glucose ?
(e) Where is most water reabsorbed ?

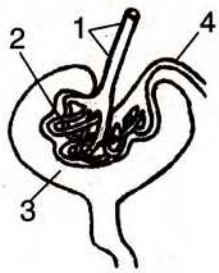
4. Given alongside is a highly simplified (but also somewhat wrong) diagram of the human kidney cut open longitudinally. Answer the questions that follow.




(a) **Define** excretion.
(b) **Name** the functional units of the kidneys.
(c) **Why** does the cortex of the kidney show a dotted appearance ?
(d) **Mention** two functions of the kidney.
(e) **Write** two differences in the composition of the blood flowing through the blood vessels, 'A' and 'B'.

[There is an error in the diagram. Can you identify it ?]
**Answer :** The blood vessels A & B do not open into the pelvis or ureter but enter into the medulla

5. Study the diagram given alongside and then answer the questions that follow:




(a) **Name** the region in the kidney where the above structure is present?
(b) **Name** the parts labelled 1, 2, 3 and 4.
(c) **Name** the stages involved in the formation of urine.
(d) **What** is the technical term given to the process occurring in 2 and 3? Briefly describe the process.

## WHAT ARE THESE — EXCRETION OR SECRETION ?

*Think of the following :*

Tears
Sweat
Saliva
Milk
Insulin
Urine

**Hint :** Think of their utility to the organism.

**SECRETION** is giving out by a cell or a gland some substance that has some utility for the body.

**EXCRETION** is the passing out of substances that have no further use in the body or are harmful.

**Answer :** Except urine, all others listed above are secretions.

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