EXCRETION IN ANIMALS AND PLANTS

7

SYLLABUS

Excretion in human beings — what is excreted and through which organs.

The renal excretory system — drawing of a simple labelled diagram.

Getting rid of wastes in plants — resins and gums.

WHAT IS EXCRETION ?

During different activities taking place in our body, the body produces many substances of which some are useful and some are useless (not required by the body). If retained in the body, they even act as poison and cause much harm and in severe cases, even death. The organs which remove these substances are called **excretory organs** and the process of removal of these substances is called **excretion**.

Substances to be Excreted

1. **Urea and uric acid** (nitrogenous wastes). These are produced as breakdown products of excess amino acids. If allowed to accumulate in the body, these are harmful.
2. **Urine pigment** (bile pigments). You usually find a yellowish tinge in the urine. This is even more prominent in summers when you urinate in less quantities. This is a harmful substance and is therefore not required in the body.
3. **Water.** Water is taken in with food and beverages in large quantities. Plentiful water in the body helps in easily "washing out", the nitrogenous wastes. The body retains some water required as a normal constituent while the excess water leaves the body in different ways.
4. **Extra Salts.** Such as the common salt (NaCl). Sodium and chlorine ions or any other ions are needed in the body only in certain proportions. Any extra quantity must be removed. Extra salts are expelled alongwith the urine.
5. **Extra Vitamins.** The vitamins absorbed from the food may be in excess. The fat-soluble ones are stored in the body to some extent, but the extra water-soluble ones such as vitamin B and C are passed out in urine. Similarly, certain medicines including antibiotics, if taken in extra quantity are passed out along with urine.

Excretion is the removal of all toxic and unwanted products (specially the nitrogenous products) from the body.

THE URINARY SYSTEM

The urinary system consists of a pair of kidneys, two ureters, a urinary bladder and a urethra.

1. **Kidneys.** The two bean-shaped **kidneys** are situated towards the back of the abdomen, one on either side of the back-bone at the level of the last two ribs. The right kidney is located slightly lower than the left one (Fig. 7.1).

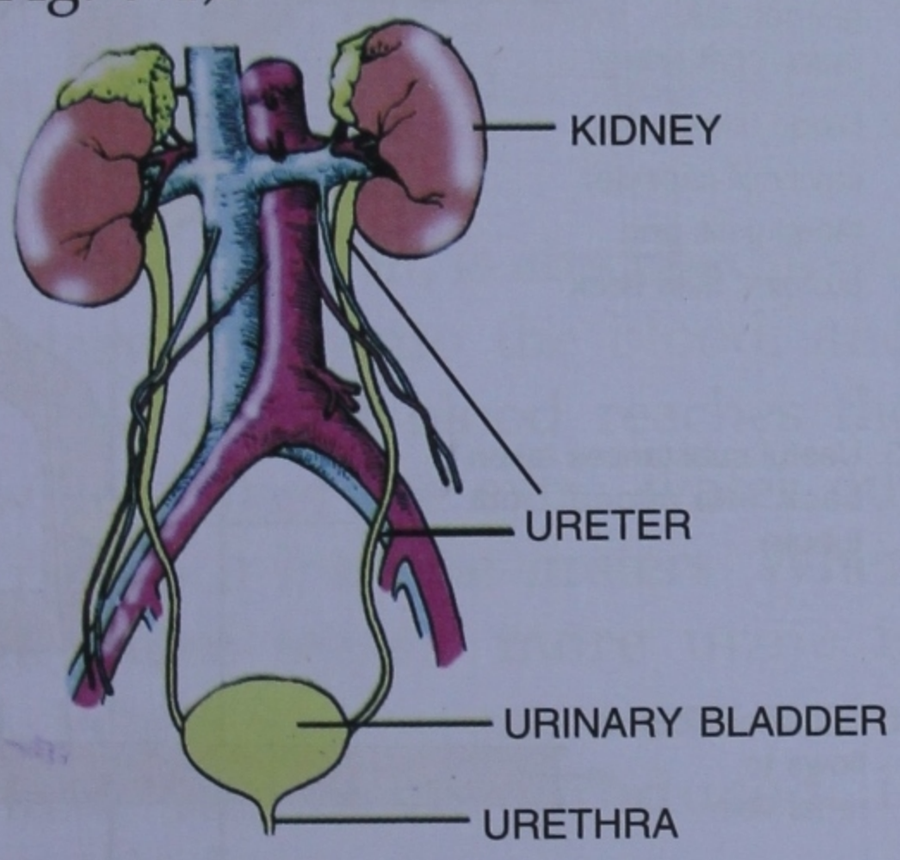


Fig. 7.1 The human urinary system (front view)

2. **Ureters.** A narrow tube called the **ureter** runs from the inner border of each kidney up to the **urinary bladder.**
3. **Urinary bladder.** It is a muscular bag situated towards the bottom of the abdomen.
4. **Urethra.** Leading from the bladder is a single median tube called the **urethra.** The urethra runs through the penis in the male, but in females it opens very close to and above the vaginal opening.

How the Bladder Empties

The base of the urethra is surrounded by a circular muscle. Normally, this muscle is tightly contracted, to close the passage. When there is an urge to empty the bladder, the circular muscle relaxes to open the passage. Simultaneously, the muscles in the wall of the bladder contract to force out the urine. This process is called **urination**.

Structure of the Kidney

Internally, each kidney is composed of an outer darker region (*cortex*) and an inner lighter region (*medulla*). The medulla drains the urine into a funnel-like pelvis which continues as a narrow ureter (Fig. 7.2).

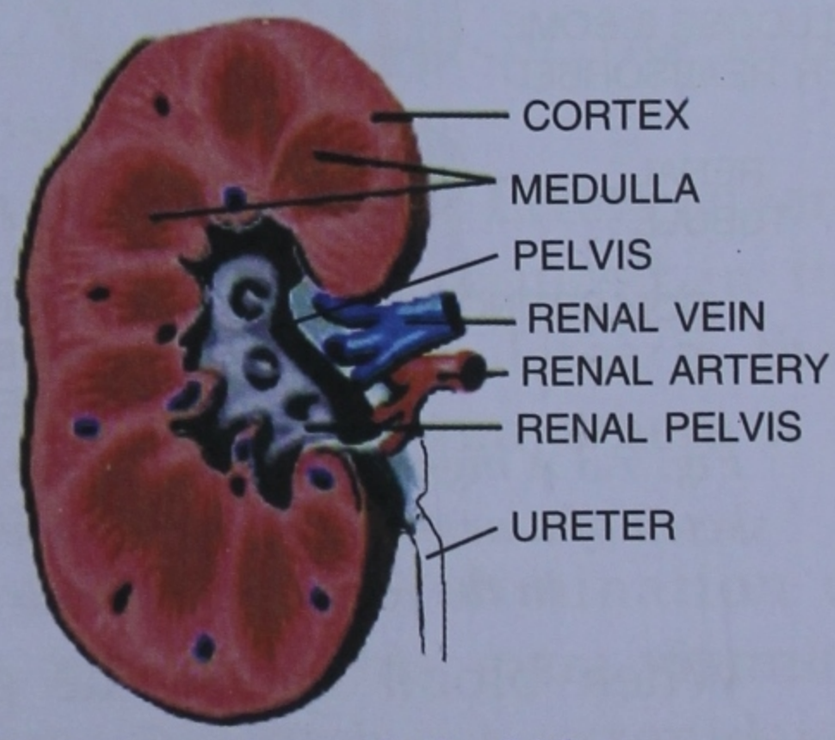


Fig. 7.2 Section through the kidney to show different regions

Inside the kidney, there are millions of microscopic tubes called ***renal tubules*** or **nephrons** (Fig. 7.3). Each nephron starts as a cup-like **Bowman's capsule** which continues behind as a narrow **tubule**. The tubule is convoluted (twisted) and opens into a collecting duct. All the collecting ducts then open into the **ureter**. Nephron

is the structural and functional unit of kidney.

Formation of Urine in the nephron

There are three distinct processes involved in urine formation — filtration, reabsorption and secretion.

(i) Filtration : Look at the Fig. 7.3. A narrow arterial branch (arteriole) is entering the Bowman's capsule. It divides into a cluster of minute capillaries called **glomerulus**. Filtration occurs in the glomerulus.

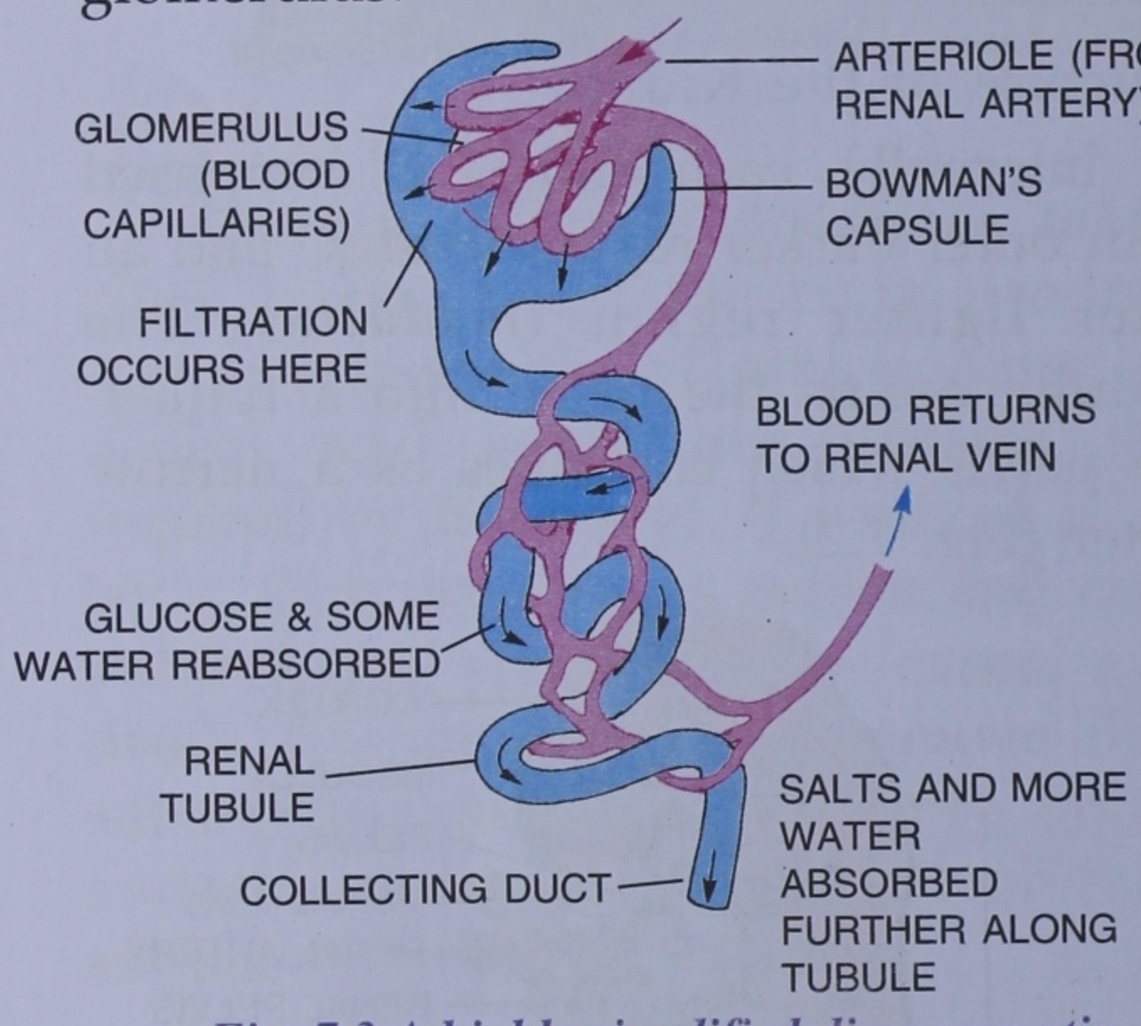


Fig. 7.3 A highly simplified diagrammatic sketch of a nephron showing the main steps in the formation of urine

When blood enters the glomerulus under pressure, some of the liquid plasma of the blood is forced out of the walls of the blood capillaries into the Bowman's capsule and then through the thin wall of the capsule into the tubule. This filtrate contains no blood cells or proteins but has water, sodium, glucose, amino acids, urea and uric acid in it.

(ii) Reabsorption : As the filtrate moves down the tubule, the useful substances such as glucose, amino acids, water, sodium, etc. are reabsorbed by the cells of the walls of the tubule in as much quantity as is needed and the rest passes downward to be passed out as urine.

(iii) Secretion : As the filtrate is passing down through the last part of the tubule, most of the potassium is secreted into it in exchange of reabsorbed sodium (Fig. 7.4).

The remaining fluid passes down through the collecting duct as *urine,* then into the pelvis of the kidney and next through the ureters into the urinary bladder.

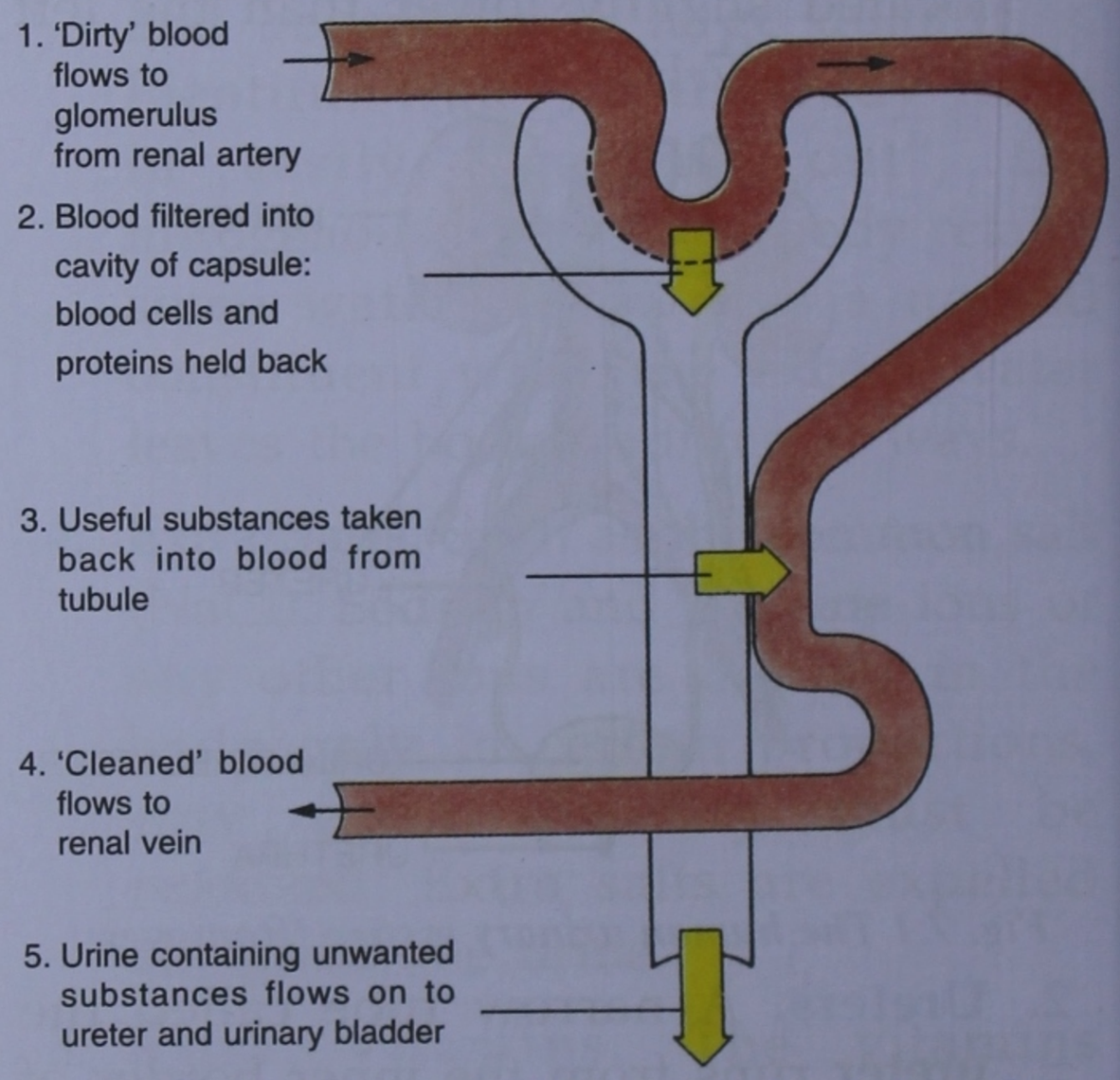


Fig. 7.4 A diagram to show very simply how the nephron cleans the blood and makes urine

Composition of Urine

The normal human urine mainly consists of **water, urea, uric acid** and some amount of **mineral salts**. Their normal percentage in urine is given in the Table 7.1 and the same has been compared with that in the normal blood.

Table 7.1 : Composition of urine and blood

Substance	Urine	Blood
Water	95	92
Proteins	0	7
Glucose	0	0·1
Chloride (salt)	0·6	0·37
Urea	2	0·03

Note down the constituents showing higher quantities in urine. The higher quantities are due to their removal from the blood so as to keep it in its normal composition. The composition of the blood will always be the same whereas that of the urine may change depending on your food.

Drinking Much Water Leads to More Urination ("a good habit for better health")

Most water taken in, is absorbed from the alimentary canal into the blood, and dilutes it. The diluted blood reaches the kidneys which takes the extra water out of it and passes it into the ureters. When you drink more water, more urine is produced. When you sweat, some water is lost and the urine produced is proportionately less.

Salt. After eating salty food, the salt is absorbed in the blood making it salt laden. The salty blood reaches the kidneys which removes the excess salt into the ureter as urine.

Accessory Excretory Organs (Skin, Lung, Liver)

Besides the kidneys, some other organs function as accessory excretory organs. In human beings, the skin, lungs and liver are such organs.

Excretory role of skin : The major function of the skin is evaporation of the sweat for cooling. Sweat is secreted by sweat glands which are located underneath the skin. These glands have ducts which open on the surface of the skin. Through these ducts, sweat comes out of the body. Now you can understand why you feel cool after evaporation of the sweat water from your skin. Thus, the main function of the skin is to cool the body. Our skin also plays a minor role in the excretion of certain waste products, like excess water, salts and traces of urea and uric acid along with sweat.

Excretory role of lungs : You have learnt that the carbon dioxide produced during the breakdown of carbohydrates passes from the blood into the lungs. From the lungs, it goes up the bronchi and wind pipe to be breathed out of the body through nose.

Excretory role of liver : Liver converts highly toxic ammonia produced in the body into less toxic urea. Urea is then carried to the kidneys from where it is excreted out in the urine.

Liver helps in the elimination of cholesterol, bile pigments, extra vitamins and many drugs which get accumulated there. It secretes these substances in the bile, and through the bile, they pass into the duodenum from where they are ultimately eliminated along with the faeces.

OSMOREGULATION

Besides removing urea and uric acid from the blood, the kidneys also help in maintaining the water and salt concentration in it. This process is called

osmoregulation (regulation of water and salt content).

During summer, we urinate fewer times than in winter and the urine passed is usually more concentrated. The reason being that in summers, we lose much water through sweat. Therefore, the kidneys reabsorb more water from the glomerular filtrate to maintain the water concentration of the blood.

WHAT HAPPENS IF KIDNEYS FAIL ?

Sometimes, one or both the kidneys may stop working properly. This may happen if they become infected, seriously injured, or damaged due to some other reason.

A person can well manage with just one kidney, but if both fail, the blood soon becomes loaded with urea and other waste substances. If nothing is done in such situations, the person may die.

One of the treatments for such a person is to use a machine which filters and cleans the blood. The process is known as **dialysis** (Fig. 7.5).

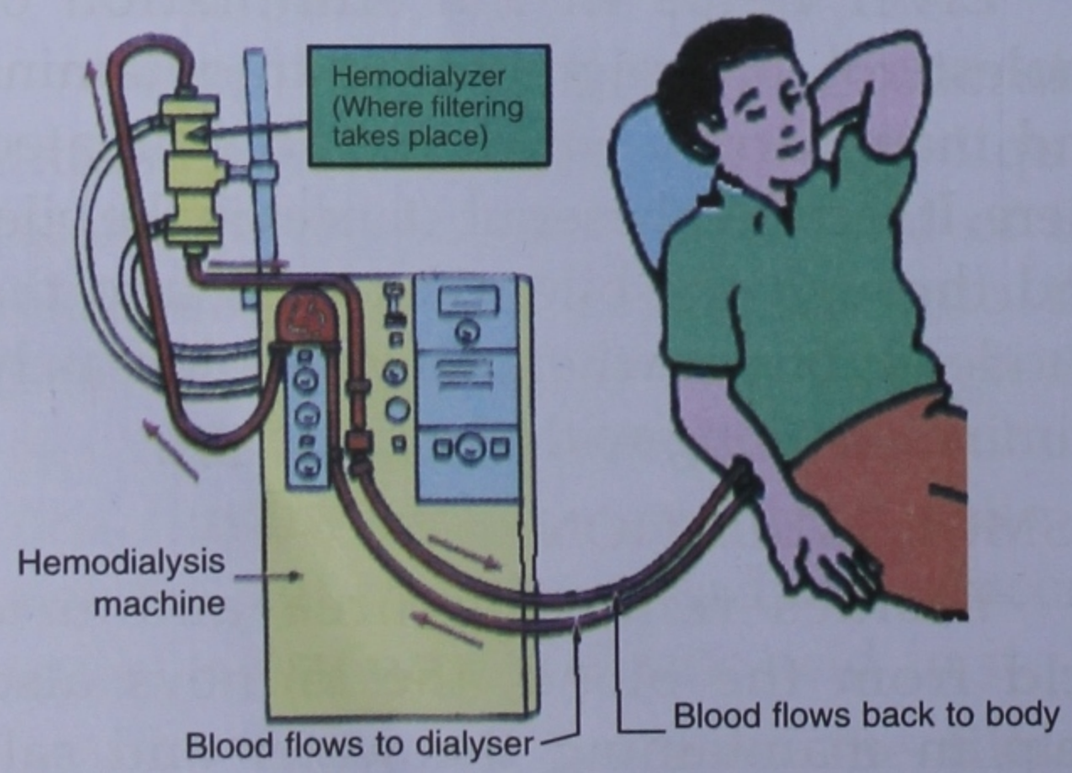


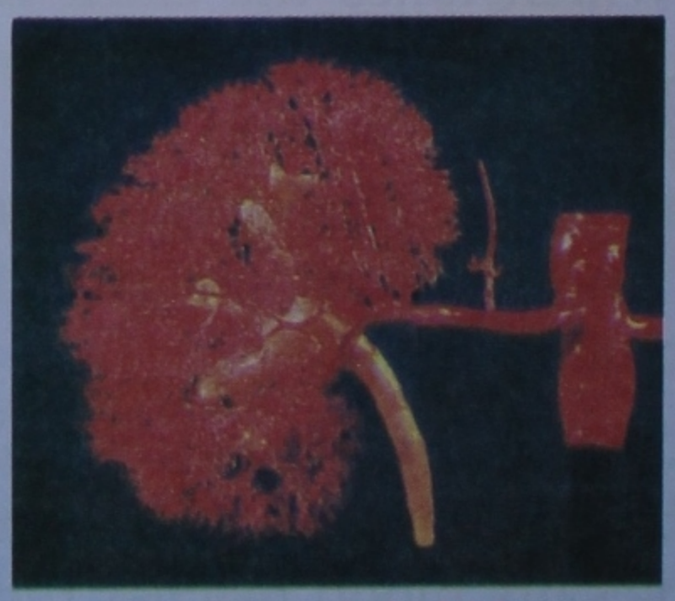
Fig. 7.5 Dialysis

A person with complete kidney failure needs dialysis in hospital to lead a normal life. As an alternative, a patient with both kidneys damaged can undergo kidney transplant from a suitable donor. The donor can live normally with one single kidney and the recipient gets a lease of life.

RENAL 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 16 kilometres.
- Blood flowing through kidneys per minute : 1 litre.
- Glomerular filtrate produced in 24 hours : 180 litres, but 179 litres is reabsorbed back into the system.
- Urine produced from glomerular filtrate after reabsorption per day : 1·2 litre.



Blood vessels in kidney
A preparation of the kidney. All tissues except the main blood vessels have been dissolved away. The two kidneys contain about 16 km of tubules and 160 km of blood vessels.

EXCRETION IN PLANTS

Plants also excrete waste materials. Though, plants do not have special organs for the removal of waste, they

have small pores on the surface of leaves called stomata (Fig. 7.6). Through the **stomata**, the plants eliminate oxygen (product of photosynthesis) during daytime, and CO_2 during night.

Excess salts are deposited in the form of crystals, *e.g.* in tomatoes and spinach.

A number of chemical substances, formed as byproducts during various activities of plants, are eliminated from the leaf surface and are deposited on or inside the bark, in old wood, old leaves, etc. The waste substances of plants are of two types :

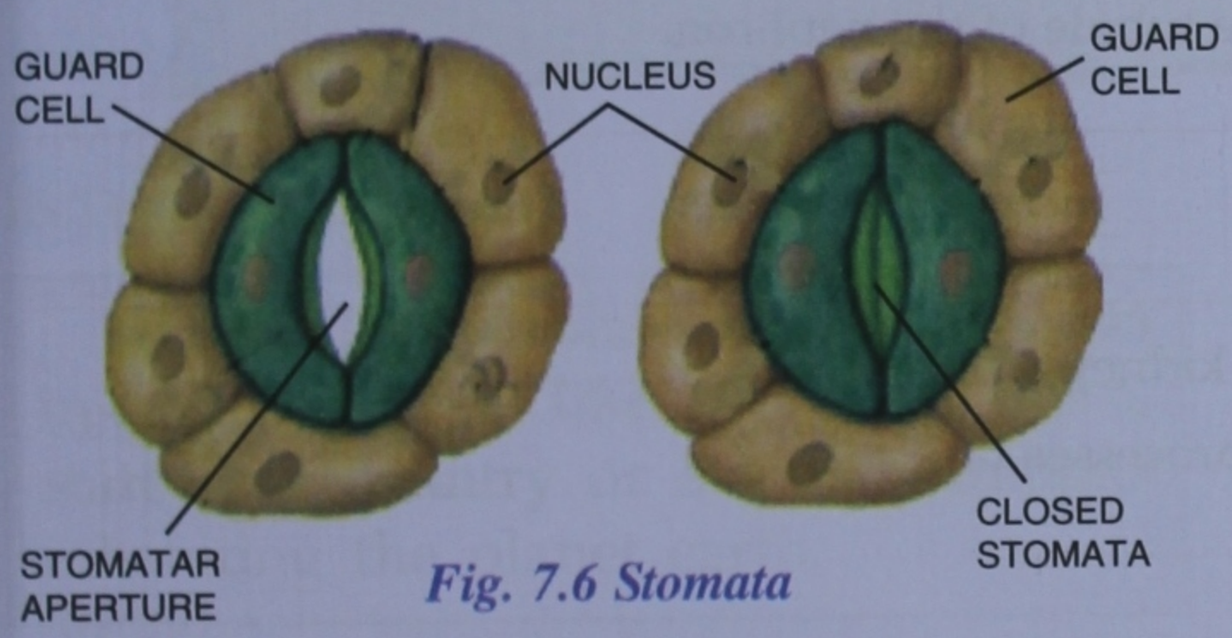


Fig. 7.6 Stomata

1. **Nitrogenous substances (alkaloids) :** Examples : **Quinine**, which gets deposited in the bark of cinchona tree and is used as a medicine for malaria, **morphine** in poppy fruits is used as an anaesthetic (a substance to make some one unconscious for surgery) and **caffeine** gets deposited in the leaves of coffee which is used as a beverage.
2. **Non-nitrogenous substances (exuded by plants) :** Examples : **Tannins** found in tea leaves, **essential oils** that are deposited in leaves of lemon, tulsi and eucalyptus plants, **resins** and **glue** that are deposited on the bark of pine trees. Resins are used in varnishes and polish.

REVIEW QUESTIONS

MULTIPLE CHOICE QUESTIONS

1. Put a tick mark (√) against the correct alternative in the following statements :

(i) The kidneys are made up of tiny tubular units called :
(a) glomerulus (b) nephrons (c) capillaries (d) Bowman's capsules

(ii) In human beings, urea is produced in :
(a) liver (b) kidney (c) spleen (d) urinary bladder

(iii) Besides water, the urine mainly contains :
(a) urea (b) nitric acid (c) glucose (d) bile pigments

(iv) Filtration of excretory wastes from the blood occurs in :
(a) collecting tubule (b) ureter
(c) urinary bladder (d) Bowman's capsule

SHORT ANSWER QUESTIONS

1. Fill in the blanks :

(i) Nitrogenous wastes in urine are in the form of _____ and _____

(ii) The excretory unit of human kidney is called _____

2. Define the following :

(i) Filtration : _____

(ii) Renal artery : _____

(iii) Dialysis : _____

(iv) Urethra : _____

3. Write *True* (T) or *False* (F) for the following statements in the spaces provided. Rewrite the false statements in correct form .

(i) Removal of solid undigested food is excretion.

_____

(ii) Medulla of kidney passes urine into urinary bladder.

_____

(iii) Selective reabsorption occurs through the tubule of the nephron.

_____

(iv) Urine is devoid of blood cells.

_____

4. Name the blood vessel that brings blood to the kidneys. ..... .

5. Where in the urinary system, do the following processes take place ?

(i) Urine formation : ..... .

(ii) Transport of urine away from kidney : ..... .

(iii) Temporary storage of urine : ..... .

LONG ANSWER QUESTIONS (Write the answers in your notebook)

1. Define excretion. Write the *four* organs of human urinary system in their correct sequence.
2. Why is excretion necessary in living beings ?
3. What are the various steps in the formation of urine ?
4. What is meant by osmoregulation ?
5. Name the constituents of normal urine.
6. Briefly write about various excretory products of plants ?
7. Describe the structure of kidney with the help of a labelled diagram.
8. Name the factors responsible for the change in the composition and volume of urine.
9. Briefly describe the *three* processes of urine formation.
10. What are the two ways by which a person can get relief in case of kidney failure ?
11. Draw a diagram of human excretion and label the following parts :
Kidney, ureter, urinary bladder and urethra.