

TOPIC 1: CLASSIFICATION OF LIVING THINGS

Kingdom Plantae, Division Coniferophyta (Conifers)

General and Distinctive Features of the Division Coniferophyta

Explain general and distinctive features of the division coniferophyta

Division Coniferophyta or the conifers belong to Kingdom Plantae. These plants are gymnosperms meaning non-flowering. They are non-flowering but seed bearing plants. They have vascular tissues. They are woody plants majority being evergreen trees. Few varieties are shrubs

What are the general and distinctive features of the Division Coniferophyta?

General characteristics

- They have secondary growth whose thickening can be observed in cross section of a stem revealing annual rings. Secondary Growth is the result of growth Lateral Meristems (Vascular Cambium & Cork Cambium).
- Most of the members of Coniferophyta live in cool climates where they form evergreen forests. They keep their leaves year-round.
- They have a large amount of internodal elongation which allows them to grow faster than the other higher plants.
- They are Xeromorphic, a characteristic that help to protect them from excessive loss of water and therefore adapt survival in extreme habitats.
- Most are large trees while a few are shrubs and other small plants.
- Most of them have hard barks which protect inner softwood.

Distinctive characteristics

- Conifers are non-flowering but seed producing plants.
- They have seeds born in cones shaped structures rather than in fruits.
- They are gymnosperms which mean naked-seed plants because they produce seeds in cones rather than inside an embryo.
- The leaves are needle-shaped and have a thick cuticle for protection and to decrease water loss.

The Structure of Pinus

Describe the structure of pinus

Pines are evergreen, coniferous resinous trees growing 3â€“80 m tall. The bark of most pines is thick and scaly. They have needle like leaves.

Pines are among the most well- known coniferous trees in the world. They thrive in temperate mountainous regions, but can also survive in tropical spots in the northern hemisphere. Pines live relatively long time than other coniferous plants. They may live between 100 and 1,000 years

- **The Stem:** The bark of most pines is thick and scaly, but some species have thin, flaking bark. The branches are produced in regular whorls appearing like a ring of branches arising from the same point.

- **Leaves:** A cross-section of pine stem has several concentric rings with distinct borders between each ring. The center of the stem is called pith. These rings are called annual rings because they grow seasonally and they help a plant to undergo secondary thickening. Generally adult pines have needle-shaped leaves which are green and photosynthetic. The leaves are in bundles or clusters. The leaves (cotyledons) on seedlings are borne in a whorl of 4–24. Juvenile leaves, which follow immediately after seedlings, have single, green leaves arranged spirally on the shoot. They also have non-photosynthetic scale leaves, similar to bud scales. They are arranged spirally like the juvenile leaves.

- **Cones:** A cone is an organ of pines that contains the reproductive structures. The woody cone is the female cone, which produces seeds. The male cones, which produce pollen, are usually herbaceous and much less conspicuous. Explain the advantages and disadvantages of the Division Coniferophyta

The Advantages and Disadvantages of the Division Coniferophyta

Explain the advantages and disadvantages of the division coniferophyta

Advantages of Conifers

- Conifers are very important for our economy because of their softwood, which is used for paper and timber, as well as cedar which many people use for their homes because of its beauty and resistance to insects. They have a large economic use as softwood in furniture. In temperate and tropical regions, they are fast-growing softwoods that will allow harvesting in close succession.
- Decoration and ceremony Many pine species make attractive ornamentals. They are planted in parks and larger gardens. Some varieties are suitable for smaller spaces. Pines are also commercially grown and harvested for Christmas trees.
- As medicine, Pines and cypress are rich in vitamin; their branches cones and oils can be extracted and used as nutrient supplements.
- Due to its soft texture conifers are widely used to manufacture Play wood.
- As other higher plants conifers are source of heat energy, used as firewood and charcoal.
- Thick forests of conifers form green belts that modify the climate.
- Conifers form a large arena for Biological research Ecological studies.
- Food uses: Some species have large seeds, called pine nuts that are harvested and sold for cooking and baking. The soft, moist, white inner bark (cambium) found clinging to the woody outer bark is edible and very high in vitamins A and C. It can be eaten raw in slices as a snack or dried and ground up into a powder for use as bread flour. Also White Pines are rich in Vitamin A and C; flour can be made from the Pine tree's inner bark. By chewing bark of pine you can eliminate bad breath. Pines can reduce the pain of skin infections by applying warm pine sap.

Division Angiospermophyta (Flowering Plants)

General and Distinctive Features of the Division Angiospermophyta

Explain general and distinctive features of the division angiospermophyta

Angiosperms are flowering plants under kingdom Plantae and division Angiospermophyta. This group of plants is sometimes called Magnoliophyta. Angiosperms are the most abundant land plants.

Like gymnosperms, angiosperms are seed-producing plants but they are distinguished from gymnosperms by their characteristic of producing flowers. These plants produce fruits that contain seeds instead of cones like it is in gymnosperms. The term angiosperm means a plant that produces seeds within fruits.

Angiosperms life cycle: The ovary has ovules that contain mega-sporocyte. Mega-sporophyte has four haploid megaspores; three megaspores disintegrate and the remaining one divides by mitotic divisions to produce eight nuclei in an embryo sac. The three nuclei are organized into the egg whereby one cell is the egg cell; the two others are egg helpers. Although these three cells look are similar, only the egg cell continues to develop to an embryo sac. The embryo sac at this stage is the female gametophyte or mega-gametophyte.

Pollination and fertilization: The pollen from the anther is transported to the stigma of a flower. In the stigma pollen tube emerges. The mature male gametophyte therefore is a germinated pollen grain, pollen tube and three sperm nuclei. The pollen tube grows downward toward the ovary through the style and penetrates the embryo sac. After discharging its contents one of the sperm nuclei fuses with the egg nucleus and form a zygote, the other sperm fuses with the polar cell of the ovary, forming the endosperm nucleus. This is what is known as double fertilization. Fertilization in angiosperms begins very soon after pollination.

Note: In gymnosperms, fertilization can occur up to a year after pollination.

Double fertilization: Double fertilization is a distinctive characteristic of the angiosperms and results in a polyploid endosperm tissue. In double fertilization each ovule receives a pollen tube that delivers two sperm cells to the embryo sac. One sperm fertilizes the egg cell to form the diploid zygote, while the other sperm fertilizes the central polar cell to form triploid endosperm. After double fertilization, the ovule develops into a seed and the ovary into a fruit.

General features of angiosperms

They bear flowers which are reproductive structures. Fertilization takes place between male and female flower by pollination that includes insect pollination, wind pollination and animal pollination.

- Angiosperms have underground root as well as aerial shoot system.
- Angiosperms have very well-developed conducting tissues. These tissues include the xylem and the phloem arranged in form of vascular bundles.
- They have root that helps absorption of water and minerals from the soil.
- Most of them have leaves that carry out photosynthesis, so they are autotrophs.
- They have alternation of generation, Sporophyte generation alternate with gametophyte generation. The sporophyte is the dominant, diploid stage and is the more visible form of the plant, with the leaves, stems, roots, and flowers. Gametophyte generation is reduced and it is found within the ovary and anther.

Distinctive features of angiosperms

- The most obvious distinguishing feature of angiosperms is the possession of reproductive structures called flowers.
- They bear seeds enclosed in a carpel (the fruit). The seeds are the fertilized ovules.
- They have endosperm produced after fertilization and before the zygote undergo its first division. Endosperm has nourishing function, it nourishes the embryo.
- They have double fertilization whereby each ovule receives a pollen tube that delivers two sperm cells to the embryo sac. One sperm fertilizes the egg cell to form the diploid zygote, while the other sperm fertilizes the central polar cell to form triploid endosperm.

- Their haploid gametophyte is confined inside the ovary (female) or anther (male) of the flower, unlike the free- living gametophytes of most other plants.
- They have conducting tissues phloem and xylem. Unlike gymnosperms which have xylem tracheid angiosperms has xylem vessels.

The Classes of the Division Angiospermophyta and their Distinctive Features

Outline the classes of the division angiospermophyta and their distinctive features

Division Angiosperms is divided into two classes which are Monocotyledonae and Dicotyledonae.

These two classes are distinguished from each other by their morphology and anatomy.

Features of Class Monocotyledonae

- Monocots have one cotyledon (or one seed leaf)
- Monocots have broad leaves with parallel venation.
- Monocots have fibrous root systems.
- The floral parts in monocots occur in threes, or multiple of three. PMonocots lack cambium secondary growth.
- Monocots have scattered vascular bundles in their stems. Typical example of monocot is a maize plant.

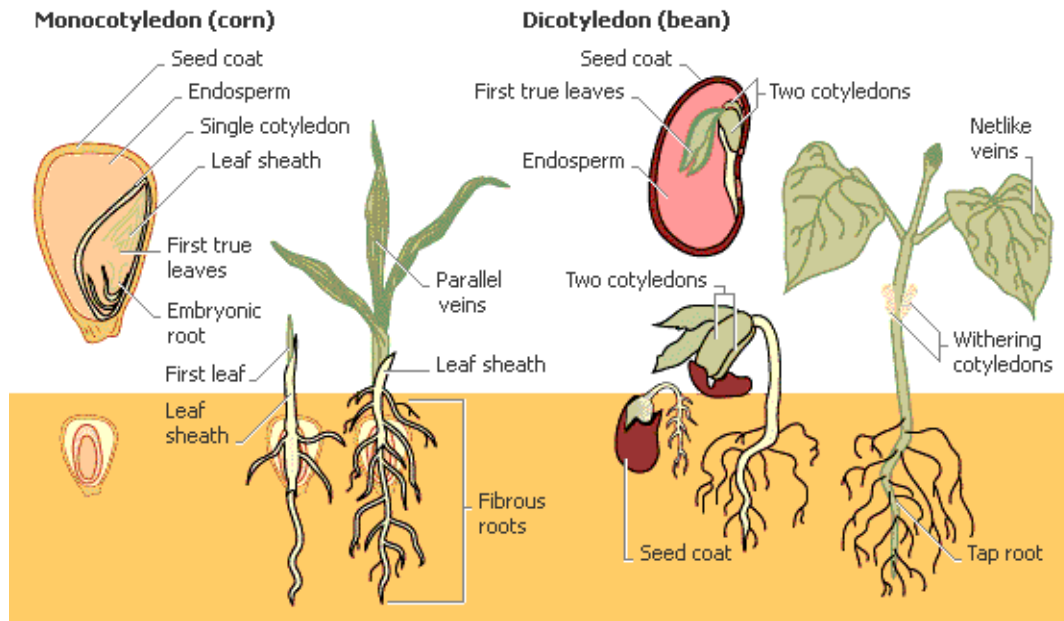
Features of Class Dicotyledonae

- Dicots have two cotyledons (or two seed leaves).
- Dicots have net venation.
- Dicots have tap root system
- Dicots floral parts occur in fours and fives and multiple of four or five.
- Dicots have cambium secondary growth.
- Dicots have vascular bundles arranged into a ring. A Typical example of dicot is a bean plant.

The Structure of Representative Plants Under Each Class (Monocotyledonae and Dicotyledonae)

Describe the structure of representative plants under each class (Monocotyledonae and Dicotyledonae)

Structure of Monocotyledonae and Dicotyledonae plants



Advantages and Disadvantages of Division Angiospermophyta

Explain advantages and disadvantages of division Angiospermophyta

Advantages of Angiosperms

- **Agriculture.** Agriculture depends on angiosperms. Angiosperms provide human food. Example; plants belonging to grass family (grains), are the most important food stocks. They include rice, maize, wheat, barley, millet, sugar cane and sorghum. Legume provides beans, several varieties of nuts and soy. Also of potatoes, tomatoes, and peppers, pumpkins, melons and varieties of vegetables to include cabbage and lettuce. Many fruits oranges, lemons and grapefruits are angiosperms.
- **Livestock.** Plants belonging to grass family are the world number one feeds of livestock. Many types of grassland in Africa are either grazed by cattle or wild animals. Also almost all feeds consumed by human are also used by domestic animals as food.
- **Wood.** Angiosperms provide different varieties of wood for furniture, paper and building materials. Carpentry and masonry depends largely on angiosperms for both soft and hard wood.
- **Textile.** Different varieties of fibers including cotton, flax, and hemp are important raw materials for textile industry. Cotton is the word first class material for clothes.
- **Medicine.** Many organic drugs are coming from angiosperm herbs. They are either industrial made or can be utilized in its raw form. Today it is believed that herbs form the best medicine when used in their fresh form than when industrial made.
- **Floriculture.** Flowers from angiosperms have great social significance as they are used in different kinds of ceremony. Roses for instance are the most sold flowers and they are highly purchased and used in wedding and burial ceremonies.
- **Forestry.** Forestry is the field of study whose base depends on both angiosperms and gymnosperms. Many forests form green belts that habit different varieties of plants.
- **Ecology.** Angiosperms provide a wide range of habitats for different species of organisms. They also serve as primary producers of energy.

- **Climate.** Angiosperms are used to modify climate. Green belts are established in order to absorb carbon and reduce global warming.
- **Tourism.** Many sites of tourism are plants oriented. Ecotourism for instance depends largely on different plant species that host different kinds of land animals.

Disadvantages of Angiosperms

- **Toxins.** Some plants are poisonous when eaten by human and other animals. They cause death to human and other living organisms. Some cassava varieties are a good example. They have cyanide acid that inhibits cellular respiration.
- **Drugs.** Some angiosperm varieties are drugs that can be abused when taken. Examples are marijuana, cocaine, tobacco and some caffeine varieties.
- **Weeds.** Some angiosperm varieties are bad weeds; they reduce crop yields. Some weeds are parasites. Example, *Cuscuta kilimanjari* is parasitic to coffee plantations.

TOPIC 2: MOVEMENT

Concept of Movement and Locomotion

The Concept of Movement and Locomotion

Explain the concept of movement and locomotion

Movement refers to change of position and posture. Therefore the change of position of body parts such as limbs and other body parts.

Locomotion is the movement or change of position of the whole organism from one place to another. But normally organisms have different kinds of movement. Plants show movement but do not show locomotion.

Since locomotion involves coordination between nervous muscular and skeletal system and all these system enable the organism to locomote.

The Importance of Movement in Animals and Plants

Explain the importance of movement in animals and plants

Animals and plants move about to:

- Find a mate and to reproduce
- Escape danger
- Seek and capture food
- To seek shelter, a suitable habitat/climate
- To avoid competition for food/water, living space etc
- Find water/soil nutrients, and hold leaves to get maximum sunlight
- Seek and capture food
- Obtain support
- Protect themselves from damage from: touch/pressure, pain or sudden temperature change
- Disperse seeds

Movement and Locomotion Actions

Demonstrate movement and locomotion actions

Demonstration of movement and locomotion



Movement action



Locomotion action

Movement of the Human Body, the Human Skeletal System

The Structures of Human Skeleton

Describe the structures of human skeleton

The contraction and relaxation of muscles cause muscular movement in vertebrate organisms such as man. The muscles work together with skeletal system to support or allow movement to occur.

BONES, CARTILAGE, JOINTS AND MUSCLES

The Functions of the Major Components of the Human Skeleton and their Adaptations

Explain the functions of the major components of the human skeleton and their adaptations

Major Components of the Human Skeleton include Bones, Cartilage, Joints and Muscles

Bones

Bones consist of living cells embedded in a hard substance made mainly of calcium and phosphorus. The bones are attached together at the joints by tough flexible fibers known as ligaments.

Bones are classified into long, short, irregular bones and flat.

- **Short bones** these are short bones, which support weight allowing for many smaller movements. Example bones on the human feet.
- **Long bones** these are strong, hollow and light containing spongy bone at the end. And spongy bone has open space and holes, which contain red marrow, which is where red cells are made. Example bones on the legs and arms.
- **Flat bones** these are bones, which support and protect body organs, these comprise ribs, breastbone, shoulder bones etc.

- **Irregular bones** these bones are for support and such bones are vertebrae also human ear has three tiny irregular bones, which conduct sound.

Cartilage

Besides bones, the skeletal system has tissue called cartilage. It's the strong flexible tissue that gives shape to some parts of the body

The cartilage keeps bones from grinding against each other, between vertebrae cartilage disks act as shock absorbers

Before birth bones are made mostly of cartilage whose cells absorb calcium after birth to produce bones

Joints

The human skeleton has about seventy movable joints.

Pivot Joint: This is the type of joint, which allows one bone to twist against another

NB. Joint is the point where two or more bones meet

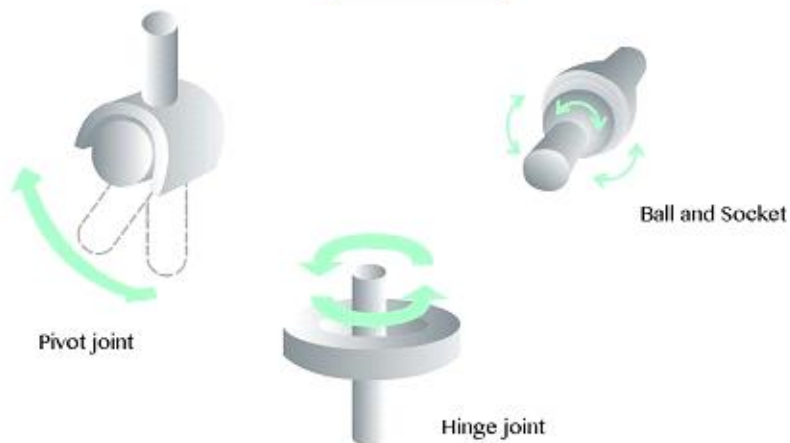
Pivot joint allows movement in several directions

Hinge joint is the joint which allows movement in one direction Example elbow

HUMAN SKELETON



JOINT TYPES



Functions of Skeleton include:

- The human skeleton provides mechanical support for the body
- Protection for internal organs e.g. skeleton of head protects the brain while chest bones protect soft organs such as the heart
- Skeleton functions as framework for anchoring the muscles
- Skeleton, together with muscles, function to bring about movement in an organism

Muscles and Movement

The Concept of Muscles

Explain the concept of muscles

A muscle is a tissue consisting of cells that have the capacity to contract and exert a pull. Muscles are made up of specialized tissues, which are known as contractile tissues. When these tissues contract they become shorter and tighter, as a result they cause movement. All muscles are made up of elongated cells called muscle fibers.

Types of Muscles

Mention types of muscles

There are three kinds of muscles in the body of a mammal. These muscles are skeletal muscles (voluntary), smooth (involuntary) muscles and cardiac muscles.

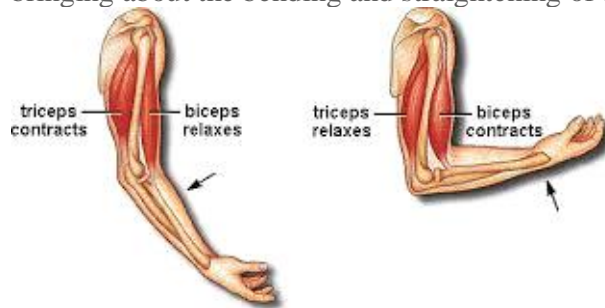
How Muscles Facilitate Movement

Demonstrate how muscles facilitate movement

Muscles are attached to bones at two points:

- At one point a muscle is usually attached to an immovable bone and other end to a movable bone.
- Muscles may be attached directly or indirectly by means of tendons. Tendons are tough whitish cords of fibrous materials which connect a bone and a muscle
- Muscles can contract and relax, but not expand when muscle contracts it becomes shorter and thicker and hence, exerts a pulling force on bone to which it is attached at a point of insertion.
- When a muscle relaxes, it lengthens and becomes thinner
- Most muscles act in pairs in such a manner that when one member of the pair contracts the other member relaxes. This means that they never contract or relax at the same time
- Muscles acting in pairs in this manner are known as antagonistic muscles. One member of the pair is called extensor while the other member is the flexor

The figure below shows how the two muscles of the upper arms that is the biceps and triceps muscles bringing about the bending and straightening of the limb.



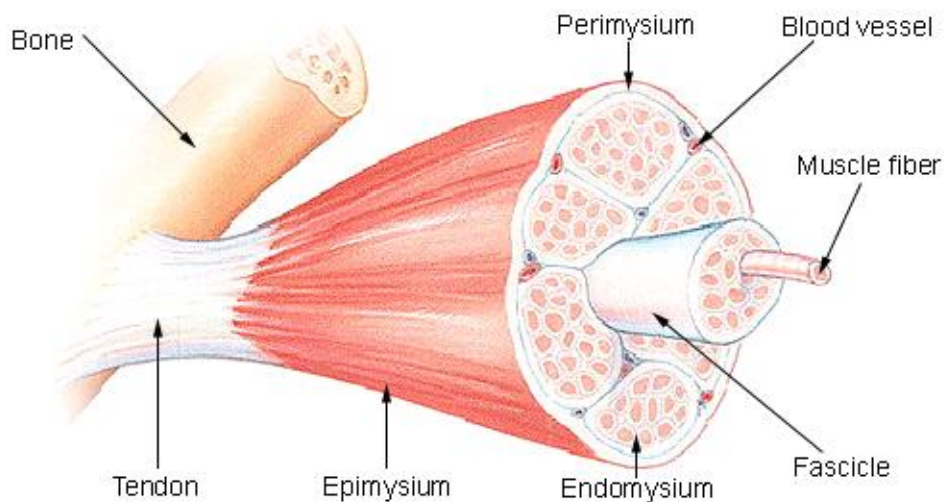
When the triceps (extensor) muscle contracts the limb is straightened. The contraction of the triceps is accompanied by the relaxation of the biceps (flexor). When the biceps muscle contracts the arm bends.

The Structure of Muscles

Describe the structure of muscles

Structure of muscles

Structure of a Skeletal Muscle



Adaptations of Different Types of Muscles to their Roles

Explain adaptations of different types of muscles to their roles

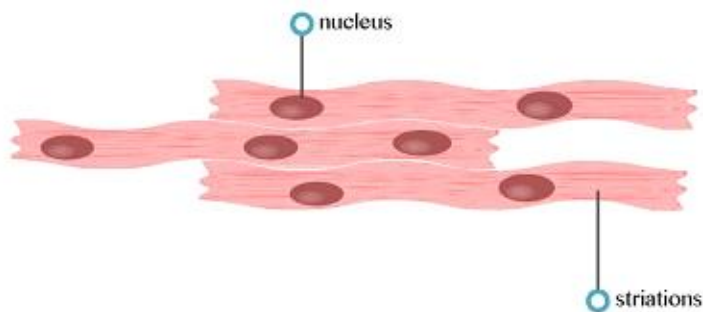
Skeletal Muscles

- These are the muscles, which are attached to bones of the skeleton
- The skeletal muscles contract powerfully and fatigue quickly
- Their contractions are controlled by the brain for this reason they are called voluntary muscles

Function of Skeletal Muscles

- Skeletal muscles are concerned with the movement of the limbs and parts of the skeleton

VOLUNTARY MUSCLES



Smooth Muscles

Smooth (involuntary) muscles are found on the walls of internal organs such as alimentary canal, blood vessels and bladder.

- These muscles are made up of cells which taper at both ends (spindle shaped)
- Smooth muscles contract slowly
- The contraction of the smooth muscle is involuntary (it is not controlled by the brain)

Function of Smooth Muscles

The smooth muscles, which are formed in different organs contract and relax to cause movements of materials through them. Example: peristalsis in alimentary canal causes movements of the materials through the canal with the help of smooth muscles.

INVOLUNTARY MUSCLES



Cardiac Muscles

This is the type of muscle, which is found only in the heart. These muscles are made up of muscle fibers which branch and connect to each other like a network.

Function

- Contraction of cardiac muscles causes the heart to keep on pumping (i.e. heart beat)

Causes, Effects and Preventive Measures of Muscles Cramps

Explain causes effects and preventive measures of m cramps

A muscle cramp is an involuntary and forcibly contracted muscle that does not relax. The cramp may involve a part of muscle, the entire muscle or several muscles that usually act together. Any of the muscles that are not at our voluntary control can cramp.

Sometimes it occurs when the body lacks salt especially for those people who work hard in hot weather they sweat a lot and get painful cramps in their legs, arms or stomach.

Causes Muscle Cramps

There are basically two major causes of muscle cramps that are:

- Lack of water or salt in the body
- Lack of oxygen in the muscles (inadequate oxygenation of muscles)

Prevention of Muscle Crampa

- Cramps from poor breathing (lack of oxygen) can be improved by rapid breathing as well as stretching the muscles
- A muscle cramp from lack of water or salt can be treated by stretching the muscles and drinking many glasses of water, which contain salt so as to replace the amount of salt lost in the body

Treatment of Muscle Cramps

Applying a soft massage on the cramped muscle, stretching the muscle and applying oil ointment on the affected area, can treat a muscle cramp.

Movement in Plants

The Concept of Movement in Plants (Movement of Curvature)

Explain the concept of movement in plants (movement of curvature)

Generally plants do not show locomotion (movement of the entire organism). However, movement of individual plant organs is possible and modified by sensitivity of the plant to external stimuli.

Plant movements in response to internal stimuli are known as **spontaneous movement**. Examples of these movements are metabolic conditions, disease conditions, vex ages and parental influence Those movements shown by plants in response to external stimuli are known as **induced or irritable movements**.

Types of Movement Exhibited by Plants

Mention types of movement exhibited by plants

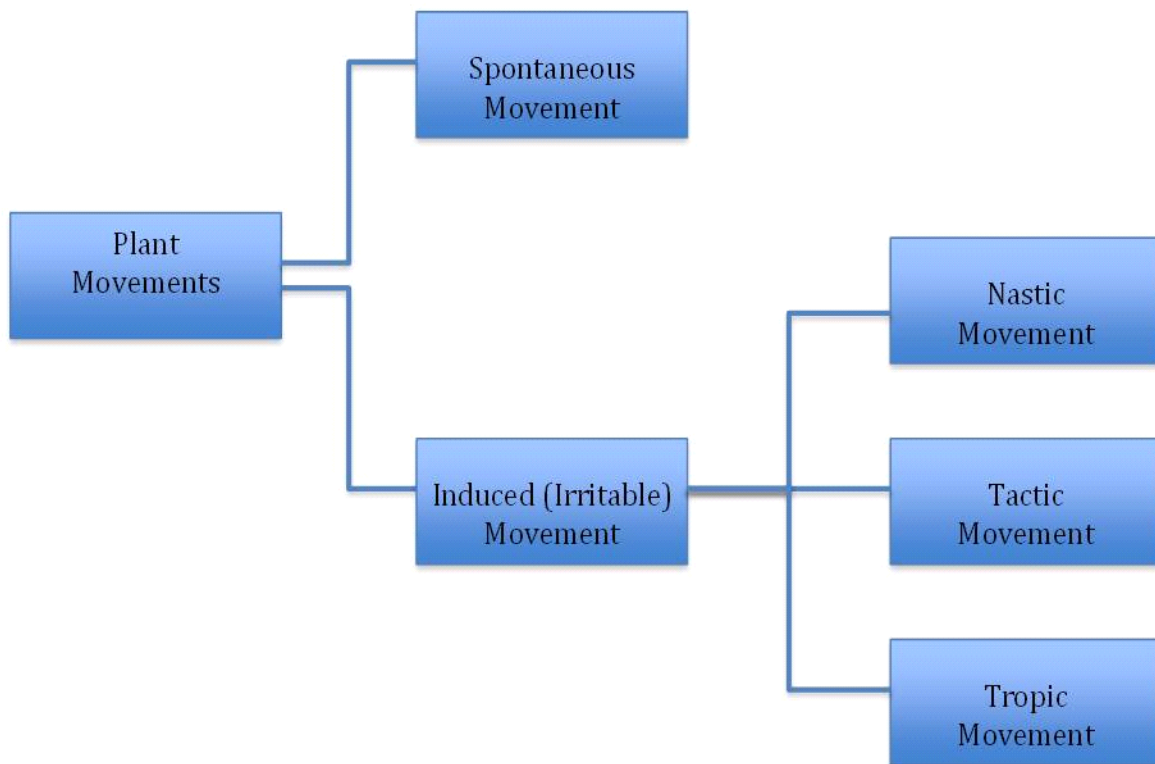
Normally there are two types of plant movements, which are:

- Spontaneous movement
- Induced (irritable) movement

Spontaneous Movement is plant movement in response to internal stimuli. Example of these movements are metabolic conditions, disease conditions, vex ages and parental influences

Induced or Irritable Movement is the type of plant movement shown by plants in response to external stimuli. Light, temperature, gravity, touch, water and chemical substances are examples of induced movement.

Induced movements include nastic movement, tactic movement and tropic movement.



A summary of the types of movements shown by plants in response to stimuli.

STIMULI

- Light
- Chemicals
- Water
- Temperature
- Contact
- Gravity
- Gravitactic or Gravitaxis

Tropic Movements in Plants

Tropic movements are the growth movements shown by a fixed part of a stationary plant towards or away from a stimulus coming from one direction. Tropic movements are also known as tropism movements.

Tropic (tropism) is growth movements, which take place at a very slow pace. The growth movement is caused by an increased or decreased rate of growth on the side of the organ, which is under the influence of the stimulus, with respect to the opposite side. This results in growth in curvature.

There are various types of tropic movements, these types are:

- Phototropism or phototropic which is a growth movement shown by part of a fixed plant in response to light
- Hydrotropism (Hydrotrropic) which is growth movement in a response to water

- Thigmotropism (Thigmotropic) which is the growth movement in response to touch
- Chemotropism (Chemotropic) which is a growth movement made by plants towards chemicals
- Thermotropism (Thermotropic), a growth movement shown in plants in response to heat.

Experiments to Investigate Movement in Plants

Carry out experiments to investigate movement in plants

An experiment to investigate movement in plants

TOPIC 3: COORDINATION

In this topic you will learn about concept of coordination, nervous coordination in humans, sense organs, drugs and drug abuse in relation to nervous coordination, and coordination in plants.

Concept of Coordination.

The Concept of Coordination in Organisms

Explain the concept of coordination in organisms

Coordination is the working together of the various organs of an organism in a systematic manner so as to produce a proper response to the stimuli. Without coordination the body becomes disorderly and it may fail to function properly.

The Ways in Which Coordination is Brought About

Outline the ways in which coordination is brought about

The coordination in simple multicellular animals takes place through nervous system only. The control and coordination in higher animals called vertebrates (including human beings) takes place through nervous system as well as hormonal system called endocrine system. Coordination in plants is under the control of hormones.

All the living organisms (plants and animals) respond and react to changes in the environment around them. The changes in the environment to which the organisms respond and react are called stimuli (singular: stimulus). The living organisms show response to stimuli such as light, heat, cold, sound, smell, taste, touch, pressure, pain, water, and force of gravity, etc. The ability to perceive, interpret and respond to stimuli is called irritability or sensitivity.

There are two types of stimuli: external and internal. External stimuli are associated with the surrounding environment such as wind temperature, light, pressure, touch, water and gravity. Internal stimuli occur within the organism, for example, a decrease or an increase in the amount of water and glucose in the blood.

When an organism detects a stimulus, it initiates a response. A response is a behavioural, physiological or muscular activity initiated by a stimulus. For example, if a man touches a very hot utensil accidentally, he quickly pulls his hand away from the hot utensil. Here, heat is the stimulus and the man reacts (responds) by moving his hand away from the hot utensil. Similarly, when the sun is bright, we close our eyes. In this case, light is the stimulus and we react by closing our eyes. Likewise, when the amount of water in the blood drops, the pituitary gland secretes an anti-diuretic hormone (ADH) which stimulates the reabsorption of water in the kidneys.

Multicellular organisms detect stimuli through sense organs called receptors. A receptor is a sense organ (e.g. eye) or sensory nerve ending (e.g. in the skin or internal organ) which receives stimuli and sets nervous impulses. Impulses are electrical transmissions or chemical stimuli that are sent from the receptor to the coordinating system in the organism. The organs that respond to the stimuli are called effectors. A coordinator is an organ (e.g. the brain and spinal cord) that receives messages from the receptors, translates them and sends the information back to an effector for action. An effector is a muscle or gland which receives impulses from nerves, brain or spinal cord and responds to them. Response is the end-action, such as a muscle contracting to cause the movement of the arm. The diagram below illustrates the five components of coordination in mammals.

Nervous Coordination in Human , Neurons

The Structure of Motor Sensory and Relay Neurons

Describe the structure of motor sensory and relay neurons

Neurones

Neurones are nerve cells. They carry information as tiny electrical signals. A neurone consists of a cell body (with a nucleus and cytoplasm), dendrites that carry electrical impulses to the cell, and a long axon that carries the impulses away from the cell. The axon of one neurone and the dendrites of the next neurone do not actually touch each other. The gap between neurones is called the synapse

Structure and functions of neurones

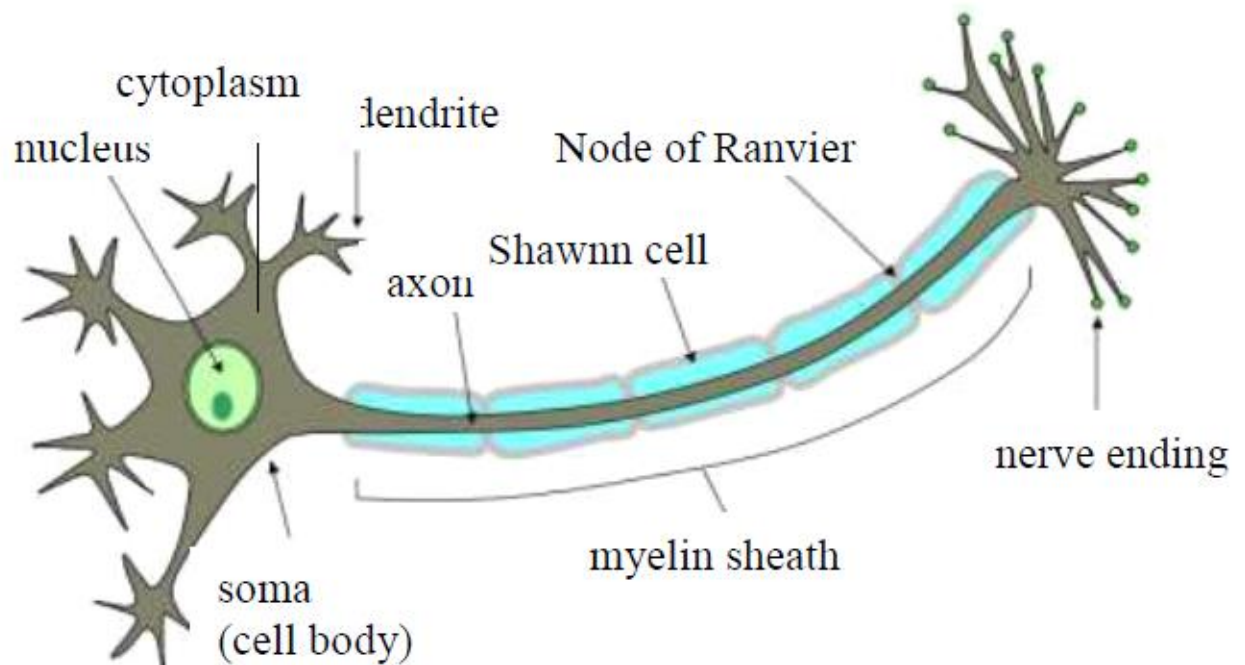
The diagram below shows a typical neurone: in this case, a motor neurone. It has tiny branches at each end (dendrites) and a long fibre (axon) that carries the signals or nervous impulses. The axon is

surrounded by a fatty layer known as the myelin sheath. This helps to protect the neurone and allow impulses to travel faster. The sheath is produced by Schwann cells. The myelin sheath has nodes (Nodes of Ranvier) that speed up transmission of nervous impulses. The cell body consists of cytoplasm enclosing the nucleus. There are also other organelles in the cytoplasm such as mitochondria that supply energy for metabolic functions.

Synapses

Where two neurones meet, there is a tiny gap called a synapse. Signals cross this gap using chemicals (neurotransmitters) released by a neurone. When the chemical diffuses across the gap it makes the next neurone transmit an electrical signal. The transmission of nervous impulses across synapses occurs thus:

- An electrical impulse travels along an axon.
- This triggers the nerve-ending of a neuron to release chemical messengers called neurotransmitters.
- These chemicals diffuse across the synapse (the gap) and bind with receptor molecules on the membrane of the next neuron.
- The receptor molecules on the second neuron bind only to the specific chemicals released from the first neuron. This stimulates the second neuron to transmit the electrical impulse.



Structure of neurone

Types of neurones

There are three types of neurones namely motor neurone, sensory neurone and relay(or intermediate) neurone. Each of these neurones has a different structure and performs different functions.

Motor neurone

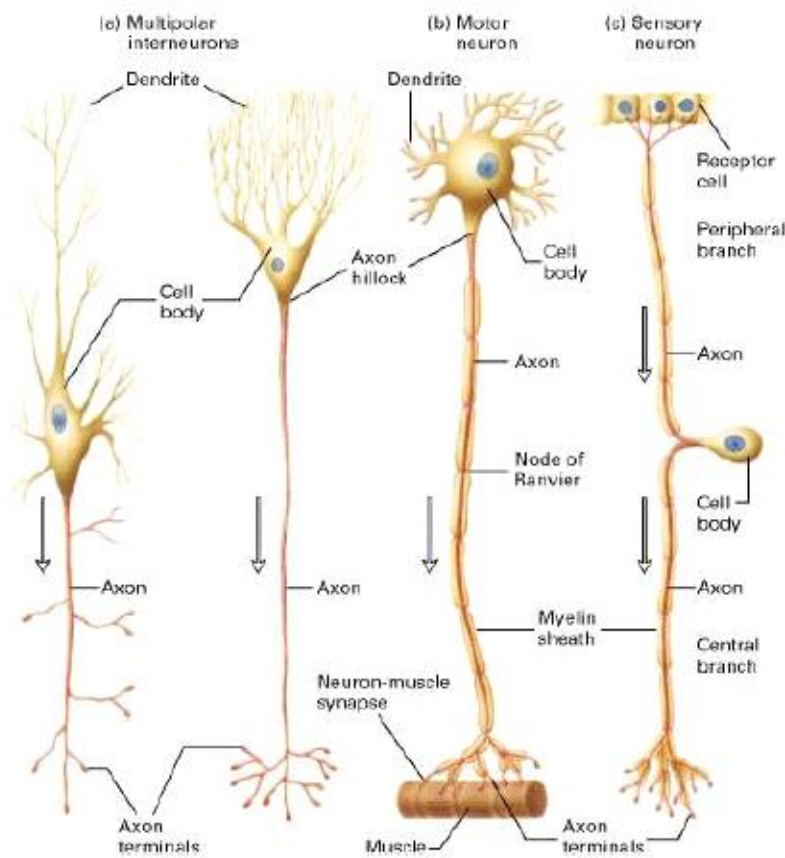
A motor neurone is a nerve cell that transmits impulses from the central nervous system(CNS) to the effector organs such as muscles or glands where response is made. The cell body of a motor neurone is at one end of the neurone and lies entirely within the central nervous system (see the diagram above).

Sensory neurone

A sensory neurone is a nerve cell that transmits impulses from the receptors to the CNS. Sensory neurones have their cell bodies off the axon and outside the central nervous system.

Relay (intermediate or inter) neurone

A relay neurone conveys messages between neurones in the CNS. Relay neurones are located in the CNS between the sensory and the motor neurones.



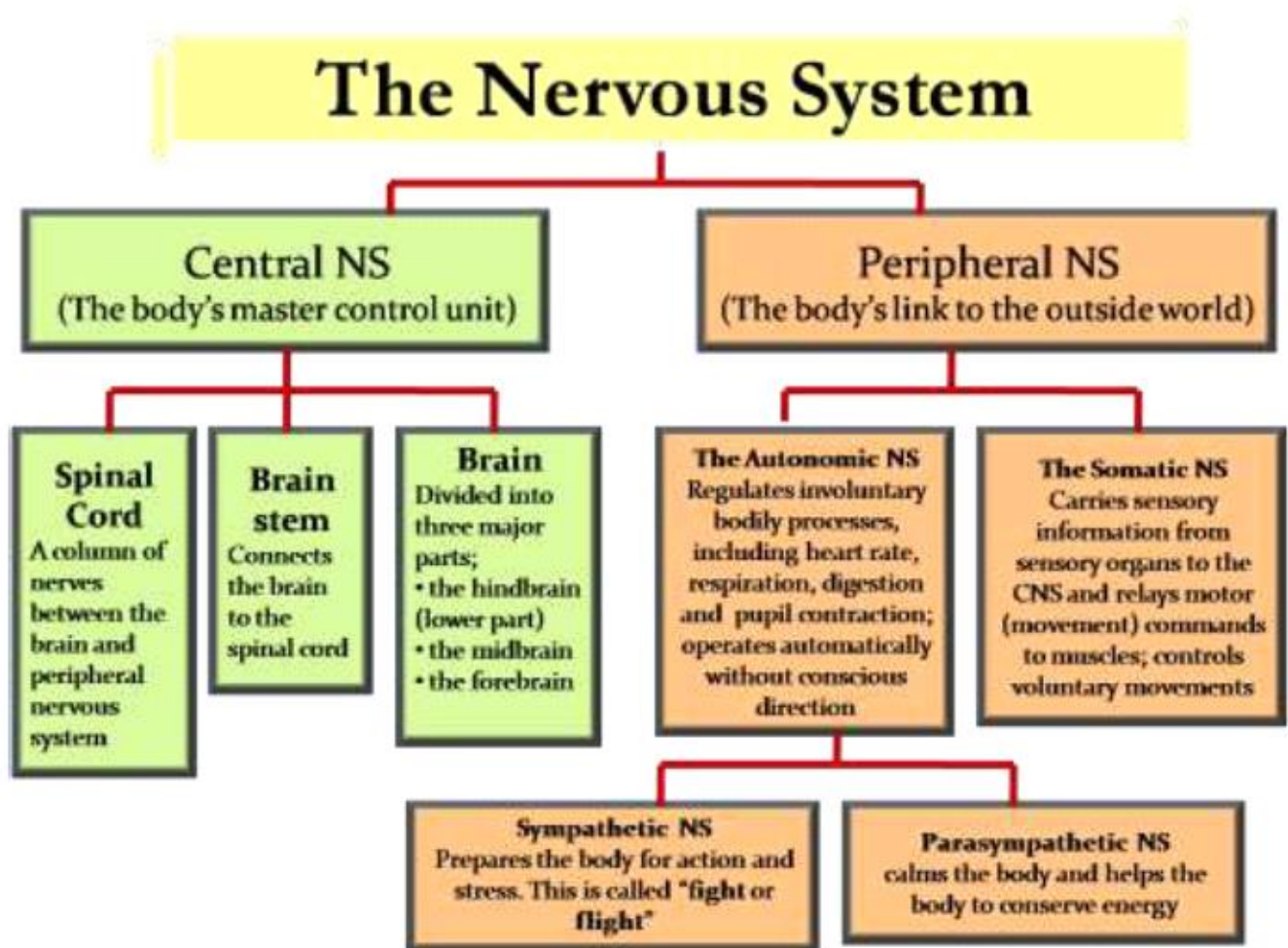
Structures of neurones

Central Nervous System (CNS)

The Meaning of Central Nervous System

Give the meaning of central nervous system

The CNS is the part of the nervous system consisting of the brain and spinal cord. It coordinates all the neural functions. The chart below shows subdivisions of the nervous system.



The brain

The human brain is a specialized organ that is ultimately responsible for all thought and movement that the body produces. This allows humans to successfully interact with their environment, by communicating with others and interacting with inanimate objects near their surroundings. If the brain is not functioning properly, the ability to move, generate accurate sensory information or speak and understand language can be damaged as well.

The brain has many different parts. Each part has a unique function that allows humans observe and interact with their environment effectively. The following are parts of the human brain and their functions:

Cerebrum

The cerebrum is the largest portion of the brain, and contains tools which are responsible for most of the brain's function. It is divided into four sections: the temporal lobe, the occipital lobe, parietal lobe and frontal lobe.

Parietal Lobe: Located in the cerebral hemisphere, this lobe focuses on comprehension. Visual functions, language, reading, internal stimuli, tactile sensation and sensory comprehension are monitored here.

Temporal Lobe: The temporal lobe controls visual and auditory memories. It includes areas that help manage some speech and hearing capabilities, behavioural elements, and language. It is located in the cerebral hemisphere.

Occipital Lobe: the occipital lobe is located in the cerebral hemisphere in the back of the head. It helps to control vision.

Cerebellum

This is commonly referred to as "the little brain". The cerebellum controls essential body functions such as balance, posture and coordination, allowing humans to move properly and maintain their posture.

Limbic system

The limbic system contains glands which help relay emotions. Many hormonal responses that the body generates are initiated in this area. The limbic system includes the amygdala, hippocampus, hypothalamus and thalamus.

Amygdala: The amygdala helps the body respond to emotions, memories and fear.

Hippocampus: This portion of the brain is used for learning memory, specifically converting temporary memories into permanent memories which can be stored within the brain.

Hypothalamus: The hypothalamus region of the brain controls mood, thirst, hunger and temperature. It also contains glands which control the hormonal processes throughout the body.

Thalamus: The thalamus is located in the centre of the brain. It helps to control the attention span, sensing pain and monitors input that moves in and out of the brain to keep track of the sensations the body is feeling.

Brain stem

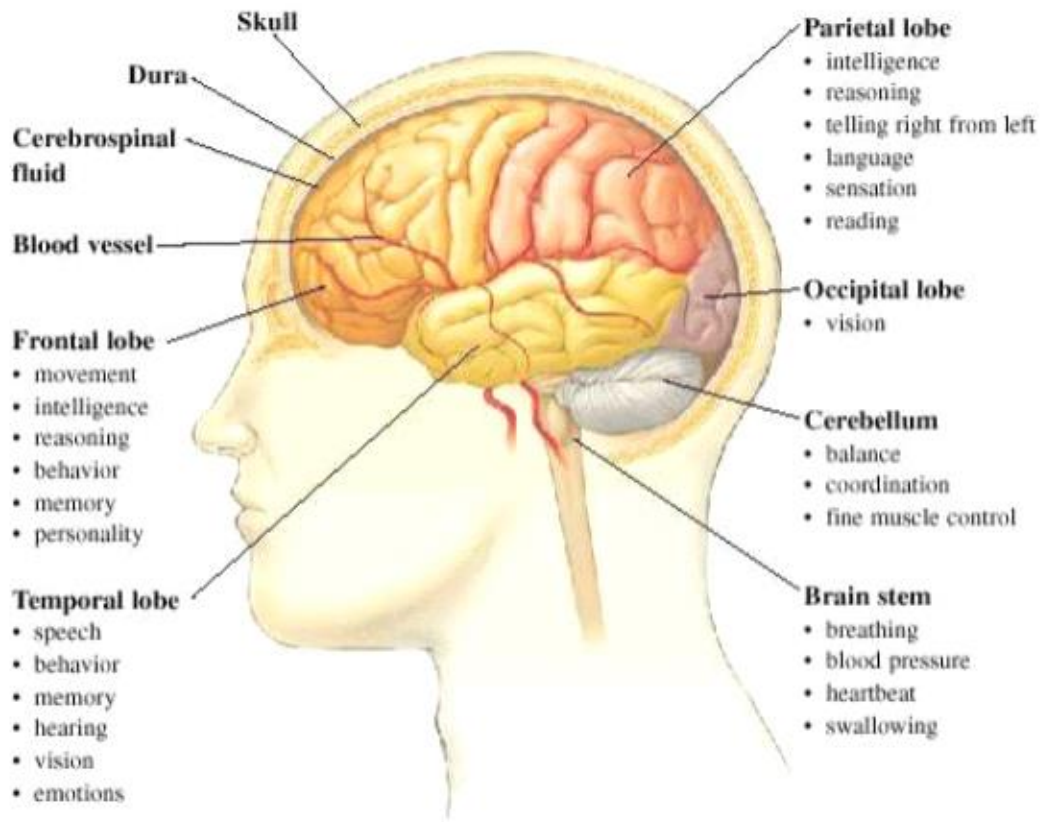
All basic life functions originate in the brain stem, including heartbeat, blood pressure and breathing. In humans, this area contains the medulla, midbrain and pons.

Midbrain: This part of the brain helps regulate body movement, vision and hearing.

Pons: The pons interprets information that is used in sensory analysis or motor control. The pons also creates the level of consciousness necessary for sleep.

Medulla: The medulla or medulla oblongata is an essential portion of the brain stem which maintains vital body functions such as the heart rate and breathing.

The diagram below shows and summarizes the basic functions of different parts of the brain.



Parts and functions of the human brain

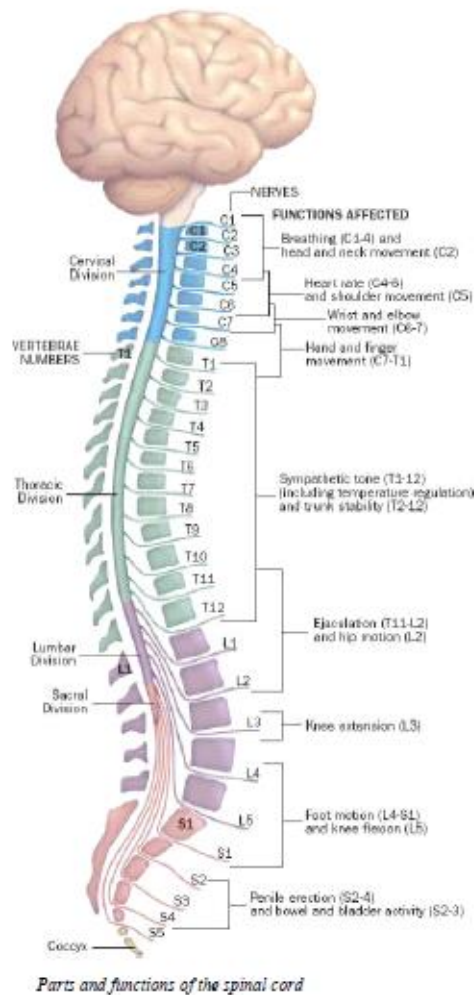
The Components of the Central Nervous System and their Functions

Identify the components of the central nervous system and their functions

The table below summarizes the structure and functions of the major components of the brain.

Component	Function(s)	Structure
Cerebellum	<ul style="list-style-type: none"> Long-term memory Co-ordination (e.g. balance) Muscle tone Movement Posture <p>Maintenance of muscle tone, balance, and the synchronization of activity in groups of muscles under voluntary control, converting muscular contractions into smooth coordinated movement. However, it does not initiate movement and plays no part in the perception of conscious sensations or in intelligence.</p>	<p>The cerebellum is the largest part of the hindbrain. Like the cerebrum, it has an outer grey cortex and a core of white matter. The cerebellum has three broad bands of nerve fibres – the inferior, middle, and superior cerebellar peduncles – which connect it to the medulla, the pons varolii, and the midbrain respectively.</p>
Cerebrospinal Fluid (CSF)	<ul style="list-style-type: none"> Bathes the brain and spinal cord Allows nutrients and waste products to diffuse between the blood and the brain/spinal cord. Protects the nerves against mechanical damage 	<p>A clear watery fluid whose normal contents include glucose, salts, enzymes, and some white blood cells (but no red blood cells).</p>
Cerebrum	<p>The cerebrum is also known as the cortex (cortex = cerebrum), and is the largest and most highly developed part of the brain.</p> <p>This is the 'learning' part of the brain, and the seat of all intelligent behaviour. It is responsible for the initiation and coordination of all voluntary activity in the body and for governing the functioning of lower parts of the nervous system.</p>	<p>The cerebrum is composed of two hemispheres separated from each other by the longitudinal fissure in the midline.</p> <p>Each hemisphere has an outer layer of grey matter, the cerebral cortex, below which lies white matter containing the basal ganglia. Nerves of the cortex are arranged on the outside surfaces as grey matter.</p>

		<p>The corpus collosum is a massive bundle of nerve fibres that connect the two hemispheres - at the bottom of the longitudinal fissure.</p>
Hypothalamus	<p>The hypothalamus is the "receptor centre", and "control centre" of the body.</p> <p>It contains several important centres controlling body temperature and eating, and water balance. Examples include osmoreceptors that balance water/salt levels and control the water content of the blood.</p> <p>It is also the satiety centre (that is concerned with "satisfaction"), for things like hunger, thirst, sex.</p> <p>It is also closely connected with emotional activity and sleep, and it functions as a centre for the integration of hormonal and autonomic nervous activity through its control of the pituitary secretions.</p> <p>The posterior lobe of the pituitary secretes two hormones:</p> <ul style="list-style-type: none"> • A.D.H. (Anti-diuretic hormone, as known as vasopressin). This works on the kidney tubules. Secretion of ADH tells the kidneys to re-absorb more water, resulting in more concentrated urine. Non-secretion of ADH results in more urination and 	<p>The region of the forebrain in the floor of the third ventricle, linked with the thalamus above and the pituitary gland below.</p>
	<p>weaker urine.</p> <ul style="list-style-type: none"> • Oxytocin. 	
Medulla Oblongata	<p>The functions of the medulla oblongata concern the body's involuntary processes, such as:</p> <ul style="list-style-type: none"> • Breathing • Heart-rate • Swallowing • Salivation • Vomiting • Blinking 	<p>The medulla oblongata is the extension within the skull of the upper end of the spinal cord, forming the lowest part of the brainstem.</p>



The Structure of the Spinal Cord and Brain

Describe the structure of the spinal cord and brain

Spinal cord

The spinal cord functions primarily in the transmission of neural signals between the brain and the rest of the body but also contains neural circuits that can independently control numerous reflexes and central pattern generators. It carries out two main functions:

- It connects a large part of the peripheral nervous system to the brain. Information (nerve impulses) reaching the spinal cord through sensory neurons is transmitted up into the brain. Signals arising in the motor areas of the brain travel back down the cord and leave in the motor neurones.
- The spinal cord also acts as a minor coordinating centre responsible for some simple reflexes like the withdrawal reflex.

The intermediate neurones carrying impulses to and from specific receptors and effectors are grouped together in spinal tracts.

The diagram shows various sections of the spinal cord and the functions of each section.

Peripheral Nervous System (PNS)

The Meaning of Peripheral Nervous System

Give the meaning of peripheral Nervous System

The peripheral nervous system is made up of a network of nerves linking various parts of the body to the brain and spinal cord. It includes the cranial nerves, spinal nerves and their roots and branches, peripheral nerves, and neuromuscular junctions.

The peripheral nervous system (PNS) has two components: the somatic nervous system and the autonomic nervous system. The PNS consists of all of the nerves that lie outside the brain and spinal cord.

The Components of the Peripheral Nervous System and Their Functions

Identify the components of the peripheral nervous system and their functions

The somatic nervous system is made up of nerves that connect to voluntary skeletal muscles and to sensory receptors. It is composed of afferent nerves that carry information to the central nervous system (spinal cord) and efferent nerves that carry neural impulses away from the central nervous system. This system is responsible for the involuntary control of the skeletal muscles, bones and sense organs.

The autonomic nervous system is further subdivided into sympathetic and parasympathetic nervous system.

- The sympathetic nervous system activates the 'fight or flight' response under sudden or stressful circumstances, for instance by raising the heart rate and dilating the pupils.
- The parasympathetic nervous system helps the body return to normal activity after an emergency, which conserves energy and replenishes the system.

Together, these two systems regulate homeostasis within the body - one preparing the body for action, and the other repairing the body afterward.

Reflex Action

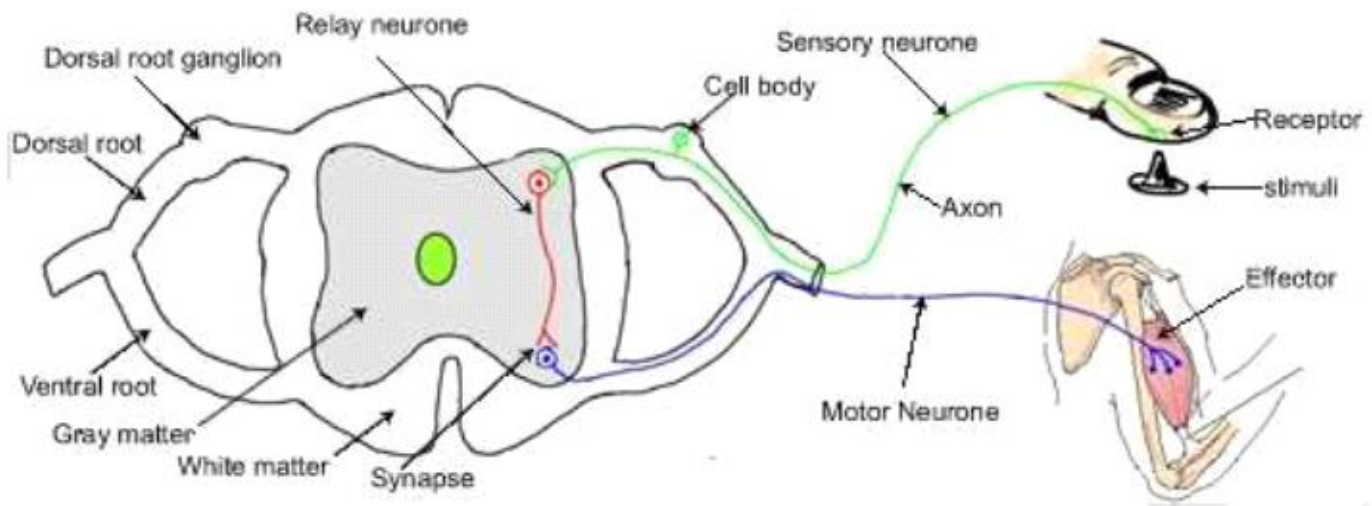
The Meaning of Reflex Action

Give the meaning of reflex action

When a receptor is stimulated, it sends a signal to the central nervous system, where the brain coordinates the response. But sometimes a very quick response is needed, one that does not need the involvement of the brain. This is a reflex action.

The reflex action is a rapid, involuntary response to a certain stimulus. The route that is followed by impulses during a reflex action is called a reflex arc.

Reflex actions are rapid and happen without us thinking. For example, you would pull your hand away from a hot flame without thinking about it. The diagram below shows a simplified reflex arc.



Reflex action of a hand being withdrawn from the a flame

This is what happens:

- receptor detects a stimulus - change in the environment
- sensory neurone sends signal to relay neurone
- motor neurone sends signal to effector
- effector produces a response

The above process appears to be a long one but, in reality, the process takes a very shorttime. It happens within seconds.

The way the iris in our eye adjusts the size of the pupil in response to bright or dim lightis also a reflex action. It happens without our thinking and beyond our control.

The Neuronic Path of a Reflex Action

Describe the neuronic path of a reflex action

A reflex action can either be simple or conditioned reflex.

Simple reflex action

An example of a simple reflex found in humans is the pupil reflex, where the pupil of theeye gets larger in dim light and smaller in bright light.The eye needs to control the amount of light entering it in different light conditions. Indim conditions, more light is allowed to enter so that a clear image can be formed on theretina. In bright conditions, less light is allowed to enter so that the retina is not damaged.

Conditioned reflex action

A conditioned reflex is some action or feeling that is learned in response to a specificsituation or stimulus.

A Russian scientist called Pavlov trained dogs to expect food whenever he rang a bell.The dogs eventually produced saliva when they heard the bell ring. The dog salivatesnaturally when given

food. Pavlov rung a bell every time the dogs were to be given food. After much repetition the dogs salivated when they heard the bell ringing, even when there was no food. This is an example of a conditioned reflex.

The dogs were conditioned to salivate when the bell rang. A ringing bell does not normally cause salivation in dogs. However, when the ringing bell becomes a secondary stimulus, it does cause salivation, even though the dog will not be able to eat the bell as food.

This is now called a conditioned reflex. In a conditioned reflex the final response (salivation) has no direct connection with the stimulus (ringing bell).

Another example of a conditioned (learned) reflex is when the driver comes across a hurdle on the road such as a ditch or a pedestrian. In such circumstances, the first thing the driver will do is to move his leg towards the brake pedal to apply the brakes. He has learned to do this action for so long that he finds himself applying the brake in any of such circumstances.

The Difference between Simple Reflex and Conditioned Reflex Action

Distinguish simple reflex from conditioned reflex action

Differences between conditioned reflex action and simple reflex action

	Conditioned reflex	Simple reflex
1	It involves more than one stimuli	Requires only one stimulus
2	Involves the brain	Mostly involve the spinal cord
3	It is an immediate action (no time to learn)	It is an immediate action (no time to learn)
4	It is acquired in one's life	It is inborn

Modifying a reflex response

In some circumstances the brain can modify a reflex response. It does this by sending an impulse along a motor neuron of the reflex arc. This enables us, for example, to hold a hot dinner plate when normally we would drop it.

Sense Organs

The Meaning of a Sense Organ

Explain the meaning of a sense organ

Sense organs are organs of the body that detect and respond to changes in the environment (stimuli) so as to survive.

Types of Sense Organs and Their Relative Position

Identify types of Sense organs and their relative position

There are five sense organs in our body: eyes, ears, nose, tongue and skin. We receive a variety of information from the environment around us through the sense organs. The sense organs contain receptors. A receptor is a cell (or a group of cells) in a sense organ which is sensitive to a particular type of stimulus (or a particular type of change in the environment) such as light, sound, smell, taste, heat, pressure, etc. The different sense organs contain receptors for detecting different stimuli.

The eyes have light receptors (which can detect light), ears have sound receptors (which can detect sound), nose has smell receptors (which can detect smell), tongue has taste receptors (which can detect taste) whereas skin has receptors for detecting touch, pressure, heat (or cold) and pain, etc.

The Structure of Each Sense Organ

Describe the structure of each sense organ

The human eye

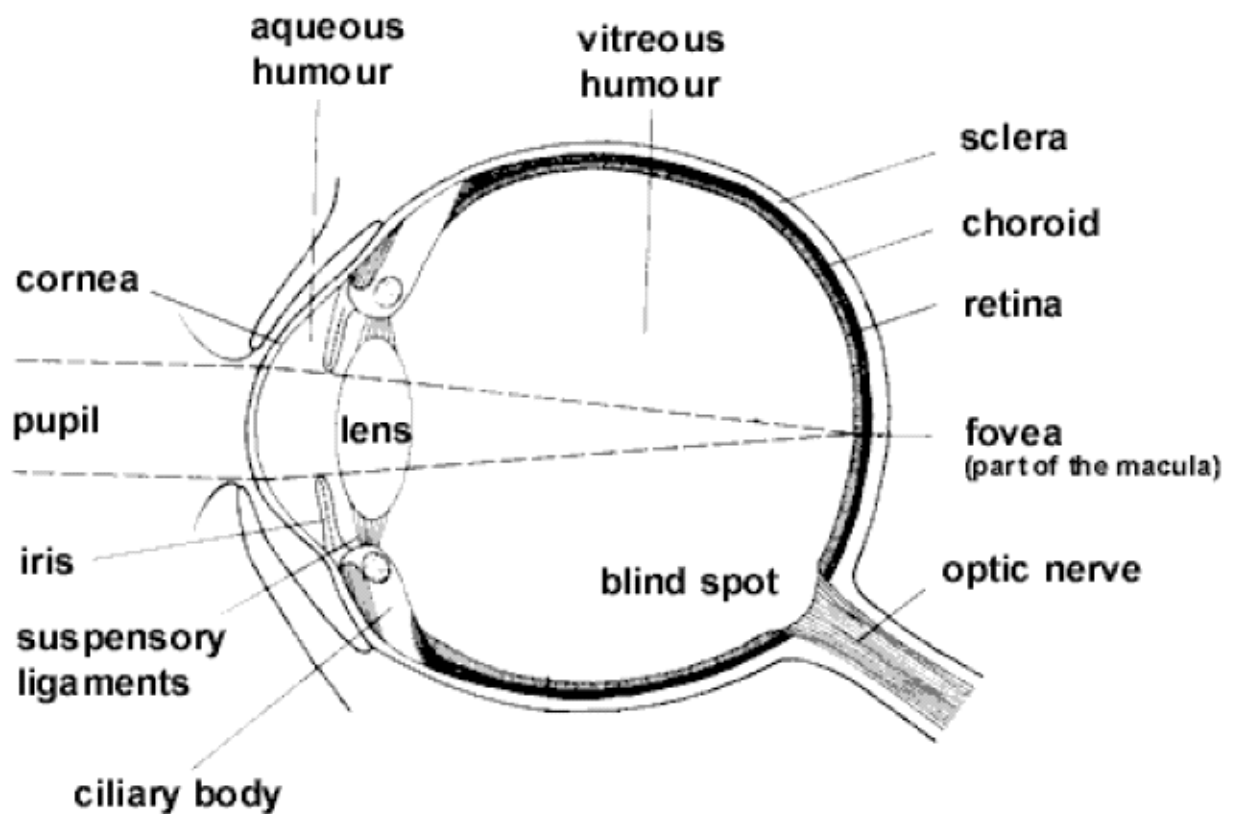
The eye is the organ for vision. The eye is one of the most complex parts of the body. The different parts of the eye allow the eye to take in light and perceive objects around us in the proper colour, detail and depth. This allows people to make more informed decisions about their environment. If a

portion of the eye becomes damaged, you may not be able to see effectively. You may even lose your vision completely.

Parts of the eye and their functions

There are several physical and chemical elements that make up the eye. The table below shows different parts of the human eye and their functions.

Eye part	Description and function(s)
Cornea	The cornea is the outer, transparent covering of the eye. This layer protects the eye from elements that could cause damage to the inner parts of the eye. The cornea also helps to focus light on the retina at the back of the eye.
Sclera	The sclera is commonly referred to as the "white" of the eye. It protects the eye and maintains the shape of the eye ball.
Pupil	The pupil appears as a black dot in the middle of the eye. This black area is actually a hole that takes in light to enable the eye focus on the objects in front of it. The pupil, thus, controls the amount of light that enters the eye.
Iris	The iris contains the pigment which gives the eye its colour. It has radial internal structure



Internal structure of the human eye

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Iris	The iris contains the pigment which gives the eye its colour. It has radial and circular muscles that control the size of the pupil by dilation and contraction. This allows the eye to take in more or less light depending on how bright it is around. The iris allows more light into the eye when the environment is dark and allows less light into the eye when the environment is bright.
Conjunctiva	This is a membrane that covers the cornea. It is thin and transparent so as to allow light to enter the eye. It is tough and protects the eye from mechanical damage.
Lacrimal glands	These glands are located on the outer corner of each eye. They produce tears which help moisten the eye when it becomes dry, and flush out particles which irritate the eye. As tears flush out potentially dangerous irritants, it becomes easier to focus properly.
Lens	This is a transparent structure filled with a jelly-like substance. The lens focuses light into the retina. It is held in place by the suspensory ligaments attached to the ciliary muscles, which allow the lens to change shape depending on the amount of light entering the eye. Through the ciliary muscles, the lens becomes thicker to focus on nearby objects and thinner to focus on distant objects.
Retina	Retina is the sensory tissue that lines the inner layer of the eye. It is the layer of the eye where images are formed, and it is connected to the optic nerve that transmits the images to the brain to be interpreted. The retina is made up millions of photoreceptors known as rods and cones.
Ciliary body	Ciliary body, also called ciliary muscles , is a ring-shaped tissue which holds and controls the movement of the eye lens, and thus, it helps to control the shape of the lens. The ciliary body contains glandular cells which secrete the aqueous humour.
Suspensory ligaments	The suspensory ligaments attach the lens to the ciliary muscles. When the ciliary muscles contract, they pull the suspensory ligaments and the lens gets long and thin to accommodate rays of light from distant objects. When the ciliary muscles relax, there is less tension on the suspensory ligaments and the lens becomes more spherical in shape. This enables the accommodation of light rays from near objects.
Choroid	The choroid lies between the retina and the sclera, which provides blood supply to the eye. Just like any other portion of the body, the blood supply gives nutrition to the various parts of the eye.
Vitreous humour	The vitreous humour is the gel located in the back of the eye which helps it hold its shape. This gel takes in nutrients from the ciliary body, aqueous humour and the retinal vessels so the eye can remain healthy. The gel in the vitreous humour is transparent to allow light to get to the retina and also helps maintain the shape of the eyeball.
Aqueous Humor	The aqueous humour is a watery substance that fills the eye. The aqueous humour gives the front of the eye its shape as well as nourishes the cornea and

	lens. This liquid is drained through the Schlemm canal so that any build-up in the eye can be removed. If the person's aqueous humour is not draining properly, s/he can develop glaucoma.
Optic nerve	Optic nerve is a cranial nerve which contains sensory neurones. The neurones transmit impulses from the rods and cones of the retina to the brain for interpretation. The optic nerve exits the eye at the blind spot.
Blind spot	It is located at the point where the optic nerve leaves the eye. The blind spot is not sensitive to light because it has no rods or cones.
Fovea	The fovea is the centremost part of the macula*. This tiny area is responsible for our central, sharpest vision. A healthy fovea is important for reading, watching television, driving, and other activities that require the ability to see detail.*Small and highly sensitive part of the retina responsible for detailed central vision. The retina is the very centre of the macula.

Adaptations of the eye to its functions

The eye is adapted to its functions by possessing the following features:

- Conjunctiva, cornea and lens are transparent to allow light to pass through them.
- Sclerotic layer is made up of (collagen) fibres; it maintains shape of eyeball/protects the eye from mechanical damage.
- Cornea is transparent and curved thus refracts light rays and allows light to pass through.
- Choroid (a layer of a tissue) has black or dark pigments that prevent internal reflections of light in the eye.
- The eye contains blood vessels in the choroids layer that supply oxygen and nutrients to the eye, giving the eye energy to perform its function, and removes the metabolic wastes from the eye.
- Retina is made of photoreceptors known as rods and cones, which trap light rays to enable the eye to do its function of vision.
- Yellow spot (fovea) has the highest concentration of cones for accurate and sharp, central vision.
- Optic nerve has sensory neurones for transmission of nerve impulses to the brain (for interpretation).
- Lens is biconvex and made up of elastic, transparent material which adjusts to focus far or near objects and allows light rays to pass through.
- Suspensory ligaments are fibrous to hold the lens in place.
- . The ciliary body contains ciliary muscles which are contractile to for controlling the curvature and hence focal length of the lens. It also contains glands that secrete the aqueous and vitreous humours.
- The iris is opaque and contractile for controlling the amount of light entering the eye (by adjusting the size of the pupil).
- Ocular muscles coordinate eye movement so that both eyes can follow a moving object together.
- The eyelid covers an eye and prevents it from mechanical damage and invasion by foreign bodies.

- Eye lashes help to prevent dust and small insects or particles from entering the eye by trapping them on their hairs.
- The presence of aqueous and vitreous humours helps the eye to bend light rays toward retina to process the signal and send impulse to the brain.

The Functions of Sense Organs and their Adaptive Features

Explain the functions of sense organs and their adaptive features

Adaptations of the eye to its functions

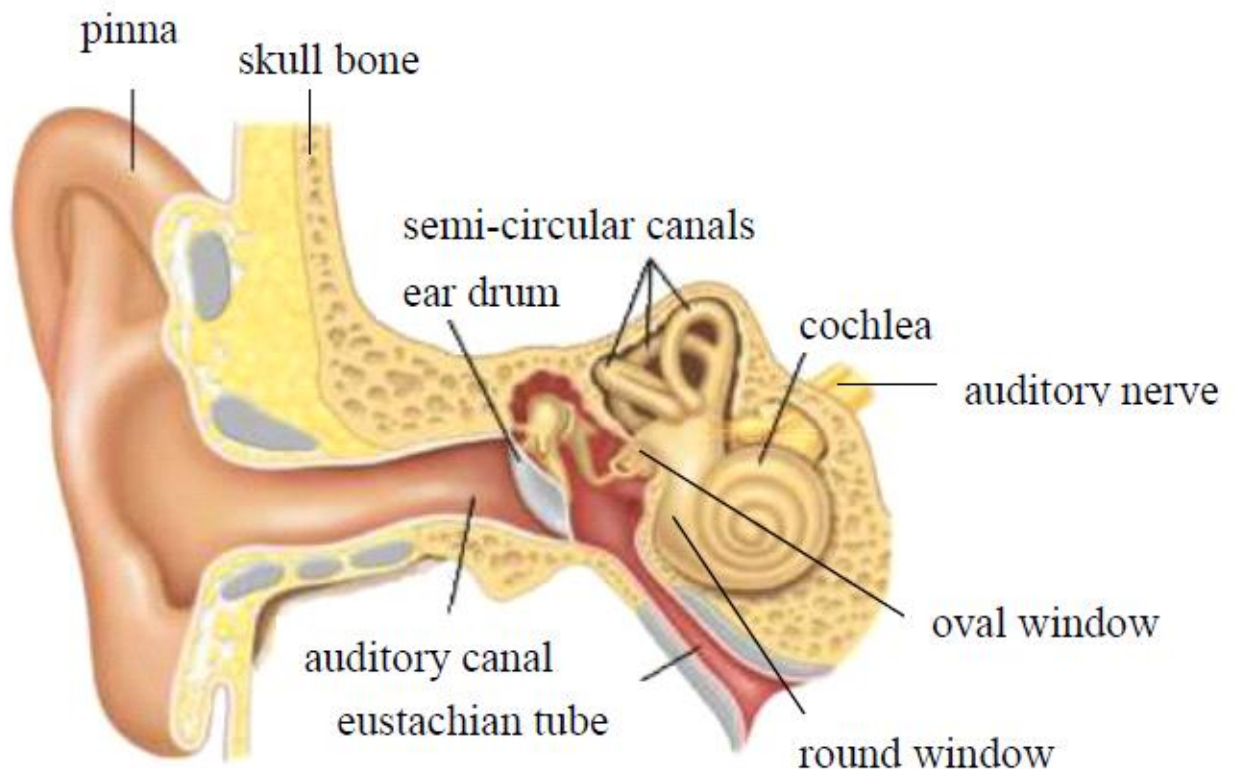
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The human ear

The ear is the organ of hearing and maintaining balance and posture. The outer ear protrudes away from the head and is shaped like a cup to direct sound waves toward the tympanic membrane, which

transmits vibrations to the inner ear through a series of small bones (ossicles) in the middle ear called the malleus, incus and stapes. The inner ear, or cochlea, is a spiral-shaped chamber covered internally by nerve fibres that react to the vibrations and transmit impulses to the brain via the auditory nerve. The brain combines the input of our two ears to determine the direction and distance of sounds. The inner ear has a vestibular system formed by three semicircular canals that are approximately at right angles to each other and which are responsible for the sense of balance and spatial orientation. The inner ear has chambers filled with a viscous fluid and small particles (otoliths) containing calcium carbonate. The movement of these particles over small hair cells in the inner ear sends signals to the brain that are interpreted as motion and acceleration. The figure below shows the internal structure of the mammalian ear.



Internal structure of the human ear

Adaptations of the mammalian ear to its functions

The ear is adapted to its functions by possessing the following features:

- The outer ear (pinna) is a flap of tissue which collects sound waves and directs them into the inner ear via the auditory canal.
- The lining of auditory canal contains wax-secreting cells which produce wax. The wax in the canal traps dust particles and other foreign bodies and hence protects the inner delicate parts of an ear from mechanical damage or microbial infections.

- The ear drum is thin and membranous, a fact that enables it to vibrate when sound waves hit it before converting the waves into vibrations and passing them on to the ear ossicles in the middle ear.
- The ear ossicles (malleus, incus and stapes) act as a lever system which can move forward and backward to amplify and transmit vibrations to the oval window.
- The Eustachian tube is hollow, a fact which allows air in and out of the middle ear to equalize the pressure between the inside and outside of the ear drum—which improves the drum's ability to vibrate
- The cochlea is coiled to increase the surface area for sound reception. It also carries auditory nerves which transmit sound impulses to the brain for interpretation.
pinna ear drum skull bones semi-circular canals auditory canal eustachian tube round window cochlea auditory nerve
Internal structure of the human ear oval window
- The presence of fluid-filled vestibular apparatus (semi-circular canals, sacculus, and utricle) in the inner ear facilitates balancing of sound when the fluid is displaced.

The tongue

The tongue is an organ responsible for taste. It is the primary organ of taste (gustation), as much of its upper surface is covered in taste buds. The tongue's upper surface is also covered with numerous lingual papillae. The tongue is sensitive and kept moist by saliva, and is richly supplied with nerves and blood vessels.

The receptors for taste, called taste buds, are situated chiefly in the tongue, but they are also located in the roof of the mouth near the pharynx. They are able to detect four basic tastes: salty, sweet, bitter, and sour.

Generally, the taste buds close to the tip of the tongue are sensitive to sweet and salty tastes, whereas those in the back of the tongue are sensitive to bitter tastes. The taste buds in the sides of the tongue are sensitive to sour tastes. At the base of each taste bud there is a nerve that sends the sensations to the brain. The sense of taste functions in coordination with the sense of smell.

The number of taste buds varies substantially from individual to individual, but greater numbers increase sensitivity. Women, in general, have a greater number of taste buds than men. As in the case of colour blindness, some people are insensitive to some tastes.



Location of taste buds in the human tongue

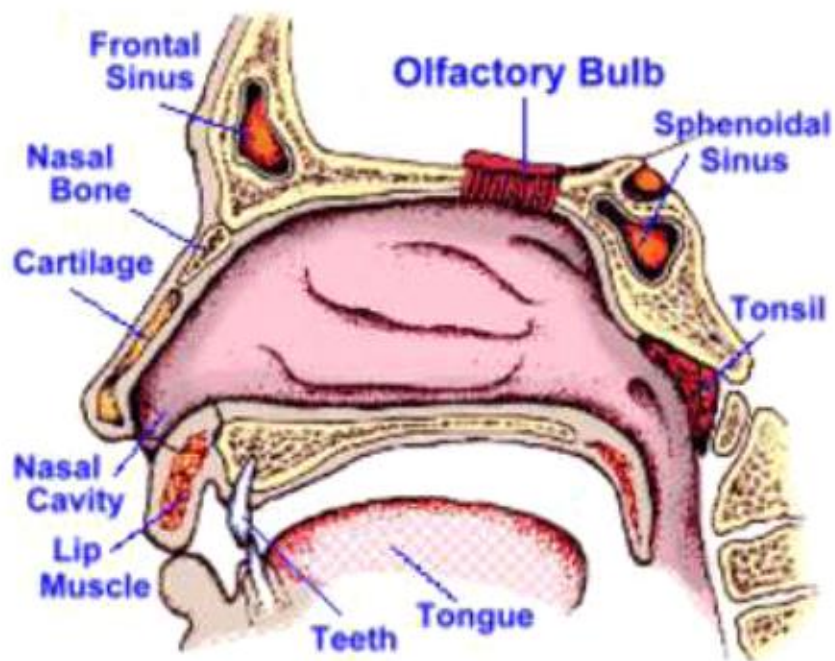
Adaptation of the tongue to its functions (as a sense organ)

The tongue is adapted to its functions by possessing the following features:

- The tongue has taste buds which help it to respond the stimuli such as sweet, bitter, sour and salty.
- At the base of each taste bud there is a nerve that sends the sensations to the brain.

The human nose

The nose is the organ responsible for the sense of smell. The cavity of the nose is lined with mucous membranes that have smell receptors connected to the olfactory nerve. The smells themselves consist of vapours of various substances. The smell receptors interact with the molecules of these vapours and transmit the sensations to the brain. The smell receptors are sensitive to seven types of sensations that can be characterized as camphor, musk, flower, mint, ether, acrid, or putrid. The sense of smell is sometimes temporarily lost when a person has a cold. Dogs have a sense of smell that is many times more sensitive than man's.



The human nose

When we want to —smell|| food we draw air high up into the nasal cavity where the chemicals come into contact with hairs on the sensory cells. Different chemicals stimulate different sensory cells and nervous impulses are set up which pass along the nerves to the brain to be interpreted.

When our nose is blocked with cold, our food may become —tasteless|| because we no longer smell it.

Adaptations of the nose to its functions

The nose is adapted to its functions by possessing the following features:

- There are olfactory nerves, which carry impulse from the nose to the olfactory lobes of the brain for interpretation.
- Presence of mucus-secreting cells, which produce mucus that keep the surface of the nose moist.
- Presence of hairs in the nose helps the nose to trap dust particles and other foreign bodies. When the mucus is blown out from the nose, it carries the dust and other foreign bodies with it, thus preventing the olfactory organs from damage.

The human skin

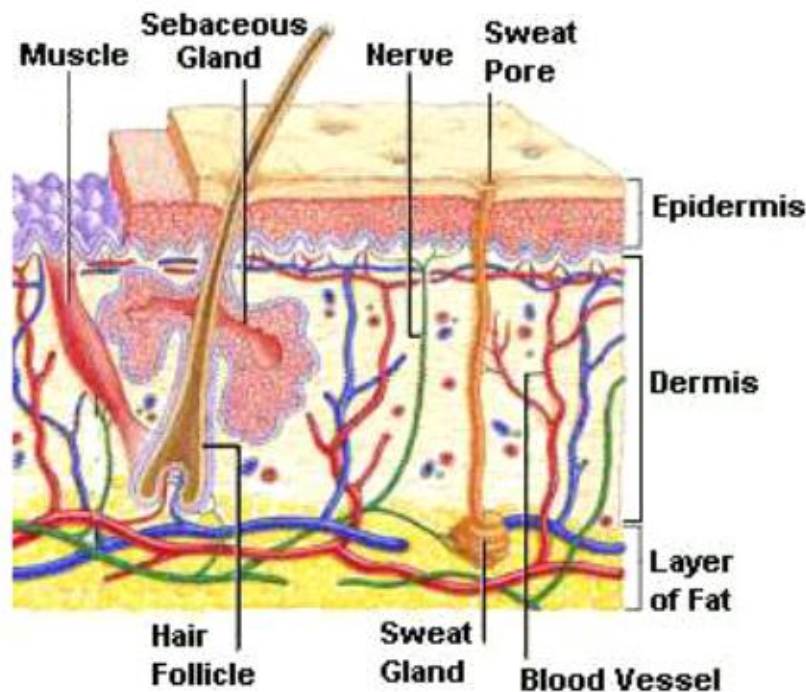
The skin is the outer covering of the body. In humans, it is the largest organ of the integumentary system. The skin has multiple layers of ectodermal tissue and guards the underlying muscles, bones, ligaments and internal organs. It protects us from microbes and the elements; helps regulate body temperature; and permits the sensations of touch, heat, and cold.

The skin has three layers:

- **The epidermis**, the outermost layer of skin, provides a waterproof barrier and creates our skin tone

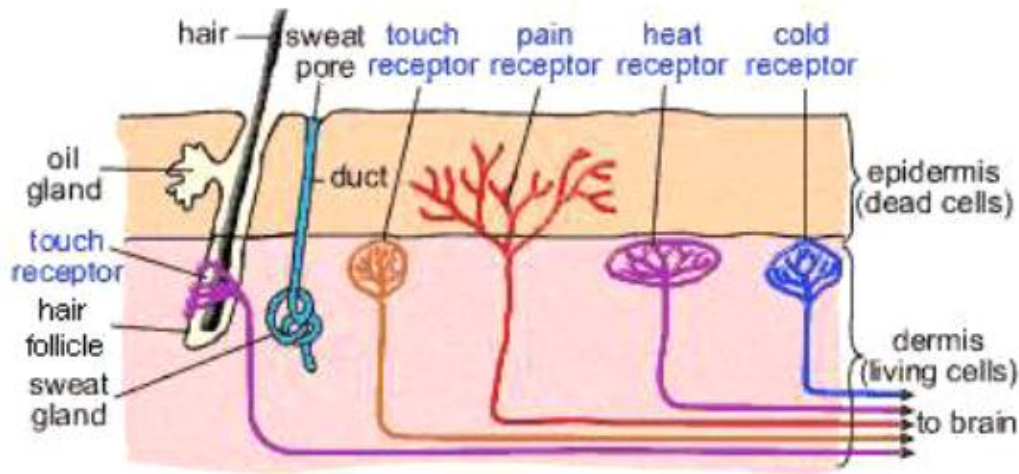
- **The dermis**, beneath the epidermis, contains tough connective tissue, hair follicles, and sweat glands
- The deeper subcutaneous layer (**hypodermis**) is made of fat and connective tissue.

The skin's colour is produced by special cells called melanocytes, which produce the pigment melanin. Melanocytes are located in the epidermis.



Internal structure of the human skin

The skin contains sensory nerve endings which are receptors. They are sensitive to pain, pressure, touch, heat and coldness. When the nerve endings are stimulated they set up nervous impulses which are sent to the spinal cord or brain to be interpreted.



Sensory receptors of the skin

Functions of skin

- Regulation: The skin plays an important role in regulation of body temperature in an organism thus helping to keep the body temperature constant (endothermic).
- The skin manufactures vitamin D through exposure to sunlight. Ergosterol in the fatty layer of the skin converts into vitamin D under the influence of sunlight.
- The skin produces melanin that protects the body from ultra violet radiations which can cause skin cancer.
- The skin acts as sensory organ due to the presence of various nerve endings.
- Protection: It prevents micro-organism and other foreign materials from entering the body.
- Excretion: Sweat glands produce sweat, which gets rid of excess heat, water, salts, some carbon dioxide and urea.
- Storage: Fat is a food store in the dermis.

Adaptations of the skin to its functions (as a sense organ)

The human skin is adapted to its sensory functions by having the following features:

- It has the hair erector muscle which controls whether the hair stands erect or lies down depending on the temperature of the surrounding.
- It is supplied with nerves which convey impulses to the CNS to be interpreted.
- Presence of blood vessels (in the dermis) which dilate when the body temperature is high to facilitate heat loss by radiation and constrict when the temperature is low to reduce heat loss. The blood vessels also supply nutrients and oxygen to the skin and remove excretory products.

- The skin has sweat glands which produce sweat to help cool the body. During a hot day, the glands produce sweat (through sweat pores). Evaporation of the sweat uses the body heat and hence helps to cool down the body.

Drugs and Drug Abuse in Relation to Nervous Coordination

The Meaning of Drugs and Drug Abuse, in Relation to Nervous Coordination

Explain the meaning of drugs and drug abuse, in relation to nervous coordination

Drugs

A drug is any chemical substance, natural or synthetic, that has known physiological effects on humans or other animals. Foods are generally excluded from this definition, in spite of their physiological effects on animal species.

Most drugs, both useful and harmful, may affect the body (especially the brain), by altering the nerve cells' natural reaction to these chemicals, or by mimicking the body's normal compounds.

Some drugs slow down the passage of stimuli by affecting nerve cell membranes, and others act like neurotransmitters, perhaps passing stronger or longer-lasting impulses. As such they may alter the way sensory information is processed, or affect the thinking process.

Stimulants are drugs which speed up the action of the brain e.g. caffeine, found in tea and coffee.

Sedatives are drugs which slow down the action of the brain e.g. alcohol. Even one alcoholic drink will have some effect on the brain.

Proper Ways of Handling and Using Drugs

Outline proper ways of handling and using drugs

Proper use and handling of drugs

When using and handling drugs the following precautions must be observed:

- Avoid taking any drug without diagnosing the disease and prescription by the doctor.
- Always stay away from peer pressures and drug addicts to avoid copying their bad habits.
- Keep yourself busy with a number of activities such as sports and games, reading books, etc. Remember 'an idle mind is the devil's workshop'!
- Report any case of drug abuse or trafficking to concerned authorities.
- Form a counselling club to advise people especially youths on how to keep off from drugs.
- If one feels addicted, s/he should seek advice from health officials.
- Never take a dose more or less than what has been prescribed by the doctor.
- Complete the prescribed dose even after you start feeling well or after the symptoms of the disease have disappeared.
- 9. Keep all drugs out of reach of children and drug addicts.

Drug addiction

Drug addiction refers to the compulsive and repeated use of increasing amounts of drugs with the appearance of withdrawal symptoms when drug use ceases. While drug use often begins as a way to seek recreation, the addictive properties of the drug make an addict crave for it permanently. This compulsion is uncontrollable and may interfere with a person's everyday life. Even when the effects

of drugs are damaging to a person's body and relationships with friends, family members and co-workers, the constant need for a drug often overcomes any rational thinking.

The human body has its own ability to produce some chemicals for its proper functioning. The continued use of the drug suppresses the body's ability to produce these chemicals or diminishes its production because these chemicals are replaced by the drug. The body thus uses the drug as a substitute for its own natural chemicals. Since these chemicals are no longer produced, the body perceives that it needs the drug for its functioning. Therefore, a person craves for the drug so much that s/he feels cannot live without taking it. At this level the drug abuser becomes addicted to the drug. This is called drug addiction.

Causes and Effects of Drug Addiction

Explain causes and effects of drug addiction

Like many mental health disorders, several causes may contribute to development of drug addiction and dependence. Some of the causes of drug abuse and addiction include the following:

- Some people take drugs to avoid physical or emotional pain, discomfort, stress, boredom, anxiety and depression.
- Some people also take drugs as a way to forget problems and life hardships they experience in life.
- Recreation: Drug users believe that taking drugs make them 'feel better' and lively.
- Peer pressure leads people to drug so as to create a sense of belonging and fitting in the peer group. It's often said that teens use drugs when their friends do. Using drugs allows these young people to fit in with their peers and blend in with the crowd
- . Desire for a new experience and arousal: Some people just take drugs as an 'experiment' to find out the experience the drug users feel, but badly end up becoming drug addicts.
- Lack of life and social skills, for example drug resistance skills that would help a person learn how to say no or avoid bad influence. People who are easy to copy habits from others, irrespective of the outcome of the given habit, can easily get into drug use.

Effects of drug abuse and addiction

Effects of drug abuse and addiction

Many illegal chemicals have extreme effects on the function of the brain, e.g. some drugs cause hallucinations - objects around you may change colour, shape and size, or you may see and experience things that are not there at all. Such experiences may cause fear, depression, and mental disorders. Mostly, these substances alter one's perception of reality.

Drugs produce a variety of short-term effects, but the most common ones include increased heart rate, high blood pressure, dizziness, tremors, mood changes and paranoia. In high dosages, the risk for more dangerous effects increases, and the potential for heart attack, stroke, respiratory failure and coma increases. The various effects of drug abuse include the following:

- Drugs confuse the mental faculties so that many drug users die in accidents, or overdose on the chemicals. Drugs can also induce them to do dangerous activities such as unsafe sex or reckless driving.
- Many drugs induce a feeling of dependency (addiction) and are linked with criminal activity.
- Solvent abuse (sniffing glue, lighter fuel, etc.) - on which one can easily overdose - can cause death by heart failure.

- Other substances can incidentally affect the body's "thermostat" - located in the hypothalamus (refer to a topic on homeostasis and osmoregulation) and cause death, following disruption of the body's temperature control and regulation of the body's water content. Even "legal" chemicals, such as alcohol (a "social" drug!), have adverse effects on the body.
- They can lead to aggressiveness, crime, violence and divorce.
- Sharing of needles used to inject drugs into the bloodstream cause HIV infections and hepatitis among the addicts. Likewise, because drugs impair one's judgement, it can lead to unprotected sex and hence become the cause of contracting other sexually transmitted diseases like syphilis, gonorrhoea, chlamydia and herpes.
- Drugs are very expensive to purchase. Therefore, the addicts spend much of their money on drugs at the expense of other family needs.
- Many drug addicts are weak and so they cannot participate in income generating activities. This leads to poverty, a fact which can lead to failure to meet one's basic needs.
- Drug addiction among women can lead to birth defects which include giving birth to small or premature babies or cause the baby to have withdrawal symptoms, birth defects or learning and behavioural problems. Additionally, illicit drugs may contain impurities that may be harmful to unborn baby
- Medical concerns like depression and anxiety can severely interrupt the addict's social and professional life, leading to mood swings, chronic fatigue and a diminished interest in former hobbies and important life events.

Preventive and Control Measures of Drug Abuse

Suggest preventive and control measures of drug abuse

Drug abuse is a serious psycho-sociological problem often difficult to be cured. The best way to avoid these tragedies is to never start taking drugs. However, nowadays specific treatments are available for different types of mental illness. A regular, prolonged and sincere treatment is required. Social therapy or rehabilitation has got a very significant role. The following activities can be done for the control of drug addiction:

- Early detection, treatment and rehabilitation of drug addicts can help minimize the problem.
- Parents should set a warm and friendly atmosphere at home so that the drug users can feel easy to cooperate with.
- Motivation of the addicts to make up for detoxification.
- The youth should be motivated to get involved in the fight against drug abuse.
- Educating the community about the problems of drug addiction.
- Enforcement of laws, rules and regulation for the control and supply of drugs.
- The school curricula should contain courses about the drug addiction and drug abuse in detail (like the topic you are reading now).
- Various effects of drug addiction must be advertised through newspapers, radio, television, magazine, social media, and many other media so as to make the problem known to as many people as possible.

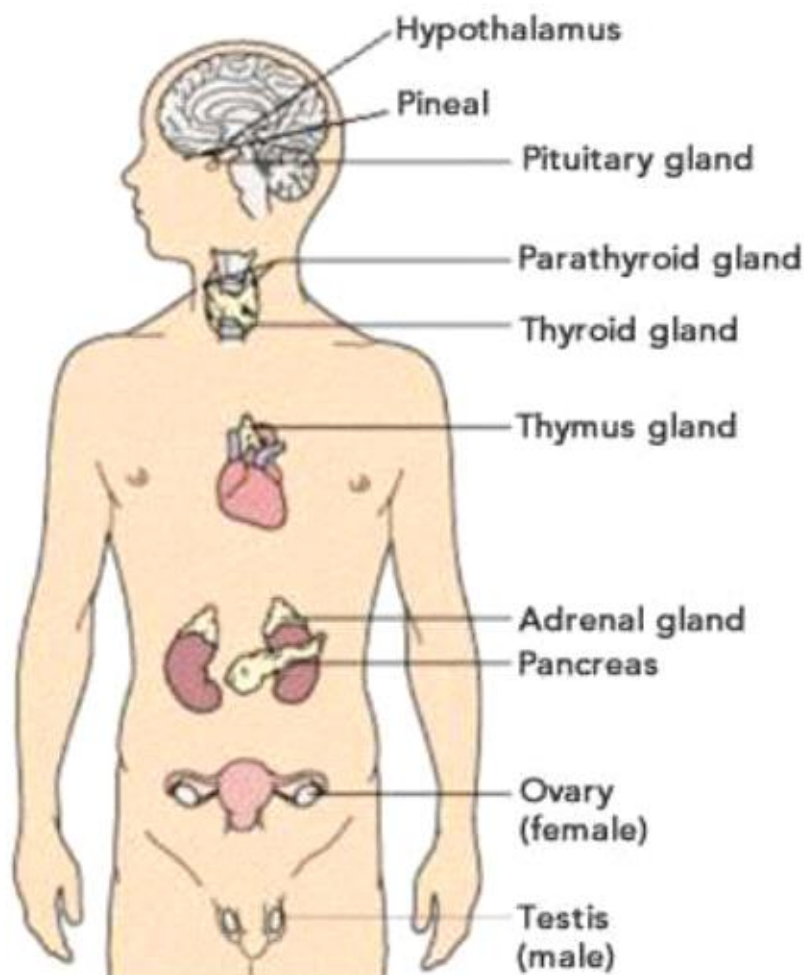
- The experience of drug users can be advertised to the people through media to make the general public aware of the effects of drugs so as to discourage those who might think of starting taking drugs.

Location of the Different Endocrine Glands in the Mammalian Body

Identify location of the different endocrine glands in the mammalian body

THE ENDOCRINE SYSTEM

The endocrine system is a collection of glands that produce hormones which regulate metabolism, growth and development, tissue function, sexual function, reproduction, sleep, and mood, among other functions. The glands are located in various parts of the human body. The function of these glands is to release various hormones, and as a whole, they are most commonly referred to as the endocrine system. These glands are pituitary gland, hypothalamus, thymus, pineal gland, testes, ovaries, thyroid, adrenal glands, parathyroid and pancreas. The location of these glands in the human body is as shown in the diagrams below.



The human endocrine system

The role of Hormones produced by each Endocrine gland

Explain the role of hormones produced by each endocrine gland

The hormones released by glands of the endocrine system regulate the functions of many cells and organs as indicated in the following table.

Disorders of Hormonal Coordination in Mammals

Outline disorders of hormonal coordination in mammals

Causes of endocrine disorders

The causes of endocrine disorders are typically grouped into two categories:

- Endocrine disease that results when a gland produces too much or too little of an endocrine hormone, called a hormone imbalance.
- Endocrine disease due to the development of lesions (such as nodules or tumours) in the endocrine system, which may or may not affect hormone levels.

The endocrine's feedback system helps control the balance of hormones in the bloodstream. If your body has too much or too little of a certain hormone, the feedback system signals the proper gland or glands to correct the problem. A hormone imbalance may occur if this feedback system has trouble keeping the right level of hormones in the bloodstream, or if your body doesn't clear them out of the bloodstream properly.

Increased or decreased levels of endocrine hormone may be caused by:

- A problem with the endocrine feedback system.
- Disease.
- Failure of a gland to stimulate another gland to release hormones (for example, a problem with the hypothalamus can disrupt hormone production in the pituitary gland).
- A genetic disorder, such as multiple endocrine neoplasia or congenital hypothyroidism.
- Infection.
- Injury to an endocrine gland.
- Tumour of an endocrine gland. Most endocrine tumors and nodules (lumps) are non-cancerous. They usually do not spread to other parts of the body. However, a tumor or nodule on the gland may interfere with the gland's hormone production.

Types of endocrine disorders

There are many different types of endocrine disorders. Majority of endocrine disorders cause the endocrine glands to produce too much (hypersecretion) or too low (hyposecretion) of a given hormone from a particular gland. Common problems that result from oversecretion (hypersecretion) or undersecretion (hyposecretion) of given hormones from given endocrine glands are explained below.

PITUITARY GLAND

Hypersecretion of growth hormone: Gigantism in children and acromegaly in adults. If the pituitary gland produces too much growth hormone, a child's bones and body parts may grow abnormally fast.

Hyposecretion of growth hormone: Pituitary dwarfism - if the condition occurs during childhood, it slows down long bone growth.

Hypersecretion of ADH: Causes increased reabsorption of water in the kidney tubules leading to production of a little urine but which is more concentrated.

Hyposecretion of ADH: Less water is absorbed from the glomeruli filtrate back to the body, leading to production of large volumes of dilute urine. This is called diuresis and is a symptom of diabetes insipidus.

THYROID GLAND

Hyperthyroidism

- Grave's disease: The most common cause for an overactive thyroid is an autoimmune disorder called Grave's disease. Grave's disease, considered an autoimmune disease, shows elevated weight loss, nervousness, excessive perspiration, nervousness, high metabolic rate and rapid, irregular heartbeat.
- Exophthalmos: protrusion of the eyeballs caused by oedematous tissue behind the eyes.

Hypothyroidism

- Cretinism (infantile hypothyroidism) - shows stunted growth, thickened facial features, abnormal bone development and mental retardation.
- Myxedema - low metabolic rate, lethargy (a condition characterized by extreme fatigue or drowsiness, or prolonged sleep patterns.), weight gain, increase in body fluids.
- Goitre - abnormal growth of the thyroid gland.

PARATHYROID GLAND

Hyperparathyroidism: demineralization of bone resulting in possible bone deformity and fracture, and stones in the urinary tract

Hypoparathyroidism: decreased plasma calcium levels which can lead to severe muscle tetany (a condition characterized by or resulting from uncontrolled muscle spasms).

PANCREAS

Hyperinsulinism: The liver is overstimulated to convert excess glucose to glycogen and fats for storage. This leads to low glucose concentration in the blood, a condition called hypoglycemia. This condition results in lack of glucose delivery to the brain causing disorientation, unconsciousness and even death (usually the result of an overdose of insulin).

Hypoinsulinism: Under-secretion of insulin causes very little glucose to be converted to glycogen and fats. This results in elevated glucose levels in the blood and urine. The condition is called hyperglycaemia, and is a symptom of diabetes mellitus. Over time, diabetics experience vascular and neural problems. Secondly, poor circulation may lead to gangrene, blindness, kidney damage and impotence.

ADRENAL GLAND

Hypersecretion of corticosteroids: Cushing's syndrome - changes in carbohydrate and protein metabolism resulting in a puffy appearance.

Hyposecretion of glucocorticoids and mineralocorticoids: Addison's disease - symptoms of the disease include fatigue, stomach upset, hypoglycaemia, sodium and potassium imbalance, dehydration, hypotension, and rapid weight loss. Death occurs with lack of treatment.

Hypersecretion of adrenaline: hypertension, obesity, headache, increased heartbeat, weak bones, hyperglycaemia, nervousness, sweating and early onset of sexual development.

Hyposecretion of adrenaline: low blood pressure, fatigue, muscular weakness, muscle wasting, inability to withstand stress, and increased dark pigmentation of the skin.

OVARIES

Hypersecretion of oestrogen: Causes decreased sexual desire, heavy menstrual flow and increased weight in females.

Hyposecretion of oestrogen: Causes failure of females to develop some secondary sexual characteristics, poor development of the reproductive organs, liver, kidney and lungs.

TESTES

Hypersecretion of testosterone: Causes males to have female features such as enlarged breasts and a wide pelvis.

Hyposecretion of testosterone: Causes failure of males to develop some secondary sexual characteristics, poor development of the reproductive organs and weak bones and muscles.

THYMUS

Not responsible for any effects of hypo or hyper secretion of thymosin.

PINEAL

Not responsible for any effects of hypo or hyper secretion of melatonin.

Coordination in Plant, Concept of Tropic and Nastic Responses

The Concept of Tropic and Nastic Responses

Explain the concept of tropic and nastic responses

COORDINATION IN PLANTS

Both, plants and animals react (or respond) to various stimuli around them. But the method of reacting to stimuli is not similar in plants and animals. They react to stimuli in different ways. For example, plants bend towards light but animals do not bend towards light. The animal amoeba reacts to the presence of food by moving towards the food particle.

The plants do not have a nervous system and sense organs like eyes, ears, or nose, etc., like the animals, but they can still sense things. The plants can sense the presence of stimuli like light, gravity, chemicals, water, and touch, etc., and respond to them. They sense these stimuli by using hormones in them.

The stimuli like light, gravity, chemicals, water, and touch, etc., are called environmental changes.

So, we can also say that the plants coordinate their behaviour against environmental changes by using hormones. The hormones in plants do not act the same way as in animals.

The hormones in plants coordinate their behaviour by affecting the growth of a plant. And the effect on growth of the plant can result in the movement of a part of the plant like shoot (stem) or root, etc towards a certain stimulus.

Experiments to Investigate the Effects of Tropic and Nastic Responses in Plants

Carry out experiments to investigate the effects of tropic and nastic responses in plants

Plants receive and respond to a variety of stimuli that are important to their survival in the environment. These responses allow the plants to survive, grow, develop and reproduce. The movement of plants in the direction of stimulus is known as 'tropism'. Tropisms are growth responses of plants that result in curvatures of plant organs toward or away from certain stimuli. Tropisms can be positive, in which case the plant will bend toward a stimulus, or negative, in which case the plant will bend away from a stimulus.

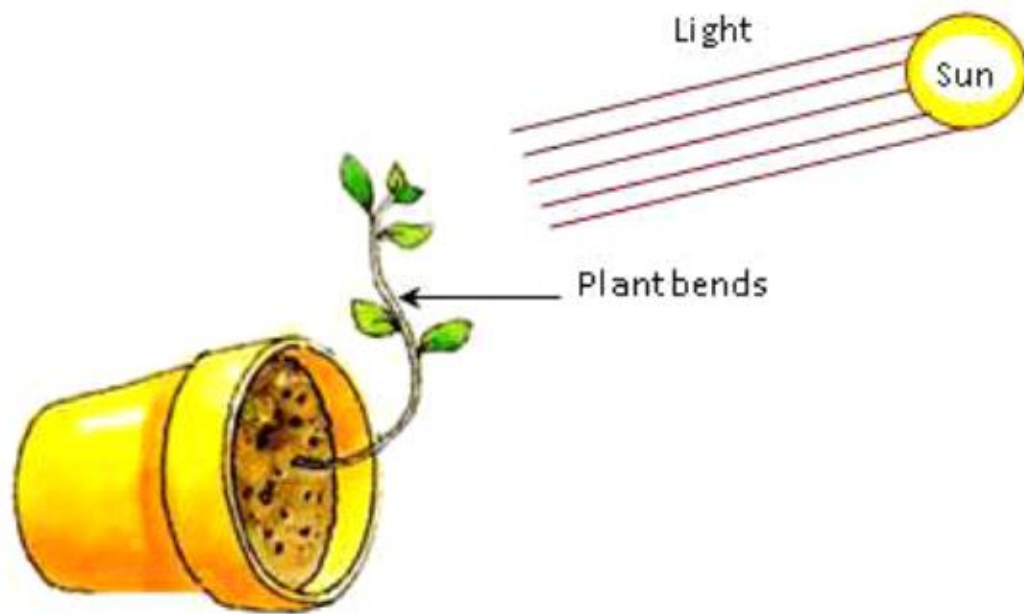
The other movements shown by the plants are associated with the growth of the plants. For example, the shoot system moves towards sunlight and the root system towards earth. Thus, the plants also respond to their environment.

Important tropisms in plants include phototropism, geotropism, hydrotropism, chemotropism and thigmotropism.

Phototropism

Phototropism is the tendency for plant organs to bend in response to a directional light source. For example, light streaming in a window from one direction will often cause the stems of plants placed nearby to bend toward the window, a positive phototropism.

Most plant shoots are positively phototropic because they tend to grow towards light. Most roots are negatively phototropic because they grow away from light.



A plant shoot bending towards light

The Importance of Tropic and Nastic Responses

Explain the importance of tropic and nastic responses

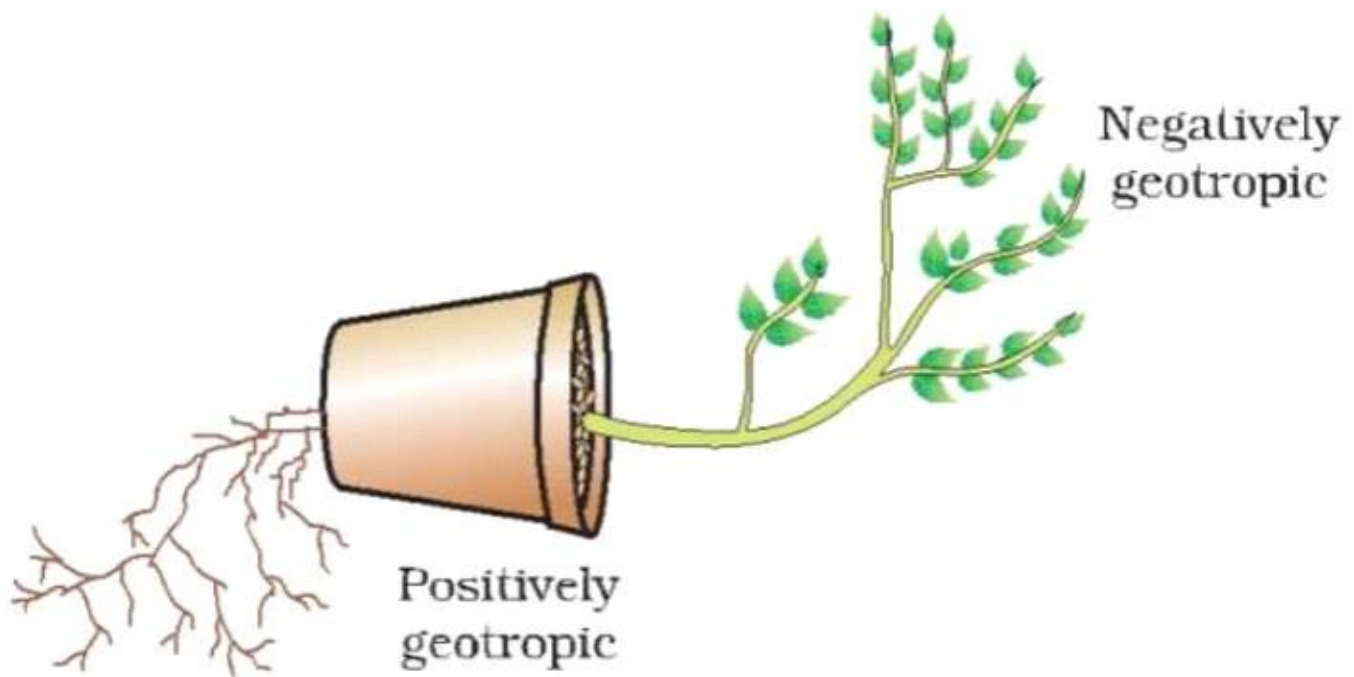
Importance of phototropism

Phototropism is important to plants because of it enables the plant leaves to be placed under direct sunlight to absorb maximum light so as to carry out photosynthesis effectively.

Geotropism

Geotropism is the movement of a part of the plant towards gravity. In most plants, roots grow downward with gravity while shoots grow upward against gravity. Within hours, the shoot of a plant placed on its side will usually bend upward and the roots will bend downward as the plant reorients its direction of growth in response to gravity.

Most plant roots grow towards gravity and are said to be positively geotropic. Most shoots grow away from gravity and are said to be negatively geotropic.



Positive and negative geotropism

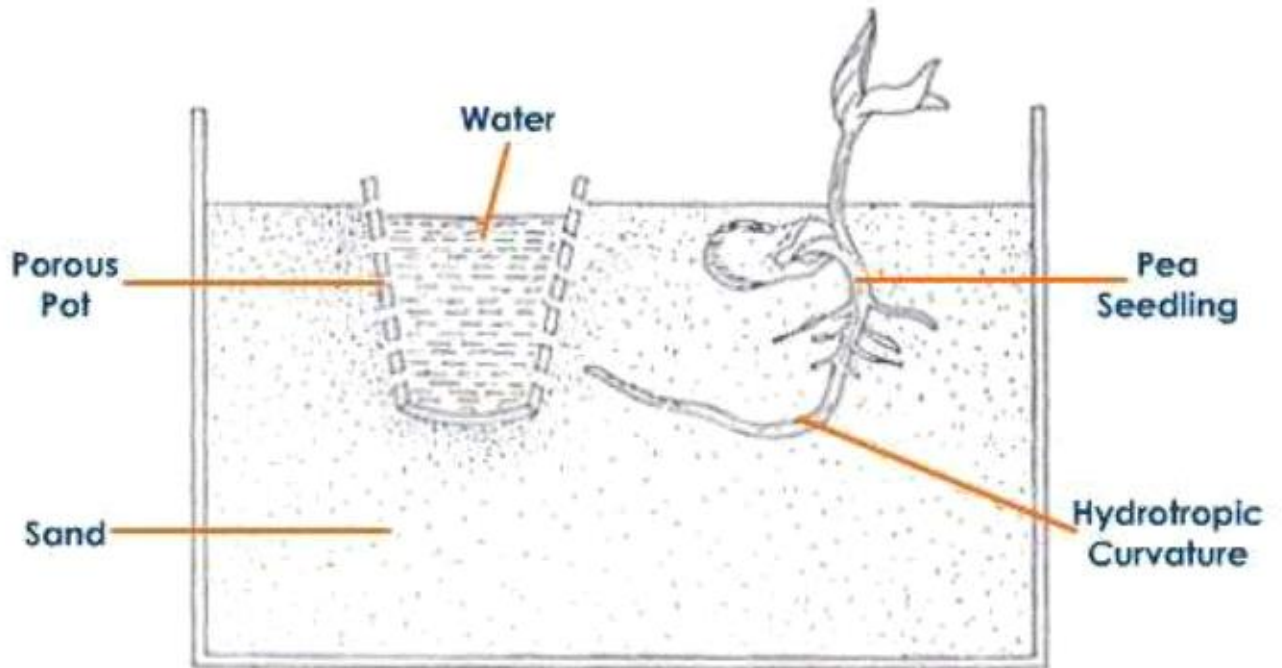
Importance of geotropism

Geotropisms are important to plants because of the following reasons:

- It enables the plants to send roots into the ground hence anchoring the plant firmly into the soil.
- It enables plant roots to absorb water and mineral salts from the soil.
- Negative geotropism exhibited by the shoot enables the shoot to grow upwards, and in so doing, exposes the plant leaves to maximum sunlight for effective photosynthesis.

Hydrotropism

Hydrotropism is the movement of a plant or part of a plant towards water. Plant roots normally grow towards moisture. They are therefore positively hydrotropic. If you plant a plant near a water source such as a porous pot or river, the roots will always grow towards water.



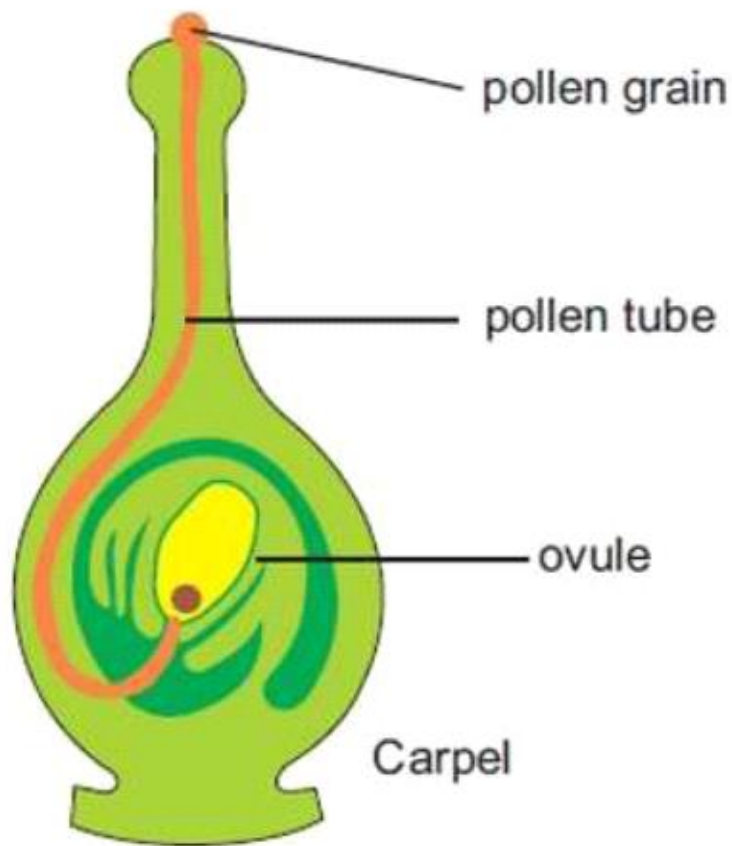
Plant roots growing towards water

Importance of hydrotropism

It enables the plants to absorb dissolved minerals and water. Water is necessary for various functions such as:

- Photosynthesis
- Numerous physiological reactions that take place within plant cells.
- Turgor pressure, which aids in plant support.
- Dissolution of mineral salts.

Chemotropism



Chemotropic response

An example of positive and negative chemo-tropism is shown by a plant's roots; the roots grow towards useful minerals displaying positive chemo-tropism, and grow away from harmful acids displaying negative chemo-tropism.

Chemotropism is the movement or growth of an organism or part of an organism in response to a chemical stimulus. During the process of fertilization the movement of pollen tube towards ovule due to secretion of a sugary chemical in the ovary is an example of chemotropism.

Importance of chemotropism

- It enables the plant to absorb mineral salts from the soil when the roots grow towards beneficial chemicals such as fertilizers.
- Negative geotropism, such as when plant roots grow away from the toxins, enables the plant to survive by avoiding contact with such harmful chemicals.
- It facilitates the fertilization process in flowering plants.

Thigmotropism or haptotropism

Thigmotropism refers to non-directional movements which take place neither towards nor away from the stimulus. The best example of nastic movement is folding and drooping of leaves of *Mimosa pudica* plant when its leaves are touched with fingers or any object. The leaves fold even when swayed about by wind. Also the specialized touch-sensitive tendrils of many vining plants, such as

pea, will bend toward the side receiving a touchstimulus. Continual stimulation can lead to the coiling of the tendril around an object,which enables vining plants to grasp objects on which they can climb



Mimosa pudica plant responding to touch stimulus



Thigmotropism in climbing plants

Importance of thigmotropism

- Thigmotropism enables crawling plants to climb up higher plants and expose their leaves to sunlight for optimum photosynthesis.
- It enables the insectivorous plants such as the Venus flytrap to trap insects and digest them to obtain nutrients.

Concept of Excretion

The Concept of Excretion

Explain the concept of excretion

Chemical reactions occur in the cells of living organisms all the time to carry out the life processes. The sum of these reactions is called metabolism. Metabolism produces useful products as well as toxic (poisonous) by-products.

These toxic substances have to be removed as they are harmful if allowed to accumulate. The removal of metabolic waste products from the body of an organism is known as excretion.

The major excretory products are carbon dioxide, excess water, and nitrogenous compounds like ammonia, urea, uric acid, etc. Carbon dioxide and water are produced in the process of tissue respiration. Nitrogenous compounds are formed from the breakdown of proteins and amino acids. Water and salts in excess of the body's needs are also excreted.

Other excretory products include chemicals from medicines, toxic substances, and circulating hormones that have already served their purpose. We will learn how metabolic wastes get eliminated.

In concise, excretion is the process by which waste products of metabolism and other non-useful materials are eliminated from an organism.

Examples of Excretory Products Eliminated by Organisms

Give examples of excretory products eliminated by organisms

Living organisms excrete various excretory products of diverse chemical nature. The following are examples of excretory products excreted by living organisms:

- **Carbon dioxide:** This is a by-product of respiration of both plants and animals. It is excreted through the pores of the stomata in plants (some of the carbon dioxide produced by respiration is used in photosynthesis). In man, carbon dioxide is eliminated from the body by lungs.
- **Water:** The concentration of water in cells must be kept within narrow limits. Too little or too much water can have a negative effect on the osmotic condition in and around the cell. Therefore, it has to be regulated. Plant cells are protected from bursting by their cell walls. Animals do not have cell walls, and will burst if they have too much water. Excess water is lost from the surface of gaseous exchange in both plants and animals. In mammals, water is also lost through sweat and through osmoregulation controlled by the kidneys.
- **Urea:** This is a compound produced in mammals from the breakdown of excess amino acids. Amino acids cannot be stored because their accumulation is toxic. They are therefore converted into a less toxic substance. This process occurs in the liver and is called de-amination. Ammonia is converted to urea by the liver. Urea is transported by blood to the kidneys where they are excreted. The kidneys are also used to remove uric acid, water, excess salts, excess hormones and bile pigments.
- **Calcium oxalate:** This is a waste material produced by plants and is stored as an insoluble crystalline structure in the cells. Calcium oxalate is stored in aging leaves, stems and roots, flowers or fruits.
- **Oxygen:** Through the process of photosynthesis, oxygen is produced as a by-product. Some of the oxygen is used for respiration, and the remainder is excreted through the stomata of the leaves. In plants, some waste substances are stored in parts of the plant that are dead. Examples of this are the tannin in the bark of trees such as mangroves and the dyes in the heartwood of trees such as logwood. The purpose of the storage of waste material ranges from protection to a decreased risk of being consumed.

Excretion in Human

The main excretory system in humans is the urinary system. The skin also acts as an organ of excretion by removing water and small amounts of urea and salts (as sweat). The urinary system includes a pair of bean-shaped kidneys located in the back of the abdominal cavity.

Excretory Organs in Human Being

There are special organs concerned with removal of excretory products from the body. Such organs are called excretory organs. The excretory organs in an animals body are the kidney, the skin the lungs and the liver. The following table shows the excretory organs and the products they excrete.

The table below summarizes excretory products in humans and the organs concerned with excretion of the product and the mode of excretion.

<i>Excretory product</i>	<i>Organ</i>	<i>Mode of excretion</i>
Carbon dioxide	Lungs	Exhalation
Urea and excess mineral salts	Kidneys	Urine
	Skin	Sweat
	Kidneys	Urine
	Skin	Sweat
Excess water	Lungs	Water vapour
Bile pigments (from breakdown of haemoglobin)	Liver	Faeces

A comparison between different excretory products can be made. Following is the comparison between different types of excretory products:

Waste	Advantages	Disadvantages	Habitat	Excreted by
Ammonia	Produced with little energy	Toxic in concentrated solution. Excretion take place in lot of water	Water	Marine and fresh water invertebrates, bony fishes, amphibians
Urea	Less toxic than ammonia. Less water is needed to excrete it	Requires more energy to produce it	Land, Sea	Adult amphibians, turtles, mammals and bony fishes
Uric Acid	Very little water is used for its excretion	Requires considerable energy to produce it	Land	Reptiles, birds, insects, gastropods (snails and slugs)
Guanine	Relatively non toxic. Less water is used to excrete it	More energy is needed	Arid habitat	Scorpions, Spiders

The excretory organs in humans beings may conventionally be put into two groups namely, primary and accessory organs:

Primary excretory organs

- **Kidneys:** Kidneys are bean-shaped organs of a reddish brown colour that are found in the sides of the vertebral column. Once the body has extracted wastes from food, it sends the wastes to the kidneys. The kidneys filter the wastes, including urea, salt and excess water, which are flushed out of the body as urine.
- **Skin:** The skin performs its excretory function via the sweat glands. These are coiled tubules surrounded by blood capillaries. These glands produce sweat that contains mineral salts, excess oils, water, and traces of urea and lactic acid from the surrounding blood vessels which are then excreted out of the body through sweat pores. The tubules extend into sweat

ducts which open on the surface of the skin as pores. Sweating also helps to cool the body during evaporation.

- **Lungs:** The lungs are very important excretory organs as they expel carbon dioxide from the body via exhalation. The lungs use cells known as alveoli to remove the carbon dioxide from our blood. Otherwise, the carbon dioxide would accumulate and have a detrimental effect to our body.

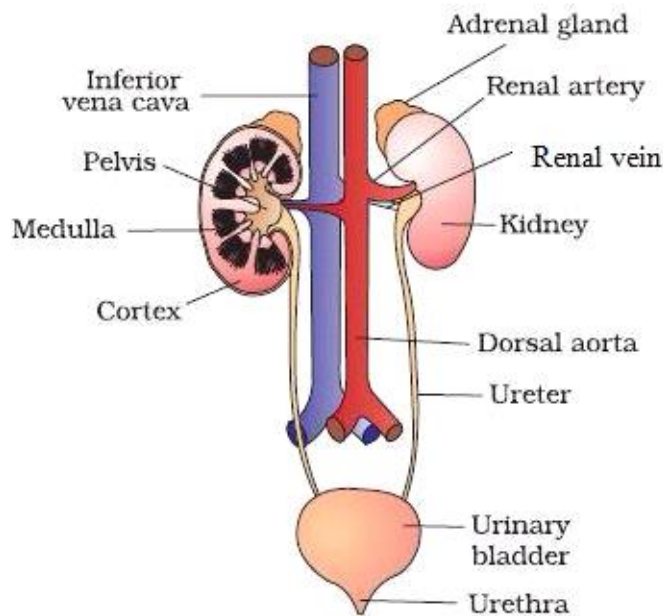
Accessory excretory organs

- **Liver:** Although considered a secondary or accessory excretory organ, the liver plays a vital part in keeping the body clean. Amino acids are the end-product of proteins. Excess amino acids cannot be stored in the body. They are taken from the gut into the liver by the hepatic portal vein. The liver converts them into useful carbohydrates (stored in the form of glycogen) and ammonia. Ammonia is very poisonous and must be removed from the body. The liver converts ammonia into a harmless compound called urea. Urea dissolves in the blood and is transported into the kidney via the hepatic vein where it is removed as component of urine. Harmful poisons and chemicals that are either produced in the body or consumed are broken down and detoxified by the liver.
- **Gall bladder:** Although the gallbladder does not have a highly significant role to play in the excretory system, it does have a function that assists the overall process. Bile, a liquid produced by the liver to break down waste, is first stored in the gall bladder. When needed, it is discharged into the small intestine whose role is to break down fats, ethanol and other acidic wastes.
- **Urinary bladder:** The waste fluid that is created in the liver and collected in the kidney is transferred into the urinary bladder where it is temporarily stored until the individual urinates. The urinary bladder provides a short term solution for storing urine in the body until it is ultimately discharged.
- **Ureters:** The ureters tubes of smooth muscle fibre transfer liquid waste from the kidneys into the urinary bladder. The urine is moved with peristaltic movements which force the urine away from the kidneys. The ureters also have ureterovesical valves which ensure the waste fluid does not travel back into the kidney.
- **Urethra:** The urethra runs through the penis in males, and serves as a carrier of semen as well as urine for their ultimate discharge out of the body. The urethra tube is shorter in females and is just above the vaginal opening.
- **Large intestine:** Food particles are absorbed into the blood stream via the small intestine. The undigested substances are transferred to the large intestine which essentially serves as a storage organ for the excretory products. The descending, ascending and transverse colons also facilitate the absorption of leftover vitamins, water and salt. The distal straight section (known as the rectum) is used for the storage of waste products (faeces) before they are excreted from the body via the anal canal with the help of internal and external sphincters.

The Urinary System and its Adaptive Features

Describe the urinary system and its adaptive features

The urinary system is a system concerned with production, storage and removal of urine. In humans, it is made up of the two kidneys, ureters, blood vessels that join them, urinary bladder and urethra.



The human urinary system

Each kidney is connected to a urinary bladder by a tube called the ureter. As urine is formed, it passes through the ureter to the urinary bladder where it is stored temporarily. Below the bladder is a tube called urethra which is surrounded by a ring of muscles called sphincter muscles. The urethra is a canal that carries urine from the bladder and expels it outside the body. The urethra passes urine when sphincter muscles relax.

The kidneys: Kidneys are bean-shaped organs that are deep red in colour located on the dorsal part of the abdominal cavity. Mammals have one pair of kidneys. Kidneys are the principle organs of the urinary system.

Functions of the kidneys

- They filter blood to remove wastes and reabsorb useful substances such as water and salts.
- They maintain appropriate water-salt balance in the blood.
- They regulate the acid-base balance such that the pH of blood remains at about 7.4 for proper functioning of the body.
- They are important in regulation of blood pressure.
- They produce erythropoietin, calcitriol and an enzyme called rennin, which is involved in the formation of the hormone, angiotensin, which raises blood pressure. Erythropoietin is a hormone that speeds up the process of the formation of red blood cells in the bone marrow. Calcitriol is an active form of vitamin D which increases the rate of calcium reabsorption for bone formation.

Structure of the kidney

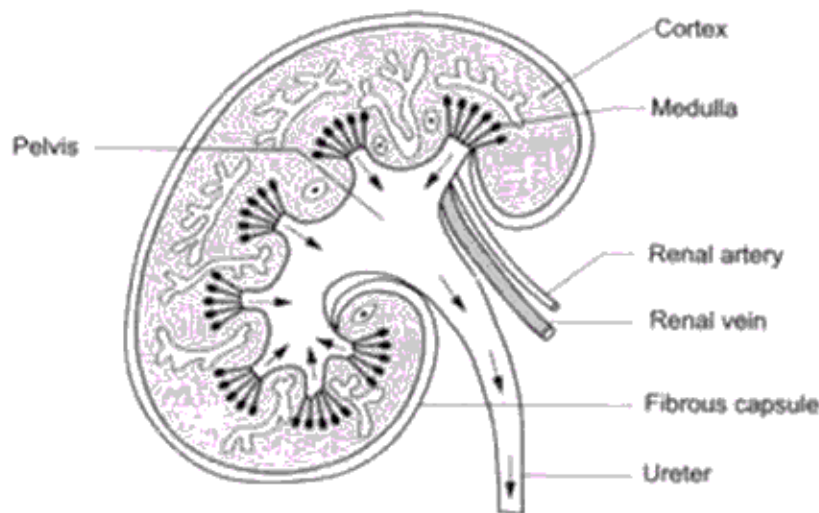
Each kidney is enclosed in a thin, fibrous covering called the capsule. The kidney has three distinct regions, namely the **cortex**, **medulla** and **pelvis**.

The cortex is the outermost layer of the kidney.

The medulla is the middle layer of the kidney, normally red in colour.

The pelvis is the space inside the kidney which collects the urine and leads it to the ureter. The ureter passes urine to the urinary bladder where it is stored before it is released out through the urethra in the genitals.

Each kidney is supplied with oxygen-rich blood from the renal artery. Deoxygenated blood is returned to the circulatory system from the kidneys via the renal vein. Blood entering the kidneys from the renal artery are rich in waste materials, and blood exiting the kidneys from the renal vein is deficient in these waste materials.



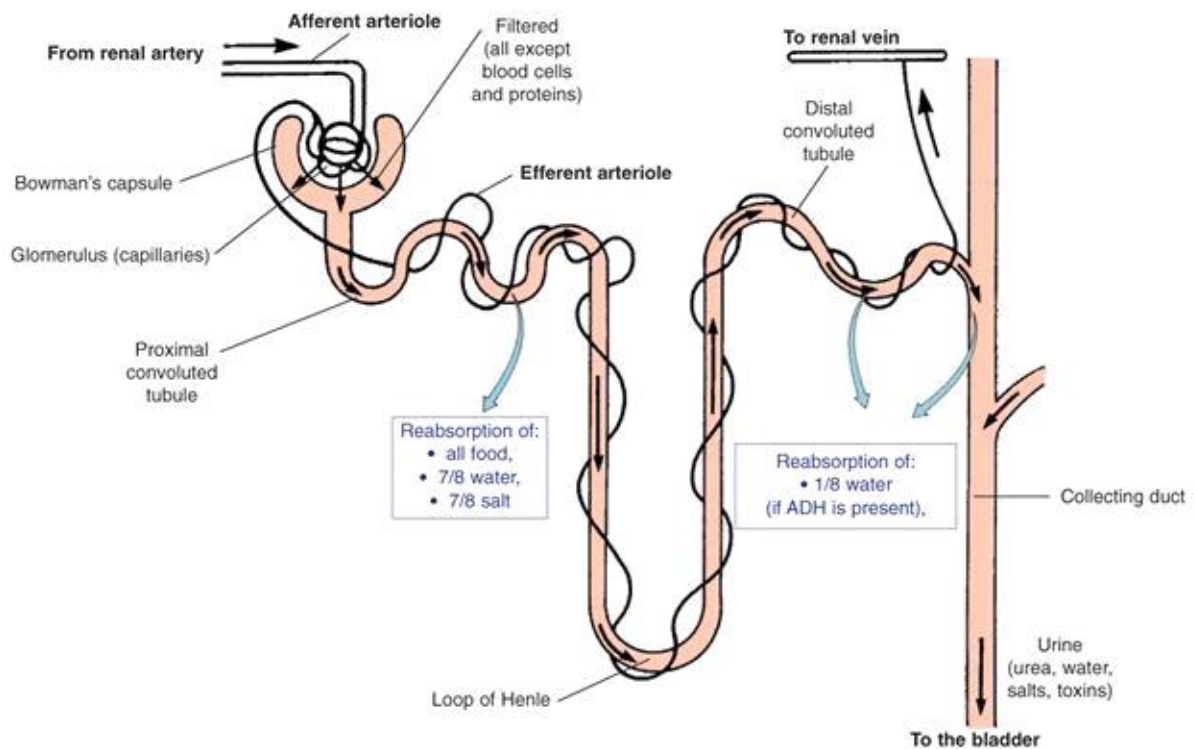
Structure of the kidney

The nephron

Each kidney is made up of numerous, coiled excretory tubules known as nephrons, and collecting ducts associated with tiny blood vessels.

A nephron consists of a long, coiled tubule, and the Malpighian corpuscle.

- The tubule of the nephron is differentiated into the proximal convoluted tubule, loop of Henle and the distal convoluted tubule.
- The distal tubule opens into the collecting duct.
- At the proximal end of the nephron is the Malpighian corpuscle, which consists of Bowman's capsule and the glomerulus.
- Bowman's capsule is a double-walled, cup-like structure which surrounds the dense network of blood capillaries called the glomerulus.



Structure of the nephron

- There is a branch of the renal artery, the **afferent arteriole**, entering the small cup-like space of the Bowman's capsule as a network of blood capillaries.
- This network is known as the **glomerulus**. Emerging from this network, the capillaries re-unite to form a small arteriole, known as the **efferent arteriole**.
- As the efferent arteriole continues it twines around the proximal and distal convoluted tubule.
- The efferent arteriole divides into capillaries at several points along the length of the tubules, absorbing various substances.
- These capillaries eventually reunite to drain into the renal vein.
- The efferent arteriole is smaller than the afferent arteriole. This difference in diameter helps to raise the glomerular pressure and aids in ultra filtration.
- Some animals do not have a well developed kidney; they may have structures called **nephridia**.
- Animals such as earthworms that are simple tube-like structures have **nephridia** that have the same role as the more complex nephrons in the kidneys.

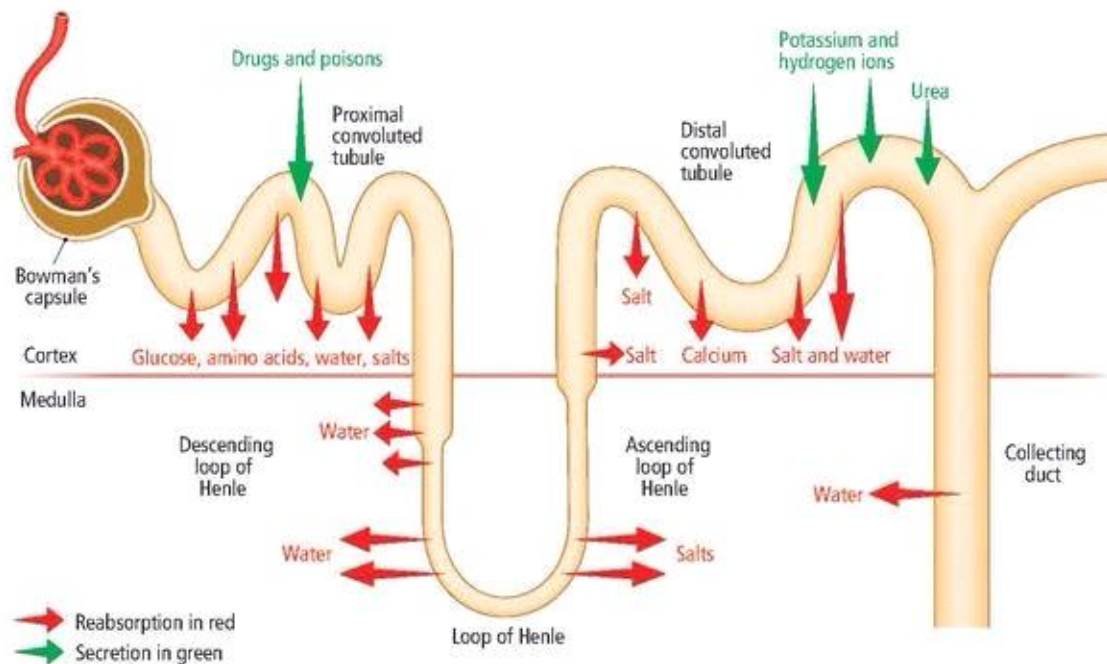
The Process of Urine Formation

Explain the process of urine formation

The blood from the afferent arteriole, which enters the Bowman's capsule, is rich in nutrients such as glucose, fatty acids, amino acids, vitamins, proteins, urea and excess salts. A nephron is the structural and functional unit of a kidney which is concerned with excretion and haemostasis.

The three (3) distinct stages of urine formation are: (1) glomerular filtration, (2) tubular reabsorption and secretion, and (3) water conservation

- Glomerular filtration:** Filtration occurs in the glomerulus (plural; glomeruli). Because the lumen of the afferent arteriole is significantly smaller than the efferent arteriole there is a large amount of pressure in the glomerulus. This pressure forces plasma, the liquid portion of the blood, through the capillary walls in the glomerulus. The plasma contains water, glucose, amino acids, urea, salts, uric acid, vitamins, and hormones. Red blood cells and proteins are retained in the blood capillaries because they are too large to pass through the wall. This process is called ultra-filtration and the fluid which passes into the Bowman's capsule is known as the glomerular filtrate. The glomerular filtrate collects in the capsule and enters the renal tubule at the proximal convoluted tubule which is coiled to increase the surface area for reabsorption of substances.
- Reabsorption :** The efferent arteriole branches into capillaries which surround the proximal convoluted tubule. There, glucose, amino acids, vitamins, hormones and about 80% of sodium chloride and water are reabsorbed into the blood capillaries. Only the substances that are useful to the body are reabsorbed. This is referred to as selective reabsorption. Normally 100% of glucose is reabsorbed. Reabsorption involves both diffusion and active transport (against concentration gradient), which uses energy in the form of ATP. The waste-containing fluid that remains after reabsorption is urine.
- Tubular secretion :** is the passage of certain substances out of the capillaries directly into the renal tubules. Tubular secretion is another way of getting waste materials into the urine. For example, drugs such as penicillin and phenobarbital are secreted into the renal tubules from the capillaries. Urea and uric acid that may have been reabsorbed are secreted. Excess potassium ions are also secreted into the urine. Tubular secretions also maintain the pH of the blood.



Reabsorption and secretion by the nephron
 Adaptations of the urinary system to its functions

- The urinary system has a large afferent arteriole, and narrow efferent arteriole, which allows build up of pressure, thus facilitating ultra-filtration.
- The glomerulus capillaries are highly coiled and semi permeable, causing a build up of pressure in the glomerulus hence ultrafiltration.
- The glomerular capillaries are semi permeable (tubule also semi permeable) to allow selective movement of materials in and out of the nephron (selective reabsorption).
- The tubules' epithelium is thin (1 cell thick) to reduce diffusion distance for faster passage and hence reabsorption of materials; and they are leakier than normal capillaries.
- It is connected to a collecting duct, which channels the filtrate (urine) out of the nephron to the ureter to allow for continuous functioning of the nephron.
- The proximal convoluted tubule and the distal convoluted tubule are coiled so as to increase the nephrons' length and hence more surface area for efficient reabsorption to take place.
- The Bowman's capsule is cup-shaped to provide maximum surface area for filtration.
- The tubule is supplied with a network of blood capillaries for maximum reabsorption.
- The nephrons are numerous in number for efficient excretion of waste products.

Complications and Disorders of the Excretory System

The table below shows some of the common complications and disorders of the excretory system, their causes, symptoms, effects and preventive measures.

The Causes, Symptoms, Effects and Control Measures of Common Complications and Disorders of the Excretory System

Explain the causes, symptoms, effects and control measures of common complications and disorders of the excretory system

Disorders of the Excretory System

Disease	Cause(s)	Symptoms	Effects	Prevention/treatment
Kidney (renal) failure – failure of the kidney to function adequately due to partial or entire destruction of nephrons	<ul style="list-style-type: none"> • Damage to the kidney due to accident or complications during surgery • Low blood volume due to excessive bleeding • Poor intake of fluids • Medication, for example, diuretics ("water 	<ul style="list-style-type: none"> • Oedema (swelling of the legs, ankles, feet, face or hands due to excess fluids) • High levels of urea in blood leading to vomiting, nausea, weight loss, blood in urine or difficulty in 	Bone damage, muscle paralysis, abnormal heart rhythm, loss of memory, pain in the back or side and if not treated earlier, can lead to death if it involves both kidneys	<ul style="list-style-type: none"> • Avoid potassium-rich foods like citrus fruits, bananas, instant coffee, peanuts and chocolate • May require a kidney transplant. • Medications e.g. phosphorus-lowering medications. • Dialysis

	<p>pills") may cause excessive water loss</p> <ul style="list-style-type: none"> • Obstruction of renal artery, causing blocking of blood flow to the kidneys • Kidney stones • Chronic diseases that gradually cause the kidneys to stop functioning • Dehydration from loss of body fluid (for example, vomiting, diarrhoea, sweating, fever) • Prostate cancer may block the urethra and prevent the bladder from emptying 	<p>urinating</p> <ul style="list-style-type: none"> • Loss of appetite 		
Kidney stones	<ul style="list-style-type: none"> • Lack of vitamins • Inadequate intake of water • Certain types of drugs • Decrease in urine volume and/or an excess of stone-forming substances in the urine. • Dehydration from reduced fluid intake or 	<ul style="list-style-type: none"> • Extreme pain and difficulty in urination • Pain in the low back and/or side, groin, or abdomen • Blood in the urine due to damage of the inside walls of the kidney, ureter or urethra • Nausea 	<ul style="list-style-type: none"> • May lead to kidney failure • Toxicity due to urine staying in the body for a long time • Severe back pain • Surgery and medications are expensive 	<ul style="list-style-type: none"> • Taking a balanced diet that is low in protein, nitrogen and sodium • Drinking plenty of water • Avoid beverages that contain caffeine like coffee. • Surgical treatment to remove the stones • May require kidney transplant

	strenuous exercise • Obstruction to the flow of urine • Infection in the urinary tract	and vomiting • Chills and fever		• Medications (painkillers)
Urinary tract infections (UTIs)	• Bacterial infection in the urinary tract	• Frequent or intense urge to urinate even though little comes out when you do • Pain during urination • Pain or pressure in the back or lower abdomen • Cloudy, dark, bloody, or strange-smelling urine • Feeling tired or shaky • Fever or chills (a sign the infection may have reached your kidneys)	• Medications are expensive. • Pain and nuisance due to urge to urinate frequently.	• Drinking a lot of fluids • Maintaining toilet hygiene • Complete urination • Cleanse genital area before sex • Urinate after sex to flush away any bacteria that may have entered your urethra • Keep genital area dry by wearing cotton underwear and loose-fitting clothes
Liver cirrhosis: a condition in which liver cells degenerate and are replaced by scar tissue, causing the liver to shrink, harden, become fibrous and fail to function normally	• Alcohol and viral hepatitis B and C • Attack by bacterial and viruses • Parasites such as liver flukes and schistosoma • Obstruction of the gall	• Loss of weight • Poor appetite • Abdominal pain • Blood stained vomit	• Severe cirrhosis is fatal • Easy bruising, yellowing of the skin (jaundice), itching, and fatigue. • Oedema, ascites (accumulation of fluid in the	• Avoiding excess consumption of alcohol • Avoiding fatty foods • Low salt intake • Eating varied, easily digestible food • Plenty of rest

	bladder <ul style="list-style-type: none"> Exposure to chemical poisons such as silica and asbestos 		abdominal cavity), and liver cancer	<ul style="list-style-type: none"> Medical treatment Liver transplant in case of severe cirrhosis
Hepatitis: Inflammation of the liver	<ul style="list-style-type: none"> It is a viral disease—virus is transmitted through body fluids such as saliva, blood and semen There are five main types of hepatitis: A, B, C, D, and E - plus types X and G 	<ul style="list-style-type: none"> Nausea Fatigue Abdominal discomfort Jaundice Dark brown urine and whitish faeces 	<ul style="list-style-type: none"> May lead to liver failure If not treated early may lead to death 	<ul style="list-style-type: none"> Hygienic processing of food Proper disposal of sewage Treatment of water Proper handling of blood Screening blood before transfusion Using sterilized needles and syringes
Bladder Cancer	<ul style="list-style-type: none"> Not yet very clear but a number of reasons such as smoking, radiation, parasitic infection, exposure to chemicals (carcinogens) may cause the disease. 	<ul style="list-style-type: none"> Blood in urine. Frequent urinary tract infections, painful urination and urge to urinate without actual flow. Weight or appetite loss. Abdominal or back pain, persistent raised temperature or anaemia. 	<ul style="list-style-type: none"> Expenses on medication. Pain - reduces the 	

Excretion in Plants

Plants unlike animals do not have excretory organs.

Plants do not need a specialized excretory system like in animals because of the following reasons:

- The rate of producing waste products in plants is much lower.

- Most excretory products from plants are removed by diffusion through the stomata or lenticels. Lenticels are areas in woody stems where the cells are loosely packed allowing gaseous exchange and removal of waste products.
- The major excretory products of plants are carbon dioxide, oxygen and water. These products are recycled. For example, the oxygen released as a by product during photosynthesis, is used in respiration by animals and plants. The carbon dioxide released during respiration is used for photosynthesis by the plants. Water is released into the atmosphere where it enters the water cycle.
- Plants produce less poisonous substances compared to the nitrogenous wastes produced by animals.
- Plants have large vacuoles which store waste substances often accumulating at concentrations that lead to crystal formation in form of oil droplets or granules.
- Plants can also store the waste products in organs that are destined to fall or die off. So they can be excreted via abscission. Other waste material such as resins, saps and latexes are forced out from the interior of some plants by hydrostatic pressure inside the plant.

The Importance of Common Excretory Products of Plants

Explain the importance of common excretory products of plants

Have you ever noticed sticky, milky or oily substances being oozed from the bark of trees?

These are excretory products and may be resins, gums, latex and or other excretory products. These products may be poisonous. However, many have found use in everyday life of humans, such as latex which is used to produce gloves and clothing. The table below shows functions of some plant waste products.

<i>Product (waste)</i>	<i>Plant source</i>	<i>Use and effects</i>
1. Tannins	Dead tissues of plants such as acacia, conifers, coffee and mangroves.	<ul style="list-style-type: none"> • Treatment/tanning of hides and skins into leather, i.e. it combines with animal proteins to form a complex compound which is not easily broken down by animal proteases. • It is used in the manufacture of inks and dyes.
2. Alkaloids: Are nitrogenous excretory products in plants and occur in various forms- Common alkaloids include:		
(a) Caffeine and theophylline	-Coffee fruits and tea leaves	-Mild stimulants to increase mental activity and reduce fatigue.
(b) Quinine	- Bark of cinchona tree.	-A drug for the treatment of malaria.-An additive in drinks to act as a stimulant.
(c) Cocaine	- Leaves of coca plant	<ul style="list-style-type: none"> • A very expensive drug for local anaesthetics. • A painkiller and also gives great mental and physical strength. • Note: Overdose may lead to hallucinations, anxiety and even death.
(d) Cannabis	-Fruits, flowers and	• Manufacture of drugs such as painkillers.

	leaves of cannabis sativa (bhang or marijuana)	<ul style="list-style-type: none"> • Results in relation, talkativeness, and greater appreciation of sound and colour. • Decreased performance in concentration, intellectual and manual tasks. • Overdose effects are similar to that of cocaine.
(e) Opiates(morphine)	-Opium poppy	Manufacture of drugs like morphine and codeine both of which are effective painkillers, muscle relaxant, cough suppressants, and anti-diarrhoeal.
(f) Nicotine	-Tobacco leaves.	<ul style="list-style-type: none"> • Manufacture of insecticides and narcotic drugs (drugs that stimulate sleep or stimulate a feeling of relaxation and mask the sensation of pain). • A common cause of respiratory and cardiac diseases, due to tar from its smoke.
(g) Papain	-Epicarp of pawpaw fruits (especially raw).	-Has proteolytic activity hence used as a meat tenderizer.
(h) Colchicine	-Roots of the crocus plant.	<ul style="list-style-type: none"> • Interferes with the process of cell division resulting into mutations; and thus useful in plant breeding. • It is also carcinogenic (cancer-causing).
(i) Pyrethrins	-Flowers of pyrethrum	Making of insecticides
(j) Khat (miraa) mirungi)	-Leaves and twigs of the “khat” plat	-Used as a stimulant.
3. Latex	<ul style="list-style-type: none"> • -Rubber tree • Sapodila 	<ul style="list-style-type: none"> • Manufacture of shoe soles, tyres, etc. • Manufacture of chewing gum.
4. Gums	Different plants such as Arabic ghath and carob, acacia tree, etc.	<ul style="list-style-type: none"> • Most are edible and thus used to thicken foods and creams. • Gum from sapodilla is used to make chewing gum. • Agar extract (a gum) from algae is used as a growth medium to culture microorganisms. • It is also used to make cough medicine.
5. Anthocyanins	-Petals and leaves of various plants, and are mostly red, blue or purple.	<ul style="list-style-type: none"> • Extracted for making dyes. • Used in making PH indicators.
6.Digitalis glycosides	-Foxglove	Manufacture of drugs used for treatment of heart diseases such as digitoxin.
7. Rennin	-Certain tree stems like the casuarina tree	-Manufacture of varnish and gum.
8. Oil	-Flowers or leaves of	

	certain trees	
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Topic 5 Concept of Regulation

The Concept of Regulation

Explain the concept of regulation

Living organisms are subjected to wide variations in temperature, light, acidity, salinity, wind speeds, availability of water minerals and nutrients. These environmental factors create a shifting external setting to which organisms must adjust or die.

The central problem for a living thing is to maintain a steady state internally in the face of an often harsh and fluctuating external environment.

Homeostasis is the maintaining of a constant condition of the internal environment of the body by regulatory process. OR It is the maintenance of constant internal balance despite fluctuation in the external environment.

Regulation is the process of controlling the internal body environment and needs. For the body to function properly things need to be regulated in the body.

Reasons that show importance of regulation

- Maintaining favorable condition such as pH and required ionic concentration for the functioning of cells, tissues and organs.
- Enabling organisms to get rid of body wastes and useless materials for example excess water and salts
- Enabling organisms to get rid of excess materials for example excess water and salts
- Ensuring survival of the organisms

Types of Regulation

Mention various types of regulation

The following are the types of regulation:

- Temperature regulation (thermoregulation)
- Blood sugar regulation
- Osmoregulation

Temperature Regulation in Animals

The Concept of Temperature Regulation in Animals

Explain the concept of temperature regulation in animals

HEAT GAIN BY ANIMALS

There are three ways of heat gain by animals:

- Metabolism of food stuffs
- Shivering

- Absorption of solar radiation

EAT LOSS BY ANIMALS

Animals lose heat through:

- Convection – This is flow of heat from the interior of an animal's body to exterior in the surrounding
- Sweating/Evaporation – This occurs when animal loose water vapour from their body surface
- Conduction – This is transfer of heat by physical contact between two bodies
- Breathing out
- Panting
- Salivation
- Defecation
- Urination

Practical Activities to Determine Temperature Regulation in Mammals

Carry out practical activities to determine Temperature Regulation in Mammals

Activity 1

Carry out practical activities to determine Temperature Regulation in Mammals

The Mechanism of Temperature Regulation in Mammals

Describe the mechanism of temperature regulation in mammals

Mammals are categorised into two groupes according to ability to mantain temperatue. namely .

- Endotherms, Homoiotherms, warm blooded
- Ectotherms, Poikilotherms, cold blooded

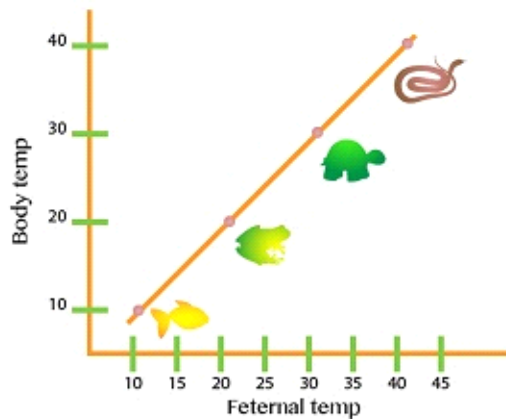
Ectothermic animals gain heat by:

- Metabolism of food stuff
- Solar radiation
- Contractions of body muscles

Each species of ectothermic animal has its own optimum temperature during which metabolic activities can take place.

The graph below shows the relationship between external temperature to internal temperature in Ectothermic animal

RELATIONSHIP BETWEEN EXTERNAL TEMPERATURE TO INTERNAL TEMPERATURE IN ECTOTHERMIC ANIMALS



When the environment is over heated ectotherms:

- Ectothermic animals example fish migrate to places with a more suitable temperature for them
- Use of shade – snakes, frogs, lizards take shade to avoid being over heated
- Pant – turtles and tortoise pant during hot day to loose excess heat

When the environment is over cooled ectotherms:

- Burrow – toads burrow during cold conditions to avoid over cooling
- Bask – snakes, lizards and chameleons bask in the sun to raise their body temperature
- Social behavior – bees cluster together to raise body temperature
- Flex their body muscles e.g. python flex its muscles and coil eggs during cold condition
- Use of metabolic heat – bees contracts their muscles using prior flying in cool weather to raise their body temperature.

Endothermic animals have ability to maintain constant body temperature despite of the changes in environmental temperature.

Endotherms gain heat only through metabolism of food substances. The temperature ranges of these animals are as follows:

- Mammals 35°C – 40°C
- Birds 40°C – 45°C

Each species of endothermic animal has their own optimum temperature during which metabolic activities occur for example homo-sapiens 36.7°C, House fowl 41°C

Temperature regulation in endothermic animals is a physiological process. It is controlled by hypothalamus and contains two thermo receptors hot and cold centers.

When the environment is OVER HEATED:

- During hot conditions hot center in the hypothalamus is activated by increase in blood temperature.

- Hypothalamus uses nerve impulses and hormones as error signals to activate responses that increase heat loss from the body.

Examples of error signals that activate responses that cause heat loss so that the core temperature is brought to its set point are:

- Sweating – Sweat glands secrete sweat and sweat pores open. Sweat evaporates at the surface of skin with heat.
- Vasodilation – Vasodilation is the increase of size of the blood vessels near the skin surface so that the heat is lost by radiation as a result of direct contact of vessels with skin.
- Flattening of body hairs: Hair erector muscles on the surface of the body reduce insulation so that heat loss is simplified.
- Panting – This is a process of opening mouths and hanging out of tongue. Dogs do this process. Panting causes heat loss by evaporation.
- Closing of shunt vessels, a process done by whales closing of shunt vessels directs most of core blood to reach the skin and increase pressure gradient between the skin and the environment hence heat is lost easily to the environment

When the environment is OVER COOLED:

Examples of corrective mechanisms, which conserve body heat, are:

- Shivering is a reflex shaking of muscles. The process results into generation of heat.
- Erection of skin hairs: hair erector muscles erect causing the skin hair to stand and collect air around them which act as insulation for heat loss.
- Vasoconstriction of blood capillaries: Vasoconstriction is a process of narrowing the blood capillaries leading to the skin. This in turn reduces the temperature gradient of the body and environment and heat loss decreases.
- Opening of shunt vessels, a process done by whales. Opening of shunt vessels and back to the internal blood circulation. The process reduces heat loss to the surrounding
- Increase in metabolic activity. An increase in respiration is affected by an increase in thyroxin secretion. During cold conditions, hypothalamus stimulating hormone which in turn stimulates the secretion of thyroxin hormone which influences fast respiration hence an increase in heat gain.

EFFECT OF OVER HEATING

If the core temperature rises above 40°C the thermo-regulating mechanism back down. Positive feedback occurs and a person goes into a state of hyperthermia and suffers heat stroke.

EFFECT OF OVER COOLING

If the core temperature falls below 32°C the pulse rate weakens. The patient becomes sluggish. This condition is called hypothermia.

VARIOUS WAYS MAMMALS ARE ADAPTED FOR COLD AND HOT CLIMATIC CONDITIONS

Adaptation of human beings in cold environment:

- Presence of hair In cold conditions hair erector muscles erect causing the still hair to stand and collect air around them which acts as insulation for heat loss
- Possession of heat under epidermis: fat is a bad conductor of heat, thus prevents heat loss

- Ability of narrowing skin blood capillaries: human beings constrict skin blood capillaries; this reduces the amount of blood passing close to the skin. This prevents heat loss by convection.
- Ability to shiver: During cold conditions human beings are able to perform involuntary muscles contractions, shivering generate heat

Behavioural Adaptations

- Wearing of heavy black clothes: During cold conditions human being put on heavy clothes, examples sweaters and coats. Heavy clothes create layer of air between the body's surface and the clothes. Trapped air is a bad conductor of heat.
- Use of heating systems in houses Human beings during cold conditions use heating systems of different types to warm houses so that they can make their living conditions comfortable.

Adaptations of human beings in hot climate

- Ability of flattening of skin hair. During hot conditions human beings relax hair erector muscles these cause body hair to lie flat on the body surface and reduce insulation so that heat loss is affected
- Ability of widening the size of the skin blood vessels During hot conditions human beings can enter a state of vasodilation where the skin blood vessels near the skin surface expand. Vasodilation enables excess heat to leave the body by radiation as a result of direct contact of vessels with the skin
- Possession of sweat glands Sweat glands secrete sweat on the body's surface through sweat pores. Excess heat is lost when sweat evaporates

Behavioural Adaptation

- Use of Shade: During hot conditions human beings take cover in shade areas to avoid being over heated
- Wearing of light-white clothes These reduce absorption of heat during hot condition
- Use of air conditioners Air conditioners reduce excess heat in houses

Adaptations of a blue whale in cold environment

- Possession of air Circular muscles near the body surface (between endothermic and epidermis) Circular muscles near the body surface shunt the blood away from the body surface during cold conditions then prevent heat loss by convection
- Possession of bladder (fat layer inside the epidermis). Bladder acts as a thermal insulator. Bladder controls the flow of heat from the body core to the body surface. The process occurs during cold condition

Adaptation of blue whale during warm condition

Possession of circular muscles near the body surface (i.e. between endothermic and bladder) where the animal is surrounded by warm sea circular muscles open blood vessels near the body surface. This allows an animal to get rid of excess body heat.

Adaptation of small mammals e.g. squirrels and bats during cold condition

Adaptation of small mammals e.g. squirrels and bats during cold condition.

During cold conditions squirrels and some bats spend the winter in a state of dormant state of hibernation in which they appear to be asleep and during which no food is eaten

Hibernation takes place in burrows. The temperature of these animals falls below normal. The chemical activities in the body go very slow using food stored as fat and glycogen.

Osmoregulation in Mammals

The Concept of Osmoregulation

Explain the concept of osmoregulation

Osmoregulation is the maintenance of constant internal salt and water concentration in an organism.

OR It is the process by which the osmotic pressure of blood and tissue fluid is kept constant.

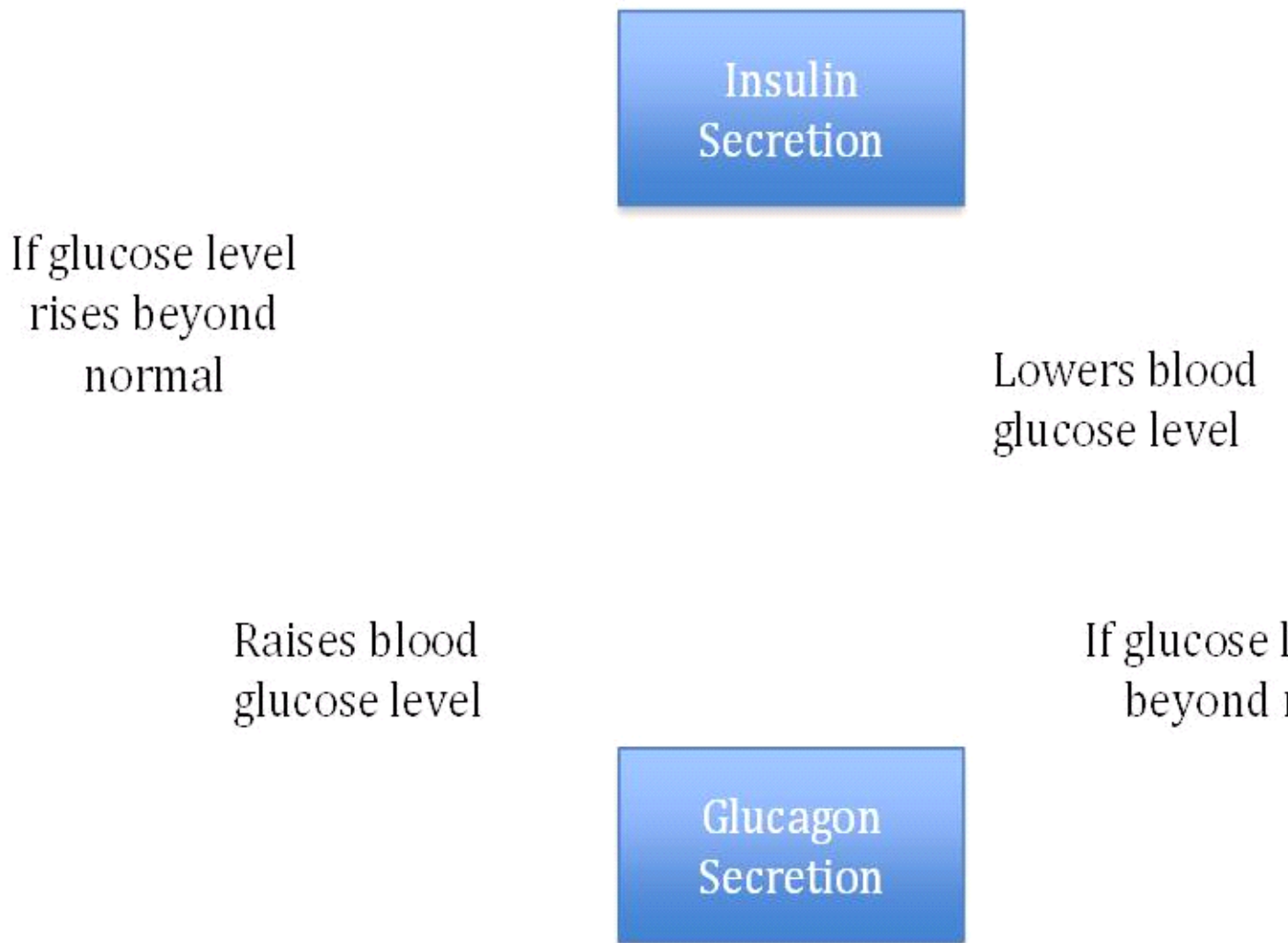
Osmotic pressure of blood and tissue fluid of an animal is exposed as the depression of freezing point in relation to the habitat in which the animal lives.

Factors which Affects the Contents of Salt and Water in the Body

Mention factors which affects the contents of salt and water in the body

Factors affecting content of salt and water in the blood include:

- **Amount of water taken in the body** Large intake of water causes blood to have too much water while fewer intakes causes less water in the blood. It is advised to take two liters equivalent to eight glasses of water per day for the body to function properly. People who are very active might need more than that.
- **Climatic condition** During hot weather there is increased sweating which cause loss of water by evaporation thus reduced amount of water in the blood. The vice versa occurs during cold weather.
- **Amount of salt taken into the body** Putting less salt in food causes reduced salt in the blood while putting too much salt in food causes increased amounts of salt in the blood. Moderate amounts of salt should be taken too much salt is not healthy as it may lead to high blood pressure. Excess salts cause the kidney to work harder as it is responsible for removing excess salts from the body.
- **Hormonal Abnormalities:** When less ADH is produced it leads to increased content of water in the blood and vice versa.
- **Blood sugar regulation:** The hormones found in the pancreas in the Langerhans control regulation of blood sugar in the body. These hormones are insulin and glucagon.
- **Insulin hormone:** This is the hormone, which is produced from the B-cell. This hormone is secreted when there is a large amount of blood sugar in the body. Insulin promotes conversion of blood sugar into glycogen and stored in the liver and skeletal muscles. Insulin forces the uptake of glucose by body cells to produce energy.
- **Glucagon hormone:** This is the hormone, which is secreted due to the lower level of glucose in blood sugar. This Glucagon stimulates liver cells to release glucose into the blood stream. Glucagon stimulates liver cells to release glucose into the blood stream. Also Glucagon stimulates absorption of glucose from the ileum.



Blood Sugar Regulation in Mammals

The Mechanisms of Regulating Sugar Level in the Blood

Explain the mechanisms of regulating sugar level in the blood

Blood sugar regulation is the maintenance of a relatively constant blood glucose level of the body.

The end product of digestion of carbohydrate is mainly simple sugars or glucose.

Glucose is absorbed from the alimentary canal active transport into the blood stream. Hence the blood sugar level in the blood rises to the extent that regulation of it is necessary.

Blood sugar in mammals is regulated using hormones, which are insulin and Glucagon. These hormones are secreted by a specialized group of pancreatic cells called islets of Langerhans. The alpha cells of the islets of Langerhans secrete Glucagon while the beta cells secrete Insulin.

When the blood sugar level rises in the body insulin is secreted. The insulin accelerates the entry of glucose into the liver and muscles to be converted into Glycogen.

Consider:



Glycogen is stored for future use in the liver and muscles

Role of Glucagon in Blood Sugar Regulation

Glucagon is secreted in response to a decline in blood sugar level in the blood stream. Glucagon promotes the conversion of Glycogen to glucose and inhibits the oxidation of glucose in the liver.

However if the level of blood glucose is low, glucagon stimulates the conversion of amino acids into glucose. The glucose formed is released into the blood stream.

Consider:



NOTE: Failure of a pancreas to secrete insulin and glucagon results to a disease called Diabetes Mellitus

The Causes, Symptoms, and Effects of High and Low Sugar Levels in the Blood

Outline the causes, symptoms, and effects of high and low sugar levels in the blood

It's important to treat symptoms of high blood sugar right away to help prevent complications

Causes

Your blood sugar may rise if you:

- Skip or forget your insulin or oral glucose-lowering medicine
- Eat too many grams of carbohydrates for the amount of insulin you took, or eat too many carbs in general
- Have an infection
- Are ill
- Are under stress
- Become inactive or exercise less than usual
- Take part in strenuous physical activity, especially when your blood sugar levels are high and insulin levels are low

Symptoms

Early signs include:

- Increased thirst
- Headaches
- Trouble concentrating

- Blurred vision
- Frequent peeing
- Fatigue (weak, tired feeling)
- Weight loss
- Blood sugar more than 180 mg/dL

Effects

Ongoing high blood sugar may cause:

- Vaginal and skin infections
- Slow-healing cuts and sores
- Worse vision
- Nerve damage causing painful cold or insensitive feet, loss of hair on the lower extremities, or erectile dysfunction
- Stomach and intestinal problems such as chronic constipation or diarrhea
- Damage to your eyes, blood vessels, or kidneys

Low Blood Sugar

Symptoms

Symptoms of low blood sugar can occur suddenly. They include:

- blurry vision
- rapid heartbeat
- sudden mood changes
- sudden nervousness
- unexplained fatigue
- pale skin
- headache
- hunger
- shaking
- sweating
- difficulty sleeping
- skin tingling
- trouble thinking clearly or concentrating
- loss of consciousness

If you have hypoglycemic unawareness, a condition in which you do not know your blood sugar level is dropping, your blood sugar can drop so quickly you may not even have warning symptoms.

When this occurs, you can faint, experience a seizure, or even go into a coma.

Very low blood sugar is a medical emergency. If you know that someone is diabetic and he or she is experiencing these symptoms, help him or her to eat 15 grams of quickly digesting carbohydrate, such as:

- a half cup of juice or regular soda
- 1 tablespoon of honey
- 4 or 5 saltine crackers

- 3 or 4 pieces of hard candy or glucose tablets
- 1 tablespoon of sugar

Causes

Low blood sugar can occur for a number of reasons. It is usually a side effect of diabetes treatment.

Diabetes and Low Blood Sugar: Diabetes affects your body's ability to use insulin. Think of insulin as the key that unlocks your cells, letting glucose in for energy. People with diabetes use a variety of treatments to help their bodies use the glucose in their blood. One very important treatment is insulin injections.

If you inject too much insulin, your blood sugar may drop too low. People also sometimes inject insulin when planning to eat a big meal, but then they do not eat enough.

Excess physical activity without eating enough can also cause a drop in blood sugar levels.

Other Causes of Low Blood Sugar

You don't have to have diabetes to experience low blood sugar. Some other causes of low blood sugar include:

- certain medications, such as quinine
- drinking too much alcohol
- some medical conditions, such as hepatitis or kidney disorders
- a tumor that produces excess insulin
- endocrine disorders, such as adrenal gland deficiency

Effects

Mildly low blood sugar levels are somewhat common for people with diabetes; however, severely low blood sugar levels can be life-threatening. They may lead to seizures and nervous system damage. Immediate treatment is critical. It is important to learn to recognize your symptoms and treat them fast. For people at risk of low blood sugar, having a glucagon kit, a medication that raises blood sugar levels, is important. Talk to your healthcare provider for more information.

Topic 6 Concept of Reproduction

Reproduction is the ability of living organisms to form new individuals of the same species from those already in existence. Here, the new organisms replace those that have died and so life continues. It can also be defined as the process whereby organisms produce new individuals of the same species. It is one of the important features of living things.

The Merits and Demerits of Sexual and Asexual Reproduction

Explain the merits and demerits of sexual and asexual reproduction

Sexual Reproduction

This is a type of reproduction in which new organism is produced when a male gamete fuses with a female gamete. Sexual reproduction involves the fusion of two gametes. The process of fusion of gametes is called fertilization.

These two gametes differ in form and function and each is produced from a different organ. In animals the gametes producing organs are called gonads. These include the ovaries and testes. In flowering plant structures concerned with the production of gametes are the ovaries and anthers. The testes and anthers produce the male gametes while ovaries produce the female gametes.

Merits of Sexual Reproduction

- It ensures genetic stability
- It ensures perpetuation of life
- It brings variation
- Leads to the interaction among organisms

Demerits of Sexual Reproduction

- Offspring have a great chance of inheriting diseases from the parent
- The reproduction takes long time
- It needs energy
- The sexual reproduction produces few numbers of offspring
- It depends on presences of two parents
- It leads to great chance of spreading diseases
- It takes a long time until offspring are produced

Asexual Reproduction

This is the type of reproduction whereby production of offspring is from single organism without the production of gametes. There is no fusion of gametes.

Examples of organisms who produce asexually are amoeba and bacteria. Asexual reproduction involves only one individual organism. That means no change of genetic material is passed from a parent to an offspring. The offspring are also identical to their parents.

In this kind of reproduction, in some organisms, body part such as roots, stems or leaves may become reproductive body organs.

Depending on the type of organisms asexual reproduction may be of different forms or ways such as:

- Fission
- Sporulation/Spore formation
- Budding
- Fragmentation
- Vegetative propagation
- Binary Fission (Splitting)
- Suckers
- Bulbils

Binary Fission (Splitting)

This is an asexual reproduction in which an organism divides into two equal parts, which are identical to each other.

Each part then grows to attain the original size of the parent cell and hence become a separate and independent organism.

binary fission in amoeba



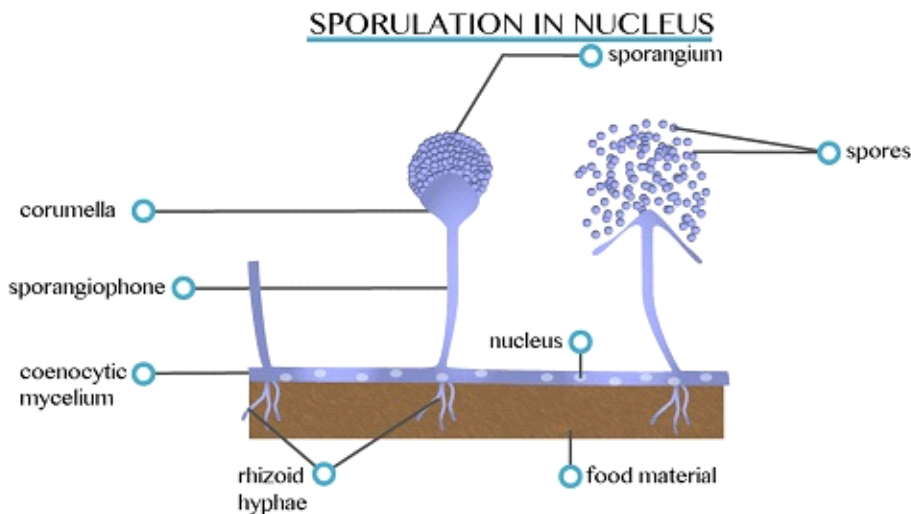
Fragmentation

This is a form of asexual reproduction in which organisms (parent) breaks into two or more parts. Fragments grow and develop into a new organism with identical features as the parent. Example worms such as Nematodes and flat worms.

Sporulation/Spore formation

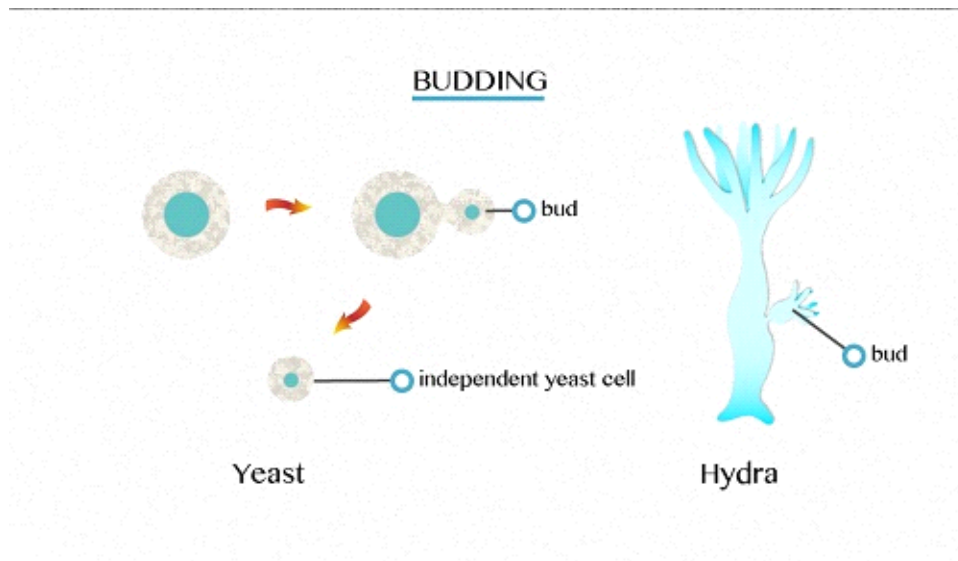
Sporulation is asexual reproduction by the use of spores. The spore develops from single cell as a result of mitosis, forming a structure known as sporangium. When the sporangium is truly developed, the wall bursts to release the spores which when placed in suitable area they germinate into new organisms.

Other organisms, which reproduce by sporulation, are ferns and mosses.



Budding

Budding is a type of asexual reproduction in which a new organism arises as an outgrowth (bud) of the older organism (parent). The bud later separates from the parent and grows to become an independent organism to attain the size of the parent. Examples: yeast and hydra



Some flowering plants reproduce through the formation of structure called buds. Roots may form such buds, leaves or underground stems and such buds sprout to form new independent plants.

Vegetative propagation

Vegetative propagation is a form of asexual reproduction found in plants in which a bud grows and develops into a new plant. The detached plant, root, stem or leaves at some stages grows and develops into an independent plant.

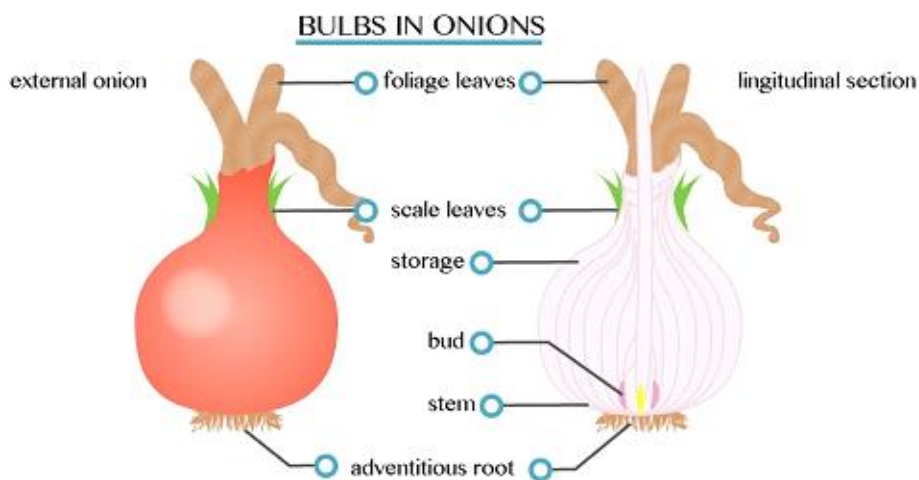
Artificial vegetables propagation: This is vegetative propagation, which occurs through man's manipulation. Man can learn from plants' natural vegetative propagation and can intervene and make propagation of plants artificially.

Natural vegetative propagation: Vegetative propagation involves different parts of plants as discussed below. Such as:

Bulb

In this type each bud grows to form a shoot, which produces a new bulb at the end of the growing season.

Bulb is a modified underground shoot having fresh strong leaves

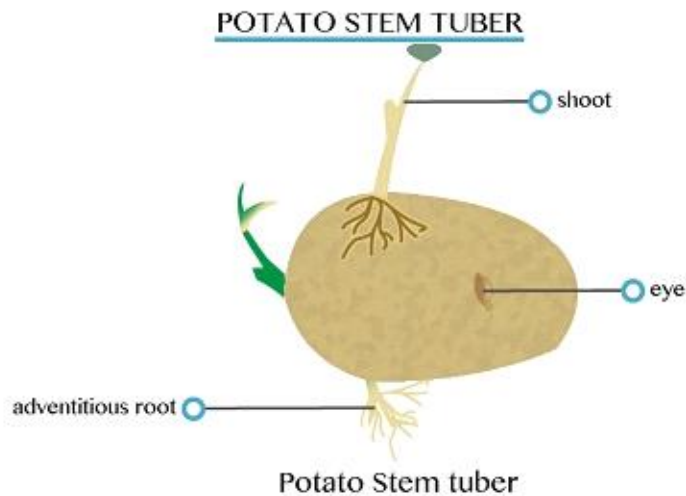


Tubers

These are short swollen underground storage organs formed from a stem or a root. New tubers are made at the end of the growing season but do not arise from old tubers.

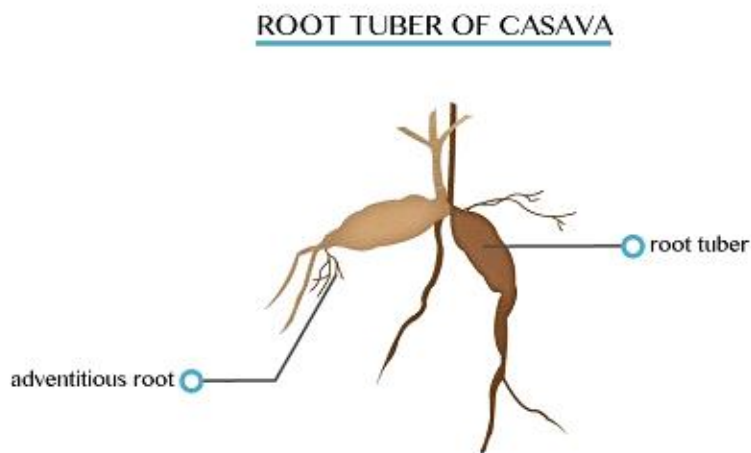
Stem tubers

These are short swollen underground stems, which store food, such as starch. Normally, yam plants form a number of tubers each of which can rise to a new plant. Such new plant continues to live after the death of the parent.



Root tubers

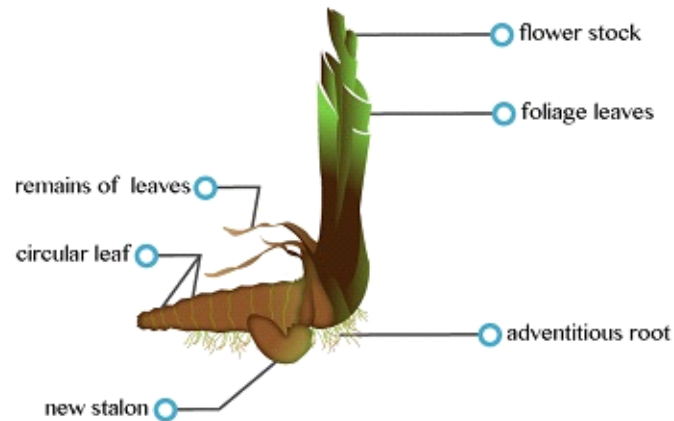
These are swollen adventitious underground roots. Root tubers such as sweet potatoes and cassava store their food in root tubers and do not bear leaves or bud.



Rhizomes

These are horizontally growing underground stems, bearing leaves, buds and adventitious roots. Examples are lilies, ferns and grass.

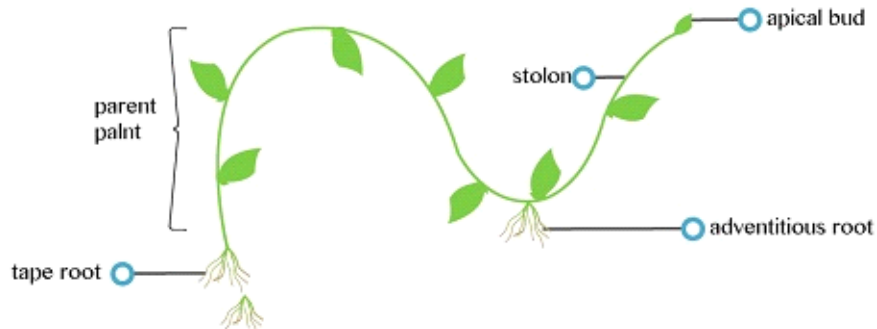
AN IRIS PLANT PRODUCING BY USING RHIZOMES



Stolons

These are slender stems, creeping horizontally as they grow along the ground surface. Examples: strawberries, black currant and oxalis.

STOLONS



Suckers

These are short horizontal branches, arising from the main stem or just below ground level. Suckers contain food reserves. Examples: Bananas, sisal and pineapples

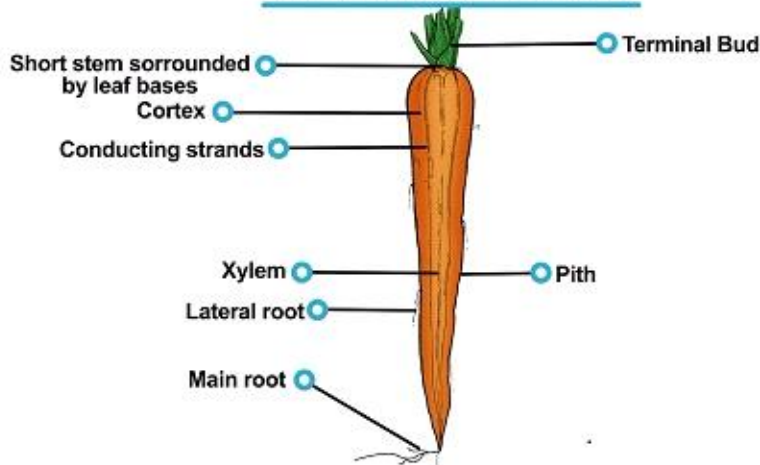
SUCKERS



Tap root

A taproot is the main root that arises from a radical. Tap roots may become swollen and act as storage organs.

TAP ROOT OF A CARROT



Tillers

These are collection of shoots. Grass plants consist of a number of tillers. Each tiller has a number of leaves, which arise from the stem of nodes at the base of the leaves.

Leaves

Some plants such as cactus propagate vegetative using leaves. When the leaves fall off from a plant they develop adventitious roots and buds, which later may grow and develop into mature plants.

Merits of Asexual Reproduction

- Asexual reproduction results into an individual with the same genetic constitution as their parent.
- Its offspring matures faster than sexually reproduced organisms
- It does not depend on processes of pollination, seed or fruit dispersal

Demerits of Asexual Reproduction

- Asexually reproducing organisms are at a great risk to perish or get destructed when environmental conditions are unfavorable
- The parents may pass undesirable characteristics to the offspring since only one individual organism is involved in asexual reproduction
- Competition for resources such as food and shelter may occur due to large number of organisms being produced

Meiosis and Reproduction

The Meaning of Meiosis

Give the meaning of meiosis

Reproduction involves the transmission of genetic materials from one generation to the next insuring that species survive. The process of reproduction involves meiosis.

Meiosis is the type of cell division, which occurs in the reproductive organs to produce sex cells known as gametes.

In this type of cell division the parent cells has diploid number of chromosomes. However the daughter cell arising from the cell division has the half number of chromosomes a condition known as haploid state.

Therefore meiosis reduces the chromosomes number into half means from $2n$ to n .

The Significance of Meiosis in Relation to Reproduction

Explain the significance of meiosis in relation to reproduction

Meiosis leads to the formation of reproductive cells (Gametes) such as ova and sperms each with half number of chromosomes of the parent cells in organisms reproducing through sexual reproduction.

It involves the possibility of exchange of pieces of genetic information between the paternal and maternal chromosomes of each pair leading to new combination of characteristics in the gametes.

It brings about variation when the members of each pair of chromosomes are separated from each other independently (Random assortment)

Meiosis leads to new combination of genes through the process of independent assortment of chromosomes occurring during meiosis I

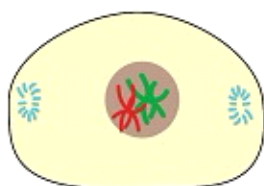
Meiosis involves number of processes from prophase, metaphase, anaphase and telephase. There are two meiotic divisions, the first and the second division. All the above named processes occur in both the first meiotic division and the second meiotic division.

First Meiotic Division

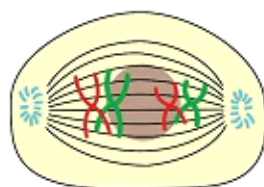
The first division of meiosis consists of:

- Prophase I
- Metaphase I
- Anaphase I
- Telophase I

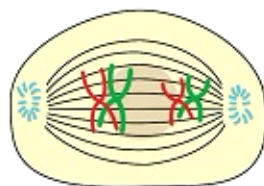
PROPHASE 1



Early Prophase 1

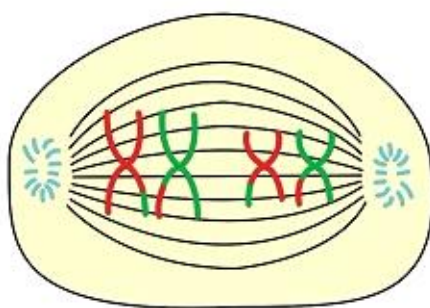


Mid Prophase 1

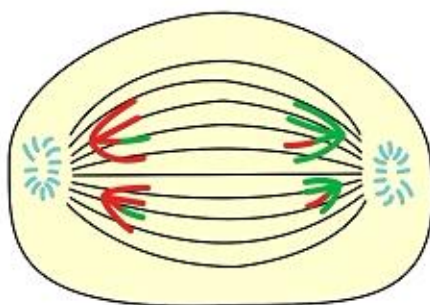


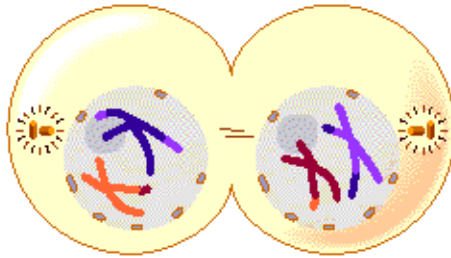
Late Prophase 1

METAPHASE 1



ANAPHASE 1





Telophase I

Prophase I

During prophase I the following events occur.

- The nucleus disappears and the centrioles if present migrate to the poles
- Chromosomes condense and the spindle is formed
- As prophase proceeds homologous chromosomes come to lie side by side and thereafter become intertwined by the process called synapsis

Through synapsis homologous chromosomes are referred to as crossing over. The point at which homologous chromosomes exchange genetic materials is known as chiasmata

Early Prophase I

The following events occur during early prophase:

- Chromosomes contract, thickening, shortening and become more visible
- Nucleus disintegrates and disappears

Mid Prophase I

- Homologous chromosomes come together (synapses) forming a bivalent

Late Prophase I

- Chromatids cross over by chiasmata which results into exchange of genetic materials

Metaphase I

- Bivalent homologous chromosomes move to the equator of the spindle

Anaphase I

- The two homologous chromosomes part company and migrate to opposite poles of the spindle
- The centromeres of the homologous pairs migrate towards the opposite poles where they are attracted.

Telophase

- The chromosomes reach their destination
- The spindle apparatus breaks down and disintegrates
- Then the nucleus membrane reforms around each set of chromosomes
- The cell constricts across the membrane and divides into two

Telophase I marks the end of the first meiotic division.

- At the end of this prophase the number of chromosomes in each cell is half the chromosomes number cell.

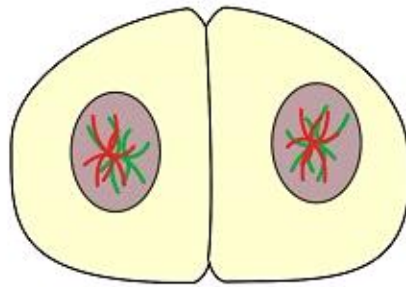
- This is the reason why first meiotic division is referred to as Reduction division

Second meiotic division

Prophase II

Centrioles replicate and a new spindle apparatuses formed

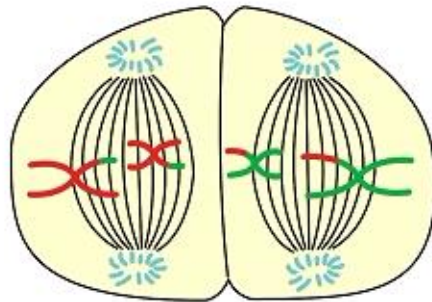
PROPHASE 2



Metaphase II

Chromosomes migrate to the equator of the spindle

METAPHASE 2



Anaphase II

- Sister chromatids part company and migrate to opposite poles of the cell

Telophase II

- The spindle apparatuses disappears
- The nucleus reforms and a new nucleus membrane is formed around each set of chromatids
- The chromatids uncoil and the cell divides into two
- Chromosomes regain their thread like structure and the cell enters interphase. Meiosis results in the formation of four daughter cells each with a haploid set of chromosomes
- It should be stressed that the four daughter cells formed have the half number of chromosomes present in the original parent cell.

Experiments to Show Stages of Meiosis Process
Carry out experiments to show stages of meiosis process
Meiosis Video

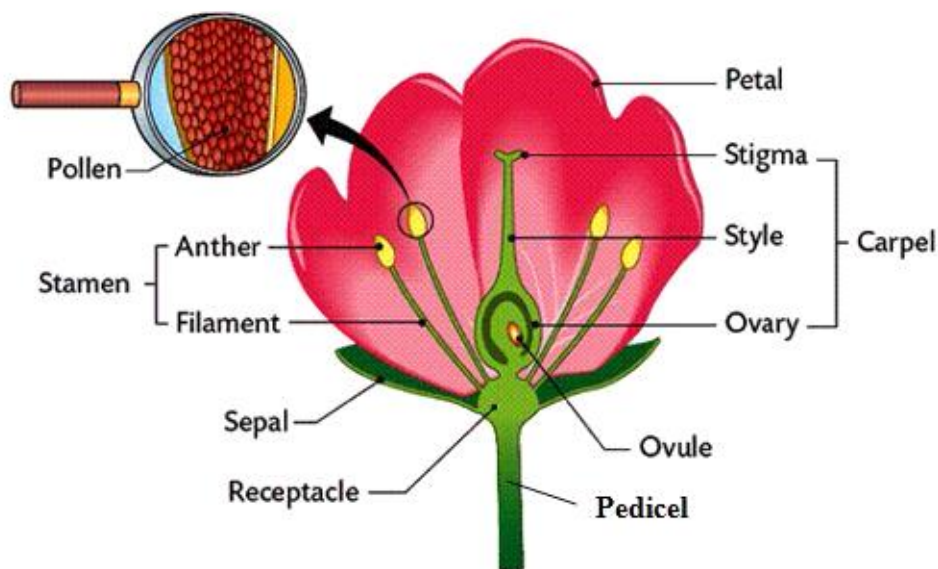
Reproduction in Flowering Plants, the structure of the Flower

Some plants use flowers to reproduce. The flowers contain all the parts needed for the reproduction process. Sexual reproduction in flowering plants takes place in the flower. Within a flower, there are usually structures that produce both male gametes and female gametes.

The Structure of the Flower

Describe the structure of the flower

A flowering plant is an angiosperm, which is any plant that produces a flower or fruit. The sole purpose of the flower is to allow the plant to reproduce. Each part of the flower plays a role in the steps of reproduction. There are male gametes and female gametes. They are both directly involved with sexual reproduction. Pollen may spread from plant to plant but can only reproduce with the same species of plants. Let's take a look at the different parts of the flower.



Structure of a flower

STERILE PARTS

Let's start with the sterile parts of the flower, or those parts that are neither male nor female. These sterile parts are not directly involved in the fertilization process. Technically, a flowering plant can reproduce without them; however, they do play important roles in helping with reproduction.

- **Pedicel:** The pedicel is a small stalk or stalk-like part bearing a single flower in an inflorescence. Some flowers have no stalk and are directly attached to the stem of the plant.
- **Receptacle:** The receptacle is the place on the stem where floral organs originate and attach. It is the axis (stem) to which the floral organs are attached. In most angiosperms, floral organs are attached in alternating successive whorls. A whorl is an arrangement of sepals, petals, leaves, stipules or branches that radiate from a single point and surround or wrap around the stem.

- **Sepals:** Sepals are the parts that look like little leaves that cover the flower before it blooms. They cup the flower to protect it while it grows. Sepals are mostly green and in most flowers they resemble leaves. A flower bud is protected by sepals. Collectively, all of the sepals form the calyx. Sepals may be hairy, for example in roses, or smooth, for example in hibiscus. Some flowers have sepal-like structures beneath the calyx known as epicalyx, for example the hibiscus flower.
- **Petals:** Petals are the delicate and usually brightly coloured part that gives the flower its character. Flowers have more than one petal, and the flower petals are collectively called the corolla. The colour and scent attracts the agents of pollination such as birds and insects. Fused petals form a corolla that can be tubular or funnel-shaped as in the flowers of sweet potato and pumpkin plants. Some of the petals of leguminous plants are keel-like and they enclose stamens and carpels. Sepals and petals are collectively referred to as the **perianth**.

Reproductive Parts of the Flower

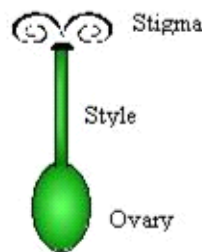
Identify reproductive parts of the flower

The flower is the reproductive unit of some plants (angiosperms). Parts of the flower include petals, sepals, one or more carpels (the female reproductive organs), and stamens (the male reproductive organs).

The female reproductive organs

The pistil is the collective term for the carpel(s). A carpel is actually three parts fused into one: stigma, style, and ovary. The stigma is at the top of the flower. It is sticky to catch the pollen. Each carpel includes an ovary (where the ovules are produced; ovules are the female reproductive cells, the eggs), a style (a tube on top of the ovary), and a stigma (which receives the pollen during fertilization).

The ovary is at the base of the flower. From the ovary, extends a tubular structure called the style and on the top of the style is a surface receptive to pollen called the stigma. The stigma can take many different forms, most of them designed to help trap pollen.



Female parts of a flower

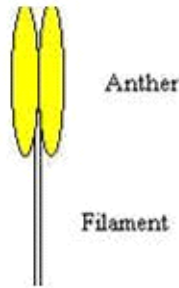
The female parts of the flower are discussed in detail below:

- **Ovary:** The ovary contains ovules. Ovules are unfertilized female gametes. The position of the ovary in relation to the receptacle varies from one flower to another. The ovary could be either superior or inferior in relation to the position of the receptacle. A superior ovary is one that is positioned above the receptacle, for example the ovary of a bean flower. An inferior ovary is one that is positioned below or enclosed within the receptacle. Examples are the ovaries of a rose and a black jack flower.
- **Style:** The style is a long tube that attaches the stigma to the ovary. The length of the style varies from one flower to another. This length determines the position of the stigma. In the maize plants, the style and the stigma hang outside the flower.
- **Stigma:** The stigma is a glandular sticky structure at the tip of the carpel. The stigma is the tissue into which the pollen grains are deposited. The branches of the stigma

correspond to the number of carpels. Five branches of the stigma indicate the presence of five carpels.

The male reproductive organs

The male parts of a flower consist of one or more stamens. Stamens are the male reproductive parts of flowers. A stamen consists of an anther (which produces pollen) and a filament. The pollen consists of the male reproductive cells; they fertilize ovules.



Male parts of a flower

The following is a detailed description of the female parts of the flower.

- **Filament:** The filament is a slender stalk that supports the anther. The filament may arise from the receptacle or the petals. It supports the anther.
- **Anther:** The anther is attached to the apex of the filament. It produces the pollen grains that contain the sperm needed for fertilization.

Types of flowers

Flowers are classified either as complete or incomplete. Complete flowers have sepals, petals, stamens and carpels. A flower with both stamens and carpel is said to be bisexual. The hibiscus flower is bisexual.

Incomplete flowers lack some of the floral parts. Flowers that have carpels only are referred to as pistillate flowers. Flowers that have stamens only are referred to as staminate flowers.

Pollination

The Term Pollination

Explain the term pollination

Pollination is the transfer of pollen grains from the anthers to the stigma of a flower. Pollen grains from the anthers are carried to the stigma by wind, insects or birds. These are referred to as the agents of pollination. Pollination, an important step in the reproduction of seed plants, is the transfer of pollen grains (male gametes) from the male reproductive organ to the female reproductive organ that contains the ovule (female gamete) or transfers it to the ovule itself.

Pollination is a very important part of the life cycle of a flowering plant. It is part of the sexual reproduction process of flowering plants, which results in seeds that will grow into new plants.

Types of Pollination

Identify types of pollination

Pollination can either be self or cross pollination:

- **Self pollination:** This is the transfer of pollen grains from the anthers to the stigma of the same flower.
- **Cross pollination:** This is the transfer of pollen grains from the anthers of the flower to the stigma of another flower of the same species.

Disadvantages of self pollination: A potential drawback is that both gametes come from the same parent. If the plant is well adapted to a stable environment, the production of uniform offspring may be advantageous. However, inbreeding will result and if there are disadvantageous recessive characteristics in the parent, they are much more likely to be exposed than if the plant cross-pollinates.

Advantages of cross pollination: Cross-pollination is less reliable and more wasteful than self-pollination, but it is genetically favourable because genes are transferred and variation increases

Factors that favour cross pollination and hinder self pollination

- **Dioecious plants:** Some plants have flowers that are only male - they have only **stamens**. Other plants of the same species have flowers that are only female - they have only **carpels**.
- **Monoecious plants:** Some flowers on a plant are only male; other flowers on the same plant are only female. So, self pollination is avoided by a difference in the timing of their development.
- **Protandry:** Anthers on some plants mature first. Pollination of immature stigma on the same plant is therefore not possible.
- **Protogyny:** The stigmas mature first.
- **Self-incompatibility:** Pollination can occur but the pollen tube doesn't grow well, if at all, so no fertilisation takes place.

Agents of Pollination

Outline agents of pollination

These are organisms or physical conditions that facilitate transfer of pollen grains from the anthers to stigmas. Plants, being immobile, normally require agents for the transport of pollen, which are commonly wind, insects, birds, mammals (bats, rodents, primates), and water. Insects are the most common animals that will pollinate a carpel. The main agents of pollination are wind, insects and birds.

Wind pollinated flowers

Wind-pollinated flowers are also those flowers whose pollen is transferred by wind from anthers to stigmas. Wind picks pollen grains from the anthers and transfers them to the stigma.

Structure of a wind-pollinated flower: The anthers and stigma of wind-pollinated flowers are exposed. This makes it easy for wind to blow the pollen that can then easily land on the stigma. Flowers of grasses are a representative of wind pollinated flowers.

Adaptations of wind-pollinated flowers

Flowers that depend on wind for pollination are adapted in various ways. Plants that are pollinated by wind have the following characteristics:

- Small petals with exposed anthers and stigma. In some plants the petals are often absent or have dull-coloured petals that do not attract insects or birds. The petals and sepals are very similar in shape and size.
- Large anthers which produce large amounts of pollen grains. Very large quantities of pollen are produced to increase chances of pollination as much will be lost while blown about.
- Anthers are loosely attached to the filaments and hang freely to allow the anthers to be easily shaken by the wind.
- The pollen grains are small, smooth, dry and light in weight and therefore easily carried in the air by wind. Some pollen grains have bladder-like structures that contain air, thus, increasing their buoyancy.
- Feathery stigmas with a large sticky surface so they are more likely to catch pollen from the air.

- Large and feathery stigmas, freely hanging out of the flowers, which provide a large surface area on which the pollen grains can land. The stigma may be branched or hairy to increase the surface area.
- Long, hairy style to expose the stigma outside the flower.
- No nectar produced because there is no need to attract pollinators to the flower.
- Not scented as the flowers do not attract insects.
- Filaments grow long so stamens hang out of the flower and shake in the wind to disperse pollen.

Feathery stigma



Wind-pollinated flower

Insect-pollinated flowers (bees, moths, butterflies)

Insect-pollinated flowers are also referred to as entomophilous flower. The term entomophilous is derived from the word entomophily- which means to be carried by insects. Features of insect pollinated flowers include the following:

- Large, brightly-coloured petals which attract insects. Flower structure may be adapted for one particular of insect, allowing them to land and feed.
- Usually scented; therefore they attract insects to the flower.
- Nectarines which contain nectar, for example, mango flowers have nectarines from which bees collect nectar for making honey, and while doing so transfer the pollen. The insects are guided to the nectarines by the nectar guides.
- Sticky stigma that insects come into contact with and deposit pollen while collecting nectar. The pollen grains picked by insects from other flowers stick onto the stigma.

- The stigma and anthers are held firmly in position within the flower. This ensures that when an insect lands on a flower, the stigma is not broken. The stigma and anthers are located inside the flower where pollinators are more likely to pick up pollen.
- The anthers are small in size and produce few but large pollen grains.
- The pollen grains are fairly large, heavy, sticky and with small spines. This enables them to adhere to bodies of pollinators (insects or birds).



A bee collects pollen on its body as it feeds

Flower pollinated by birds: Birds pollinate flowers when they search for nectar. Birds such as sunbirds have long slender and slightly curved beaks that they use to probe into the flower. Pollen grains stick on the beak. The pollen grains are deposited on the stigma of another flower of the same species by the bird as the bird feeds.



A bird feeding on nectar

Fertilization

The Concept of Fertilization

Explain the concept of fertilization

Fertilisation is the union of the male and female gametes to form a zygote. Pollen must fertilise an ovule to produce a viable seed. Fertilisation starts when a pollen grain lands on the stigma. Only after pollination, when pollen has landed on the stigma of a suitable flower of the same species, can a chain of events happen that ends in the making of seeds.

After a male's pollen grains have landed on the stigma during fertilization, pollen tubes develop within the style, burrowing down to the ovary, where the sperm fertilizes an ovum (an egg cell), in the ovule. A pollen tube emerges from the grain, its growth being controlled by the tube nucleus at the tip of the tube. It may grow downwards in response to chemicals made by the ovary (a response known as chemotropism).

In a process called fertilisation, the two gametes join and their chromosomes combine, so that the fertilised cell contains a normal complement of chromosomes, with some from each parent flower. The fertilised ovule goes on to form a seed, which contains a food store and an embryo that will later grow into a new plant. The ovary develops into a fruit to protect the seed. Some flowers, such as avocados, only have one ovule in their ovary, so their fruit only has one seed. Many flowers have lots of ovules in their ovary, so their fruit contains many seeds.

There are 2 types of seeds. Some are endospermic while others are non-endospermic. In endospermic seeds the food reserve is the endosperm, which is outside the plant embryo. Examples of this type of seed are maize and wheat. Non-endospermic seeds have food reserve within the cotyledon(s) of the plant embryo. This occurs in broad beans.

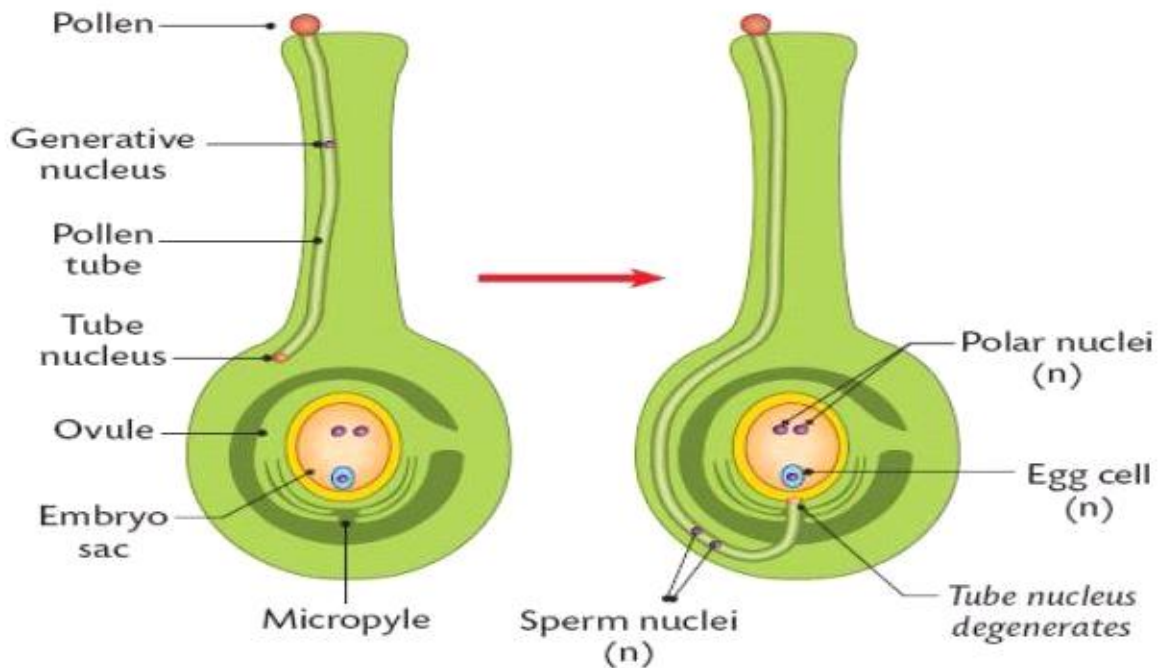
Process of Fertilization in Flowering Plants

Explain process of fertilization in flowering plants

During the growth and extension of the tube, the **generative nucleus**, behind the tube nucleus, divides by mitosis to produce **2 male haploid sperm nuclei**. The pollen tube enters the ovule through the

micropyle and penetrates the embryo sac wall. Then, the tip of the tube bursts open, the tube nucleus disintegrates, creating a passage for the male nuclei and what follows is called **double fertilisation**

- 1 male gamete fuses with the egg cell to produce a **diploid zygote** which undergoes mitosis to form a **diploid embryo**.
- 1 male gamete fuses with both the polar nuclei to produce the **triploid primary endosperm nucleus**. The triploid nucleus undergoes mitosis to form the **endosperm**. The endosperm stores food materials that the embryo utilizes for growth and during germination.



The process of fertilisation

Immediately after fertilization the ovule becomes the seed and the ovary becomes the fruit.

This is what happens:

- The **zygote** divides many times by mitosis to produce an **embryo**. It differentiates to become a **plumule** (young shoot), **radicle** (young root) and either 1 or 2 **cotyledons** (seed leaves). It is attached to the wall of the embryo sac by a suspensor.
- The **primary endosperm nucleus** divides many times by mitosis to produce **endosperm tissue**. In some seeds this endosperm is a food store for later use by the seed. In others it may gradually disappear as the cotyledons develop.
- To accommodate all this growth the embryo sac expands and the nucellus is crushed out of existence, giving its nutrients to the embryo and endosperm.
- The integuments surrounding the embryo sac become the tough and protective **testa** (seed coat). The micropyle remains though so that oxygen and water can be taken in during seed germination.
- The water content of the seed decreases drastically so the seed is prepared for dormancy.
- The ovary wall becomes the **pericarp** - the fruit wall, the whole ovary now being the fruit. The function of the fruit is to protect the seeds and to aid in their dispersal, e.g. by an animal. That is why they can be brightly coloured and sweet; animals will eat them and

scatter the seeds either at the time of eating or when they are passed out of the gut in defecation, unharmed.

A detailed account of what happens after fertilisation is given below:

- **Formation of the testa:** The testa is also referred to as the seed coat. The two integuments of the embryo sac fuse to form one seed coat. The seed coat thickens and hardens. Sometimes the outer integument forms the hard thick testa while the inner integument remains thin and transparent. The thin transparent inner integument is referred to as the tegmen. The testa protects the seed against dehydration, physical damage and invasion by microorganisms. The micropyle permits oxygen and water to enter the seed during germination. The hilum is a scar on the testa that marks the point of attachment to the fruit.
- **The formation of the embryo:** The egg cell nucleus fuses with the male nucleus to form a zygote. The zygote undergoes mitosis to form the embryo. An embryo is a rudimentary plant comprising the plumule, radicle and cotyledons.
- **Formation of the pericarp:** The ovary wall becomes thick and swells up with food substances. The pericarp develops from the ovary wall. The pericarp is often the edible layer in fruits. In mature fruit it may dry up or remain fleshy.
- **Disintegration of the floral parts:** The sepals, petals, stigma and style wither, dry up and fall off. In some cases, some of the floral parts may become fleshy and form part of the fruit. The fruit retains scars at the points of attachment to the pedicel and style.

Reproduction in Mammals

The Male and Female Reproductive Systems

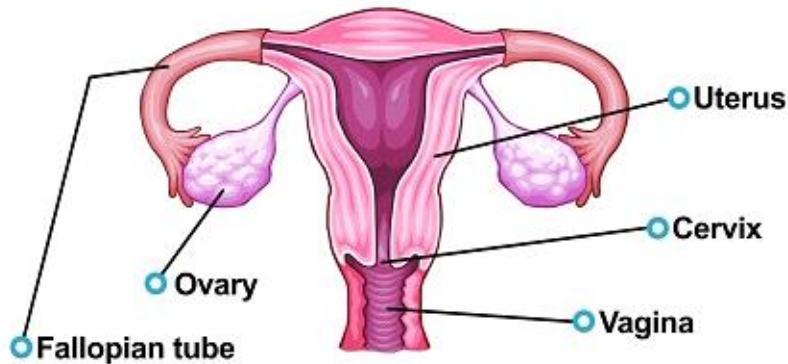
Describe the male and female reproductive systems

Female Reproductive System

In humans, like animals, female reproductive system is composed of:

- **Ovaries:** Ovary is situated near each kidney. Ovary produces ova, estrogen and progesterone as female sex hormones.
- **Fallopian tube:** It is also known as egg tube/oviduct, it is a funnel shaped opening. Fertilization normally takes place within this tube.
- **Uterus:** The two fallopian tubes unite to form an expanded tubular organ called uterus womb. It is there that fertilized ova implant and develop into an embryo. N.B. Placenta is formed as an embryo develops, so as to allow penetration of nutrients, gases (oxygen and carbon dioxide) and waste products of metabolism. An embryo receives nutrient and oxygen gases from maternal blood circulation and give out waste product through placenta into maternal blood system.
- **Vagina:** This is the posterior part of the female reproductive duct connecting the uterus with the exterior. It is in this region that sperms are deposited. N.B. Placenta with an endocrine at the last period of pregnancy, it secretes progesterone like ovaries, which prevent production of ova and contractions of the uterine walls.

FEMALE REPRODUCTIVE SYSTEM

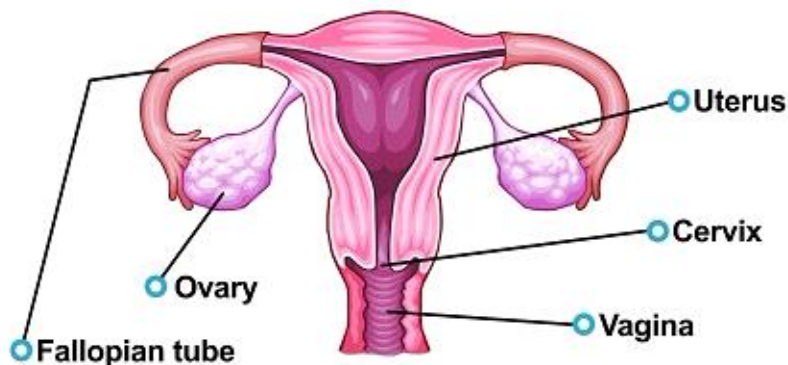


Male Reproductive System

The male mammal reproductive system is composed of:

- **Testicles:** These are situated in a pouch of skin called scrotum. They produce sperms as endocrine gland it produces secretes male sex hormone called testosterone. Testosterone influences male secondary characteristics during puberty in males.
- **Sperm duct:** It Is attached to each testicle, it acts as a temporary store for sperms. Each epididymis leads into a duct called sperm duct or vas di deferens.
- **Vas deferens:** Is the structure, which carries sperms away from the epididymis to penis
- **Seminal vesicles and prostate glands:** These are situated just below the urinary bladder and two structures called seminal vesicles. Each seminal vesicle has a tube which leads to the sperm duct. Around the junction of urinary bladder and urethra is a gland called prostate gland

FEMALE REPRODUCTIVE SYSTEM



Gamete Formation and Fertilization

The Process of Gamete Formation in Mammals

Outline the process of gamete formation in mammals

Gamete formation: Puberty

On average, female attain puberty (Sexual Maturity) when they are 14 years old and male when they are 16 years old. In both sexes, attainment of puberty is accompanied by certain behavioral changes as well as development of certain structures.

Those changes are known as secondary sexual characteristics.

NB: Puberty can be defined as the period when male/female changes from childhood to adulthood. These changes are influenced by sex hormones that are testosterone in males, progesterone and estrogen in females.

Secondary characteristics in males:

- Hairs on their chins and pubic region
- Shoulders widen
- Voice deepens
- Pay more attention to female sex

Secondary characteristics in females:

- Enlargement of the mammary gland and hips
- Deposition of fat which gives them more round appearance
- Development of pubic hair
- Menstruation cycle
- Pay more attention to males (young men)

NB: At puberty sex organs become fully functional in males and females.

Gamete formation: During puberty stage is when both males and females are able to produce fertile cells which united (of male and female) can cause pregnancy.

It is believed that female gametes are produced before puberty but after puberty is when they are fully matured and fertile while male gamete at large are produced during and after puberty that is when can cause pregnancy when united with female gamete.

The Processes of Ovulation and Menstruation

Explain the processes of ovulation and menstruation

Ovulation: It refers to the release of ova/ovum from ovaries to the uterus. It is expected to occur at the middle of the menstruation cycle.

Menstruation Cycle: This can be defined as the period between one and next menstrual cycle (28 days)

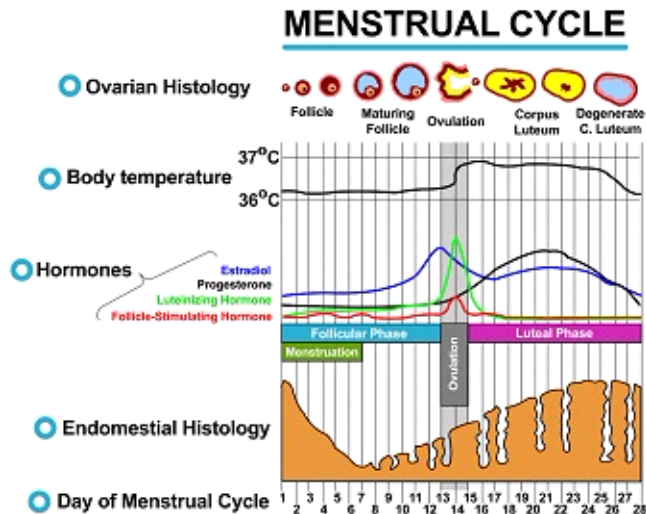
Menstruation: This is the discharge of mucus, epithelial cells and blood through vagina (3-5 days)

NB: The menstruation and liberation of ova every 28 days alternates between the two ovaries whereby in humans is called menstrual cycle and in non-human mammals is called oestrus cycle.

The Process of Fertilization Pregnancy and Child Birth

Explain the process of fertilization pregnancy and child birth

The Menstrual Cycle



At the beginning of the cycle, the menstruation can take place between 3-5 or 7th day from the first day. At this period the secretion of female sex hormones are very low but increase after menstruation stops.

After menstruation oestrogen secretion increases, follicle stimulating hormone secreted to encourage production of ovarian follicle.

Luteinizing hormone is for maturation and ovulation of follicle while oestrogen prepares (thickening) the uterine for implantation when fertilization takes place.

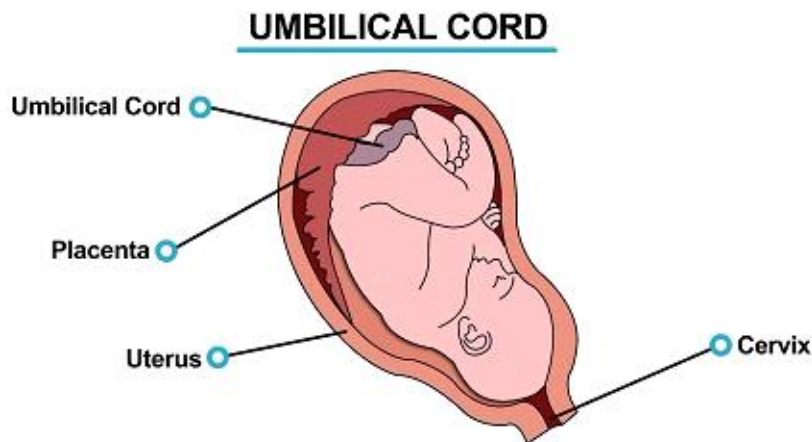
At the 14th (middle) day is when ovulation can take place and secretion of progesterone increases so as to thicken the uterine wall ready for pregnancy.

NB: If no fertilization occurs, the cycle starts again.

Placenta: This is the portion of uterus, which is invaded by the villi and the thickened portion of the chorion. The chorion like amnion is a thin membrane but it has a thick portion called villi, finger-like projection.

Umbilical Cord

- It connects the developing embryo to placenta to the maternal blood system
- It carries two arteries and a vein of blood circulation of an embryo
- AN embryo uses umbilical cord for gas exchange, receiving nutrients and removal of waste products via placenta into maternal blood system



Birth

- It starts by a sudden fall in the level of oestrogen and progesterone resulting in periodic contractions of muscular walls of the uterus which cause pains called labour pains
- Under the influence of hormones a child is given out through vagina

Copulation

- When a male is sexually stimulated, the spongy penis is filled with blood and becomes erect. The erect penis is inserted into the vagina and moved back and forth, this movement stimulates sense organs in the penis and ejaculation occurs.
- Ejaculation refers to the release of sperm into the vagina; it can cause pregnancy when the fertile sperm unites with fertile ova.

Fertilization: It can be defined as the process of uniting male and female gametes to form a zygote. The sperms remain alive for up to 48 hours while ova remains alive for up to 36 hours.

Pregnancy: It refers to the situation when a female conceives. That is fertilization takes place to form zygote. Soon after zygote is formed its cell starts to divide into many cells called embryo. It takes 3-5 days for the zygote to reach to uterus for implantation.

Implantation:

- Refers to the process whereby an embryo attaches itself to the uterine wall
- It takes 3 – 5 days to implant fully
- After implantation envelope is formed, the outer chorion, inner amnion
- Between these membranes of envelop there are fluids called chorionic fluids and amniotic fluids respectively, both fluids act as shock absorbers, protecting embryo from physical damage

Factors Which May Hinder Fertilization

Outline factors which may hinder fertilization

A normal couple that is trying to start a family will usually be successful after a few months.

However, at least one in ten couples do not conceive after a year or more of trying.

There are many reasons why couples can't produce children, some of them are:

- Ova are not released in normal monthly cycle
- The fallopian tubes may be blocked/twisted
- The women may make antibodies that destroy the sperm

- The vas deferens may be blocked
- A high proportion of the sperm produced are abnormal
- Very few sperms are produced in one ejaculation

Ways of overcoming these problems

- In – Vitro Fertilization (IVF)
- Fertility Drugs
- Artificial Insemination

The Concept of Artificial Insemination and its Importance

Explain the concept of artificial insemination and its importance

Artificial insemination, also known as AI, is a procedure used to treat infertility that involves direct insertion of semen into a woman's womb. It is a process originally used on livestock that has been adapted for human use. In human use, the sperm could originate from the woman's male partner, unless the male is infertile or there is no male partner (i.e. single woman or woman in same sex relationship).

The most commonly used method of artificial insemination, is IUI (Intrauterine Insemination), as it has the best success rate. Other types of AI are:

- IUTPI (Intrauterine tuboperitoneal insemination)
- ICI (Intracervical insemination)
- ITI (Intratubal insemination)

Artificial insemination is beneficial to couples or individuals in many circumstances. For example a couple may be producing healthy sperm and eggs but not necessarily be able to have intercourse (maybe due to a medical condition). Some other scenarios where artificial insemination could be beneficial are listed below.

- A woman may want to raise a child alone - in this case she would request a sperm donor to be artificially inseminated.
- The female may be infertile due to *cervical factor infertility*- the cervix is supposed to produce a mucus that helps sperm travel to the womb. With cervical factor infertility, the cervix is either not producing enough of this mucus, or it is producing mucus containing sperm killing substances.
- The woman may be suffering *Endometriosis*- this is when cells from the womb lining start to grow in places they should not within the woman's reproductive system e.g. ovaries or fallopian tubes. One of the possible results of this condition is infertility. Artificial insemination can be successful in mild to moderate cases of this.
- The female could have semen allergy - this is rare but can still happen, due to certain proteins in the sperm the woman may suffer an allergic reaction when the sperm makes contact. With IUI most of the proteins would be removed before sperm insertion.
- The male is unable to produce enough sperm for successful fertilization.
- The man is impotent (*erectile dysfunction*)- and would therefore be unable to perform sexual intercourse.
- The male could be infertile as a result of a medical treatment - some treatments carry the risk of infertility e.g. radiotherapy. Before the treatment the male would have been given the chance to freeze some of his sperm.

- The couple could be in same sex relationship - two women who want to raise a child together would use sperm from a donor, which one of the women would receive via artificial insemination.
- Reason for infertility cannot be determined - IUI may be recommended to a couple that cannot conceive even if no underlying reason for the infertility can be identified.

Multiple Pregnancies

The Meaning of Multiple Pregnancies

Give the meaning of multiple pregnancies

Multiple pregnancy refers to a situation when more than one ovum is released into the reproductive tract of the female. On this occasion it is possible for more than one ovum to be fertilized, consequently several viable embryos may enter the uterus where they are implanted and developed.

The Causes of Multiple Pregnancies

Explain the causes of multiple pregnancies

Multiple pregnancies may occur naturally or arise as a result of reproductive technology involving fertility drug or during an IVF program.

Causes of Multiple Pregnancy Include:

- More than one ovum released into the reproductive track
- One fertilized ovum splitting up into more than one embryo resulting to twins

Difference between Identical Twins and Fraternal Twins

Differentiate between identical twins and fraternal twins

Identical Twins: These are fully identical since they come from a single fertilized ovum, which has split to give two or four embryos and developing to give babies. They have the same sex and appearance.

Fraternal Twins: Resulting when more than one ovum (ova) are released at a time and are fertilized. They may have the same sex but not identical at all.

Disorders of Reproductive System

Types of Disorders of Human Reproductive System

Mention types of disorders of human reproductive system

Reproductive system is the one dealing with the birth of a child. We have two types of reproductive systems, which are male reproductive system and female reproductive system. The main function of reproductive system is to fuse the gamete causing fertilization. Conserving the baby in a mother's womb till the day of bearing a child. Also is the one providing birth/bearing of a child.

There are many disorders that affect the reproductive system. These problems may be found in both male and female reproductive systems. Disorders affecting male reproductive system are Impotence, Premature Ejaculation, Inflammation and Autoimmunity. Female disorders of the reproductive system are Damage to the Oviducts (inflammation), Pelvic Inflammatory Diseases (PID), Congenital Malformation and Functional Disorder.

The Causes and Effects of the Reproductive System Disorders

Explain the causes and effects of the reproductive system disorders

Male reproductive system disorders

Impotence

This is the inability to achieve or maintain an erection of the penis. A male could not erect the penis even though he will touch the sex organs.

Causes of Impotence

- Impotence is usually psychological disturbance. It may occur any time during the life time of a male
- Strong alcohol consumption and use of drugs
- Diseases also may cause impotence

Effects of Impotence

- Impotence causes failure in performing the social act, thus one cannot have children
- May cause psychological disturbances to the person
- If an impotent person is married, impotence may lead to the break of that marriage
- It may lead to the contamination of diseases such as HIV/AIDS, gonorrhea when a couple get out of marriage to get sexual satisfaction

Premature Ejaculation

Premature ejaculation is the situation where a man reaches orgasm before penetration of the penis into the female track. Before inserting penis into the female track the male ejaculated long time outside the female track.

Causes of premature ejaculation

- Fear, anxiety and sometimes is the first time to have sexual intercourse
- Psychological factors may also lead to a problem

Effects of premature ejaculation

- The person (male) fails to satisfy a woman
- May lead to the breakage of marriage when a woman finds another male for sexual satisfaction
- May cause psychological disturbances in the man's mind

Autoimmunity

This is a situation in which antibodies are made, which attacks own sperm, thus reducing the number of sperms. It may lead to have small number of sperms in the sperm store area.

Causes of Autoimmunity: Antibodies react to one's own sperm. It is not exactly known what causes autoimmunity.

Effects of Autoimmunity

- It causes infertility to a person
- May cause psychological effects to the person who suffering from this problem
- No more production of children

Inflammation

It is the condition in which the urethra is blocked. It allows no movement of sperm out of the penis and also the urine.

Causes of inflammation

- May be caused by swelling of the prostate gland
- Also inflammation may cause the problem

Effects of inflammation

- Inflammation may lead to sterility (infertility)
- May cause psychological problems to the person

- May cause severe pain during sexual intercourse as one/man wants to ejaculate but sperms fail to pass through urethra

DISORDERS OF THE FEMALE REPRODUCTIVE SYSTEM

DAMAGE OF THE OVIDUCTS (INFLAMMATION)

Oviduct of the female may be blocked and causes the female organs to do fertilization of an ovum

Causes of damages to the Oviduct (inflammation): It may be caused by the infections due to different diseases. The infections may cause scarring, thus leading to partial or complete blockage of the oviduct.

Effects of damage to the Oviduct (Inflammation): It causes infertility to the female. A female may not have the ability to carry/conceive a child due to failure of fertilization of an egg in the fallopian tube.

PELVIC INFLAMMATORY DISORDER (PID)

This is the pelvic infection caused by bacteria. This condition causes damage to the oviducts. It occurs commonly to women with many sexual partners and women who use the coil contraceptive method

Effects of PID: The condition may lead to infertility. A woman may fail to bear a child and if she does so the child will not be normal

CONGENITAL MALFORMATION

Some women are born with blocked oviduct or with no uterus (it mostly happens in very few cases)

Causes of malformation: This is a woman born with disorder caused by problems in the reproductive system

FUNCTIONAL DISORDERS

This is a condition in which a woman fails/unable to experience sexual pleasure during the sexual act

Causes of functional disorders

- The cause may be psychological
- Also may be biological one

Effects of functional disorders

- May cause someone to stay away not conducting sexual intercourse
- May lead to end in marriage

Possible Remedies of Reproductive System Disorder

Suggest possible remedies of reproductive system disorder

Treatment of Impotence

- If the causes of impotence are psychological, counseling may help to cure it
- If the cause is biological, one has to attend hospital for medical check up

Treatment of premature ejaculation

- Counseling is the most effective way to be adopted to treat the problem
- Medical treatment may be applied to stop the problem

Treatment of Autoimmunity

This disorder is more difficult to treat

Treatment of inflammation

One/man should have to seek medical advice or intervention

Treatment of damage to the Oviduct (Inflammation)

Surgery is the most effective way of treating this problem.

Treatment of PID

- If a woman feels she has PID she should have to go to the hospital for the right treatment

- Abstaining from many sexual partners so as to overcome more infections/problem

Treatment of functional disorders

- Counseling is the most effective way that may be used to help the patient regain their confidence
- Patients may go to the hospital for further checks and treatment

Complication of the Reproductive System

Types of Complications of the Reproductive Systems

Mention types of complications of the reproductive systems

Most women give birth normally and perfectly but some problems can and do occur in their reproductive system and causes effects to the newly formed embryo. The problems/complications are abortion/miscarriage, ectopic pregnancy and still births also breech birth.

- **Miscarriage:** This is the loss of a developing embryo before six months are over. Medically, miscarriage is considered as the natural abortion. It may result from foetus not being fully developed, failure of the embryo to implant properly or due to deformed embryo.
- **Ectopic Pregnancy:** Occasionally the fertilized ovum fails to reach the uterus and instead implants else where in the reproductive track. For example it can be implanted in the fallopian tube instead of uterus. This situation is known as ectopic pregnancy. Only 1 out of 50,000 ectopic pregnancies may be delivered safely.
- **Abortion:** Refers to the premature termination of pregnancy. Abortion may occur naturally (miscarriage) or be induced. **Induced Abortion** is the abortion that is deliberately brought out for medical reasons. **Spontaneous Abortion** is the kind of abortion that occurs without humans or medical intervention. That is not induced in any way. It is also referred to as miscarriage.
- **Breech Birth:** This is the situation where a baby is born feet or buttocks first. In such cases, duration of delivery is critical, too fast delivery may result in damage and too long delivery may cause oxygen deprivation and if left for a longtime may result to death of the baby. Sometimes it becomes necessary to remove the baby by other means such as forceps (surgical tongs) or Caesarian (C) section
- **Caesarian Delivery:** This is the removal of the baby from the uterus using surgical means through making an incision in the abdominal and uterine wall. Caesarian delivery can be done when either the baby is too big to pass the female reproductive structures or the mother's reproductive structures are too small.

Other complications that occasionally arise during childbirth and generally require management by an obstetrician may be described as follows:

- Non-progression of labour (long-term contractions without adequate cervical dilation) is generally treated with cervical prostaglandin gel or intravenous synthetic oxytocin preparations. If this is ineffective Caesarian section may be necessary.
- Fetal distress is the development of signs of distress by the child. These may include rising or decreasing heartbeat (monitored on cardiotocography). Shedding of meconium in the amniotic fluid and other signs.
- Non-progression of expulsion (the head or presenting parts are not delivered despite adequate contractions); this can require interventions such as vacuum extraction forceps extraction and

Caesarian section. In the past a great many women died during or shortly after childbirth but modern medical techniques available in industrialized countries have greatly reduced this totally.

- **Unanticipated heavy bleeding** during or after childbirth is potentially lethal in places without immediate access to high-level emergency care. Heavy blood loss leads to hypovolemic shock, insufficient perfusion of vital organs and death if not rapidly treated by stemming the blood loss and blood transfusion.

Causes of Complications of the Reproductive System

Outline causes of complications of the reproductive system

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Ways to Minimize the Occurrence of Complications and Disorders of the Reproductive System

Suggest ways to minimize the occurrence of complications and disorders of the reproductive system

The following are the way of minimizing occurrence of complications and disorders of the reproductive system.

- Stop/minimizing amount of alcohol that we take/drink may keep us away from impotence and other infections that may lead to disorders in reproductive systems
- Practicing different duties/activities and participating in exercises also sports and games helps to reduce psychological problems which may lead to disorders in the reproductive system
- Medical check up between the partners who want to get married to know their Rhesus factors, blood groups, infections and HIV/AIDS in order to minimize the death or miscarriage during pregnancy
- Getting early treatment of any infections like gonorrhea, syphilis, bilharziasis, which may cause damage to the fallopian tubes and urethra in male and female.

Sexuality and Sexual Health and Responsible Sexual Behaviour

The Concept of Sexuality

Explain the concept of sexuality

Sexuality includes fondness or readiness for or interest in a sexual activity.

Sexuality is the function of whole personality begins at birth and end at death it includes:

- How you feel about yourself as a person
- How you feel being a man or woman
- How you get along with member of the same or opposite sex
- It also includes genital and reproductive processes such as intercourse and child bearing

Social Cultural Factors Influencing Sexual Behaviour in Different Age Groups of People

Mention social cultural factors influencing sexual behaviour in different age groups of people

Sexual Behaviour in Children

Factors influence sexual behavior in Children:

- Start at infancy when children shown their own bodies
- Also sexuality is shown at early age (play age)
- Children also do and learn from their fellow children on different sexual matters
- Education – in school and community
- Initiation rites
- Religious beliefs
- Mass Media
- Economic status – both poor and rich

Sexual Behaviour in Adolescents

Factors influence sexual behaviour in adolescents:

- Early marriage
- Social pressure (tradition of being independent)
- Drug addiction – it can stimulate or depress the sexual practice
- Peer pressure
- Education – school and community
- Moral decay
- Marriage breakdown and problems
- Poverty
- Mass Media
- Lack of proper guidance and counseling

Difference Between Responsible and Irresponsible Sexual Behaviour and Their Impact on Oneself Family and Community

Differentiate responsible from irresponsible sexual behaviour and their impact on oneself family and community

Responsible sexual behaviours are the behaviours, which are acceptable in the societies to elicit or trigger sexual activity like marriage.

Irresponsible sexual behaviors are those behaviours of an individual, which are not acceptable by family as well as societies, example use of alcohol and drugs (drug addiction) and prostitution to trigger sexual activities.

Effects of irresponsible Sexual Behaviour

To an individual:

- Becoming pregnant at a tender age, thus losing the opportunity of being officially married or continuing with studies
- Being in danger of contracting fatal venereal disease such as syphilis, HIV/AIDS, gonorrhea etc.
- It may lead to death, when an individual tries to abort an unwanted pregnancy
- Getting a responsibility of caring for a family at an early age
- It can degrade the personality of a person. For example prostitutes or rapists have no place to put their faces in some societies

To family

- Breakage of marriage
- Lead to conflict in the family or marriage
- Loss of particular relative if he/she contracts disease like HIV/AIDS

Ways of Eradicating Irresponsible Sexual Behaviours/Practices in the Family and Community
Suggest ways of eradicating irresponsible sexual behaviours/ practices in the family and community
There are several measures that can be taken to eradicate irresponsible sexual behaviours in the family and community. The measures include the following:

- Old children should not sleep with young children on the same bed without strict follow-up by the parents/guardians.
- Keeping out of all situations culminating to sexual arousal such as watching pornographic movies, alcoholism, meeting in isolated places, attending night clubs and accompanying ill groups of people like homosexuals, harlots, and rapists.
- Adults, guardians, parents, and teachers should talk openly to children about relationships and sexual-education matters to make them informed about the aftermath of irresponsible sexual behaviours.
- Close supervision and guidance of children
- Getting involved in age-appropriate activities (for example, sports, boys/girls clubs, after-school activities, and craft activities) to help keep one's minds out of sexual mood and desires.
- Protection for children from scary or traumatic events, including media coverage of such events as wars, bombings, or shootings; and
- Closely observing what your child watches on television and in the movies or is exposed to in music and on the Internet.
- Following religious teachings on sexuality.

Appropriate Life Skills Required to Cope with Adolescent Sexuality and Sexual Behaviour
Mention appropriate life skills required to cope with adolescent sexuality and sexual behaviour
Life skills are behaviours that enable individuals to adapt to and deal effectively with the demands and challenges of life. There are many such skills, but core life skills include the ability to:

- make decisions, solve problems, and think critically and creatively;
- clarify and analyze values;
- communicate (including listen, build empathy, be assertive, and negotiate);
- cope with emotions and stress; and

- feel empathy (understand and care about other peoples' needs, desires and feelings) with others and be self-aware.

Some life skills required to cope with adolescent sexuality and sexual behaviour include the following:

- Educating youth about health-related issues, such as alcohol, tobacco, and other drug use; nutrition; reproductive health; and preventing HIV/AIDS and other sexually transmitted infections (STIs). Life skills education can also be effective in preventing school dropout and violence among young people.
- Referring young women to age-appropriate reproductive health services.
- Promoting youth's livelihood through vocational training, recreation, etc.
- Mobilizing and empowering individuals, families, and communities in order to reach, influence, and involve everyone to become a part of the solution.
- Parents and teachers strictly supervising teenagers at home and school, respectively.
- Adults and parents inculcating good moral behaviours to adolescents by serving as good examples for them to follow.

Family Planning and Contraception

The Concept of Family Planning and Contraception

Explain the concept of family planning and contraception

Family planning is a decision made by a person freely on how many children he or she may want to have and when she or he wants to stop.

Contraception refers to prevention of conception that is prevention or preventing the fusion of the male gamete with the female gamete. Birth control is broad it includes measures taken to prevent birth after fertilization.

There are two methods used namely Artificial family planning methods and Natural family planning methods.

- **Artificial Family Planning Methods** includes sterilization, oral contraceptives, intra-uterine devices, Norplant, diaphragm and condoms
- **Natural Family Planning Methods** includes rhythm, the basal body temperature and withdrawal (coitus interrupt)

Social Practices which Enhance Family Planning

State social practices which enhance family planning

Social cultural practices, which enhance family planning, include the natural methods of family planning, which are:

Abstinence

This refers to the avoidance of sexual intercourse or can be defined as refusal by sexually active male and female to have sexual intercourse.

Advantage of Abstinence

- It is the most effective method of preventing conception
- The approximated rate of failure of this method is zero percent

Disadvantages of Abstinence

It is said to be unrealistic for many to practice this method

Rhythm Method (Calendar Method)

This is modified from abstinence. No intercourse is done during the fertile period. These days can be counted or identified by counting the days between menstrual period and also by observing certain associated physical changes such as small changes in body temperature. A woman may also keep a written chart of her menstrual cycle for certain months and is taught how to determine the number of days each month when sexual intercourse must be avoided. Total abstinence is about 7 days in a month.

Advantages of the Rhythm Method

- The method is said to be natural and widely acceptable
- It has no cost
- It is said to be 77-87% effective

Disadvantages of Rhythm Method

- The approximate failure rate is 20%
- It requires good knowledge and good record keeping
- It also requires a period of abstinence
- Irregularity of the menstrual period (cycle)

Temperature Method

This method is based on the changes of a woman's body's temperature due to her menstrual cycle. The temperature is said to drop during the menstrual period and remains low until the release of an ovum. A rise in temperature is noted at ovulation and sexual intercourse should be avoided at this time if conception is not intended.

Advantages of the Temperature Method

- The method is said to be 76-80% effective
- It costs nothing
- It does not require fitting and regular checkups

Disadvantages of the Temperature Method

- The approximate failure is said to be 20-24%
- Sperms released to a female tract a few day before ovulation may survive until ovulation
- Irregularity of the ovulation may cause fluctuation of temperature

Billing Method (Ovulation Method)

This method is based on the fact that the secretion from the female tract changes noticeably during the course of her menstrual cycle. The appearance of clear thin mucus in female tract secretions at ovulation is noted and sexual intercourse is avoided during these times.

Advantages of Billing Method

- It is said to be 76-80% effective
- It costs nothing (it is cheap)
- It does not require fitting and regular check ups

Disadvantages of Billing Method

Regularity of ovulation may cause fluctuation of temperature

Coitus Interruption (withdrawal)

Coitus interruption or withdrawal is another natural method of birth control in which a male withdraws his penis from a female tract before ejaculation. This method is one of the oldest methods of birth control. Coitus interruption requires unusual degree of will power.

Advantages of Withdrawal

- The method is costless
- It is reliable for 76-80% when practiced

Disadvantages of Withdrawal

- The method requires some degree of will power
- It has a high failure rate in case fluid released from the penis just before ejaculation may contain viable sperms
- Sperms may leak from penis before is withdrawal even without ejaculation

Artificial Methods of birth control

Barrier Methods

These methods prevent sperms from entering the female tract. These methods include:

Condom: This is a thin rubber sheath, which prevents sperms from entering into the female tract.

Male condom is worn over an erect penis during intercourse and prevents sperms from being released into the female tract that way preventing union of sperm and ovum.

Advantages of Condoms

- Condoms are said to be 85% to 93% reliable when used properly (handled with care)
- They may help prevention of sexually transmitted diseases such as fungal infection
- They are cheap and easily and obtained

Disadvantages of Condoms

- Condoms can tear and leak. In such cases they become useless
- A condom may slip off the penis after climax
- Condoms may disrupt the act of love making (reduce sensation)

Female Condoms

Female condoms are equivalent to male condoms in that:

- It is a thin rubber tube with a close end which fits inside the female tract
- Female condoms are relatively new, so not much is known about them. They give a woman some control and are said to have the advantages as those of the male condoms

Diaphragm

This is another barrier method that prevents entering of sperms into the female tract. A diaphragm is a flexible rubber, which fits over the cervix and prevents entry of sperm to uterus. It is applied with contraceptive jelly (cream) or spermicidal chemicals, which kill sperms. A doctor must prescribe this method.

Advantages of Diaphragm

- The method is said to be cheap
- It can be inserted a few hours before sexual act

Disadvantages of Diaphragm

- The diaphragm must be fitted by a doctor and training is required for the woman to fit it
- It disrupts spontaneity
- It occasionally causes pain in the abdomen
- It needs check up after every six (6) months

- It should be left in place six hours after intercourse

Spermicidal

These are chemicals, which kills sperms. Spermicidal foam, or spermicidal jelly is placed in an applicator, which is inserted and emptied into the female tract just before sexual intercourse. These kill sperm and block cervix.

Advantages of Spermicidal

- It is cheap
- It is effective for about an hour

Disadvantages of Spermicidal

- It is messy
- It has a high failure rate if used on its own

The pill

This is one of the most widely used contraceptive methods. The pill is an oral contraceptive by synthetic oestrogen and progesterone taken daily by the female. It functions by suppressing the normal release of gonadotropins from the pituitary. These synthetic hormones prevent the ovulation process, thus hindering fertilization.

Advantages of the pill

- The pill is said to be very effective i.e. it is about 98% successful
- A woman has control over the method
- It has no interference with sexual intercourse

Disadvantages of the pill

- It is not suitable for all women. There may be increased risk of blood clotting in some women
- It is not recommended for older women or women who smoke
- Short term side effects of the pill include nausea, weight gain, tissue swelling, fluid retention and minor headaches

The Importance of Male Involvement in Family Planning

Outline the importance of male involvement in family planning

People go for family planning or control for a number of reasons. Among these are:

- To ensure both partners are healthy and observe medical measures that are advised, giving enough time for a mother's full recovery after giving birth
- Ability to cater for the needs of many children
- Couples decide to practice child spacing so that they can cater for their needs
- Helps to improve the health of a mother by helping women to avoid pregnancy at early age, unwanted pregnancies and to become pregnant at late age of 35 years

Importance of Family Planning and Contraception

- Some family planning methods help to prevent the transmission of HIV and sexually transmitted infections
- Family planning reduces the need for unsafe abortion
- Family planning reinforces people's rights to determine the number and spacing of their children
- Family planning helps to build the health of a mother

- Family planning enables the couple to be able to handle the family by catering to the needs of family

Maternal and Child Care

The Concept of Maternal and Child Care

Explain the concept of maternal and child care

A pregnant mother needs a lot of care and consideration for the best of her health and that of the child. Basically there are two types of care given to pregnant mother. These are pre-natal and post-natal care. The care given before birth is called pre-natal care and the care given during birth is called natal care. But a pregnant mother also needs a care and support after birth of the child; this kind of care and support provided after birth is called post-natal care.

Maternal care during pregnancy (Pre-natal care)

Pre-natal care means before birth; therefore pre-natal care means a care given to a pregnant woman before delivery.

Things to be done by a pregnant mother

- Visit ante-natal clinic for counseling
- Maintain general body cleanliness all the time
- Have enough rest
- Wear loose-fitting dresses and low heeled shoes for comfort
- Eat well balanced diet containing all types of food

Things to be avoided by a pregnant mother

- Doing tiresome and manual work. Example lifting heavy loads
- Taking any medicine not prescribed by the doctor
- Taking drugs such as alcohol, cigarettes which could be detrimental to the unborn baby
- Tight clothes and high heeled shoes
- Avoid situations leading to chances of contracting venereal diseases such as gonorrhea, syphilis and AIDS which might affect the baby
- Avoid stressful situation

Care during natal period

Natal period is the period when the pregnant mother gives birth to the child she has been carrying in her womb for about nine months. A number of things need to be considered during natal period:

- An expectant mother needs to undergo labor under supervision of a trained nurse or trained birth attendant whenever this is possible
- If any complications occur that can not be solved by either a trained nurse or a trained birth attendant arises, an expectant mother should be referred to the health center or hospital for medical assistance
- Most births are perfectly normal but problems can and do occur. When problems arise, modern delivery facilities or techniques such as Caesarean section and vacuum extraction are used. Care should be taken not to damage any organ of the baby or the mother
- In case a newborn baby is pre-mature appropriate services should be given to it so as to help it accomplish a normal pattern of growth and development

Post-natal services to the mother and the child

These are care and services provided to the mother and the newborn child after birth. After birth a mother has another big responsibility and role of breast-feeding the child.

Also a mother should attend post-natal clinic for medical checks and immunization of the child

Balanced diet should be supplied to a lactating mother so as to ensure that she gets enough nutrition for her benefit and ultimately that of the child.

Proper nutrition will help her to restore the tissue worn out during the natal period. This helps also the newborn baby to have enough milk from its mother. The health of both the mother and her child should be seriously taken care of.

Child health care

Mothers should breast-feed the child whenever possible, mother's milk is better than any other food because of the following:

- It contains antibodies that are much needed to the child
- In case the mother has no health problems such milk is free from contamination
- Mother's milk also contains much proteins and vitamins which are very important for the child's growth
- Breast milk is easily digested than other milk example bottled milk. Therefore children who take milk from their mother rarely suffer from constipation
- Mother's milk is said to contain some chemicals which help in development of the nervous system of the child
- Regular attendance of post-natal clinic for the child is very important. The child should also get immunized against different infections and diseases such as polio, measles and other diseases
- The mother should follow medical advice on how to handle the child and in case of any problems report it to the personnel concerned

Social-Cultural Factors which Affect Maternal and Child Care in the Family and Community

Mention social-cultural factors which affect maternal and child care in the family and community

These include the following:

- **Female Genital Mutilation (FGM):** This is the practice of circumcising women. It is said to have effects during childbirth. It causes women to experience pain, bleeding, and shock and may lead to infection.
- **Local Belief:** These are certain local beliefs and taboos such as banning women to eat certain types of foods such as protein rich foods, which could help to build their health and that of the child.
- **Working** especially hard work such as cultivation: Hard work may cause several problems to the pregnant woman such as miscarriage or pain.
- **Alcohol Consumption during pregnancy:** In most cultural practices taking alcohol is considered as a normal behaviour. But alcohol during pregnancy affects both the health of the mother and that of the child.

Appropriate Ways of Providing Maternal and Child Care for People Living with HIV/AIDS (PLWHA)

Suggest appropriate ways of providing maternal and child care for people living with HIV/AIDS (PLWHA)

These include the following:

- To ensure frequent medical check up for both maternal and child
- To ensure they get well balanced diet

- Avoid sharing sharp objects like razor blades
- Counseling in order to help them deal with their feelings of loss and grief
- To avoid discrimination for people living with HIV/AIDS
- Ensure the use of polite language when providing care to them
- Wearing of gloves when cleaning their bodies and clothes