TOPIC 1: CLASSIFICATION OF LIVING THINGS

Kingdom Fungi

Member of the kingdom Fungi include fairly familiar organisms such as mushrooms, toadstools and bracket fungi. There are also less obvious but very important members such as mold, which grow on bread, ripe fruits and other food.

The General and Distinctive Features of the Kingdom Fungi

Explain the general and distinctive features of the kingdom Fungi

General features of kingdom fungi

- Fungi are found in damp or wet places
- They have eukaryotic cells with a rigid protective wall made of chiti
- They are heterotrophs, some are saprophytic where others are parasitic
- They store food as glycogen
- They reproduce using spore
- They are non-mobile

Distinctive features of kingdom fungi

- They have chitin in their cell wall
- They have septate

The Phyla of the Kingdom Fungi

State the phyla of the Kingdom Fungi

Phyla of the kingdom fungi

- Ascomycota
- Zygomycota
- Basidiomycota

Ascomycota

Ascomycota are also called sae fungi. They produce spore in sae-like cell called asei. These spores are called ascopores. Examples of Ascomycota are bakers'yeast, cup fungi and ringworm fungi.

Characteristics of phyla Ascomycota

- Their cell wall is not made by chitin but cetin polysaccharide component of phosphoric acid
- Have granulated cytoplasm
- Store food in form of glycogen
- Reproduce asexually by budding and sexually by means of ascospores.

Distinctive features

- Reproduce sexually by means of ascospores

(i) Reproduce sexually by means of ascospores

KINGDOM PLANTAE

This kingdom has four divisions

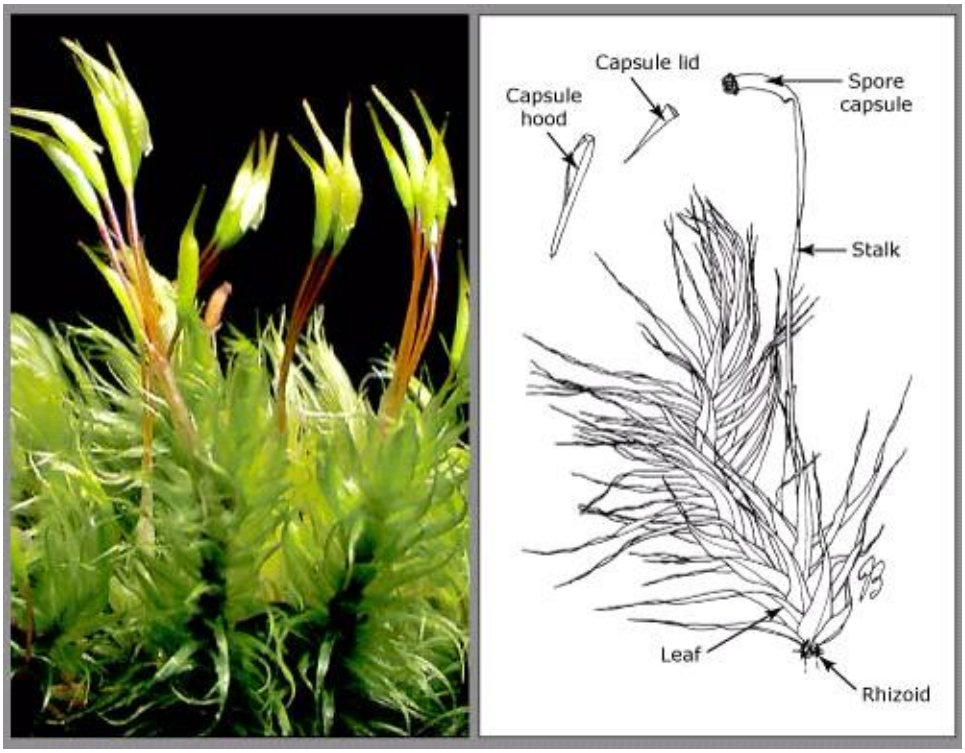
- **division bryophyta**
- **division filicnophyta**
- **division coniferophyta**
- **division angiospermophyta**

DIVISION BRYOPHYTA

The Structure of Mosses

Describe the structure of mosses

Mosses are small, soft plants called bryophytes, that are typically 1–10 cm (0.4–4 in) tall, though some species are much larger. They commonly grow close together in clumps or mats in damp or shady locations. They do not have flowers or seeds, and their simple leaves cover the thin wiry stems. At certain times mosses produce spore capsules which may appear as beak-like capsules borne aloft on thin stalks.



Advantage and Disadvantages of Mosses

Outline advantage and disadvantages of Mosses

On the advantage side, it can help to hold the bonsai soil in place and prevent it from washing out of the container. Moss can increase the water retention capability of the soil by slowing evaporation.

On the disadvantage side, a thick carpet of moss can reduce the diffusion of gases into the soil and to the roots, which can result in root rotor poor drain age conditions. Moss can grow up onto the surface root sand trunk of your bonsai, and soften their bark, promoting its decay.

Division Filicinophyta (Pteridophyta)

General and Distinctive Features of the Division Filicinophyta

Explain general and distinctive features of the division Filicinophyta

This division was formerly called Pteridophyta. The division Filicinpphyta includes a group of primitive vascular plants. The adult plant body in these plants is a sporophyte. It shows differentiation into true roots, stems and leaves. The stem is mostly herbaceous. Leaves may be smaller or larger. Vascular tissues are present in all the vegetative parts of the plant body.

Characteristics of division Filicinophyta

Members of this kingdom include horsetails, ferns and mosses.

- Reproduction involves production of spores inside special structures called sporangiawhich occur on the underside of the leaves called sporophylls. Sprangia may sometimes be found in groups called sori.
- The plants may be homosporous - producing only one type of spore or heterosporous -producing two different types of spores; smaller microspores and larger megaspores.
- They are seedless vascular plants, which contain vascular tissues but do not produce seeds.

The Structure of Ferns

Describe the structure of Ferns

Ferns are intermediate in complexity between the more primitive bryophytes (mosses, liverworts,and hornworts) and the more advanced seed plants. Like bryophytes, ferns reproduce sexually bymaking spores rather than seeds. Most ferns produce spores on the underside or margin of their leaves. Like seed plants, ferns have stems with a vascular system for efficient transport of water and food. Ferns also have leaves, known technically as megaphylls, with a complex system of branched veins.

In general, ferns consist of the following structures:

Fronds

The frond is the "leaf" of a fern. It is divided into two main parts, the stipe (leaf stalk or petiole) and the blade (the leafy expanded portion of the frond).

Rhizomes

Rhizomes would be comparable to "stems" in the flowering plants. Fronds arise from the rhizome. In some epiphytic ferns (ferns that grow on trees) and in terrestrial creeping ferns the rhizome roams widely and is quite visible.

The rhizome contains the conducting tissues (xylem and phloem) and the strengthening tissues (sclerenchyma fibres). The conducting tissue, known as the vascular bundle, carries the water, minerals, and nutrients throughout the plant.

Roots

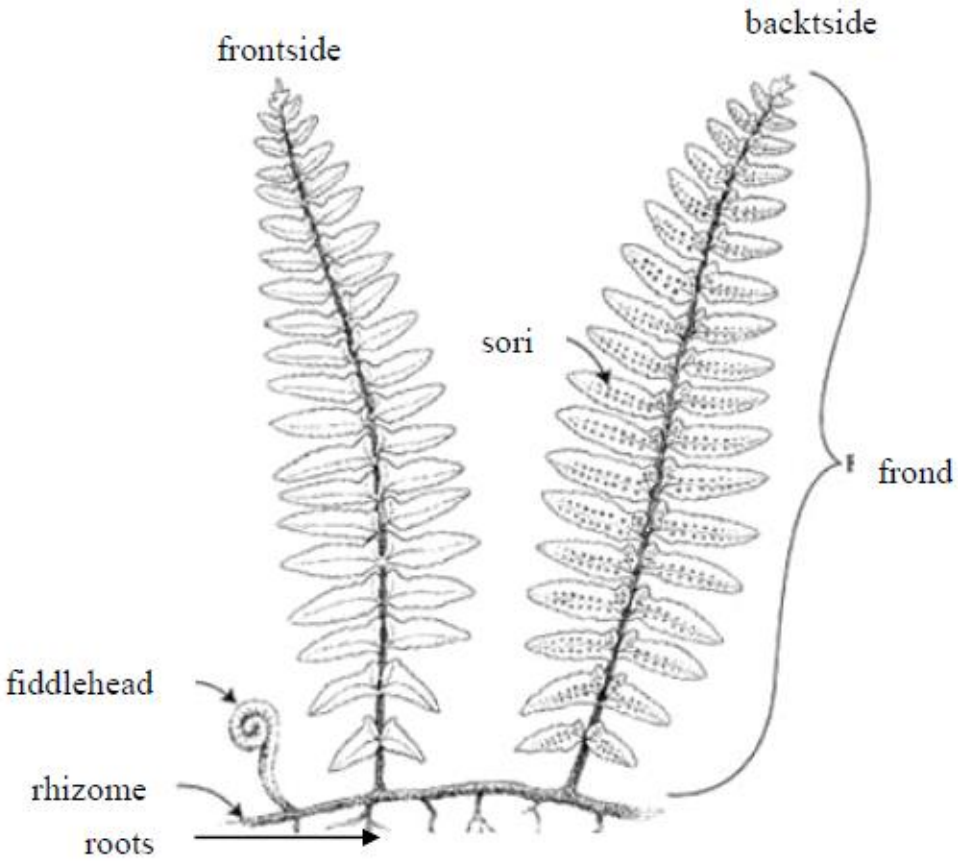
Roots are formed from the rhizomes or sometimes from the stipe. The roots usually do not divide once they grow from the rhizome. Tree fern roots grow down from the crown and help thicken and strengthen the trunk. The roots anchor the plant to the ground and absorb water and minerals.

Sporangia

The sporangia are the reproductive structures of the ferns and fern allies. They produce the dust like spores that are the "seeds" by which ferns are propagated. Several sporangia grouped together are called a sorus. Most ferns have their sporangia on the underside of the frond, arranged in an organized pattern usually associated with veins in the pinnule (leaf). Many times (but not always) the ferns provide a protective covering for the sorus called an indusium.

Spores

The "seeds" of the ferns and fern allies are called spores. Normally they are formed in groups of four. Spores contain oil droplets and sometimes chlorophyll in their nucleus.



A fern plant

Advantages and Disadvantages of Ferns

Outline advantages and disadvantages of ferns

Advantages of ferns

- Some ferns are edible and hence serve as a source of food.
- They provide nutrients to the soil to improve soil fertility.
- They cover the soil and prevent soil erosion.
- They are used as decoration materials.

Disadvantages of ferns

- They harbour dangerous organisms like snakes and insects.

- Some ferns are poisonous when eaten.

TOPIC 2: NUTRITION

Concepts of Nutrition and food Nutrients

INTRODUCTION

Meaning of nutrition

Nutrition is the process by which organisms take in and use nutrients.

Nutrients are any substances that nourish an organism.

Food is any material when taken in absorbed and utilized meet requirement of plant and animal body.

The Concepts of Nutrition and Food Nutrients

Explain the concepts of nutrition and food nutrients

FUNCTION OF FOOD

- Oxidized to release energy
- Used in growth of cells
- Used to repair lost cells and tissue

TYPES OF NUTRITION

There are two main types of nutrition: autotrophic nutrition and heterotrophic nutrition.

Autotrophic Nutrition

Is the process by which organisms manufacture their own food from simple inorganic substances like carbon and hydrogen using either light energy (photosynthesis) or chemical energy (chemosynthesis)

H**eterotrophic Nutrition**

Is the process in which organisms get nutrients by eating other organisms

The Importance of Nutrition in Living Things

Outline the importance of nutrition in living things

IMPORTANCE OF NUTRITION

- Prevent diseases
- Helps growth and development of cells, tissue and organs
- It helps to repair damaged parts
- It helps to protect the body against infection and diseases

Nutrition in Mammals, Human Nutrition

Human Nutrition

Human Nutrition is the provision to obtain the essential nutrients necessary to support life and health.

OR

Are several types of food substances that are needed by the human body for its proper functioning. The basic food substances include proteins, carbohydrates, lipids, vitamins, minerals, roughage and water.

Different Types of Food Substances and their Functions in Human Body

Identify different types of food substances and their functions in human Body

PROTEINS

These are substances, which contain elements oxygen and nitrogen.

SOURCE OF PROTEINS

Foods such as Meat, liver, eggs, beans, milk, cheese, peas, groundnuts and mushrooms are good sources of protein.

FUNCTION OF PROTEINS

The following are the function of protein

- It is used in body building
- Used by body for tissue growth and repair such as healing of wounds and replacement of skin
- Used as a source of energy, especially when the body lacks carbohydrates and lipids
- It enables red blood cells to transport oxygen in our bodies

CARBOHYDRATES

Carbohydrates are mainly made of carbon, hydrogen and oxygen

SOURCES OF CARBOHYDRATES

Foods such as maize, rice, bananas, potatoes, cassava, wheat (bread, cake) and yams are rich in carbohydrates.

FUNCTIONS OF CARBOHYDRATES

The following are the function of carbohydrates

- They are chief source of energy
- In plants they are stored as starch
- In animals they are stored as glycogen

LIPIDS

These are compounds of carbon, hydrogen and oxygen. They are insoluble in water. Lipids are made up of fatty acid and glycogen

SOURCES OF LIPIDS

Foods such as fish, nuts, seed oils, avocados and olives are good sources of lipids.

FUNCTIONS OF LIPIDS

- Lipids are used as a source of energy
- Protect the organs such as heart and kidneys

VITAMINS

Vitamins are chemical substances in small amounts that are used to maintain the body.
Vitamins can be grouped into two categories: water-soluble and fat-soluble vitamins.
Fat-Soluble Vitamins can be stored in the body. Examples of fat-soluble vitamins are Vitamins A, O, E and K

Water-Soluble Vitamins are not stored in the body. Vitamins B and C are water soluble. Vitamin B is of various forms, namely Vitamin B1, B2, B6 and B12.

SOURCES, FUNCTIONS AND SIGNS OF VITAMIN DEFICIENCIES

VITAMIN	SOURCE	FUNCTION	SIGN OF DEFICIENCY
Vitamin A(Retinol)	Liver, Milk Carrots, Orange and Yellow Vegetables	Essential for the formation of membranes of the eyes and the respiratory tract	- Night blindness- Increased risk of infections
Vitamin B1(Thiamine)	Lean meat, liver, eggs, tomatoes, yeast extract sand brown rice	Carbohydrates metabolism of all foods and release of energy to cells	- Beriberi- Loss of Appetite - Muscle cramps- Heart failure
Vitamin B2(Riboflavin)	Liver, meat, wholegrain, cereals, yeast extracts	Needed for metabolism of all foods and release energy to cells	- Cracks and sores around the mouth and nose- Visual problems
Vitamin B6(Pyridoxine)	Meat, vegetables, yeast extracts, whole grain cereals	Essential in protein metabolism	- Nerve irritability- Sores in the mouth and eyes- Anaemia
Vitamin B12(Cyanocobalamin)	Fish, meat, eggs, milk and liver	Builds genetic materials, help to form red blood cells	- Anaemia- Nerve damage- Weight Loss
Vitamin C(Ascorbic Acid)	Pawpaw, Citrus fruits, Fresh Green, vegetables, tomatoes and potatoes	- Increase resistant to diseases.- Improve absorption of iron.- Used in synthesis of collagen in the bones and gums	
Vitamin D(Calciterol)	Egg yolk, milk, oil fish and liver	Helps to build and maintain teeth and bones	- Rickets in children- Osteoporosis (soft bones) in adults
Vitamin E(Tocopherol)	Sunflower oil, butter, brown rice and peanuts	- Antioxidant- Prevents damage of cellmembrane	- Nerve abnormalities- Infertility in rats
Vitamin K	Green vegetables and liver	Needed for normal blood clotting	Defective blood coagulation resulting in excessive bleeding.

MINERALS

Certain mineral elements are vital for the proper functioning of the body. Some are required in relatively large quantities and therefore called macro minerals and others are required in very small quantities and are referred to as micro

Macro minerals include calcium, phosphates, potassium, iron, zinc, sodiumchlorine and magnesium.
Micro minerals include iodine, fluoride, manganese and copper.
Examples of minerals, their source and their function in the body

MINERAL	SOURCE	FUNCTION	SIGN OF DEFICIENCY
Calcium	Milk, Cheese, eggs and green vegetables	- Helps build strong bones and teeth- Important in clotting of blood	- Weak bones- Bleeding easily
Phosphates	Meat, Milk, Fish, Eggs and nuts	- Builds bones and teeth- Helps in muscle and nerve activity	- Poor bone and teeth formation
Potassium	Peanuts, bananas, orange juice and green beans	Needed for nerve and muscle function	- Poor muscle contraction

Iron	Liver, kidney, beans and green vegetables	Essential for making hemoglobin	- Anemia
Zinc	Meat, yeast	Helps to heal wounds	- Skin problems
	Extracts and crab		
Sodium	Table salt	- For nerve and muscle activity	- Muscle cramps
Chlorine	Table salt	Formation of hydrochloric acid in the stomach	- Poor digestion of protein
Magnesium	Spinach, pumpkin seeds, black beans	- Relaxation of nerves and muscles- Strengthening of bones	- Muscle weakness- Irregular heartbeat- Weak bones
Copper	Meat, fish and liver	Activation of enzyme	- Anemia- Bone and joint problems
Manganese	Kidneys, liver, tea, coffee, nuts and fruits	Formation of bones	- Nausea- Dizziness- Loss of hearing
Iodine	Iodized table salt and sea food	Production of thyroid hormones which regulate growth	- Goitre (enlarged thyroid gland)

ROUGHAGE
- This is dietary fiber that is obtained from the indigestible parts of plants.

SOURCES OF ROUGHAGE
Foods such as fruits, beans, cabbage, spinach, cassava, and whole baked potatoes are good sources of roughage.

FUNCTIONS OF ROUGHAGE
It helps in the passage of food and feces through the gut by aiding contraction of the gut muscles

WATER
This is a compound containing element hydrogen and oxygen

SOURCES OF WATER
Rainfall, Rivers, Springs etc.

FUNCTIONS OF WATER
- Used in digestion of food
- Used in transport of material in the body
- Used as solvent in chemical reaction

The Concept of Balanced Diet in Terms of Food Quality and Quantity
Explain the concept of balanced diet in terms of food quality and quantity

A BALANCED DIET
Meaning of balanced diet: A balanced diet refers to food containing all types of food nutrients in the correct proportions. We should eat a diet low in fats, sugars and salts but high in protein, carbohydrates, vitamins, minerals and roughage. More importantly we should take in large amounts of water.

IMPORTANCE OF A BALANCED DIET

In order for the body to function properly, different food substances are required to do different works for example:

- Carbohydrates provide energy
- Vitamins needed to keep the body healthy
- Minerals are needed for protection against diseases
- Water is a universal solvent

Nutritional Requirement for Different Groups of People

Explain nutritional requirement for different groups of people

NUTRITIONAL REQUIREMENTS FOR DIFFERENT GROUPS OF PEOPLE

The following nutritional requirement

- Expectants: There diet should contain more protein and minerals (Calcium (Ca) and Iron (Fe))
- Lactating Mothers: Their requirements are like those of expectants but in greater amount to feed the body
- Children: Require a lot of proteins for growth and development of body tissue.
- The elderly People: They require adequate amounts of vitamins and minerals to maintain their health
- Sedentary workers: These are individuals who stay in one place for a long time while performing their daily occupational activities. Due to their lifestyle and occupation, obesity is increasingly common among them, they limit their intake of food rich in lipids.
- Sick people: They need special and plenty of nutrients to help recover their health, those who have incurable diseases such as HIV/AIDS should get food that will help them to manage their conditions. They need to take plenty of fruits and water.

Different Types of Nutritional Deficiencies and Disorders in Human Beings

Outline different types of nutritional deficiencies and disorders in human beings

NUTRITIONAL DEFICIENCIES AND DISORDERS

Malnutrition

This is the condition, which occurs when one fails to feed on a balanced diet. It may be too little or eating only one type. These deficiencies and disorders include obesity, rickets, kwashiorkor, marasmus and anorexia nervosa.

Nutritional Disorders

These are conditions of ill health in a person, which arise as a result of lifestyle.

The Causes, Symptoms, Effect and Control Measures of Nutritional Deficiencies and Disorders

Explain the cause symptoms, effect and control measures of nutritional deficiencies and disorders

Causes of Malnutrition

There three cause of malnutrition

- Eating too little
- Eating too much
- Eating one type of food

Effects of Malnutrition

- Excessive feeding causes obesity

- Under nutrition causes deficiency diseases

CAUSES, SYMPTOMS, EFFECTS AND PREVENTION MEASURES OF NUTRITIONAL DEFICIENCIES AND DISORDERS IN HUMAN BEINGS

DISEASE	CAUSES	EFFECTS	SYMPTOMS	PREVENTION
Kwashiorkor	Shortage of protein in diet	- Poor growth- Diarrhea- Loss of appetite- Pale skin- Dry skin- Change colour and texture- Body becomes weak and stomach protrudes	- Consumption of foods rich in protein	
Marasmus	- Lack of and equate amount of food- Ignorance of balanced diet preparation of food, food hygiene	- Weight loss- Slowed growth- Decreased activity- Lac k of energy – Shrunken buttocks		- Getting adequate amounts of food - Balanced diet
Rickets	Lack of vitamin D, Phosphates and Calcium		- Bow legs- Knock knees- An odd shaped skul- Deformed spine	- Provide food rich with vitamin D, Phosphates and Calcium
Scurvy	Lack of vitamin C		- Pain in joints- Stunted growth- Bleed in gums	- Provide diet which contains fruits- Avoid prolonged cooking
Goitre	Lack of iodine		- Swelling of the thyroid gland	- Provide iodized salt and water(H2O)

Digestive System in Human

DIGESTIVE SYSTEM IN HUMAN BEINGS

The digestive system of human refers to the human alimentary canal and the organs and glands associated with it.

Parts of the Human Digestive System and their Adaptive Features

Identify parts of the human digestive System and their adaptive features

THE MAIN PARTS OF ALIMENTARY CANAL

The main parts are:- Mouth, Oesophagus, stomach, small intestine, (duodenumand ileum), large intestine (colon) and rectum.

ADAPTATIONS OF STOMACH TO ITS MODE OF FUNCTION

- Stomach has sphincter muscles to prevent food from flowing back into the oesophagus
- Stomach has gastric glands, which produce gastric juice for the digestive process.
- Also in the stomach of a young baby there is renin which coagulates milk
- Stomachs have mucus which protects it from corrosion by digestive enzymes
- There is hydrochloric acid for the emulsification of fats and killing of bacteria

ADAPTATIONS OF ILLEUM TO ITS FUNCTIONS

The following are the adaptations of ileum to its mode of functions:-

- It has secretory glands, which produce digestive enzymes
- It is connected to the liver by the bile duct which enable the bile to reach ileum
- It has finger like projections called villi for the absorption of food
- The ileum is very long to ensure sufficient absorptions of food
- The villi have large network of blood capillaries for transporting absorbed food to all parts of the body
- The inner lining of the ileum is folded to increase the surface area for absorption

The Digestion Process in Human Being

Explain the digestion process in process in human being

DIGESTION PROCESS IN HUMAN BEINGS

Digestion is the process by which food is broken down into a form that can be absorbed and used by the body.

Digestion process involves two processes, which are mechanical breakdown of food and chemical break down of food. The mechanical breakdown of food takes place in the mouth where the food is chewed by teeth so as to reduce it into small pieces.

Digestive enzymes achieve chemical break down of food. The digested food is absorbed and assimilated in the body.

The digestion process starts in the mouth where food is mechanically broken down by teeth. The presence of food in the mouth stimulates the salivary gland to produce more saliva.

FUNCTIONS OF SALIVA

- Have salivary amylase enzyme that converts starch into maltose
- To moisten the food
- To provide medium for enzyme reactions
- Have mucus to lubricate food for easy swallowing
- Saliva consists of Sodium and Calcium salt to ensure alkaline medium or amylase enzyme

Difference between the Human Digestive System with that of Other Mammals

Compare the human digestive system with that of other mammals

DIFFERENCES BETWEEN HUMAN DIGESTIVE SYSTEM AND RUMINANTS'DIGESTIVE SYSTEM

The ruminants' digestive system differs from human digestive system in the following ways:

- Ruminants have more elaborate system to enable cellulose digestion
- The stomach of ruminants have four chambers (rumen, reticulum, omasum, abomasum)
- The food is regurgitated, chewed, and again then passed to omasum.

Common Disorders and Diseases of the Human Digestive System

Outline common disorders and diseases of the human digestive System

DISORDERS AND DISEASE OF THE DIGESTIVE SYSTEM

These include diseases and disorders that affect teeth, oesophagus, stomach,small intestine and large intestines

Examples are:- dental caries, heart burn, ulcers, constipation and flatulence.

- **Dental caries**This is commonly referred to as tooth decay. It occurs when bacteriadestroy the outer part of the tooth.
- **Heart burn**Refers to the burning or painful sensation in the oesophagus. It is caused by regurgitation of hydrochloric acid in the stomach which leads to the irritation of oesophagus.
- **Stomach ulcers**Refers to the sore in stomach lining. It is caused by erosion of stomachwall due to enzyme reactions.
- **Constipation**Refers to the decrease in frequency of formation of stool. It occurswhen the stool becomes dry and hard due to excessive waterabsorption in the colon.
- **Flatulence**This is caused by excess gas in the digestive tract

Causes, Symptoms, Effects and Control Measures of Common Disorders and Diseases of the Human Digestive System

Explain causes, symptoms, effects and control measures of common disorders and diseases of the human digestive system

SYMPTOMS OF DENTAL CARIES

- Tooth ache
- Holes in the teeth

CONTROL MEASURES TO CARIES

- Regular brushing of teeth
- Damaged teeth can be filled with artificial crown
- Minimization of intake of foods rich in sugar
- Avoid eating very hot or cold foods
- Have regular dental check ups

SYMPTOMS OF STOMACH ULCERS

- Burning pain in the stomach
- Nausea and vomiting
- Tiredness and weakness
- Blood in vomit or stool

CONTROL MEASURES TO STOMACH ULCERS

- Medication
- Avoid smoking
- Avoid taking alcohol
- Avoid eating acidic foods

SYMPTOMS OF CONSTIPATION

- Lack of bowel movements for two or three days
- Hard stools
- The urge to go for long call even after you have just been to the toilet

PREVENTION OF CONSTIPATION

- Eat enough fibre
- Drink enough water
- Exercise regularly
- Seek medical help

CAUSES OF FLATULENCE

- Swallowed air
- Eating food that causes gas such as beans, cabbage, milk and onions
- Poor absorptions of carbohydrates

SYMPTOMS OF FLATULENCE

- Abdominal pain
- The constant urge to pass wind
- Excessive belching
- Accumulation of gas in the stomach

PREVENTION OF FLATULENCE

- Avoid foods that produce gas
- Chewing food properly
- Limit the amount of food which are

Nutrition in Plant, Mineral requirement in Plants
Essential Mineral Element in Plant Nutrition
Mention essential mineral element in plant nutrition
The mineral requirement in plant growth are categorized into two groups:

- Micro nutrients or minerals
- Macro nutrients

Macro nutrients are minerals that are required in a large quantity for the plant growth.
They include

Nitrogen, phosphorus, potassium, sulphur, sodium, magnesium, carbon, hydrogen,and oxygen.

Micro nutrients; these are nutrients that are required in small amount for the plantgrowth.
They include; iron, cobalt, fluoride, silicon, iodine, copper and zink

The Roles of Essential Elements in Plant Nutrition

Investigate the roles of essential elements in plant nutrition

The role of essential mineral elements in plant nutrition

element	role	Deficiency
nitrogen	Protein synthesis Manufacture of chlorophyll Promotes normal plant growth	Leaves become pale green, yellow, small leaves, thin weak stem and stunted growth
phosphorus	Promote root and branch growth Protein synthesis and energy release in respiration	Poor growth of roots,leaves and branches Leaves become reddish puple
Potassium	Used during photosynthesis and protein metabolism inyounger lieves	Yellow leaves with dead spots especially at marginsand tips
Calcium	Promotes normal plant growth and cell wall formation	Poor root growth Death of growing regions
Magnesium	Manufacture chlorophyll	Yellowing of leaves
Sulphur	Protein synthesis	Stunted growth Yellow patchers on leaves

PHOTOSYNTHESIS

The Concept of Photosynthesis

Explain the concept of photosynthesis

Photosynthesis is the process where by green plants manufacture their own food byusing light energy produced from the sun. photosynthesis takes place in plantsespecially in leaves so as to make their own food by the presence of different factors.

FACTORS FOR PHOTOSYNTHESIS

Chlorophyll, corbondioxide, sunlight energy, mineral salts, temperature and water.Equation for photosynthesis:

The Structure of the Leaf in Relation to Photosynthesis

Describe the structure of the leaf in relation to photosynthesis

The petiole or leaf stalk attaches the leaf to the branch or stem. It keeps the lamina inposition that will enable it to get a maximum amount of sunlight. The lamina has alarge surface area, thus maximizes the absorption of light energy and carbondioxide.The lamina is also thin so that carbondioxide and light energy diffuse over a shotdistance to reach cells.

The mid rib and veins contain xylem and phloem. Xylem vessels transport water andmineral salt to the leaf. Phloem vessels transport manufactured food to other parts ofthe plant.

The Process of Photosynthesis

Explain the process of photosynthesis

It takes place inside the cell organelles known as chloroplasts. Photosynthesis takesplace in two stages the light stage and the dark stage.

The Importance of Photosynthesis in the Real Life Situation

Outline the importance of photosynthesis in the real life situation

Importance of photosynthesis in daily life:

- All organisms which are heterotrophy depend on autotrophy as source offood.
- Living organisms depend on oxygen for their aerobic respiration producedduring photosynthesis
- . Photosynthesis convert light energy into chemical energy which is used byother organisms
- . Humans depend on photosynthesis for the energy containing fossil fuelwhich have developed over a millions of year.

Properties of Food Substance

The Basic Food Substances and Their Properties

Mention the basic food substances and their properties

Basic food substances:

- i. Carbohydrates
- Protein
- Lipids

CARBOHYDRATES

Is the kind of food substance nutrients made up of carbon, hydrogen, and oxygen.Example: cassava, maize, rice etc.

TYPES OF CARBOHYDRATES

- Monosaccharide
- Disaccharide
- Polysaccharide

MONOSACCHARIDE:

Monosaccharide is also known as simple sugar. They include glucose, fructose andgalactors. These sugars dissolve in water and form sweet solutions. Monosaccharideare reduced sugar. The general formulae for monosaccharide is $(CH_2O)_n$

Where “n” represents a number of carbon atoms and have a value between 3& 6.Example the formulae of glucose is $(C_6H_{12}O_6)$

Disaccharides:

This is the kind of carbohydrate which is formed when two monosaccharidemolecules combine.

Two glucose molecules combine to form maltose.$(C_6H_{12}O_6) + (C_6H_{12}O_6)$ condensation – $C_{12}H_{22}O_{11} + H_2O$some disaccharide are reducing sugars example lactose and maltose , other are nonreducing sugar example sucrose

Polysaccharides:

Is the type of carbohydrates formed by condensation involving severalmonosaccharideExample starch, chitin etc

Properties of polysaccharides:

- They are not soluble in water
- They are non reducing sugar
- . They are not sweet

- When put in water they form suspension

Common Reagents and Chemicals used to Determine Food Properties

Identify common reagents and chemicals used to determine food Properties

TEST FOR CARBOHYDRATES

PROCEDURE	OBSERVATION	CONCLUSION
Dissolve the food sample in water Add an equal amount of Benedict solution to the solution	Food sample dissolveColor change from blue to green to orange,yellow and finally brick red	Reducing sugar is present
Dissolve the food sample in water to getsolution Put 2 cm of a solution obtained in a test tube Add 1 cm of HCL acid	FIZZING COLORCHANGE FROM BLUE,GREEN,YELLOW,orange and finally brick red	Non reducing sugar is present
Boil the mixture Allow the mixture to cool Add small amount of sodium hydroxide,shake the test tube after every additional continue until fizzing stops Add 2 cm of Benedict solution then boil the mixture	FizzingColor change from blue, green to yellow to orange and finally brick red	Non reducing sugar is present
TEST B FOR STARCH Add small amount of food sample solution in a test food.Add few drops (2-3)of iodine solution in the food sample	Color change from blue to black	Starch is present

Food Tests for Reducing Sugars, Non Reducing Sugars, Starch, Proteins and Lipids (Fats and Oil)

Carryout food tests for reducing sugars, non reducing sugars, starch, proteins and lipids (Fats and Oil)

PROTEINS

Food Processing, Preservation and Storage.

The Concept of Food Processing , Food Preservation and Food Storage

Explain the concept of food processing , food preservation and food storage

Food processing refers to all the ways in which food is treated in order to make itedible, appetizing and safe to eat or to keep it fresh for a long time.

Some of activities involved in food processing are;

- Picking, sorting and washing fruits and vegetables
- Cooking by boiling steaming, roasting backing or frying
- Converting raw materials into other products for example making cheersfrom milk or sugar from sugar cane

FOOD PRESERVATION

Food preservation refers specifically to the methods of food processing that areused to prevent food from spoiling or going bad

Methods of food preservation

- Keeping out micro organisms for example by canning or bottling

- Using high temperature to kill microorganisms that cause spoilage eg.By pasturalization and boiling
- Using very low temperature to slow down the growth of microorganisms for example refrigerationiv.
- Irradiation which is by using radiations such as gamma rays to killmicro organismsv
- Eliminating the moisture that is needed for growth of micro organismfor instance by drying, salting, smoking etc
- Adding chemicals such as salt sugar, carbon monoxide to preventphysical changes in food

FOOD STORAGE

Refers to the methods used to keep or reserve of food for future use. Foodstorage can be done on a small scale at the family level for example in afamily granary or food store. Or large scale for large populations e.g ingovernment stores of grains.

The Importance of Food Processing, Preservation and Storage

Explain the importance of food processing, preservation and storage

The following are the importance of food preservation

- prevents wastage of food
- it saves money by preventing spoilage of food
- maintains the quality of food
- prevents the growth of micro organisms that can cause illness
- improve the flavor of food
- removes armful toxins and micro organisms from food
- makes food available even where they are not in season
- enables transportation of delecate and perishable food such as milk andfruit over long distance

Traditional and Modern Methods of Processing, Preserving and Storing Food

Differentiate between traditional and modern methods of processing, preserving and storing food

They are two methods of food processing and preservation which are;

- traditional methods
- modern methods

TRADITIONAL METHODS

These are methods used to process and preserve food which doesn't require the use oftechnology.

These are methods used to process and preserve food which doesn't require the use oftechnology. The following are the traditional ways.

CURING

It involves additional of substances such as salt, sugar, spaces and vinegar toanimal foods, moist meat and fish. Curing removes water making itunavailable for the growth of microorganism it also improve the taste of food.Sausages, becon and curried beef are made by curing meat.

DRYING IN THE SUN

Thus method is used to preserve rice, maize, cloves, banana, beans, peas,meat, fish etc.Here food is left for long time on the sun in order to reduce its moisturecontent. Reducing the amount of water in food discourages the growth ofmicroorganisms. Some food such as banana and cassava are cut into smallpieces to fasten the process.

SMOKING

Smoking is the traditional method which is used to reduce moisture content offood to prevent growth of microorganisms. Grains, meat, fish can be driedslowly over the smoking wood fire

COOKING

Traditional methods of cooking are simple and include boiling, steaming,backing, in hot hash and roasting. These processes help to soften food,improve flavor and preserve food. Example potatoes, bananas, and maize canbe boiled before being dried.

STORAGE IN GRANARIES AND PITS

Dry grains are stored in granaries which are usually raised above the ground.The grains are sometimes mixed with neem leaf ash or groundnuts oil to further prevent attack by microorganisms.Granaries keep grains safe from insects rodents and birds. Example harvestedyams, potatoes and cassava can be stored in large pits in the ground after drying.

ADVANTAGES OF TRADITIONAL METHODS OF FOOD PROCESSING ANDPRESERVATION AND STORAGE

- They are simple and they can be done by most people
- They use locally available materials and simple technology thus keeping costslow
- No harmful chemicals are added to the food
- Curing and smoking add distinct flavor.
- Most methods do not destroy nutrients

DISADVANTAGES:

- Food can be preserved and stored for the limited period of time
- They are manual and thus difficult to apply on a large scale
- Traditional methods are highly limited in the variety of food that can beprocessed preserved and stored.

MODERN METHODS OF FOOD PROCESSING AND PRESERVATION

REFRIGERATION AND FREEZING

Is the temporary storage of food at low temperature of up to 4 centigrade inorder to slow down the growth of microorganisms. Freezing involves storingfood at very low temperatures in order to stop the growth of microorganisms .frozen food can be kept for months.Food that can be refrigerated include milk, fresh fruits, vegetables, juice andbutter. Freezing is mostly used for meat, fish, fruits and vegetables.

PASTEURIZATION

Thus method of preservation was named after its inventor Louis Pasteur. Itinvolved heating food to a very highest temperature for a short time in order tokill the micro organisms that can cause spoilage.Pasteurization maintains the nutrients content and flavor of food. Examples offood that can be pasteurized are milk and fruity juice.

CANNING AND BOTTLING

In this method, food is preserved by heating it in airtight vacuum, sealedbottles or cans. The container is filled with food then the air is pumped out toform a vacuum. The container is sealed and heated to kill microorganisms andenzymes but not enough to overcook the food. Food that can be bottled orcanned include tomatoes, fruits, juice, beef, fish and packed beans. Bottled orcanned food can be kept for months or even years.

USING ADDITIVES

This method involved the use of chemicals such as sodium benzoate, sodiumchloride, and vinegar are added to food to slow down the growth of microorganisms. This is commonly done to pressure fish and meat

DRYING

Food is dried by using either hot blast of air from a vacuum drayer. Afterdrying the food is then sealed in moisture –proof containers.

IRRADIATION

Is the modern method which involve the use of rays of energy to stop thegrowth of microorganisms in stored food. Example in onions, beans andpotatoes. This makes food last longer. It also prevents sprouting in onions andpotatoes.

ADVANTAGES OF MODERM MOTHODS

- Food can last for many months and even a year
- Modern methods can process, preserve, and store large variety of food.
- They are advanced technology bused in fast and can handle huge quantities offood.

DISADVANTAGES;

- The chemicals used can be harmful if eaten in excess
- These advanced technology involve means where they are used only in certain areas for instance refrigeration requires electricity.
- The process used for example canning and pasteurizing require special skills.
- Sometimes nutrients are lost thus lowering the nutritional value of food

DIFFERENCES BETWEEN TRADITIONAL AND MODERN METHODS OFFOOD PROCESSING AND PRESERVATION

TRADITIONAL METHODS	MODERN METHODS
Less costiful	High cost iful
It involves the use of low technology	It involves the use of advanced technology
It processes and preserves food for alimited amount of time	Preserves food for months and evenyears
It uses local materials to process and preserve food It is used by most people	It uses chemicals to process and preserve foodIt is used by few people
It select type of food to be processed and preserved	It is not selective

TOPIC 3: BALANCE OF NATURE

The Natural Environment

The Concept of Natural Environment

Explain the concept of natural environment

Natural environment is made up of all living and non living things that occur naturally on earth. An organism living anywhere in any environment is affected by the things around it such as air, water, animals, plants, microorganism, stones, rock, soil, clouds and the sun. everything around it in fact makes its natural environment. It is important to understand that the environment includes all living things as well as non living things.

IMPORTANT TERMS

- Ecology: is the branch of biology that deals with studying interaction oforganisms with their environment
- Population: is the total number of organisms of the same species living in a certain area. Example the number of frogs in a pond
- Community: this refers to the sum of total of all population of different organisms living in a specific called habitat
- Habitat: is the specific area where an organism is found and adopted. i.e it is an appropriate for the certain community example an ocean, grassland, and a pond
- Ecosystem: refers to a natural unit made up of living and non living things whose interaction

Biotic and Abiotic Components of the Environment

Describe biotic and abiotic components of the environment

There are two components of environment,;

- Biotic (living things)
- Abiotic (non living things)

BIOTIC COMPONENT

These are living components in the environment such as animals, plants, fungi, andmicroorganisms. These organisms interact together in number of ways and these waysof interaction include the following;

- Competition That organisms must compete for limited resources in struggle for life. For anorganism to survive in an ecosystem it must compete with partner for thelimited resources.
- Predation Is the system in which one organism utilize the other as food. The eater is a predator while the eaten is a prey and a number of predators and preysregulate each other
- Symbiotic relationship This is where there is a close relationship or association between organism sthis association could take various forms like mutualism, commensalism, and parasitism
- Adaptation Adaptation has enabled organisms to survive. They may be anatomically structurally physiologically or behavioral. Eg some organisms are poisoners totheir predator while others while others develop warming colouration

ABIOTIC COMPONENTS

These include non living organisms that are found in ecosystem. Example air solar,energy, soil, and nutrients. Generally abiotic components of an ecosystem consist ofphysical environment and they are as follows.

- Climatic factor Several change of climatic condition influence or determine the survival of organisms in ecosystem such condition include temperature, humidity,pressure etc
- Aquatic condition Changes in the aquatic environment and the nature of environment it is self determined by the type of organism found in the area such a changes include water current, wave action, salinity, etc
- Light condition factor These affect much plant population where photosynthetic process depend onthe availability of light.
- Soil factor/conditionThese are also adaphic factors and they include soil texture, soil structure and soil PH

Various Organism in their Natural Environment in the Community

Identify various organism in their natural environment in the community

Activity 1

Identify various organism in their natural environment in the community

The Importance of the Natural Environment

Explain the importance of the natural environment

IMPORTANCE OF NATURAL ENVIRONMENT

- It is a source of food to organisms
- It provides shelter and security for organisms
- It allow living and non living things to interact
- It provides an appropriate setting for organisms to reproduce andincrease in number.

Interactive of Organisms in the Environment

Ways in Which Living Organisms Interact with the Non Living Component of the Environment

Identify ways in which living organisms interact with the non living component of the environment

The following are the interaction of organism in the environment

The Interaction of Organisms among Themselves

Explain the interaction of organisms among themselves

INTERACTION AMONG LIVING ORGANISMS

- CompetitionThat organisms must compete for limited resources in struggle for life. For anorganism to survive in an ecosystem it must compete with partner for thelimited resources .EXAMPLE lions and leopards both hunt zebra, and so theyare competitors
- PredationIs the system in which one organism utilize the other as food. The eater is apredator while the eaten is a prey and a number of predators and preysregulate each other. e,g cats eat mice
- SymbiosisThis is where there is a close relationship or association between organismsthis association could take various forms like mutualism, commensalism, andparasitism
- Mutualism is a relationship where two organisms benefit each other forexample the rhizobium bacteria in the root nodules of legumes fix nitrogeninto nitrate to ne used by the plant
- AdaptationAdaptation has enabled organisms to survive. They may be anatomicallystructurally physiologically or behavioral. Eg some organisms are poisoners totheir predator while others while others develop warming coloration
- Commensalism is the interaction that is beneficial to one organism and isneutral to the other organism. For example when a bird builds a hole or a nestin a tree
- Parasitism is the association where one organism benefit while the other isharmed. E.g plasmodium that cause malaria to human

Food Chain and Food Web

The Meaning of Food Chain and Food Web

Explain the meaning of food chain and food web

FOOD CHAIN

Is the sequence of living things in which each organism is the food of the next in thesequence.

- 1. Grass →Zebra→Lion

- Maize plant→grasshoppe→rFrog

FOOD WEB

Is made of interconnecting food chains

The Components of a Food Chain and Food Web

Mention the components of a food chain and food web

Producers

Are organism that can manufacture their own food for example green plantsand green bacteria

Primary consumers

They are organisms that feed on producers for example rabbits, buffalo andsheep

Secondary consumer

They are organisms that feed on primary consumer

Decomposers

These organisms feed on dead matter and break it down thereby facilitatingdecomposition. For example bacteria and fungi

The Difference between Food Chain and Food Web

Distinguish food chain from food web

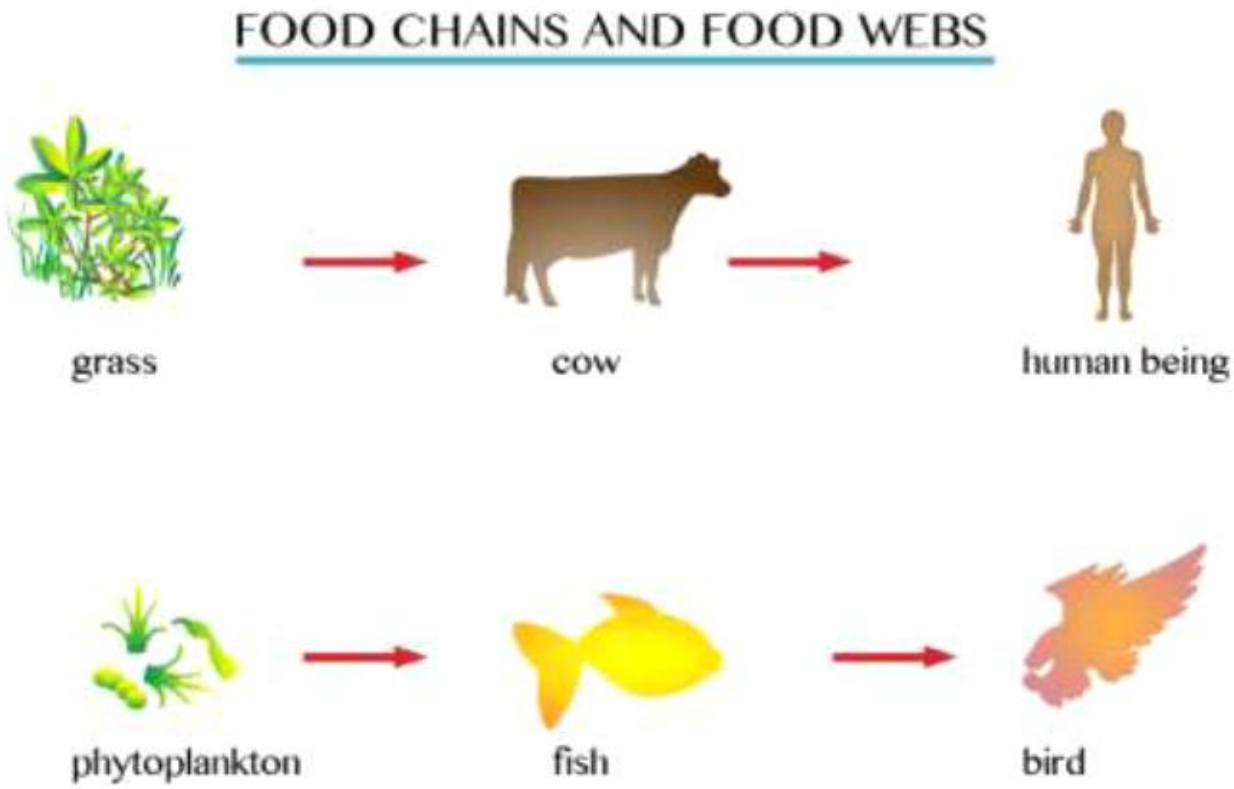
Differences between food chain and food web

Food chain	Food web
1. It consists of the single straight pathwaythrough which food energy travels in an ecosystem	1. It consists of a number of interconnectedfood chains through which energy travelsin an ecosystem
2. Usually members of the higher trophiclevel feed upon a single type of organismsof lower trophic level	2. Usually members of the higher trophiclevel feed upon many organisms of lowertrophic level
3. Isolated or separate food chainsincreases the instability of the ecosystem	3. Presence of complex food websincreases the stability of the ecosystem
4. It does not have any effect on improvingthe adaptability and competitiveness of theorganisms	4. More complex food webs improves theadaptability and competitiveness of theorganisms

Diagrammatic Representation of a Food Chain and Food Web

Construct a diagrammatic representation of a food chain and food web

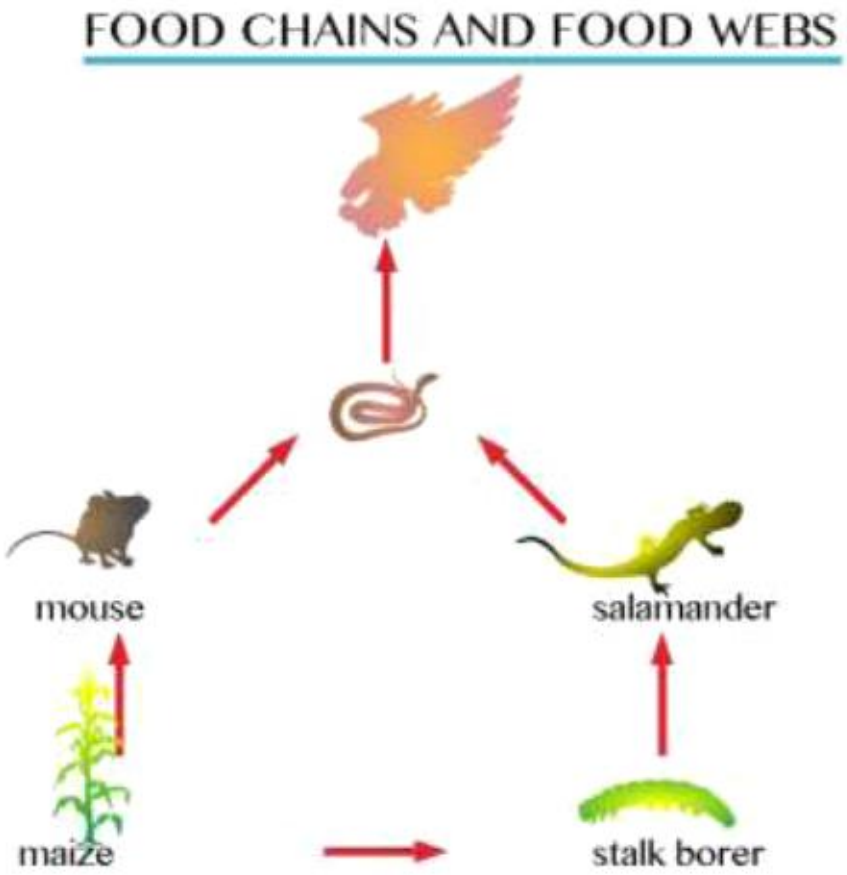
Food chain



Food chain example

- Grass →cow→human being
- Phytoplankton→fish→bird

Food web



The Significance of Food Chain and Food Web in Real Life Situation

Explain the significance of food chain and food web in real life situation

The following are the significant of food chain and food web

- Food chains and webs help in the flow of energy from producers to consumers andfrom one trophic level to another, without which energy flow would be impossible.
- Food chain studies have had an important role in ecotoxicology studies tracingpathways and biomagnifications of environmental contaminants.
- Learning how the food chain works enable us to understand the importance livingorganisms that make up the food chain and how the ecology is balanced. This iscrucial since any interruption in food chain could lead to ecosystem imbalance.
- Food chains and webs show the flow of energy through an ecosystem.
- Understanding the effect of polluting the natural environment enable us to avoid orcontrol environmental pollution so as to maintain natural ecosystems.

TOPIC 4: TRANSPORTATION OF MINERALS OF LIVING THINGS.

The Concept of Transportation of Materials in Living Things

The Concept of Transportation of Materials in Living Things

Explain the concept of transportation of materials in living things

Unicellular organisms (for example amoeba), nutrients (for example oxygen and food) and waste products (for example carbon dioxide) can simply diffuse into or out of the cells from the surroundings. But in multi cellular organisms (for example humans and trees), many cells are very far away from the body surface, hence a transport system is required for the exchange of materials.

Organisms require transport systems so as to carry out various life processes. These life processes include nutrition, respiration, excretion, growth and development, movement,reproduction and coordination. For these life processes to take place, transport of materials is inevitable. Materials are transported either from environment into the organisms or from one part of an organism to another, and can also be transported from an organism into the environment.

For example, during nutrition organisms take in food substances that they need to produce energy, grow and carry out other life processes. These food substances must be taken in from the environment. The same case applies to reproduction which requires the movement of gametes(sex cells) from the sex organs to the area where fertilization occurs. Therefore, transport is very important for the survival and existence of living things.

The Importance of Materials in Living Things

Outline the importance of materials in living things

Transport of materials is very important for the survival and development of living organisms. If transportation never existed, then no life on earth could be possible. The following is an outline of the importance of transport of materials in living things:

- It facilitates the removal of waste materials from the organism's body, the excess of whichcould harm an organism.
- It ensures that essential materials like oxygen, nutrients, water, hormones and mineral saltsare supplied to the cells and tissues as required.
- It enables essential substances to move from one part of the body to another. For example,food manufactured by photosynthesis in plant leaves is transported from leaves to otherorgans of the plant for use or storage.

Diffusion, Osmosis and Mass- flow

The Meaning of Osmosis, Diffusion and Mass- Flow

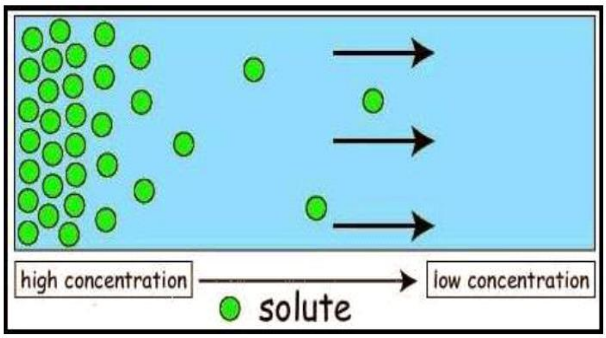
Explain the meaning of osmosis, diffusion and mass- flow

Life processes in organisms take place at the cell level. Therefore, it is necessary for substances to move in and out of the cells. There are two ways through which substances can move across the membrane. Materials in living organisms move by diffusion, osmosis and mass flow.

Diffusion

This is the movement of materials from a region of higher concentration to a region of lower concentration until equilibrium of two sides is maintained. Diffusion can also be defined as the movement of ions or molecules from the region of higher concentration to the region of lower concentration, without involving any permeable membrane. A difference in concentration of a substance between two regions is known as concentration gradient.

Diagram showing diffusion



The process of diffusion

Materials are transported in the body system of living things from the area where they are abundant to areas where they are less abundant, and this process or mechanism of transportation in these animals is termed as diffusion. Diffusion occurs in exchange of gases like oxygen or carbon dioxide during respiration in animals and plants. Also, diffusion takes place during distribution of nutrients and digested foods in living organisms.

Osmosis

This is the movement of water molecules from a region of higher concentration to a region of lower concentration through a semi-permeable membrane. A partially-permeable membrane is a membrane that allows small particles such as water molecules to pass through it, but not larger particles such as sugar molecules and ions from salts. Examples of semi-permeable membranes are cell membranes and a pig's bladder. These membranes allow transportation of water through them. In spite of the fact that they allow transportation of water through them, they do not permit the passage of sugar or salt molecules because they are solutes. Osmosis occurs when water moves down its concentration gradient across the semi-permeable membrane.

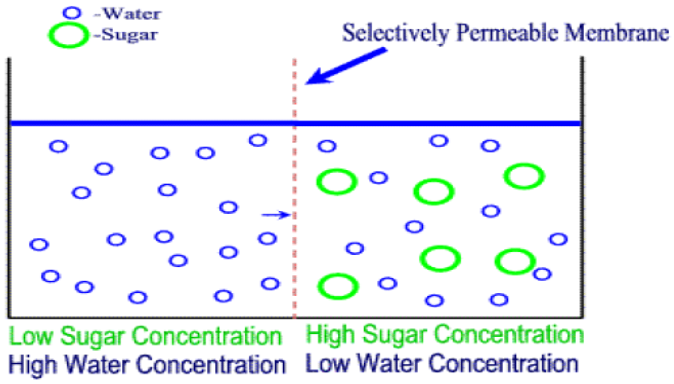
Therefore, for osmosis to take place there must be:

- two solutions with different concentrations; and
- a partially permeable membrane to separate them.

A dilute solution has a high water concentration, while a concentrated solution has a low waterconcentration. For example, when salt is dissolved in water:

- A little dissolved salt produces a dilute solution with a high water concentration
- A lot of dissolved salt produces a concentrated solution with a low water concentration.

Diagram of osmosis



The process of osmosis

Mass flow

Diffusion and osmosis occurs very slowly and cover short distances. In animals and plants,materials are usually transported a long distance and in large quantities. For example, food nutrients from the small intestine have to be moved to cells in the extremities such as toes and fingers, where the nutrient materials have to be transported a long distance. Therefore, an efficient and fast mechanism is required to facilitate this movement. That is when mass flow comes in.

Mass flow is the movement of materials in large quantities and across a long distance in the body of an organism due to differences in pressure between the two regions. Materials in higher plants and animals are moved by the process of mass flow. For example, the manufactured food in plant leaves has to be moved to all plant parts, for use or storage, by mass flow.

Experiments to Demonstrate the Process of Diffusion, Osmosis and Mass Flow

Carryout experiments to demonstrate the process of diffusion, osmosis and mass flow

Demonstration of the process of diffusion

Take a bottle of perfume and move to one corner of the classroom. Open a bottle and observe what happens. The result is, after a few seconds, the whole classroom is filled with a smell of the perfume. This means that the molecules of the perfume moves from the region of higher concentration (the bottle) to a region of lower concentration (air). That is why the smell is felt by a person standing several meters away from the source of the perfume.

Some important processes that involve diffusion are:

- Gaseous exchange in the lungs of animals and in the leaves of plants
- Absorption of digested food in the ileumThe process of diffusion
- Removal of west materials from cells
- Absorption of nutrients and oxygen into cells

Demonstration of the process of osmosis

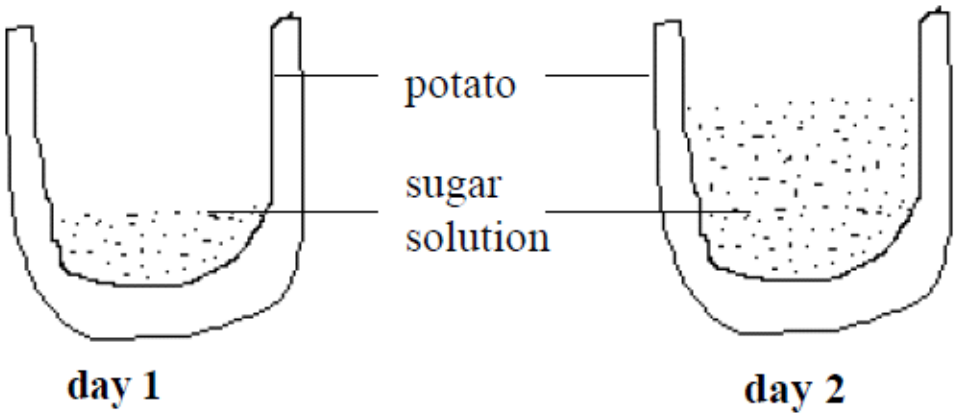
Procedure

Peel a potato and cut it as shown in the diagram below. Then fill the depression with brine(concentrated solution of sodium chloride). Leave the set up until the next day and observe what happens to the level of brine in the potato.

Result

In the following day, you will find that the level of brine will have risen as shown. This means that water has moved from the potato to the brine solution causing the brine level to rise up. The water has moved from a region of high water concentration (the

potato) through the cell membranes of the potato cells (partially permeable membrane) to the region of low water concentration (the brine).



The Differences between Diffusion, Osmosis and Mass Flow

Outline the differences between diffusion, osmosis and mass flow

Differences between diffusion and osmosis

Diffusion	Osmosis
It is the movement of all types of substancesfrom the area of their higher concentration tothe area of their lower concentration	It is the movement of only solvent or waterfrom the area of their higher concentration tothe area of their lower concentration through apartially permeable membrane
Diffusion can operate in any medium	Osmosis operates only in a liquid medium
Diffusion is applicable to all types ofsubsstances (soilds, liquids and gases)	It is applicable only to solvent part of asolution
It does not require any semi-permeablemembrane	A semi-permeable membrane is a must foroperation of osmosis
It is purely dependent upon the free energy ofthe diffusing substance	Osmosis is dependent upon the dregree ofreduction of free energy of one solvent overthat of another
It helps in equalizing the concentration of thediffusing substance througout the availablespace	It does not equalize the concentration ofsolvent on the two sides of the system
Turgor pressure or hydrostatic pressure doesnot normally operate in diffusion	Osmosis is oppossed by turgor or hydrostaticpressure of system
It is not influenced by solute potential	Osmosis is dependent upon the solute potential
Diffusion of a substance is mostly dependentof the presence of other sustances	It is dependent upon the number of particles ofother substances dissolved in a liquid

Factors like water potential, solute potentialand pressure potential do not affect diffusion	Factors like water potential, solute potentialand pressure potential affect osmosis in aliving system

The Roles of Diffusion, Osmosis and Mass Flow in Movement of Materials in Living Organisms

Explain the roles of diffusion, osmosis and mass flow in movement of materials in living organisms

Materials are transported in the body system of living things from the area where they areabundant to areas where they are less abundant, and this process or mechanism of transportationin these animals is termed as diffusion. Diffusion occurs in exchange of gases like oxygen orcarbon dioxide during respiration in animals and plants. Also, diffusion takes place duringdistribution of nutrients and digested foods in living organisms.

- Through the process of osmosis, nutrients get transported to cells and waste materials getmoved out of them.
- The pressure within and outside each cell is maintained by osmosis as this process ensures abalance of fluid volume on both sides of the cell wall. If fluid volume within a cell is morethan the fluid volume outside it, such pressure could lead the cell to become turgid andexplode. On the contrary, if fluid volume outside the cell is more than the fluid volumewithin, such pressure could lead the cell to cave in. Both cases would be detrimental tonormal and healthy cellular function.
- It is via osmosis only that roots of plants are able to absorb moisture from the soil andtransport it upwards, towards the leaves to carry out photosynthesis. Plants wouldn't existwithout osmosis; and without plants, no other life could exist as they are a vital link of theentire food chain of the planet.
- Without osmosis, it would be impossible for our bodies to separate and expel toxic wastesand keep the bloodstream free from impurities. The process of blood purification is carriedout by the kidneys which isolate the impurities in the form of urine.
- Therefore, the role of osmosis is twofold: it helps maintain a stable internal environment in aliving organism by keeping the pressure of intercellular and intracellular fluids balanced. It alsoallows the absorption of nutrients and expulsion of waste from various bodily organs on thecellular level. These are two of the most essential functions that a living organism cannot dowithout.

Transport of Materials in Mammals, the Structure of the Mammalian Heart

The External and Internal Structures of the Mammalian Heart

Describe the external and internal structures of the mammalian heart

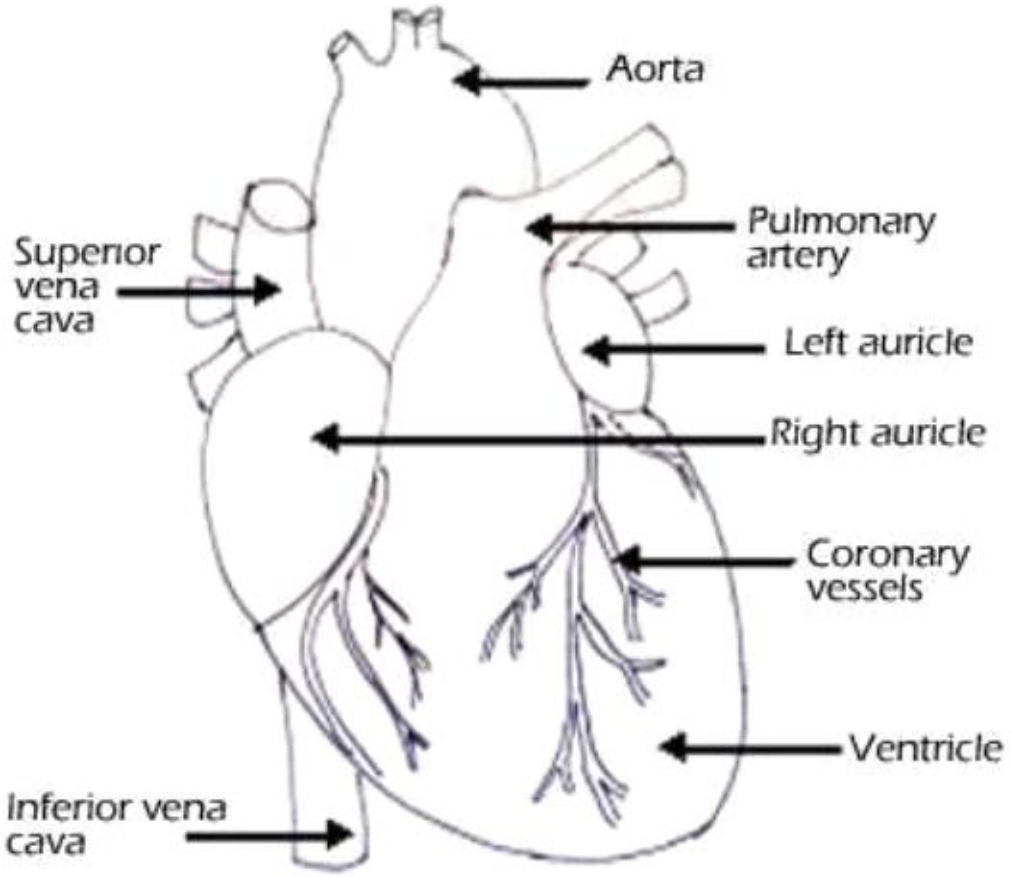
TRANSPORT OF MATERIALS IN MAMMALS

Mammals are the complex multicellular organisms whose bodies are made up of numerous cellsand tissues. In this case, diffusion alone is not enough to insure efficient carrying out of lifeprocess. Therefore mammals have an elaborate transport system that is made up of the heart,blood and blood vessel.

The structure of the mammalian heart

The heart is a muscular organ about the size of a closed fist that functions as the body'scirculatory pump. It takes in deoxygenated blood through the veins and delivers it to the lungsfor oxygenation before pumping it into the various arteries. The heart is located in the thoraciccavity between the two lungs.

The external structure of the mammalian heart is as shown in the labelled diagram below:



EXTERNAL STRUCTURE OF THE MAMMALIAN HEART

The mammalian heart is broader at the top and narrower at the bottom. It is enclosed by a double layer of tough and elastic membranes called pericardium. These membranes prevent the heart from ever-expanding when beating very fast. Also the pericardium secrets a fluid which enables the membranes to move smoothly against each other.

The walls of the ventricles are thicker than those of the auricles because the ventricles pumpblood a greater distance than the auricles. Auricles pump blood to the ventricles while theventricles pump blood to the other parts of the body.

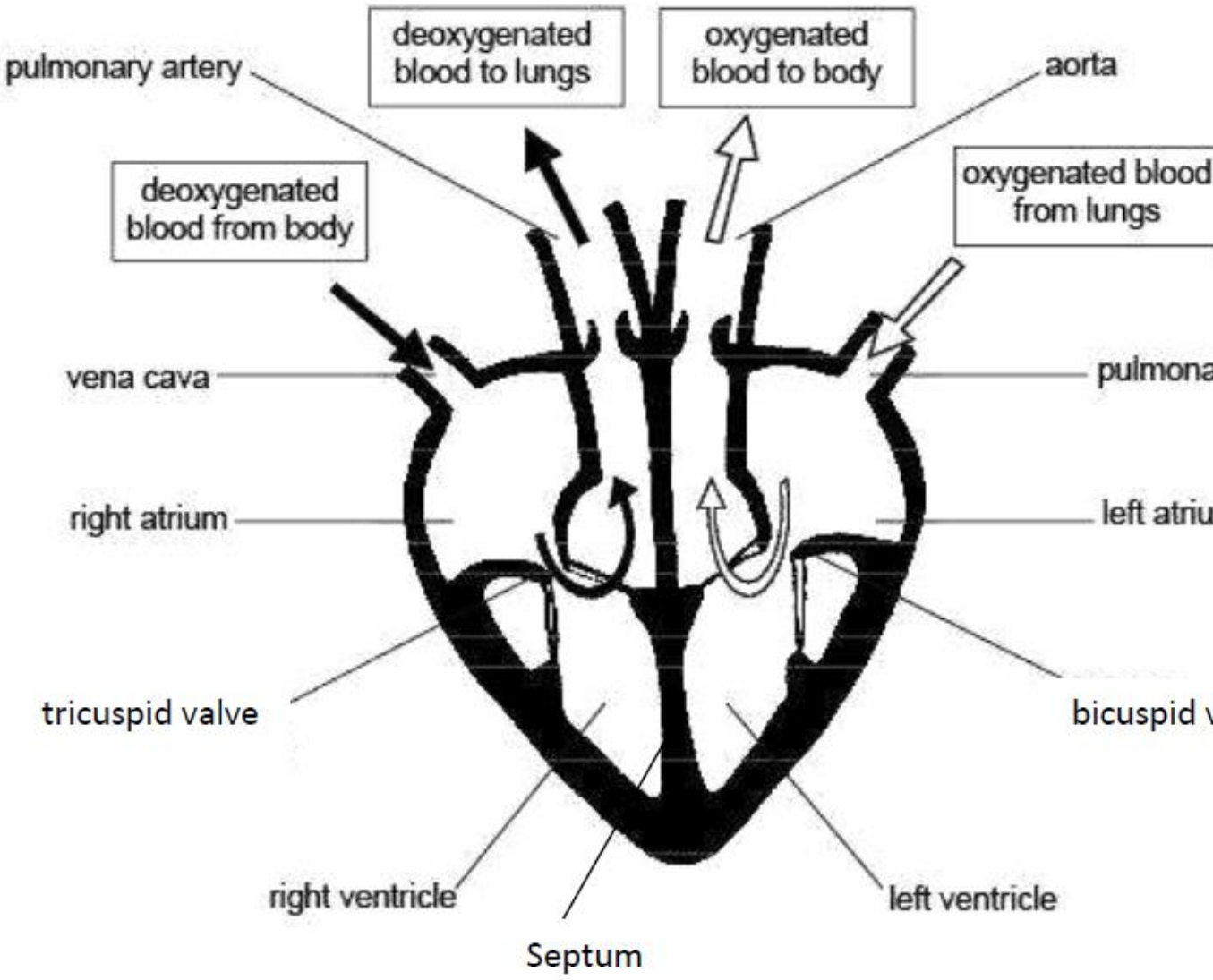
The left ventricle is thicker than the right ventricle because the right ventricle pumps blood to thelungs while the left ventricle pumps blood to the rest of the body parts.The heart consists of four chambers, right and left atria and right and left ventricles. Thefunctions of each part and the associated structures are as follows:

- The right atrium links to the right ventricle by the tricuspid valve. This valve preventsbackflow of the blood into the atrium above, when the ventricle contracts.

- The left atrium links to the left ventricle by the bicuspid valve. This valve also preventsbackflow of the blood into the atrium above, when the ventricle contracts.

- Semi-lunar (pocket) valves are found in the blood vessels leaving the heart (pulmonary arteryand aorta). They only allow exit of blood from the heart through these vessels followingventricular contractions.
- Ventricles have thicker muscular walls than atria. When each atrium contracts, it only needsto propel the blood a short distance into each ventricle while ventricles pump blood to distantbody parts.
- The left ventricle has even thicker muscular walls than the right ventricle. The left ventricleneeds a more powerful contraction to propel blood to the systemic circulation (all of the bodyapart from the lungs). The right ventricle propels blood to the nearby lungs. So, thecontraction does not need to be so powerful.

INTERNAL STRUCTURE OF THE MAMMALIAN HEART



The heart has several valves. And these valves have flaps that ensure that blood flows in one direction only.

These valves include the following:

- The tricuspid valve; found between the right auricle and right ventricle

- The bicuspid valve: found between left auricle and left ventricle
- Semi-lunar valves which are located at the bases of the pulmonary artery and aorta to preventblood from flowing back into the ventricles.

These valves will close if the blood flows back. The valves are held in place by tendons which prevent the flaps from turning inside out.The right and left sides of the heart are separated by septum which is a thick muscular wall which prevents mixing of oxygenated and deoxygenated blood.

The Functions of the External and Internal Parts of the Mammalian Heart

Explain the functions of the external and internal parts of the mammalian heart

Functions of parts of the mammalian heart

Part of the heart	Function
Aorta	The largest artery in the body; it conducts freshly oxygenated bloodfrom the heart to the tissues.
Superior vena cava	Large vein that brings deoxygenated blood from the upper parts ofthe body to the right atrium
Inferior vena cava	Large vein that brings deoxygenated blood from lower regions of thebody to right atrium
Pulmonary artery	Carries deoxygenated blood from the right ventricle to the lungs
Pulmonary vein	Blood vessel that carries oxygenated blood from the lungs to the leftatrium
Right atrium	This chamber of the heart receives deoxygenated blood from thebody (from the superior and inferior vena cava).
Left atrium	This chamber of the heart receives oxygenated blood from the lungs
Tricuspid valve	Located on the right side of the heart between the right atrium (RA)and right ventricle (RV)
Bicuspid valve	Located on the left side of the heart between the left atrium (LA) andthe left ventricle (LV)
Right ventricle	The chamber of the heart that pumps deoxygenated blood to thelungs
Left ventricle	Receives blood from the left atrium and pumps it into the aorta fortransport to the body cells
Septum	Divides the right and left chambers of the heart

The Adaptations of the Parts of the Mammalian Heart to their Functions

Explain the adaptations of the parts of the mammalian heart to their functions

The heart is adapted to carry out its functions by having the following features:

- The cardiac muscle is adapted to be highly resistant to fatigue.
- The heart has a large number of mitochondria enabling continuous supply of energy to theheart and numerous myoglobins (oxygen storing pigment).
- The presence of the cardiac muscles enables the heart to beat rhythmically.
- The pericardium which surrounds and protects the heart from physical damage.
- Pericardial fluid which prevents friction when the heart beats.

- The outer layer of the pericardium attaches to the breastbone and other structures in the chestcavity and thus helps to hold the heart in place.
- Bicuspid and tricuspid valves between atria and ventricles which prevent the backflow ofblood.
- Septum which prevents the mixing of deoxygenated blood in the right and oxygenated bloodin the left chambers of the heart.
- Its own blood supply for supplying nutrients and removing waste.
- The left ventricle has thick muscular wall to pump blood at a higher pressure to the distantbody tissues,
- The heart is supplied with the nerves which control the rate of heartbeat depending on thebody requirements.

Blood vessels

Blood vessels are intricate networks of hollow tubes that transport blood throughout the entirebody. This is an essential function as blood delivers valuable nutrients to and removes wastesfrom our cells. Blood vessels are constructed of layers of connective tissue and muscle. Theinner blood vessel layer is formed of endothelium. In capillaries and sinusoids, endotheliumcomprises the majority of the vessel. There are three types of blood vessels namely arteries,veins and capillaries. Each of these vessels has a different structure and function.

The Structure of Arteries, Veins and Capillaries

Describe the structure of arteries, veins and capillaries

Basic structure

- Capillaries consist of anendothelium whichis only one cell thick.
- Walls of arteries and veins consist of 3 layers.
- The inner layer consists of a thin layer of endothelial cells.
- The middle layer is made up of smooth muscle with some elastic fibres. This layer controls the diameter of the vessel and hence the amount of blood and its rate of flow.
- The outer layer is composed of connective tissue; this holds the blood vessels in place in the body.

Detailed structure

Arteries

- The walls of arteries are much thicker as it carries blood away from the heart at high pressure.
- Major arteries close to the heart also have thick layers of smooth muscle in their walls to withstand the increases in pressure as the heart pumps.
- The walls also have a large proportion of elastic fibres in both the inner and middle layers – this allows for the arteries to stretch according to the increases in volume of blood. As the heart relaxes the artery walls return to their original position, hence pushing the blood along – maintaining a constant flow in one direction.
- Arteries are near the surface of the skin; the changes in the arteries diameter can be felt as a pulse.

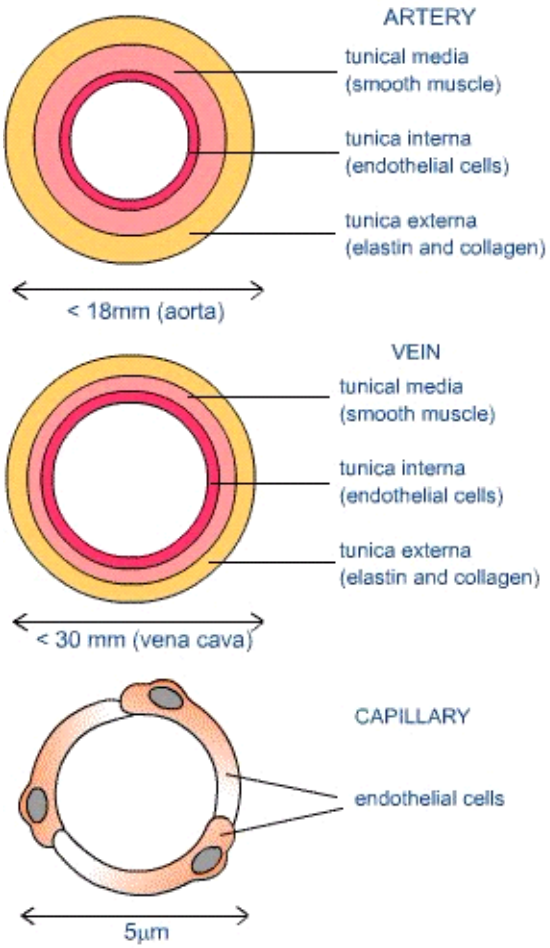
Veins

- The walls of veins are thinner than the walls of arteries, as the blood they receive from the capillaries is at a much lower pressure.
- The walls have fewer elastic fibres and the lumen is wider (to allow for easier blood flow).

- Veins have two mechanisms for keeping the blood flow constant and in one direction. Firstly, many veins are close to muscles, hence when the muscles contract they compress the walls of the vein – pumping blood forwards. Veins also havevalves which are spacedalong regular intervals in veins. They work much like one-way swinging doors – as the blood is forced through the valve opens. However, once the pressure drops and the blood flow decreases, the valve shuts – preventing backflow of blood.

Capillaries

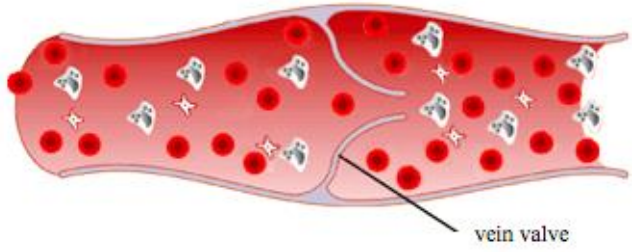
- They are extremely, tiny microscopic vessels that bring blood into close contact with the tissues, for the exchange of chemical substances between cells and the bloodstream.
- The one cell thick endothelial layer is a continuation of the lumen arteries and veins.
- Diffusion is a relatively slow process and hence the structure of capillaries is suited to slowing down the flow of blood.
- In order to maximize the exchange of substances between the blood and cells, capillaries have thin walls (for more efficient diffusion) a small lumen (that forces blood cells to pass through in single file, slowing down the rate of flow and maximizing their exposed surface area).
- They form an expansive blood flow network, such that no cells are far from blood supply



How different blood vessels are adapted for their function

Blood	***Function***	***Adaptation***

vessel		
Artery	Carries blood away from heart at high pressure	Thick, elastic, muscular walls to withstand pressure and to exert force (pulse)
Vein	Returns low-pressure blood to heart	Large diameter to offer least flow resistance. Valves to prevent back flow.
Capillary	Allows exchange of materials between blood and tissues	Thin, permeable walls



Cross-section of a vein

Cross section of vein

Differences between arteries, veins and capillaries

Arteries	***Veins***	***Capillaries***
All arteries carry blood**away**from the heart	All veins carry blood**towards**the heart	Capillaries carry blood**from arteries to the veins**
With the exception of the pulmonary artery, all arteries carry**oxygenated**blood	With the exception of the pulmonary vein, all veins carry**deoxygenated**blood	Blood**slowly loses its oxygen**
They carry blood which is usually**rich in digested food**materials	Except for the hepatic portal vein, they carry blood which usuallyhas**littledigested food**materials	Blood**slowly loses its food**
Have relatively narrower lumens (see diagrams above)	Have relatively wide lumens (see diagrams above)	Have relatively narrow lumens (see diagrams above)
Have relatively a**thick**layer of muscles and elastic fibres	Have relatively a**thin**layer of muscles and elastic fibres	They**do not have**muscles and elastic fibres
They have**thick outer walls**	They have**thin outer walls**	Walls are only**one cell thick**
They carry blood at**high pressure**	They carry blood at**low pressure**	**Pressure gradually falls**as blood flows from arteries to veins
Do not have valves (except for the semi-lunar valves of the pulmonary artery and the aorta)	Have valves throughout the main veins of the body to prevent the back flow of blood.	Have no valves
Have bright red blood (because it is rich in oxygen)	Brown-red blood	Brown-red blood

Located deep in the to body surface	Located near to body surface	Capillaries are found inside all tissues
Walls are**not permeable**	Walls are**not permeabl**e	Walls are**permeable**
Blood flows in pulses	Nopulse	Pulse gradually disappears

Simple Experiments to Determine Pulse Rates in Human Being

Carry out simple experiments to determine pulse rates in human being

Activity 1

Carry out simple experiments to determine pulse rates in human being

The Blood

The Major Components of the Blood

List the major components of the blood

Blood is the red fluid that circulates in our blood vessels. The average human body containsabout 4 to 5 litres of blood. Blood is classified as a connective tissue and consists of two maincomponents:

- Plasma which is a clear extracellular fluid.
- The solid component, which are made up of the blood cells and platelets

The solid component is made up of blood cells except for the platelets, which are tiny fragmentsof bone marrow cells.

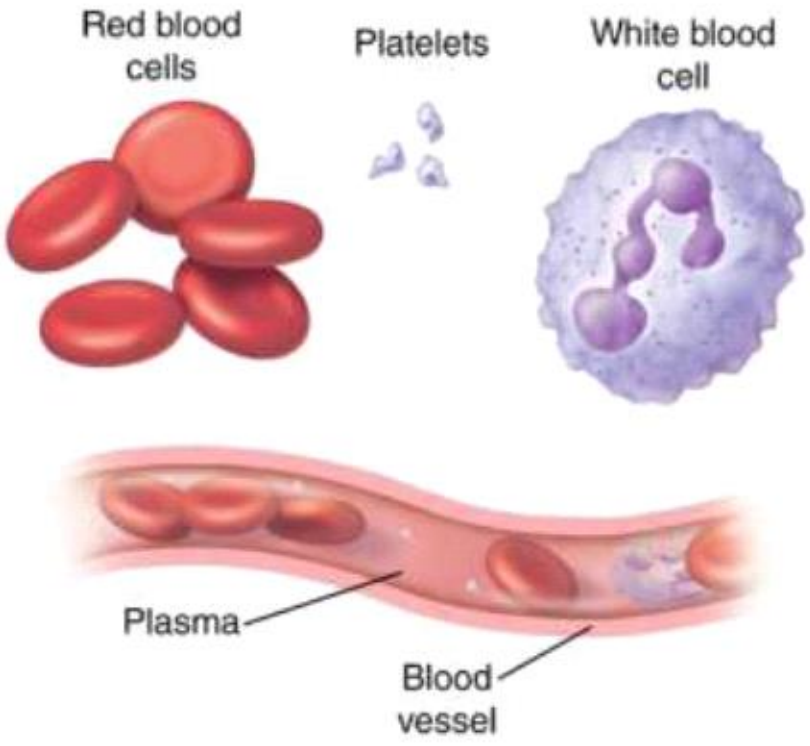
The solid component consists of blood cells (corpuscles) which include:

- Erythrocytes, also known as red blood cells (RBCs)
- Leukocytes, also known as white blood cells (WBCs)
- Platelets, also known as thrombocytes

Red blood cells, most white blood cells, and platelets are produced in the bone marrow, the softfatty tissue inside bone cavities. The white blood cells (lymphocytes) are also produced in thelymph nodes and spleen, and in the thymus gland.

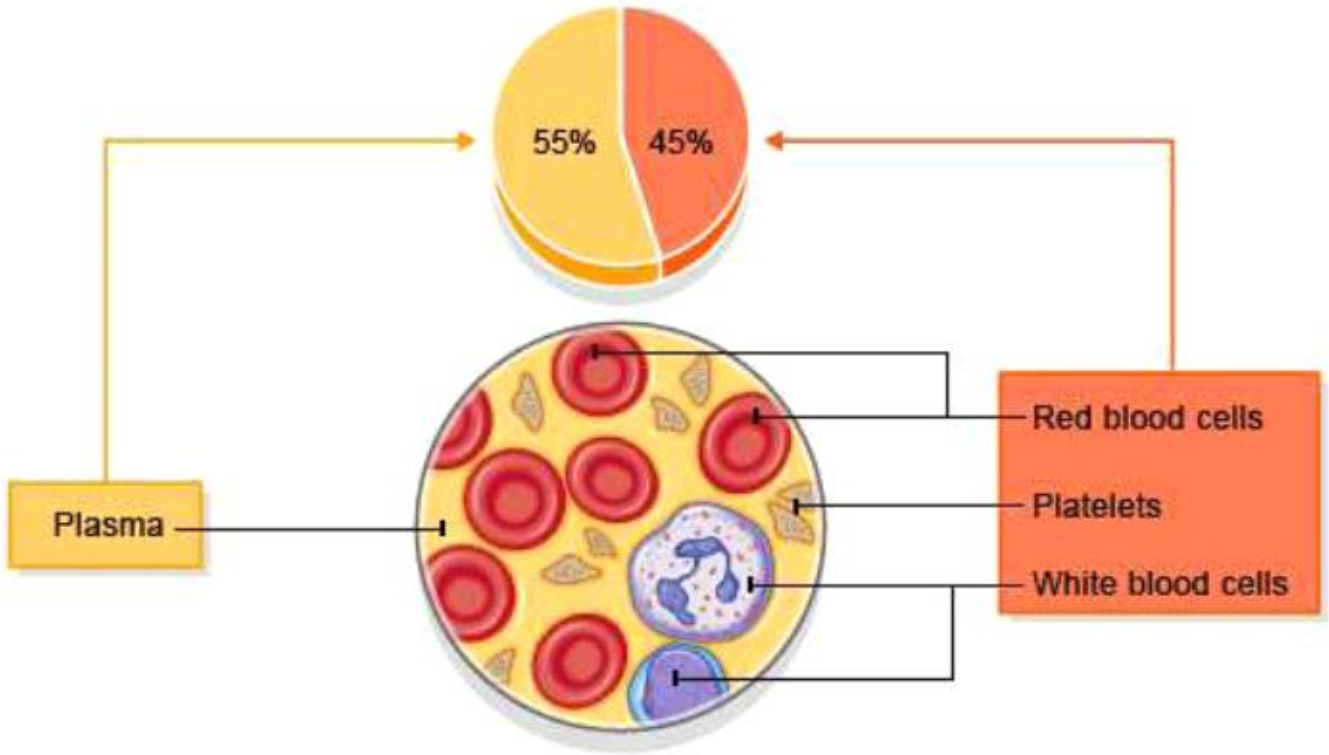
Within the bone marrow, all blood cells originate from a single type of unspecialized cell calleda stem cell. When a stem cell divides, it first becomes an immature red blood cell, white bloodcell, or platelet-producing cell. The immature cell then divides, matures further, and ultimatelybecomes a mature red blood cell, white blood cell, or platelet.

Blood cells



Blood cells

By volume, the plasma constitutes about 55% of whole blood, and red blood cells, platelets and white blood cells about 45%.



The Function of Major Blood Components

Explain the function of major blood components

Red blood cells

Red blood cells (RBCs) have two main functions:

- To pick up oxygen from the lungs and deliver it to tissues elsewhere.
- To pick up carbon dioxide from other tissues and unload it in the lungs.

Erythrocytes transport oxygen in the blood through the red pigment called haemoglobin.Haemoglobin contains iron and proteins joined to greatly increase the oxygen carrying capacityof erythrocytes. The high surface area to volume ratio of erythrocytes allows oxygen to be easilytransferred into the cells in the lungs and out of the cells in the capillaries of the systemic tissues.Erythrocytes are produced inside red bone marrow from stem cells at the astonishing rate ofabout 2 million cells every second.

White blood cells

Although the white blood cells accounts for only about 1% of the blood, they play a veryimportant role in the body. Their main function is to protect the body against disease pathogens.There are two of white blood cells, each of which plays a specific role in protection of the bodyagainst illness and disease.

- Phagocytes: Engulf and digest invading bacteria and viruses (pathogens). It is the body'smain defence against germs (microbes).
- Lymphocytes: produce antibodies which neutralize antigens from bacteria or viruses. Theykill microbes or make them clump together, to be removed in the lymph glands.

White blood cells are produced in the yellow marrow of the bone, spleen, thymus and lymphaticsystem.

Platelets

Platelets are small fragments of bone marrow cells and are therefore not really classified as cellsthemselves. Platelets have the following functions:

- Secrete vasoconstrictors which constrict blood vessels, causing vascular spasms in brokenblood vessels.
- Form temporary platelet plugs to stop bleeding.
- Secrete procoagulants (clotting factors) to promote blood clotting.
- Dissolve blood clots when they are no longer needed.
- Digest and destroy bacteria.
- Secrete chemicals that attract neutrophils and monocytes to sites of inflammation.
- Secrete growth factors to maintain the linings of blood vessels.

In general, the blood platelets functions in healing of the wounds when the skin gets broken. Thisis achieved by clumping together of the platelets to form a network of mesh, hence bleeding isstopped.

Plasma

Plasma is the non-cellular or liquid portion of the blood. Plasma is a mixture of water, proteins,and dissolved substances. Around 90% of plasma is made of water, although the exactpercentage varies depending upon the hydration levels of the individual. Blood plasma has thefollowing functions:

- Plasma serves as a transport medium for delivering nutrients to the cells of the various organsof the body.
- It transports waste products derived from cellular metabolism to the kidneys, liver, and lungsfor excretion.
- It fights infections since it contains antibodies.
- It is also a transport system for blood cells, and it plays a critical role in maintaining normalblood pressure.
- Plasma helps to distribute heat throughout the body and to maintain homeostasis, orbiological stability, including acid-base balance in the blood and body.6. It carries and transports some hormones.

The Effects of HIV on White Blood Cells

Explain the effects of HIV on white blood cells

The HIVs in the blood of a HIV-positive person attack the white blood cells (lymphocytes). Theviruses reproduce and increase in number within the lymphocytes. Then the lymphocytes burstand release more viruses in the bloodstream. The released viruses attack more, new white cells.The attack continues in that cycle until many white cells are destroyed. Because there are only afew white cells left to fight against pathogens, the body immunity gets low. Once the immunityis lowered, the body is often attacked by diseases and a person suffers from AIDS.

Blood Groups and Blood Transfusion

The Concepts of Blood Group and Blood Transfusion

Explain the concepts of blood group and blood transfusion

Human blood can be grouped into four blood groups namely groups A, B, AB and O. They werediscovered in 1900 and 1901 at the University of Vienna by Karl Landsteiner in the process oftrying to learn why blood transfusions sometimes cause death and at other times save a patient.This classification is based on the type of antigens in the red blood cells and antibodies in theplasma.

Red blood cells have proteins (antigens) on their surface: A, B or A and B. Plasma hasantibodies which can cause agglutination: anti-A and anti-B.

Serum is blood plasma without fibrinogen. It can be stored without clotting, and is used intransfusions.

Blood group	Antigen	Antibodies	Agglutinates
A	A	Anti-B	Anti-A serum
B	B	Anti-A	Anti-B serum
AB	A and B	None	Anti-A and anti-B serums
O	None	Anti-A and anti-B	Neither serum

Consider the table above. People with type A blood will have the A antigen on the surface oftheir red cells (as shown in the table). As a result, anti-A antibodies will not be produced bythem because they would cause the destruction of their own blood. However, if B type blood isinjected into their systems, anti-B antibodies in their plasma will recognize it as alien and burstor agglutinate the introduced red cells in order to cleanse the blood of alien protein.

Individuals with type O blood do not produce any antigens. Therefore, their blood normally willnot be rejected when it is given to others with different blood types. As a result, type O peopleare universal donors for transfusions, but they can receive only type O blood themselves. Thosewho have type AB blood do not make any antibodies. Their blood does not discriminate againstany other blood type. Consequently, they are universal receivers for transfusions, but their bloodwill be agglutinated when given to people with every other type because they produce both kindsof antigens.

Blood grouping

It is easy and inexpensive to determine an individual's blood type from a few drops of blood.This is how blood typing/grouping it is done: A serum containing anti-A antibodies is mixedwith some of the blood. Another serum with anti-B antibodies is mixed with the remainingsample. Whether or not agglutination occurs in either sample indicates the blood type. Forinstance, if an individual's blood sample is agglutinated by the anti-A antibody, but not the anti-Bantibody, it means that the A antigen is present but not the B antigen. Therefore, the blood typeis A.

Rhesus factor

Some people have another antigen called Rhesus antigen on their red blood cells while othersdo not have it. Those having this antigen are referred to as Rhesus positive (Rh+) and thosewithout are it are Rhesus negative (Rh-). Rh antigen occurs in red blood cells and Rh antibodyoccurs in blood plasma.

If Rh antibody mixes with Rh antigen during blood transfusion, agglutination will occur. Rh+ canstimulate the Rh- to produce antibodies to act against Rh+ antigens. However, the Rh- cannotstimulate the Rh+ blood to produce antibodies against Rh-. Therefore, an Rh+ person can receiveblood from the Rh- donor. The donated blood below is group AB rhesus positive (AB+).

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Donated blood

The Relationship between Blood Groups and Blood Transfusion

Outline the relationship between blood groups and blood transfusion

Blood transfusion

Blood transfusion is the transfer of blood from one person (donor) to another person (recipient)through blood vessels. Transfusion is done to replace lost blood due to illness, accidents or bleeding. The donor is the person who gives blood while the recipient is the person who receives blood.

When performing blood transfusions it is important to avoid combining corresponding antigensand antibodies because they cause agglutination of red blood cells which may lead to death ofthe recipient. Agglutination is the clumping of red blood cells. Blood transfusion is only possibleif blood groups are compatible. Blood group compatibilities are as shown in the table below.

Recipient	Donor			
	A	B	AB	O
A	√	×	×	√
B	×	√	×	√
AB	√	√	√	√
O	×	×	×	√

Note: a tick (√) means compatible and a cross (×) means incompatible.

Individuals with blood group AB can receive blood from individuals of all blood groups and areknown as universal recipients. Individuals with blood group O can donate blood to individualsof all blood groups and are known as universal donors.

The Advantages and Disadvantages for Blood Transfusion

Explain the advantages and disadvantages for blood transfusion

Advantages of blood transfusions

Blood transfusion does so much for patients in need. The gift of life is donated, tested, processedand sent to hospitals' transfusion service departments where more important work is done toensure it is compatible with the recipient.

Blood transfusion has a number of advantages. These are some of the benefits the donated bloodcan provide for patients in need:

- Increase low haemoglobin levels: low haemoglobin can cause damage to body organs andtissues due to low oxygen levels. Donated blood, with sufficient haemoglobin, can correct theproblem of low haemoglobin level of the recipient.
- Help stop bleeding: bleeding may not be controlled if platelets and/or clotting factors arelow. Receiving blood with high clotting factors can solve the problem.
- Keeps the heart pumping: low blood volume can lead to low pressure and the heart may notbe able maintain the circulation of blood.
- Help with serious blood infections when other methods fail. For example, blood transfusionmay serve as a treatment method for people with sickle cell anaemia or blood cancer(leukaemia).
- Provide red cells and platelets when the bone marrow is compromised as with blood cancers,bone marrow transplants, chemotherapy, etc.
- Provide red cells and platelets for patients with blood disorders such as sickle cell.
- Save someone's life: people who have had a big loss of blood due to a number of reasons canhave their lives saved once they receive donated blood.
- Because blood transfusion involves screening of the donor's blood, if the donor has anyhealth problem it can be detected and hence treated before getting worse.

Disadvantages of blood transfusions

Although blood transfusions can be life-saving, they are not without risks. The following aredisadvantages of blood transfusions:

Medical reactions:

- Allergic reaction: This is the most common reaction. It happens during the transfusionwhen the body reacts to plasma proteins or other substances in the donated blood.
- Fever reaction: The person gets a sudden fever during or within 24 hours of thetransfusion. Headache, nausea, chills, or a general feeling of discomfort may come withthe fever.
- Haemolytic reactions: In very rare cases, the patient's blood destroys the donor red bloodcells. This is called haemolysis. This can be severe and may result in bleeding and inkidney failure.

Diseases:If proper screening of the donated blood is not observed, it can causetransmission of diseases from the donor to the recipient. Examples of such transmissiblediseases are HIV virus, hepatitis, and other infections.

Patients who are given too much blood can develop high blood pressure, a concern forpeople who have heart disease.

Precautions to be Taken During Blood Transfusion

Outline precautions to be taken during blood transfusion

Blood transfusion precautions

Certain precautions and guidelines must be adhered to in blood transfusion to ensure the safetyof the procedure. The precautions may include the following:

- Donated blood must carefully and thoroughly be screened for any infectious diseasesbefore being transfused to the recipient. The blood should be screened for diseases likehepatitis B, HIV virus, and all sexually transmitted diseases (STDs).

- The donated blood must be matched with the recipient's blood type, as incompatibleblood types can cause a serious adverse reaction (transfusion reaction). Blood isintroduced slowly by gravity flow directly into the veins (intravenous infusion) so thatmedical personnel can observe the patient for signs of adverse reactions.

- During blood transfusion, vital signs such as body temperature, heart rate, and bloodpressure are carefully monitored.

- Some patients may get a sudden fever during or within 24 hours of the transfusion, whichmay be relieved with pain-relieving drugs such as panadol, diclofenac or paracetamol.This fever is a common reaction to the white blood cells present in donated blood.

Blood Circulation

Blood Circulation in Humans

Describe blood circulation in humans

Blood circulation is the flow of blood from the heart to all body parts and back to the heart.Blood circulation or circulatory system, also called cardiovascular system, is one of three mainsystems in human body which consist of organs and tissues.

The cardiovascular systems of humans are closed, so the blood never leaves the network of bloodvessels. But oxygen and nutrients diffuse across blood vessel layers and enter interstitial fluid,which carries it to the target cells and carbon dioxide and wastes in the opposite direction.

The human blood circulation consists of two circulations namely the pulmonary circulation andsystemic circulation.

Pulmonary circulation

Pulmonary circulation is the movement of blood from the heart, to the lungs, and back to theheart again. This is just one phase of the overall circulatory system. In this type of circulation,the blood flows from the right ventricle to the lungs and from the lungs to the left auricle. In thepulmonary circulation, the blood circulates to and from the lungs, to release the carbon dioxideand pick up new oxygen.

In the pulmonary circulation, blood from all body parts (except the lungs) enters the right auriclethrough vena cava. From the right auricle the blood descends into the right ventricle through thetricuspid valve. When the ventricle contracts, the blood is pushed into the pulmonary artery thatbranches into two main parts: one going to the left lung, and another to the right lung. The fresh,oxygenated blood returns to the left auricle of the heart through the pulmonary vein.

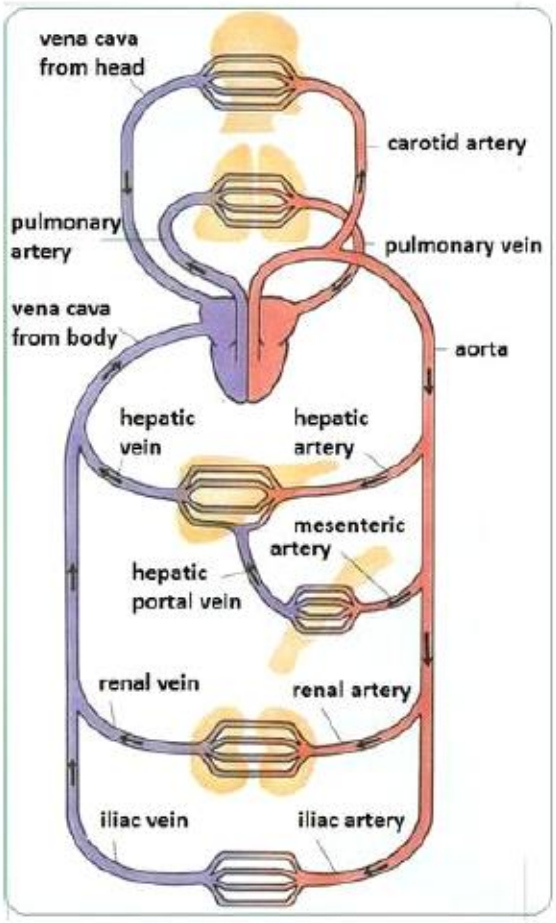
Systemic circulation

Systemic circulation is the flow of blood between the heart and the body parts. In this particularcirculation, the blood flows from the left ventricle to different parts of the body and from22different parts of the body to the right auricle. The systemic circulation supplies nourishment toall of the tissues located throughout your body, with the exception of the heart and lungs becausethey have their own systems. Systemic circulation is a major part of the overall circulatorysystem. In this circulation, the blood circulates into the body’s systems, bringing oxygen to all itsorgans, structures and tissues and collecting carbon dioxide waste.

The systemic cycle begins when the oxygenated blood coming from the lungs enters the leftauricle. As the chamber fills, it presses open the bicuspid valve and the blood flows down intothe left ventricle. When the ventricles contract during a heartbeat, the blood on the left side isforced into the aorta. This largest artery of the body is an inch wide. The blood leaving the aortabrings oxygen to all the body’s cells through the network of ever smaller arteries and capillaries.The used blood from the body returns to the heart through the network of veins. All of the bloodfrom the body is eventually collected into the two largest veins: the

superior vena cava, whichreceives blood from the upper body, and the inferior vena cava, which receives blood from thelower body region. Both venae cavae empty the blood into the right auricle of the heart.

The process by which blood passes through the heart twice before it returns to the other parts ofthe body is called double circulation.



Human blood circulation

The Importance of Blood Circulation in Humans

Explain the importance of blood circulation in humans

Importance of blood circulation

Blood circulation is essential for a healthy body. Blood circulation is important because itfacilitates the following processes to take place in the body:

- Every cell in the body needs to received oxygen and nutrients. Blood rich in oxygen is sent tothe body organs, tissues and cells to nourish them through blood circulation.
- It enables transportation of waste products from body tissues to excretory organs so as to beremoved from the body.
- Protects the body against diseases and infections through the white blood cells.

- Facilitates blood clotting to prevent loss of blood.
- Maintains body temperature by distributing body heat evenly from the liver and spleen to allbody parts.

Disorders and Diseases of the Human Blood Circulatory System

Mention disorders and diseases of the human blood circulatory system

Additional notes on diseases and disorders of the circulatory system:

Hypertension

High blood pressure (hypertension) is defined as high pressure (tension) in the arteries, which arethe vessels that carry blood from the heart to the rest of the body.

Blood pressure readings are given as two numbers. The systolic blood pressure (the top number)equals the pressure in the arteries as the heart contracts. The diastolic pressure (the bottomnumber) is the pressure in the arteries as the heart relaxes. Normal blood pressure is below120/80; blood pressure between 120/80 and 139/89 is called "pre-hypertension," and a bloodpressure of 140/90 or above is considered high blood pressure.

Complications of high blood pressure include heart disease, kidney (renal) disease, hardening ofthe arteries (atherosclerosis or arteriosclerosis), eye damage, and stroke (brain damage).

The Causes, Symptoms and Effects and Control/Measures of the Disorders and Diseases of the Human Blood Circulatory System

Outline the causes, symptoms and effects and control/measures of the disorders and diseases of the human blood circulatory system

Causes and effects of diseases and disorders of the human vascular system

	Disease / Disorder	Description	Causes	Effects / Symptoms
1	Anaemia	A reduction inthe quantity of(oxygencarrying)haemoglob in inthe blood and/orbelow normalquantity of redblood cells.	The many possible causesinclude:1.Haemorrhagica naemia - due to lossof blood2.Iron-deficiencyanaemia - due toinsufficient iron, oftendue tdietarydeficiency.3.Haemolytic anaemiaresult from theincreased destructionof red blood cells e.g.due to toxic chemicals,autoimmunity, theaction of parasites,abnormal forms ofhaemoglobin orabnormal red bloodcells.4.Anaemia can also becaused by the impairedproduction of red bloodcells, as in leukaemia(when red blood cellproduction in the bonemarrow is suppressed).	Main symptoms are:Excessivetiredness Breathlessnesson exertion Pallor (i.e.looking pale, esp.on face andpalms) Low resistance toinfe
2	Angina	Pain afterphysical effort	Narrowed coronary arteriesbeing unable to supplyincreased blood flow requiredfor increased physicalexertion. (The arteries	Typical symptomsinclude short-termdiscomfort such as anache, pain or tightnessacross the front

			mayhave been narrowed by theaccumulation of atheromatousplaque - see atherosclerosis,below.)	of thechest when orimmediately followingexertion or othersituations in which heartrate is increased e.g. dueto panic or an argument.Other less commoneffects & symptoms arealso possible e.g. similarpain when or soon aftereating.
	Aneurysm	Balloon-likebulge or swellingin the wall of anartery	In general, causes can begenetic or due to disease, e.g.1. a degenerative disease a syphilitic infection -causing damage to themuscular coat of theblood vessel2.a congenital deficiencyin the muscular wall	Aneurysms can causethe wall of the bloodvessel to weaken. Whenan aneurysm gets biggerthe risk of ruptureincreases. That can leadto severe haemorrhage(bleeding) and othercomplications - some ofwhich may be lifethreatening.
3	Arteriosclerosis	Hardening of thearteries.(Arteriolosclerosis is thehardening ofarterioles.)Artery wallsthicken, stiffenand loseelasticity, aprogressivecondition thattypicallyworsens overtime unlessaction is taken toaddress it.*Note*: Healthyarteries areflexible andelastic.	High blood pressure (alsoknown as hypertension) iswidely cited as a cause of, orat least a contributory factorto, the development ofarteriosclerosis.To reduce risk, keep bloodpressure within a healthyrange. See also how to reducerisk of atherosclerosis (below).	Arteriosclerosis (incombination withatherosclerosis orotherwise) can reducethe flow of blood,hence the supply ofoxygen, nutrients etc.,to tissues in theaffected area.Arteriosclerosis canaffect any artery in thebody but is of greatestconcern when occurs inthe heart (coronaryarteries) or the brain.
4	Atherosclerosis (Atheroma)- a commontype ofarteriosclerosis (see above)		•Multiple fatty plaques(consisting of e.g.cholesterol andtriglyceride)accumulate on theinner walls of arteries.To reduce risk:1. Eat sensibly (seebalanced diet)2.Don't smoke3. Take appropriateregular exercise4. Maintain a healthybody weight5. Do not consumeexcessive alcohol	A chronic disease thatcan remainasymptomatic fordecades. However,blood flow is restrictedand eventuallyobstructed.Various complicationsof advancedatherosclerosis arepossible. One of themost significant risks isof an infarction due tosoft plaque

				suddenlyrupturing, causing theformation of a thrombus(blood clot) that canslow or stop blood flowleadingto death of thetissues fed by the artery.Thrombosis of acoronary artery cancause a heart attack(Myocardial infarction).The same process in anartery to the brain iscommonly calledstroke.6. CoronarythrombosisA thrombus is ablood clot.Thrombosis is acondition inwhich bloodchanges from aliquid into aCoronary thrombosis canoccur due to the accumulationof fatty deposits (plaques)inside the arteries, i.e.atherosclerosis. The hardeningof arteries (arteriosclerosis)can also contribute to reducedCan lead to a
6.	Coronarythrombosis	A thrombus is ablood clot.Thrombosis is acondition inwhich bloodchanges from aliquid into asolid state,producing a 'clot'(thrombus).Coronarythrombosis isthe condition inwhich thethrombus isformed in one ofthe 3 majorcoronary arteriesthat supply theheart.	Coronary thrombosis canoccur due to the accumulationof fatty deposits (plaques)inside the arteries, i.e.atherosclerosis. The hardeningof arteries (arteriosclerosis)can also contribute to reducedblood flow leading to coronarythrombosis.	Can lead to amyocardial infarction(heart attack).Sensations that might beindications of coronarythrombosis leading tomyocardial infarctioninclude: sudden sharppain behind thesternum (breastbone) sudden sharppain on the lefthandside of thechest, that mightspread down theleft arm pain radiatingtowards the jaw,ear, handsstomach, rightarm constrictingsensation in thethroat areadifficultybreathing sudden, severedizziness and/orfainting,experienc

				ed withpain.
7.	Haemophilia	Blood clots onlyvery slowly.	Deficiency of either oftwo blood coagulationfactors:o Factor VIII(antihaemophilic factor), oro Factor IX(Christmasfactor) Hereditary -symptoms in males;may be 'carried' byfemales who can pass itto their sons withoutbeing affectedthemselves.	The person mightexperience prolongedbleeding after any injurythat causes an openwound. In severe casesof haemophilia theremay be spontaneousbleeding into musclesand joints.Treatment: Bleeding incases of haemophilia hasbeen treated bytransfusions of plasmacontaining the missingfactor, or withconcentratedpreparations of FactorVIII or Factor IXobtained by freezingfresh plasma.
8	Haematoma	A collection oraccumulation ofblood outside theblood vessels,which may clotforming aswelling.	The different types ofhaematoma generally havedifferent causes: An intracerebralhaematoma may bedue to a head injury. A perinealhaematoma may occurdue to bleeding from avaginal tear orepisiotomy (cut) duringchildbirth.	Effects & symptomsalso depend on the typeof haematoma: An intracranialhaematomamight compressthe brain andincrease pressurewithin the skull A subduralhaematoma canbe lifethreatening
9.Haemorrhoids	Haemorrhoids(also called'piles') areswellingscontainingenlarged andswollen bloodvessels in oraround therectum and anus.	Risk factors - rather than directcauses - include: excessive body weight prolonged constipatione.g. due to insufficientdietary fibre. prolonged diarrhoea lifting heavy objectsfrequently pregnancy – which canplace increasedpressure on pelvicblood vessels, thoughhaemorrhoids oftendisappear after thebirth age (above 50 years) family history ofhaemorrhoids (geneticpredisposition)	Symptoms ofhaemorrhoids caninclude: Bleeding (brightred blood) afterpassing a stool A pile movingdown, outside ofthe anus(prolapse) a mucusdischarge afterpassing a stool itchiness aroundthe anus soreness andinflammationaround the anussensation ofbowels still beingfull and in needof emptying	

Practical Exercises to Measure Human Pulse Rate and Blood Pressure

Carry out practical exercises to measure human pulse rate and blood pressure

Activity 2

Carry out practical exercises to measure human pulse rate and blood pressure

The Lymphatics System

The Concept of Lymphatics

Explain the concept of lymphatics

The lymphatic system is a network of tissues and organs that primarily consists of lymph vessels,lymph nodes and lymph. The tonsils, adenoids, spleen and thymus are all part of the lymphaticsystem.

There are 600 to 700 lymph nodes in the human body that filter the lymph before it returns to thecirculatory system.

The spleen, which is the largest lymphatic organ, is located on the left side of the body just abovethe kidney.

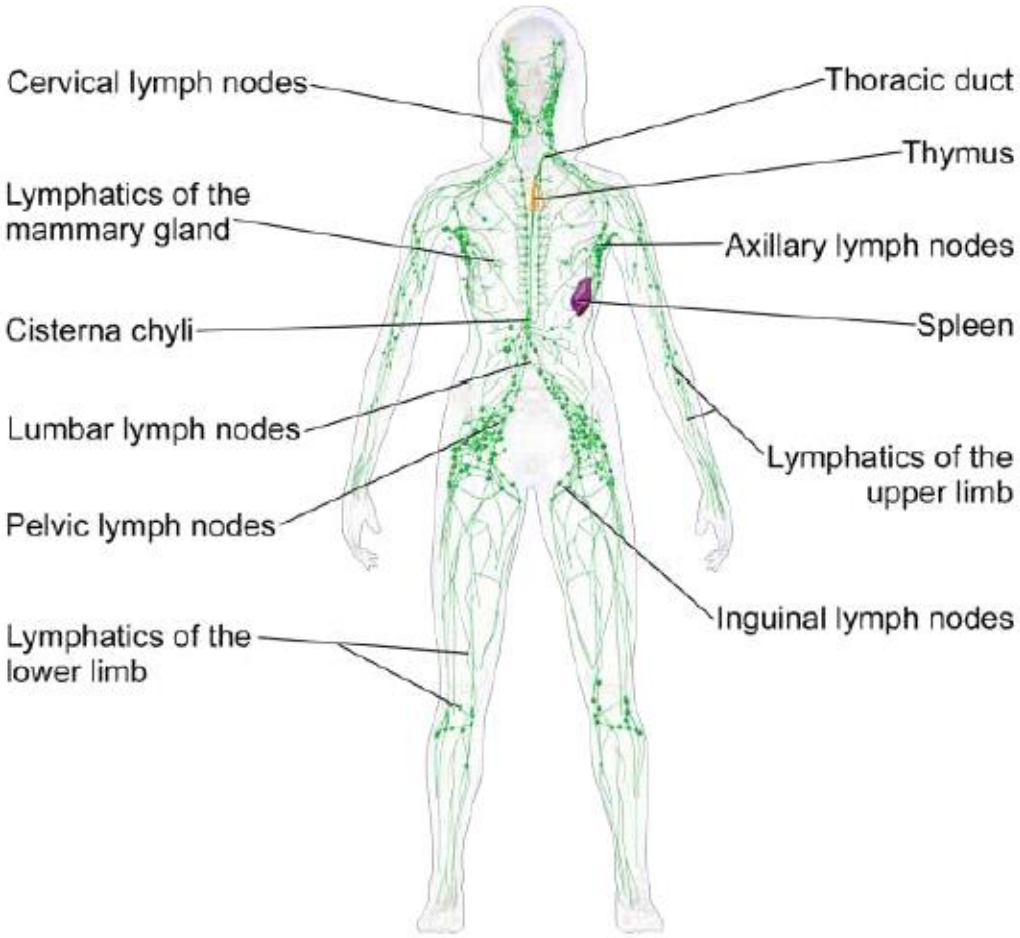
The thymus, which stores immature lymphocytes and prepares them to become active T cells, islocated in the chest just above the heart.

Tonsils are large clusters of lymphatic cells found in the pharynx.

The Components of the Human Lymphatic System

Describe the components of the human lymphatic system

The Human Lymphatic System



The Human Lymphatic System

Functions of the lymphatic system

The lymphatic system performs the following functions:

- Removes excess fluid and waste products from the interstitial spaces between the cells andreturns it into the bloodstream.
- It also functions in transporting white blood cells to and from the lymph nodes into thebones, and antigen-presenting cells (APCs), such as dendritic cells, to the lymph nodes wherean immune response is stimulated.
- Special lymph vessels (lacteals) absorb fat and fat-soluble vitamins from the small intestineand deliver these nutrients to the cells of the body where they are used by the cells.
- Protects the body against germs. Lymph glands produce lymphocytes which produceantibodies that fight against microbes. They also contain phagocytes, which eat dead whitecells and microbes in the lymph.

The Common Disorders and Diseases of the Lymphatic System

Mention the common disorders and diseases of the lymphatic system

There are several diseases and disorders that affect the lymphatic system. The two commondisorders of the lymphatic system are lymphoedema and lymphatic filariasis (elephantiasis).

Lymphoedema

Lymphoedema is a chronic swelling of the limbs caused by the accumulation of lymph fluid thatoccurs if the lymphatic system is damaged or not functioning properly. While the limbs aretypically involved, the face, neck and abdomen may also be affected.

The lymphatic system consists of a series of lymph nodes (glands) connected by a network ofvessels, similar to blood vessels. Fluid surrounding body tissues usually drains into nearbylymph vessels so it can be transported back into the blood. However, if the lymph vessels areblocked, the fluid can't be reabsorbed and will build up in the tissue.

Symptoms

Swelling of the limbs (arms or legs) is the common symptom of this disorder.

Effects

Unlike oedema, lymphoedema is a long-term condition that can cause discomfort, pain and a lossof mobility.

Elephantiasis

Lymphatic filariasis, commonly known as elephantiasis, is a parasitic infection that causesextreme swelling in the arms and legs. It is a painful and profoundly disfiguring disease. Whilethe infection is usually acquired in childhood, its visible manifestations occur later in life,causing temporary or permanent disability.

The disease is caused by the filarial worm, which is transmitted form human to human via thefemale mosquito when it takes a blood meal. The parasite grows into an adult worm that lives inthe lymphatic system of humans.

Symptoms

Elephantiasis is typically characterized by a thickening of the skin and subcutaneous tissue thatgives rise to the grossly enlarged and swollen limbs that earn the condition its name. In additionto the characteristic swelling, people with this disorder sometimes have bouts of fever andheadache.

Cause

The disease is caused by thread-like nematode worms, known as filariae. The larvae(microfilariae) of the parasite are taken up by the mosquito when it feeds. When the larvae reachthe third stage of development, they are introduced to a new host, who then develops theinfection.

Effects

- Filarial infection can cause lymphoedema of the limbs, genital disease (hydrocele, chylocele,and swelling of the scrotum and penis). It also causes recurrent acute attacks, which areextremely painful and are accompanied by fever.
- The infected people may have lymphatic and kidney damages.
- Sometimes the swollen limbs become infected.
- The infected person is disabled and cannot work to earn his/her living.

Causes, Symptoms, Effects and Prevention of Disorders and Diseases of the Human Lymphatic System

Explain causes, symptoms, effects and prevention of disorders and diseases of the human lymphatic system

Prevention and control

Effective treatment and preventive efforts would include:

- spraying insecticides to kill mosquitoes;
- giving antibiotics to prevent or control infection;
- giving medications to kill microfilariae circulating in the blood;
- applying pressure bandages to reduce swelling; and
- surgically removing infected tissue.

Transport of Material in Plants in Plants, the Vascular System

The Concept of Vascular System

Explain the concept of vascular system

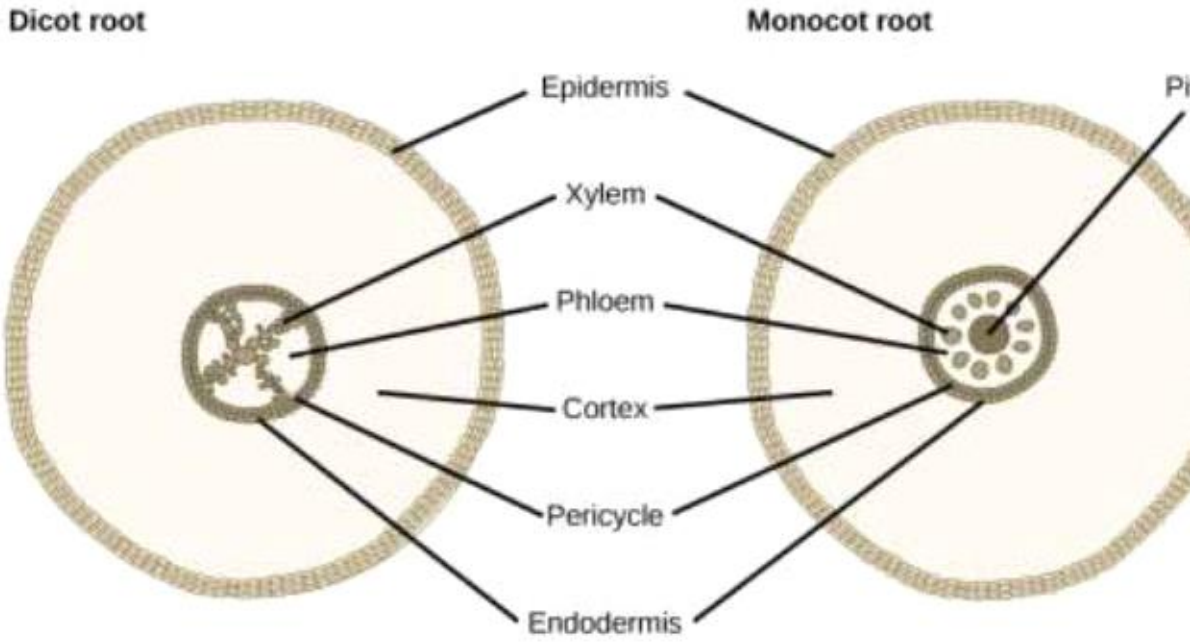
TRANSPORTATION IN PLANTS

Materials to be transported across the plant body are water, minerals and food. Apart from thesenutrients, substances like the hormones also have to be transported. The transport of materialstakes place through a specialized tissue called the vascular tissue. The tissue is made up of xylemand phloem tissues. Xylem tissue transports water and mineral salts from the soil to all parts ofthe plant. Phloem tissue transports manufactured food from the sites of photosynthesis to allparts of the plant.

In between the xylem and phloem is the vascular cambium. The cells of cambium tissue divideto form a new xylem and phloem. As these cells divide and multiply, the plant increases its girth.The xylem grows inward from the vascular cambium while the phloem grows outward from thevascular cambium.

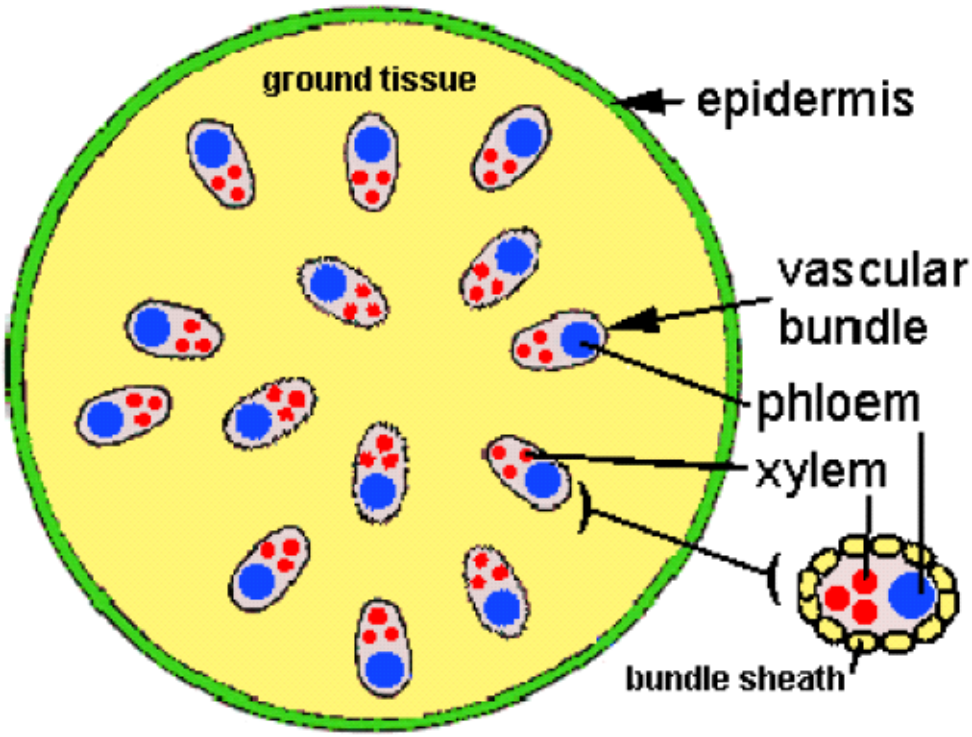
The arrangement of the vascular bundles in the stem, root and leaf of dicot and mocot plantsdiffers in a number of ways. The diagrams below show the manner they are arranged in therespective organs.

The vascular tissue in the root is arranged in the inner portion of the root, which is called thevascular cylinder. A layer of cells known as the endodermis separates the vascular tissue fromthe ground tissue in the outer portion of the root. The endodermis is exclusive to roots, andserves as a checkpoint for materials entering the root's vascular system. A waxy substance calledsuberin is present on the walls of the endodermal cells. This waxy region, known as theCasparian strip, forces water and solutes to cross the plasma membranes of endodermal cellsinstead of slipping between the cells. This ensures that only materials required by the root passthrough the endodermis, while toxic substances and pathogens are generally excluded. Theoutermost cell layer of the root's vascular tissue is the pericycle, an area that can give rise tolateral roots. In dicot roots, the xylem and phloem are arranged alternately in an X shape,whereas in monocot roots, the vascular tissue is arranged in a ring around the pith.In



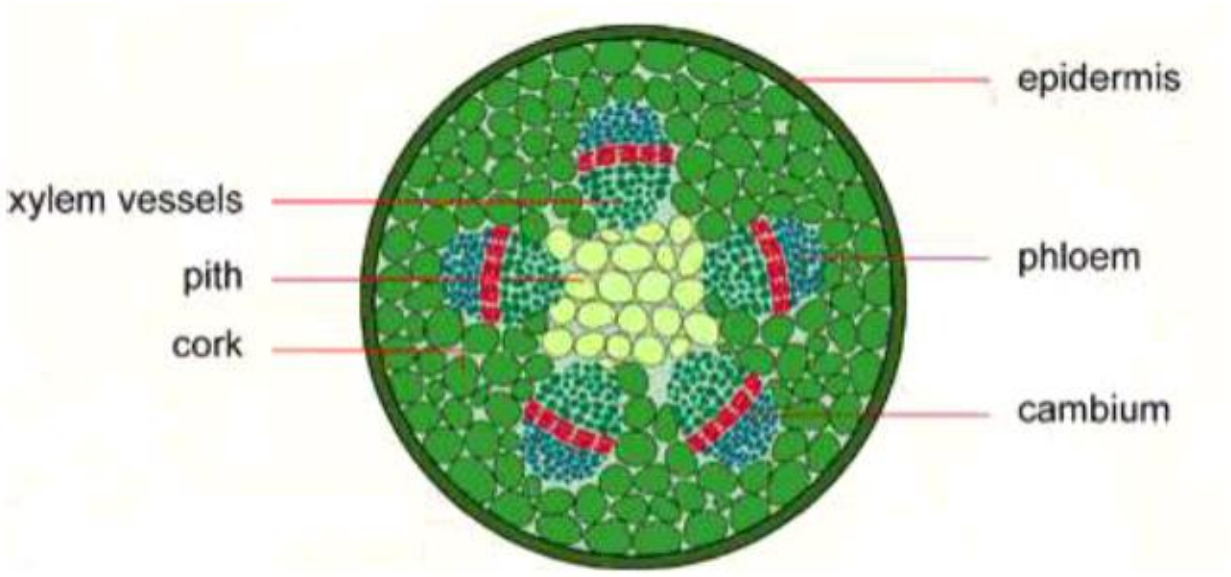
In typical dicots (left), the vascular tissue forms an X shape in the centre o monocots (right), the phloem cells and the larger xylem cells form a charac the central pith.

In monocot stems, the vascular bundles are scattered throughout the stem as indicated in thefigure below.



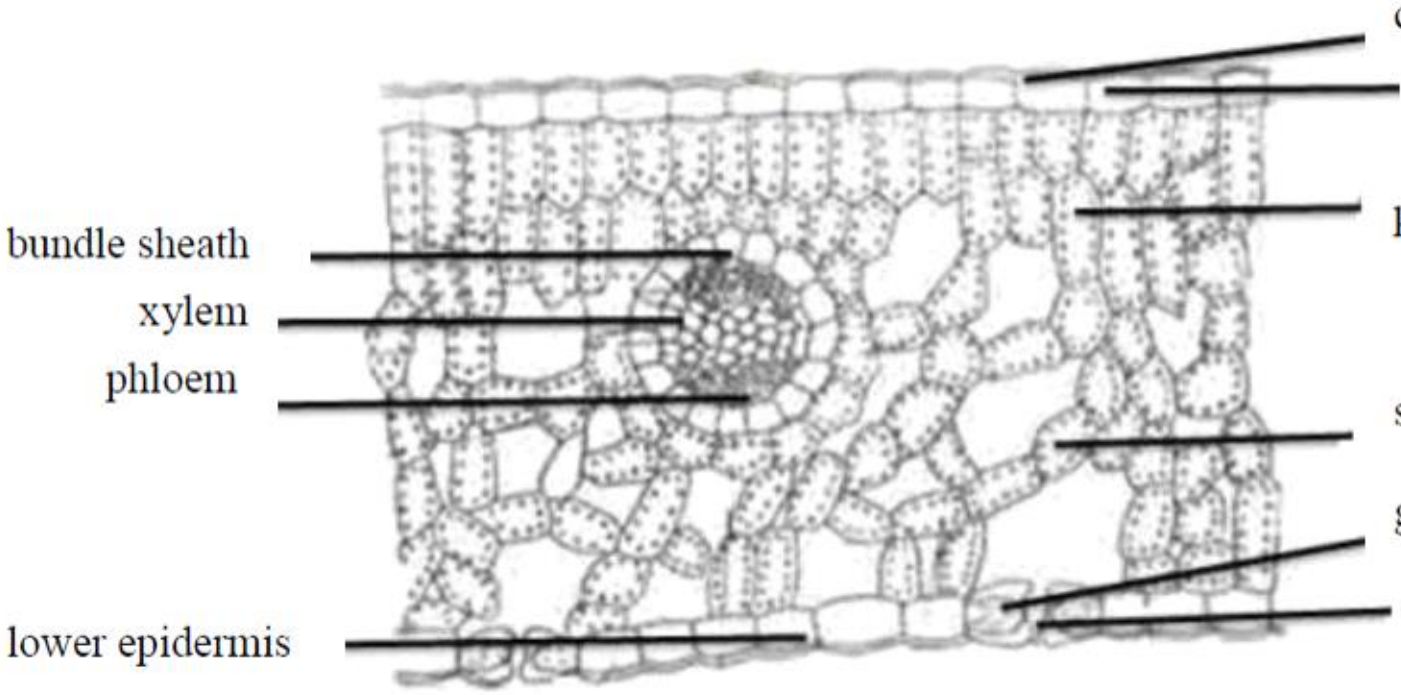
Arrangement of vascular bundles in a monocot stem

In dicot stems, the vascular bundles are arranged in a ring around the pith.

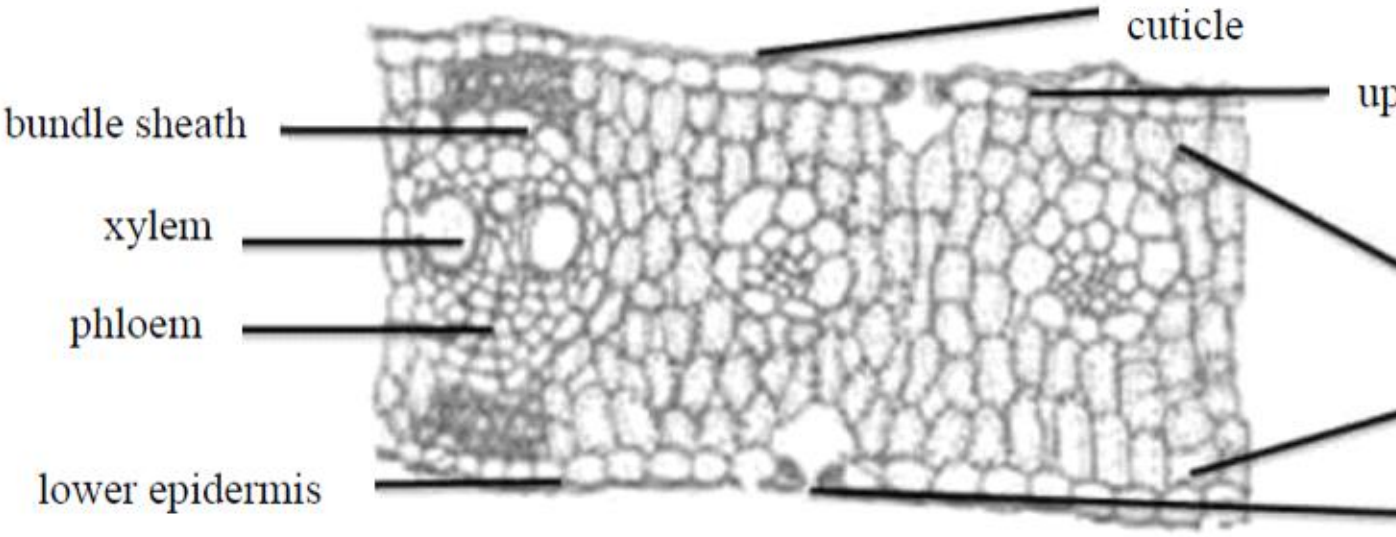


Arrangement of vascular bundles in a dicot stem

The arrangement of vascular bundles in the leaves of dicots and monocots differs. The diagramsbelow show the differences in arrangement of the bundles. Can you notice the differences? Thexylem and phloem vessels are enclosed in a bundle sheath.



Internal structure of a dicot leaf



Internal structure of monocot leaf

Components of Vascular System

Describe components of vascular system

The vascular (transport) system in plants is made of vascular bundles. The vascular bundles aremade of xylem and phloem which are separated by a wall called vascular cambium, often simplyshortened as cambium (see diagrams discussed in the previous section).

Xylem

It is the vascular tissue that transports water across the plant body. Xylem is made up of fourdifferent types of cells. They are tracheids, vessels, xylem fibres and xylem parenchyma. Ofthese only tracheids and vessels are involved in the transport of water and minerals.

Tracheids

Tracheids are elongated dead cells that have sloping end walls. The cavity is empty as the cellsare dead. The walls are thickened with a material called lignin to prevent them from collapsingas water is transported up the plant. These thickenings are in different patterns. The cells arearranged end to end.

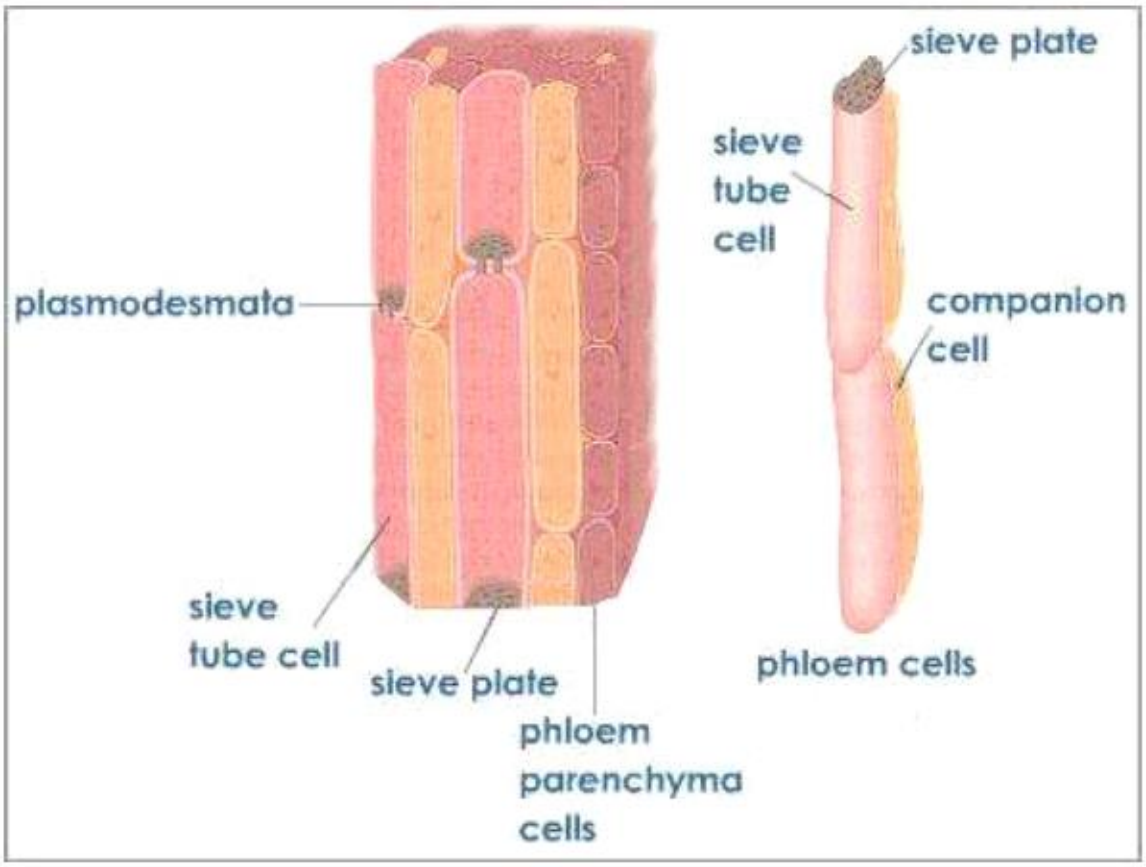
Vessels

Vessels are also dead cells that have variously patterned thickened walls. These thickenings aredue to lignin. The vessels are arranged end to end. The end walls of the vessels are eitherpartially or fully dissolved. This results in the formation of long tubes that carry water.The xylem vessels and tracheids together form long tubes that have a narrow diameter. Thus theyfunction as capillaries (narrow tubes) to transport water.

vessels

Phloem

It is the vascular tissue that transports organic substances like sucrose across the plant body. It ismade up of four types of cells namely sieve tubes, companion cells, phloem fibres and phloemparenchyma. Except for phloem fibres, all the other three types of cells are living. Sieve tubesand companion cells are mainly involved in the transport of the materials.



Phloem

Sieve tubes

They are tubes formed by cells that are joined end to end. The end walls of these cells haveperforations. The mature sieve tube cells are enucleated. The cytoplasm of the sieve tube cells iscontinuous through the perforations of the end walls. This helps in the transport of materials.

Companion cells

They are smaller cells associated with the sieve tubes. They have dense cytoplasm and elongatednucleus. They are in contact with the sieve tube cell through pores in the wall.

The Function of Vascular System in Plants

Explain the function of vascular system in plants

The vascular system is mainly responsible for transportation of materials within a plant body.The xylem and phloem tissues are specialized to perform different functions in a plant body.

Functions ofphloem

The xylem functions in transport (translocation) of manufactured food from the leaves to thecells of the plant, storage organs, fruits, etc.

Functions ofxylem

- Provides support for woody plants.
- Transports water and solutes from roots to all plant parts.

Absorption and Movement of Water and Mineral Salts in Plants

The Functions of Root Hairs in Absorption and Movement of Water and Mineral Salts in Plants

Explain the functions of root hairs in absorption and movement of water and mineral salts in plants

Water and mineral uptake by roots

Plants absorb water from the soil through the root and transport it to the stem, leaves andflowers. Roots have root hairs that are unicellular, thin-walled outgrowths of the epiblema (skinof the root).

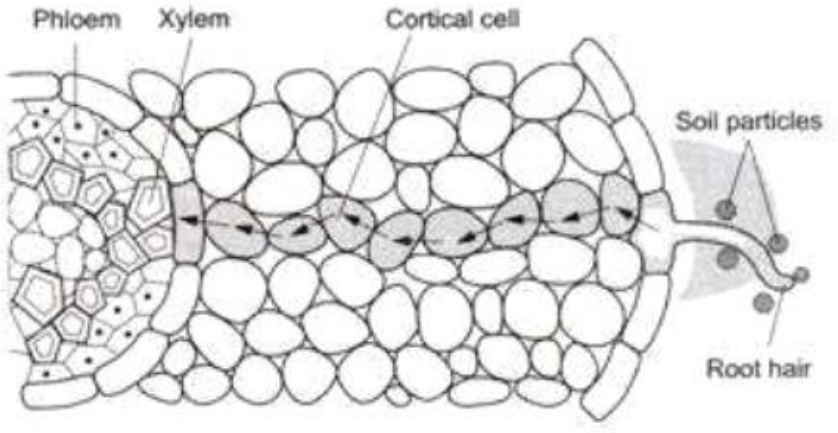
The root hairs are in close contact with the thin film of water surrounding the soil particles.There are mineral salts such as nitrates, chlorides, sulphates, phosphates, etc., dissolved in thiswater.

Water is absorbed by osmosis, while the minerals are absorbed as ions by active transport(transport against the law of diffusion, by spending cellular energy). The cell membrane hastransport proteins that allow the ions to cross the membrane. The ions then move upward throughthe xylem, to the leaves and other aerial parts of the plant.

The cell wall of each root hair is permeable to water and minerals, but its cell membrane and themembrane around the vacuole are semi permeable membranes. The root hair cells take upmineral ions by active transport.

This creates a concentration difference of these ions between the root and the soil. Now, the soilsolution has higher water content than the cell sap of the root hair. Hence, water from the soildiffuses into the root hair. The root hair cells now become turgid, while the adjacent cells of thecortex have lower water content.

This results in the diffusion of water from the root hairs into the cortical cells (see figure below).After passing through the cortical cells by osmosis, the water reaches the endodermis (tissueseparating the cortex from the vascular tissues). The endodermis forces water into the xylemtubes through passage cells.



Absorption of water through root hair

The pressure with which water is pushed into the xylem tubes of the root is called root pressure.The water moving upwards forms a column, which is maintained up to a certain height due toroot pressure.

The Movement of Water and Dissolved Mineral Salts in Plants

Outline the movement of water and dissolved mineral salts in plants

Upward movement of water within the plant

There are several processes that enable the water to move up a plant. These processes includeroot pressure, transpiration pull, cohesion, adhesion and capillarity.

Root pressure

As long as the soil is damp, there will be water taken in by the root hairs. As more water is takenin, the water that is already in the xylem vessel will be pushed up the plant. This is called rootpush or root pressure and it helps to push water up to the leaves.

Root pressure is capable, under ideal atmospheric conditions, of pushing water one or two feetabove the ground. Since root pressure is not strong enough to move water up very high, anotherprocess called transpiration pull is needed to enable the water to continue moving up the plant.

Experiments to Demonstrate Transpiration pull, Root Pressure and Capillarity

Conduct experiments to demonstrate transpiration pull, root pressure and capillarity

Transpiration pull

Transpiration is the loss of water through the leaves and other parts of the plant. Mosttranspiration occurs through openings, called stomata, on the underside of the leaves. Astranspiration occurs, water is lost. This water is replaced by water in the xylem vessels. Thiscauses an upward pull (transpiration pull or transpiration stream) on the water in the vessels.Thus, water is pulled up through the plant, and more enters by the roots to replace it.

Cohesion

Cohesion is the force of attraction between similar molecules. Transpiration pull is possiblebecause water molecules cling to each other by cohesion. When water molecules cling to eachother as they move up the stem and into the leaves, they pull up more water molecules up theplant. This process, however, is facilitated by transpiration pull since the water molecules lostthrough transpiration is being replaced by more water molecules absorbed by the roots.

Adhesion

Adhesion is the force of attraction between different molecules. As water molecules are stucktogether by cohesion, the entire column of water in the xylem adheres to the sides of the xylem.It is said that the water in under tension as the column moves up the xylem. At the same time, thexylem tube narrows because of the tension.

Cohesion and adhesion forces maintain a continuous column of water in the xylem vessels fromthe roots to the leaves of plants.

Capillarity

Capillarity is the tendency of water to rise through narrow tubes. The lumen of xylem tracheidsand vessels is very narrow and this enables water to rise through it by capillarity. Capillarity isassisted by adhesion and cohesion forces.

The Concept of Transpiration

Explain the concept of transpiration

Transpiration is the evaporation of water from plants. It occurs chiefly through the leaves whiletheir stomata are open for the passage of carbon dioxide and oxygen during photosynthesis.

Transpiration also occurs through the cuticle and lenticels. Lenticels are pores in the stems ofwoody plants that allow gaseous exchange between the atmosphere and the internal tissues.

The Significance of Transpiration in Plants

Outline the significance of transpiration in plants

Transpiration is of immense importance in plant life as it is of great benefit to the plant. Thefollowing are the reasons why transpiration is important in plants.

Cooling of the plant

The leaves absorb the radiant energy. Some of the light energy is utilized in photosynthesis. Therest is converted into heat energy resulting in an increase in leaf temperature. However, rapidloss of water in the form of water vapour from the aerial parts of the plant through transpirationbrings down their temperature. Transpiration thus provides a significant cooling effect whichkeeps the plant from being overheated.

Mineral transport

Mineral salts remain dissolved in the soil water and are absorbed by the roots. Minerals that arcabsorbed and accumulated in the xylem duct of the root move up and are distributed in the plantby the transpiration stream.

Water movement

The absorbed water is transported from roots to leaves through the xylem vessels. This is greatlyinfluenced by transpiration pull. Water loss due to transpiration results in the development of lowwater potential in the leaf tissues. Thus, water moves from the xylem vessels to the leaf cells.

Development of mechanical tissues

Greater amount of transpiration helps in the development of mechanical tissues in plants. Theplants become healthier and more compact, the cell walls become thick and cutinized and theplants are able to resist the attack of fungi and bacteria.

Maintenance of turgidity

Transpiration maintains an optimum degree of turgidity in cells. Under favourable conditions,plants absorb excess amount of water, which is given off by transpiration to maintain theoptimum turgidity for better growth.

Increase of taste of fruits

The solutes inside the cell become more concentrated when transpiration is rapid. Consequently,the concentration of sugar solution in the cells of fruits increases and fruits taste sweeter.

Wilting

When the rate of evaporation is higher than that of absorption of water from the soil, as it occursduring drought conditions, the plant wilts. Wilting is beneficial when a plant cannot obtainenough water to replace that lost by the plant through transpiration because it causes the closureof the stomata (singular: stoma). Thus, the rate of evaporation is greatly reduced.

Transpiration as a necessary evil

Transpiration is a necessary evil because of the following facts:-

- A large amount of absorbed water is lost during transpiration which is harmful to plants.
- Unnecessary wastage of energy takes place during the process of water absorption which islost due to transpiration.
- When the rate of transpiration is high in plants growing in soil deficient in water, an internalwater deficit develops in plants which may affect metabolic process.
- Many xerophytes undergo structural modifications and adaptations to check transpiration.

Considering both the beneficial and harmful effects of transpiration, it may be concluded that itis definitely advantageous in spite of its harmful consequences.

Factors Affecting the Rate of Transpiration in Plants

Outline factors affecting the rate of transpiration in plants

The rate of transpiration can be affected by both plant features and environmental factors.

Plant factors

These plant parameters help plants control rates of transpiration by serving as forms of resistanceto water movement out of the plant. They include the following:-

Root system

Plants with extensive root systems absorb a great amount of water and therefore much water ismoved up the plant. Thus, plants with extensive root systems have higher rates of transpirationthan those with few roots.

Size of leaves

A plant with broad leaves tend to lose more water than that with small leaves. This is because thebroad leaves have large surface areas over which transpiration takes place.

Leaf structure

The structure of a leaf has a great influence on the rate of transpiration. The following areanatomical structures of a leaf that affect the rate of transpiration:-

Number of stomata

Stomata are pores in the leaf that allow gaseous exchange to take place, and water vapour toleave the plant. Special cells called guard cells control each pore's opening or closing. Someplants have many stomata while others have a few stomata. The more the stomata, the higher therate of transpiration and vice versa.

Position of stomata

Plants with few stomata on the upper surface of the leaf experiences a little transpirationcompared to those with many stomata on the lower leaf surface. This is because the uppersurface is highly stricken by direct sunlight hence increasing the rate of transpiration.

Epidermal hairs

Epidermal hair on the leaf traps a thin layer of still air close to the leaf surface. For the water lostfrom the leaf to get into the atmosphere, it has to cross this resistant layer of air. The layer thuschecks excessive loss of water from the leaf. Likewise, the water vapour from the leaf is alsotrapped by the epidermal hairs. This prevents further loss of water vapour from the leaves andhence slows down the rate of transpiration.

Size of stomatal air spaces

Large air spaces between the cells of the spongy mesophyll and stomata, called substomatal airspaces, increase the rate of transpiration. Small substomatal air spaces reduce the rate oftranspiration.

Cuticle

The cuticle is the waxy layer present on all above-ground tissue of a plant and serves as a barrierto water movement out of a leaf. Because the cuticle is made of wax, it is very hydrophobic or'water-repelling'. Therefore, water does not move through it very easily. The thicker the cuticlelayer on a leaf surface, the slower the transpiration rate. Cuticle thickness varies widely amongplant species. In general, plants from hot, dry climates have thicker cuticles than plants fromcool, moist climates. In addition, leaves that develop under direct sunlight will have muchthicker cuticles than leaves that develop under shade conditions.

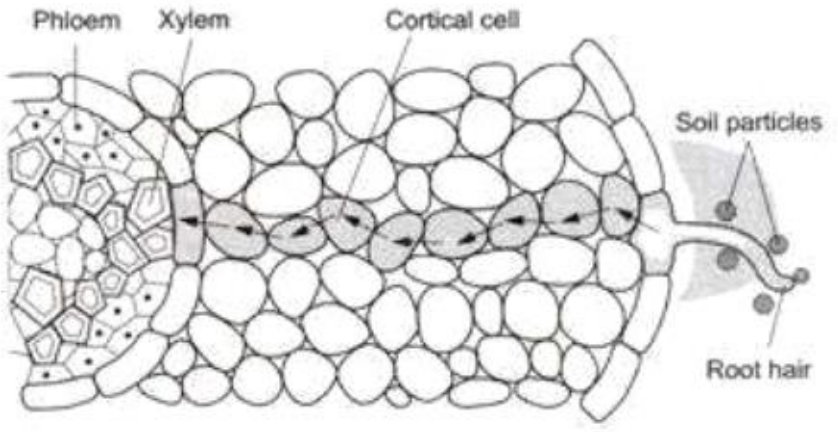
Environmental factors

Some environmental conditions create the driving force for movement of water out of the plant.Others alter the plant's ability to control water loss.

Light

Plants transpire more rapidly in the light than in the dark. This is largely because light stimulatesthe opening of the stomata (mechanism). Light also speeds up transpiration by warming the leaf.

Photosynthesis occurs in the presence of light. A higher light intensity increases the rate ofphotosynthesis in the guard cells. As the guard cells absorb water from the soil forphotosynthesis, they become turgid and hence the stomata are opened, and hence a higher rate oftranspiration.



Absorption of water through root hair

Temperature

Plants transpire more rapidly at higher temperatures because water evaporates more rapidly asthe temperature rises. At 30°C, a leaf may transpire three times as fast as it does at 20°C.

Relative humidity

Relative humidity is the amount of water vapour in the air compared to the amount of watervapour that air could hold at a given temperature. When the air is less moist, the relativehumidity is low, and thus the rate of transpiration is greater. When relative humidity is high, theatmosphere contains more moisture, reducing the rate of transpiration. Therefore, transpirationincreases with the decrease in relative humidity.

The rate of diffusion of any substance increases as the difference in concentration of thesubstances in the two regions increases. When the surrounding air is less humidity, diffusion ofwater out of the leaf goes on more rapidly.

Wind

The wind removes water vapour and thus increases the rate of transpiration. High winds lead tostomatal closure to stop the rapid water loss and hence bring a drop in rate of transpiration.Moderate winds may reduce transpiration by lowering the temperature of the leaf.

When there is no breeze, the air surrounding a leaf becomes increasingly humid thus reducingthe rate of transpiration. When a breeze is present, the humid air is carried away and replaced bydrier air, thus increasing the rate of transpiration.

Soil water

The source of water for transpiration out of the plant comes from the soil. Plants with adequatesoil moisture will normally transpire at high rates because the soil provides the water to movethrough the plant. Plants cannot continue to transpire without wilting if the soil is very drybecause the water in the xylem that moves out through the leaves is not being replaced by the soil water. Thus, the rate of transpiration will increase when there is adequate amount of water inthe soil and will decrease when the soil contains little moisture.

Atmospheric pressure

Transpiration is high at low atmospheric pressure and it is low at high atmospheric pressure.Plants that grow naturally at higher altitudes, where the atmospheric pressure is low, havemodified leaves to reduce the rate of transpiration.