Life Processes

Excretion

INTRODUCTION

- There are various metabolic activities which take place inside the living organisms.
- All these activities are chemical reactions. As a result of these chemical reactions several end products are formed. These end products are harmful or not useful to the body. These are called as metabolic wastes.
- These must be removed from the body for proper functioning of the body.

Excretion : The elimination of all metabolic waste products from the body is called as excretion.

- Waste materials are ammonia, urea, uric acid, carbon dioxide, pigments, salts, excess of water etc.
- Ammonia, urea, uric acid are nitrogenous waste products.

Defaecation or egestion is the removal of indigestible substances from the body, i.e., the passage of faecal matter through the anus. The difference lies in the fact that the faecal matter is not produced by metabolism. Secretion is the production of useful substances, such as enzymes and hormones, by metabolism.

EXCRETION IN ANIMALS

Types of Animals on the basis of excretory matter they release:

(i) **Ammonotelic:** Ammonia is the most toxic and uric acid is the least toxic. The process of removing ammonia is called **ammonotelism** and organisms that excrete ammonia are called **ammonotelic** (bony fishes, aquatic amphibians and insects).

(ii) **ureotelic**: The organism that release urea as nitrogenous wastes are called **ureotelic** (mammals, terrestrial amphibians).

(iii) **uricotelic:** The organism that excretes uric acids is called **uricotelic** (reptiles, birds and land snails).

Excretion in Unicellular Organisms:

Specific excretory organs are absent. Waste products (e.g., Ammonia, CO_2) generally pass out from the surface of the body into surrounding water by simple diffusion. Fresh water unicellular forms also posses an osmoregulatory organelle called contractile vacuole, e.g., Amoeba, Paramecium. Contractile vacuole collects water and some wastes from the body, swells up (undergos diastole), reaches the surface and bursts

(undergoes systole) to releae its contents to the outside. Osmoregulation is required in fresh water forms as fresh waterhas a tendency to enter their bodies due to higher internal osmotic concentration.

Excretion in Multicellular Organisms:

Sponges and coelenterates do not have specific excretory organs as water bathes almost all their cells. Excretory structures appear for the first time in flatworms (platyhelminthes). They are flame cells. Nephridia are excretory organs of annelids, green glands in crustaceans, maphighian tubules in insects, and kidneys in molluscs. Kidneys form a urinary system in vertebrates. Some accessory excretory organs of vertebrates including human beings are skin, lungs and large intestine.

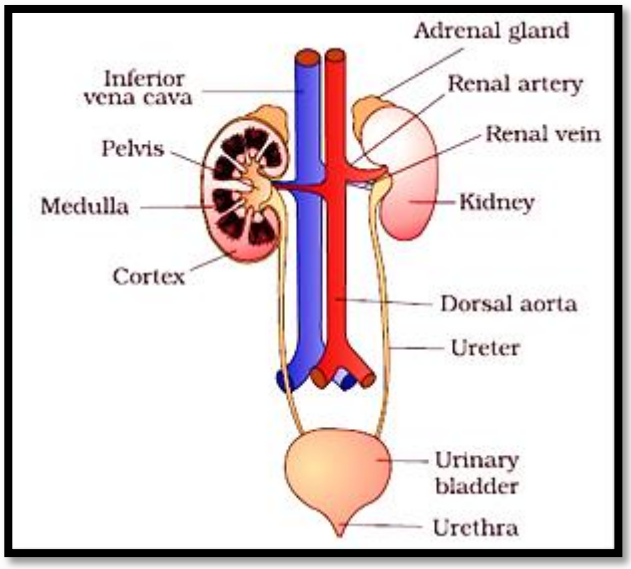
Excretory organs of different animal groups:

S.NO.	ANIMAL GROUPS	EXCRETORY ORGANS
1.	Protozoans (e.g. Amoeba, Paramecium)	Plasma membrane.
2.	Sponges (e.g. Sycon)	Plasma membrane of each cell.
3.	Cnidaria (e.g. Hydra)	Plasma membrane of each cell.
4.	Platyhelminthes (e.g. Planaria)	Flame cells (Solenocytes).
5.	Nemathelminthes (e.g. Ascaris)	H-shaped excretory system of canals and renette cells.
6.	Annelids (e.g. Neries, Earthworm)	Nephridia; chloragogen cells (yellow cells) in earthworm.
7.	Arthropods (a) Prawn (b) Most insects (c) scorpion and spiders	 Green glands Malpighian tubules, coxal glands Malpighian tubules, coxal glands
8.	Molluscs (e.g. Unio, Pila)	Kidney, In Unio kidneys are called organs of Bojanus.
9.	Echinoderms (e.g. Starfish)	Dermal branchiae and tube feet.
10.	Hemichordates (e.g. Balanoglossus)	Glomerulus.

Human Excretory System

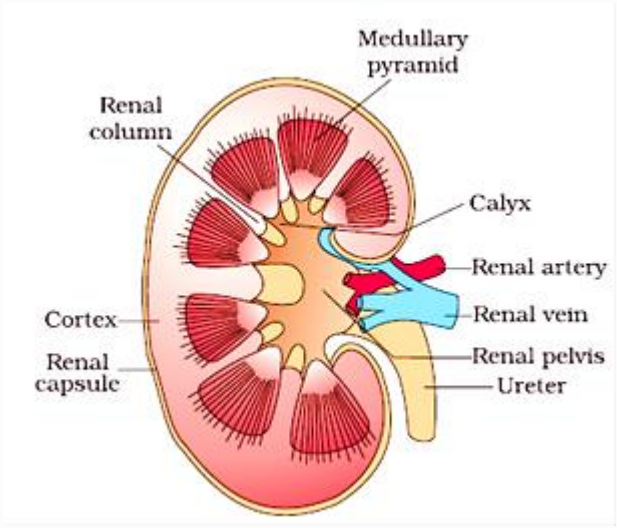
Human excretory system consists of:

1. A pair of kidneys
2. A pair of ureters
3. A urinary bladder
4. A urethra



1. **Kidney:** These are main or primary excretory organs of man.

- The kidneys are reddish-brown bean shaped structures present in the upper part of the abdominal cavity, on either side of the vertebral column.
- Each kidney is made up of large number of coiled tubes called nephrons (uriniferous or renal tubules).



L.S. of kidney

- These filter the nitrogenous waste materials and excess of water from the blood and form the urine.

2. **Ureters:** These are a pair of long, narrow, thin walled and tubular structure which starts from the kidney, run downward and open in urinary bladder.

3. **Urinary bladder:** It is a thin walled, elastic, pear-shaped and distensible sac present in lower part of abdomen.

- The urinary bladder stores the urine. When the muscles around the urinary bladder contract, the urine is excreted out through a small opening called the urethra.

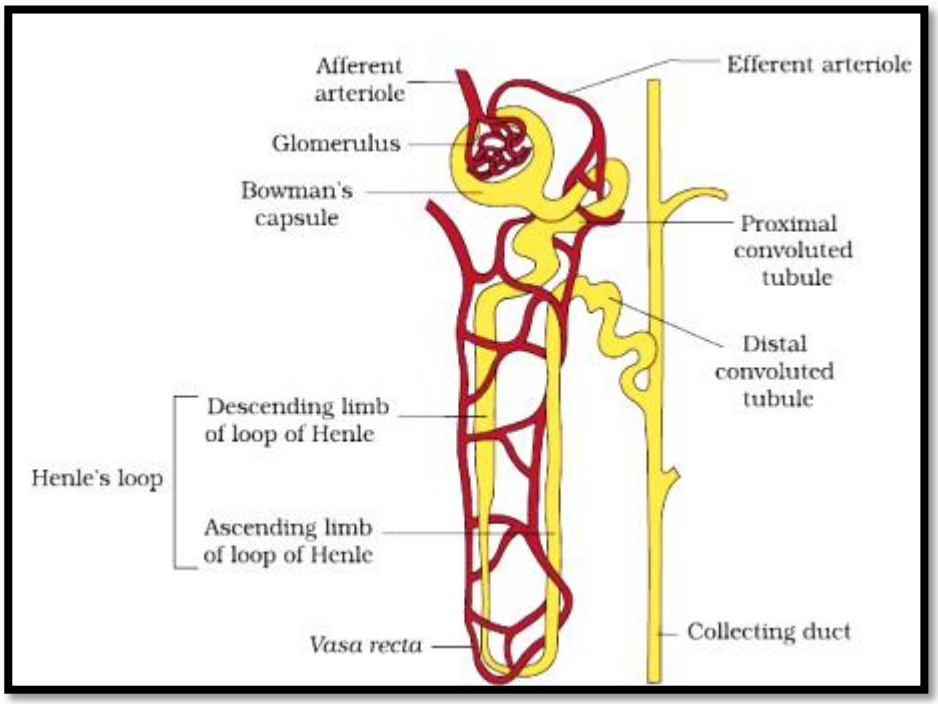
4. **Urethra:** It is muscular and tubular structure which extends from the urinary bladder to the outside. It carries the urine to the outside.

Structure of nephron:

Diagram

Structure of a Nephron :

- **Henle's loop** and **Distal Convoluted tubule**.



The nephron is the structural and functional unit of the kidney. The nephron can be differentiated into the following regions.

Malpighian Corpuscle :

This consists of two parts:

1. Bowman's Capsule :

This is a cup - shaped structure which is double walled in the hollow of which is a net work ofcapillaries called the glomerulus. (This is a knotted mass of blood capillaries formed by the afferent arteriole (incoming) and the efferent arteriole (outgoing)).

Renal Tubule :

This is the remaining part of the nephron, continuous with the Bowman's capsule. It is lined with ciliated epithelium and differentiated into the following regions :

(a) Proximal Convoluted Tubule (PCT) :

This is the region behind the Bowman's capsule and consists of a coiled tube that descendsto form the Henle's loop. The proximal convoluted tubule is present in the cortex region.

(b) Henle's loop :

This is continuous with the proximal convoluted tubule and is U-shaped having a narrowdescending limb and a thick ascending limb. This part of the nephron descends from the cortexinto the medulla region.

Distal Convoluted Tubule (DCT)This is another coiled and twisted tubule that continues from the ascending limb of loop of Henle found in the renal cortex.

(c) Collecting Tubule :

The distal convoluted tubule continues to form the collecting tubule.

(d) Collecting Ducts :

Several collecting tubules fuse to form large collecting ducts which pass downwards fromthe cortex to the medulla region.

5. **Collecting duct :** Collecting tubule receives distal tubules of several uriniferous tubules. Several such tubules unite to form a large collecting duct. The collecting ducts are held together and converge to form a pyramid. The pyramid opens into the pelvis which leads into the ureter.

Urine formation

Mechanism of urine formation: It occurs in three steps as follows:

1. **Glomerular Filtration-** the water, minerals, ions, and solutes are diffused out of the blood and move into the Bowman's capsule forming a filtrate.

2. **Tubular reabsorption**: the necessary substances such as water, glucose, amino acids, vitamins, mineral ions in the filtrate are reabsorbed by the tubules of the nephrons. The loop of Henle regulates the water reabsorption

3. **Tubular secretion**: K+, H+, creatinine and excessive water are secreted out from the tubules into the filtrate. Such a filtrate is called the urine.

Urine Formation Per Day

Glomerular filtration rate (GFR) is termed as the volume of filtrate formed by both kidneys per minute. On average, 125 mL/min filtrate is produced in men and 105 mL/min filtrate is produced in women. However, 99% of produced filtrate is returned to circulation by the process of reabsorption. Therefore, only about 1–2 litres of urine are produced per day in a healthy human body.

Micturition – The process of expulsion of urine from the urinary bladder is called micturition. The neural mechanism that causes it is called micturition reflex. Urine formed in nephron is stored in urinary bladder till a voluntary signal is given by CNS. This initiates the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine.

Disorders of Excretory System

Uremia– there is high concentration of non-protein nitrogen (urea, uric acid, creatinine). Urea can be removed by hemodialysis.

Renal failure– also known as kidney failure where glomerular filtration is ceased and both kidney stops working. Kidney transplant is the ultimate method in correction of acute kidney failure.

Glycosuria – Presence of glucose in urine occur in diabetes mellitus.

Hematuria - Presence of blood in urine.

Other organs of excretion

(a) Skin

- Sweat glands in the skin allow evaporation of excess water along with some salts which have to be excreted out of the body. Sweating is a vital function of your body. Sweating helps in thermoregulation of the body. Sweat glands secrete fluids that will cool your body in cases of extreme heat.
- Sebaceous glands in the skin excrete excess oil outside in the form of sebum.

(b) Lungs

Lungs are the respiratory organs in human beings. Pulmonary artery carries impure blood to the lungs from the heart.The alveolar cells of the lungs help in exchange of oxygen with carbon dioxide to provide the former to the bodily tissues. Lungs excretel carbon dioxide out of the body.

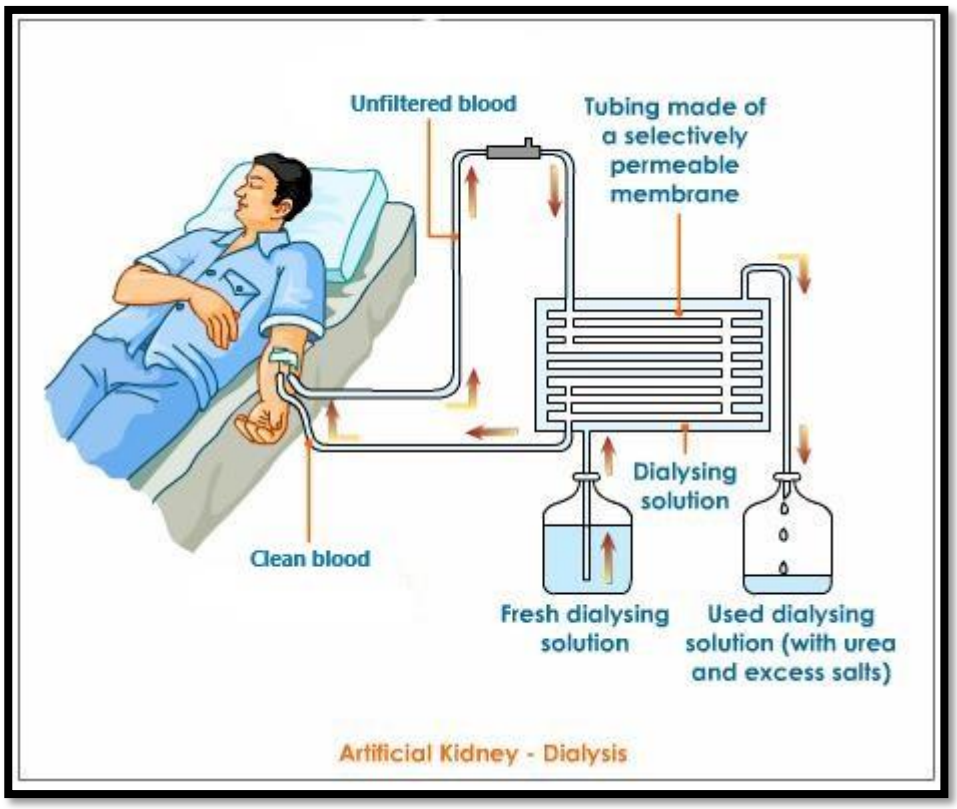
(c)liver

Nitrogenous metabolic wastes, such as urea and uric acid produced in the liver from excessive proteins.

Bile pigments : Bile pigments (e.g., bilirubin & biliverdin) derived by the breaking down of haemoglobin of the erythrocytes.

Artificial kidney :

- In case of loss or damage of one kidney, the other kidney performs the function of both the kidneys and the person can lead a normal life.
- But the failure of both the kidneys leads to death. The procedure used for cleaning the blood of a person by separating the waste substance (urea) from it is called Dialysis.



Dialysis:

Dialysis is the process which involves separation of nitrogeneous wastes from the blood artificially. Dialysis is performed using a device which removes nitrogenous wastes from blood in case of kidney failure.

- An artificial kidney contains a number of tubes with a semi-permeable lining suspended in a tank filled with dialysing fluid.
- The patient's blood is passed through these tubes.
- During this passage, waste products from the blood diffuse into the dialysing fluid.
- The purified blood is pumped back into the patient.
- In case of permanent damage to the kidneys, dialysis has to be performed for about twelve hours, twice a week. Now a days, diseased kidney may be replaced with healthy one by kidney transplantation to lead a normal life.

EXCRETION IN PLANTS :

Plants do not produce nitrogenous wastes like urea and uric acid because extra amino acids and nucleotides are not formed. They produce other types of waste products, called secondary metabolites, e.g., alkaloids, tannins, aromatic oils. Excess of water is got rid off through transpiration. Excess of oxygen formed during day in photosynthesis organs can be considered as waste. It passes out through diffusion.

The other wastes of plant metabolism are as follows :

(i) Nitrogen Waste Products - They are byproducts of general metabolism. The common onesare alkaloids, e.g., quinine, morphine, atropine.

(ii) Organic Acids - They are metabolic intermediates. Some of them are without any other use.Rather on accumulation they may prove toxic, e.g., oxalic acid.

(iii) Tannins - They are complex aromatic compounds which are formed as secondary metabolites.

(iv) Latex - It is an emulsion of varied composition which is exerted by special tubular cells called laticifers.

(v) Resins - They are oxidation products of aromatic oils.

(vi) Gums - They are degradation products of cell wall.

It saline habitates, the plants have to absorb excess salts that are required to be eliminated.