Chapter # 15
Homeostasis

Q.1. How do the organisms maintain internal environment?

Ans: Every organisms is facing two types of environment

(i) Internal environment with in the body

(ii) External environment his surroundings

HOMEOSTASIS:

The protection of internal environment from the harms of fluctuations in external environment is termed as homeostasis.

The changes always take place in external environment but the organisms makes adjustments to keep its internal fluctuations with in a narrow range.

The different components of internal environment which are affected by *fluctuations* of external environments are:

(i) Water (ii) Solutes (iii) Temperature

These components are balanced in the body through following processes:

1: Osmoregulation:

It is a regulation of water and ion concentrations in the body.

2: Excretion:

The process in which nitrogenous wastes are removed from the body is called excretion.

3: Thermoregulation:

Thermoregulation is the ability of an organism to maintain its body temperature within a certain range.

Control Systems

The control system has been acquired for the variety of homeostastic regulations.

Physical Control System

It has three components.

(1) Receptor (2) Control center (3) Effector

In a physical control system e.g. temperature control system, there is a sensor (thermometer) that monitor temperature change from a set point and signals to control center to take action by switching on heater or cooling units in response to drop or rise in the temperature compared to set point.

Living Control System:

The living control system exactly on the mechanism of physical control system.

This system has three components.

(i) Receptor (ii) Control Centre (iii) An Effector

In living system there is set point in temperature regulated (endothermic) animals. The receptors (sensor) detect temperature change, e.g. of increase, and signal to control center for action of cooling systems and the vice versa. Detection of change and signaling for effector's response to control system is a feedback mechanism. In these processes there is an inverse effectors response to the change in external environment as there is generally cooling effector's response to warmth sensing in external environment, thus are termed as negative feedback.

External Environemt

Fluctuations in wide range

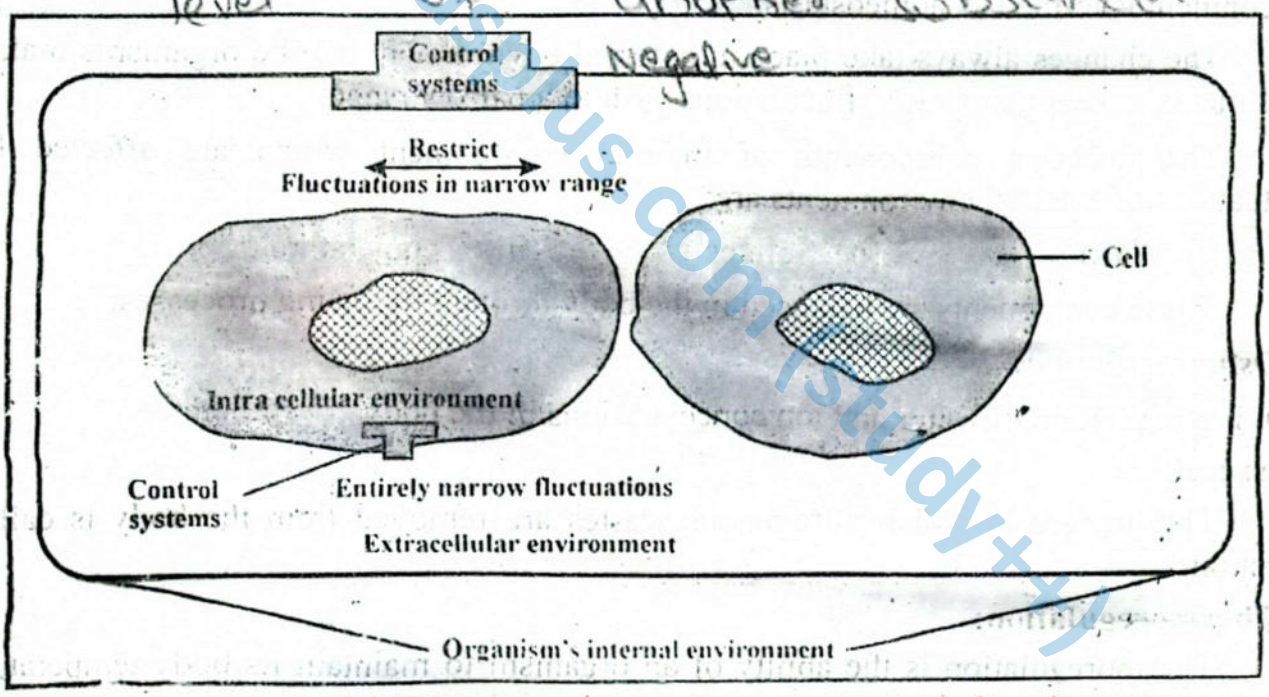

Fig. Homeostasis: Controlling systems lower fluctuations in internal environments

Q.2. Explain the process of osmoregulation? How do the water and solutes balance in the body?

Ans: OSMOREGULATION:

The process in which the water and ion concentration in the body is regulated is osmoregulation.

Water:

Water is the most important solvent in the cell which is to be maintained. Every cell has definite amount of water in relation to salts. Through the process of osmoregulation the quantity of water is maintained in the body.

Different types of environment:

According to the availability of water the cell has to face three types of environment:

(i) Hypotonic (ii) Isotonic (iii) Hypertonic

1: Hypotonic (Hypo - under, less)

When the external environment of the cell has low solute concentration and high water potential then it is called hypotonic environment. Thus in hypotonic condition there is diluted solution compared to cell concentration. In hypotonic environment the water enter cell from outside and the cell become turgid.

2: Isotonic (iso - same)

When the external environment of the cell has same solute concentration and water potential then it is called isotonic environment.

3: Hypertonic (Hyper - over, above)

When the external environment of the cell has higher solute concentration and lower water potential then it is called hypertonic environment. In hypertonic environment the water is moved out of the cell leaving behind concentrated solutions and thus the cell shrinks.

Role of Osmoregulation:

To avoid such situations cells osmoregulate themselves to keep water and salts balance in plants and animals. Osmoregulation has enabled the animals and plants to distribute themselves in wide range of habitats.

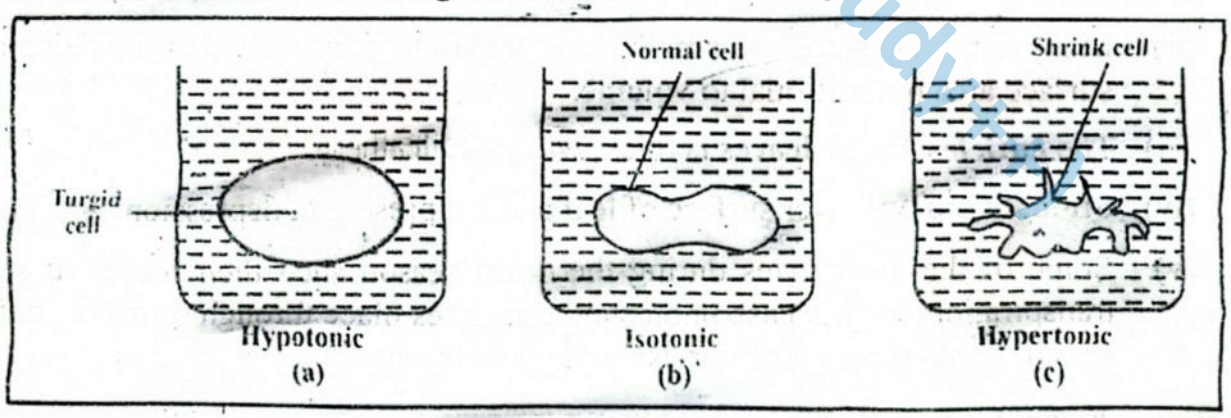

Fig. Response of the cell to various external environments i.e. different concentrations of solution without any regulation with control system at cell membrane, cell remain in normal state despite differences in its internal to external environments.

Q.3. How does the osmoregulation take place in plants?

Ans: According to the availability of water, plants are divided in three groups.

1. Hydrophytes 2. Mesophytes 3. Xerophytes

1: Hydrophytes / Hypophytes

These are those plants which live in aquatic environment. They have lot of water supply therefore they have adapt themselves to remove the flooding of its cells in fresh water. They show following adaptations.

(i) The surface area of leaves is very large so that lot of water can **transpire** easily.

(ii) On the upper surface of leaves there are a number of **stomata** which promote the loss of water in the atmosphere.

(iii) They have poorly developed **root system** to absorb a little amount of water from soil.

Example : Loctus

2: Mesophytes:

These plants have moderate supply of water. In sufficient supply of moderate water stomata are kept open to promote loss of excess water but in less supply stomata are closed to prevent the loss.

Example: Examples of such plants are brassica, rose, mango etc.

3: Xerophytes:

These plants have to face severely dry terrestrial conditions. They show the following adaptations:

(i) The **transpiration rate** is reduced.

(ii) Many xerophytes possess **small, thick leaves** to limit water loss by reducing surface area proportional to volume.

(iii) The **cuticle** of their leaves is thick, waxy and leathery.

(iv) **Stomata** are on lower surface of leaf and are present in depression.

(v) Some of the xerophytes during the driest season shed their leaves to stop transpiration. In this case photosynthesis takes place through stems. In rainy season stem stores water for use in dry conditions.

Example: Cactus.

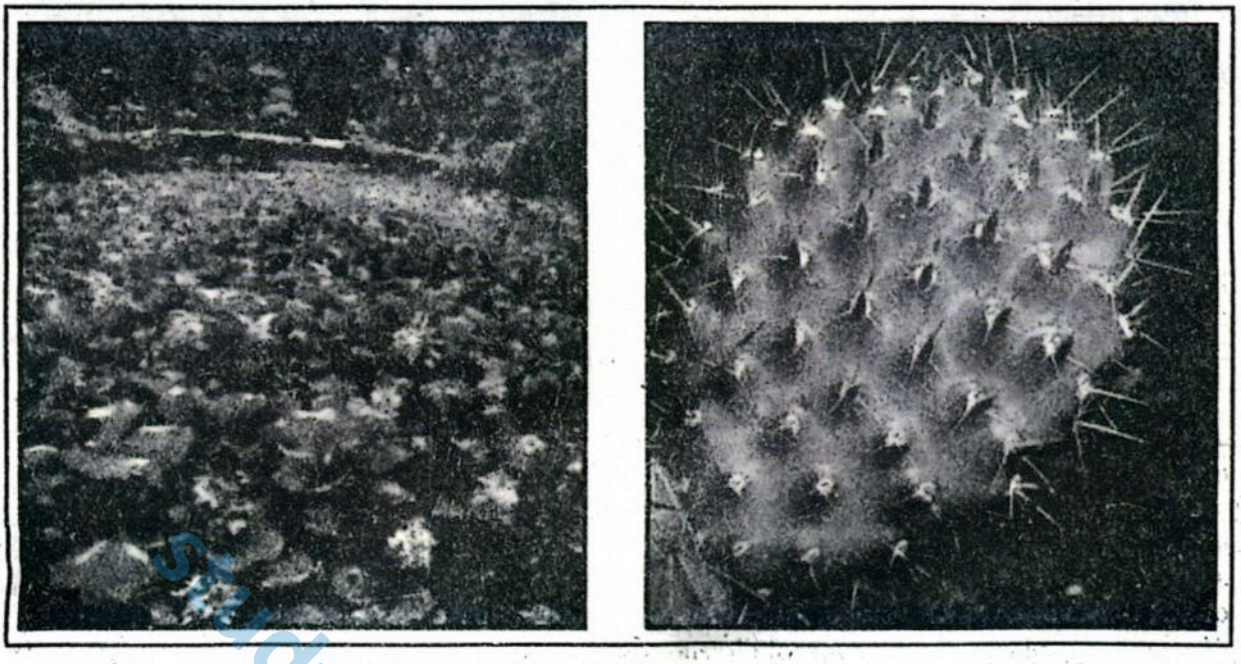

Fig. a. A hydrophytic plant

Fig. b. A xerophytic plant

Q.4. Which type of adaptations are found in animals for osmoregulation?

Ans: In reference to the balancing of the water and solutes in the body, the animals are divided into two categories:

1. Osmoconformers
2. Osmoregulators

1: Osmoconformers:

The animals which do not maintain their internal solute concentration are called osmoconformers. *Such* animals maintain the total ionic concentrations of their body fluid at the same level as that of medium in which they are living and change the ionic concentration of their body fluids when the ionic concentration of the external environment change.

2: Osmoregulations:

Such animals maintain an internal solute concentration what *does* not vary regardless of the environment in which they are living. When the body fluid concentration differs from the outside environment then these animals actively regulate to discharge excess water in hypotonic and excrete salts in hypertonic conditions.

OSMOREGULATION IN DIFFERENT ENVIRONMENTS

1: Marine environment:

There are different methods found in marine animals to osmoregulate their bodies.

(i) Invertebrates:

Many of the invertebrates living in the marine environment are osmoconformers. Thus they do not maintain their internal solute concentration.

(ii) Vertebrates:

(a) Hagfishes:

Hagfishes are isotonic with the surrounding sea's water.

(b) Cartilaginous fishes:

Many of the cartilaginous fishes maintain lower internal salt concentration than that of sea's water. To osmoregulate their body, their kidneys excrete salts through gills and they also have salt excreting organs such as rectal glands. They have an efficient system of active transport through which they get rid of salts.

(c) Bony fishes:

Bony fishes are descendants of fresh water. Their body is hypotonic i.e. high water potential and low salt concentration so they lose water constantly from their body to outside which is hypertonic. Such fishes drink a large amount of seawater and excrete **concentrated urine** resulting in maximum water loss.

(d) Other fishes:

The body fluids of some fishes have very low concentration of salts. To live in seawater they increase the concentration of salts in the body by retaining urea in suitable amount of concentration. As urea is very toxic in high concentration and may cause many harms to the body so they retain an other chemical **trimethyamine oxide** for protection against urea.

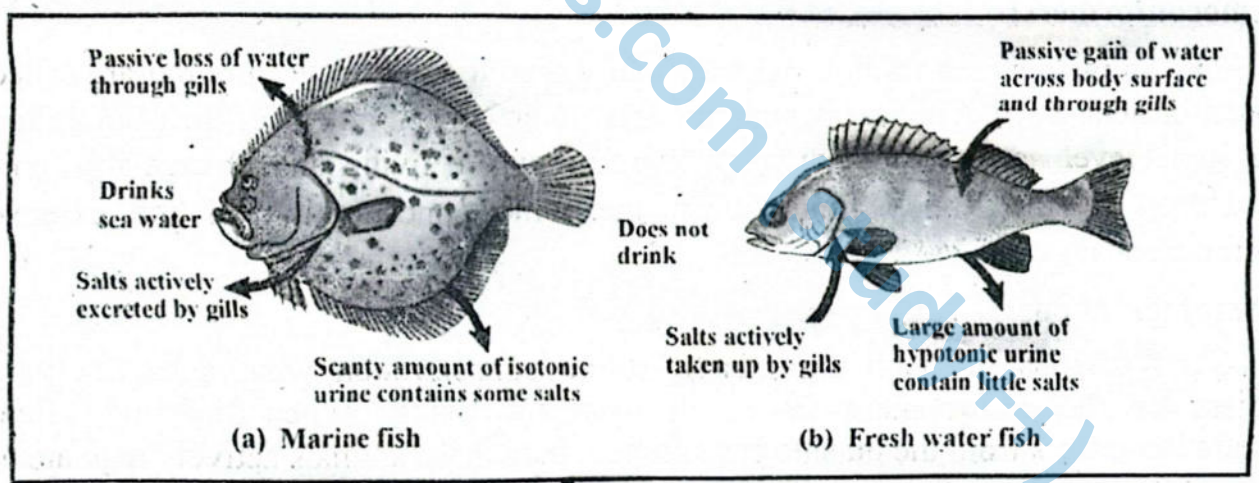

Fig. Osmoregulation in: (a) Marine fish (b) Fresh water fish

2: Fresh water environment:

Fresh water has very low salt concentration thus the animals living in this environment are in danger of loss of salts and from their body and entry of large amount of water in their body. Thus the above mentioned animals show the following adaptations to get rid of large amount of water.

(i) Protozoa:

Many protozoan such as Amoebae and Paramecium expel the large amount of water by special structures called **contractile vacuoles**.

(ii) Fishes:

Fishes and some other animals remove excess water by producing large volumes of very **dilute urine**. The loss of salts is balanced by using salt containing food and by active uptake of salts by gills and skin.

Terrestrial Environment:

In terrestrial environment the water supply to the animals is very moderate or even less. So there is a danger of loss of water through evaporation. This may lead to dehydration which can bring serious results in terrestrial animals. To live in such environment the animals show the following adaptation.

(i) Covering of Body

Terrestrial animals have special covering on their body surface which prevents loss of the water. These coverings may be waxy exoskeleton of insects or multi layered **dead keratinized skin cells** of many vertebrates.

(ii) To compensate the loss of water, they drink and eat the moist food.

Metabolic and Behavioral Adaptations

(i) Production of Concentrated Urine

Some animals produce concentrated urine with the help of kidneys which have the ability of reabsorbing filtered water.

(ii) Anhydrobiosis

Terrestrial animals have the quality of an hydrobiosis. It is the condition in which animals can tolerate dehydration. This ability differs in different animals.

(iii) Limited Drinking

Some desert mammals can survive without drinking water. For example, Kangroo rat can survive without drinking water. They feed only on seeds of desert plants containing more carbohydrate. This carbohydrate produce water on metabolism.

Q.5. Define excretion? How does the excretion takes place in plants?

Ans: Excretion

"The elimination of the wasteful metabolites mainly of nitrogenous nature outside the body is called excretion".

Or

It is a process in which the nitrogenous wastes are removed from the body.

Explanation:

Animals use the food which contain: nutrients such as carbohydrates, proteins lipids and nucleoproteins etc. When the metabolism of carbohydrates and lipids occur then CO_2 and water are produced. On the other hand proteins and nucleoproteins on

metabolism give nitrogenous wastes which are highly toxic and therefore should be removed from the body. Therefore the process of excretion is needed.

EXCRETION IN PLANTS:

Excretion in plants is entirely different from animals. The waste products of plants are CO_2 and H_2O. They also produce some organic and inorganic compound which are stored for various purpose and removed when necessary.

Excretion of Gases and Water:

During the process of photosynthesis plants produce oxygen which is considered as waste product at that time. When the plants respire they produce CO_2 and water as waste products. Water is dominated from the plant body through transpiration or it may by used for maintaining turgor in cells.

Excretion of organic and inorganic compounds:

(i) Leaves (ii) Bulb

(i) Leaves (Excretophore)

Plants produce various wastes organic and inorganic compounds which are stored in vacuoles of the leaves. The leaves having such wastes fall off on the ground in the autumn season. Thus in the autumn season gardener find rotted autumn leaves as good source of mineral. Such leaves are therefore called ***excretophore*** as they get rid of accumulated wastes. The change of colour of these leaves is due to presence of excess pigmented compounds and toxic materials.

(ii) Bulb:

Some organic and inorganic wastes also accumulate in certain bulbs. **Blue bell** is one of the example which leaves the bulb underground.

Excretion of chemicals:

Some trees deposit strange chemicals in their branches and trunks especially in old xylem which is no longer used for water transport. This take place in **ebony** which produces very **black wood** in the center due to accumulation of these strange chemicals. These are considered to be waste material.

Waste material as weapon:

Sometimes these waste materials are considered as chemical weapons by secreting them in the soil to compete other plants. The example of such plants is conifers.

Q.6. Name different excretory products produced by animals. What is thei nature with reference to their habitats?

Ans: Animals produce different kinds of excretory products which are as follows:

(1) Water:

Water is considered an excretory product in hypotonic environment. Where water potential is very high in the body cells.

(2) Salts:

Salts are removed by animals of hypertonic environment.

(3) Amino group:

Amino group (NH_2) is produced during the catabolism of amino acids or transferred to another molecule for removal or reuse. If it remains in the body it may cause convulsions, coma and may lead to death. Therefore it may be removed from the body as soon as possible.

(4) Excessive Nitrogen:

Excess amount of nitrogen is excreted from the body of animals in form of ammonia urea and uric acid.

(5) Less amount of Nitrogen:

Less amount of nitrogen is excreted from the body of animals in the form of creatinine, which is trimethyl oxide very small quantities of amino acids, purine and pyrimidine. Metabolism of purine and pyrimidine bases produces wastes of hypoxanthine, xanthine, uric acid, allantoin, urea and ammonia.

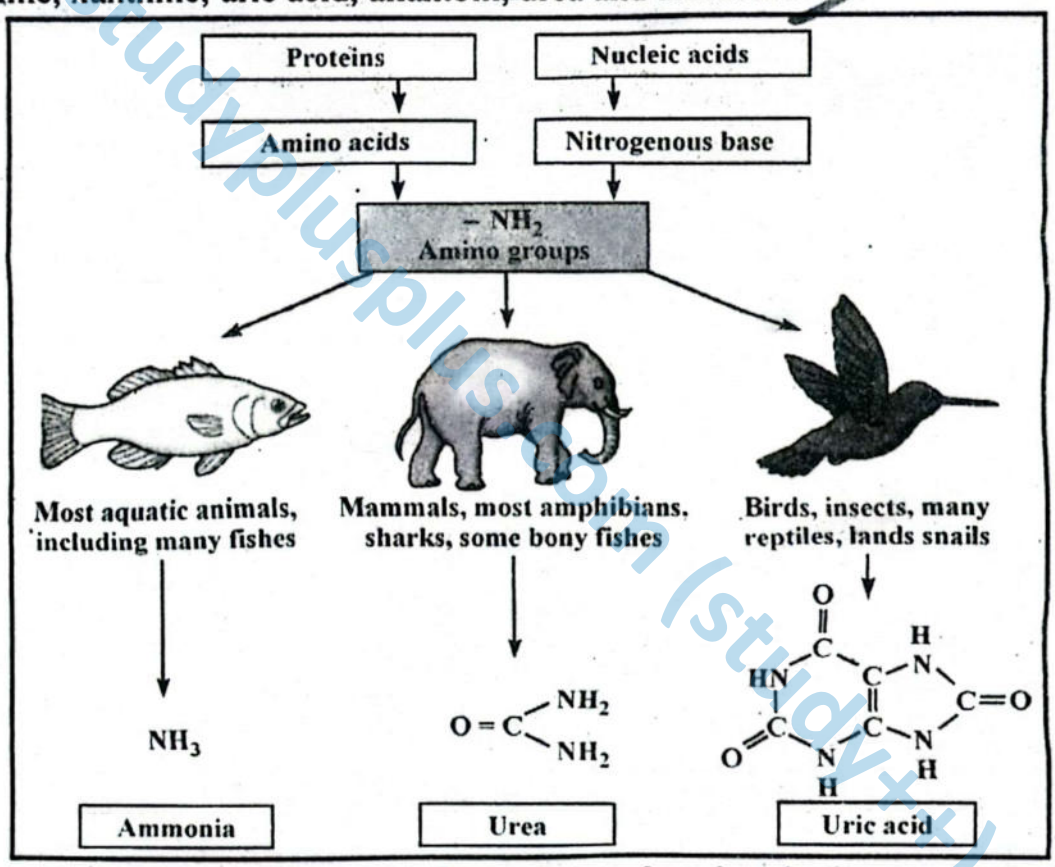

Fig. Main types of excretory products in animals

Q.7. Discuss the nature of excretory products in animals to various habitats specifically in association of water availability?

Ans: Different nitrogenous products in animals are ammonia, urea and uric acid. Animals excreting ammonia, urea and uric acid are called as ammonotelic, ureotelic and uricotelic respectively. Ureotely and uricotely are evolutionary adaptations of nitrogenous wastes in their habitats. Animals have adapted not only chemical nature of excretory products but also the excretory structure.

AMMONIA:

Ammonia is a highly toxic compound. It can easily dissolve in body fluids. As it is very toxic so its concentration is kept low in the body. For this purpose a large amount of water is required so that it is readily expelled out through urine as it is produced. As the excretion of ammonia requires a large amount of water so it is the excretory product of those animals that lives in hypotonic environment i.e. fresh water. To excrete 1gm ammonia 500 ml of water is required.

UREA:

Urea is the excretory product of those animals that live in moderate supply of water. Urea is less toxic as compare to ammonia which requires only 50ml of water to remove its 1gm. The excretory nitrogen produced during metabolism undergoes urea cycle to convert into urea.

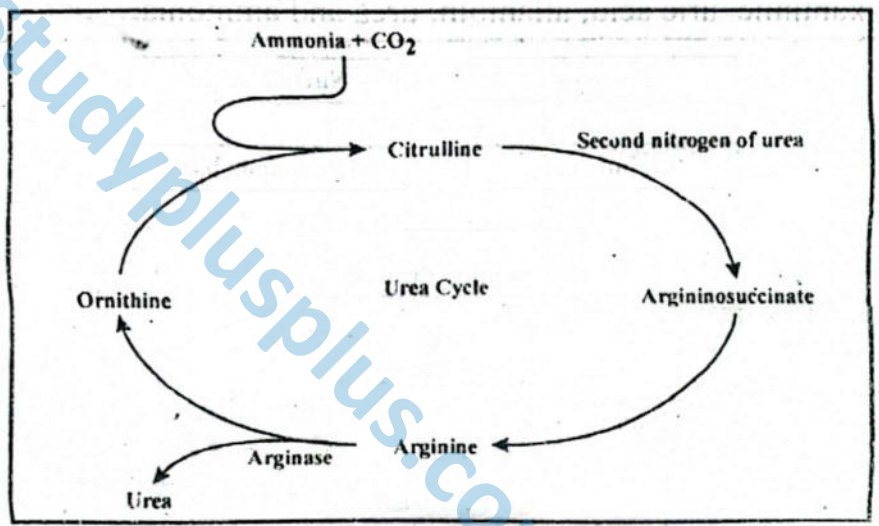

Fig. Metabolic pathways in urea cycle

URIC ACID:

Uric acid is a waste product of those animals which have acid shortage of water supply. 1 gm of uric acid requires only 1ml of water. Reptiles and birds excrete uric acid as they live in such environment.

Q.8 (a): How does the excretion take place in hydra and planaria?

Ans: EXCRETION IN HYDRA:

There are no specialised excretory structures in hydra. Waste products are taken out from the body simply by diffusion in the isosmotic surroundings.

EXCRETION IN PLANARIA:

Planaria belongs to the group of flat worms. It has a very simple tubular excretory system which is called protonephridium.

Protonephridium:

It is a network of closed tubules which has no opening. This tubular system is spread on the whole body. This system also has very special cells called flame cells.

Every flame cell has tuft of cilia whose beating move the interstitial fluid in whole of the tubular system. These cells are termed as **flame cells** because when their cilia moves they look like flame. The tubular system opens into the ducts called excretory ducts which open to the exterior through several **nephridiopores.**

Excretory Material:

The excretory material in flat worms is nitrogenous waste. As some of them live in fresh water so they excrete dilute urine while some of the parasitic flatworm live in isotonic environment.

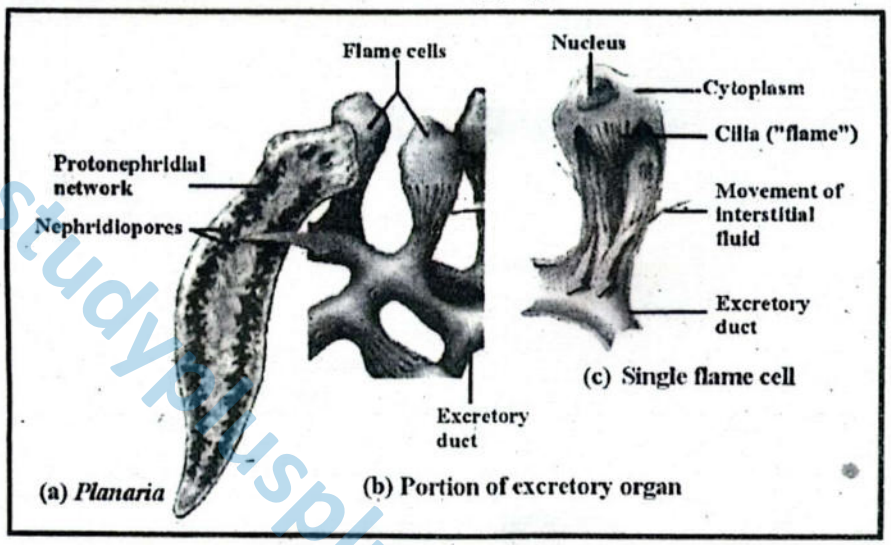

Fig. Excretory system in *Planaria*

Q.8 (b): Explain the excretory system in earthworm.

Ans: Earthworm is annelid and it live in soil. It also consists of system of excretory tubules called metanephriduim. Each segment of earthworm has a pair of metanephridia.

Structure Metanephriduim:

This system consists of internal ciliated opening nephrostome which is immersed in coelomic fluid. Nephrostome is surrounded by network of capillaries.

Function of the Nephrostome:

The nephrostome collects that fluid which is present in coelom. Nephrostome has large network of capillaries. As fluid moves along the tubule epithelium reabsorbs the salt from lumen and send to blood vessels surrounding the nephridium. The left over appears as urine containing nitrogenous waste.

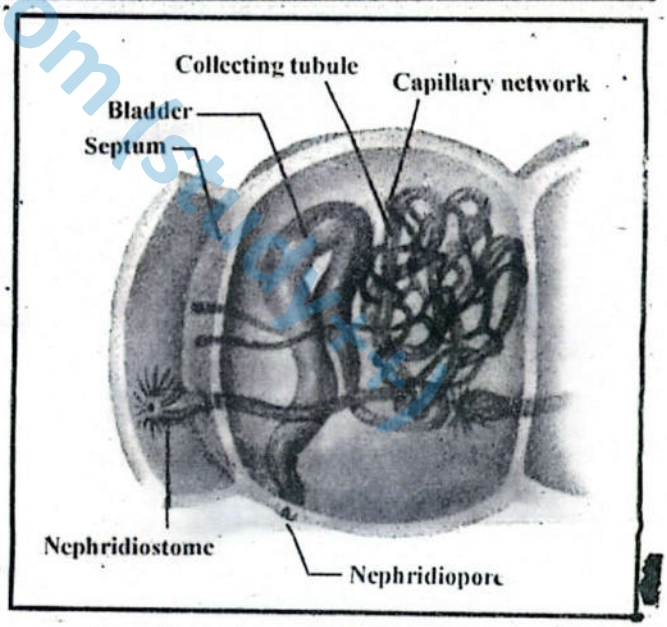

Fig. Excretory system in earthworm

Q.9. How does the excretion take place in cockroach?

Ans: Arthropods especially the insects eliminate metabolic waste by unique system malpighian tubules that extend from the digestive system to the haemolymph.

MALPIGHIAN TUBULES:

Structure:

These are the slender projections that are blind at one end. These are attached at the junction of midgut and hind gut. These are the only excretory structures in animals kingdom that are associated with digestive tract.

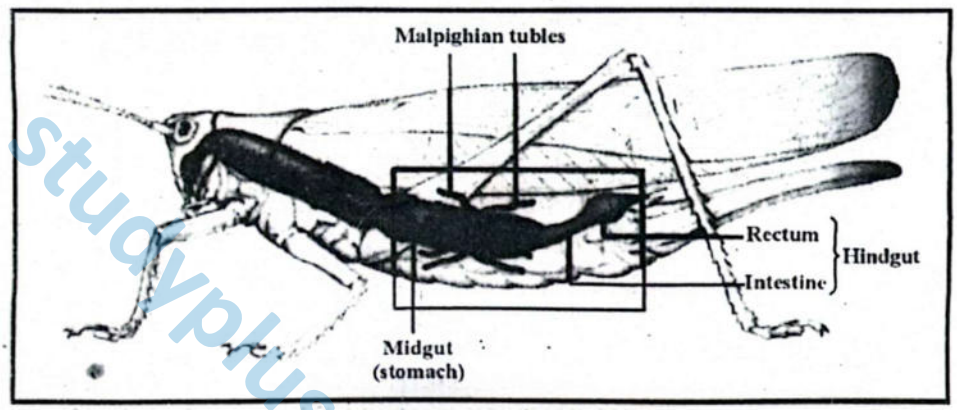

Fig. Excretory system in insect

Function:

Malpighian tubules remove nitrogenous waste from hemolymph (as cockroach do not contain red blood cells so the fluid present in the sinuses is called hemolymph). The epitheluim lining of the tubules transports solutes including salt and nitrogenous waste from haemolymph into the lumen of the tubules. Fluid then passes to hind gut into the rectum. Rectum reabsorbs most of the salts and water. In this way rectum reabsorbs most of the salts and water and excrete nitrogenous wastes in the form of uric acid crystals along the faces. In this way terrestrial insects can live in high shortage of water.

Q.10 (a): What are the metabolic wastes produced in the human beings?

Ans: Metabolic wastes:

The wastes which are produced during the metabolism are called metabolic wastes. If these wastes are not removed they can cause serious results. Human beings produce the following metabolic wastes:

1. Urea produced during the metabolism of amino acids.
2. Creatinine from muscle creatine.
3. Uric acid from nucleic acids.
4. Bilirubin which are the end products of haemoglobin breakdown and metabolites of various hormones.
5. Various toxins are produced in the body which are ingested in the form of pesticides, drugs and food additives.

Q.10(b): How does the liver play an excretory role in the body?

Ans: LIVER:

Liver is an important organ for the metabolic reactions. Liver performs the following major homeostatic functions:

(1) Synthesis of various products (2) Maintain urea cycle
(3) Make many conversions (4) Recycling
(5) Detoxification

1. Synthesis:

(i) Liver produces many poisonous chemicals such as ammonia, urea and uric acids from the nitrogen of amino acids. The major homeostatic effect of this function is to support kidney in waste disposal.

(ii) It synthesise plasma proteins like prothrombin fibrinogen and albumin etc. Prothrombin and fibrinogen helps in blood clotting, while albumin maintains osmotic balance of blood.

(iii) Lipids, cholesterol and lipoproteins are formed in lipid. These compounds regulate blood chemistry, store energy and help to maintain cell membranes.

(iv) Lipids play an important role in bile production. Bile emulsifies fats in small intestine.

2. Urea Cycle:

Urea is a principal excretory product. One of the major nitrogenous waste urea is formed in the liver. Urea is produced during urea cycle. Two ammonia and one carbon dioxide molecules combine in cycle to produce one molecule of urea. One ammonia, CO_2 and ornithine combine to form citrulline. Another molecule of ammonia joins citrulline to give arginine. An enzyme arginase split the arginine into urea and ornithine.

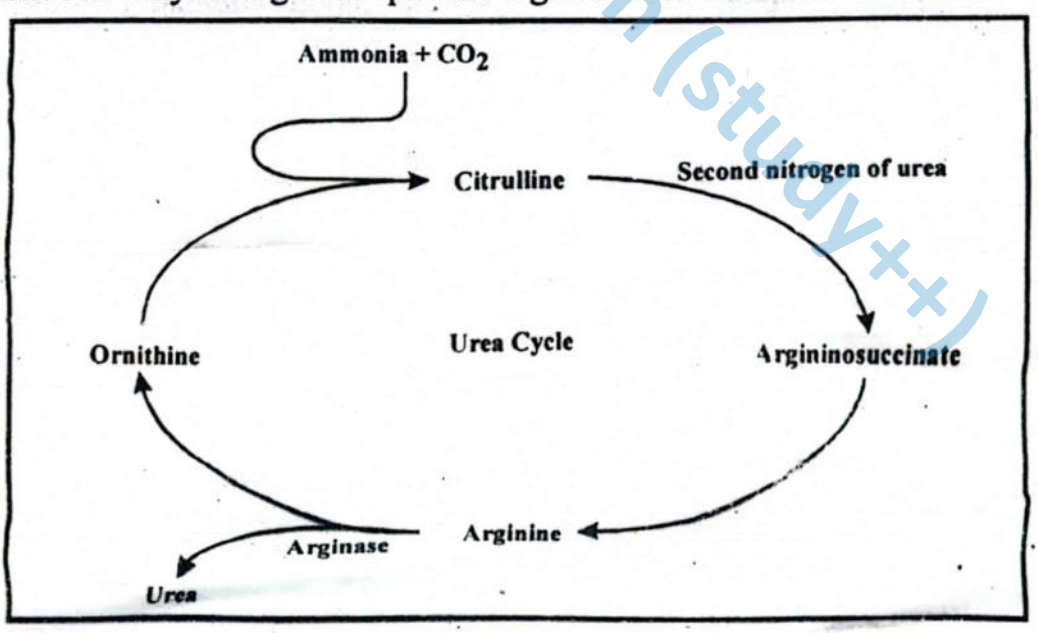

Fig. Metabolic pathways in urea cycle

3. Storage:

Liver can store iron and glycogen. Iron is an important element of haemoglobin which is involved in oxygenation of tissues while glycogen is an important energy reserves.

4. Conversions:

Liver convert glucose of the blood into glycogen. Glycogen energy is stored in the form of glycogen which can be used when needed.

5. Recycling:

Liver is responsible for recycling of contents of red blood cells which help in oxygenation of tissue.

6. Detoxification:

Liver can detoxify many harmful chemicals. Such as food additive, pesticides drugs etc. It thus assist kidney in toxin disposal.

Table: Major homeostatic functions of the Liver

Functions	Major effects on homeostasis
Synthesis: Nitrogenous wastes: NH_3, urea, uric acid	Support kidney in waste disposal
Plasma proteins: Like a) prothrombin, fibrinogen & b) albumin etc.	a) Blood clotting b) maintain osmotic balance of blood
Bile	Emulsifies fats in small intestine
Lipids, cholesterol, lipoproteins	Regulate blood chemistry, store energy and help to maintain cell membranes
Storage: Iron	Oxygenation of tissues as constituent of haemoglobin
Glycogen	Energy reserves
Conversion: Excess glucose in blood to glycogen, lactic acid to glycogen and stored glycogen to glucose.	Energy storage and use
Recycling: Contents of old red blood cells (e.g., iron and other constituents of haemoglobin)	Oxygenation of tissue
Detoxification: Many harmful chemicals (e.g., food additives, pesticides, drugs etc)	Assist kidney in toxin disposal

Q.11. Explain structure and function of the urinary system of human beings?

Ans: Urinary system consists of the following organs:

KIDNEY:

Kidney is an important organ of urinary system. Two kidneys are located asymmetrically one on each side of the vertebral column. Each kidney is a bean shaped organ convex side of the kidney is present outward while the concave side faces to the vertebral column. Each kidney is about 12cm long, 6cm wide and 3cm thick. Right kidney is present anteriorly than the left kidney.

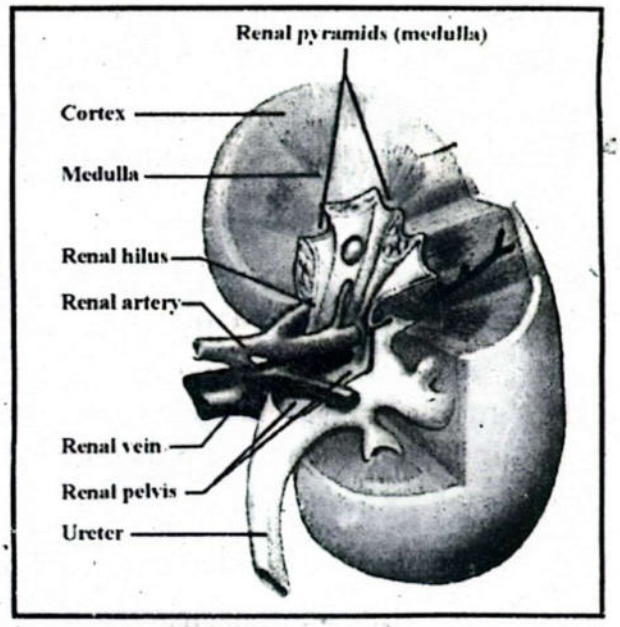

Fig. The structure of a kidney

Pelvis:

Urine is collected in a central cavity of the kidney which is called pelvis.

Ureter:

It is a tube which leads from the concave side of each kidney. Urine leaves the kidney through ureter.

Urinary bladder:

The ureters of both the kidneys drain into the urinary bladders through urethral orfice.

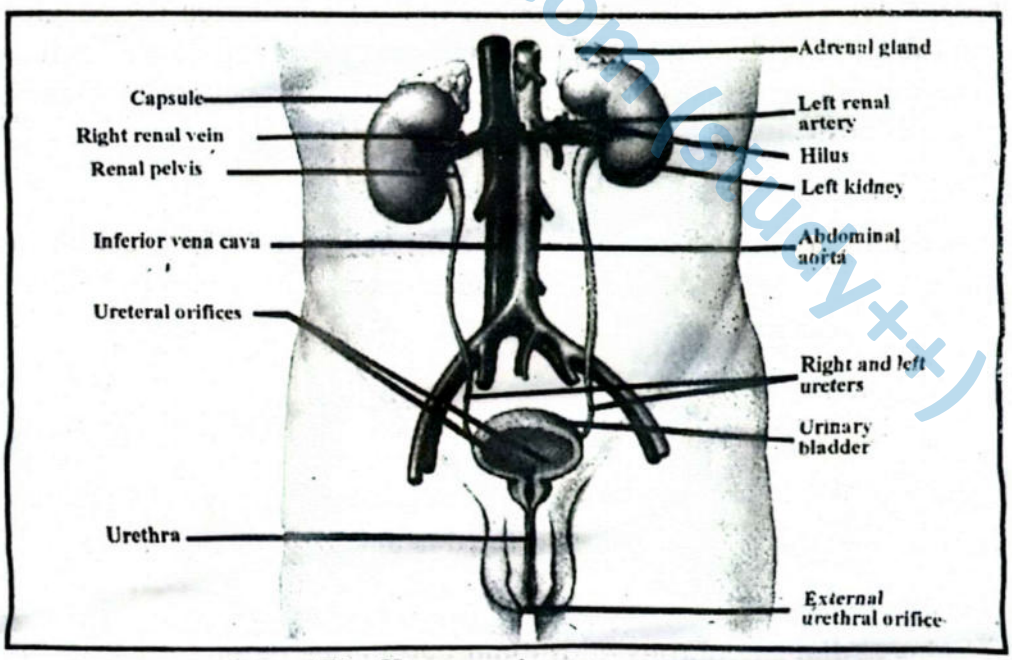

Fig. Human urinary system

Urethera:

Urine leaves the body during urination through a tube called urethera which empties near the **vagina in females** or through the **penis in males.** There are special muscles called **sphincter muscles** which are present near the junction of urethera and the bladder which control the urine in bladder.

NEPHRON:

It is the structural and functional unit of kidney. A nephron is arranged along two distinct regions cortex and medulla.

Cortical Nephron

The nephrons which are arranged along the cortex are called cortical nephron.

Juxtamedullary Nephron

Those nephrons which are arranged along the border of cortex and medulla with their tubular system looping deep in inner medulla are called juxtamedullary nephrons. Juxtamedullary nephrons play an important role in the production of concentrated urine.

Structure of nephron:

Nephron is divided into two main portions:

(i) Renal corpuscle (ii) Renal tubule

(i) Renal corpuscle:

Renal corpuscle is further divided into two parts:

(a) Bowman's capsule and (b) Glomerulus.

The inner end of each nephron forms a cup shaped swelling which is called Bowman's capsule. The capsule surrounds a ball of capillaries called glomerulus. The blood enters the glomerulus through **afferent arteriole** and leave it through **efferent arteriole**. The blood vessels divides further to form the network of capillaries called peritubular capillaries.

(ii) Renal Tubule:

The second part of the nephron is a long and narrow tube called loop of Henle. Bowman capsule continues as convulated tubules know as:

(i) Proximal Tubule

(ii) Loop of Henle

(iii) Distal Tube

Dital tubule finally empties into collecting tubule. Loop of Henle has three parts, first part is coiled, second is U shaped and third is also coiled.

Vasa recta:

In juxtamedullary nephrons additional capillaries extend down to form a loop of vessels called vasa recta.

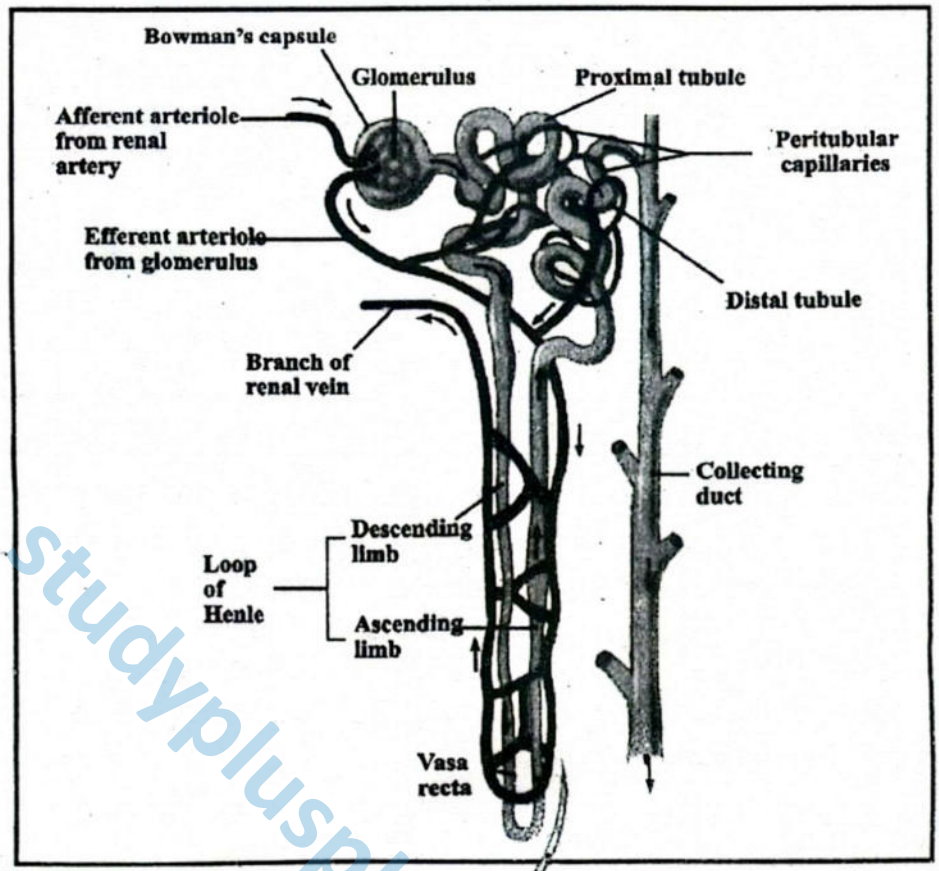

Fig. A nephron with vascular supply

Function of Kidney:

The kidney performs three functions:

(i) Pressure Filtration (ii) Reabsorption (iii) Secretion

All these functions are performed in the nephron.

(i) Pressure Filtration / Ultrafiltration

A large number of liquids is filtered from the blood in glomerulus and goes to the Bowmann's capsule. The glomerular walls are excellent for filtration processes as they *have very small* pores. Blood cells and most of the protein molecules being longer in size are unable to pass through the walls of the glomerulus and the blood which reaches here creates the filtration pressure. The filtrate appearing in glomerulus is called glomerular filtrate. The glomerular filtrate contain numerous useful substances such as glucose amino acids, salts *etc. in* aqueous solution.

(ii) Reabsorption:

All the useful constituents of the glomerular filtrate are reabsorbed. When filtrate reaches the first part of the renal tubules, 2/3 of the filtrate containing useful materials like glucose and amino acids, is reabsorbed in the blood. The waste materials are not absorbed from the filtrate which becomes dense. Thus when filtrate leaves proximal tubules it mostly contains nitrogenous wastes.

(iii) Tubular Secretion

The tubular epithelium also secrete substances into the human, this secretion is very selective and is mainly of hydrogen ions to **balance pH value** of the filtrate passing through tubule.

Urine Formation:

Passing through the middle part the filtrate is diluted or concentrated according to the need. When the filtrate is passed through the last part of the duct it takes the form of urine.

Q.12. How does the kidney work as an osmoregulatory organ?

Ans: The concentration of excretory products depends upon the availability of water. The production of varied concentration of urine depending on availability of water shows that kidney functions as an osmoregulatory organ.

MECHANISM IN LESS SUPPLY OF WATER:

If the supply of water is less then the water is conserve. This is done by counter current and hormonal mechanisms.

Counter Current Mechanism

The interstitial fluid of the kidney is gradually concentrated from cortical to medullary part. Thus inner medulla is highly with the presence of urea and a *mechanism* called counter current multiplier.

"The mechanism which causes gradual osmotic outflow of water from the *filtrate* back to kidney as it passes downward in the descending loop of Henle is called counter current multiplier".

Moreover ascending loop of Henle does not allow outflow of water from its filtrate. Instead of it, Na ions are transported actively into the kidney interstitium to sustain its high concentration.

Hormonal Control

The adrenal cortex secretes a hormone called **aldosterone**. The function of the aldosterone is the active uptake of sodium in ascending limb of loop of Henle. Water reabsorption also takes place in collecting tubule. **Antidiuretic hormone** performs this *function* to transport water from filtrate in collecting tubules back to the kidney.

MECHANISM IN HIGH SUPPLY OF WATER:

In excess supply of water, reabsorption of water from the filtrate is reduced, specifically due to inhibition of release of **antidiuretic hormone.** The reduction in reabsorption causes large volumes of diluted urine. Mammalian kidney including human is adapter to conserve water by 99.5% reabsorption of glomerular filtrate.

Q.13. What are the various kidney problems and how they are cured?

Ans: The major kidney problems are:

(1) Kidney stones (2) Renal failure

(1) KIDNEY STONES:

Diagnosis

The "Kidney stones" is diagnosed with x-rays, sonography and ultrasound machine.

What is Kidney Stones?

Stoney materials which are found in the kidney are said to as kidney stones. These stones cause "Urinary Obstruction" and are generally complicated by inflections.

Kidney stones have specified chemical nature. In this problem stones material are deposited in the kidney which cause difficulties in urination. This disease becomes more complicated during infections.

Causes:

The stony material is formed during metabolic disease i.e. hypercalcemia and hyperoxaluria.

Hypercalcemia:

High level of circulating calcium in blood because of other disease is called Hypercalcemia. It causes the kidney stone.

Hyperoxaluria:

Oxalate level in the blood is increased which leads to the formation of calcium oxalate stones. Oxalates are present in tomato and green vegetables 70% of the kidney stones are produced due to the presence of calcium oxalate. Calcium phosphate is the source of 15% of kidney stones while uric acid may cause 10% of kidney stones.

Cure:

The cure of this disease is lithotripsy.

Lithotripsy:

This is non surgical method in which extra corporeal shock wave lithotripsy is most common. In this procedure high concentration of X-ray or ultra sound are directed from the machine outside the body to stone *inside. The* shock wave break the stone in tiny pieces or in sand which passes through urine. This *method is usual* use for stones present in kidney ureter or gall bladder.

Fig. The kidney stones: Stone of phosphates are formed and trapped in the pelvis area.

Surgery:

The kidney stones can also be removed by kidney surgery.

(2) RENAL FAILURE:

Due to some pathological and chemical problems the nephron can be destroyed especially its glomerular part. This destruction leads to increase in plasma level of urea and other nitrogenous wastes which may increase blood pressure and anemia etc.

Cure:

The cure of this disease is by two methods:

(i) Dialysis (ii) Kidney Transplant.

(i) Dialysis:

It is used after kidney failure and dialysis is done again and again until kidney is transplanted. In this method blood is cleaned through artificial kidney or by filtering it within abdomen. Dialysis is of two types hemodialysis and peritoneal dialysis.

Dialyzer:

It is a kidney machine that work on same principle as natural kidney works.

(a) Hemodialysis:

The meaning of hemodialysis is cleaning the blood. Blood is circulated through artificial kidney which is called dialyzer. It is actually a machine which has two spaces separated by membrane. Blood enters from one side of the membrane and dialysis (clean) fluid on the other side. The wastes and excess water is passed from the blood through the membrane into dialysis fluid.

(b) Peritoneal dialysis:

The abdomen has a peritoneal cavity whose epithelium lining is called **peritoneum. Peritoneal cavity** is filled with dialysis fluid that enters the body. Through **catheter**. Excess water and wastes pass through the peritoneum into dialysis fluid. This process is repeated several times in a day.

(ii) Kidney transplant:

Dialysis is not the permanent cure of the disease. In uremia which is end stage of renal failure new kidney is transplanted. For transplantation it is necessary that there is cross matching of the kidney.

Q.14. What kind of adaptations do the plants show for thermoregulation in their body?

Ans: *Thermo regulation in plants:*

Plants show great adaptation in low and high temperature.

HIGH TEMPERATURE:

Problems:

1. The main problem in high temperature is that enzymes of the plants may get denatured. This causes the destruction of metabolism of plant which may kill plants.
2. In not weather stomata get closed which results in water deficiency.

Adaptation:

To compete with these problems plant show following adaptations.

1. Plants produce large quantities of special proteins called heat shock proteins. These proteins prevent denaturation.
2. Plants of temperate regions can face the stress of 40°C and above.
3. Plants use evaporative cooling to manage with high temperature.

Low temperature:

Problems:

In low temperature the following problems can be created:

1. The fluidity of cell membrane is changed as lipids become locked in crystalline structure. This affects the transport of solutes and structure of proteins.
2. Freezing leads to the formation of ice crystals in cell wall and protoplasm. The formation of crystals in cell wall does not cause serious problems and plants can survive but if they are formed in protoplasm and organelle then the cells are killed.

Adaptations:

1. To compete with cold stress plants increase the proportion of unsaturated fatty acids which help the membrane to maintain structure at low temperature by preventing crystal formation.
2. Plants living in cold regions bring changes in solutes composition of cells which causes cytosol to super cool with out ice formation. Examples of such plants are oaks, maples roses etc.

Q.15. Describe thermoregulatory strategies in animals especially mammals including human in cold temperature.

***Ans:* Gain and loss of temperature:**

Animals change the rate of their body heat and produce heat through metabolic processes. This transfer of heat is done in different ways.

Temperature classification of animals:

With reference to the thermal characteristics animals are *divided as following:*

1. Poikilotherms:

The animals with body temperature that fluctuates with that of environment are called poikilotherms.

Examples: All invertebrates, amphibians and reptiles fall to this group.

2. Homeotherms:

The animals which maintain their stable body temperature and do not change as the temperature of environment changes are called homeotherms.

Example: Birds and mammals.

Other classification system:

The classification which is discussed above arouse many complications because

(i) There are some deep sea fishes which do not change their body temperature

(ii) Lizards regulate their temperature.

(iii) There are some birds and mammals which change the temperature of their body as the surrounding temperature changes. Therefore another scheme of classification is introduced. This scheme is based on the "source of Heat Production". According to this system the animals are divided into three categories.

1. Endotherm 2. Ectotherm 3. Heterotherm

1. Endotherm:

The animals that generate their own body heat through heat production as by product of metabolism are called endotherm.

Example: Birds, fishes, flying insects.

2. Ectotherm:

The animals which produce very low metabolic heat which can be exchanged with the environment however absorb heat from their surroundings are called ectotherm.

Example: Many invertebrates, fishes, amphibians and reptiles.

3. Heterotherm:

The animals which have the capability of producing varying degree of endothermic heat but do not regulate their body temperature within a narrow range are called heterotherms.

Example: Bat, Humming bird.

Adaptation of heat exchange:

Different adaptation for regulation of heat exchange are:

Structural adaptations:

These are as follows:

1. Long term changes in sub dermal fatty layer insulation or **pelage**.
2. The presence of sweat glands.
3. Modification of lungs for **panting**.

Physiological adaptor:

1. Animals regulate the flow of blood towards the skin. When the temperature is high the flow of blood becomes greater which dissipate heat and when temperature is less they lower the flow of blood to economize the heat loss.
2. Some of the muscles get activated which cause plumage fluffing.
3. Activation of sweat gland is a source of evaporative cooling.

Behavioral adaptations:

1. Some of the animals arrange their place for short period so that heat exchange is minimal. Example is of ground squirrels that move to burrows in midday heat and lizard bask in sun to gain heat.
2. By adjusting their posture animals try to control the amount of surface area available for heat exchange.

THERMOREGULATION IN MAMMALS(HUMAN):

Endothermy in mammals:

Mammals maintain their body temperature between 36-38^{0}c. Mammals maintain their body temperature thus this endothermy is much helpful to keep high metabolic rate and availability of energy every time. All these things provide greater adaptations.

Adaptation in cold temperature:

1. When it is too cold the rate of heat production is increased by increased muscle contraction by movements or shivering called as **shivering thermogenesis**.
2. Some of the hormones as thyroid hormone trigger the heat production which is called **non shivering thermogenesis**.
3. Some mammals have **brown fat** which is specialized for heat production.
4. On a cool day human's temperature may by several degrees lower in arms and legs than in trunks. Here the most important glands are present which balance the temperature.
5. **Vasoconstriction**, skin blood vessels constrict diverting blood from skin to deeper tissues and reducing heat loss from skin surface.
6. Most land mammals in the low temperature raise their **furs**. In doing so they can trap the thicker layer of still air which acts a good insulator between animal skin and surroundings.
7. Some of marine animals as whales and seals inhabit much colder water than their body temperature, have a thick layer of insulating fat called a **blubber** just under the skin.

Adaptations in warm temperature:

1. ***Vasodilation,*** skin blood vessels dilates which radiates the heat from skin surface.
2. The **sweat glands** are activate which increase evaporative cooling. Marine mammals dispose off their skin excess heat into warm seas by large blood vessels in outer layer of skin.

3. **Panting** the evaporative cooling in respiratory heat is also heat reducing mechanism.
4. Bats use saliva and urine for **evaporative cooling.**

Feed back control in thermoregulation:

Thermoregulation is a homeostatic feed back mechanism. The homeostatic thermostat is present in a part of brain called hypothalamus which respond to change in temperature of set point which is 37°C.

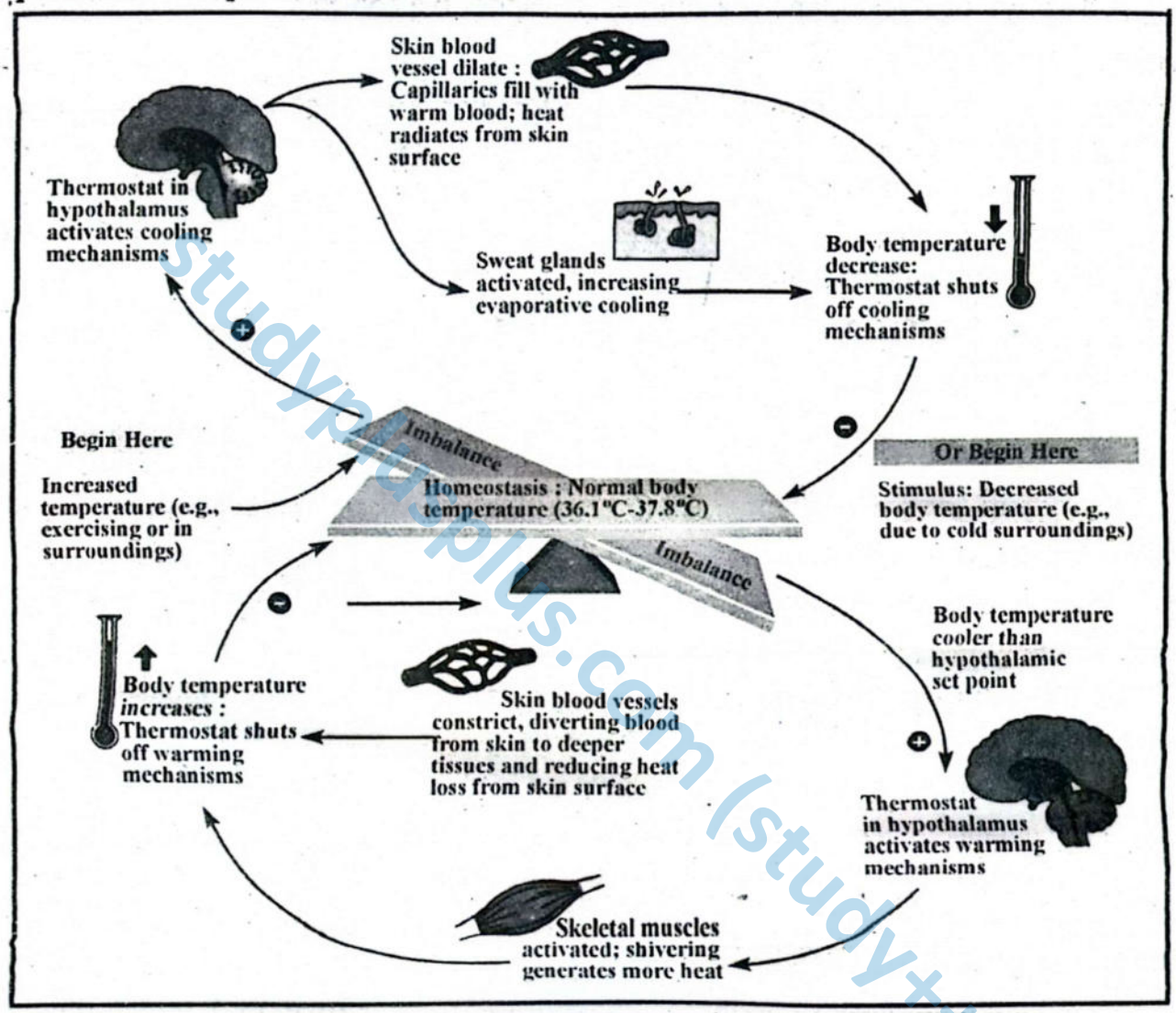

Fig. The thermostat function of the hypothalamus and feed back control mechanisms in human thermoregulation.

Response in high temperature:

When temperature is high above 37°C then the thermoreceptores *in skin*, hypothalamus and other parts of nervous system send signal to the system that increase *blood flow to skin and cause sweat gland activation.*

Response in low temperature:

At low temperature cold receptors send impulses to hypothalamus to inhabit heat loss mechanism and activate heat conservation mechanism.

Temperature in fever:

This is also called pyrexia. When any infection is caused due to some pathogen then the number of leukocytes is increased. Pathogens and leukocytes produce chemicals called pyrogens. Pyrogens displace the set point of hypothalamus above normal point of 37°C. Fever helps in stimulating protective mechanism against pathogens.

SOLVED EXERCISE

Q.1: Fill in the blank with appropriate words.

(i) ..... is the ability of an organism to regulate its fluid contents.

(ii) The detoxification of ammonia excretion to ..... requires the precursor of onetime.

(iii) In kidney nephron is closely associated with network of ..... .

(iv) In insects salt and water reabsorption takes place in ..... .

(v) The antidiuretic hormone act on ..... to promote reabsorption of water in vertebrate nephron.

(vi) The nephrons arranged along the border of cortex and medulla, with tubular system looping deep in the inner medulla, are called ..... nephron.

(vii) The non surgical procedure of removing kidney stone is termed as ..... .

(viii) ..... Is the homeostatic thermostat in human.

Ans:

(i)	Osmoregualtion	**(ii)**	Urea
(iii)	Peritubular capillaries	**(iv)**	Rectum
(v)	Collecting tubule	**(vi)**	Juxtamedullary
(vii)	Lithotripsy	**(viii)**	Hypothalamus

Q.2: Encircle the correct answer from the multiple choices.

(i). The protection of an internal environment from the harms of fluctuations is the definition of which of the followings?

(a) Osmoregulation (b) Excretion

(c) thermoregulation (d) Homeostasis

(ii) The category of the plants that has adaptations of small and thick leaves to *limit* water loss are called?

(a) Hydrophytes (b) Xerophytes

(c) Mesophytes (d) Hygrophytes

(iii). The environment where the animals produce large volumes of diluted urine.

(a) Hypotonic aquatic (b) Isotonic aquatic

(c) Hypertonic aquatic (d) Terrestrial

(iv) Which of the following is called as excretophore i.e. contribution mainly in the elimination of wastes in plants?

(a) Stem (b) Roots

(c) Leaves (d) Flowers

(v) The excretory product that requires minimum water for its elimination compare to others.

(a) Urea (b) uric Acid

(c) Creatinine (d) Ammonia

(vi) The group of animals whose excretory system is structurally associated with nutritive tract.

(a) Vertebrates (b) Earthworm

(c) Planaria (d) Insect

(vii) The excretory structures that deliver urine from kidney to urinary bladder.

(a) Urethera (b) Pelvis

(c) Ureter (d) Collecting tubule

(viii) The metabolic wastes that are ingested into the body and must be removed.

(a) Pesticides (b) Drugs

(c) Food additives (d) All of these

(ix) Which of the following is not endotherm?

(a) Birds (b) Amphibian

(c) Flying insects (d) Mammals

(x). Name of type of adaptation from the following that is responsible for *shivering* thermogensis.

(a) Structural (b) Physiological

(c) Behavioral (d) None of these

Ans: **(i)** d **(ii)** b

(iii) a **(iv)** c

(v) b **(vi)** d

(vii) c **(viii)** d

(ix) b **(x)** b

Q.3: Short questions

(i) Differentiate between osmoconformers and osmoregulators.

Ans: Osmoconformers are those animals which do not require to adjust their internal osmotic state. The animals whose body fluid concentration has great difference as compare to their environment and they need to adjust their internal osmotic state are called osmoregulator.

(ii) Define anhydrobiosis with an example.

Ans: The characteristic of the animals in which terrestrial animals can tolerate dehydration is called anhydrobiosis e.g. targigrades have 85% water normally but can dehydrate to less than 20% and survive in this state.

(iii) Why does filtration takes place only at glomeruli part of nephron and nowhere else?

Ans: Filtration takes place in glomeruli because their walls are porous and fraction of blood reaching here provides filtration pressure.

(iv) Mention two metabolic altered states that generally (70%) cause kidney stone formation.

Ans: Two metabolism altered states are hypercalcemia in which calcium level in blood is increased and hyperoxaluria in which oxalates level is increased.

(v) What is a renal failure?

Ans: Renal failure means destruction of nephron especially the glomerular part which is caused due to some pathological and chemical factors.

(vi) Account one each main adaptation in plants to high and low temperatures.

Ans: In high temperature plants use evaporative cooling. While in low temperature fluidity of cell membrane is altered.

Q.4: Extensive questions.

(i) Discuss nature of excretory products in animals to various habitats, specifically in association of water availability.

Ans: *Please see* Q.No. 7

(ii) Account the excretory system in earthworm.

Ans: Please see Q.No. 8 (b)

(iii) Highlight the role of liver as an excretory organ.

Ans: Please see Q.No. 10 (b)

(iv) Draw a labeled diagram of a vertebrate nephron with all blood supply. State the function of each part.

Ans: Please see Q.No. 11

(v) Describe thermoregulatory strategies in mammals including human in cold temperature

Ans: Please see Q.No. 15

(vi) Discuss excretion in plants.

Ans: Please see Q.No. 5

(vii) Discuss some kidney problems with their cures.

Ans: Please see Q.No. 13