SUBJECT: BIOLOGY

TERM: FIRST TERM

CLASS: SS2

SCHEME OF WORK

1. Digestive System
2. Transport System
3. Respiratory System
4. Excretory System
5. Nutrient Cycling in Nature
6. Decomposition in Nature
7. Ecological Management
8. Adaptation
9. Pollution
10. Revision
11. Examination and Closure

TOPIC: DIGESTIVE SYSTEM

Digestive system is a group of connected organs that work together to break down food, absorb essential nutrients for energy and repair, and eliminate undigested food material.

Parts and Types of alimentary Tracts

The alimentary canal include the following parts: mouth, pharynx, oesophagus (gullet), stomach, small intestine (ileum), large intestine (colon), caecum, rectum and anus. All these parts are present in most vertebrates. However, there are modifications of different parts of the alimentary tract in various animals.

There are two types of alimentary tracts namely;

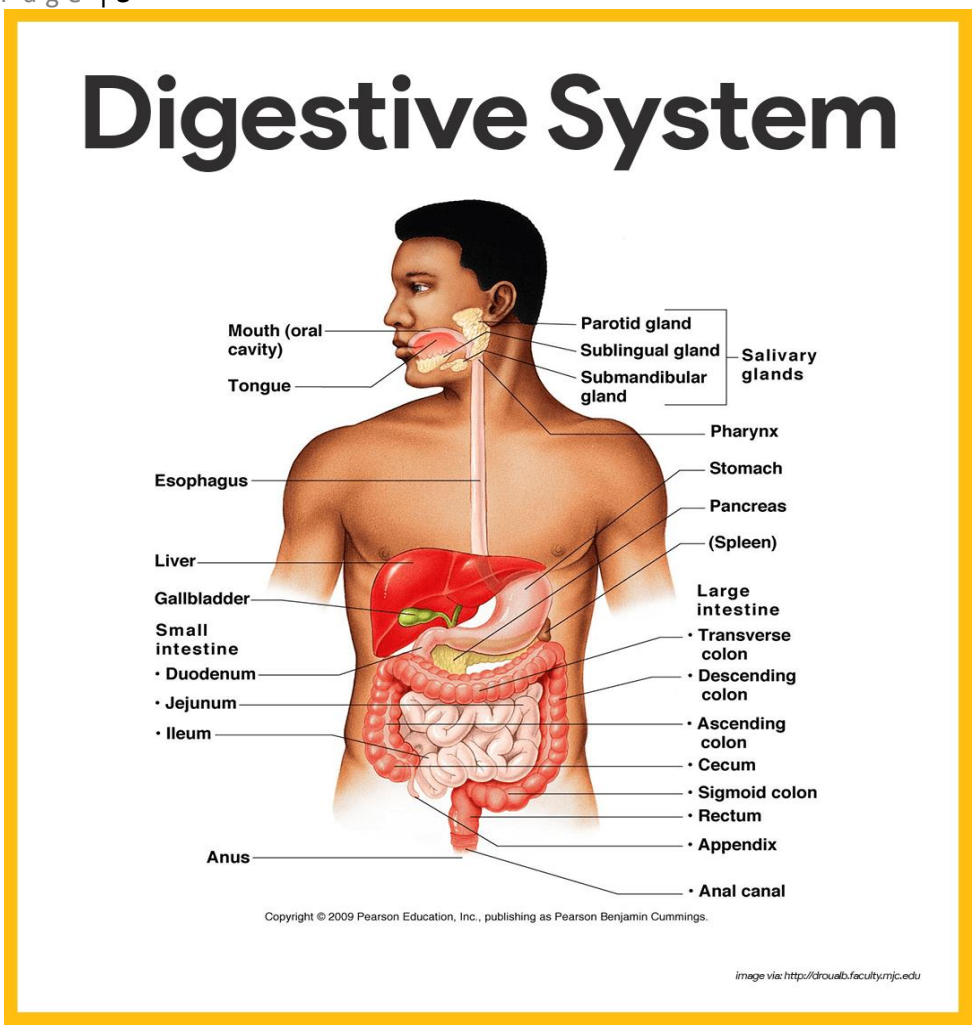
1. Incomplete digestive tract: Organisms with incomplete digestive tracts have one opening to the outside world called the mouth which serves for ingestion and egestion. Examples of organisms with incomplete digestive tracts include hydra and planaria
2. Complete digestive tract: Organisms with complete digestive tracts have two openings to the outside world called mouth and anus. The mouth serves for ingestion while the anus is for egestion. Earthworm, bird and goat are examples of animals with complete digestive tracts.

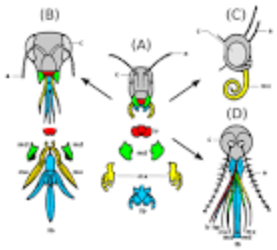
Alimentary canal of different animals

1. Planaria: planaria is a free-living flat worm that feeds on small aquatic animals called zooplanktons, crustaceans and rotifers. It has a simple alimentary canal with one opening - the mouth. The mouth opens into a short buccal cavity which leads into the pharynx. The pharynx leads into the intestine. The intestine has three main branches: one anterior and two posterior. Digestion of food in planaria is intracellular.
   Activity: Draw a well-labelled diagram of the alimentary canal of a planaria.
2. Earthworm: The alimentary canal of earthworm consists of mouth, buccal cavity, pharynx, oesophagus, crop, gizzard, intestine and anus. While the crop stores food temporarily, the gizzard is for grinding food into small particles. Digestion in earthworm is extracellular, that is, digestion is outside the cells.
   Activity: Draw a well-labelled diagram of the alimentary canal of an earthworm.
3. Cockroach/Grasshopper: Grasshopper feeds on green vegetable while cockroach feeds on household materials. The alimentary canal consists of foregut, midgut and hindgut.
   - Foregut: It consists of mouth, oesophagus, crop and gizzard.
   - Midgut: The midgut consists of six caeca. The caeca open into the midgut and secretes digestive juice which contains three kinds of enzymes that complete the digestion of carbohydrates, protein and fats. Digestion and absorption take place in the midgut.
   - Hindgut: The hindgut consists of small intestine, rectum and anus.

   Activity: Draw a well-labelled diagram of the alimentary canal of a cockroach.

4. Bird: The digestive system of the bird includes the mouth (beak), pharynx, oesophagus, crop, proventriculus, gizzard, intestine, caecum, rectum and anus (cloaca). The food picked by the beak moved from the mouth through the oesophagus to the crop.





Modifications and Mechanisms of Feeding in some Animals

There are five modifications and mechanisms of feeding associated with some organisms. These feeding mechanisms include:

Absorbing Mechanisms, e.g. tapeworm

The tapeworm is an endoparasite which carries out parasitic feeding on its host i.e., the man. It has no mouth but absorbs digested food from the intestine of its host. The body of the tapeworm is modified and adapted for parasitic feeding as follows:

1. The alimentary canal is absent; hence food is absorbed through its entire body surface.
2. The tapeworm has hooks and suckers which are used for attachment to the intestine of the host to avoid dislodgement.
3. The body has thick cuticle which resists digestive enzymes of the host.
4. The flat body surface of the tapeworm provides a large surface area for the absorption of already

digested food.

5. The entire body surface is used also for the absorption of food.

Biting and Chewing Mechanism, e.g. Grasshopper or Cockroach

The grasshopper or cockroach has mouth parts adapted for biting and chewing. These insects have four different mouth parts which are modified and adapted for biting or chewing food. These mouth parts are:

1. **Labrum**: The grasshopper has labrum or upper lip which prevents the food from falling off the mouth.
2. **Mandibles:** It possesses a pair of mandibles which are heavy, toothed and jaw-like structure used for cutting and chewing food materials.
3. **Maxillae:** The grasshopper also has a pair of maxillae which is also a biting blade. This breaks down the food which the mandibles have chewed into smaller particles.
4. **Labium:** The labium (lower lip) prevents the wastage of food from the mouth.

Sucking mechanism: There are three popular organisms which exhibit sucking mechanism. These are mosquito, butterfly, and housefly. These insects have different modifications of mouth parts adapted for feeding on food through the mechanism of sucking.

Mosquito

1. The mosquito possesses a piercing mouth part called the **proboscis** used for sucking the blood of man and animals.
2. The mouth parts altogether form a strong **stylet,** capable of penetrating the skin to suck blood.
3. The stylet, except the labium, is sharp and pointed to ease penetration into the skin.
4. The mouth can produce saliva to prevent clotting of blood while it is being sucked in.
5. It has the ability to fold back the labium easily so as to allow the stylet to perform its work of penetration of the skin to suck blood.

Butterfly

The butterfly feeds on liquid food like nectars of flowers. It has its mouth parts modified for sucking in the following ways:

1. It possesses a long, coiled proboscis, used for sucking nectars of flowers.
2. The insect is capable of recoiling the long proboscis under its head when not in use.
3. There is the non-functioning of the other mouth parts due to the type of food taken by the insects.

Housefly

The housefly feeds on liquid food materials. It has mouth parts modified for sucking in the following ways:

1. The housefly possesses enlarged **labella**, which are sucking structures for liquid food.
2. It has the ability to feed on solid food, e.g. sugar by pouring out its saliva to change the food to a liquid state.
3. It has sucking mechanism called **sponging** in which the mouth is placed on the liquid food and it will start to rush into the mouth.
4. The labella have fine channels which aid rapid absorption of liquid food into the mouth.

Grinding mechanism: This is common among mammals, e.g. man, cattle, sheep, goat, etc. These animals are capable of grinding the food before swallowing. This grinding is aided by the presence of hard and strong teeth made of enamel and dentine.

The animals are adapted to the grinding mechanism by the following features:

1. They possess different sets of teeth to grind food.

2. The teeth are hard and strong to withstand biting, chewing or grinding and cracking of food.
3. They possess incisors which are sharp with flat edges used for cutting off bits of food.
4. Animals have pointed canine teeth which are used for tearing food.
5. There is presence of premolars and molars with undulating and wide surfaces used for grinding of food.
6. The absence of front teeth (incisors) in sheep (a herbivore) is a special adaptation as it helps to grind the grasses during feeding by the animals.

Trapping and absorbing mechanism: The trapping and absorbing mechanism is common among the insectivorous or carnivorous plants such as bladderwort and sundew. Bladderwort and sundew have structures which enable them to adapt to this mode of feeding.

1. Sundew, for example, traps insects by undergoing nastic movements in response to touch from the body of the insects.
2. The sundew leaf has long hairs which carry digestive glands.
3. Insects, on landing on these hairs, cause other hairs to curl over the insect and cover it.
4. The sundew is capable of secreting a fluid rich in enzyme to digest the insect externally.
5. The protein so synthesized is easily absorbed by the carnivorous plant into its body.

FEEDING HABITS

Organisms exhibit different feeding habits. These are:

a. Filter feeding
b. Fluid feeding
c. Parasitic feeding
d. Saprophytic feeding

FILTER FEEDING: Filter feeders which are also called **microphagous feeders** feed on very tiny organisms which cannot be easily picked to the satisfaction of the feeder. Filter feeders are mainly aquatic animals, e.gs are mosquito larva, mussel, ducks and prawns.

FILTER FEEDING IN MOSQUITO LARVA

The mouth of mosquito larva for example has horny jaws and two small ciliated appendages or mouth brushes. These are used to create a current in water. The small coloidal particles or planktons, small plants and animals are filtered from water and ingested into the mouth as food.

PARASITIC FEEDING

Parasitic feeding is found in both plants and animals. Animal parasites are tapeworm, roundworm, liverfluke, louse, tick and guineaworm while plant parasites are cassytha, dodder and mistletoe.

SAPROPHYTIC FEEDING

Saprophytes are mainly non-green plants which do not have chloroplasts and therefore cannot manufacture their own food. They then feed on dead and decaying organic matter from which they derive their food. Examples of saprophytes are rhizopus, mushroom, mucor. Their body is adapted in the following ways:

a. They have hyphae instead of roots through which they pour out enzymes for digestion.
b. They are capable of carrying out extracellular digestion, i.e. digestion of food outside the body cells of the plant.
c. The digestion portion of the organic matter is later reabsorbed into the body.

PROCESS OF FEEDING IN PROTOZOA

Protozoa like Amoeba exhibit holozoic mode of nutrition. Amoeba feeds on micro organisms like diatoms, demids or other organic particles. It engulfs the food particles by putting out its pseudopodia which surround the

food particle by forming a cup-shape when the two ends of the pseudopodia touch. The pseudopodia on meeting or touching, fused and enclosed the food into the body with little drop of water; this forms a food vacuole. The food is digested inside the food vacuole.

FEEDING IN HYDRA

Hydra feeds mainly on small crustaceans or other smaller aquatic organisms. The food is captured by the action of **nematocysts** borne on the tentacle. A nematocyst has a **stinging thread** which contains poisonous substance. The food is carried into the wide mouth by the tentacle. Enzymes are secreted into the enteron by the gland cells. The digested food is absorbed into the body while the undigested parts are sent back into the enteron and forced out through the mouth.

EVALUATION

1. What is a digestive system?
2. List three parts of digestive tract.
3. Name the types of digestive tract.
4. .State two similarities between the alimentary canal of a bird and a cockroach.
5. .Mention the differences between the alimentary canal of a bird and that of a cockroach.
6. Briefly explain absorbing mechanism in tapeworm.
7. Name three sources of food for cockroaches.
8. What is the mechanism of sucking in housefly called?
9. Explain grinding mechanism in mammals

TOPIC: TRANSPORT SYSTEMS

MEANING OF TRANSPORT SYSTEM

Organisms need to be able to move materials such as respiratory gases, nutrients, waste products and heat both into and out of, and within its body.

A transport system is a means by which materials are moved from an exchange surface or exchange surfaces to cells located throughout the body system.

Specialized exchange surfaces are biological structures whose features are such that they permit the highly efficient transfer of materials e.g. respiratory gases, across them through mechanisms such as diffusion or active transport. Although many micro-organisms accept materials directly through their cell membrane.

Mass flow is the movement of a fluid in one direction, usually through a system of tube-like vessels. Examples of mass flow in mass transport systems include the movement of blood and the movement of xylem and phloem through plants.

Need for Transportation

The need for transportation in living organisms includes:

1. Transport is necessary for every cell of the organism to obtain all the essential materials for its metabolism, e.g. nutrients, oxygen, water etc.
2. It is also necessary to remove and dispose metabolic wastes, e.g. carbon dioxide, water, urea etc.
3. In plants, transport is necessary to move mineral salts and water from the roots to the stems and leaves.
4. Transport is also required to move hormones in plants and animals from where they are produced to the
5. area of need.
6. Glucose from the leaves and storage organs are some of the substances being regularly transported in plants.

Materials for Transportation

The following things are transported by blood:

1. **Antibodies**: Antibodies are produced by white blood corpuscles and transported by the blood to all parts of the body for tissue respiration or for storage in storage organs.

2. **Carbon dioxide**: Animals breathe in oxygen and breaths out $CO_{2.}$:Metabolic process of respiration going on 0in the body cells constantly releases carbon (IV) Oxide and water. These diffuse in exchange of oxygen across the capillary wall into the blood stream. The release of carbon (IV) Oxide from the body of animals helps to maintain the adequate internal body temperature of animals.

3. **Hormones**: Hormone is produced by the endocrine glands of the animal body. It is transported by blood to the action sites. These action sites are where these hormones are needed and used.

4. **Oxygen**: Oxygen is the principal gas that holds the lives of animals. The red blood cells contain haemoglobin. This haemoglobin combines with oxygen to form what is called Oxyhaemoglobin. The oxyhaemoglobin assists in distributing oxygen to cells and tissues where they are needed in the body.

5. Urea: Waste products arising from body metabolism of animals are carried by blood to the kidney, skin and so on for excretion. In the other words, urine is transported from the kidney to the bladder and then excreted from the body through the possible part of the body.

6. **Excess salts**: These are also produced from cells and excreted by the skin and kidney.

7.. Water: This is a universal solvent. All living things both plants and animals needs water for survival. The total amount of water in a man of average weight (70 kilograms) is approximately 40 litres, averaging 57 percent of his total body weight. Water is transported from one part of human body to the other. Water is also released as sweat through the skin pores. It is a very important class of food needed by animals.

Media of Transportation

In all organisms, a liquid or fluid is the medium of transportation of materials. Generally, there are four major media of transportation which are:

1. **Cytoplasm:** Cytoplasm is used as the medium of transportation of materials in lower unicellular organisms such as Amoeba and Paramecium. Materials such as glucose, amino acids, oxygen, water and carbon dioxide are transported from one part of the cell to another through cytoplasm.
2. **Cell sap or Latex**: Cell sap or latex is used as the medium of transportation of materials in plants. Cell sap is a concentrated solution found in the vacuole of cells which serves as a stronger solution. As a result of this the cell sap is able to transport water and dissolved mineral salts from the soil through the root hairs to the upper parts of the plants.
3. **Blood**: The blood is a powerful medium of transportation of materials in most animals especially vertebrates. The blood in its fluid state is able to move large materials over the entire body through blood vessels like arteries, veins and capillaries from where they are produced or obtained to their point of destination.
4. **Lymph**: Lymph is one of the media of transportation in higher animals. it is a fluid similar in composition to tissue fluid, although it contains extra lymphocytes, there is no red cell present. It returns fluid to the main veins through opening in the subclavian (left jugular) vein below the neck. Example of lymph vessel is the lateal which transports fatty acids and glycerol.

Mechanism of Transportation in some Organisms

Among the unicellular protists, oxygen and nutrients are obtained directly from the aqueous external environment by simple diffusion. The body wall is only two cell layers thick in cnidarians, such as Hydra, and flatworms, such as Planaria. Each cell layer is in direct contact with either the external environment or the gastrovascular (a part of the body involved in both digestion and circulation) cavity. The gastrovascular cavity of Hydra extends from the body cavity into the tentacles, and that of Planaria branches extensively to supply every cell with oxygen and nutrients.

TRANSPORT SYSTEM IN MAN

The human transport system is a system of tubes with a pump and valves to ensure one way blood flow. We need a transport system to deliver oxygen, nutrients and other substances to all our body cells, and take away waste products from them.

Composition and Structure of Blood

Structure of the Blood: The blood is a tissue in fluid form consisting of several types of cells floating in a liquid called plasma. An average adult has about 5.5 litres of blood.

Blood Cell or Corpuscles

The blood cells are made up of

a. Red blood cells or erythrocytes
b. White blood cells or leucocytes
c. Blood platelets or thrombocytes

Red blood cells or erythrocytes: These are one of the smallest cells in the body, they are round with a dent in the middle, we call this shape a Biconcave disc. One cubic litre of blood has about $5^1/_2$ million red blood cells. The function of the red blood cells is to transport oxygen from the lungs to the body cells. When the blood reaches the lungs, oxygen diffuses from the alveoli to the red blood cells and combines with **haemoglobin** (a red protein) forming an unstable compound called **oxyhaemoglobin.** When the blood reaches the body cells, the oxyhaemoglobin is easily split into oxygen and haemoglobin again, the oxygen diffuses through the blood plasma to the cells. They also take part in blood clotting.

White Blood Cells or leucocytes: White blood cells are one of the substances floating in the blood plasma. They are completely different in function than red blood cells. White blood cells are part of the Immune System, they play a big role in protecting the body by killing bacteria which cause disease, also known as pathogens. White blood cells can be distinguished from red blood cells easily because they are much bigger, with a nucleus, and present in fewer amounts with about 5,000-10,000 of them existing in cubic millilitre of blood.

Types of White Blood Cells

Phagocytes: They kill bacteria by engulfing them, taking them in the cell then kill them by digesting them using enzymes, this process is called **phagocytosis**. Most white blood cells are the phagocyte type.

Lymphocytes: Unlike phagocytes, lymphocytes have a large nucleus. They are produced in the lymph nodes (in the lymphatic system). Lymphocytes kill bacteria by secreting antibodies and antitoxins which kill the pathogens directly or make them easier to kill. Each pathogen could be killed by a certain type of antibody.

Blood Platelets or thrombocytes: Platelets are tiny cell fragments that prevent bleeding when the skin is cut, and stops bacteria from entering the systems through the wound. There are about 250,000 platelets in one cubic millilitre of blood.

Blood Plasma: This makes up most of the blood. It is mostly water with some substances dissolved in it, these include carbon dioxide, hormones, food nutrients, urea and other waste products. The blood plasma transports substances from one place to another.

Functions of Blood

1. **Respiration:** Transportation of oxygen and carbon dioxide is the fundamental function of the blood. Transport of oxygen from the lungs to different tissues, and the transport of carbon dioxide from the tissues to lungs are mainly carried out by the blood.
2. **Transport of food materials:** Blood is the only medium by means of which the absorbed food materials are transported to various parts of the body.
3. **Excretion:** Metabolic wastes such as urea, uric acid, creatine, water, carbon dioxide, etc., are transported by blood, to kidney, lungs, skin and intestine for removal.
4. **Regulation of blood temperature:** The blood has an important role in the regulation of body temperature by distributing heat throughout the body. This heat is generated in the muscles by the oxidation of carbohydrates and fats.
5. **Maintenance of acid-base balance:** The blood has buffering capacity and maintains normal acid-base balance in the body.
6. **Regulation of water balance:** Blood serves to maintain water balance in the body by exchanging water between the blood and the tissue fluid.

7. **Defence:** Blood affords protection to the body against infections and the antibodies.
8. **Transport of hormones:** Blood is the only medium which serves to distribute hormones to different parts of the body.
9. **Clotting:** Loss of blood from the body through injury is prevented by the action of thrombocytes of the blood.
10. **Transport of metabolites:** Blood is responsible for the supply of chemicals and essential metabolites.

THE LYMPH

This is a liquid, associated with the lymphatic system. It is colourless. It is in form of a fluid. It is similar in composition to the tissue fluid, but it contains extra lymphocytes. Red cells are not present. Movement of the lymph is enhanced by the action of muscles. It moves through vessels, e.g. lacteal. Some swellings do exist in groups along the lymph vessels especially in the neck, groin and armpit, called ***lymph nodes.*** The lymph nodes are where lymph passes through to be made pure before entering into the blood stream. The lymphatic system is second to the circulatory system. But unlike the circulatory system, it ends blindly.

Functions of the Lymph

The functions of the lymph include:

1. **Body defence:** The lymph node produces white blood cells, hence aids body defence.
2. **Absorption of fatty acids and glycerol**

PROCESS OF BLOOD CLOTTING

When the skin is cut, some reactions take place that results in platelets releasing an enzyme called **thrombokinase.** The thrombokinase reacts with **prothrombin** and calcium ions to form **thrombin.** The thrombin acts on **fibrinogen** (another soluble protein in the plasma) and converts it into soluble network of **fibrin**. The fibrin forms long fibres that clot together blocking the cut, thus preventing any bleeding, this is called **blood clotting.**

CIRCULATORY SYSTEM IN MAMMALS

Circulatory system refers to the continuous movement or flow of blood round the body involving the heart and the blood vessels.

Importance of Circulatory system

1. Helps in excretion of waste products from the body.
2. Digested food materials like glucose, amino acids, fatty acids and glycerol are carried from the intestine to the tissues where they are stored or used up, water and oxygen are also carried by the blood.
3. Protection of the body against diseases e.g. white blood cells.
4. Regulation of the body temperature: the blood helps in the distribution of heat produced in muscles and organs like liver, to other parts of the body.
5. Helps in blood clotting in wounds e.g. blood platelets.
6. Sustains life by supplying nutrients to cells.

Types of Circulatory System

Circulatory system in animals can be grouped into three major categories:

a. Closed and opened circulatory systems

b. Single and double circulatory systems

c. Pulmonary and systemic circulatory systems.

Closed and Opened Circulatory System

i. **Closed Circulatory System:** The closed circulatory systems are made up of blood vessels called arteries from the heart which branch many times into small units called capillaries but eventually join up with other vessels called veins that are connected to the heart. By this design, blood is therefore always confined within the cavities of the vessels and the heart and never comes into direct contact with the cells of the body.

Some invertebrates like annelids and all the vertebrates have closed circulatory systems.

In mammals, for example, there is no mixing of oxygenated blood in the heart. While oxygenated blood is confined to the left part of the heart, deoxygenated blood is confined to the right side.

ii. **Opened Circulatory System:** In this system, the blood vessels lead out of the heart but end in blood spaces called **haemocoels** within the body cavity. In these spaces, the blood comes into direct contact with the cells after which it is returned to the heart, Arthropods and some molluscs have opened circulatory systems.

Single and Double Circulatory Systems

i. Single circulatory system: In a single circulatory system, the blood only passes through the heart once every time it makes one complete movement round the body. This system is common in fish which has only two-chambered heart, one auricle and one ventricle.

ii. Double circulatory system: In double circulatory system, the blood passes through the heart twice every time it makes one complete movement round the body. Each time the blood passes through the heart, it goes through a separate pathway. This is found in mammals.

The double circulation gives rise to the two pathways involved in double circulatory system called **pulmonary** and **systemic circulation.**

Pulmonary and Systemic Circulation

i. Pulmonary Circulation: The pulmonary circulation involves the movement of blood between the heart and the lungs. In other words, it involves the movement of blood from the heart to the lungs for oxygenation.

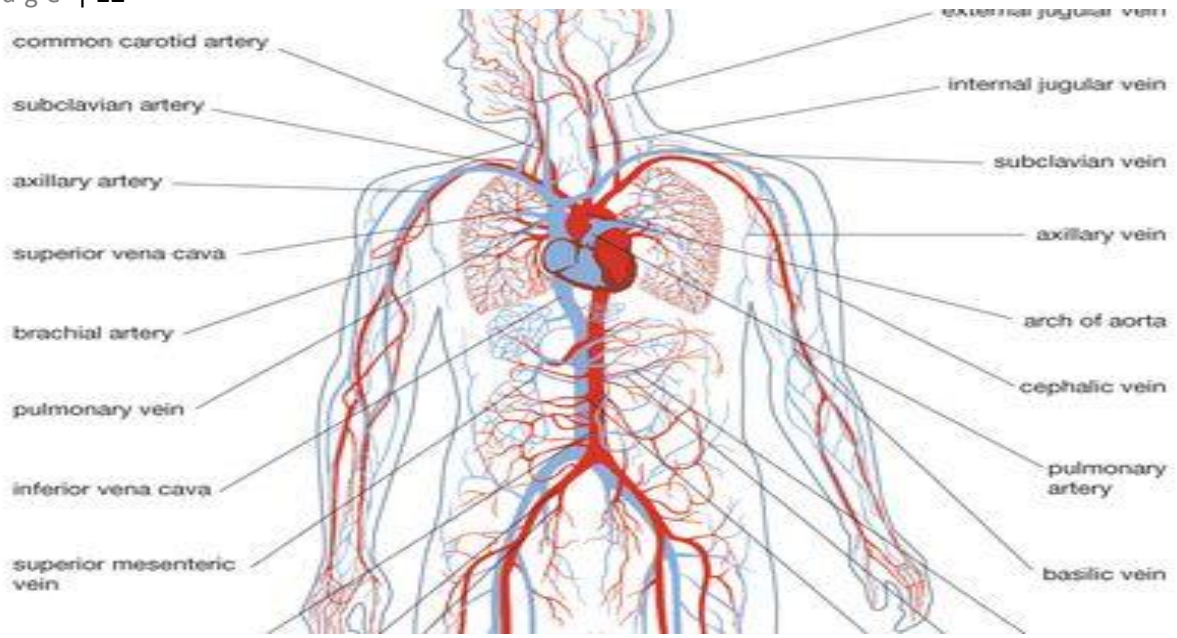
ii. Systemic Circulation: The systemic circulation involves the movement of blood between the heart and all other parts of the body besides the lungs. In one complete circulation, blood from any part of the body enters the heart for the first time, it is then sent to the lungs for oxygenation. From the lungs, it is brought back to the heart for the second time before it can be redistributed to all parts of the body. This is the sequence involved in double circulation.

Pulmonary and systemic circulation can be represented mathematically by linear equation as:

Pulmonary circulation = Heart + Lungs

Systemic circulation = Heart + Body

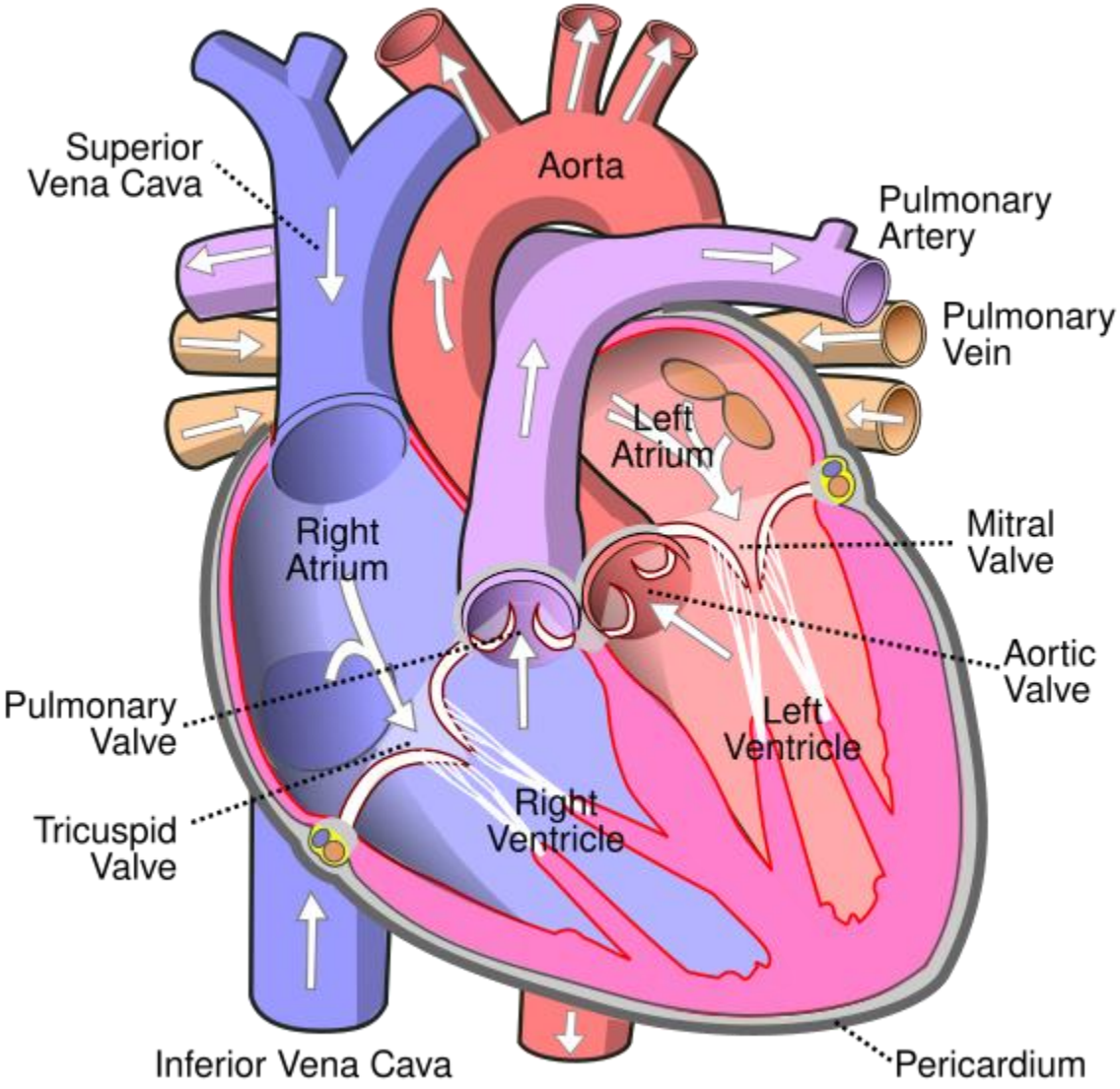
The appearance of heart twice in the two equations represents the double circulation of blood in mammals.



Parts of the Circulatory System

The organs that are responsible for blood circulation in the body are together called the circulatory system. The circulatory system consists of the heart and blood vessels.

The Heart



The heart pumps blood to all part of the body through the circulatory system. The heart is a muscular organ that lies in the chest cavity and is almost conical in shape. The heart is constantly beating, contracting and relaxing. There are about 70-75 beats per minute although this beating rate may vary with individuals. Beating rate is faster in children than in adults.

The heart is reddish in colour. It is made up of special muscles called **cardiac muscles**. It has two-layered membrane called the **pericardium.** The space between the two layers is filled with fluid called **pericardial fluid**. This fluid reduces the friction caused by the pumping movement of the heart between the heart walls and the surrounding tissue.

The Structure of the Heart

The mammalian heart is divided into four chambers:

1. The right auricles
2. The left auricles
3. The right ventricles
4. The left ventricles

The walls of the ventricles are normally thicker than those of the auricles. Also, the wall of the left ventricle is thicker and more muscular than that of the right ventricle. This is because it is throughout the left ventricle that blood is pumped or forced out of the heart to all other parts of the body.
An aperture guarded by a valve known as **biscupid** or **mitral valve** is between the left auricle and left ventricle. The valve is made of two cusps which moves only in one direction, i.e. into the ventricle, thereby enabling valve to channel the blood in one direction which is from the auricle into the ventricle.
When the ventricle is filled with blood, the cusps close up the aperture between the left auricle and left ventricle. This makes sure that the blood does not flow back into the auricle.
Also, a **triscupid valve** consisting of three cusps is located at the aperture between the right auricle and right ventricle. It functions in the same manner as the biscupid valve, i.e. it allows the flow of blood from the right auricle to the right ventricle, and not vice versa.

HEARTBEAT

Heartbeat is the pumping action of the heart. It is caused by contraction and relaxation of the four muscular chambers of the heart. It occurs in two stages:
Diastole and Systole
1. Diastole: This is the first stage of heartbeat. During this stage, the two auricles contract, creating a high blood pressure in the blood contained in them. The pressure causes the bicuspid and tricuspid valves to fold downwards into the ventricles, allowing blood to flow from auricles into ventricles, hence deoxygenated blood enters the right ventricle from the right auricle while oxygenated blood enter from the left auricle.
When the ventricles are full, the cuspid valves close up the apertures between the upper and lower chambers of the heart. This happens by means of the blood forcing the cusps upwards so that they meet one another at the centre of the apertures.
2. Systole: This is the second stage of heartbeat. This stage involves the contraction of the two ventricles. This leads to blood being forced into two trunks of the main arteries and out of the heart.
Deoxygenated blood from the right ventricle passes into the pulmonary artery while oxygenated blood from the left ventricle passes into the aorta. During this occurrence, blood from the body fills up the auricles again.

BLOOD VESSELS

The blood vessels are the tubes that carry blood within the body. In other words, blood vessels are the tubes within the body, through which blood moves "to and fro" the heart. i.e. from the heart and to the heart. They are majorly three: Arteries, Veins and Capillaries
1. Arteries: These are the blood vessels, through which blood moves away from the heart to the body. They carry blood away from the heart to the body. They have thick muscular walls with small lumen or canal. The walls of the arteries are elastic in order to withstand the high pressure of the blood, coming from the heart. They divide and become smaller as they live the heart to form arterioles.
2. Veins: These are blood vessels, through which blood moves from the body to the heart. They carry blood to the heart. They are less elastic than arteries with large lumen or canal. Valves are present in veins to prevent back flow of blood due to reduced pressure. The smaller veins from capillaries which join them to form bigger veins are called venules.
3. Capillaries: These are blood vessels which join the arteries to the veins. They are tiny. They are located in the junction between arteries and veins around tissues and organs of the body. They have thin walls. They are tiny so as to penetrate to all parts of the internal organs. They aid the diffusion of oxygen, nutrients and waste products.

Differences between Artery and Vein

The following are some of the differences between artery and vein.

Artery	Vein
It carries blood away from the heart	It carries blood to the heart
Its wall is elastic	Its wall is not elastic
It has thick wall	It has thin wall
Pressure is high	Pressure is low
It has small lumen	It has large lumen

TRANSPORT SYSTEM IN PLANTS

In a simple plant like an alga, materials enter or leave the cells in the body by diffusion. In higher land plants, special conducting tissues, known as vascular tissues carry out transport. A vascular bundle is made up of several vascular tissues, and it consists of mainly xylem and phloem tissues. Vascular bundles are found in the root, stems and leaves of flowering plants.

Some Plant Tissues and Their Functions

1. The cambium tissues: These are made up of narrow living cells with thin walls and dense cytoplasm.

Function of cambium tissues

Cambium tissues can divide and multiply. Because of this ability, plants are able to produce secondary xylem and phloem, thus resulting in the growth of secondary thickening - growth in width of stems. Therefore, they are responsible for the growth of secondary thickening in plants.

2. The xylem tissues: These are made up mainly of dead cells with lignified cell walls.

Functions of xylem tissues

Xylem tissues are responsible for the transportation of water and dissolved mineral salts from the roots to other parts of the plants.

They also give support and rigidity to plants.

3. The phloem tissues: These consist of thin-walled living cells with dense cytoplasm, which have perforated cross walls.

Function of phloem tissues

The phloem tissues transport manufactured food from the leaves to other parts of the plant. The transported manufactured food can be stored or used immediately.

PROCESSES NECESSARY FOR TRANSPORTATION IN PLANTS

The following processes aid and are necessary for transportation in plants:

a. Transpiration.
b. Translocation.
c. Transportation of water in the xylem tissue.
d. Absorption of water and mineral salts.

1. Transpiration

Transpiration is the removal of water from aerial parts of plants into the atmosphere in form of water vapour. Plants can lose water through:

a. The lenticels in the stem and is referred to as **lenticular transpiration**.
b. The stomata in the leaves and is referred to as **stomata transpiration**.
c. The cuticle of the leaf surface and is referred to as **cuticular transpiration.**

Conditions/Factors Affecting the Rate of Transpiration

The following are the factors/conditions which affect the rate of water loss from the aerial parts of plants:

1. **Humidity:** The higher the humidity of the atmosphere, the slower the rate of transpiration, and the lower the humidity, the faster the rate of transpiration.
2. **Light:** High light intensity leads to high rate of photosynthesis, leading to rise in temperature, thus higher rate of transpiration, and vice versa.
3. **Temperature:** Increase in temperature leads to higher rate of transpiration while decrease in temperature leads to lower rate of transpiration.
4. **The size of the stomata pores:** When stomata open due to turgidity of the guard cells, transpiration occurs, while flaccidity of the cells causes the guard cells to close and prevent transpiration from taking place.
5. **Soil water:** The higher the level of soil water, the higher the rate of absorption, consequently the higher the rate of transpiration and vice versa.
6. **Wind:** The higher the speed of wind, the higher the rate of transpiration and vice versa.

Advantages/Benefits/Importance of Transpiration in Plants

1. It brings about the movement of soil water.
2. It helps to remove excess water from plants.
3. It enables plants to absorb water and mineral salts from the soil.
4. It cools the plants.

2. Translocation

This is the process by which materials or manufactured food substances are transported from where they are produced to where they are needed. It begins from the leaves to other parts of the plants. It occurs through the tissue called ***phloem***. The materials translocated in plants include: sugar, glucose, oil, hormones, etc..

3. Transportation of water in xylem tissue

Transport of water in xylem tissue is due to the following processes:

a. **Transpiration pull:** The continuous flow of water from the roots to the leaves forms transpiration stream. As the water evaporates from the leaf cells and as photosynthesis produces more sugar, the osmotic pressure in the leaf cells increases with respect to that in the xylem cells. This causes more water to flow into the leaf cells from the xylem vessels. So, there is a pull on the water columns in the xylem vessels and water is drawn up in the plant.
b. **Capillary action:** The upward movement of water through the xylem is mainly achieved through capillary action. It is due to the attraction between the water molecules and the walls of the xylem vessels. The xylem vessels that extend from the roots to the leaves form very fine capillary tubes. Water the rises up such tubes.
c. **Root pressure and suction pressure:** Root pressure is usually created as a result of differences in osmotic pressure between the cell sap and the concentration of soil nutrients. The cell sap, being more concentrated, tends to draw up the nutrients. On the other hand, suction pressure is the total force by which the cell absorbs water from its surroundings. The suction pressure is normally created when water

is lost in form of transpiration through the stomata of the leaves. By these exposures, the movement of water from the soil to the xylem tissues through the root hair is achieved.

4. Absorption of water and minerals by roots of plants

The young root hairs of flowering plants have direct contact with water in the soil. The cell sap in the root hairs is more concentrated than the soil water; hence water is able to pass from the soil into the root hairs by osmosis. The water passes through the thin layer of cytoplasm or cell membrane which is selectively permeable into the vacuole of root hairs. The extra water raises the turgor pressure of the vacuole or reduces the osmotic pressure and forces water out in the cell walls towards the cortex.

The cell next to the root hair cell on the inside has a lower turgor or higher osmotic pressure, hence water will pass into it by osmosis. In this way, the water absorbed will get to the xylem vessels.

Similarities between Transport System in Plants and Animals

These include:

1. Materials or food nutrients and hormones are transported in fluid form in both.
2. Diffusion plays a major role in both.
3. Tubular or Cylindrical vessels are necessary in both.
4. Liquid medium is required in both.

Differences Between Transport System in Plants and Animals

Plants	**Animals**
Materials are transported through different vessels (xylem and phloem)	Materials are transported in the same vessels
Cell sap is the medium of transport	Blood is the medium of transport
Root pressure or transpiration generates force for pull for transport	Heat generates forces for transport
The transport medium is not tissue	The transport medium is made up of cells of different types of tissues

EVALUATION

i. Mention the three types of blood cells.
ii. List the blood vessels in higher animals.
iii.What is pulmonary circulation?
iv. List the vascular bundles in plants.
i. Mention the three types of blood cells.
ii. List the blood vessels in higher animals.
iii.What is pulmonary circulation?
iv. List the vascular bundles in plants.

TOPIC: RESPIRATORY SYSTEM

Respiration can be defined as biochemical activity of the cell, in which glucose is broken down by a series of reactions, controlled by enzymes, to release energy. Respiration is characterized by the breathing in of oxygen and breathing out of carbon dioxide. Oxygen breaks down the food substances (glucose) to release energy. The energy released by this process is used in various life processes.

IMPORTANCE OF ENERGY

1. Energy is needed for transportation of materials within the body.
2. It is needed by animals for movement.
3. It is important in excretion in living organisms.
4. Energy is required for reproduction.
5. Energy is required in the transmission of nerve impulses and co-ordination.

TYPES OF RESPIRATION

Aerobic Respiration

This is the type of respiration which requires oxygen to break down glucose (substrates) into water, carbon dioxide and energy (ATP).

Anaerobic Respiration

This is the type of respiration which does not require the presence of oxygen to provide energy. During anaerobic respiration, glucose is broken down to yield carbon dioxide, alcohol (ethanol) and energy.

Phases or Stages of Respiration

The process of respiration is in two stages: ***External Respiration*** and ***Internal (tissue) Respiration.***

1. External Respiration (breathing): This is the exchange of gases between the environment and the respiratory organs of an organism. The process of breathing in oxygen is known as **inspiration** or **inhalation** while the process of breathing out carbon dioxide is known as **expiration** or **exhalation**.

2. Internal (Tissue or Cellular) Respiration: This is the process by which food substances are oxidized within the cells to release energy, carbon dioxide and water. It only takes place when inhalation occurs, i.e. when oxygen is breathed in. The oxygen breathed in is used to oxidize the food substances. Carbon dioxide, water and energy are the products of this process. It can be represented by the equation:

$C_6H_{12}O_6 + 6O_2 \quad 6H_20 + 6C0_2 + \text{Energy}$

(Glucose) (Oxygen) (Water) (Carbon dioxide) (ATP)

Condition Required for Respiration

For efficient respiration to take place, the following conditions are required:

1. **Respiratory organ:** Respiratory organ refers to the organ through which oxygen is taken into the body and carbon dioxide, water vapour, are given off. In other words, respiratory organ is the organ through which gaseous exchange takes place. E.g. lungs in mammals and gills in fish
2. **Respiratory medium:** By respiratory medium, we refer to the surroundings, from which an organism obtains oxygen. E.g. air and water
3. **Transport medium:** Transport system refer to the system which moves the dissolved gases, e.g. oxygen, around the body to all cells and eliminates gases, e.g. carbon dioxide, out of the body. An example of this is blood.
4. **Ventilation:** Ventilation is the movement of air or water, in one direction over the respiratory surface. It

helps to renew the air or water near a respiratory surface with fresh ones. It increases the rate of gaseous exchange.

5. **Respiratory surface:** This refers to the surface of a respiratory organ e.g. lungs.

Characteristics or Features of Respiratory Surfaces

The following are the features of the respiratory surfaces of living thing (plants and animals):

1. They are moist.
2. They are permeable to allow the movement of gases in and out.
3. They are highly vascularized - equipped with capillaries or similar network to transport diffused gases.
4. They have adequate supply of transport medium.
5. They are thin-walled to shorten diffusion distance and make diffusion easier and faster.
6. They have a large surface area to aid easy diffusion of gases.

DIFFERENT ORGANISMS AND THEIR RESPIRATORORY SYSTEMS

ORGANISMS	**RESPIRATORY SYSTEM/ORGAN**
Unicellular organisms, e.g. Amoeba and Paramecium	Body surface
Hydra and tapeworm	Cell membrane
Earthworm	Wet skin or body surface
Fishes, e.g. Tilapia	Gills
Arthropod, e.g. insects	Tracheal system
Arachnids, e.g. spiders	Lung books
Tadpoles	Gills
Reptiles, e.g. lizard	Lungs
Amphibians, e.g. toads and frogs	Mouth, skin and lungs
Aves, e.g. birds	Lungs
Mammals	Lungs
Flowering plants	Stomata and lenticels

Mechanism of Respiratory System in Lower Animals

Unicellular organisms

There are no special respiratory organs in unicellular and aquatic organisms such as Amoeba and Paramecium. Oxygen that dissolves in water diffuses into the body while carbon dioxide goes out of the body through the entire body surface. The cell membrane acts as the respiratory surface. The process of gaseous exchange in unicellular organisms is made possible by **simple diffusion**. These organisms have large surface area to volume ratio hence diffusion through the body surface alone is enough to satisfy its gaseous exchange needs.

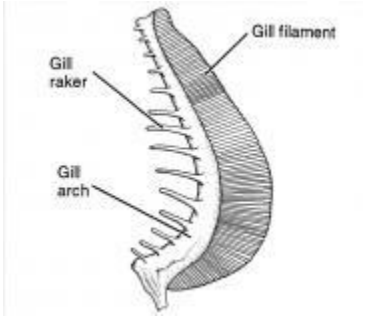
Insects

Insects generally use the tracheal system for gaseous exchange. The insects have tiny openings in their abdomen called **spiracles** through which oxygen diffuses into the body and carbon dioxide diffuses out the spiracles lead into certain tubes called **tracheae** (singular, **trachea**). These tracheae further divide into smaller tubes called **tracheoles** and these tiny tubes get into the tissues and cells through the body fluid. Insects such as cockroach, grasshopper, etc. use the tracheal system.

MECHANISM OF RESPIRATORY SYSTEM IN HIGHER ANIMALS

FISH

The organ for respiratory system or gaseous exchange is the **gill**. The gills are located at both sides of the head region. The gills which are in three or four are arranged in the gill chamber. Each gill consists of a **gill filament** (where gaseous exchange takes place), **gill raker** (which helps to stop food particles from entering the gill chamber) and the **gill arch** (on which the gill filaments are built). The gill chamber is closed externally by **operculum.**



Toad

Tadpole: The young toad called tadpole uses **gills** for gaseous exchange. At the tadpole stage, the animal develops **external gills** through which direct diffusion of gases takes place between the animal (tadpole) and the respiratory medium (water). Oxygen dissolved in water can easily diffuse into the body and carbon dioxide can also easily diffuse out of the body by **simple diffusion**. This is made possible because the ratio of body surface to volume is very large.

RESPIRATORY SYSTEM IN TOAD

Three different respiratory organs are used by toads for gaseous exchange. The respiratory organs are: **mouth, skin** and **lungs.**

1. Respiration in Toad through the mouth (Mouth or Buccal Respiration)

When toads are on land, they have the ability of breathing through the mouth. The mouth serves as an efficient respiratory organ because:

a. It has large surface area.
b. It has a thin mucus for easy diffusion.
c. It is well supplied with blood capillaries.

2. Respiration in Toad through the skin (Skin or Cutaneous Respiration)

Both on land and in water, the toad can respire through the skin. The toad's skin serves as an efficient respiratory organ because:

a. It has a large surface area and thin covering.
b. It is moist due to continuous secretions from mucus gland.
c. It is well vascularized, i.e., well supplied with blood capillaries.

3. Respiration in Toad through the lungs (Lungs or Pulmonary Respiration)

When on land, the toad can carry out gaseous exchange with its lungs. How it works is similar to that of mouth or buccal respiration.

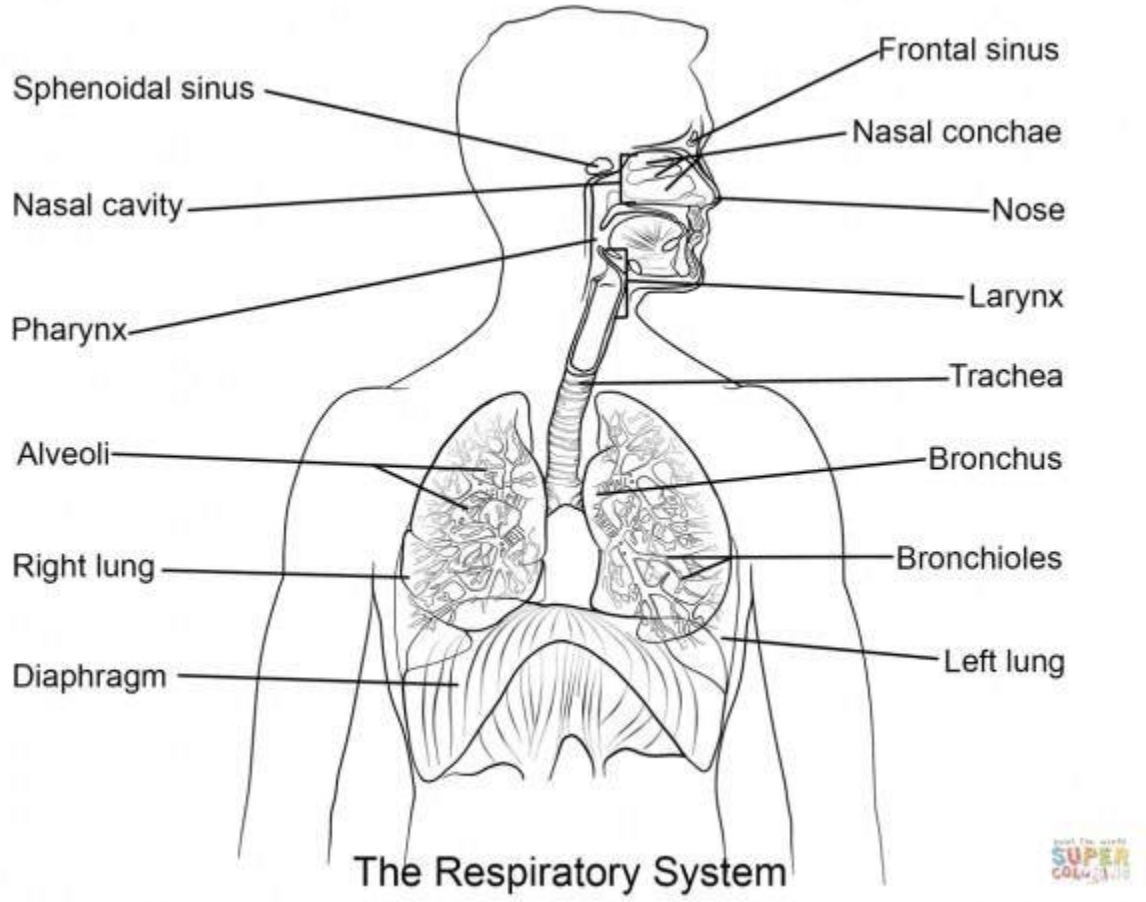
Respiration in Mammals

The most complex respiratory system is found in mammals. Most vertebrates, including birds, lizards and mammals use the lungs as their only respiratory organs where gaseous exchange takes place.

LOCATION OF THE LUNGS

The lung is a pair of reddish, elastic organ, on each side of the heart of a mammal, located within the thoracic cavity of the body. The thorax is supported by a **bony framework** and consists of the thoracic cavity. It is made up of the sternum in the front, back bone or vertebral column at the back, twelve pairs of ribs at the sides and a dome-shape muscular wall, referred to as diaphragm.

THE RESPIRATORY SYSTEM OF MAN



The respiratory system of man is typical of the respiratory system of mammals in general. It includes the **nostrils** and **mouth**, the **pharynx**, the **larynx** or voice box, the **trachea** or wind pipe, the **bronchus**, the **bronchioles** and the **alveoli**.

Movement of Air into the Lungs

The following are the path taken by air to the lungs and it moves:
Air can enter the body either through the nose or mouth. The ***nose*** and ***mouth*** are separated by the palate, so you can breathe through the nose when you are eating. Before the air inhaled through the nose reaches the

lungs, it becomes damp, warm and filtered. Both the nasal cavity and the mouth open into the **pharynx**. The larynx leads to the windpipe or **trachea**. A flat piece of tissue, the **epiglottis** covers the entrance to the larynx and trachea when food is swallowed into the oesophagus which lies just behind the trachea. The trachea branches into two: the **bronchi** (singular: **bronchus**). Each bronchus leads to the lungs where it branches into small tubes called **bronchioles**. The bronchioles lead to numerous air sacs called **alveoli** (singular: **alveolus**). The alveoli are richly supplied with blood capillaries and are sites or surfaces where gaseous exchange takes place.

MECHANISM OF RESPIRATION IN MAMMALS

The mechanism of breathing in mammals including man involves two phases or stages. These are:

1. External Respiration (breathing).
2. Internal or Tissue or Cellular Respiration.

Process of Inhalation or Inspiration in Man

The following processes are involved during inhalation in man:

1. The thoracic cavity first increases in volume.
2. The diaphragm contracts and becomes flattened.
3. The intercostal muscle contracts.
4. The sternum is moved forward.
5. The ribs are moved upwards and outwards.
6. There is an increase in the volume and a decrease or fall in the pressure of the thoracic cavity.
7. Consequently, air from outside is drawn into the lungs or alveoli through the nose, trachea, bronchus and bronchioles leading to an increase in the size of the lungs.

Process of Exhalation or Expiration in Man

The following processes are involved during exhalation in man:

1. The thoracic cavity first decreases in volume.
2. The diaphragm relaxes and assumes its dome-shape.
3. The intercostal muscles relax.
4. The sternum now moves backwards or inwards.
5. The ribs are moved downwards and inwards.
6. There is a decrease in the volume and an increase in the pressure of the thoracic cavity.
7. Consequently, air containing waste products like carbon dioxide and water vapour from inside the alveoli or lungs are forced out through bronchioles, bronchi, trachea, and finally to outside through the nose. This finally leads to a decrease in the size of the lungs.

During expiration, the air in the lungs is never completely exhaled or removed. The air left in the lungs is called **residual air** while that which is exchanged with each breathe is called **tidal air**.

The approximate composition of inhaled and exhaled air is shown in the table below.

COMPARISON OF INSPIRED AND EXPIRED AIR

Air component	**Inhaled air**	**Exhaled air**	**Reason for difference**

Oxygen	21%	16%	Oxygen is absorbed across respiratory surface, then used by cells in respiration.
Carbon dioxide	0.03%	4.1%	Carbon dioxide is made by cells as a waste product of respiration, and is released across the respirator surface.
Nitrogen	78%	78%	Nitrogen gas is not used by cells.
Water vapour	Variable	Saturated(higher)	Respiratory surfaces must be kept moist. Some of these moisture evaporates and are lost as air is breathed out.
Temperature	Variable	Always higher	Air is warm as it passes through the respiratory passages.

RESPIRATORY SYSTEMS IN PLANTS

Plants do not have special respiratory organs for gaseous exchange. However, gases move in and out of the plants through the **stomata** and **lenticels**.

Stomata

Stomata (singular: **stoma**) are the tiny pores present in the leaves (lower epidermis) which helps in gaseous exchange. Each stoma is surrounded by two bean-shaped cells called guard cells. Stomata are more abundant in the lower epidermis of leaves and are very few in the upper epidermis. The closing and opening of the stomata are controlled by the **guard cells.**

Functions of stomata are:

1. Helps in gaseous exchange that is respiration.
2. Helps in photosynthesis.
3. They remain closed during night due to the loss of water by transpiration

Lenticels

Lenticels are breathing pores or tiny openings found in the bark of older stems. A lenticel consists of a loose mass of small thin-walled cells which permit easy diffusion of gases in and out of the plant.

Differences between respiration and photosynthesis

Respiration	**Photosynthesis**
Respiration occurs in every living cells	Photosynthesis occurs only in autotroph
It takes place at all times	It takes place only in the presence of sunlight
Food substances are broken down	Food substances are built up

(i.e. catabolism)	(I.e. anabolism)
High energy containing food, e.g. oxygen and carbohydrate are used	Low energy substances like carbon dioxide and water are used
Carbon dioxide and water are the by-products	Oxygen is the by-product

EVALUATION

1. State the types of respiration in cells.
2. Explain briefly the aerobic respiration .
3. . State three features of respiratory surfaces.
4. What is internal respiration?
5. Describe mechanism of respiration in fish
6. Explain the processes of respiration in toad
7. . Describe respiratory system of man
8. Explain the mechanism of respiration in mammals

TOPIC: EXCRETORY SYSTEM

Excretion is the removal of harmful and unwanted toxic waste products of metabolism.

Note: The terms **secretion** and **egestion** are often confused with excretion. Hence it is important to understand clearly what they mean.

Secretion: Secretion is the production of useful chemical substances like hormones, enzymes or other molecules by the cells of glands like the bile, endocrine glands like the islets of Langerhans or unicellular glands like the epithelial mucosal lining of the large intestine.

Egestion: Egestion is expelling the undigested wastes from the body. Food which is not digested and thus is not assimilated by the body is passed to the last part of the alimentary canal called the **rectum** and egested out in the form of faeces or excreta.

Importance of Excretion

Waste products produced in the body by metabolic activities must not be allowed to remain in the body because of the following reasons:

1. The excretory products are harmful to the body and so must be removed.
2. Some are poisonous and must never be allowed to accumulate within the body.
3. Excretion helps to maintain water balance in the body.
4. Excretion also helps to maintain salt balance, i.e. homeostasis in the body.
5. Waste products when not removed can interfere with normal metabolic activities of the body.

The table below shows the excretory organs/organelles and waste products of some organisms

Organisms	**Excretory systems / organs**	**Waste products**
Protozoa e.g. Amoeba and paramecium	Contractile vacuole and Body surface	Carbon dioxide, excess mineral salt and water
Flatworms e.g. Tapeworms	Flame cells	Carbon dioxide, urea,

		nitrogenous waste and water
Annelids e.g. Earthworms	Nephridia	Carbon dioxide, urea, nitrogenous waste and water
Insects e.g. cockroach	Malpighian tubules	Carbon dioxide, uric acid and water
Crustaceans	Green glands	Carbon dioxide, urea, ammonia and water
Fishes	Kidneys	Carbon dioxide, urea and water
Amphibians e.g. Toad	Kidneys	Sweat containing urea, salt and water
Reptiles	Kidneys	Bile salts, water and urea
Birds	Kidneys and lungs	Carbon dioxide, and water vapour
Mammals	Kidneys, skin, liver and lungs	Urine containing urea, salts, water, hormones and uric acid
Flowering plants	i. Stomata and lenticels ii. Bark of trees	i. Carbon dioxide, oxygen and water ii. Tannins, mucilage, gum, crystals, anthocyanin, alkaloid, resin, oil and latex

EXCRETORY MECHANISM IN SOME ORGANISMS

An earthworm has a segmented body. Each segment of the body except the first three and the last segment have a pair of tubes called **nephridia**.

The nephridia are the excretory organs of the earthworm. Each nephridium has a ciliated funnel, the **nephrostome** at one end, which opens to the outside through a small pore called **nephridiophore**. This opens into the body cavity of the segment in the front. The nephrostome leads into a long coiled tube made up of:

a narrow ciliated tube, a middle ciliated tube, a wide non-ciliated tube, and a muscular tube which opens to the exterior via an excretory pore. The nephridium thus opens at both ends.

Each nephridium is surrounded by a capillary network. The waste products, mainly urea, are extracted from the blood capillaries surrounding the nephridia. Waste products are also removed from the fluid into the body cavity and passed into the funnel.

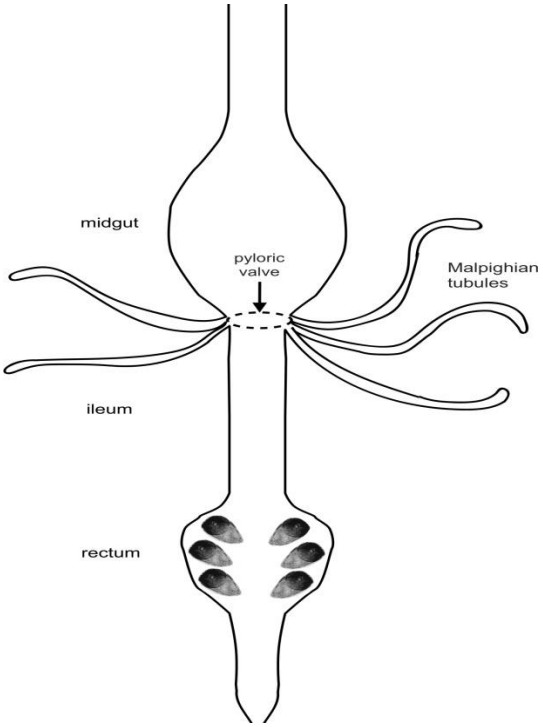
EXCRETORY SYSTEM OF INSECTS

The organs responsible for excretion in insects are the **Malpighian tubules**. These are outgrowth from the exterior portion of the small intestine. They are fine, long and slender.

Insects have the remarkable ability to conserve water so that they can be found in the hottest and driest places on earth. Their ability to conserve water can be attributed to several factors:

1. Their outer surface is waterproof because of a layer of wax.
2. The spiracles prevent water loss from the gaseous exchange surface which is inside the body.
3. They have an extremely efficient excretory system.

The malpighian tubules are found floating between glands and organs in most parts of the thorax and abdomen. The malpighian tubules are found in six groups, each consisting of up to twelve tubules. A malpighian tubule consists of two parts - the distal (free) end and the proximal end (the portion next to the gut).



Mechanism of Excretion in Insects

Nitrogenous waste products and water which are liberated into the **haemocoel** [a body cavity in spiders, crustaceans, and other arthropods through which the blood or **hemolymph** (a fluid in some invertebrates that functions like the blood) circulates] are absorbed at the distal end of the malpighian tubules. The nitrogenous wastes are converted to uric acid as they pass along the malpighian tubules towards the gut.

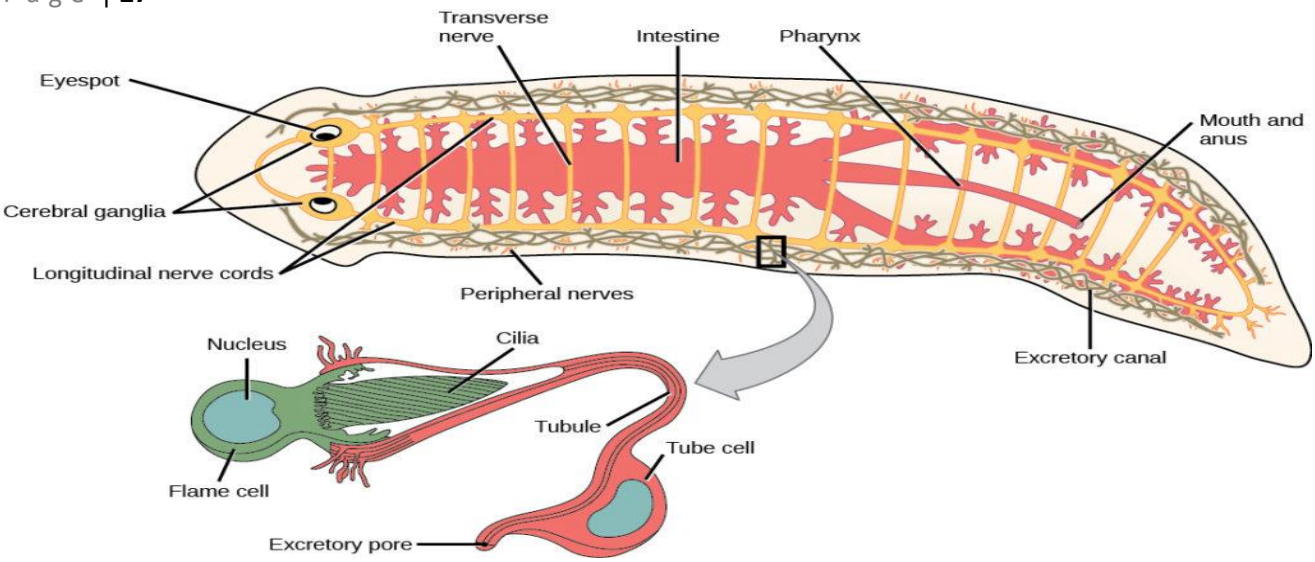
A lot of water is also reabsorbed so that by the time the uric acid reaches the proximal end of the tubules, it is changed to solid crystals. In the hind gut, more water is reabsorbed by the rectal gland. Thus, the urine which eventually leaves the body is very concentrated, almost a dry solid.

EXCRETORY SYSTEM OF FLATWORM

Flatworm may be free-living or parasitic, and aquatic or terrestrial. Parasitic worms live inside their host's bodies in a fluid environment.

The excretory organs of the flatworms, especially free-living planarians, are the **flame cells.** In these animals, there are two longitudinal excretory canals with a number of openings to the exterior on the surface. The canals consist of numerous branched tubules. The fine end of the tubules end in a specially hollow structures called **flame cells**.

In a flame cell, the nucleus is displaced to one side of the cell and the cytoplasm has a large hollow called the **cell lumen**. The lumen is continuous with the fine tubules. A bunch of flagella hangs down the lumen.



Mechanism of Excretion in Flatworm

The waste products, especially water, ammonia and carbon dioxide diffuse from the surrounding cells into the flame cells. With the aid of flagella, the fluid containing the waste products is propelled into the tubules. From there, the fluid passes into the exterior.

EXCRETION IN MAMMALS

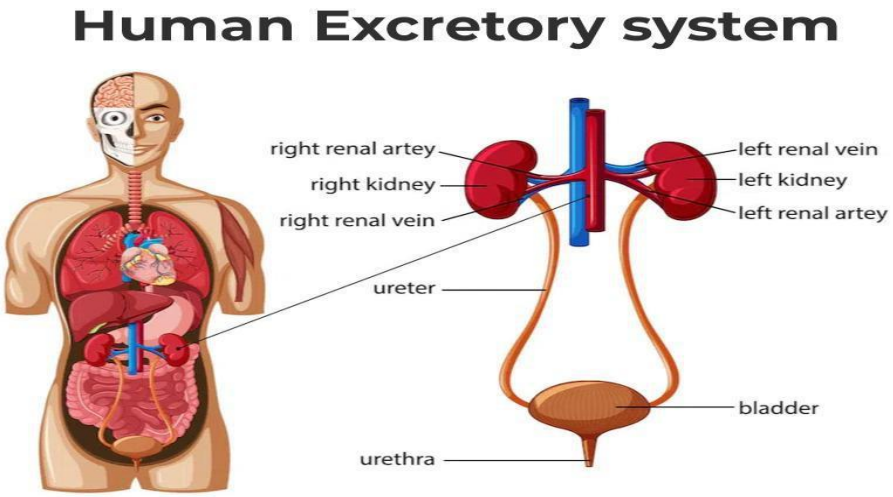
In mammals, there are four excretory organs: lungs, which excrete water vapour and carbon dioxide; skin, which excretes water, salts and urea through sweat; liver, which excretes bile pigments called bilirubin; and kidneys, which excrete water, mineral salts, urea, uric acid, and creatinine.

EXCRETORY SYSTEM OF MAMMALS

The excretory system of mammals includes the kidneys, the ureters, the bladder, the urethra, the associated renal artery and renal vein. The kidney is supplied with blood vessels. The renal artery supplies blood to the kidney while the renal vein takes away blood from the kidney.

A long narrow tube called **ureter** connects the kidney to the urinary bladder where urine is stored temporarily. The urinary bladder leads to the **urethra** which opens to the exterior from which urine is finally passed out.

THE KIDNEY

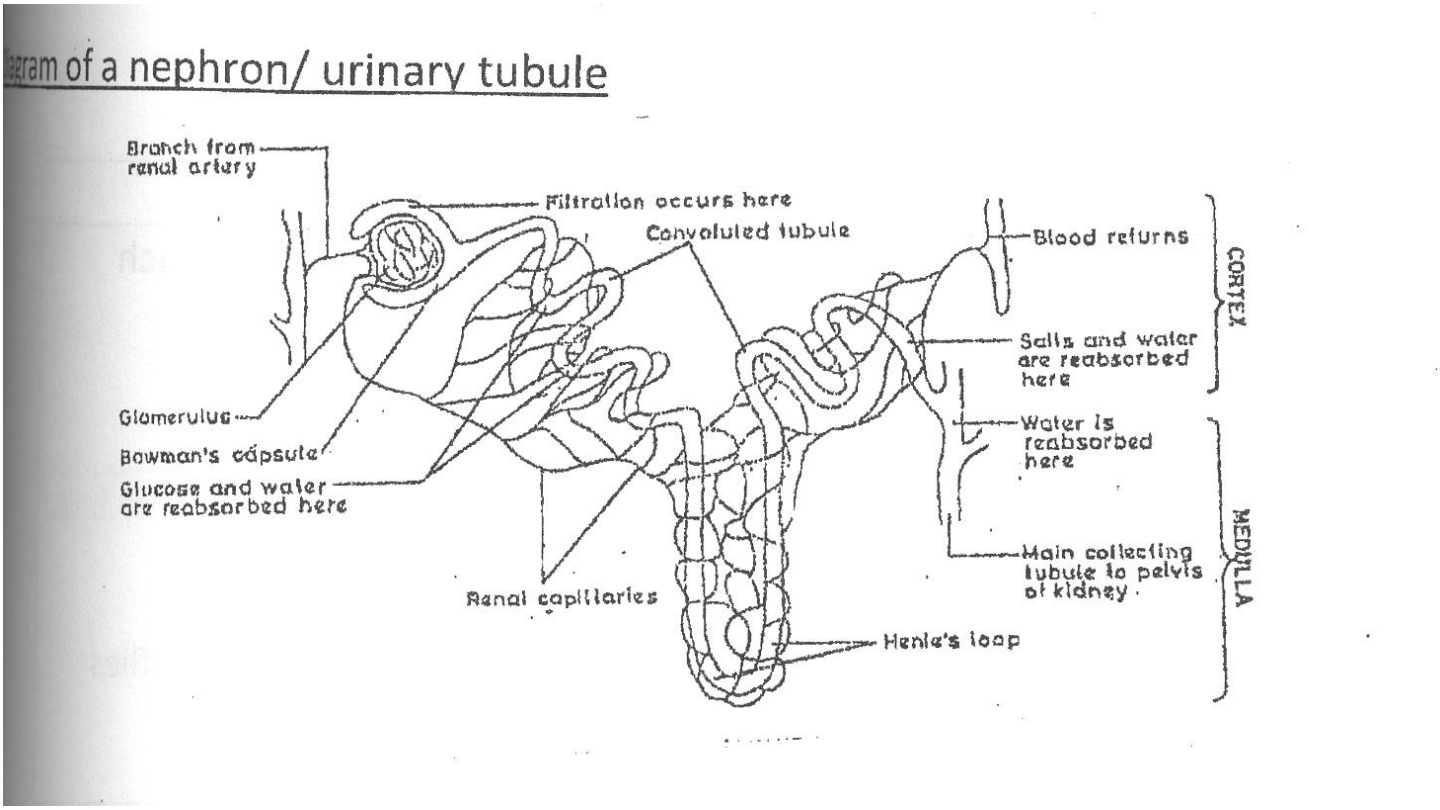


The mammalian kidney is a bean shaped and reddish brown organ, located at the posterior end of the abdomen. The right kidney is slightly lower in the body than the left kidney. The paired kidneys are the excretory organs of mammals. They remove unwanted nitrogenous substances like urea and other ammonium compounds from the blood. They also maintain the osmotic pressure of the blood by controlling the excretion of water and salts. In a longitudinal section, the kidney has two distinct regions: **cortex** and **medulla**. The cortex is the outer region and the medulla is the inner region. Over one million fine narrow tubules called the **urinary tubules** pass through both regions. They open at the tips of triangular-shaped masses of tissues called **pyramids.** The pyramids open into a funnel-shaped cavity called the **pelvis**. The pelvis is continuous with the ureter. The kidney has many tiny capillaries which are branches of the **renal artery** and **renal vein.**

THE URINARY TUBULE The urinary tubule is the functional unit of the kidney. Each urinary tubule starts in the cortex as a cup-shaped structure called the **Bowman's capsule.** The capsule opens into a short coiled tube referred to as the **proximal convoluted tubule**. Then it straightens out as it passes into the medulla where it makes a U-shaped loop called the **Henle's loop** before re-entering the cortex. In the cortex, the tubule becomes coiled again to form the **distal convoluted tubule.** The tubule bends once again and completes its courses in the medulla. The tubule widens as it approaches the pelvis. Along with many other tubules, it pours its contents into a wider main **collecting duct** which eventually join up and open into the pelvis at the apices of the pyramids.

The renal artery branches in the kidney. Each branch breaks into a mass of blood capillaries in the Bowman's capsule. This mass of capillaries is called the **glomerulus.**

The capillaries in the glomerulus re-join to form a blood vessel leading out of the capsule. This vessel then branches into a capillary network around the urinary tubule before re-joining to form a branch of renal vein.



MECHANISM OF EXCRETION IN MAMMALS (FORMATION OF URINE)

The processes involved in the formation of urine are as follows:

(A) ultra filtration (B) selective reabsorption (C) hormonal secretion.

1. Ultra filtration: In the first phase, blood is brought to the kidney by renal arteries. As it circulates through the glomerulus of each Bowman's capsule, water, urea, nitrogenous compounds, mineral salts, sugars, glucose and plasma solutes are filtered into the capsule.

This process of filtering materials from the glomerulus into the Bowman's capsule is called **ultra filtration.**

2. Selective reabsorption: The fluid in the capsule or glomerular filtrate now flows down the tubule. At the proximal convoluted tubule and Henle's loop, some water, sugars, amino acids and salts which are useful to the body are reabsorbed into the blood capillaries against concentration gradient or by active transport.

This process of reabsorbing useful materials back into the blood is called **selective reabsorption.**

3. Hormonal Secretion: The fluid in the tubule becomes more concentrated as it flows through the distal tubule where more water is reabsorbed by the action of **Anti-diuretic Hormone (ADH)** and urine is finally formed.

The urine gradually trickles into the renal pelvis and propelled by peristalsis through the ureter into the urinary bladder. When the bladder is full, it contracts and discharges the urine through the urethra.

EXCRETION IN FLOWERING PLANTS

The gums, oils, latex, resins, etc. are some waste products stored in plant parts like barks, stems, leaves, etc. Eventually, plants shed off these parts.

EVALUATION

1 Explain briefly the meaning of excretion.

2. State the difference between excretion and egestion.

3. State three importance of excretion.

4.Name any two organisms and their excretory organs.i. List any three excretory products in mammals.

5. Describe the structure of a mammalian kidney.

6. Explain briefly the process of urine formation in man.

7. List three excretory products of flowering plants

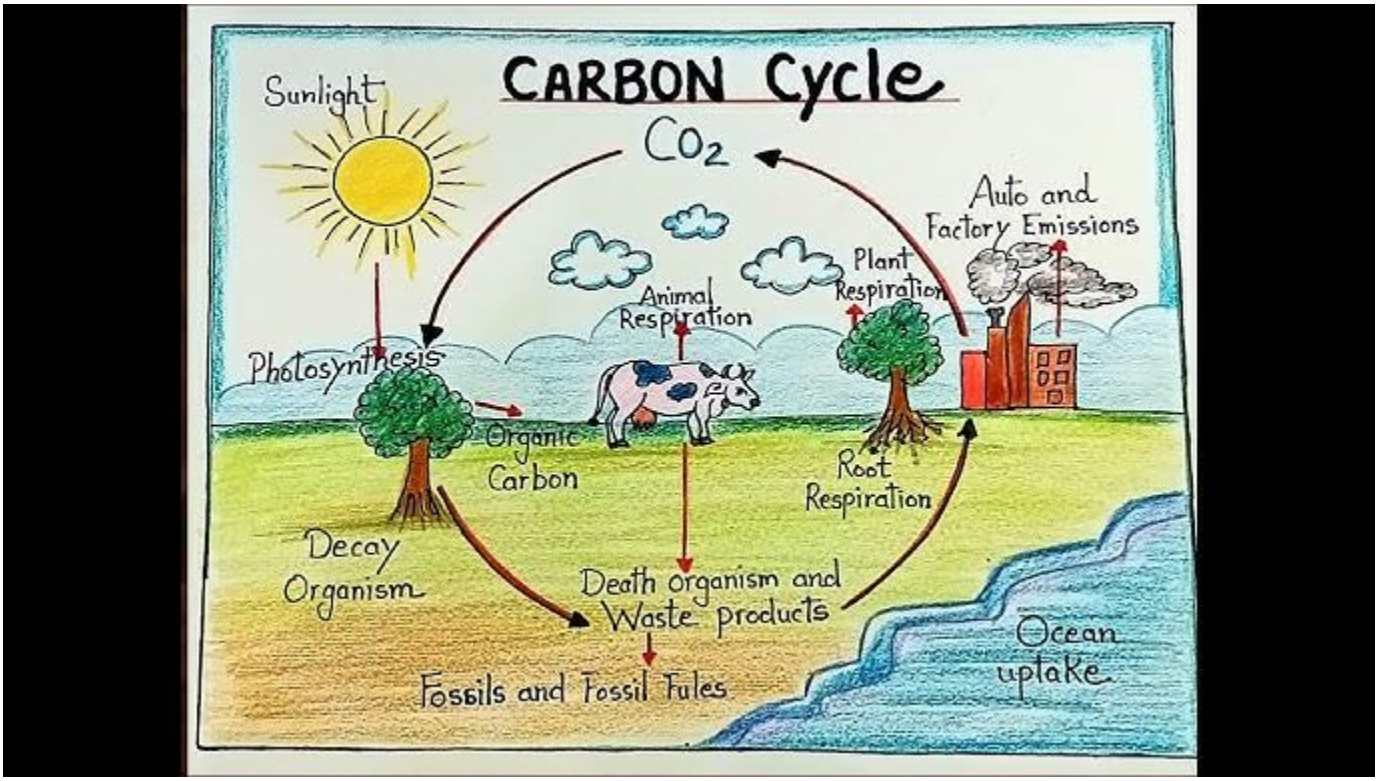
TOPIC: NUTRIENT CYCLING IN NATURE

Nutrient cycling refers to the circulation of certain nutrients like carbon, oxygen, water, sulphur, nitrogen etc. in nature.

THE CARBON CYCLE: Carbon cycle involves the series of processes which contribute to the circulation of carbon in nature.

Process of Carbon Cycling

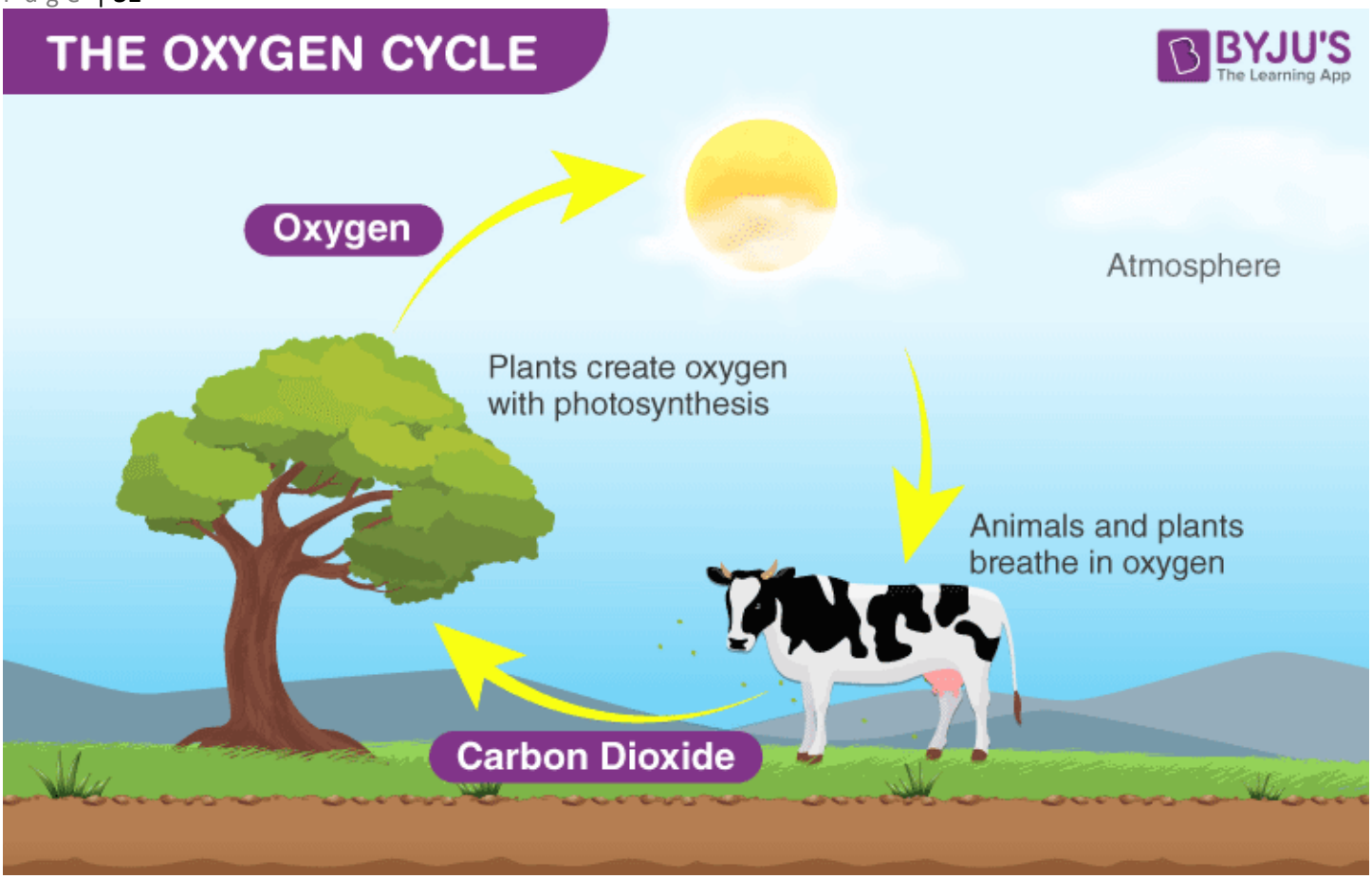
1. Carbon dioxide is removed from the air mainly by photosynthesis during which plants use it to manufacture their food.
2. Carbon is lost in form of carbonates of calcium and magnesium through leaching and drainage.



Importance of Carbon in Nature

1. Plant life uses carbon dioxide obtained from the air to manufacture their food during photosynthesis.
2. It provides carbon which is the major building block of all organic matter.
3. It helps to purify the atmosphere and maintain atmospheric level of carbon dioxide.

OXYGEN CYCLE: Oxygen cycle involves the circulation of oxygen between the living organisms (plant and animals) and the non-living things like fuels, water etc.

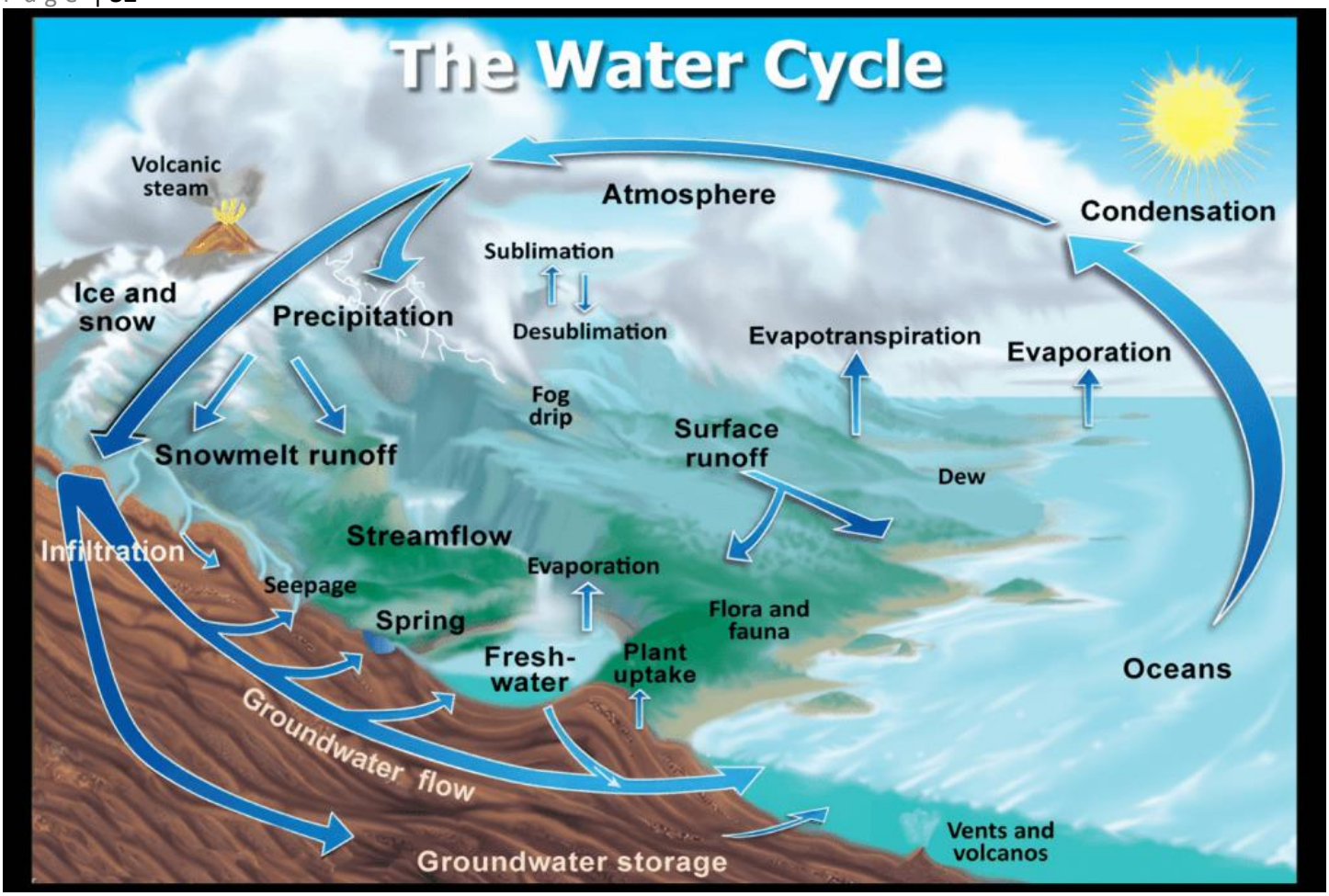


Importance of Oxygen Cycle

1. It enables oxygen to be available continuously through photosynthesis by green plants.
2. It ensures purification of the air to avoid pollution during decay.
3. It ensures the continuation of life by the provision of oxygen derived from plants.

CARBON-OXYGEN BALANCE: Oxygen constitutes for 21% of the gases in the atmosphere. Respiration, decay and combustion are the processes which remove oxygen from the atmosphere while photosynthesis is the process that releases oxygen in to the atmosphere. A decrease in the atmospheric oxygen level by 2-8% does not cause any significant effect but a slight increase in the atmospheric carbon dioxide may cause a **green house effect,** i.e. increase in the retention of the sun's radiant (heat) energy. So to prevent this, there is need to always balance the carbon-oxygen level in the atmosphere.

WATER CYCLE: Water cycle is defined as the continuous movement of water from the atmosphere to the earth and from the earth to the atmosphere.



The Process of Water Cycling in Nature

The atmosphere receives water through:

1. Evaporation from oceans and land.
2. Transpiration from plants.
3. Breathing or respiration by plants and animals.

The land receives water through:

1. Rainfall or precipitation.
2. Infiltration and percolation

IMPORTANCE OF WATER TO LIVING ORGANISMS

1. Water provides the medium for absorption of dissolved mineral salts by plants.
2. Water is an essential raw material in the process of photosynthesis.
3. It acts as a medium of transport for plant nutrients.
4. It constitutes a large portion of the blood.
5. Water aids excretion of waste products.

NITROGEN CYCLE: Nitrogen cycle involves the complex process by which nitrogen is naturally added and removed from the soil. It is a sequence of reaction indicating the various means by which nitrogen is added to and removed from the atmosphere and the soil.

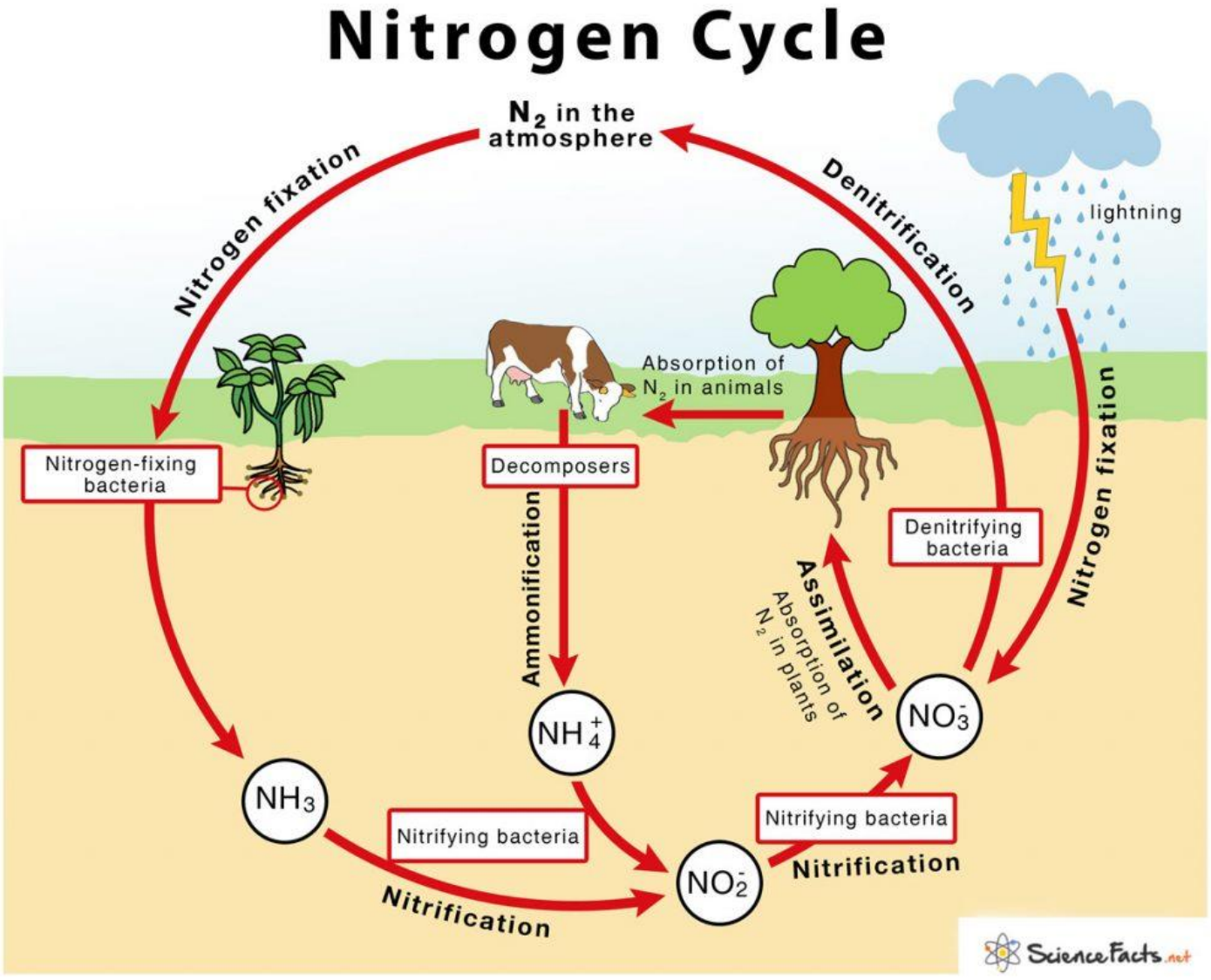
NITROGEN CYCLE INVOLVES THE FOLLOWING STAGES

1. **Symbiotic Nitrogen Fixation**: some bacteria such as **rhizobium leguminosarium** which live in the root nodules of leguminous plants can fix atmospheric nitrogen directly into the plants. The plant

supplies carbohydrate for use by the bacteria while the bacteria supply the plant with combined nitrogen.

2. **Non-symbiotic Nitrogen Fixation**: Some bacteria such as **Azotobacter** and **Clostridium** also live freely in the soil and can fix atmospheric nitrogen into the soil either aerobically or anaerobically.
3. **Electrical discharge**: Nitrogen can be fixed into the soil during lightening and thunderstorm.
4. **Ammonification and nitrification**: The process involving the formation of ammonium compounds from the dead and decaying of plants and animals and their waste products like urine and faeces is called **ammonification**. A further reaction known as **nitrification** involves the conversion of ammonium compounds first into nitrite by nitrifying bacteria called **nitrosomonas**. Plants can only absorb nitrates from the soil.
5. **Denitrification:** This is the process which involves the conversion of nitrate to nitrogen gas by certain bacteria. The nitrogen gas so formed can escape into the air.

NOTE: Denitrification is the only major stage in which nitrogen is lost from the soil while other stages involve the fixing of nitrogen into the soil.



SUMMARY OF WAYS BY WHICH NITROGEN IS MADE AVAILABLE TO SOIL

1. Through nitrogen fixation.

2. Through thunderstorm and lightening.
3. By application of artificial fertilizers.
4. By application of farmyard manure/poultry droppings.

SUMMARY OF WAYS WHICH NITROGEN IS LOST FROM THE SOIL

1. Action of denitrifying bacteria.
2. Absorption by plant roots.
3. By action of leaching.

DECOMPOSITION IN NATURE

Decomposers are fungi or bacteria which live saprophytically or feed on dead remains of plants, animals and organisms leading to or resulting in recycling of nutrients by breaking down organic matters to produce soluble nutrients which are absorbed by plants. Decomposers cause the remains of plants and animals to decay.

CLASSES OF DECOMPOSERS

1. **Micro-decomposers:** These are small or microscopic organisms that can cause decay, e.g. certain bacteria and fungi.
2. **Macro-decomposers**: These are bigger organisms that can cause decay of dead organic materials, e.g. earthworms, termites, snails, mushroom and toad stools.

ROLE OF DECOMPOSERS IN ECOSYSTEM

1. They enrich the soil with nutrients required for plant growth.
2. They contribute to environmental pollution.
3. Decomposition is useful in the making of cheese and yoghurt.
4. They allow the ecosystem to function by enabling the recycling of nutrients.
5. They also prevent an unsightly accumulation of waste on earth surface.

EVALUATION

1. Define and nutrient cycling.
2. State the importance of nutrient cycling.
3. Explain the process of carbon cycling.
4. Discuss carbon – oxygen balance in nature.
5. What is oxygen cycle?
6. State three importance of oxygen cycle.
7. Describe the process of water cycle.
8. In which way is water important to life?

TOPIC: ECOLOGICAL MANAGEMENT

BIOLOGICAL ASSOCIATIONS

In a community there exist different kinds of biological associations between organisms of different species. Some of these biological associations are beneficial, some are neutral while others are harmful.

TYPES OF ASSOCIATIONS

Symbiosis: Symbiosis is a close association between two organisms in which both of them benefit from each other. Symbiosis is a beneficial association and each member is called a **symbiont.**

Examples of Symbiotic Association

a. **Alga and fungus in lichen:** Lichens, which consist of fungi and algae, are another well-known

examples of symbiosis. Algae receive shelter and a moist environment by dwelling within the fungi. In turn, the algae provide the fungi with food through photosynthesis.

b. Flowers and Insects: Insects obtain food from flowers in the form of pollen and nectars while in return, the insects bring about cross-pollination in the plant they visit, thus enabling plants to reproduce sexually.

c. Protozoa in the intestine of termites.

d. Nitrogen fixing bacteria in the root nodules of leguminous plants.

e. Bacteria in the rumen of ruminants.

COMMENSALISM: Commensalism is an association between two different species where one species enjoys a benefit, and the other is not significantly affected. In other word, Commensalism is a relationship wherein one participating organisms is benefited while the other is neither helped nor harmed.

Examples of Commensalism

a. **Oyster and crab**: The habitation of a crab is in the oyster shell in which case the crab is protected, yet no harm is done to the oyster.
b. **Remora fish and shark**
c. **Man and intestinal bacteria**

Other examples of commensals include bird species, such as the great **egret** (**Ardea alba**), that feed on insects turned up by grazing mammals or on soil organisms stirred up by plowing. Various biting lice, fleas, and louse flies are commensals in that they feed harmlessly on the feathers of birds and on sloughed-off flakes of skin from mammals.

PARASITISM: Parasitism is a close association between two organisms in which one, known as the **parasite**, lives in or on and feeds at the expense of the other organism which is known as the **host**. The parasite benefits from the association while the host usually suffers harm or may die.

Examples of parasitism

a. Man and tapeworm
b. **Mistletoe and flowering plant**: The mistletoe is a plant parasite that lives on other larger flowering plants. The mistletoe benefits because its host gives it support and raises it up to a position from which it can receive sunlight. The parasite also absorbs water and mineral salts from the host while the host suffers harm by losing to the parasite part of the water and mineral salts that it has absorbed.

Fungal parasite of host plants include:

a. Ustilago on maize.
b. Puccinia on maize, wheat or barley.
c. Phytophthora palmivora on cocoa.
d. Phytophthora infestans on tomato/potato.
e. Alternario on tomato.

PREDATION: Predation is a type of association between two organisms in which the **predator** kills the other, called the **prey** and directly feeds on it. The predator which is usually larger in size and always stronger than the prey benefits by deriving its food while the prey is completely eliminated.

Examples of predation

a. The hawk and chicks of domestic fowls.
b. The lion and goat

COMPETITION: Competition involves the interactions among two organisms of same or different species in which one outgrows the other and survives while the other can neither grow nor survive. Competition can be

interspecific or intraspecific.

1. **Interspecific Competition:** Interspecific competition refers to the interactions between individuals of different species, both of which require the same resources that is in short supply. Interspecific competition is often greatest between organisms that obtain their food in similar ways. Example, the flowering plants due to its size and numerous branches and leaves are capable of eliminating the grasses for sunlight, nutrients and water. Competition is more acute between similar organisms than between ones that are less similar.
2. **Intraspecific Competition:** Intraspecific competition occurs when individuals of a single species or of the same species compete for a resource in short supply. Food and mating partners provide examples of causes for intraspecific competition. Competition for space may occur in some animals such as for nesting sites, wintering sites or sites safe from predators. Example, the adult domestic fowls are capable of eliminating the young chicks by depriving the chicks of food in the pen.

TOLERANCE: Tolerance is the ability of living organisms to withstand or tolerate little unfavourable changes in the environment which affect their survival. Living organisms can only survive in a particular habitat if they can tolerate the ranges of the abiotic factors that operate in it. Too little or too much of certain environmental factors such as light, heat, cold, acidity and alkalinity might produce unfavourable conditions.

Tolerance Range: this is defined as the range between the minimum and maximum limits to which organisms can tolerate certain changes in their environment so as to survive. For example, for most animals, the minimum temperature limit is 0^oC while the maximum is 42^oC. Their tolerance range is 0^oC-42^oC. Below or above the organisms may die. Also while some plants can withstand long period of drought, many others cannot.

Geographical Range: this refers to the areas where a species of organism can only be found within the minimum and maximum limits of tolerance.

ADAPTATION: Adaptation is defined as the ability of an organism to live successfully in a particular habitat as a result of its structure, appearance and behaviour. In other words adaptation is the change in structure, function and behaviour of an organism in order to adjust or survive in its environment.

It is expected that every organism must adapt to its environment in order to survive. Plants and animals possess certain features which enable them to adapt to either aquatic or terrestrial habitats.

ANIMAL ADAPTATION

Adaptation of Animals to Aquatic Habitat

a. Possession of streamlined body for easy movement in water, e.g. Tilapia fish and toad.
b. Possession of sticky under surface for attachment to surfaces of objects, e.g. tadpoles.
c. Possession of tails for swimming, e.g. tadpoles

Adaptation of Animals to Terrestrial Habitat

a. Possession of powerful limbs for movement, e.g. mammals.
b. Possession of skin as in mammals and cuticle by insects to protect and prevent drying up and injury.

Adaptation of Animals to Arboreal Habitat

a. Possession of wings for flight, e.g. birds
b. Possession of bright colour as well as camouflage, e.g. chameleon.

PLANT ADAPTATION

Adaptation of plants to aquatic habitat

a. Possession of waxy cuticles on leaves to prevent wetting, e.g. water lettuce.
b. Possession of breathing roots for gaseous exchange, e.g. white mangrove.
c. Possession of long stem and flower stalk to expose the flowers and leaves, e.g. water lily.

NOTE: Plants that can live in water are called **hydrophytes.**

Adaptation of Plants to Terrestrial Habitat

a. Possession of thick bark on the stems to protect internal tissues.
b. Possession of thick, waxy cuticles on leaves to prevent water loss through transpiration.
c. Possession of numerous leaves to enhance better photosynthesis.

NOTE: Plants which can survive in extremely dry places are called **xerophytes** while plants that can survive in places which are not dry or too wet are called **mesophytes.**

SPECIAL ADAPTATION OF SOME ORGANISMS

a. Adaptation of Tilapia Fish for Movement.
b. Adaptation of Birds for Flight.
c. Adaptation of Chameleon.
d. Adaptation of Endoparasites e.g. Tapeworm.
e. Adaptation of Toad or Frog for Food, Protection and Movement.

EVVALUATION

i. What is nitrogen cycle?
ii. Describe the process of nitrogen cycle
iii. State the stages of nitrogen cycle.
iv. Explain briefly how nitrogen is gain and lost in the soil
i. Briefly explain the following with examples
a. Symbiotic nitrogen fixation
b. Non symbiotic nitrogen fixation
ii.Define the followings: Nitrification, Ammonification and denitrification

TOPIC: POLLUTION

Pollution is defined as the release of toxic or harmful substances into the environment by their natural forces or man and other animals to an extent that causes biological damage to man and his resources.
The harmful substances that cause pollution in the environment are called **pollutants.**

TYPES OF POLLUTION

1. Air pollution
2. Noise pollution
3. Land pollution
4. Water pollution

AIR POLLUTION

The major air pollutants, their sources, harmful effects and their control.

Air Pollutants	**Sources**	**Effect**
Carbon monoxide	Burning of fuel in cars and some industrial processes	It causes suffocation because it combines with haemoglobin and reduces its ability to carry oxygen which results in death

Sulphur dioxide	Burning from vehicle exhaust, coal mining and cement factory	It causes impaired health such as the irritation of eyes, lungs and skin, cough and other respiratory tract diseases. It can cause acid rain
Nitrogen oxides	Electrical discharge in air and industrial processes	It irritates the skin and respiratory system
Smoke and soot	Burning of substance from industries, machine and coal into the air	Smoke reduces visibility
Dust particles	Mining, quarries, machines and industrial processes	Pollen grains containing dust can affect the lungs resulting in asthma
Radio-active rays	Industrial processes such as electric plants that use radioactive substances	It impairs health as it is known to destroy or alter genes

CONTROL OF AIR POLLUTION

a. Industries should be sited far away from residential areas.
b. Legislation should be made against indiscriminate burning that may bring about smoke.
c. There should be provision of filters or absorbers to be worn around mining and industrial areas so as to reduce pollution from waste gases.

NOISE POLLUTION

Pollutant: Noise

Sources

a. Industrial noise
b. Car horns and sirens
c. Noise from generators etc.

Effects of Noise Pollution

a. It causes loss of hearing or deafness
b. It causes general irritation or temperedness
c. It can cause changes in behaviours
d. Noise can cause high blood pressure or hypertension

Control

a. Legislation should be made against the use of loud speakers in public places
b. There should be installation of soundproof in industries and generators

LAND POLLUTION

The major land pollutants, their sources, harmful effects and control are listed below.

Land Pollutants	**Sources**	**Effects**
Refuse	Home, offices, industries and markets	It can cause respiratory disorder.

Sewage	Homes and offices	It serves as breeding ground for diseases causing organisms
Metal scraps	Abandoned vehicles and machines	It occupies land space
Pesticides and fertilizers	Pesticides sprayed on crops and fertilizers used in soils	Excess fertilizers can cause soil acidity
Chemicals e.g. toxic waste	Chemical waste from industries	These are poisonous to plants and animals
Glass particles	Glass manufacturing or industries using bottles	It does not decay hence it prevents proper land use
Crude oil(oil spillage)	Oil drilling, loading or unloading of oil tankers	It destroys soil and renders it infertile

CONTROL OF LAND POLLUTION

a. Refuse should be burnt in incinerators.
b. Legislation should be made by government against dumping of harmful or toxic wastes.
c. Metal scraps, tin cans, bottles, motor vehicle parts should be recycled.
d. Pesticides and fertilizers should be applied as instructed.
e. Oil pipelines should be maintained and checked regularly to prevent sabotage or

WATER POLLUTION

The major water pollutants, their sources, harmful effects and their control.

Water Pollutants	**Sources**	**Effects**
Sewage	City sewage system	It makes water unfit for human consumption It supports the growth of pathogens that can cause diseases, e.g. cholera
Pesticides and fertilizers	Washed by erosion from farms to rivers, streams or ponds	It leads to rapid vegetative growth of water plats which makes fishing and movement impossible, e.g. Algae bloom
Chemical wastes	Industries and ships at harbours	It can accumulate in human body and become toxic later, e.g. lead and mercury
Excreta or faeces	Humans and animals	It serves as a medium for the breeding of pathogens
Crude oil(oil spillage)	Oil drilling, loading and unloading of oil tankers.	Food chain is affected It leads to migration of animals.

CONTROL OF WATER POLLUTION

a. There should be efficient and proper sewage disposal system.
b. There should be efficient techniques to deal with or prevent oil spillage.

c. Government or local authorities should strictly monitor all industrial wastes.
d. There should be public enlightenment on waste disposal.
e. Dumping of refuse or petrochemical by-products into the rivers should be avoided.

EVALUATION

1. What is pollution?
2. What are the root causes of major environmental pollution in urban centers?
3. How does plastic pollution directly impact marine and terrestrial ecosystems?
4. Compare and contrast how air, water, and soil pollution mutually reinforce each other.
5. What are the primary human activities that trigger climate change through air pollution?

METHODS OF PURIFYING WATER

Methods involved in purifying water include:

a. Boiling
b. Addition of chemicals, e.g. alum or chlorine
c. Filtration
d. Distillation
e. Sedimentation and boiling
f. Sterilization, e.g. by using ultra violet light.