**KENYA INSTITUTE OF EDUCATION**

**FORM THREE BIOLOGY VOICE OVERS**

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| BI3-000000text | Hello students; Welcome to this digitized form three biology course. In form two we covered the topics; transport in plants and animals, gaseous exchange, respiration and excretion and homeostasis. In this course, we will cover four topics. These include: - Classification II, Ecology, Reproduction and Growth and Development. |
| BI3-100000text | **CLASSIFICATION II** |
| BI3-100000otext | **Objectives** By the end of the topic, you should be able to:  1. State general characteristics of each of the five kingdoms. 2. State main characteristics of phyla Arthropoda, chordata and major divisions of the Kingdom Plantae. 3. Name classes of division spermatophyta. 4. Describe the main characteristics of classes of phyla arthropoda and chordata 5. Use observable external features to construct simple dichotomous keys of plants and animals 6. Use already constructed dichotomous keys to identify organisms. |
| BI3-100000btext | **Background information**  Classification is the placing of animals and plants in a series of increasingly specialized groups. This is based on their similarities and differences in structure and origin. Classification makes it possible to identify living organisms since similar organisms are grouped together while those which are different are grouped separately. It also makes it easy to study living organisms and even do research. Without classification, it would be difficult to deal with living organism since each organism would be treated as a separate entity. Carolus Linnaeus is credited with coming up with a universal system of classification.  The illustration below shows the five major units used in classification of organisms |
| BI3-101000text | **Introduction**  In form one, we covered classification I. We identified the major taxonomic units as: -  Kingdom, Phylum/Division, Class, Order, Family, Genus and Species.  We also named the five kingdoms as follows: - Monera, Protoctista, Fungi, Plantae and Animalia.  The animation below shows the representatives of the five kingdoms that are used in classification of living organisms. Click on the play button to view the animation.  In classification II we are going to look at the general characteristics of the members of these Kingdoms. We will also cover construction and use of Dichotomous key to identify living organisms. |
| BI3-102000text | **Kingdom Monera** This kingdom comprises of bacteria and blue green algae. Their general characteristics are: - • Presence of a cell wall not made up of cellulose. • They are Unicellular and microscopic. • They have few organelles which are not membrane bound. • They are prokaryotic - this means that the nuclear material is not bound by a nuclear membrane. • Movement is by flagellum. • They reproduce asexually by binary fission. • Most respire anaerobically.  The illustration shows the generalized structure of a bacterium |
| BI3-103000text | **Kingdom Protoctista:**  Members include: amoeba, paramecium, plasmodium, spirogyra, algae, Chlamydomonas and euglena.  The animation shows examples of some members of kingdom Protoctista such as euglena, chlamydomonas and spirogyra. Click on the play button to view the animation.  The illustration below shows the main parts of an amoeba. |
| BI3-103100text | **Characteristics of members of kingdom Protoctista**  • Varied body forms: Some are unicellular while others live in colonies. The unicellular include amoeba, paramecium, euglena and chlamydomonas. The multicellular include spirogyras that are also thalloid in nature. • They are eukaryotic that is their nuclear material is bound by a nuclear membrane.  • Protoctista has many organelles such as mitochondria, food vacuoles and contractile vacuoles. • Most are mobile, movement propelled by means of pseudopodia, cilia or flagella whereas others are sessile. The lashing of the flagellum in the chlamydomonas and the Euglena causes forward movement. The beating of cilia in the paramecium causes spiral movements.    Click on the play button below to see the movement in paramecium, amoeba and chlamydomonas  • Some of the Protoctista are heterotrophic while others are autotrophic.  Play the animation to see phagocytosis in amoeba.  • The mode of reproduction is mainly asexual by fission, Fragmentation or sporulation depending on the species. • In some, specialized structures are used to perform specific functions such as contractile vacuoles for osmoregulation. |
| BI3-104000text | **Kingdom Fungi.** This kingdom comprises mushrooms, toadstools, yeasts, bread moulds and Penicillia which are well known saprophytes. The parasitic ones cause animal and plant diseases such as ringworms in humans and wheat rust tomato and potato blight in plants.  The animation below shows Mushrooms, Bread moulds, yeast and toadstools which are examples of Kingdom Fungi. Click on the play button to see the organisms. |
| BI3-104100text | **General characteristics of members of kingdom fungi.** - They are eukaryotic. - They lack chloroplasts. - Some are unicellular while others are multicellular. The unicellular ones are the simplest forms for example yeast while the multicellular forms have a basic unit called the hypha. Hyphae appear as filaments which collectively make up the mycelium.  The photograph below shows mycelium in a rhizopus  - Fungi reproduce, both asexually and sexually. Asexual reproduction is by spores formation or budding as in yeast whereas sexual reproduction involves fusion of nuclei in hyphal branches. |
| BI3-105000text | **Kingdom Plantae.** The general characteristics of kingdom Plantae are;  • Eukaryotic and multicellular • Body differentiated into leaves, stem and roots • Have cells with cellulose cell wall • Have transport system • They are autotrophic • Reproduction is both asexual and sexual  • They show alternation of generation. |
| BI3-105100text | **Divisions of the kingdom Plantae are:** • Bryophyta e.g. moss plant • Pteridophyta e.g. fern plant • Spermatophyta e.g. maize plant  The following are the photographs of the moss, fern and the maize plants representing the three divisions of kingdom plantae. |
| BI3-105200text | **Division Bryophyta:**  Examples are moss and liverworts. The members have the following general characteristics • They are terrestrial green plants which grow in humid or moist surfaces for example on the barks of trees, rocks, wall of buildings among others.  The following photographs shows moss plants growing on walls of buildings, rocks and barks of trees.  • They are not differentiated into roots, stem and leaves. Instead they have rhizoids for anchoring and absorbing water and dissolved mineral salts.  The illustration shows rhizoids of a moss plant.  • They show alternation of generations.  • The gametophyte is the gamete producing part and is dominant while the sporophyte is the spore producing part and is born on the gametophyte. • They are non – vascular. |
| BI3-105300text | **Division pteridophyta** These include the ferns and horsetails. The ferns show a wide variety from the small to giant tree ferns of more than ten metres tall.  A giant fern tree and a dwarf fern tree are shown on the photographs  • They have chlorophyll so they can photosynthesis (are autotrophic). • They have roots, stems and leaves but no flowers. • The leaves are called fronds and grow from the stem  On the illustration, roots stem and fronds of a fern are shown.  • On the lower surface of the fronds they bear spore producing structures called sori. • They posses clearly defined vascular tissue. • They show alternation of generation where the sporophyte is dominant. |
| BI3-105400text | **Division spermatophyta** This division falls under the kingdom plantae. Members of this division are the common green plants around us.  The photographs below show pine, palm, coffee, tea, coconut, Nandi flame, jacaranda and maize plants which are examples of members of division spermatophyta.  They are referred to as the seed bearing plants and share the following general characteristics;  1. Plant body differentiated into roots, stems, leaves and seed bearing structures.  The animation shows the different parts of a maize plant highlighting some of its features. Click on the play button to view the animation.  2. Vascular tissue is highly developed with xylem tissue containing both xylem vessels and tracheids. 3. Seeds are produced after fertilization 4. They contain chlorophyll for photosynthesis.  5. Reproduction is sexual and does not depend on water for fusion of gametes. |
| BI3-105500text | **Sub-divisions of division spermatophyta**  Division spermatophyta contains two main Subdivisions; gymnospermaphyta and angiospermaphyta.  **Sub-division Gymnospermaphyta**  Plant members in this group include pine, cyprus, and cedar.  The photographs below show the pine, cyprus and cedar plants.  General characteristics of gymnospermatophyta • Bear cones of two types; male and female cones  The male and the female cones are also shown on the photograph below.  • Show xerophytic characteristics e.g. rolled leaves, needle – shaped leaves, sunken stomata, thick waxy cuiticle. • Xylem tissue which is mainly made of tracheids and phloem does not have companion cells • Seeds are borne on female cones and are not enclosed in a fruit wall (naked seeds) |
| BI3-105600text | **Classes of Gymnospermaphyta** Sub-division gymnospermaphyta is divided into three main classes.  These are:- 1) Coniferales 2) cycadales and 3) Ginkoales  The pedigree chart shows the pine, cycad and ginko biloba which are members of sub - division gymnospermaphyta.  **Class Coniferales** The member plants in this class include pine, cedar and Cyprus  General characteristics of the class coniferales include; - Needle – shaped leaves - Thick waxy cuticle - Female cones appear on lateral buds on young shoots while male cones are usually small and form clusters around the base of the terminal buds e.g. pinus. **Class cycadales** -They have long compound leaves which are clustered at the apex of a thick usually short unbranched stems. -They have cones which are borne at the apex of the trunk among the leaves e.g. cycads **Class ginkoales** They are rare plants with fan like deciduous leaves. Representatives of this class are the Ginko biloba plant.  Play the animation to see, the needle-like leaves of the pine, the compound leaves of the cycad and the fan like leaves of ginko biloba. |
| BI3-105700text | Sub-division **Angiospermaphyta** Members include grasses such as bamboo, wheat, oat and maize; shrubs such as lantana camara and hibiscus species. Examples of herbs include black jack, persely and examples of trees are Croton, Eucalyptus species and the Nandi flame.  The photographs below show grasses like bamboo and wheat, shrubs like lantana camara and hibiscus and trees like eucalyptus and Nandi flame.  They have the following general characteristics  • They produce flowers • They are Bisexual • They have seeds enclosed by a fruit wall • Their xylem tissues have tracheids and vessels while phloem has companion cells. |
| BI3-105800text | **Classes of angiospermaphyta**  Sub-division angiospermaphyta is divided into two classes i.e. dicotyledonae and monocotyledonae  **Class Dicotyledonae** Class dicotyledonae has the following general characteristics - Embryo of the seeds has two cotyledons - Broad leaves with network of veins - Vascular bundles in the stem arranged in a concentric rings with a pith and narrow cortex - Has vascular cambium - Tap root system with a centrally placed xylem alternating with phloem - Flowers have floral parts in fours or fives or their multiples. - Have petiole  The diagram shows various parts of a bean plant (*Phaseolus vulgaris*). |
| BI3-105900text | **Class Monocotyledonae** Examples of class monocotyledonae are bamboo, maize among others. The members of this class share the following general characteristics; - Narrow leaves with parallel veins - Fibrous roots - Floral parts in threes or multiples of three - Leaf petiole modified to leaf sheath - Vascular bundles in the root are arranged in a ring and lack vascular cambium  The diagram below shows various parts of a maize plant (*Zea mays*). |
| BI3-106000text | **Kingdom animalia** This is a group of living organisms with distinct characteristics which include;  • They are eukaryotic and multicellular • No cell wall • All are heterotrophic • Most reproduce sexually while a few reproduce asexually • Most show locomotion but a few are sessile Kingdom Animalia is made up of many phyla but in this course, we will learn the characteristics of only two phyla; namely:-Phylum arthropoda and Phylum chordata.  Below are photographs of members of phylum arthropoda (centipede, millipede and grasshoppers) and phylum chordata (frog, lizard, fish, bird and man). |
| BI3-107100text | **Phylum arthropoda** Members of this phylum have segmented bodies, jointed appendages and an exoskeleton. This phylum is divided into five classes based on;   * Number of limbs * Number of body parts * Number of antennae The classes are: - • Crustacea • Chilopoda • Diplopoda • Insecta • Arachnida   The photographs below show some members of phylum arthropoda; crayfish, centipede and grasshoppers |
| B13-107200text | **General characteristics** The main characteristics of the phylum arthropoda include: -  - Jointed appendages- some paired and specialized for various functions. - Body covered with hardened exoskeleton made of chitin and is shed off periodically in a process called moulting. - They have segmented bodies. - Body of most members divided into three body parts namely the head, thorax and abdomen some have two body parts with the head and thorax fused to form a cephalothorax and abdomen.  The photographs highlight various features of members of phylum arthropoda. Some of the features highlighted are jointed appendages, exoskeleton and segmented bodies.  - Members are bilaterally symmetrical. - Have open circulatory system where blood flows in open cavities – haemocoel with a tubular dorsal heart. - Well developed head with eyes, sensory structures and fairly well developed brain. - Gaseous exchange is through the tracheal system though a few aquatic forms use gills. - Sexes are separate with reproduction being sexual.  The animation below shows the various characteristics of members of the phylum arthropoda. Click on the play button to view the animation |
| BI3-107300text | **Class crustacea** The name crustacean is derived from “Crusta” which means a hardy shiny coat. Members include lobsters, crayfish, shrimps, crabs and water fleas.  The photographs represent some members of class crustacea such as lobsters, crayfish, shrimps, crabs and water fleas.  They share the following characteristics: - • Head fused with thorax to form a cephalothorax.  •Covered by a shiny coat the carapace. • Two pairs of antennae • A pair of compound eyes • Three pairs of mouth parts – open pair mandible and two pairs maxillae • Five to twenty pairs of limbs modified for locomotion, feeding and defense located on cephalothorax and abdomen.  The animation shows the different parts of a crayfish (crustacean). Play the animation to see the parts. |
| BI3-107400text | **Class chilopoda** These are arthropods with a pair of walking legs on each segment. This class is comprised of centipedes.  The illustration below shows the various parts of a centipede  General characteristics of chilopoda are;  • Dorsal-ventrally flattened • Body divided into two parts head and trunk • Body comprising of up to 15 or more segments • A pair of walking legs in each segment • A pair of simple eyes on the head. • A pair of antennae • Posses poison claws on the head which secrete poisonous substances. • Gaseous exchange is through a tracheal system • Have separate sexes.  The animation outlines some of the characteristics of class chilopoda. Play the animation to view the characteristics |
| BI3-107500text | **Class diplopoda** This class comprises the millipedes  The illustration below shows the various parts of a millipede  The following are the general characteristics • Diplopods have three body parts, the head short thorax consisting of four segments and a body trunk • The body has numerous segments each bearing two pairs of walking legs except for the first thoracic segment. • The head has a pair of antennae and mandibles • Members have cylindrical body  • They have two clumps of many simple eyes • Each body segment has a pair of spiracles for breathing • Millipedes have no poison claws  Play the video to see the movement of a millipede |
| BI3-107600text | **Class arachnida** This class includes, the spiders, scorpions, ticks and mites.  Photographs of a spider, scorpion, tick and a mite which are members of class arachnida are shown below.  They have the following general characteristics. • The body has two parts; the cephalothorax and abdomen • The cephalothorax consists of a fused head and thorax  • The ventral side of cephalothorax has two chelicerae each having a claw-like structure which produces poison that paralyses prey. • The cephalothorax has four pairs of walking legs each having seven joints • Each leg ends in two toothed claws • Have no antenna. • The cephalothorax commonly has eight simple eyes • Others are parasitic and have specially adapted mouth parts for piecing and sucking blood. • Most arachnids have book lungs for gaseous exchange • Some members are carnivorous and are able to paralyze the prey using the poison produced.  The illustration shows the various parts of members of class arachnida |
| BI3-107700text | **Class insecta** Examples of members of this class include: Butterfly, grasshopper, termites and cockroach.  Examples of members of class insecta, that is, Butterfly, grasshopper, termite and cockroach are shown in the Photographs below.  The general characteristics of class insect are: • The body is divided into three parts, head, thorax and abdomen • The thorax is made up of three segments with three pairs of legs.  • Some insects have one or two pairs of wings on the thorax. • The head has a pair of antennae, a pair of compound eyes and several simple eyes.  The illustration shows the various parts of members of class insecta such as three body parts, a pair of antennae, compound eyes and the tracheal system  • The mouth parts consist of mandibles, maxillae and labium. • The mouth parts are modified according to their feeding habits. E.g. chewing, piercing and sucking. • The abdomen is made up of eleven or fewer segments with terminal parts modified for reproduction. • They breathe through spiracles; gaseous exchange is through the tracheal system. • Excretion is through malphigian tubules, which remove uric acid. • The insects undergo complete or incomplete metamorphosis. In complete metamorphosis The egg hatches into the larva which changes into the pupa and then into the adult. In the incomplete metamorphosis The egg hatches into the larvae which are called the nymph. These grow from the 1st instar 2nd instar 3rd instar and 4th instar. The nymph are similar to the adult but lacks wings and is sexually immature  Play the animation below to see some of the characteristics of members of class insecta |
| BI3-108000text | **Phylum Chordata** This phylum consists of the fish, amphibians, reptiles, birds and mammals.  Below are photographs showing organisms belonging to different classes of phylum chordata. They include tilapia (fish), frog (amphibians), crocodile (reptiles), domestic fowl (aves) and cow (mammals).  Members of this phylum have the following general characteristics.  • Notochord present at some stage in the lifetime which persists in some organisms but changes to vertebral column in higher animals. • Have an endoskeleton made of cartilages and bones • Have a post anal tail • Have a dorsal and hollow nerve cord situated in the vertebral column.  The illustration shows the vertebral column in human  • Bilaterally symmetrical • Have segmented muscle blocks called myotomes on either side of the body. • Have limbs that are formed from more than one body segment e.g. fins in fish, walking legs in frogs and wings in birds • Have a ventrally located heart with closed circulatory system.  • Have openings into the pharynx called pharyngeal or visceral clefts at some stage in their life cycle  Play the animation to see the various characteristics of members of phylum chordata |
| BI3-108100text | **Class Pisces** All members of this class live in water and include tilapia, sharks, Nile perch, Sardines, dolphin etc.  The photograph shows the various parts of a fish.  - They have the following general characteristics • Are all aquatic • Most have their bodies covered with scales • Have gills for gaseous exchange • Have fins for locomotion • Have a streamlined body to facilitate movement in water.  Play the video to see the role of fins and streamlined body in fish locomotion.  • Have a lateral line which acts as a sensory organ • Are poikilothermic / ectothermic. • Reproduce sexually with fertilization being internal.  The following figure is an illustrated summary of the general characteristic of class of Pisces. |
| BI3-108200text | **Class amphibia** This class comprises of the toads, frogs, salamanders and the newts.  Below are photographs of a toad, frog, salamander and the newt which are members of class amphibia  - They spend part of their life in water and land. Adult amphibians go to water for reproduction; and the earlier stages of development take place in water (eggs and tadpoles).  They have the following general characteristics - Soft and moist skin - Four well developed pentadactyl limbs for locomotion - Gaseous exchange occurs through the gills in tadpoles; and lungs, buccal cavity and moist skin in adults - Closed circulatory system - Are poikilothermic - Reproduction is sexual with external fertilization. The females lay eggs in water as the male sprays the eggs with sperm.  Play the video to view the process of reproduction in frogs. |
| BI3-108300text | **Class reptilia** The word reptilia come from a word “reptilis” which means ‘crawl’ because they move by creeping or crawling.  The animation shows crawling movements in reptiles.  Animals in this class include snakes, turtles, tortoises, crocodiles and lizards.  The photographs of a snake, turtle, tortoise, crocodile and a lizard are shown below.  Main Characteristics include • Have a dry scaly skin which in a tortoise is hardened to form a shell. • Two pairs of limps except the snake • Fertilization is internal with most laying eggs covered in a leathery shell to reduce desiccation. In a certain species of chameleon the fertilized egg is retained within the oviduct and gives birth to live young ones. • Mostly terrestrial and a few being partially aquatic • Double circulatory system with most members having a three chambered heart; two atria and a partially divided ventricle.  **Note:**  A crocodile has a four chambered heart • Well developed lungs for gaseous exchange • They are poikilothermic or ectothermic. • They have an internal auditory meatus • They have lungs for gaseous exchange • They are endothermic • They have a double circulation with a four chambered heart  The illustration shows various characteristics of members of class reptilia. |
| BI3-108400text | **Class aves** These are birds. They are terrestrial and arboreal while some have adapted to aquatic life. Examples include:  Chicken, weaverbird, hawks, eagle and turkeys.  The photographs show some members of class aves which include; Chicken, weaverbird, eagle and vulture.  They have the following general characteristics: - • Body covered with feathers for insulation and flight • They have beaks • The sternum is enlarged to form a keel for attachment of flight muscles  The illustration below shows the skeleton in birds  • The hind limbs have scaly skin • The hind limbs are for walking or swimming. •The forelimbs are modified into wings for flight. However some birds cannot fly e.g. ostrich and the emu. •They have an internal auditory meatus. • They have lungs for gaseous exchange • They are endothermic (Homoiothermic). • Fertilization is internal. •They lay yolky eggs with calcareous shells.  • They have a double circulation with a four a chambered heart.  Click on the play button to see movement of various types of birds. |
| BI3-108500text | **Class mammalia** This class consists of the most advanced forms of animals. Examples include mice, cats, dogs, cattle, gazelles, giraffes, elephants, monkeys and human beings.  Examples of mammals are shown in the photographs below.  They have the following general characteristics • Body covered with fur or hair • Have external ear lobes • Females have mammary glands for milk production. • Have well developed lungs for gaseous exchange • Have a highly developed brain • Have a well developed closed circulatory system with a four chambered heart. • Are Homoiothermic / endothermic. • Have sweat glands • They have muscular diaphragm separating the thoracic and abdominal cavities  The illustration outlines various characteristics of mammals such as highly developed brain, gaseous exchange and a four chambered heart. |
| BI3-109100text | **Dichotomous Key** The term dichotomous key comes from a word ‘dichotomy ' meaning divide in two parts. A dichotomous key consist of a series of part contrasting statements that describe characteristics of a particular organism. It only uses inheritable observable features.  Common features used for identification of organisms when constructing a dichotomous key are: -  **Features used in animals** - Number of body parts for example in insects the ant has 3 body parts. - Feeding structures for example beaks in birds and duck.  - Presence and type of eyes e.g. millipede simple eyes & housefly compound eyes - Presence & number antennae e.g. one pair of antennae in insects. - Structures on body surface such as fur, hair, feathers and scales. - Locomotory structures e.g. fins, legs and wings.  The illustrations below outlines the common features used for identification of animals when constructing a dichotomous key. They include the following: - Number of body parts, exoskeleton, compound eyes, segments and antennae in arthropods; fins and scale in fish; beaks and feathers in birds and fur or hair in mammals.  The photographs below shows the main features used in identification of animals using dichotomous key. |
| BI3-109200text | **Features used in Plants.** - Leaf venation is either parallel veins or Network veins. - Leaf lamina is either narrow or broad  - The tip of the leaf may be pointed as in the bean or could be ovate as in the oxalis or lobbed as in geranium. - Plants root system may be fibrous as in maize or tap root as in bean. - In plants flowers are borne on stems as solitary e.g. hibiscus or in cluster called inflorescence as in the sun flower - In plants may have various stems types e.g. woody stem as in fig tree, Herbaceous stem as in black jack or succulent/ fleshy as in sugar cane. - Most stem are cylindrical but a few may be rectangular e.g. lantana camara. - Leaves may be green e.g. commelina or colored e.g. purple color of tradescantia.  -leaves are attached to the stem by either petiole or leaf stalk e.g. cassava leaf or a sheath as in the napier grass.  The following are photographs outlining the main features used in identification of plants: - Leaf arrangement (alternate or opposite), leaf type (simple or compound), leaf colour (green or not green), leaf venation (parallel or net work), leaf shape (broad or narrow) and leaf margin (serrated or dentate).  Play the animations below to view the common features used in identification of plants. |
| BI3-109300text | **CONSTRUCTING A DICHOTOMOUS KEY** First step involves looking at the organisms and picking a single distinguishing characteristic that separates the organisms into two groups. Label the two groups as 1a and 1b. Then continue picking a new distinguishing characteristic to separate organism in 1a until each organism has its own separate set of characteristics and is fully identified then repeat the same procedure to1b.  Let us demonstrate how to construct a dichotomous key using the following organisms. **PLANTS**   Tradescantia  Cassia siamea  Zea mays  phaseolus vulgaris  Jacaranda  **ANIMALS**  Spider dragon fly Termite  Millipede centipede  The photographs below show plants and animals to be used in the construction of the dichotomous key. |
| BI3-109400text | **Example of a dichotomous key**  **Dichotomous key**   1 a) Can photosynthesize ……………………………........……..……go to 2  b) Cannot photosynthesize ……………………….…….........…….go to 6 2 a) Leaf simple …………………………………………….………….go to 3  b) Leaf compound …………………………………..……....……….go to 5 3 a) Leaf purple ………………………………………………..………Tradescantia  b) Leaf green ………………………………………….………..……go to 4 4 a) Leaf with parallel venation ……………………………..........….Zea mays  b) Leaf with network venation …………………………..…...........phaseolus vulgaris 5 a) Leaf pinnate ……………………………………………………...cassia siamea  b) Leaf bipinate ………………………………………………….......Jacaranda 6 a) Animals with wings ……………………………………..…….....Dragon fly  b) Animal without wings ………………………………..……….......go to 7 7 a) Animal with three pairs of legs ……………………........….....…termite  b) Animal with more than three pairs of legs …………................go to 8 8 a) Animal with one pair of legs per segment …………................Centipede  b) Animal with two pairs of legs per segment …………..............Millipede  The following are the steps that can be followed to identify the animals in the above key.  **STEPS IDENTITY**  1a, 2a, 3a ……………………………………………………………...Tradescantia 1a, 2a, 3b, 4a …………………………………………………………Zea mays 1a, 2a, 3b, 4b …………………………………………………………Phaseolus vulgaris 1a, 2b, 5a ……………………………………………………………...Cassia siamea 1a, 2b, 5b………………………………………………………………Jacaranda 1b, 6a…………………………………………………………………...Dragon fly 1b, 6b, 7a………………………………………………………………Termite 1b, 6b, 7b, 8a…………………………………………………………..Centipede 1b, 6b, 7b, 8b…………………………………………………………...Millipede  Play the animations below to see the identification of living organisms using the dichotomous key. |
| BI3-200000text | **ECOLOGY** |
| BI3-200000otext | **Objectives** By the end of this topic, you should be able to:- • Define the term ecology, habitat, biomass, ecosystem and carrying capacity. • Identify the physical (abiotic) and biological (biotic) factors in a given ecosystem. • Describe the interrelationship of organisms in an ecosystem • Differentiate between saprophytism and symbiosis • Explain the importance of fungi and bacteria as decomposers • Relate the mode of transmission to prevention / control of a named parasite • Describe the adaptive characteristics of a named parasite to the host. • Describe the nitrogen cycle • Explain the flow of energy in an ecosystem. • Identify and construct food chains, food webs, pyramid of numbers and pyramid of biomass.  • Explain the various methods of estimating population. • Relate the adaptations of plants to various habitats. • Describe the effects of pollutants in air, water and soil on humans and other living organisms. • Identify the symptoms of different types of human diseases and methods of transmission and control. |
| BI3-200000btext | **Background information** All living organisms live, grow and develop in a certain area of the environment. For them to survive, they need food, water and even shelter. These resources are provided by the surrounding environment where a particular organism is found. For example, a lion in maasai mara will feed on the animals such as gazelles and even drink water found in the same reserve. There is therefore a constant interaction between living and non-living things in a certain area. In this topic we shall look at such relationships and even their impacts to each other and the environment.  Click on the play button below to see living and non-living things interacting in an ecosystem |
| BI3-200000text1 | **Introduction** Ecology is derived from two words ECO/oikos which means house or “place to live” in and logos which means study of. Therefore ecology is the study of the interrelationships of organisms to each other and to their environment. To bring out this let’s look at this illustration. For a cabbage to grow it requires light, rainfall among other factors. Worms rely on cabbages for survival. Therefore there exist a relationship between a cabbage, worm and the weather.  The video below shows a cabbage relying on sunlight and rainfall to grow. On the other hand, Worms rely on the cabbage for survival. Click on the play button to view the video.  Ecology is sub-divided in to two main branches, that is, synecology and autecology.   * Synecology is the study of different species living and interacting in the same ecosystem e.g. wild beasts, warthogs, zebras and termites living in the same ecosystem.   Play the video below to see different species of organisms living and interacting in the same ecosystem e.g. wild beasts, warthogs, zebras and termites living in the same ecosystem.   * Autecology involves the study of a single species or individual group of organisms, for example the wildebeest in Maasai Mara.   Play the video clip to view wild beasts migrating; This is a study of a single species |
| BI3-201100text | **Terms used in ecology**  Some of the terms that are used in ecology include: - Biosphere, habitat, niche, population, community, ecosystem and carrying capacity.  **Biosphere (Ecosphere)**  It is the part of the earth and atmosphere inhabited by living organisms.  The video shows the biosphere (Ecosphere) where human beings, animals, birds and trees live and interact. Click on the play button to watch the video. |
| BI3-201200text | **Habitat**  This is the physical location that an organism lives in with a particular set of conditions. Examples are a fish living in a pond, a grasshopper in a field, and monkeys in a forest. The pond, the field and forest are habitats. Some habitats are formed of land therefore referred to as terrestrial or can be formed of water therefore referred to as aquatic.  The photographs below show organisms and their habitats. Examples are a fish living in a pond, a grasshopper in a field, and monkeys in a forest. |
| BI3-201300text | **Niche** Describes where an organism lives and how it lives. This includes the position that an organism occupies in a habitat such as physical space and the role the organism plays in the habitat in terms of feeding relationships and interactions with other species.  In this photograph giraffes, buffaloes, zebras and egrets are living in the same habitat but each organism is playing a different role. For example, giraffes are browsers, zebras, buffaloes and gazelles are grazers, while the egrets are commensals. All these organisms drink water from the same river**.** |
| BI3-201400text | **Population**  -Refers to the total number of a particular species of organisms living in a particular habitat at a particular time. For example:  The number of flamingos at Lake Nakuru is approximately 250,000.  The Photograph shows flamingoes in lake Nakuru.  The population of people in Kibera as per 2009 census is approximately 170,070.  This Photograph shows people in kibera slums. |
| BI3-201500text | **Community** - This refers to all the organisms of different species that live within the same habitat. In an old log of wood you will find termites, mushrooms, caterpillars, garden worms and many other organisms living together though they belong to different species. A community changes gradually from few organisms to many organisms.  The video clip shows garden worms, mushroom, caterpillars and termites all inhabiting a log of wood. Click the play button to watch the video clip. |
| BI3-201600text | **Ecosystem**  -An ecosystem is a unit comprised of several habitats and their communities of organisms living together in a self sustaining environment.  Play the video clip below to see a tropical forest inhabited by birds, monkeys and different types of plants. This is example of an ecosystem. |
| BI3-201700text | **Carrying capacity** -This is the maximum population of a species that a particular habitat can support indefinitely under a given set of environmental conditions without depletion of resources in that habitat.  Photograph one shows an area inhabited by few organisms that the resources can sustain while in photograph two, there are very many organisms that the available resources cannot sustain and therefore the resources have been depleted. |
| BI3-202000text | **Factors in an ecosystem.**   These factors are divided into two groups namely:   * Abiotic factors * biotic factors   Play the video clip below to see various organisms such as the birds and monkeys interacting in a forest bringing out factors like competition and predation |
| BI3-202100text | **Abiotic factors** This refers to all the non-living environmental factors which affect the distribution of organisms in an ecosystem.  **Light** The sun is the main source of energy for all life on earth. Green plants and photosynthetic bacteria need light energy to manufacture food. Animals depend on plants for food either directly or indirectly.  Light affects growth and distribution of plants e.g. a forest that has a thick canopy there is limited undergrowth, but in a well light forest i.e. without a thick canopy there is thick undergrowth. Light intensity is measured by a photographic light meter while light penetration in water is measured using a seechi disc.  Photograph one show a photographic light meter while photograph two shows a seechi disc.  **Temperature** Biochemical processes in most organisms function efficiently within a narrow range of temperature. This therefore affects the distribution of organisms in a habitat. Organisms must develop physiological and behavioral adaptations to cope with extreme temperatures. For example, the bear has thick fur to cope with extremes of low temperatures in the polar regions.   Air temperature is measured by a thermometer while air temperature range is measured by the maximum and minimum thermometer. |
| BI3-202200text | **Atmospheric pressure.**  The atmosphere exerts pressure on the earth. This varies with altitude and determines the relative concentration of oxygen needed for respiration and carbon (IV) oxide for photosynthesis. This affects the distribution of organisms in a habitat. Decrease in atmospheric pressure increases the rate of transpiration and therefore the need to conserve water by plants.  The illustration shows the variation of oxygen and carbon IV oxide concentration with attitude and the distribution of organisms.  Atmospheric pressure is measured using a barometer.  Play the video clips below to see a barometer in a weather station.   **Humidity.** Humidity refers to the amount of water vapour in the atmosphere. When humidity is high there is much water vapour in the atmosphere creating fog and mist e.g. in the Limuru area, but when it is low there is less water vapour in the atmosphere like in the desert where the sky is clear. This in turn affects the distribution of organisms on earth. Humidity is measured using a wet and dry bulb hygrometer. |
| BI3-202300text | **Wind.** Wind is moving air. It increases the rate of water loss from organisms therefore affecting their body. It carries water vapour to the upper parts of the atmosphere where it condenses and precipitates as rain. . In desert areas wind aids in formation of sand dunes. Stable sand dunes may become habitats for growth of desert plants. Play the video to see a sand dune being formed by strong desert winds  Wind causes wave formation in lakes and oceans, which enhances aeration of water in these water bodies.  In the video clip, sea storms are formed by strong waves of water blown by wind. Click on the play button to view the video clip.  Trees growing in areas experiencing strong winds may have stunted and distorted growth.  Play the video to see strong wind blowing through the forest trees producing whistling sound.  Wind also disperses spores and seeds and influence dispersal |
| BI3-202400text | **Biotic factors:** These are factors in an organism’s environment that arise from other living organisms. These factors may affect an organism in many ways. For example,  **Competition**,  This is an interaction that occurs between two or more organisms, populations, or species that share some environmental resource which is in short supply. An example is the jackal and the owl competing for the mouse (common prey).  The video clip shows competition where both the jackal and the owl are chasing the same mouse. Click on the play button to watch.  **Predation** This is the food relationship in which one organism kills the other for food and feeds on it. The organism which kills another for food is referred to as the predator while the one killed is the prey. An example is the antelope and the jackal. Play the video to see predation whereby only the jackal is chasing an antelope  **Parasitism.** This is an association in which one organism (parasite) lives on (ectoparasitism) or in (endoparasitism) the body of another organism (host) from which it obtains nutrients causing harm to the host. E.g. Ticks on the body of a cow.  Play the video clip to see parasitism whereby a cow is infested with ticks.  **Symbiosis** This is an interaction between individuals of different species (symbionts) in which both individuals benefit e.g. the Rhizobium bacteria in the root nodules of the leguminous plants.  The photograph shows symbiosis between a leguminous plant and the rhizobium bacteria forming the root nodules. |
| BI3-203000text | **NITROGEN CYCLE** Nitrogen is one of the elements that make up proteins. Proteins are needed for growth in both plants and animals. Animals depend on plants for their protein needs since they cannot synthesis their own food. Plants on their part can synthesize proteins (using nitrogen) but cannot utilize free nitrogen in the atmosphere.  Plants obtain nitrogen in two forms; either in the ammonium form (NH4+) or as nitrates (NO3-).   The illustration below shows the nitrogen cycle |
| BI3-203100text | **Nitrogen fixation** This is the conversion of atmospheric nitrogen into nitrates. It occurs in the following three ways  -Oxidation of nitrogen by lighting during thunderstorms.  -Free-living blue-green algae and other bacteria such as Azotobacter and Clostridium.  -Symbiotic bacteria and other bacteria such as Rhizobium in root nodules of legumes. The nitrates are absorbed by plants which use them to synthesize proteins. Plants are eaten by animals which convert plant protein to animal protein through assimilation. When both plants and animal die they are fed on by saprophytic bacteria and fungi in the process releasing ammonia (NH3). Animals excrete, releasing ammonia and urea. Ammonia gets into the soil, and combines with water and other elements to form ammonium compounds (salts). The ammonium salts are then converted to nitrates by nitrifying bacteria of the genera Nitrosomonas and Nitrococcus. The nitrites are then converted to nitrates by nitrifying bacteria of the genus Nitrobacter. The nitrates are absorbed by plants. Some nitrates are converted to either free gaseous nitrogen or nitrites by denitrifying bacteria called Pseudomonas denitrificans. This process takes nitrogen back to the atmosphere from where it was obtained, and in the process reducing the fertility of the soil.  The illustration below shows the process of nitrogen fixation from free nitrogen in the atmosphere to nitrates in the soil. |
| BI3-204000text | **Energy flow in an ecosystem** The main source of energy in any ecosystem is the sun. This energy is trapped by green plants during photosynthesis to form food which is a potential energy in chemical form stored in the plant. The plants are therefore called Producers in an ecosystem.  Some organisms such as herbivores feed directly on plants and are known as primary consumers.  The primary consumers are in turn fed on by carnivores which are called secondary consumers.  The secondary consumers are fed on by tertiary consumers. - On death of a tertiary consumer, they are eaten by a vulture which is called a quaternary consumer. These feeding levels are called trophic levels. When all living organisms die, they are decomposed by saprophytic bacteria and fungi, which are together referred to as decomposers. -This flow of energy from one trophic level to the next results in loss of some energy in the form of heat. -Energy is also lost in the processes of excretion, respiration or defecation. -When organic materials are fully decomposed, all the energy is lost from the ecosystem. -As such energy flows through an ecosystem and is never recovered.  The illustration shows energy flow in an ecosystem. The energy flows from the sun to the producers, primary consumers, secondary consumers, tertiary consumers and finally decomposers |
| BI3-205000text | **Food Chains** A food chain is a linear representation of the flow of energy from a producer through a sequence of living organisms in which each eats the one below it in the chain and is eaten by the one above it.  The video clip shows a feeding relationship whereby the gazelle feeds on the grass, the lion feeds on the gazelle while vultures feed on the dead lion. Click the play button to view the video.  -Arrows are used to point to the eater. If decomposers are included in the chain, they are always placed at the end of the chain.  -Examples of food chains are given below. |
| BI3-206000text | **Food Webs**  -A single organism in a food chain can be a source of energy or nutrients for more than one organism. For example: green grass may be fed on by a gazelle, zebra, water – buck, dik dik and many other herbivores. Each of these herbivores may in turn be fed on by different carnivorous animals and so on.  -As such feeding relationships may be more complex than is revealed by food chains. Therefore feeding relationships will always consist of a network of different food chains forming a food web. Food web may be regarded as a system of food chains that are linked to one another in a given community. The following is an example of a food web.  The photographs show different organisms that are represented in the food web. |
| BI3-207000text | **Pyramid of numbers** This is a diagrammatic representation of the number of organisms at each trophic level of a food chain in an ascending manner. The number of organisms at each trophic level of a food chain can be counted or estimated.  The numbers of organisms can be obtained by totaling the population of all the species at that trophic level e.g. total number of plants (producers), Total number of herbivores (primary consumers), and Total number of carnivores (secondary consumers).  The numbers can then be used to draw a diagram (pyramid of numbers) which shows the relationship between the numbers of organisms occupying each trophic level.  The figure below shows a pyramid of numbers.  From the pyramid, it is realized that the number of organisms transferring energy to the next energy level decrease as one ascends the pyramid.  Sometimes the numbers of organisms feeding on a primary producer are more than the number of producer(s). For instance if we were to draw a pyramid of numbers for caterpillars feeding on a leaf of cabbage and themselves are being fed on by a few birds, the pyramid of numbers would look different as shown. This is called an inverted pyramid of numbers. The figure shows an inverted pyramid of numbers. |
| BI3-208000text | **Pyramid of Biomass**  Biomass refers to the total dry weight of organisms at each given trophic level of a food chain. The total dry mass is the mass of tissue only without any water.  A pyramid drawn using total dry mass of organisms at each trophic level is called a pyramid of biomass.  When drawing a pyramid of biomass, a scale must be used in order to draw boxes whose lengths are proportional to the dry mass of organisms while the heights remain the same.  An example of a pyramid of biomass is given below. |
| BI3-209000text | **Population estimation methods** The number of individual of a given species in an ecosystem should be determined regularly to enable proper planning of the utilization of the resources available to avoid exceeding the carrying capacities. To determine the population of an organism in a given habitat, the following methods are used.  a) Quadrat b) Line and belt transects c) Capture – recapture method  Below are illustrations of a Quadrant, line transect and belt transect population estimation methods. |
| BI3-209100text | **Quadrat.** A quadrat is a square of a wooden or metallic frame of a known area. It can be 1m², 0.5m² or any area. It is made by joining four pieces of wood/metal together.   The following are the steps followed when using a quadrat. i) Identify a selected area ii) Toss the quadrat over the shoulder in the selected area iii) Make a table with rows indicating the number of throws while the columns have the titles to show results after every throw. iv) Count the number of the organism of interest and record. Sometimes it is impossible to say where one plant stops and another begins. In this case use a percentage area of the quadrat covered. v) Repeat the above procedure for at least four times for a good sampling vi) Add the total number of all the values of organism obtained and divide by the number of throws done to get an estimate of the population.  Play the video below to see secondary school students estimating population using the quadrat method. |
| BI3-209200text | **Transect**  This is a tape or string running along the ground in a straight manner between two poles. There are two types of transects: line and belt transects.  **Line transect** A single line of either a string or a tape is tied to two pieces of wood as pegs and marked at intervals of one metre.  The photograph shows the line transect method.  **Belt transect** Two single lines running parallel to each other separated by known width through a selected area in a habitat.  The photograph shows the belt transect method. |
| BI3-209300text | **Steps to follow when using transect method to estimate populations** i) Select the area of study. ii) Make a sketch of the whole area selected above. iii) Fix a one peg firmly on the ground and tie one end of string/ tape or any other material that be used to the peg. iv) Fix the other peg firmly on the ground at a different part of the area but to cover the total length of the string to be used. v) Mark the string starting from one end to the other at 1m intervals. vi) Count and record the number of the organism of interest that falls along the line in intervals on a table.  vii) Find the average number of organisms and use it to estimate the population of the organism of interest in the whole area of study.  The video clips below show students estimating the population using line and belt transect methods. Click on the play button to view the video clip. |
| BI3-209400text | **capture – recapture method** This method involves the following steps: i) Capture of organisms using an appropriate method e.g. fish net for fish and a pitfall trap for crawling insects. ii) Mark the captured organisms using an ink or varnish which should not have any effect on the organism. Count them and release them. iii) After a fixed interval of time capture organisms for the second time and count them. Among this group some will be marked while others will be unmarked. Count them separately. Repeat the same procedure severally.  Play the video clip below to see people estimating the populations of fish in a fish pond using capture recapture method.  The population is then estimated by:  Number of organisms initially captured multiplied by the Number of organism recaptured divided by the number of marked- recaptured organisms  Play the video clip below to see students estimating the populations of mosquitoes using capture recapture method.  This method is based on the following assumptions. a) Organisms mix freely in the population b) Enough time is allowed for mixing between capture and recapture c) Organisms’ movement is restricted to the geographic area under study d) That immigration, emigration, birth and death rates are negligible e) That the marking does not interfere with the free movement of animals or make them less camouflaged to their predators or poison them to death. |
| BI3-210000text | **Adaptations of plants to life in various habitats** In this section we shall learn about the distinguishing characteristics that plants posses to enable them thrive in desert, terrestrial, water and salty marshes. Different habitats are inhabited by different species of plants with varying abundance. These plants thrive in different habitats because they have characteristics that suit them to these habitats. These characteristics are called adaptations. The adaptations enable the plants to grow in areas with different levels/quantities of the abiotic and biotic factors.  There are four main groups of plants namely: - Xerophytes - Mesophytes - Halophytes - Hydrophytes. |
| BI3-210100text | **Xerophytes** These are plants that are adapted to life in a dry habitat to endure prolonged conditions of drought as in arid and semi-arid areas. These habitats are characterized by low humidity, winds, very high day temperatures and low night temperatures; and unpredictable and poorly distributed rainfall.  **Adaptations of Xerophytes** -Leaves are modified to spines or thorns to reduce the surface area over which transpiration can occur. E.g. Acacia. -Leaves have thick waxy cuticle to minimize the rate of cuticular transpiration -Some plants roll or fold their leaves to reduce the rate of transpiration by not exposing stomata.  Play the animation see rolling of leaves by plants on hot days to reduce the surface area exposed to sunlight -They shed their leaves during the dry season to reduce the surface area exposed to transpiration  The animation shows a tree shedding off its leaves during dry weather conditions. -Have reversed stomata rhythm to reduce the rate of water loss by transpiration -Have reduced number of stomata to reduce the rate of transpiration -Swollen stems and leaves for storage of water e.g. Cactus and Baobab. -Leaves have resin coatings to increase reflection of solar radiation hence lower transpiration rate. -Others posses very deep roots to absorb water from deep in the soil e.g. Acacia others -Some have superficial roots that grow horizontally e.g. acacia -Roots are close to the soil surface to absorb water after a short/light rain.  The photographs below shows the following :- a) needle like leaves of acacia and pine trees. B) Thick waxy cuticle of the sisal leaves. C) Succulent stem of cactus d) deep roots of acacia e) shallow extensive roots of baobab. |
| BI3-210200text | **Mesophytes**  Mesophytes are plants living under normal conditions of water supply or in well watered soils Their habitats have adequate rainfall, high humidity, less winds, shallow water table with moderate to high temperature. Such ecosystems as savannah, rainforests and reserve forests have Mesophytes growing in them.  **Adaptations of Mesophytes to their habitats:** -Those found in forests (trees) grow tall due to competition for light. -Some have slender, delicate stems to climb larger trees in order to reach light -Epiphytic mesophytes grow and support themselves on the branches of tall trees.  The photograph shows a thick forest with tall trees, climbers and epiphytes.   -Mesophytes in areas with adequate water supply have broad leaves and thin cuticles to encourage water loss by transpiration.  -Shallow rooted mesophytes have buttress/prop roots for extra support, and also to absorb water after light rains e.g. Baobab.  -Those in drier areas have deep roots to absorb water from relatively deeper ground waters e.g. Eucalyptus  -Some have waxy and shiny surfaces to reflect the strong light rays and drip off rain water.   -The leaves are arranged in a regular mosaic pattern to minimize overlapping and overshadowing such that each leaf receives adequate light for photosynthesis.  In this photograph, leaf mosaic arrangement is shown. |
| BI3-210300text | **Hydrophytes** These are plants that live in fresh water or in very wet places. Usually part or whole of the plant is in the water and hence their adaptations are those that minimize the possibility and effects of absorption of excess water, obtaining enough light and gases from air.  **Adaptations of hydrophytes to their habitats** -Floating hydrophytes have fibrous roots for absorption of mineral salts e.g. papyrus and sedges. -They have an aerenchyma tissue (air-filled tissue) which reduce density for buoyancy and gaseous exchange e.g. water hyacinth -Have photosensitive chloroplasts hence can photosynthesize at low light intensities -Leaves are covered by a waxy substance to reduce excessive water absorption e.g. water hyacinth. -Most emergent and floating types have broad leaves with maximum number of stomata on the upper surface for efficient gaseous exchange and rapid loss of excess water through transpiration. -Flowers are raised above the water to allow for pollination  The photograph below shows a water hyacinth broad leaves floating on water and its flowers raised above the water to facilitate pollination. -Most of them lack xylem and support tissues and hence pliable. This avoids breakage by water currents e.g. sedges. -Most of them lack cuticles, but for those which have cuticles, it is very thin to allow for absorption of water, mineral salts and carbon (IV) oxide gas. |
| BI3-211000text | **POLLUTION** May be defined as the release of substances or forms of energy into the environment by human activities in such quantities whose effects are either harmful or unpleasant to humans and other living organisms  There are various types of pollution. These include the following: -   * Air pollution. * Water pollution * Soil pollution |
| BI3-211100text | **Air Pollution** It is the release of substances or forms of energy into the air by human activities in excess amounts which are harmful to living organisms dependent on that part of the air.  **Air pollution is caused by the following** -Sulphur based chemicals e.g. sulphur (iv) oxide and hydrogen sulphide – produced by industries will lead to bronchitis, pneumonia and heart failure when inhaled. - Oxides of Nitrogen e.g. Nitrogen II oxide (NO) and nitrogen (iv) oxide (NO2). Produced from burning petroleum fuel in motor vehicles. They are also released during industrial manufacture of Nitric acid. These are poisonous to animals affecting respiratory systems when inhaled. - Smoke and fumes containing carbon (II) oxide (CO), carbon (IV) oxide (CO2) and carbon particles. These are produced from industries, burning of coal, burning of petroleum fuels, motor vehicles exhaust, burning of natural gases and charcoal. Their effects include affecting visibility due to smoke on roads, block stomata hence no photosynthesis co is a respiratory poison. Carbon (IV) oxide causes green house effect  Play the video clip to see factory chimneys releasing thick smoke into the air while a lorry is releasing thick smoke from the exhaust. - dust from quarries and cement manufacture which affects the respiratory surfaces of organisms. Dust also clogs the stomata and blocks the stomata affecting photosynthesis.  Play the video to see a lot of dust being produced from a road construction site while a tanker is spraying water on the road under construction to reduce dust. -Aerosols which contain CFCs, whose main effect causes the depletion of the ozone layer.  The video clip shows a person spraying herself with perfume. Click the play button to view the video clips. -Noise is produced by machines in factories, heavy vehicles, aeroplanes, music players and jua kali workshops. This affects hearing in animals e.g. Human beings become insensitive to low pitched sound.  On the video clips below, jua kali artisans are hammering metals in a workshop producing a lot of noise.  There are many measures that are put in place by the government to enforce legislative cuts to ban use of leaded and sulphur based petroleum products.  The photograph shows a billboard of a petrol station advertising unleaded petrol and low sulphur diesel.  In controlling dust e.g. in road construction the government is enforcing the use of wet methods where water is sprayed to reduce the amount of dust raised. In industries that produce a lot of noise it is a government policy now that everybody wears ear muffs.  Play the video to see textile factory workers wearing ear muffs to minimize noise. |
| BI3-211200text | **Water pollution** Water pollution refers to the release of substances or energy forms in water bodies in quantities that are harmful to living organisms that depend on that water. The causes include release of domestic and industrial wastes in the ocean and oil spillage from tankers whose effects are harmful to the living organisms.  Play the video clips to see the following:- • Sewage pipe discharging sewage material into the lake.  • Oil spillage at the sea showing water birds trapped in the oil.  In controlling water pollution apart from enforcing and providing for heavy penalties, there is also proper treatment and disposal of domestic and industrial effluents before discharge.  • Play the video to view industrial effluent treatment ponds and the raw sewage treatment ponds.  **Soil pollution** The other type of pollution is soil pollution which is the release of chemicals or solids that accumulate to levels that cause harm to soil organisms. The causes include petroleum products spilled on land when oil tankers involved in an accidents, then household wastes and industrial wastes which are non-biodegradable e.g. rubber, plastic containers crap metals and glass bottles.  •Play the video clip to see an overturned oil tanker with oil leaking.  The control of soil pollution involves recycling of plastic, glass and metal. |
| BI3-212000text | **HUMAN DISEASES**  A disease is a condition in which the body cells, tissues, organs or the entire organism’s body is affected and therefore normal function is impaired or not carried out normally. In human beings diseases can be caused by the following: a) Bacteria b) Virus c) Protozoa d) Fungi  e) Nutritional deficiencies  f) Genetic disorders A pathogen is an organism that causes impairment of the normal body function.  In this sub-topic, we shall consider Bacterial diseases, protozoan diseases and parasitic worms. |
| BI3-212100text | **Bacterial diseases** These are diseases caused by bacteria. Examples include cholera and typhoid. The bacteria are spread by houseflies and through eating contaminated food. The diseases spread easily after the initial infection to cause an epidemic.  The video shows individuals with cholera and typhoid symptoms such as abdominal pains, diarrhearing and vomiting. |
| BI3-212200text | **Cholera Cause** Cholera is caused by a bacterium called *Vibrio cholerae* which thrives in infected water.  The diagram shows *Vibrio cholerae* bacterium.  The bacterium is transmitted through coming into contact with contaminated food. The disease is spread easily after the initial infection to cause an epidemic.  Play the video clip below to see a poorly built pit latrine surrounded by flies which may later contaminate food and water spreading cholera.  **Symptoms** They appear between one to six days after infection depending on the health of a person. i) The bacteria secrets enzyme mucinase which digests the inner lining of the intestines ii) Exposed wall of the intestine becomes irritated and damaged by the toxins produced by the bacteria iii) Abdominal pains iv) Violent diarrhea and vomiting v) Dehydration  The animation shows the process of infection and symptoms of cholera.  **Prevention and treatment** - Proper disposal of faeces to prevent contamination of water - Pit – latrine should be dip and kept clean - Boiling drinking water, or chlorinating it. - Wash hands after visiting the latrine - Oral rehydration should be administered - Isolate infected persons. |
| BI3-212300text | **Typhoid** **Cause** Caused by bacterium called *Salmonella typhi*.  The diagram below shows a bacterium *Salmonella typhi* Poor disposal of urine and faeces may cause contamination of the water supply from rivers, dams and lakes. Healthy individuals can be infected by taking contaminated food or water. The photograph shows sewage being disposed in to the river.  **Symptoms** Its incubation lasts for about two weeks, after which a fever and rush develop, followed by severe diarrhea, leading to dehydration. The bacteria attacks walls of the intestine and cause patches of sores. In severe attacks the sores may burst and cause perforation in the intestine.  **Prevention and Treatment** There should be proper sewage disposal There should also be proper sewage treatment Boiling drinking water or chlorinating it. Proper handling of food. Regular medical checking for all food handlers Vaccination of healthy people with weakened typhoid bacteria Treatment involves administering antibiotics.  The photographs show a sewage treatment plant, a person being vaccinated and a packet of antibiotics. |
| BI3-212400text | **Protozoan diseases** Examples of diseases are malaria and amoebic dysentery  **Malaria** Caused by a protozoan parasite of the genus *Plasmodium*, which are of four different species: *Plasmodium vivax Plasmodium ovale Plasmodium falciparum Plasmodium malariae*  The photograph shows a plasmodium  The parasite is transmitted from one infected person to a healthy person by a female anopheles mosquito.  The photograph shows a anopheles mosquito.  **steps of infection**  i) Mosquito bites an infected person & sucks blood ii) Plasmodium develops into an infective stage iii) Same mosquito bites a health person and pass the parasite from its salivary glands into blood stream. iv) Plasmodium migrates to liver cells and multiplies. V) Plasmodium leaves liver cells and back into blood stream when they start destroying the red blood cells.  The animation shows the process of infection of a health person by malaria. Click on the play button to view the animation.  **Symptoms** -High regular fevers, Lack of appetite, Profuse sweating, vomiting, headaches, muscle and joint pain, enlargement of liver & Spleen and convulsions.  **Prevention and treatment** -Vaccination  -Use of treated bed nets -Use of mosquito repellants -Spraying of their dwelling places e.g. stagnant water using insecticides -Draining stagnant water and clearance of vegetation near homes -Empty containers e.g. tins, polythene papers should be destroyed to avoid stagnant-water which is a breeding ground for mosquitoes. -Use fish in ponds to feed on mosquito larvae -Use of sterilized male mosquitoes to mate the females reducing the mosquitoes in number -Taking of ant malarial drugs when traveling to malaria prone areas -Proper diagnosis through a laboratory test, administering a full dosage of the malaria drugs. -Use natural pyrethroids in mosquito control  Play the video clips below to see mosquitoes being sprayed using insecticides, draining of stagnant water, clearance of bushes and empty containers being destroyed. |
| BI3-212500text | **PARASITIC WORMS *Ascaris lumbriocoides*** - It’s a parasitic round worm - It’s widespread and infects small intestines of pigs and human being though other organs may be infected. - The female is slightly larger than the male though both appear in a brown yellow color.  The photograph shows *ascaris lumbricoides* worms and a packet of dewormers.  **Mode of transmission** - Swallowing contaminated food & drinking infected water. - Consumption of contaminated fruits & vegetables - Direct infection from faeces to mouth especially in children.  **Effects of the parasite on host** - Constipation - Intestinal blockage - Obstruction of bile duct, pancreatic duct and appendix - Anaemia - Irritation of the trachea leading to damage of lungs as the larvae migrate. - Coughing  Play the animation to see blocked small intestine, bile duct, and appendix leading to large rounded stomach.  **Prevention and treatment** - Boiling drinking water or chlorinate - Proper sanitation disposal - Personal hygiene - Regular deworming - Using drugs to kill the worms or inactivate the eggs |
| BI3-212600text  BI3-212600text2 | **Schistosomiasis (bilharzia)**  It is caused by the flat worms of genus schistosoma Examples of the species that cause schistosomiasis are *Schistosoma mansonii* and *Schistosoma haematobium*. - The parasite inhabits fresh water canals, dams and rivers  The photograph shows a bilharzia worm.  **Modes of transmission** - The worm is transmitted between humans and tiny snails found in fresh water streams, rivers and irrigation canals. - The adult worms deposit their eggs into the hepatic portal vein of the humans.  Play the animation to see bilharzia worms depositing eggs in the hepatic portal vein of human.  - The eggs are then released to water where they hatch into free swimming ciliated larva which then finds its way into a snail and develops to infective stage.  **Effects of parasite on the host** - The host skin is destroyed when the larvae is penetrating - Severe abdominal pains - Blood in the urine due to destruction of tissues by the parasite. - It can cause death if untreated due to lowered body immunity.  **Prevention and treatment**  - Treating or chlorinating drinking and bathing water.  - Proper sanitation disposal.  - Use of chemicals to destroy snails which are the intermediate hosts.  - Using drugs to kill the adult worms or inactivate the eggs. |
| BI3-300000text | **REPRODUCTION IN PLANTS AND ANIMALS** |
| BI3-300000otext | **Objectives** By the end this topic you should be able to: - • Describe the location and appearance of chromosomes and chromosome movement during mitosis and meiosis. • Differentiate between mitosis and meiosis stating their significance in reproduction • Describe asexual reproduction (binary fission, spore formation and budding)   in living organisms.  • Describe the process of fertilization in plants • Differentiate between internal and external fertilization as exhibited by amphibians and mammals (humans) • Describe the role of hormones in human reproduction  • Identify and explain the methods of transmission and prevention of sexually transmitted infections. |
| BI3-300000btext | **Background information** All organisms are brought to being, live, and eventually they die. New organisms arise from existing organisms of the same kind thus ensuring continuity of species. For example a maize plant will give rise to a new maize plant while a cat will give rise to a new cat. The development of a new generation of organisms from existing generation is referred to as reproduction. In form one we defined the term reproduction while in this topic we shall cover in details the process of reproduction in different organisms. |
| BI3-300000text2 | **Introduction** Reproduction is the process by which living organisms give rise to new organisms of the same kind. There are two types of reproduction depending on whether or not sex cells are involved. These are: - sexual and asexual reproduction.  In this topic we shall cover the following areas: - • Cell division • Asexual reproduction in living organisms. • Fertilization in flowering plants • Reproduction in Amphibians • Fertilization, implantation and role of placenta in humans. • Gestation period • Role of hormones in reproduction in humans • Sexually transmitted infections  The video clip below shows a bee landing on a flower to facilitate pollination, budding in yeast, fertilization in frogs and a sperm swimming towards the oviduct. Click on the play button to view the video clip. |
| BI3-301000text | **Cell division** Reproduction, growth, repair and replacement of old cells involves the multiplication of cells. For cells to be able to multiply, they undergo cell division where one cell divides into two, two cells divide into four and so on.  • The resultant cells from these divisions are called daughter cells which are similar to the parent cells.  Play the animation below to see the cells dividing.  • In order to understand the process of cell division, it is important that we discuss and understand chromosomes which are the vehicles of heredity. They determine characteristics of daughter cells and the organisms that develop from these cells. |
| BI3-302000text | **Chromosomes**  •These are thread like structures found In the nucleus of a cell. • Chromosomes remain invisible when a cell is not dividing. However, as a cell prepares to divide, the chromosome threads coil up forming a thicker, shorter and more compact structure. • Each chromosome consists of two parallel strands called chromatids. • The two chromatids are joined at one point called centromere. The chromatids, occurring in pairs are exact copies of one another, with the same length and shape. These pairs are called homologous pairs; each member of the homologous pair is called a homologous chromosome.  The illustration below shows two chromatids joined together at the centromere to form a chromosome. |
| BI3-303000text | **MITOSIS** • In mitotic cell division, a cell divides into two daughter cells and each of the daughter cells have the same number of chromosomes as the parent cell i.e. the diploid number of chromosomes. • The process of mitosis occurs in a sequence of stages, each of which is a continuation of the other. Each stage merges with one another without interfering with cellular activities. • The stages of mitosis are: Interphase, Prophase, Metaphase, Anaphase and Telophase  The animation below shows the process of mitosis starting from interphase, prophase, metaphase, anaphase and telophase. Click on the play button to view the animation.  **Interphase** • Often regarded as the resting stage • Cell has normal appearance as any non-dividing cell • Nucleolus is visible • Chromosomes are not visible even under the light microscope During this phase, • Chromosomes replicate • Organelles are synthesized through duplication. • There is a built-up of energy to be used during mitosis. |
| BI3-303100text | **Early Prophase** • Chromosomes become visible; nucleolus shrinks. • Centrioles move to opposite ends (poles) of the cell • Spindle fibers begin to form Centrioles **Late Prophase** • Chromosomes become shorter and thicker • Each chromosome is seen to consist of a pair of chromatids joined at the centromere • Nucleolus disappears and nuclear membrane disintegrates.  Play the animation below to view, chromosomes becoming shorter and thicker, nucleolus shrinking, Centrioles moving to opposite ends (poles) of the cell and spindle fibers beginning to form  **Metaphase** • Chromosomes arrange themselves on equator of the cells. • Homologous chromosomes do not associate • Chromosomes become attached to spindle fibres at the centromere This animation show chromosomes grouping themselves on equator of the cell and they become attached to the spindle fibres at the centromere. Click on the play button to see the animation. |
| BI3-303200text | **Anaphase** • Contraction of spindle fibers causes the chromatids to separate and move to opposite poles of the cell • The spindle apparatus begins to disappear • In animal cells the cell membrane begins to constrict towards the end of anaphase.  Play the animation to see contraction of spindle fibers causing the chromatids to separate and move to opposite poles of the cell, the spindle apparatus beginning to disappear and the cell membrane beginning to constrict to form two new cells in an animal cell.  **Telophase** • The chromatids arrive at their respective poles • Spindle fibres disappears completely  • A nuclear membrane forms around each set of chromatids – which are now called chromosomes • Cytoplasm divides into two, leading to the formation of two daughter cells.  **Importance of mitosis** • Brings about growth since more new cells are formed • Replacement of old or damaged cells • Preserves the number of chromosomes as in the parent cell. |
| BI3-304000text | **MEIOSIS** • Meiosis takes place during gamete formation • The number of chromosomes in daughter cells is haploid meaning that they are half of those in parent cell. • Occurs in two successive stages, each stage going through the same series of events. Hence the terms meiosis I and Meiosis II. • The parent cell first divides into two, and then the two daughter cells divide to give a total of four daughter cells. • The first meiotic division separates homologous chromosomes from one another; hence called reduction stage while the second meiotic division separates the chromatids in a chromosome from each other; this is mitotic stage. • The phases are the same as in mitosis. They are however indicated as I or II to indicate the stage in meiotic division  Play the animation below to see the process of first and second meiotic division. |
| BI3-304100text | **MEIOSIS I** This is the first phase of Meiosis. It involves halving or reduction of the number of chromosomes. It comprises Interphase I, Prophase I, Metaphase I ,Anaphase I and Telophase I.  **Interphase I**  During Interphase I, • Chromosomes replicate • Organelles are synthesized through duplication. • There is a built-up of energy to be used during meiosis.  **Prophase I** During this phase, • Centrioles collect at the opposite ends of the cell • Nucleolus disappears • Homologous chromosomes lie side by side forming units called bivalents • Chromosomes shorten and thicken, becoming visible • Chromatids of homologous chromosomes may coil around each other; and at times remain joined at certain points that are called chiasmata (singular – chiasma) At these points, some important genetic exchanges may occur.  The animation shows appearance of two pairs of chromosomes, formation of chiasmata, crossing over of chromatids and the Centrioles migrating to the opposite sides of the nucleus. Click on the play button to view the animation.  **Note**  It is common for one or both of the chromatids of the two homologous chromosomes to break at the chiasmata and join up with the chromatids of another chromosome in the bivalent. • During this stage, genetic materials are exchanged, a process called crossing over. |
| BI3-304200text | **Metaphase I** During metaphase I • Spindle fibres are fully formed and attach to the chromosomes at the centromere • The homologous chromosomes which are still paired up as bivalents move to the equator of the cell. • At this stage, some have already exchanged portions during crossing over.  **Anaphase I** - Homologous chromosomes separate.  - They migrate to opposite poles with their centromere leading.  - Cell membrane begins to constrict around the middle.   **Telophase I** • Spindle apparatus disappear • Nuclear membranes reform around the two sets of chromosomes • Once the chromosomes reach the poles, the cell divides into two new cells, each with half the number of chromosomes as the parent cell  Play this animation to see homologous pairs of chromosomes aligning themselves on the equator of spindle fibers, homologous chromosomes separating and migrating to the opposite side along the spindle fibres and formation of new cells when the cell membrane constrict at the middle. Each cell has half number of chromosome (haploid).  **Note:**  • Separation of Homologous chromosomes into two daughter cells has been achieved in the first meiotic cell division. The second meiotic division will separate the chromatids from one another. |
| BI3-304300text | **SECOND MEIOTIC DIVISION** After the first meiotic division, the daughter cells should proceed to Interphase. However the nuclear membranes sometimes fail to form around the two sets of chromosomes at the poles and the cell proceeds directly to prophase II of meiotic II. During second meiotic division, the chromatids separate resulting into four haploid daughter cells. Four stages prophase II, metaphase II, Anaphase II and Telophase II are involved.  **Prophase II** • New spindle fibres are formed  **Metaphase II** • Centrioles replicate and a new spindle is formed in each new cell • Chromosomes collect around the equator of the cell and attach to the spindle fibres at their centromeres • Chromosomes orientate themselves towards the opposite poles.  **Anaphase I**I • Sister Chromatids are pulled by contraction of spindle fibers towards opposite poles and become separated.  The animation shows the formation of spindle fibers in each of the haploid daughter cells, aligning of individual chromosomes onto the equator of spindle fibers and the sister chromatids separating at the centromere and migrating to the opposite poles in each daughter cell. Click on the play button to view the animations.  **Telophase II** • Spindle apparatus disappear • Nucleolus and nuclear membranes are reformed • Chromatids at the opposite poles are now the chromosomes • Cells constrict along the middle, giving a total of four daughter cells, often called a tetrad • Each cell has half the number of chromosomes meaning its haploid (n)  • The chromosomes uncoil and become thin and invisible.  Play the animation below to see the formation of four haploid daughter cells. |
| BI3-304400text | **Significance of Meiosis** • It helps in restoring a constant diploid number of chromosomes in organisms after fertilization. • Brings about genetic variation among members of a species during chiasmata formation and subsequent crossing over.  **Comparison between Mitosis and Meiosis Similarities** • They both occur in plant and animal cells • They both involve division of cells.  **Differences.** • In mitosis the homologous chromosomes do not associate with one another while they pair up/lie side by side in meiosis. • In mitosis there is no crossing over while in meiosis chiasma formation leads to crossing over. • In mitosis unpaired chromosomes align on the equator of spindle fibres during metaphase while in meiosis paired chromosomes align on the equator during metaphase I. • Mitosis takes place in a single nuclear division while meiosis takes place in two nuclear divisions each with four stages. • Mitosis produces two daughter cells while meiosis produces four daughter cells • Mitosis produces diploid daughter cells (2n) while meiosis produces haploid daughter cells ( n) • Mitosis takes place in somatic (body) cells while meiosis takes place in sex cells (gonads) leading to formation of gametes. |
| BI3-305100text | **ASEXUAL REPRODUCTION**  Asexual reproduction involves formation of new individuals from a single parent without the formation of gametes. Meiosis is not involved and the offsprings are genetically identical to the parents. In this lesson we shall discuss three types of asexual reproduction. • Binary fission in amoeba • Spore formation in rhizopus • Budding in yeast  The photographs below show examples of offsprings resulting from asexual reproduction. These include:-rhizopus, amoeba and yeast. |
| BI3-305200text | **Binary fission in amoeba** In the Amoeba a mature cell becomes stationary when conditions are favorable. The nucleus starts to divide into two .The cytoplasm divides into two portions and forms two daughter cells that separate from each other and are identical.  The animation below shows binary fission in amoeba. Click on the play button to view the animation  **Spore formation in rhizopus** In the saprophytic mould e.g. Rhizopus that grow on bread, spores are carried by the wind from the sporangium. The spores germinate and form the mycelium with many branches. Some of the hyphae grow vertically and are called sporangiophore. At the tip it swells to form the sporangium which bears the spores. When fully mature it burst to release the spores which are dispersed.Play the animation below to see spore formation in rhizopus.  **Budding in yeast.** • Yeast is usually found in sugar and minerals  • When conditions are favorable a small area of the cell-wall of a mature parent cell softens and forms a projection of bud which bulges outwardly. • The nucleus divides into two and one of the nuclei moves into the new bud. • The bud then grows in size and separates off.  • When budding occurs rapidly the individuals do not separate at once and there results a short chain of cells.  Play the animation below to view the process of budding in yeast. |
| BI3-306000 text | **SEXUAL REPRODUCTION IN FLOWERING PLANTS** Sexual reproduction is a type of reproduction in which male and female gametes are involved to form a new cell which develops into a new organism. In flowering plants the flower is the sexual reproductive organ. The flower may have both male and female parts that produce gametes or the two can be on different flowers.  The diagram below shows the male and the female parts of flowers.   The male and female gametes fuse to form a zygote through a process called fertilization. The zygote then develops into a new organism. The offspring show genetic variation from the parents.  The animation shows the male and female gametes fusing to form a zygote. The zygote develops into a new organism which is different from the parents showing genetic variation. Click the play button to view the animation. |
| BI3-306100text | **Pollination and fertilization in flowering plants** • In flowering plants pollination precedes fertilization. • Pollination is the transfer of pollen grains from the anther to the stigma of a flower of the same species. • The pollen grains from the anthers are transferred to the stigma by pollinating agents such as wind and insects.  Play the video clip below to see pollination in an insect pollinated flower. When the bee lands on the flower it facilitates the transfer of pollen grains from the stamens to the pistils  • The pollen grain on the stigma absorbs nutrients and germinates to form a pollen tube. The pollen tube has a tube nucleus and a generative nucleus which is also the male nucleus. • The pollen tube grows down the style into the embryo sac with the tube nucleus leading. • In the process, the generative nucleus divides into two male nuclei. The pollen tube enters the embryo sac through the micropyle and when it reaches the centre of the ovule it penetrates the wall of the embryo sac and burst open. • The tube nucleus disintegrates and the two male nuclei enter the embryo sac. • One of the male nuclei fuses with egg cell to form the zygote which develops into an embryo while the other fuses with the two polar nuclei within the embryo sac to form the triploid nucleus which is the primary endosperm nuclei. The zygote undergoes mitotic division and develops into an embryo which then develops into a seed. The ovary wall changes into fruit wall.  On the animation below, the pollen grain on the stigma absorbs nutrients and germinates to form a pollen tube which has tube nucleus and a generative nucleus. The pollen tube grows down the style and enters the embryo sac through the micropyle facilitating fertilization. Click on the play button to see the process. |
| BI3-307000text | **Reproduction in amphibians**  Amphibians are animals that live both on land and in water. Examples of amphibians are frogs, toads, newts and salamanders.  The photographs below show examples of amphibians such as frogs, toads, newts and salamanders.  They exhibit external fertilization. Eggs are laid in water and sperms are shed over them resulting to the gametes fusing outside the body. • Mating takes place in the water. The male attracts a female by emitting croaking sounds. It mounts on the receptive female and clings to her nuptial pads found on the underside of the digit of the fore legs. The male then holds on female as she lays the eggs into the water and sheds sperms over the eggs as they are laid. The eggs are enclosed in transparent gelatinous substances in the water which swells up forming a thick jelly-like layer. Eggs float in water until they hatch into tadpoles which undergo  Changes in body form (metamorphosis) to become adults.  On the video clip, the Male frog is mounting on the receptive female as she lays the eggs into the water and sheds sperms over them. Click on the play button to watch the video clip. |
| BI3-308000text | **FERILIZATION IN HUMAN BEINGS** Fertilization is the fusing of the sperm nucleus with the ovum nucleus to form a zygote. It takes places in the upper part of the oviduct. During copulation, seminal fluid is deposited into the vagina of the female and suction force draws up the fluid through the cervix into the uterus. The sperm then swims towards the egg along the oviduct where fertilization takes place.  Play the animation below to see the movement of the sperm through the female reproductive system. |
| BI3-308100text | **The human sperm** It’s the male gamete. Has the following adaptations • Has a head that contains a large nucleus with little cytoplasm and an acrosome. Acrosome is a cap like sac near anterior part; it bursts during fertilization to release lytic enzymes that digest the outer membrane of ovum to allow the sperm to penetrate.  • Middle piece contains numerous mitochondria that produce energy to the sperm as it moves up from the vagina to the oviduct. • Tail enables the sperm to swim towards the egg. The figure shows the human sperm.  **The human ovum** - It’s the female gamete. It’s spherical in shape. - It has more cytoplasm and yolk granules. - It is surrounded by Vitelline membrane beneath which lies a plasma membrane.  The diagram shows a **human ovum** |
| BI3-308200text | **Process of fertilization in human beings** During sexual intercourse sperms are deposited into the vagina.  • Sperms move up the uterus by sanction force and swim towards the ovum in the oviduct due to chemical attractions released by the ovum. • In a single ejaculation, millions of sperms can be released but only one will fertilize the egg.  The Illustration shows a spermatozoon penetrating an ovum for fertilization to take place.  When the sperm comes into contact with egg:  • Acrosome bursts, releasing lytic enzymes. • Lytic enzyme dissolves the egg membranes. • The burst acrosome is modified to form a fine filament that is used to penetrate the egg. • Head of sperm enters the ovum leaving the tail outside the ovum. • Vitelline membrane undergoes modification to stop other sperms from entering the ovum. • Bursting of the head of the sperm releases the male nucleus which fuses with female nucleus to form a zygote. All these happen within the female reproductive system hence internal fertilization. The zygote undergoes a series of mitotic cell division to form a hollow ball of cells with a cavity which gets fluid filled through secretion of a fluid from the oviduct. This mass of cell is called blastocyst. The blastocyst moves down the oviduct towards the uterus aided by cilia movements and contraction of smooth muscles along the oviduct.  This process takes about 7 days.  On the animation, many sperms are swimming from the vagina through the uterus to the oviduct where fertilization takes place. Only one sperm penetrates the ovum and the two nuclei fuse to form a zygote. The zygote develops into a blastocyst as it moves towards the uterus for implantation. Click on the play button to view the animation. |
| BI3-309000text | **IMPLANTATION** On reaching the uterus the blastocyst develops fingerlike projections from the outermost walls called chronic villi which grow into the soft wall of the uterus (endometrum). This embedding of the blastocyst into endometrium of the uterus is known as implantation. After this process the blastocyst is now called an embryo.  The figure shows implantation in the human uterus. |
| BI3-310000text | **FORMATION OF THE PLACENTA** Forms at the site where the embryo gets embedded into the uterine wall. During implantation the blastocyst differentiates into three layers: the chorion, the ammion and the allantois. The outermost layer is called the chorion and beneath it is the ammion which surrounds the embryo. Between these two membranes is a cavity called the amniotic cavity and is filled with a fluid called amniotic fluid secreted by the amnion.  The fluid acts as a shock absorber for the foetus protecting it from mechanical injury. Amniotic fluid also suspends the foetus providing it with a fluid environment which supports the foetus; it also allows it’s free movement during growth. It lubricates the foetus as it makes any movement. The chorionic villi, allantois and part of the endometrum tissues form the placenta.  The illustration shows chorionic villi, allantois and part of the endometrium tissues forming the placenta  The allantois membrane contributes to the formation of umbilical artery and umbilical vein which branches into a network of blood capillaries. Some cells from the amnion and chorion form umbilical cord which is a tubular structure .The umbilical cord connect the embryo to the placenta. The umbilical cord increases in size as the embryo develops. On reaching the third month the embryo is now referred as foetus.  **Note** that the maternal blood system has no direct connection with the foetal blood system to avoid bursting the delicate foetal blood vessels.  Exchange of materials is through sinuses in the uterine wall and capillary systems of the foetus across the intercellular space by diffusion. |
| BI3-311000text | **ROLE OF THE PLACENTA** It serves several functions in the development of the foetus • It facilitates the transfer of nutrients needed for healthy growth and development • Transfer of metabolic wastes product between the foetus and the mother • Gaseous exchange : oxygen diffuses into the foetal blood stream from that of the mother and carbon IV oxide transported from the foetal blood stream to that of the mother • Hormone : in early stage of development the hormone progesterone is secreted by the ovary this role is take up by the placenta after the fourth month • Protection: the foetus is protected from the maternal high blood pressure by the placenta since there is no direct link. The placenta filters harmful bacteria from reaching the foetus • Antibodies from the mother pass through the blood stream of the foetus to build up natural immunity  Play the animation below to see the exchange of materials between the placenta and the embryo  **Note**  Some micro-organisms e.g. viruses and drugs e.g. alcohol and tobacco pass through the placenta and therefore can harm the foetus. |
| BI3-312100text | **Gestation period**  This is the period between implantation and birth Various developmental changes take place and the period varies in different mammal’s e.g. in human it is about 278 days, while in mice it’s about 25 days and in elephant it’s about 640 days.  **Developmental stages between one to six months** In human beings the following developmental stages occur:   **Between day seven up to 3 months**  •Blood cells form and circulation of blood starts. • Heart muscles develop and rhythmic contraction thereafter • Eyes develop  • Brain and spinal develop • Skeleton develops and brains starts to function • The stomach, liver, kidney and limbs begin to function.  The figure shows the foetus below three months  **Between 3rd month and 6th month**  •Genital organs develop. • Hair form on the head. • Baby grows in size rapidly and becomes fully formed  This figure shows the foetus between 3-6months.  If this foetus leaves the womb before the six month it will not survive and is called **miscarriage**. If the foetus is forcefully expelled physically or chemically this condition is called **abortion.** |
| BI3-312200text | **Developmental stages between six to nine months and birth** Premature birth is the birth of the baby after the seven month. Premature babies are cared for in incubators. Between the 6th to 9th months, the baby gains full growth. To grow, protein, iron, calcium and phosphorus must be supplied in the right proportions from the mothers’ circulatory system.  **At the 9th month:** • There is a reduced level of progesterone in the mother’s blood. • Posterior lobe of pituitary gland releases oxytocin. • Oxytocin removes the inhibitory effect on contractions of the endometrium whose muscles start contracting  • Dilation of cervix • Rupture of the ammion and chorion releasing the amniotic fluid through the cervix. • Contraction of the uterine wall pushing the foetus downwards head first through the cervix. • Baby is born. • Newborn takes first breath due to changes in pressure and Carbon IV oxide and the lungs expand and become functional. • Ligature of the umbilical cord and then cutting to separate the baby from the placenta.  • Expulsion of the placenta as afterbirth from the womb.  Play the video clip to see the process of normal birth. |
| BI3-313000text | **ROLE OF HORMONES IN HUMAN REPRODUCTION**  Hormones play a crucial role in the development and control of physiological, physical and emotional changes in both males and females. The hormones are responsible for secondary sexual characteristics observed in both males and females after puberty. During puberty an individual attains sexual maturity.  **Role of hormones in development of secondary sexual characteristics.  In males.**  Hormones that control secondary sexual characteristics in males are known as androgens. Androgens are secreted by testes. Secretion of androgens increases at around the average age of 13-14 years.  At this stage they are responsible for the following • Deepening of the voice. • Growth of hair in pubic and armpits, and on the chin.  • Body becomes more masculine.   • Production of gametes (sperms)  The Illustration shows growth of hair in armpits, pubic region and beards in males.  Play the video clip to see the difference between 6 years old and 18 years old males. It outlines masculinity (biceps, calf muscles and broadening of the chest) in males.  **In females**  Hormones that control secondary sexual characteristics are known as oestrogens. Production of oestrogen begins as early as age 10 depending on the individual they bring about the following changes  • Development of mammary glands  • Enlargement of pelvic girdle and widening of hips  • Growth of hair in the pubic and armpit region  • Body becomes more feminine  • Brings about maturity of the ovaries  • Onset of menstruation  The Illustration shows the difference between the pelvic girdle of a young girl of 6 years and that of an adolescent girl of 15years. It also illustrates growth of pubic and armpit hair of an adolescent girl. |
| BI3-313100text | **Role of hormones in menstrual cycle**  The hormones that control the menstrual cycle are produced by the pituitary gland and the ovary. They are Follicle Stimulating Hormone, oestrogen, Luteinizing hormone and progesterone.  **The role of FSH**  • Causes graafian follicle to develop in the ovary. • Stimulates tissues of the ovary to secrete oestrogen.  The Illustration below shows the flow of follicle stimulating hormone (FSH) from the pituitary glands in the brain to the ovaries where it leads to development of graafian follicles and stimulate secretion of oestrogen.  **The role of Oestrogen** • After menstruation, it causes, healing, repair and growth of endometrium.  • High concentration of oestrogen in blood inhibits production of FSH. This prevents ripening and growth of more follicles in the ovary. • High concentration of oestrogen stimulates the pituitary gland to secrete luteinizing hormone.  The illustration shows the repair and growth of endometrium due to secretion of oestrogen.  **The role of Luteinizing hormone** • Causes ovulation - this is the release of a mature ovum from the ovary. • Causes formation of corpus luteum from a mature follicle cells. • stimulates corpus luteum to secrete progesterone.  Play the animation to see the development of graafian follicle in the ovary, release of the egg into the fallopian tube and the change of the graafian follicle to corpus luteum  **Role of Progesterone** • stimulates the thickening and increased, blood supply to the endometrium. • Inhibits secretion of both FSH and Luteinizing hormone • Maintains pregnancy incase fertilization took place.  If fertilization does not occur the corpus luteum disintegrates.  The disintegration of the corpus luteum stops the production of progesterone which is necessary for preparing endometrium for implantation.  The thickened endometrium sloughs off and is discharged out of the uterus as blood and tissue debris; this is menses. This process is known as menstruation. The menstrual cycle starts with development of graafian follicles, ovulation and ends with menstruation. The cycle lasts for 28 days. |
| BI3-314000text | **SEXUALLY TRANSMITTED INFECTIONS** These are diseases transmitted through sexual intercourse. The diseases include gonorrhea, syphilis, Hepatitis, candidiasis, HIV/AIDS, Herpes, and Trichomoniasis.  Signs and symptoms  Play the video clips below to see the signs and symptoms.  Prevention, control and treatment  Play the video clips below to view the prevention, control and treatment. |
| BI3-400000text | **GROWTH AND DEVELOPMENT** |
| BI3-400000otext | **Objectives**  By the end of this topic you should be able to;  • Differentiate growth from development.  • Analyze experimental data on growth rate. • Distinguish the types of germination. • Measure one aspect of growth in a given seedling. • Explain apical dominance. • Distinguish between complete and incomplete metamorphosis in insects. • Explain the role of hormones in regulating growth and development in plants. |
| BI3-400000btext | **Background information**  In form one, we said that growth and development is one of the characteristics of living organisms. This means that all living organisms increase in size and also change their form and complexity with time. In this topic we shall discuss:-   * The difference between growth and development. * How to measure growth in a given organism. * How to analyze experimental data on growth rates. * Germination in plants. * Metamorphosis in insects. * The role of hormones in growth and development. |
| BI3-401000text | I**ntroduction**  Growth may be regarded as the permanent and irreversible increase in size of an organism. • It involves a permanent increase in such measurable aspects as length, weight, width and so on.  Development on the other hand is the gradual change in form and complexity of an organism in the course of its life. • It involves modifications of cells formed during cell division into different shapes to form specialized tissues. • Many changes that occur during development of an organism are not measurable. In animation 1, the child increases in size due to cell division and elongation (growth), while it develops organs such as eyes, ears, hands and legs due to cell differentiation (development).  In animation 2, the seedling increases in size due to cell division and elongation (growth) while it develops organs such as leaves, flowers and fruits due to cell differentiation (development). Click the play button to view the animations |
| BI3-402000text | **Germination** - Germination is the process through which a seed develops into a seedling. - For the process to occur water is absorbed through the micropyle in a process called imbibition causing the seed to swell. - The water taken up is used to dissolve and break down the stored food in the cotyledon into soluble food substance, which is then taken to the growing regions of the plumule and radicle. - A seed embryo germinates into a seedling with a radicle developing into a root as the plumule develops into a shoot.  • The radicle increases in size forming roots which may assume different shapes i.e. Specialized roots.  • The plumule develops into the shoot system which differentiates into stems, branches, leaves and flowers. Play the animation below to see seed absorbing water through the micropyle, swelling and the germinating in to a seedling.  - There are 2 types of germination  • Epigeal germination  • Hypogeal germination. |
| BI3-402100text | **Epigeal germination** - If all the necessary conditions for germinations are present, the radicle emerges first, grows out through the micropyle down into the soil as a primary root and other roots arise from it. - The part of the embryo between the cotyledon and the radicle is called hypocotyl.  - The hypocotyl curves and pushes upwards protecting the delicate shoot tip, then straightens and elongates carrying the cotyledons above the soil level. - This type of germination is called epigeal germination.  The illustration below shows the process of epigeal germination in a bean plant.  Play the animation below to view a germinating bean seedling. The cotyledons are raised above the soil level. |
| BI3-402200text | **Hypogeal Germination** - If all conditions are availed, the radicle emerges first, along its protective covering called coleorrhiza. - The radicle grows down and develops some root-hairs behind its tip. - Other adventitious roots arise from the base of stems producing a fibrous root system. - The part of the embryo between embryo and cotyledon is called epicotyl. - The epicotyl elongates above the soil and allows the plumule to grow out of its sheath (the coleoptiles) to form the 1st foliage leaves and start manufacturing food.  - The cotyledons remain below the ground but the stored food is broken down and transported to the growing region making it shrink and reduce in size. The cotyledon then withers away. - This type of germination is known as hypogeal germination.  The photograph below shows a germinating maize seed with the radicle emerging.  The illustration shows the process of hypogeal germination in maize. The cotyledons are left on the ground |
| BI3-402300text | **Conditions necessary for germination** For germination to occur, the following conditions are necessary: • Water • Oxygen • Favorable temperature • Hormones • Enzymes • Seeds must be viable (viability) |
| BI3-403100text | **MEASUREMENT OF GROWTH** Growth can be estimated by measuring some aspect of an organism such as height, weight, volume and length over a specified period of time.  Play the video below to see a person measuring the length and breadth of plant leaves. |
| BI3-403200text | **Sigmoid curve** This can be demonstrated by taking the study of growth in the length of the leaf. The results obtained are plotted into a graph and interpreted. The curve acquires the S-shaped graph called Sigmoid-Curve. The Sigmoid curve may therefore be divided into four parts. These are: -Lag Phase, exponential phase, Deceleration phase and Plateau phase.  The illustration shows a sigmoid curve obtained from measurement of growth. |
| BI3-403300text | **Parts of a sigmoid curve**  a) Lag Phase (slow growth). Growth is slow initially and this is due to the fact that the number of cells dividing are few and has not adjusted to the surrounding environmental factors. This is illustrated by the region between A and B.   b) Exponential phase (Log Phase) - Phase of very fast growth due to the increase in the numbers of cells dividing, the cells have adjusted to the environment and all the other factors are not limiting. On the curve this is between B and C.  c) Deceleration phase  This is the phase during which growth becomes limited due to the following reason. • Most cells are fully differentiated. • Fewer cells are dividing. • Shortage of oxygen and nutrients due to high demand by the increased number of cells • Limited space due to high number of cells • Accumulation of metabolic waste products • Limited acquisition of carbon (iv) oxide in plants  This is between C and D.  d) Plateau (stationery) phase. The overall growth has ceased and the parameters are constant. This is due to the fact that the rate of cell division is equal to the rate of cell death, and that nearly all the cells have differentiated. This refers to region D-E.  The animation shows a sigmoid curve. |
| BI3-404000text | **ROLE OF GROWTH HORMONES IN PLANTS**  Plant hormones are chemical substances produced in small quantities within the plant body but play a major role in growth and development. They are mainly produced at the shoot tips and a few at the root tips. Major plant hormones include:- • Auxins  • Gibberellins  • Cytokinins  • Ethylene  • Abscisic acid  • Florigens |
| BI3-404100text | **Auxins** This is a group of hormones produced at the shoot tip and root tip and works in association with other plant hormones to bring about various growth responses. Auxins have various effects on growth and development in plants  -Enhance tropic responses such as phototropism and geotropism.  -Stimulates cell division and cell elongation in stems and roots  -Stimulates growth of adventitious roots from the stem  -Stimulates development of an ovary into a fruit without fertilization i.e. parthenocarpy.  -Enhance apical dominance.  The photographs below show the following; - a) tendrils of a passion fruit b) Seedlings bending towards light (phototropism), c) sugarcane cutting dipped in a solution of auxins and roots emerging. |
| BI3-404200text | **Gibberellins** Another group of plant hormones that are important to plant growth are the Gibberellins. The most noticeable effect of Gibberellins is the stimulation of rapid growth in dwarf varieties of plants. E.g. If cabbages which are naturally dwarf are treated with gibberellins, they can grow to high heights due to rapid cell division and elongation.  This photograph shows bolted cabbage  **Cytokinnins** Another group of active growth substances are the Cytokinins. In the presence of auxins, they stimulate cell division thus bringing about growth of roots, leaves and buds. Cytokinins also promote the formation of adventitious roots from the stems and stimulate lateral bud development in shoots.  The photograph shows sugar cane with adventitious roots  **Ethylene** The other hormone produced in gaseous form and released in small quantities is the hormone Ethylene. Its major effects are ripening of fruits and leaf fall.  Play the video below to see the ripening of pineapples. |
| BI3-404300text | **Abscisic acid** This hormone influences shedding of leaves and brings about a reduction in plant activities during dry seasons. Its concentration is high in such plant organs like fruits, buds, tubers and seeds. It is also highly concentrated at the bases of leaves. It has the following effects:  - Causes leaf fall (abscission) and fruit fall.  -Promotes seed dormancy.  -Inhibits seed germination.  -Inhibits sprouting of buds from stems. -Retards stem elongation.  -Causes closing of stomata at high concentrations. Play the video clip to see leaves and fruits falling due to the effect of abscisic acid  **Florigen** This hormone promotes flowering in plants  The illustration below shows a bud opening to form a flower. |
| BI3-405000text | **APICAL DOMINANCE**  The inhibition of growth of lateral buds in a plant by the presence of a growing apical bud is called apical dominance. We have learnt that auxins, particularly IAA promote stem and root elongation. However, they are also capable of affecting other aspects of plant growth and development. High concentrations of auxins inhibit the sprouting of lateral buds thus hindering growth of many branches. Since auxins are more concentrated near the shoot apex, their inhibitory effects is greater on the branches higher up than the branches nearer to the roots. Hence lower branches are often longer than those nearer the shoot apex, creating a cone-shape of a free. The failure of lateral buds to develop (grow to greater lengths) in the presence of the apical buds is due to the top-down diffusion of auxins in concentrations higher than those that should promote lateral bud development. This phenomenon is the one exploited in pruning coffee, tea, hedges etc to increase the number of side branches in order to form dense vegetation for increased yields.  Photograph 1 shows cone shaped trees due to apical dominance. In photograph 2, a trimmed hedge has a lot of lateral growth due removal of the shoot tips while the hedge which is not trimmed has little lateral growth due to apical dominance. |
| BI3-406000text | **Metamorphosis** This refers to all the developmental changes that take place from the time a fertilized egg is laid until the adult stage is attained in insectss . There are two types of metamorphosis.  These are: - a) complete metamorphosis  b) Incomplete metamorphosis |
| BI3-406100text | **Complete metamorphosis** Occurs in most insects including the bee, housefly, wasp, moth and butterfly. It involves fertilized eggs being laid hatching into larvae. In housefly, the larvae are called maggots while in butterfly and moth it’s known as caterpillar. The larvae grow fast and shed its cuticle several times to become the pupa. Pupa is a non-feeding stage which later develops into an adult which resembles the original mother insect.  The animation below shows complete metamorphosis in a housefly. |
| BI3-406200text | **Incomplete metamorphosis** This occurs in insects such as the cockroach, grasshopper and locusts. In this type of development, the egg hatches into a nymph which resembles the adult insect, except that it is sexually immature and has no wings. The nymph feeds and undergoes several moulting to form an adult insect. Moulting is influenced by a hormone ecdysone and therefore the process of moulting can be referred to as ecdysis.  The animation below shows incomplete metamorphosis in a grasshopper. |

**GAMES VOICE OVERS**

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| **Classification** | | |
| **BI3-104000qtext1** | By clicking on the box, identify the odd one out | |
| **BI3-104000qtext2** | Click on the small box against the statement below whether true or false about fungi. | |
| **BI3-105200qtext1** | Identify members of the division Bryophyta from the following list by ticking the correct answer | |
| **BI3-105200qtext2** | From the list provided on the left hand column select the general characteristics of the division bryophyta. | |
| **BI3-102000qtext** | True or false; a swimming pool is usually blue due to presence of blue green algae. | |
| **BI3-103000qtext** | Drag and drop words from the list provided to complete labeling the organism drawn below. | |
| **BI3-105300qtext** | Click whether the following statement about pteriodophyta are true or false | |
| **BI3-105600qtext** | Which of the following is false about sub-division gymnospermaphyta? Put a tick on the correct answer. | |
| **BI3-105700qtext** | Using observable features, drag and drop the correct labels for the parts marked on the diagram. | |
| **BI3-100000etext1** | Fill in the spaces provided by typing in the correct answer. | |
| **BI3-106000qtext3** | Type from the list below the appropriate words to complete the following sentences. | |
| **BI3-106000qtext4** | Type from the list below the appropriate words to complete the following sentences. | |
| **BI3-100000etext2** | Type from the list below the appropriate words to complete the following sentences. | |
| **BI3-100000egame3** | From the following list, click on the odd ones out. | |
| **BI3-100000etext4** | Click on the correct statements about angiospermaphyta. | |
| **BI3-100000etext5** | Drag and drop the following into their correct kingdom | |
| **BI3-100000etext6** | Click whether the following statements about the order coniferales are true or false. | |
| **BI3-100000etext7** | Cycads belong to the class Dicotyledonae. True or false | |
| **Ecology** | | |
| **BI3-201100qtext1** | You are provided with the following Photographs. Drag and drop the correct word that matches the pictures provided | |
| **BI3-201100qtext2** | Type in the correct answer in the spaces provided. | |
| **BI3-201100qtext3** | Cactus is xerophytes. Which term best describes this statement? Click the correct answer. | |
| **BI3-202000qtext1** | Match the biotic factors given with their corresponding measurement instrument. | |
| **BI3-202000qtext2** | Give one word which describes the relationship between the following living organisms in a habitat by typing in the correct answer. | |
| **BI3-202000qtext3** | Which of the following factors does not affect distribution of organisms in a lake? Click on the correct answer. | |
| **BI3-203000qtext1** | Fill in the spaces provided with the correct words. | |
| **BI3-203000qtext2** | Below is a simplified scheme of Nitrogen cycle.  From the list of words provided, drag and drop to complete the scheme with appropriate words | |
| **BI3-203000qtext3** | Identify processes A, D and F by typing in the correct answer. | |
| **BI3-203000qtext4** | Identify the organisms responsible for the processes M, N and P by typing in the correct answer. | |
| **BI3-203000qtext5** | Study the food web below and answer the questions that follow.  From the food web construct three food chains in which a black jackal is a secondary consumer. | |
| **BI3-206000qgame2** | State two immediate effects in the ecosystem of eliminating mice | |
| **BI3-206000qtext3** | To what trophic level do the following organisms belong? Type in the correct answer. | |
| **BI3-210000qtext1** | Indicate whether the following statements are true or false. Click on the appropriate box. | |
| **BI3-210000qtext2** | Below is a photograph of an aquatic weed. State three adaptive features that enable it survive in its habitat. | |
| **BI3-212000qtext1** | Below is a list of diseases. Drag and drop a matching disease to its causative agent. | |
| **BI3-212000qtext2** | Which of this hygiene practices can go a long way in preventing diseases? Click on the correct answers. | |
| **BI3-211000qtext** | Which of the following processes is not a source of pollution. Tick on the correct answers. | |
| **Reproduction** | | |
| **BI3-307000qtext** | | Fill in the blank spaces in the paragraph below. |
| **BI3-308000qtext1** | | Label the parts marked in the structure below using drag and drop method |
| **BI3-308000qtext2** | | Click the correct answers from the choices provided. |
| **BI3-309000qtext** | | Which statement best describes implantation? Click on the correct answer. |
| **BI3-310000qtext1** | | Type in the correct word in the blank spaces to complete the labeling |
| **BI3-310000qtext2** | | Using arrows show the direction of movement of materials between the baby and the mother. |
| **BI3-312100qtext** | | Indicate whether the following statements are True or False |
| **BI3-305100qtext** | | Type in the blanks an example of an organism associated with the following mode of reproduction. |
| **BI3-306100qtext** | | Drag and drop to label the diagram from the list of words provided below. |
| **BI3-301000qtext1** | | Drag and drop to label the diagram of the chromosome below from the list of words provided. |
| **BI3-301000qtext2** | | Type in the correct answer to fill the spaces in the sentence provided below. |
| **BI3-301000qtext3** | | State whether the statements below are true or false by clicking on the appropriate box. |
| **BI3-301000qtext4** | | Below is a diagram of dividing cells. Identify the type and stage of cell division represented by typing in the correct answer. |
| **BI3-313000qtext1** | | Drag & drop the secondary sexual characteristics listed below to the appropriate category where they are exhibited |
| **BI3-313000qtext2** | | Arrange the hormones that control menstrual cycle in the order in which they are produced. |
| **BI3-313000qtext3** | | Using the illustrated diagram shown, drag and drop the hormones to show the point of secretion. |
| **Growth and development** | | |
| **BI3-404000qtext1** | | Type in the correct answer on the spaces provided. |
| **BI3-404000qtext2** | | Tick the correct statement that corresponds to the effects of auxins |
| **BI3-404000qtext3** | | Click whether the following statements are true or false for the growth hormones. |
| **BI3-401000qtext1** | | Click against the processes that are involved in growth from the list below |
| **BI3-401000qtext2** | | Type in the process that leads to development in a cell. |
| **BI3-401000qtext3** | | Click in the box whether the following statements is true or false. |
| **BI3-402000qtext1** | | You are provided with pictures of two seedlings. From the list provided drag and drop the matching word to the part on the diagram to complete the labeling. |
| **BI3-402000qtext2** | | Match the words in column A to the functions given in column B by dragging and dropping the correct plant part to its functions |