

Science

Gr 11

Teacher's Instructional Manual (Biology component)



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Competency 1.0 : Investigates the adaptation of mechanisms which are adapted to perform body functions efficiently

Competency Level 1.1 : Investigates on the nervous coordination process in human

Activity 1.1 : Let's be sensitive to coordination

Time : 120 minutes

- Quality inputs :**
- Three copies of instruction for exploration given in annex 1.1.1
 - Text books
 - Pastel and demy sheets

Learning -Teaching process – :-

Step 1.1.1

- Call two volunteer students to the front.
- Let one student inhale the vapor of a harmless but unpleasant (bad) smell from a substance like Margosa oil.
- Move a finger in front of the eyes of the other student.
- Get the class to observe the responses of the two students .
- Inquire their ideas about the reactions of the above students.
- Conduct a discussion highlighting the following points.

- We turn our face away from bad/ offensive smell and shut our eyes to protect them against a possible danger (threat).
- We have developed adaptations according to the changes in the environment.
- Changes in the environment that can bring out a response from our sensory organs are known as '**stimuli**'.
- The minimum intensity / concentration of a stimulus, which brings out a response in our body is known as the "Threshold value".
- The five sensory organs in our body namely eyes, nose, ears , tongue and skin are known as 'receptors' .
- The reaction to a stimulus is known as 'response'.
- The organs that respond to stimuli are '**effectors**'.

(15 minutes)

Step 1.1.2

- Divide the class into three groups.
 - Provide them with pastel, demy papers and copies of instruction for exploration.
 - Assign tasks and get them to start investigation as a group.
 - Instruct them to get prepared for a group presentation.
- (60 minutes)

Step 1.1.3

- Get each group to present their findings to the class.
- Give first opportunity to the respective groups for elaboration.
- Allow other groups to propose constructive suggestions.
- Elaborate highlighting the following points.

- The adjustments in our body in response to the internal and external environmental changes are known as 'coordination'.
- Coordination is essential for the survival of organisms.
- Coordination occurs through electrical and chemical means.
- The electrical coordination is handled by the nervous system while the chemical coordination is done by hormones.
- The basic unit of the nervous system is nerve cell which is known as 'neuron'.
- A neuron consists of a cell body and many nerve fibers.
- The long nerve fiber is known as 'axon' while the short ones are 'dendrites'.
- Dendrites bring in the message to the cell body, while the axon carries the message away from the cell body.
- The cell body of neurons are found in brain, spinal cord or ganglia and the axons from many cells gather to form a nerve.
- A collection of cell bodies formed as a node away from the central nervous system is known as a ganglion.
- The nervous system is divided as the central nervous system and the peripheral nervous system.
- Central nervous system consists of the brain and the spinal cord.
- The brain consists of three parts namely cerebrum, cerebellum and medulla oblongata.
- The cerebrum is divided into two halves namely the left cerebral hemisphere and right cerebral hemisphere.

- Cerebrum controls some essential, complex and highly important activities such as thinking, sensitivity and motor activities.
- The cerebellum coordinates the voluntary muscular movements, posture and balance.
- All nerves originating from the brain and spinal cord and distributed throughout the body are collectively known as the peripheral nervous system.
- Peripheral nervous system consists of 12 pairs of cranial nerves and 31 pairs of spinal nerves.
- The 10th cranial nerve pair (motor neurons) travels up to organs in the thoracic and abdominal regions.
- Peripheral nervous system connects sensory and motor organs.
- Medulla oblongata controls all the involuntary actions, such as heart beat and respiration.
- There are three types of neurons termed as sensory neurons, motor neurons and intermediate neurons.
- Sensory neurons carry impulses from the sense organs while motor neurons carry impulses to the effectors. Intermediate neurons act as the connecting bridge between sensory neurons and motor neurons.
- Impulses from receptors travel through the sensory neurons to the intermediate neurons and then through the motor neurons to reach the effectors. This is the normal pathway of a response to stimuli which is known as a 'reflex arc'.
- A reflex arc is the functional unit of our nervous system
- The pathway of a reflex arc could be through the brain, brain and spinal cord or only through the spinal cord.
- A 'reflex action' is a response to an instant stimuli which exists for a very short period. It does not involve the voluntary command of the brain.
- Reflex actions are named as spinal reflexes and cranial reflexes depending on the pathway of the reflex arc.

- Actions that can be controlled by us are known as voluntary actions while those which we have no control of are involuntary actions.
- Autonomous nervous system is a part of the peripheral nervous system.
- The autonomous nervous system consists of a group of ganglia connected to the peripheral nervous system.
The autonomous nervous system controls the functioning of glands and involuntary muscles (smooth. and heart) such as the heart, intestines, stomach and bladder.
- The sympathetic system stimulates certain functions of the above organs while the parasympathetic system inhibits the same functions.
- Some example are given below.

Effector	Parasympathetic system	Sympathetic system
Heart	functioning becomes slower	functioning becomes faster
Iris	contracts	expands
Salivary glands	secretes	-
Anal sphincter	relaxes	contracts
Urinary bladder sphincter	relaxes	contracts
Sweat gland	-	secretes

- The ganglia controlling the sympathetic and parasympathetic systems are situated separately.
- Almost all internal organs are provided with both sympathetic and parasympathetic nerves.

(45 minutes)

Criteria for assessment and evaluation

- Explains the nervous coordination process in man
- Accepts the fact that the survival of organisms depend on nervous coordination

- Demonstrates the mechanism of nervous coordination.
- Discovers the integrated steps of phenomena.
- Harmonizes with the environment.

Instructions for group exploration

Let's be aware of nervous coordination

- Focus your attention to the incident relevant to your group from the list given below.
 - Blinking quickly when a small insect flies close to your eyes.
 - Rapid heart beat of a person who has done a wrongful act
 - Opening an umbrella as soon as it starts raining.
- Refer the facts given in your text book
- Identify the components of the nervous system controlling the response assigned to your group.
- Discuss and represent diagrammatically how the components are connected sequentially.
- Investigate other instances in daily life where the similar processes take place.
- Explain how the nervous coordination based on the incident assigned to you contributes towards the successful survival of yourselves.
- Be prepared for a creative presentation.

Competency 1.0 : **Investigates on the adaptation of mechanisms which are adapted to perform body functions efficiently**

Competency Level 1.2 : **Acts accordingly to ensure the proper functioning of the sense organs**

Activity 1.2 : **Let's find out the necessity of sense organs**

Time : **120 minutes**

Quality inputs :

- Four copies of the instructions for exploration given in annex 1.2.1
- Text book
- Demy paper & pastel

Learning - Teaching process :-

Step 1.2.1

- Call a volunteer to the front .
- Let him play the role of a person whose sensory organs are not functioning properly.
- Let the other students try to communicate with him.
- Conduct a discussion highlighting the following points.

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| <ul style="list-style-type: none">• If not for the sensory organs we are unable to respond to any stimuli from the environment.• Such a person cannot survive.• The sensory organs of a human are eyes, nose, ears, tongue and skin.• Our awareness helps to maintain the health and efficient functioning of the sensory organs . |
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(15 minutes)

Step 1.2.2

- Divide the class into four groups.
- Provide the groups with instructions for exploration, demy paper and pastel.
- Assign the tasks and engage groups in exploration.
- Prepare them to present their findings to the whole class.

(60 minutes)

Step 1.2.3

- Get each group to present their findings to the class.
- Give first opportunity for elaboration to the respective group which made the presentation.
- Get other groups to propose constructive suggestions.
- Elaborate highlighting the following points.

- Our eyes receive optical stimuli to enable vision.
- Binocular vision enables us to have a 3D vision.
- The structural & functional relationship of the eye to facilitate vision is as follows.
 - The transparent, gelatinous and biconvex eye lens focuses light rays onto the retina.
 - Ciliary muscles around the lens – controls the focusing of the lens by adjusting the curvature of the lens through contraction and relaxation of muscle fibers.
 - Iris with its circular muscles which forms a central opening (Pupil) adjusts the diameter of the pupil to control the amount of light entering the eye.
 - The inner layer of the eye forms retina as a screen on which images are focused.
 - Optical nerve- carries the signals from the images formed on retina as nerve signals to the brain.
 - Blind spot which is where the optical nerve joins the retina. Images formed on it doesn't stimulate a signal to the brain.
- Light travelling from an image form a small inverted image on the retina.
- Our brain inverts it and gives us the correct image.
- Some common eye defects are long sightedness, short sightedness and colour blindness.
- Long sightedness is when one can see distant objects clearly but cannot see close by objects clearly. Short sightedness is clear vision of close objects and unclear vision of distant objects.
- Long sightedness and short sightedness can be corrected by wearing convex and concave lenses respectively.
- Complete colour blindness is a hereditary disease which cannot be cured and the affected person sees everything in black and white.
- Red green colour blindness also cannot be cured. Affected person cannot differentiate red and green colours from each other.
- Ear is responsible for the sense of hearing.
- It also helps to maintain sense of balance.
- Ears consist of three parts; outer ear, middle ear and inner ear.
- Outer ear and middle ear are filled with air, while the inner ear is filled with fluid.
- The outer ear is separated from the middle ear by the tympanic membrane.

- Middle ear has three tiny bones closely connected to each other, known as the ear ossicles.
- The Eustachian tube in the middle ear which is connected to the throat contributes to balance the air pressure between the outer ear and middle ear.
- The inner ear is a complex structure and contains a fluid
- This fluid is concerned in maintaining the body balance.
- Sound waves vibrate the tympanic membrane, which makes the ossicles vibrate and then transmits it through the fluid in the complex structure of the inner ear which then stimulates the auditory nerve.
- The hearing range of humans is limited to 20Hz- 20 000Hz and therefore cannot hear anything below or above that range.
- Skin consists of many types of cells and tissues and is the largest organ of the body.
- Skin consists of the following layers.
 - Epidermis with dead cells
 - Dermis which consists of sensory receptors, blood capillaries, hair follicles and sweat glands.
 - Hypodermis with fat deposit cells.
- The main functions of our skin are ;
 - Controlling body temperature
 - Protecting the body against microorganisms, friction, dehydration and harmful rays such as UV rays.
 - Acting as a receptor site of stimuli
 - Excretion
 - Synthesis of vitamin D
- Skin is a sensory organ and has receptors for touch, pain, pressure, heat and cold.
- The nerve endings which are receptors for these senses are found in the dermis and hypodermis.
- Places like face & finger tips have a large number of sensory receptors for touch.
- Tongue has receptors sensitive to taste known as taste buds
- A taste bud consists of a collection of cells sensitive to chemical receptors.
- Tip of the tongue is sensitive to sweet & salt taste while the base is sensitive to bitter taste. The two sides have receptors for sour taste.
- The odour and taste enables us to identify the diversity of food.
- The lining of the upper parts of the nasal cavity consists of many olfactory cells. They are also a kind of chemical receptor cells.

- When chemical vapour responsible for a smell reaches the olfactory receptors they are stimulated to send a signal through the olfactory nerve to the brain.

(45 minutes)

Criteria for assessment and evaluation

- Explains the structure and functions of sensory organs.
- Accepts that the sensory organs are essential for the survival of an organism.
- Uses labeled diagrams to represent the structure of sensory organs.
- Pays attention to the well-being of the body.
- Adjusts the behaviour by understanding the scientific background.

Annex 1.2.1

Instructions for group exploration

Let's find out the necessity of sensory organs

- Focus on the sensory organ assigned to you from the list given below.
 - Eye
 - Nose
 - Skin
 - Tongue
 - Ear
- Use the text book to extract data about the organ assigned to your group. (If possible use other resources such as models, posters, articles, medical personnel etc.)
- Discuss the contribution of main parts of the organ to carry out the function of the particular organ.
- Discuss the functions of the organ, abnormalities and their reasons.
- Suggest behavioural changes that could contribute to the well-being of the organ.
- Be prepared to present your findings to the class.

- Competency 1.0** :Investigates on the adaptation mechanisms which adapted to perform body functions efficiently
- Competency Level 1.3** :Investigates on the hormonal coordination processes in human
- Activity 1.3** :Let’s identify the interrelations in our body
- Time** :120 minutes
- Quality inputs :**
- Three copies from the instructions for exploration given in annex 1.3.1
 - The article on "A hidden chemical force" given in annex 1.3.2
 - Demy papers and pastels

Learning Teaching process :-

Step 1.3.1

- Direct a student to present the article to the class.
- Conduct a discussion highlighting the following facts.

- A group of chemicals known as hormones also contribute to the coordination of our body functions.
- They are produced in endocrine glands.
- The endocrine system maintains the internal atmosphere (tissue fluid) constant so that our metabolic functions are optimal.

(15 minutes)

Step 1.3.2:

- Divide the class into three groups.
- Provide each group with instructions for exploration sheets, demy papers and pastel.
- Assign the tasks and engage groups in exploration.
- Prepare groups to present their findings to the class.

(60 minutes)

Step 1.3.3

- Get each group to present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Let other groups propose constructive suggestions.
- Review highlighting the following points.

- Coordination is building inter- relations between all systems of the body for regulating their functions.
- Coordination is controlled by the nervous system as well as the endocrine system.
- While the nervous system controls short term coordination, the endocrine system is for long term coordination.
- A gland is a structure which secretes a specific chemical or a group of chemicals.
- There are two types of glands namely exocrine & endocrine glands.
- The secretions from exocrine glands are carried to their required destination through ducts originating from the gland.
- Salivary and sweat glands are examples for exocrine glands.
- Endocrine glands have the following characteristics;
 - Secrete chemicals called hormones
 - Add the secretions directly to the blood stream since they are ductless
- Hormones are chemical messengers.
- They have the following common characters.
 - They are organic compounds
 - Transported through the blood stream
 - Produced at one place and act at a different place
 - Induce only the target organs
 - Needed in very small quantities
- Some important facts about the endocrine system is given in the table (annex1.3.2)
- Our cells are immersed in a fluid medium called the tissue fluid.
- Changes in this fluid affect the metabolism of the body .
- Therefore, the tissue fluid is considered as the internal environment of our body.
- Tissue fluid is non other than blood plasma minus the plasma proteins.
- Any changes in the composition of the tissue fluid will change the consistency in blood plasma which will be carried to the respective receptors through blood stream, causing them to respond .
- Changes in the consistency or physical factors in the internal environment is limited to a narrow range.
- Homeostasis is regulating the internal environment within this small range.

- Regulating the osmotic balance - blood glucose level and body temperature are some examples.
- Water (Fluid) regulation is done through the kidneys and skin while the liver and our skin control blood glucose level and body temperature respectively.
- Osmotic balance can be simplified as follows.
- When the fluid percentage of tissue fluid is lowered or when there is excessive sweating, the volume of urine produced by kidneys is reduced.
- When the fluid percentage of the tissue fluid is high or when sweating is minimal because of cold weather, the volume of urine produced by kidneys is increased.
- In a normal healthy person the average blood glucose level is 90 mg per 100 cm³ but may vary on his /her genetic factors.
- Regulation of the blood glucose level can be simplified as follows.
 - Insulin is secreted when the glucose level in tissue fluid is high.
 - This insulin induces liver cells to store excess glucose as glycogen.
 - When the glucose level in tissue fluid is low glucagon is secreted by the pancreas.
 - Glucagon induces the liver to convert glycogen to glucose which is then released to the blood stream.
- Regulating body temperature can be simplified as;
 - When the external temperature is high tiny blood capillaries in our skin are dilated providing more blood to the skin to avoid increase in body temperature.
 - Then the excess heat is used to evaporate sweat. In addition heat is lost by convection.
 - During this process the hairs lay flat(parallel) on the skin and skin colour becomes reddish.
 - Metabolic rate is reduced to decrease the amount of heat produced by the body.
 - As a result the person may feel lethargic and appetite is lowered.
 - When the temperature in environment is low to protect our body temperature from falling low blood capillaries in our skin constrict and blood supply to the peripheral of body is reduced.
 - Skin becomes pale and hairs erect forming an insulating air layer around the body.

- If the temperature is very low body muscles start constricting fast causing shivering which generates heat.
- To stop body temperature from falling the metabolic rate increases producing more heat and the appetite increases.
- A person living in cold environment for a long time is adapted to conserve heat by having a thick sub cutaneous fat layer which acts as a heat insulator .
- For an optimum level of metabolism our body temperature must be kept at 37°C.
- Fluctuation of body temperature above 39 °C or below 34.5 °C is not tolerable to human beings and could even be fatal.

(45 minutes)

Criteria for assessment and evaluation

- Explains how non nervous coordination and homeostasis contributes to the well being of our body.
- Accepts that the homeostasis is essential to maintain metabolism of the body at an optimum level.
- Presents the mechanisms of homeostasis using diagrams.
- Uses suitable methods to summarize the information.
- Acquires necessary facts using reliable sources of information.

Annex 1.3.1

Instructions for group exploration

Let's identify the interactions of the human body

- Focus your attention on the mechanism assigned to your group regarding the maintenance of internal environment of the body at an optimum level.
 - Regulating body fluid level (regulating osmotic balance)
 - Regulating blood glucose level
 - Regulating body temperature
- After studying the text book, draw a block diagram to represent the mechanism assigned to your group.
- According to your theme, explain the functions of important organs in regulating the internal environment (homeostasis).
- Express your ideas about the importance of blood tissue for the above.
- Prepare to present your findings creatively.

Annexe 1.3.2

A hidden chemical force !

You have grown up to be a young adult from a tiny baby. Have you ever wondered about the fascinating phenomena of growing up ? Our body is full of such interesting scientific wonders. Now, let's listen to one of them.

There is a group of chemicals known as “ hormones” in our body. They are produced by certain glands, but these glands are special because they do not have ducts to transport their secretions to the respective targets. In short they are ductless glands, also known as endocrine glands by scientists. Why? Because they secrete directly to the blood stream that flows through the glands. But mind you, they do not secrete in an ad hoc manner. Either a nervous message from the brain or a hormone produced by a major endocrine gland only can stimulate these glands to secrete.

Here is a summary of a few glands ,some hormones produced by them and their functions. Please study it.

Gland	Hormone	Function
Pituitary	Growth hormone	Controls growth
Thyroid	Thyroxin	Controls metabolic rate
Adrenal glands	Adrenaline	Prepares the body for sudden actions
Islets of Langerhans in pancreas	Insulin Glucagon	regulates the blood glucose level
Ovaries	Oestrogen Progesterone	onset and maintaining of secondary sexual characters in females, controlling the menstrual cycle and pregnancy
Testis	Testosterone	Producing onset of secondary sexual characters in men and stimulating sperm production

Hormones travelling with blood stimulate only the target organ or gland to carry out the expected result, but if by any reason the hormone is not released into the body as required it could produce adverse reactions from the body.

Dwarfs are people who could not produce enough growth hormone at the right time. Low level of thyroxin hormone could put the body into a very difficult state. That is why hormones are known as an invisible chemical force.

Competency 1.0 :Investigates on the adaptation of mechanisms which are adapted to perform body functions efficiently

Competency Level 1.4 :Investigates on plant growth substances and their uses

Activity 1.4 :Have you noticed the movements of plants ?

Time :120 minutes

Quality inputs :

- The article “How to reap the whole pineapple harvest at the same time” annexed as 1.4.1
- Two copies of instructions for exploration sheets
- Demy papers and pastels

Learning -Teaching process :-

Step 1.4.1:

- Get a student to read the article about how to reap the whole pineapple harvest at the same time.
- Conduct a discussion highlighting the following facts.

- In agriculture it is often important to gather the harvest as a bulk.
- In nature, pineapple plants do not produce flowers or fruits at one particular time of the year.
- Therefore, using synthetic chemicals to induce fruit forming is an effective method.
- Certain chemicals can affect plant growth .

(15 minutes)

Step 1.4.2

- Divide the class into two groups.
- Provide each group with instruction for exploration sheets Demy papers and pastel.
- Assign the tasks and engage them in exploration.
- Prepare all groups to present their findings to the class.

(60 minutes)

Step 1.4.3

- Get each group to present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Allow other groups to propose constructive suggestions.
- Review highlighting the following points.

- Chemicals that could control growth and development in plants as well as many other physiological responses are known as growth substances.

- In this competency level, we will be considering only about a popular group of growth substance known as Auxins (Indole-acetic acid IAA).
- Unlike in animals, plant growth substances are not produced in special glands but by groups of cells in various parts of the plant.
- Some growth substances are transported to other regions of the plant while some affect the same area it is produced at
- A plant part growing towards or away from a stimuli is known as a tropic movement.
- A movement towards the stimuli is known as a positive tropic movement while a movement away from the stimuli is a negative tropic movement.
- Given below are some examples for tropic movements.
 - A shoot tip bending towards unidirectional light rays – positive phototropic
 - A root tip growing towards gravity – positive geotropic
 - A shoot tip growing away from gravity – negative geotropic.
- The concentration of auxins increases just below the shoot tip in the opposite side to where the light rays fall. Those cells elongate bending the shoot tip towards light.
- The root tip grows towards gravity because the cells just above the root tip on the opposite side to gravity elongate bending the root tip towards gravity.
- The effect of growth substances on positive geotropic movements of root tips are not discovered yet.
- The following growth movements in plants are also controlled by growth substances.
 - Elongation of stems & roots in a plant.
 - Parthenogenesis
 - Flower and fruit formation
 - Apical dominance
 - Growth of adventitious roots
 - Falling of fruits and leaves
 - Ripening of fruits
- In agriculture and horticulture synthetic hormones are used to acquire following results.
 - To induce root formation in cuttings
 - To produce flowers or fruits as required
 - To preserve cut flowers and leaves
 - Accelerate ripening of fruits
 - As synthetic pesticides (e.g.; MCPA, 2, 4 –D)
 - To increase the rate of cell division and growth rate of tissues in tissue culture.

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| <ul style="list-style-type: none">• Some examples for synthetic auxins are Indole Buteric Acid (IBA) and Naphthalene Acetic Acid (NAA). |
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(45 minutes)

Criteria for assessment and evaluation

- Explains how plant movements occur as responses to stimuli.
- Accepts that plant growth substances, contribute for the survival of a plant.
- Analyses how plant growth substances can be used to fulfill human needs effectively.
- Builds concepts using definitions .
- Displays the skill of employing environmental phenomena in a constructive manner.

Annex 1.4.1

The way of reaping the whole pineapple harvest at the same time.

The instructions given by our agriculture instructor regarding my pineapple plantation turned out absolutely correct . These were the important facts he mentioned on that day.

"Your pineapple plantation has been growing well. It has been treated and fertilized at the correct time. Now your target must be gathering the whole harvest at the same time. For that, you can spray calcium carbide on the surface of the soil, close to the roots in correct proportions.

The process that takes place can be described as follows,

Calcium carbide reacts with water and releases acetylene gas, which acts as an artificial hormone and induces flowering of all pineapple plants. Afterwards by maintaining your plantation properly you can reap the whole harvest at the same time".

Instructions for group exploration

Have you noticed the movements of plants ?

- Pay your attention towards the given types of plant movement.
 - Tropic
 - Nastic
- Conduct a discussion to reveal details about the type of plant movements by referring to text book.
- Collect information regarding the contribution of the particular plant movement towards the existence of the plant
- From the incidents given below select the type of plant movement assigned to you and describe the way response occurs according to the stimuli.

- Sleeping (shrinking) of *Mimosa* leaves when touched against foot.
 - Shrinking of *Sesbania* leaves, when the sun sets.
 - Growing of a chilli plant vertically upwards, when kept horizontally inside a box.
 - The shoot of a croton plant gradually growing out of the window when the plant pot is placed close to the window.
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- With regard to the themes given below highlight the changes that take place in the plants you have selected.
 - Activation of growth substances naturally in plants
 - Application of artificial hormones to plants
 - Get ready to present your findings in an attractive manner.

Competency 2.0 :Investigates on the reproduction of organisms

Competency Level 2.1 :Investigates on how to employ asexual reproduction methods scientifically to maintain the continuity of plants

Activity 2.1 :Let’s grow a plant from another plant

Time :120 minutes

- Quality inputs :**
- Three copies of instructions for explorations given in annex 2.1.1
 - Instructions for the teacher in annex 2.1.2
 - Text book
 - Demy sheets and pastel

Learning -Teaching process :-

- Step 2.1.1:**
- Show the diagrams of grafting and layering methods given in the text book to the class.
 - Conduct a discussion highlighting the following points.

- Grafting and layering are two techniques employed to obtain new plants .
- These methods enable us to produce mature plants in shorter time.
- In horticulture these methods are more productive .
- There are many more methods to obtain new plants.

(15 minutes)

- Step 2.1.2:**
- Divide the class into three groups.
 - Provide each group with instructions for exploration sheets, demy papers and pastel.
 - Assign the tasks and engage them in exploration.
 - Prepare all groups to present their findings to the class.
- (60 minutes)

- Step 2.1.3:**
- Make each group present their findings to the class.
 - Give the first opportunity to the respective group to elaborate on their findings.
 - Allow other groups to propose constructive suggestions.
 - Review highlighting the following points.

- Reproduction is essential for the Survival of a plant species
- Natural and artificial vegetative reproduction are two methods of propagating new plants.
- Natural vegetative reproduction could occur at different parts of a plant.
- Artificial vegetative propagation can be categorized as planting cuttings, layering, grafting and tissue culture.
- Vegetative (asexual) propagation produces daughter plants which are identical to the mother plant.
- Natural vegetative propagation could occur through following methods,
 - Reproduction through buds in leaves – *Bigonia*, *Bryophyllum* (*Akkanapa*), *Epiphyllum oxypetalum* (*Kadupul*)
 - Reproduction by roots – *Aegle marmelos* (*Beli*), Bread fruit, Curry leaves, Valentine plant
 - Runners – Sweet potato, *Centella* (*Gotukola*), *Desmodium triflorum* (*Undupiyaliya*)
 - Underground stems –
 - Rhizomes – Ginger, Turmeric, Banana, *Languas galanga* (*Arattha*), *Canna edulis* (*Buthsarana*)
 - Corms – *Colocasia* (*Habarala*), *Alocasia* (*Gahala*), *Gladiolus* (*Kiri ala*)
 - Stem tubers – Potatoes, *Coleus rotundifolius* (*Innala*)
 - Bulbs – Onions
- Apart from the above methods vegetative propagation occurs by bulbils or axial buds in some plants.
- Advantages of vegetative propagation are;
 - Obtaining daughter plants identical to mother plant
 - Propagating seedless plants like banana and pineapple
 - Harvesting in a short period
- A disadvantage of vegetative propagation is
 - Do not produce new varieties
- Artificial methods of propagation include;
 - Allowing stem cuttings to grow
 - Layering
 - Grafting
 - Tissue and cell culture.

- Layering is when roots are allowed to grow in a branch while still attached to the mother plant.
- A branch close to the ground level or even a higher branch can be used in layering.
- Grafting is done between two plants of the same family or between different varieties of the same species.
- Grafting different varieties of mango plants is a graft between same species, while a graft between wood apple and orange plants is an example for grafting between the same family.
- Grafting is of two types as bud grafting and twig grafting.
- In grafting, the plant fixed to the soil is called the stock and the part that is joined is called the scion.
- The advantages of grafting are as follows.
 - Obtaining daughter plants identical to the plant from which the scion is taken
 - Plant with a strong and healthy root system can be selected as the stock
 - Obtaining harvest in a short time
 - A method of propagation for seedless plant varieties
 - To produce plants resistant to diseases
- In a successful grafting the two cambiums of the stock and scion combine to form a continuous transport tissue system.
- Then the stock and scion combine to form one new plant and starts growing as one unit.
- In tissue culture non reproductive cells or tissues are grown in a culture medium to produce new plants - it is an asexual reproduction method.
- Every living cell in a plant contains a full genetic potential that codes for the inherited potentials of that plant.
- The following conditions should be provided for a tissue culture;
 - A sterile liquid culture medium containing minerals, vitamins and other growth factors needed for a plant
 - An optimum temperature (18- 30°C)
 - Required amount of sunlight
 - Sterile conditions to prevent microorganism growth in the medium

- The steps followed in a tissue culture are;
- Adding a small portion of a plant tissue (Surface should be sterilized)to the sterile culture medium.
- The tissue implanted undergoes mitotic cell divisions to form non specialized group of cells (Callus).
- Then these unspecialized cells are transferred to a growth medium where shoots and roots are formed.
- The tiny, immature plants are grown in a culture medium first and then transferred to pots containing soil medium and grown in a green house.

(45 minutes)

Criteria for assessment and evaluation

- Explains the natural and artificial vegetative propagation in plants using examples.
- Appreciates the advantages of using vegetative parts to produce new plants.
- Discovers different methods suitable for each plant in propagation.
- Uses natural biological processes in a productive manner.
- Uses technical knowledge in essential tasks.

Annex 2.1.1

Instructions for group exploration

Let's grow a plant from another plant

- Focus on natural and artificial vegetative reproduction of the plants assigned to your group.
 - Breadfruit, *Bryophyllum*(Akkapana), Ginger, *Colocasia* (Habarala), *Cyperus rotundus* (Kaladuru), Onion, Jute, *Centella* (Gotukola), Croton, Rubber
 - Curry leaves, *Bigonia*, Banana, *Alocasia* (Gahala), Potato, wild onions, Jute, Sweet potato, Rose, Rambutan.
 - *Aagle marmelos*(Beli), *Bryophyllum* (Akkapana), *Lasia spinosa* (Kohila), *Colocasia* (Habarala), *Coleus rotundifolius* (Innala), Red onions, Pineapple, *Cyperus rotundus* (Kaladuru), Shoe flower, Mango.
- Identify the part used to reproduce in the plants assigned to your group.
- Discuss how a new plant grows from them highlighting the following facts.
 - Providing nutrition for the daughter plant
 - Producing new buds.
 - Surviving unfavourable conditions
- Highlight the advantages and disadvantages of vegetative propagation methods of the plants assigned to you compared to tissue culture.
- Get ready to present your findings to the class.

Instructions for the teacher

- Students are not expected to engage in practicals of layering or grafting. Focusing their attention to the scientific basis of the above methods is sufficient.
- Scientific names are not expected to be remembered by students.
- The plant groups for the exploration is arranged in the order given below. If it is difficult to find any plant it can be substituted with a suitable plant found in the locality.
- Vegetative propagation of plants by using:
 - Roots
 - Leaves
 - Rhizomes
 - Corms
 - Stem tubers
 - Bulbs
 - Bulbils
 - Runners
 - Cuttings
 - Grafting

Competency 2.0 :Investigates on the reproduction of organisms

Competency Level 2.2 :Investigates on how to employ sexual reproduction methods scientifically to maintain the continuity of plants

Activity 2.2 :Let’s investigate sexual reproduction of plants

Time - :120 minutes

Quality inputs :

- The dialogue named “How do seeds germinate” in annex 2.2.1
- Four copies of instructions for exploration in annex 2.2.2
- Text book
- Demy sheets and pastel
- Experimental set up (germinating green gram)

Learning - Teaching process :-

Step 2.2.1:

- Get students to present the dialogue along with the experimental set up.
- Conduct a discussion highlighting the following points.

- Green gram plants producing a new plant by seeds is a way of sexual reproduction.
- If observed for 7 days the different stages of growth could be seen in germinating “green gram” seeds.
- In some plants fruits grow without forming seeds.
- This process is known as parthenogenesis.
- Sexual reproduction via seeds is a complex process.

(15 minutes)

Step 2.2.2:

- Divide the class into four groups.
- Provide each group with demy, pastel and copies of instructions for exploration.
- Assign the tasks and engage the groups in exploration.
- Prepare all groups to present their findings to the class.

(60 minutes)

Step 2.2.3:

- Make each group present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- Sexual reproduction is necessary for the survival of plants.
- The flower is the organ of sexual reproduction .
- A flower consists of the following parts;
 - Stalk
 - Calyx
 - Petals
 - Androecium
 - Gynoecium
- Gynoecium of a flower consists of stigma, style and ovary.
- The androecium or the stamen consists of anther and filament (stalk).
- Flowers with only a gynoecium or an androecium are known as unisexual flowers.
- Some examples for unisexual flowers are bitter guard, pumpkin, coconut flowers.
- When both the gynoecium and androecium are present in one flower it is a bisexual flower.
- Some examples are shoe flower, passion fruit, chilli and lime flowers.
- There are a large number of pollen grains in an anther.
- Pollination is when pollen grains from one flower falls on the stigma of the same or different flower.
- Wind, animals and water are the pollinating agents.
- Flowers pollinated by animals show the following adaptations
 - Odour
 - Colorful flowers
 - Presence of nectar
 - Sticky and large pollen
 - When the corolla is small they combine to form an inflorescence.
- Some examples for plants pollinated by animals are *Thunbergia*, *Sesbenia*(Katurumurunga), Winged beans, lady's fingers (okra) and passion fruit
- Flowers pollinated by wind show the following adaptations
 - Light and small pollen
 - Producing large numbers of pollen
 - Branched or feathery stigma
 - Flowers occurring at the top of the plant

- Some examples for flowers pollinated by wind are coconut, corn, grasses etc.
- *Vallisnaria* is an example for a plant pollinated by water.
- There are two types of pollination as self pollination and cross pollination .
- Self pollination is when mature pollen from a flower falls on the stigma of the same flower.
- Cross pollination is when mature pollen from any flower falls on the stigma of another flower belonging to the same species.
- Flowers show the following adaptations to prevent self pollination while promoting cross pollination.
 - Having unisexual flowers
 - Androecium and gynoecium maturing at different times
 - Androecium and stigma at two different levels.
 - Having stamens and stigma facing away from each other.
 - Self sterility – Stigma being sterile to pollen from the same flowers
 - Because of cross pollination inherited characters mix producing variations.
 - A mature pollen grain coming out from an anther consists of the following parts;
 - A thin inner membrane and a rough outer membrane
 - Cytoplasm containing a generative nucleus and a tube nucleus
- When a pollen grain falls on a mature receptive stigma it germinates.
- The tough outer membrane ruptures and the inner membrane grows into a pollen tube.
- The pollen tube grows towards the ovules in the ovary through the style.
- Fertilization occurs when the male gamete cell fuses with a female gamete in the ovary.
- The fertilized cell is known as a zygote and develops to form an embryo.
- After fertilization the flower undergoes the following changes.
 - Ovules become seeds

- Ovary becomes a fruit
- Outer cells of the ovules become seed coats
- Ovarian wall becomes the outer walls of the fruit
- Generally anther, style, stamen, sepals and petals wither off
- In some plants like brinjal, mangosteen the sepals do not wither and fall but stay on
- After fertilization when the embryo does not develop properly it produces a fruit with non viable seeds
- When seeds start growing into a plant it is known as germination of seeds
- For proper germination the following factors are essential
 - Viability of the seed
 - Proper temperature
 - Water
 - Air
- If a seed does not germinate even when all the essential factors are present it is known as seed dormancy
- Seed dormancy could be due to;
 - Immature embryo
 - Seed coat being impermeable to water or O₂ gas
- When water penetrates a germinating seed the volume of the seed increases.
- Water activates the enzymes in seed leaves and complex molecules of food are digested into simple molecules.
- This food is used for the growth of radicle and plumule.

(45 minutes)

Criteria for assessment and evaluation

- Explains the sexual reproduction process in angiosperms
- Elaborates the importance of sexual reproduction in plants for their sustainability
- Shows concern for natural ecological interactions
- Demonstrates different stages of sexual reproduction in plants
- Discovers facts through explorations.

Annex 2.2.1

How do seeds germinate ?

- Chamari - Aruna, show me the experimental set up.
- Aruna :- Here, come and see. I have germinated Mung (Green Gram) seeds for several days. Here are the different stages of germination.
- Chamari :- Do you know that there are some fruits without seeds? Dont they produce new plants?
- Aruna:- Yes, fruits like pineapple and breadfruit do not have seeds, These fruits cannot produce new plants because they are unfertilized ovules grown into fruits. This process is known as parthenogenesis.
- Chamari:- That is true. Those plants propagate by their vegetative parts like new bread fruit plants growing from the roots of its parent plants.
- Aruna:- Do you know that it is possible to induce parthenogenesis using synthetic hormones? Seedless fruits of papaw, grapes, oranges and tomatoes are some such example.
- Note :- Begin preparing the experimental set up 7 days before this activity by following these steps.

Line a glass vessel with a white sheet of paper and fill the vessel with wet soil. For 7 days place one soaked Mung seed each along the wall between the white sheet and the glass at the same height (Use an ekel to push the seed in)

Annex 2.2.2

Instructions for group exploration

Let's find out about sexual reproduction in plants

- Focus your attention to the flower assigned to your group from the following list.
 - Passion fruit flower
 - Jasmine flower
 - Lotus flower
 - Coconut flower
- Compare the morphology of the flower given to you with a typical flower
- Discuss the following factors regarding your flower
 - Pollinating agent
 - Method of pollination
 - Adaptations for pollination
- Express your ideas about fertilization, fruit and seed formation of the flower.
- Be prepared to present your findings creatively.

Competency 2.0 :Investigates on the reproduction of organisms

Competency Level 2.3 :Examines the significance of reproduction in maintaining the continuity of humans

Activity 2.3: : Let's explore the structure and functions of human reproductive system

Time : :120 minutes

Quality inputs :

- The television discussion given in annex 2.3.1
- Three copies of instructions for exploration included as annex 2.3.2
- Demy sheets and pastel

Learning - Teaching process :-

Step 2.3.1:

- Get students to present the discussion to the class.
- Conduct a discussion highlighting the following facts.

- | |
|--|
| <ul style="list-style-type: none">• Reproduction is the process for continuity of life . . .• Awareness of scientific facts about human reproduction is essential . |
|--|

(15 minutes)

Step 2.3.2:

- Divide the class into three groups.
- Provide each group with demy, pastel and copies of instructions for exploration.
- Assign the tasks and engage the groups in exploration.
- Prepare all groups to present their findings to the class.

(60 minutes)

Step 2.2.3:

- Make each group present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- | |
|--|
| <ul style="list-style-type: none">• Human beings are unisexual organisms, therefore males have a male reproductive system only, while females have female reproductive system.• The main functions of a female reproductive system are producing ova, carrying a foetus and delivering it.• Ovaries, fallopian tubes, uterus, and vagina are the main parts of the female reproductive system. |
|--|

- Main functions of male reproductive system are producing sperms and ejecting them into the female reproductive system.
- Scrotum, testis , spermatic duct , urino genital duct and penis are the main parts of the male reproductive system.
- Sperms are produced in testis in males, while ova are produced in ovaries of a female.
- The hormone testosterone is responsible for controlling secondary male sexual characters and sperm production.
- Sperms are produced in seminiferous tubules in the testis as a result of many cell divisions.
- A sperm consists of a head, body and a tail and is a motile cell.
- Once produced in the testis sperms are temporarily stored until ejaculated by sexual arousal or involuntarily via the spermatic ducts and the urino- genital duct.
- Sperms released into the vagina swim through the uterus and enter the fallopian tubes.
- The chromosomes in the nucleus of the sperm head carry the inherited paternal characters to the offspring.
- As a result of cell divisions in the ovaries ova are produced
- Ovum is a spherical structure surrounded by a membrane.
- The nucleus of ova holds the chromosomes that are responsible for inheriting maternal characters to the offspring.
- Although sperms are produced and matured regularly, production, maturation and release of ova occurs in a cycle.
- Along with the secondary sexual character changes that occur at puberty the first menstruation of a girl is known as attaining age.(menarche)
- Hormones oestrogen and progesterone control the onset of secondary sexual characters and maintain them and also regulate the menstrual cycles in a female.
- The mechanism of a menstrual cycle which usually occurs once in 28 days could be summarized as follows
 - Decrease of oestrogen and progesterone levels in blood.
 - Start of menstrual flow – the inner membrane (endometrial) of the uterus breaks up and the tissues move out with the blood for about 4 days through the vaginal opening.
 - The endometrial tissues start growing again.

- After about 14 days from the previous flow, the levels of oestrogen and progesterone hormones in blood increases.
- An ovum is released from one of the ovaries (ovulation).
- If the ovum is fertilized by a sperm in the fallopian tubes it gets implanted in the uterine wall.
- After the implantation the concentration of oestrogen and progesterone hormones are maintained at a high level in the blood stream thus preventing menstruation and further ovulation.
- In case of no fertilization the concentration of oestrogen and progesterone drops in the blood stream causing menstruation flow after 14 days from ovulation.
- Starting from the first day of menstrual blood flow another cycle starts and the process repeats but ovulation occurs from the other ovary this time.
- At rare occasions both the ovaries could ovulate or more than one ovum could be released and if fertilized produce non identical twins.
- If the zygote is separated into two halves and is implanted in the uterus identical twins will develop.
- Pregnancy could be confirmed by a urine test once the embryo starts growing.
- The developing embryo is connected to the uterine wall by placenta.
- Only certain materials are exchanged through the placenta between the mother and the foetus.
- Maternal blood and foetal blood do not mix.
- The growing foetus is enclosed in a fluid filled sac which develops along with the foetus.
- The embryo is known as a foetus when it is 3 months old and has all the basic parts of a human body.
- The cord that connects the foetus to the placenta is the umbilical cord.
- The gestation period is approximately 40 weeks.
- When the time comes to deliver the baby, oxytocin hormone is secreted which causes a series of strong and rigorous contractions of the uterine wall forcing the foetus out from the cervical opening.
- At the second stage the placenta and other tissues connected to it are forced out through the vaginal opening .

- Right after the delivery the hormones prolactin and oxytocin stimulates the production and secretion of breast milk respectively.
- Once the foetus is delivered, the concentration of oestrogen and progesterone in maternal blood stream falls back to the normal levels and menstrual cycles could start again.
- When a woman reaches the age of 45-50 her menstruation cycles stops. It is known as menopause.
- Gonorrhoea, syphilis and AIDS are some of the sexually transmitted diseases.
- Gonorrhoea is caused by the bacteria species *Neisseria gonorrhoea*.
- Gonorrhoea is transmitted sexually or from mother to foetus.
- Males affected by Gonorrhoea show symptoms such as light yellow discharge from the penis, need to urinate often, burning sensation during urination and could even lead to infertility.
- Symptoms shown by females are a yellowish discharge from the vagina, abdominal pain, irregular menstruation, burning sensation during urination, need to urinate often, discharge from the anus and even sterility because of blocked fallopian tubes.
- Most of the females do not show any outward symptoms but are carriers of the disease.
- An infant born to a Gonorrhoea affected mother could go blind if the vaginal discharge comes into contact with the infant's eyes during the delivery.
- Syphilis is caused by the bacteria species *Triponema pallidum*.
- Disease is transmitted by sexual interactions with an infected person, blood transfusion and from an infected mother to her foetus.
- Symptoms occur at three different stages.

- In the primary stage, sores appear around the infected sex organs and mouth.
- Several weeks later the secondary stage occurs. Skin rashes, head ache, fever, and pain in joints, inflammation of lymph nodes are the symptoms.
- If proper treatment is not received at these stages the person acts as a carrier of the disease although no visible symptoms are present .
- In third stage nervous system and heart could be damaged.
- The foetus of an infected mother could be severely affected causing an abortion or a still birth.
- AIDS is caused by Human Immuno Deficiency Virus.(HIV)
- HIV could be infected by sexual intercourse with an infected person ,transfusion of blood and blood related fluids, unsterilized injection needles and also from an infected mother to her foetus or to the infant while giving birth or by breast milk.
- HIV attacks the immune system so the natural immunity is impaired, and the patient is easily susceptible to other diseases
- Symptoms of AIDS are prolonged diarrhoea, fatigue, loss of weight , heavy breathing,cough for long periods and enlargement of lymph nodes.
- Sexually transmitted diseases can be prevented by correct attitudes, responsible and sensible sexual behavior and avoiding unnecessary risks in matters concerning your health.

(45 minutes)

Criteria for assessment and evaluation

- Explains the structure and functions of male and female reproductive systems.
- Accepts that each reproductive system is adapted to match each other and to perform its functions efficiently in producing a child.
- Presents male and female reproductive systems by diagrams.
- Shows concern towards biological processes.
- Shows the ability to behave responsibly according to the gender.

Television talk show

Presentator - Yes, now we welcome our honoured guest, specialist doctor in obstetrics and gynecology. We are here to create awareness among adolescents about reproductive health.

Pre :- Doctor, let's start by explaining how important it is to educate our school children about reproductive health.

Doctor - Yes, it has become a necessary requirement to educate our young generation about the correct and scientific facts of reproduction. Perhaps you already know that reproduction is the natural process of ensuring the survival of all organisms including humans.

Presentator - Do we have to learn about the reproductive systems also?

Dr. - Certainly, the male and female reproductive systems should be taught separately with the functions of each part, because if they do not know the truth and the scientific facts they will easily be misguided and get into all sorts of trouble. Especially because our culture does not encourage children to discuss their doubts about reproduction with adults, it is our responsibility to teach all the necessary and important facts in our science lessons.

Presentator - Diseases related to the reproductive system has become a challenge now. I think we should discuss about this also.

Dr. Of course, our children must be well aware of their body functions and face the challenges from the internal and external environments wisely. Then they will be strong enough to face sex related physical and psychological problems and also avoid sexually transmitted diseases. The most important fact in today's discussion is this . Human reproduction has been included in the science syllabus with two aims. One is to make sure our children grow up as healthy citizens. The second aim is to see them become wise parents who contribute towards the social well-being.

Instructions for group exploration

Let's explore the structure and functions of human reproductive system

- Focus your attention to the part assigned to your group from the process of delivering a healthy infant starting from a gamete. The topics are;
 - The whole process occurring in a female reproductive system when fertilization does not occur.
 - The whole process within a male reproductive system.
 - The full process of foetal development starting from fertilization until delivery.
- Use your text book to clarify the structures and their functions related to your topic.
- Discuss the role of hormones in each process.
- Suggest any deviations from the normal procedure and methods to prevent them.
- Be prepared to present your findings to the class in a creative manner.

Competency 2.0 :Investigates on the reproduction of organisms

Competency Level 2.4 :Investigates the contribution of reproduction in maintaining the continuity of organisms

Activity 2.4: :Lets investigate how cells divide and identify the reproductive method.

Time :120 minutes

Quality inputs :

- The dialogue annexed as 2.4.1
- Two copies of instructions for group explorations annexed as 2.4.2
- Demy paper and pastel

Learning - Teaching process :-

Step 2.4.1

- Get two students to present the discussion to the class.
- Conduct a discussion highlighting the following facts.

- | |
|--|
| <ul style="list-style-type: none">• Organisms reproduce by sexual and asexual reproductive methods.• Both sexual and asexual reproduction contributes to the continuity of life . |
|--|

(15 minutes)

Step 2.4.2:

- Divide the class into two groups.
- Provide each group with demy, pastel and copies of instructions for exploration.
- Assign the tasks and engage the groups in exploration.
- Prepare all groups to present their findings to the class.

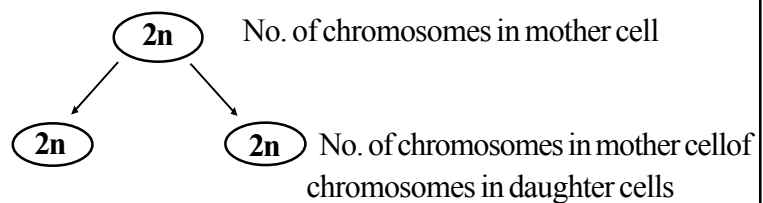
(60 minutes)

Step 2.4.3:

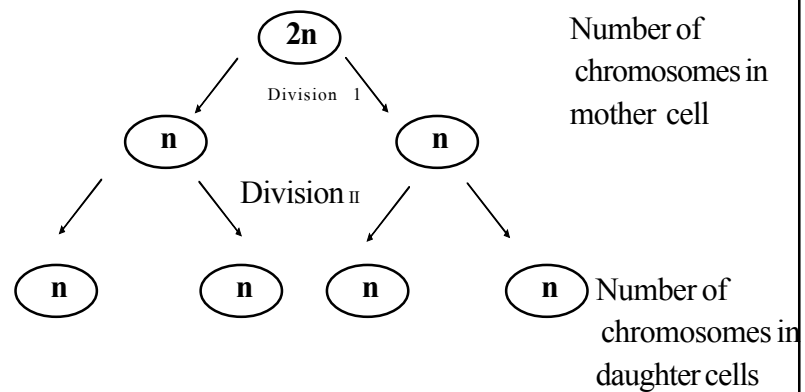
- Make each group present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- | |
|--|
| <ul style="list-style-type: none">• A new cell is formed by the division of an existing cell.• When a cell divides, the nucleus divides first, followed by the cytoplasm. |
|--|

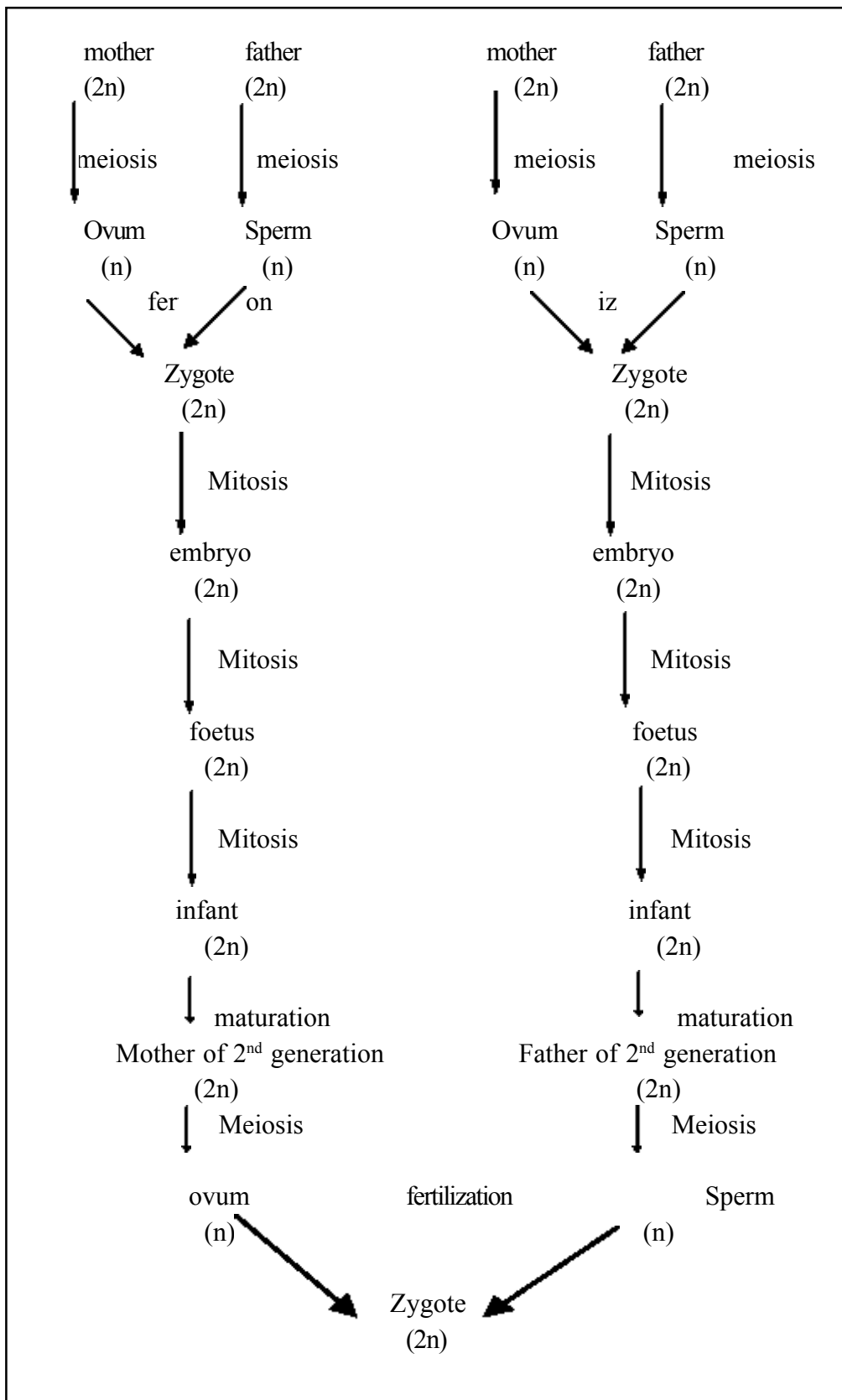
- The number of chromosomes in a cell of an organism is specific to that species.
- There are 23 pairs of chromosomes in a human cell.
- Each pair of chromosomes consists of one chromosome from the father (sperm cell) and one from the mother (ovum)
- A pair of matching chromosomal strands inherited from father and mother are known as a homologous chromosome pair.
- During cell division a nucleus could divide by one of these methods;
 - Mitosis
 - Meiosis
- In mitotic cell division, each daughter cell receives exactly the same number of chromosomes as the mother cell.
- Only two daughter cells are formed at the end of each mitotic division.
- It can be represented as follows;



- In meiosis the homologous pairs in mother cell are separated and divided equally among the two daughter cells. Hence the daughter cells are haploid.
- Each daughter cell receives only half the number of chromosomes in the mother cell.



- An ovum or a sperm contains only half the number of chromosomes of a body (somatic) cell.
- At the end of meiosis four daughter cells are formed, from each parent cell.
- When an ovum (n) is fertilized by a sperm (n) the resulting zygote ($2n$) acquires the full specific number of chromosomes for the species.
- This process can be represented as follows.



- The importance of meiosis could be listed as follows.
 - To maintain the number of chromosomes of a species constant .
 - Creating genetic variations by producing new characters that lead to evolution .
- The importance of mitosis is;
 - Producing somatic (body) cells to form a new organism starting from a single celled zygote
 - Replacing worn out and dying cells
e.g.: – blood cells, epidermal cells of the digestive tract, skin
 - Forming new cells and tissue of a healing wound.
 - Regeneration
e.g. :- when a gecko loses its tail it grows again
 - Producing new organisms by asexual reproduction –
e.g :- *Amoeba*, sponges
- Fast replication of cancer cells is an adverse effect of mitosis
- Sexual and asexual reproduction can be compared as follows.

Sexual	Asexual
<ul style="list-style-type: none"> • A zygote formed by fertilization of an ovum/ female gamete with sperm/male gamete formed by meiosis • Both mitotic and meiotic cell divisions involved • Daughter organisms (progeny) differ from the parents 	<ul style="list-style-type: none"> • No meiotic cell divisions, no gametes formed, no fertilization occurs • Only mitotic cell divisions are involved • Progeny is identical to the mother

- Sexual reproduction increases the variations in each new generation. This increases the chances of survival of the species and also contributes towards evolution.

Criteria for assessment and evaluation

- Explains the contribution of mitotic and meiotic cell divisions in sexual and asexual reproduction.
- Accepts that both sexual and asexual reproduction is essential for the continuity of life.
- Compares meiosis and mitosis.
- Observes the interrelations between biological processes.
- Works cooperatively.

Annex 2.4.1

Wonders of progeny

Beli tree : I am very keen to produce my children. How else am I to make sure the continuity of our kind? Look at my fruit. All those small plants scattered around that area originated from the seeds in a fruit like this. When people eat Beli fruits they throw away the seeds which can germinate.

These seeds germinate, grow and bear flowers, fruits and seeds. They are the results of sexual reproduction.

Cat: Really? When I reproduce I give birth to kittens. That is also sexual reproduction. Have a look at my children, they are of different colours and of course, they are different in behavior.

Beli Tree: So are my children growing from my seeds. I am sure some of them are better adjusted to the environment than me. That's not all. Listen to this. If you fail to produce kittens you cannot continue your generation, but I have another method to ensure survival of my genes if all my flowers are withered. See all these small beli plants around me; they also are my children, originating from my roots. They share identical characters with me, because they are a products of asexual reproduction.

Instructions for group exploration

Let's investigate how cells divide and identify the method of reproduction

- Focus your attention to the topic allocated to your group from the following
 - Mitotic cell division
 - Meiotic cell division
- Collect data about the relevant topic using your text book
- Expand your findings under these sub topics
 - number of daughter cells
 - number of chromosomes in the nucleus of a daughter cell
 - time taken for a cell division
- Use diagrams whenever possible
- Highlight the places where the particular type of cell division can be seen in organisms .
- Discuss the contribution of the particular division method for the continuity of life.
- Prepare to present your findings creatively to the class.

Competency 3.0 :Investigates the mutual relationship between organisms and the environment.

Competency Level 3.1 : Analyses the environment biologically

Activity 3.1 :Let’s observe the environment from a scientific point of view

Time :120 minutes

Quality inputs :

- The story about the "Polar bear and brown bear" in annex 3.1.1
- Three copies of instructions for exploration given in annex 3.1.2
- Instructions for the teacher given in annex 3.1.3
- Demy paper and pastel.

Learning - Teaching process :-

Step 3.1.1

- Get two students to present the story to the class.
- Conduct a discussion highlighting the following points.

- A single organism in the environment is known as an individual.
- A species is defined as a collection of individuals that share more similarities but also show differences and are able to produce fertile offspring by interbreeding.
- The story about the polar bear and brown bear is an exception from the common definition.
- Some species are spread all around the world.
- Some species are limited to one country or a small geographical region.

(15 minutes)

Step 3.1.2:

- Divide the class into three groups.
- Provide each group with instruction sheets, demy paper, pastel and engage them in exploration.
- Prepare all groups for a presentation.

(60 minutes)

Step 3.1.3

- Get each group to present their findings.
- Give the first opportunity to the respective group to elaborate on their findings.
- Let other groups propose constructive suggestions.
- Review highlighting the following points.

- A single organism of a species is an individual.
- A population is a group of individuals of one species living in a specific area at a specific time.
- Population density depend on the number of births, deaths, arrivals and departures.
- Population density can change with time.
- A community is a collection of all interacting populations living in a specific area .
- Predation is one organism preying on another living organism.
- When one individual directly absorbs its nutritional needs from another living individual of a different species it is called parasitism.
- In mutualism both participating species benefit.
- The relationship which benefits one organism but does not harm or benefit the other is called commensalism.
- An ecosystem is all the living communities and the interacting non living abiotic environment in a particular area.
- Natural ecosystem as well as artificial ecosystem have been identified.
- The whole area of earth where living organisms can exist is called the biosphere.

(45 minutes)

Criteria for Assessment and evaluation

- Illustrates the different levels of organization in the Biosphere.
- Accepts the importance of interrelations between organisms for maintaining the balance in the environment.
- Builds up on the different kinds of interrelations in an ecosystem.
- Displays awareness of the changes in the environment.
- Arrives at the totality through studying basics.

Polar bear and Brown bear

Announcer : Sir, recently our customs officers have raided a batch of an endemic species of fish known as "Ruby barb" when attempting to export illegally.

Will you please explain to us what is a species ?

Prof : There are millions of species in the world. Scientifically a species is a group of individuals who share many similar characters but also have some differences. They are able to produce fertile offspring through interbreeding.

Announcer : What do you mean by fertile offspring?

Prof: A fertile offspring is an organism capable of breeding to ensure the continuation of its species.

Announcer : So, what you are saying is fertile offsprings are produced only when interbreeding occurs among the same species.

Prof : Mm..... yes, but there is a rare instance when a fertile offering was produced by interbreeding between two closely related species.

Announcer : Oh! Could you please tell us the details?

Prof : At the Washington zoo interbreeding between an Alaskan brown bear and a polar bear produced a fertile bear cub. However, we follow certain criteria to make our studies of the environment easy. Nature is not bound to follow our criteria. That is why we sometimes come



across deviations, So we must keep our minds open, and study all these situations when learning science.

Annex 3.1.2

Instructions for group exploration

Let's observe the environment from a scientific point of view

- Focus your attention on the topic assigned to your group.
 - Terrestrial ecosystem
 - Aquatic ecosystem
 - Synthetic (man made) ecosystem
- Identify the interrelationship between the different organization levels of the Bio-sphere.
- From the ecosystem assigned to you , prepare a list of interrelationships under the following topics.
 - Individuals
 - Number of individuals in a population/ number of populations
 - Communities
 - Predation, parasitism, competition, commensalism.
- Get ready to present your findings in an attractive way.

Annex 3.1.3

Instructions for the teacher

- When assigning ecosystems you may choose one of the examples given below or any other ecosystem similar to them.
 - Terrestrial ecosystem - garden, grass land , forest
 - Aquatic ecosystem – tank (wewa), pond, marshy land, fish tank
 - Man made ecosystem - paddy field, chena,a flower bed, park etc.

Competency 3.0 :Investigates on the mutual relationships between organisms and the environment

Competency Level 3.2 :Contributes to maintain the balance of ecosystems.

Activity 3.2: :Let's protect the balance of the environment through scientific observations

Time :120 minutes

Quality inputs :

- The advertisement "space garden" annexed as 3.2.1
- Two copies of the instructions for exploration given in annex 3.2.2
- Text book
- Pastel and demy sheets

Learning -Teaching process :-

Step 3.2.1

- Get a student to present the advertisement "The space garden" to the class.
- Ask the students whether they would like to spend a holiday in a space centre.
- Conduct a discussion highlighting the following points.

- All organisms on earth belong to an ecosystem.
- An ecosystem is a collection of living communities interacting with the abiotic environment around them.
- A space station cannot be considered as an ecosystem due to following reasons.
 - Non availability of environment factors favourable for living organisms naturally.
 - Non existance of a stabilized community of biotic organisms.
 - No cyclic circulation of materials.
 - No interactions between the living and the environment.
- For the proper balance of an ecosystem there should be regular interactions between living components ,non living components as well as between living and non - living components.

(15 minutes)

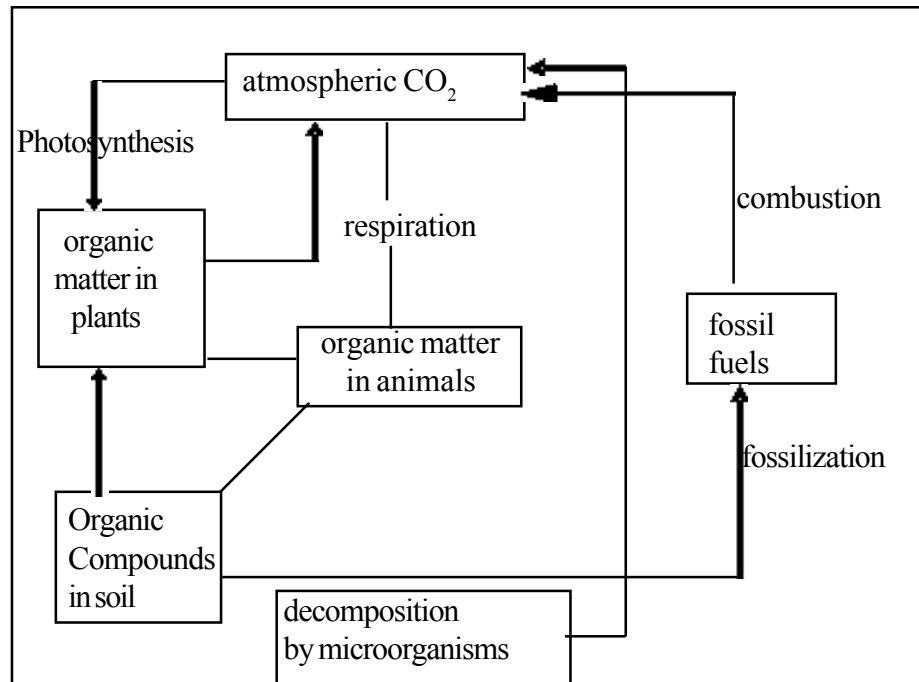
Step 3.2.2:

- Divide the class into two groups.
 - Provide each group with instructions for exploration
 - Pastel and demy papers .
 - Assign the tasks and engage the groups in exploration.
 - Prepare the groups to present their findings to the class.
- (60 minutes)

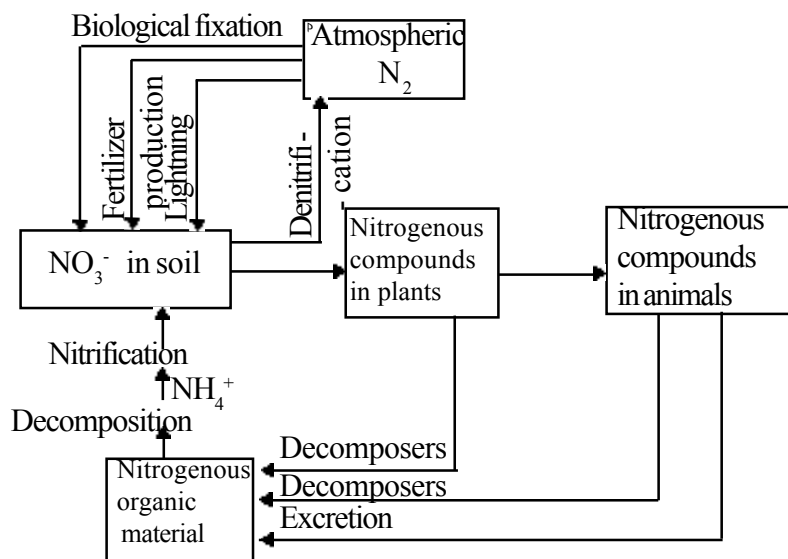
Step 3.2.3:

- Make each group present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- Energy is essential for the existence of an ecosystem.
- Sun is the principle energy source of all ecosystems on earth.
- The energy flow through an ecosystem can be explained as follows.
 - Green plants (Producers) produce food using sunlight and raw materials from the environment.
 - The energy stored in that food passes through different levels of consumers through food chains and food webs.
 - When energy is transformed from one link to the other of a food chain 90% of energy is released to the environment (energy dissipation).
- The energy flow through an ecosystem can be represented by an energy pyramid.
- Living organisms obtain raw materials needed for daily needs from the abiotic environment.
- Raw materials in the environment are limited.
- Therefore, these substances should be released back to the environment by some cyclic process.
- Microorganisms play a very important role in these cyclic decomposing processes.
- In an ecosystem oxygen, carbon and nitrogen are the main elements undergoing these cyclic processes.
- Green plants play a major role in oxygen and carbon cycles.
- The only process that absorbs CO_2 from the environment and releases O_2 into the environment is photosynthesis.
- The cyclic movement of carbon in the environment can be represented as follows.



- Man affects the carbon cycle by adding non degradable organic matter to the environment.
- Some examples for non degradable materials are polythene, polystyrene (Rigiform) & pesticides like aldrin, dieldrin & toxafin.
- During fossilization of organic matter in soil, following changes occur.
 - formation of organic deposits in the sea
 - decomposition of these materials by microorganisms under anaerobic conditions
 - after millions of years under high pressure and temperature organic matter become hydrocarbons
- The nitrogen cycle can be represented as followed.



- Although 78% of the atmosphere is N_2 by volume, most organisms cannot consume Nitrogen as N_2 gas.
- Only a few varieties of bacteria can convert atmospheric N_2 into nitrogenous compounds in their body.
- That is known as biological Nitrogen fixation.
- Microorganisms play a very important role in these cyclic decomposing processes.
- Some bacterial species can convert NO_3^- ions in the soil to N_2 gas in the atmosphere.
- This process is known as denitrification..
- Decomposers in soil convert the Nitrogen in organic matter into Ammonium (NH_4^+) ions and it is called nitrification.
- A few bacterial species can convert NH_4^+ ions into NO_3^- ions. It is called nitrification.
- Plants can absorb nitrogen in the forms of NH_4^+ and NO_3^-
 - Some human activities that affects the balance of nitrogen cycle can be given as,
 - disposing non degradable waste material to the environment.
 - using synthetic nitrogen fertilizers
 - adding substances harmful for the microorganisms in soil.
 - creating conditions unfavourable for microorganisms.

(45 minutes)

Criteria for assesment and evaluation

- Explains the role of biotic and abiotic factors in maintaining the balance of an ecosystem.
- Accepts that unwise interferences into ecological balance could be catastrophic.
- Creates models to represent natural processes in a balanced ecosystem.
- Builds connections using the data given .
- Discovers the scientific background of natural phenomena.

Annex 3.2.1

'The space station'

This is a radio advertisement created to attract people to spend a holiday in a space station.

Wherever you live in planet earth it's definitely bound to be a polluted ecosystem. In addition, it's a busy world ... a society filled with tension ... depreciating aesthetic value...

Do you feel there is no place on earth left for you to spend your holiday in relaxation and restfully?

Here is a great opportunity for you! Come visit our space station.

Enjoy a blissful holiday in our resort with ample oxygen, suitable food, sports activities and artificial lighting systems, comfortable rooms.

Everyone will get a special space suit to wear as long as you are in the station. Experience the amazing environment. So hurry up make your bookings right now.

Annex 3.2.2

Instructions for group exploration

Let's protect the balance of the environment through scientific observations

- Focus your attention to the process assigned to your group which is related to maintaining the balance of an ecosystem.
 - Energy flow through an ecosystem
 - Circulation of elements in an ecosystem
- Collect data relevant to your topic from the text book
- Highlight the interactions of biotic and abiotic factors in an ecosystem regarding your topic.
- Build a model/chart by arranging the relationships in the proper order.
- Identify the human activities which disturb the process and their adverse effects.
- Suggest suitable remedies to minimize the damages .
- Prepare to present your findings to the class in a creative manner.

Competency 3.0 :Investigates on the natural relationships between organisms and the environment.

Competency Level 3.3 :Uses strategies to minimize harmful effects on the existence of biosphere

Activity 3.3: :Let's protect the environment, protect the world

Time :120 minutes

Quality inputs :

- The poem ‘ A smile through tears’ annexed as 3.3.1
- Three copies of the 'Instructions for explorations sheet'
- Text book
- Pastel and demy sheets

Learning - Teaching process :-

Step 3.3.1

- Get a student to recite the poem to the class.
- Inquire about the habitats of the baby elephant mentioned in the poem.
- Conduct a brain storming session highlighting the following points.
 - Animals are in danger because of some human activities.
 - It is very important to employ strategies to conserve animals to protect bio diversity.
 - Conservation can be *in-situ* or *ex-situ* .
 - In-situ conservation is conservation of organisms in their natural habitats, for example;
 - Sanctuaries
 - Highly protected natural reserves
 - Natural reserves
 - National Parks
 - *Ex-situ* conservation is protecting the organisms in some other protected environment other than their natural habitats; some examples are zoo, botanical gardens,herbarium, animal protection centres.
 - *Ex-situ* conservation is needed to protect the organisms facing extinction due to changes in their natural habitats.

(15 minutes)

Step 3.3.2:

- Divide the class into three groups.
- Provide each group with a sheet of paper, pastel and instructions for explorations.
- Assign tasks and engage the groups in exploration.
- Prepare them to present their findings to the class.

(60 minutes)

Step 3.3.3:

- Get each group to present their findings to the class.
- Give the first opportunity to the same group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- Human activities could bring about harmful effects on environmental balance.
- Population growth, deforestation, irrigation based agriculture, urbanization & industrialization are some such activities.
- Environmental pollution could be categorized under three groups as air pollution, water pollution and soil pollution.
- Because of environmental pollution the whole earth faces an environmental crisis.
- Some of them are global warming, acid rains, depletion of the ozone layer, desertification, depletion of biodiversity and eutrophication.
- Several strategies are employed to minimize environmental pollution.
- Conservation of biodiversity raising community awareness, acts and protocols and laws on conservation of environment are some such attempts.
- The motto of environmental conservation should be 'Think globally act locally'.

(45 minutes)

Criteria for assessment and evaluation

- Explains the harmful effects of human interference in ecological balance.
- Shows sensitivity towards environmental conservation.
- Plans actions to minimize environmental crisis.
- Suggests sustainable development strategies.
- Contributes to solve global issues.

‘Smile through tears’

While crossing the rail track
wrapped in my mother's warmth
A fuming train appeared from nowhere crushing her head.
but, she didnot forget her little son
still, the memory looms large in my mind
drawing me to her with her trunk,
Embracing me and breathing her last
Alone in the forest so beautiful
But not for too long.
For the loving humans came along
Offering me their warmth
" Ath Athuru Sevena" at Udawalave
was a true refuge for me
Feeding, bathing and protecting me from danger
Making me a pachyderm big and strong.
They will release me
To my own forest where I belong
I raise my head
And look
At the jungle, with past memories
I feel some happiness.
That no father or mother
No more will get killed by trains
for , we the giants on earth
To make us safe, in our own land
Our human friends
Have made fences, barricades,
Made laws
Today we are safe in our own land

Instructions for exploration

Let's protect the environment to protect the world

- From the topics related to environmental pollution focus your attention to the topic assigned to your group.
 - Pollution of air
 - Pollution of water
 - Pollution of soil
- Identify the factors responsible for the topic given to you using the text book as a guide.
- Discuss their experiences and knowledge about your topic with your group members.
- Identify the global and local issues concerning your topic.
- Design a strategic plan to overcome the problems caused by the above issues.
e.g: :- creating public awareness through street drama, poster exhibitions
"shramadana" campaigns.
- Get ready to present your findings to the class in a creative manner.

Competency 4.0 :Investigates the contribution of genetic material for the establishment of biodiversity

Competency Level 4.1 :Investigates on the patterns of inheritance of traits in organisms

Activity 4.1 :Let's find the fascinating facts about inherited characters

Time :120 minutes

Quality inputs :

- Flash cards annexed as 4.1.1
- 3 copies of the instructions for explorations annexed as 4.1.2
- 3 copies of the article "Phenotype and genotype" annexed as 4.1.3
- Demy papers and pastels

Learning –Teaching process :-

Step 4.1.1:

- Show the flash cards to the class.
- Conduct a discussion highlighting the following points.

- The incident highlights an instance when a black (coloured) child was born to white parents.
- A hidden character among the parents is expressed through the child.
- This character could have been hidden for several former generations.
- Inherited characters are transformed through generations by chromosomes.
- Genes which are carried by chromosomes are responsible for inheritance of characters.

(15 minutes)

Step 4.1.2:

- Divide the class into three groups.
- Provide each group with demy, pastel and instructions for explorations.
- Assign tasks and engage the groups in exploration.
- Prepare all groups for a presentation.

(60 minutes)

Step 4.1.3:

- Get each group to present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- Mendal used garden pea plants of the species *Pisum sativum* for his experiment.
- He carried out his experiments according to the scientific method giving special attention to the following points
 - Selecting a suitable organism
 - Hybridization of only one character at a time (mono hybridization)
 - Planning simple experiments and recording all the observations continuously and regularly
 - Developing hypothesis based on the observations and rechecking the hypothesis
- Following special characters were considered for selecting garden peas for his experiments.
 - Having contrasting characters
 - Pure line of characters are protected due to occurrence of natural reproduction by self pollination.
 - It was possible to produce seeds by cross pollination
 - They had a short life cycle
 - Hybridized plants produced fertile offspring
 - Seeds were easily germinated
- In heredity the male and female organisms selected for hybridization is known as the parental generation (P).
- Their offspring is known as filial generation (F).
- The first generation of offspring or progeny is F_1 while the second generation is F_2 .
- Chromosomes exist as homologues pairs.
- During the formation of gametes these chromosome pairs separate (segregation) by meiosis.
- Based on his observations, Mendal disclosed the following facts,
 - There are two factors (genes) controlling each contrasting trait (character) of an organism
 - When gametes from these factors separate / segregate and only one factor enters a gamete
 - In a monohybrid, of the morphological ratio between the dominant and recessive traits is 3:1 in the F_2 generation
 - In this F_2 generation the ratio among homozygous dominant pairs heterozygous pairs: homozygous recessive pairs is 1:2:1 and is also known as the genotype ratio

- In human beings a combination of XY chromosomes produce a male and XX chromosomes produce a female

(45 minutes)

Criteria for Assessment and evaluation

- Explains the pattern of heredity using monohybrids.
- Accepts the importance of heredity as a means of biodiversity..
- Discuss the genetic basis of heredity.
- Builds up a whole picture from analyzing the basics.
- Makes learning easy by identifying the patterns.

Annex 4.1.1

Born Black to White Parents

Annex 4.1.2

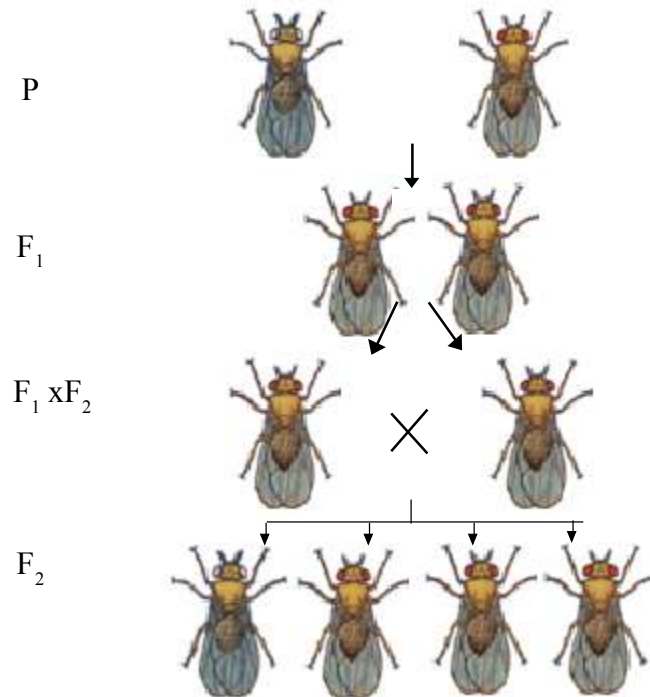
Instructions for group exploration

Let's find the fascinating facts about inherited characters

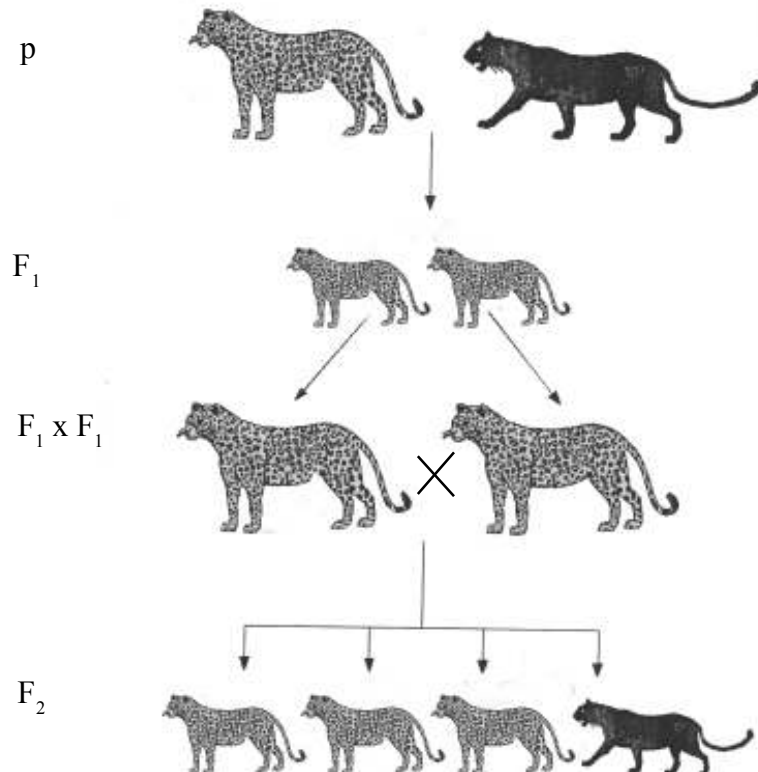
- From the given list of examples for inheritance of characters from generation to generation, select the phenomena assigned to your group.
 - Inheritance of red eyes or white eyes in *Drosophila*
 - Inheritance of spotted skin or dark (black) skin in leopards
 - Inheritance of black or brown skin in rats
- Study the respective chapter in your text book.
- Find out what a phenotype chart and a genotype chart are.
- Select the appropriate phenotype chart from the sheet given to you.
- Compare the Mendelian experiment results with your phenotype chart.
- Prepare the genotype chart relevant to your phenotype chart.
- Try to explain the example given to you under the following themes.
 - Inheritance of characters by chromosomes
 - Homologous chromosome pairs and segregation of chromosomes during meiosis
 - Dominant genes and recessive genes
 - Homozygous and heterozygous genotypes
- Explain how sex determination in humans occurs.
- Prepare to present your findings attractively.

Phenotype and Genotype

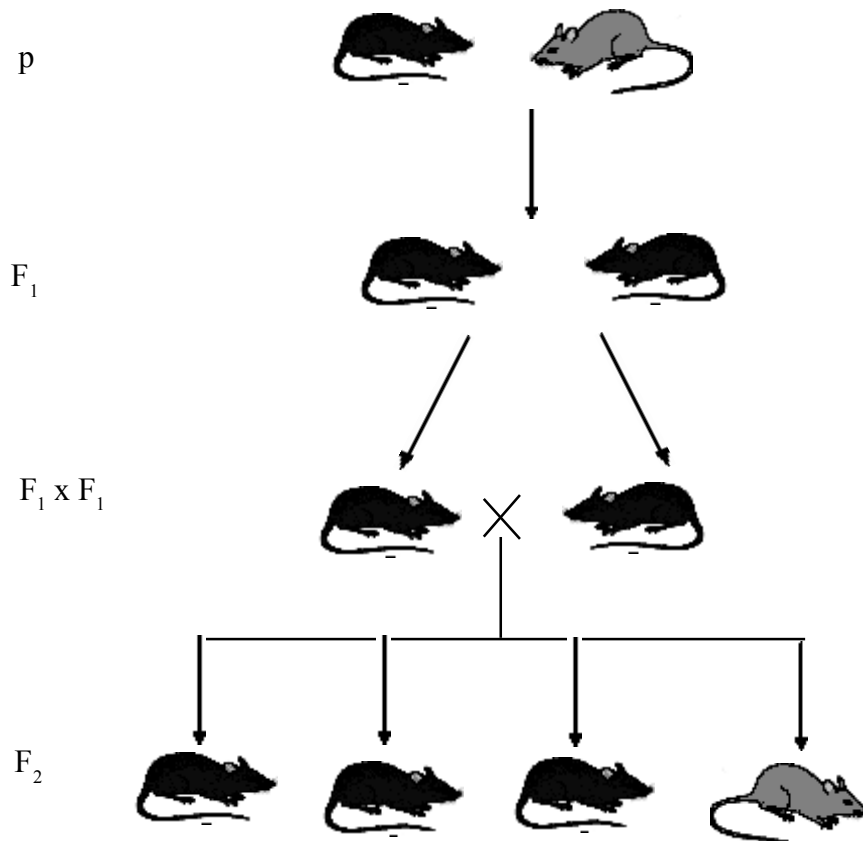
- Phenotype of *Drosophila* – eye colour



- Phenotype of leopard – Skin colour



- Phenotype of mice – Skin colour



- Contrasting traits

The easily detectable morphological differences among the organisms of a species is known as contrasting traits.

e.g ;– tall plants/ short plants, red flowers/ white flowers
smooth seed coats / wrinkled seed coats
in garden peas

- Phenotype

The physical appearance / morphology or external features of an organism with respect to a considered trait .

e.g ;– When considering the height of a plant tall /short are phenotypes
When considering the colour of the flower red / white are phenotypes.

- Genes

The genetic factors responsible for the traits of an organism found in chromosomes.

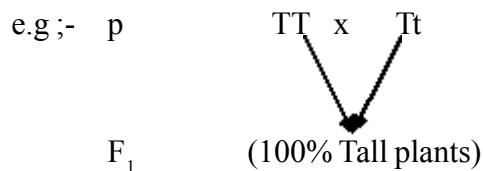
- Genotype

The genetic combination of an organism with respect to a trait considered. Could be expressed using symbols.

e.g ;– Tallness – TT or Tt
Shortness – tt
Red flowers – RR or Rr
White flowers – rr

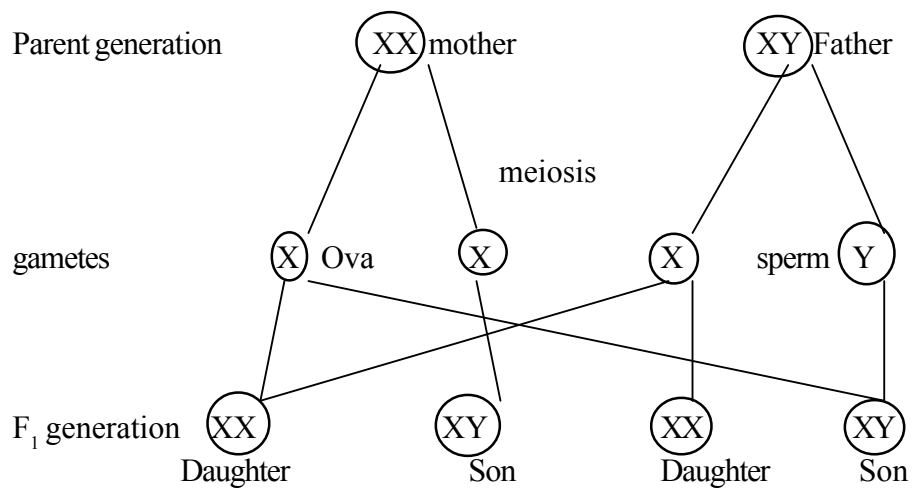
- **Homozygous and heterozygous**
 If the pair of genes (alleles) coding a trait are identical that organism is Homozygous .
 e.g; – (TT/tt, RR/rr)
 If the pair of genes coding a contrasting trait is non identical it is a heterozygous pair.
 e.g :- (Tt/Rr)

- **Dominant trait and dominant gene**
 When an organism is homozygous or heterozygous for a contrasting trait the trait that always appears in the phenotype is the dominant trait . If homozygous both genes are dominant. When heterozygous the gene coding for the phenotype is the dominant gene.



Hence T is the dominant gene, tallness is the dominant trait

- **Recessive trait and recessive gene**
 The phenotype which will appear only when the organism is homozygous for the contrasting trait but will be hidden/ suppressed when heterozygous is the recessive trait. The gene responsible for that phenotype is the recessive gene.
 e.g ;– When the genotype is Tt pea plants were tall but when it was tt the pea plants were short.
 Therefore t is a recessive gene .
 When heterozygous the T gene dominates Therefore T gene suppresses the t gene.
- **Homologous chromosomes**
 In sexual reproduction gametes are formed by meiosis. First the chromosomes in the cell nucleus pair up with its matching partner. It is known as a homologous pair .
 During meiosis these chromosomes segregate (separate) to form two different gamete cells. Each new gamete will have only one set of chromosomes that is only half the number of chromosomes in the maternal cell.
- **Sex determination in humans**
 Human beings have 23 pairs of chromosomes. 22 pairs are somatic and the 23rd pair is known as sex chromosomes. These sex chromosomes could be XX or XY . If XX the outcome is a female but if the pair is XY it is a male. The chart below represents how sex is determined in generations.



Competency 4.0 :Investigates the contribution of genetic material for the establishment of biodiversity

Competency Level 4.2 :Investigates on the significance of genetics to humans

Activity 4.2 :Let's observe the importance of Genetics

Time :120 minutes

- Quality inputs :**
- The flashcard with the names of plant varieties produced from hybridization annexed as 4.2.1
 - 4 copies of the instructions for explorations given in annex 4.2.2
 - Reading material annexed as 4.2.3
 - Demy papers and pastels

Learning – Teaching process :-

Step 4.2.1

- Produce the flash card which contains the names of some hybrid plant varieties to the class.
- Inquire how the names are formed for the varieties.
- Conduct a discussion highlighting the following points.
 - It is possible to obtain organisms with required characters from hybridization.
 - Some examples for improved varieties are tomato, paddy, coconut, chillies and potatoes
 - There are many research centers for plant hybridization.
 - Hybridized plants show following characters;
 - Better yield
 - Resistance to diseases and pests
 - Adaptability to diverse drastic environmental conditions such as aridity, soil with high salinity or marshy lands.
 - High nutrition value and longer keeping qualities (shelf life).
 - The following are the disadvantages of artificial or selective breeding;
 - New varieties could be more vulnerable for some diseases and pests.
 - They might invade the environment.
 - Seeds from hybridized plants might dilute their favorable qualities after a few generations.
 - Therefore to ensure the same favorable qualities every season we may have to use hybridized plant seeds every season.

- Risk of disappearance of wild genes when only selected genes are used for a long time.

(15 minutes)

Step 4.2.2:

- Divide the class into four groups.
- Provide each group with instructions for exploration, the leaflet, Demy and pastel .
- Assign tasks and employ them in exploration.
- Prepare all groups for a presentation.

(60 minutes)

Step 4.2.3:

- Get each group to present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- Inheritance of some hereditary characters cannot be explained by Mendelian patterns.
- Some such examples are gene linkage ,incomplete dominance and mutations.
- There are a large number of genes in a chromosome of any organism.
- Gene linkage occurs when two or more genes are linked on the same chromosome, they are called linked genes.
- Linked genes on X or Y chromosomes are known as sex linked genes.
- Haemophilia and red – green colour blindness are sex linked genes on X chromosomes.
- People suffering from red – green colour blindness cannot differentiate red from green colour.
- The genotype of a person affected by colour blindness could be given as X^cX^c or X^cY .
- The heterozygous genotype X^CX^c acts as carries of the disease.
- Symptoms of haemophilia is the inability to form a blood clot or slow clotting .
- Haemophilia is inherited by a recessive gene linked to X chromosome.
- A haemophilic male will have the genotype X^hY .
- The heterozygous genotype X^HX^h is a carrier female.
- The main symptom of Thalassemia is anemia caused by a defect in hemoglobin.

- Thalassemia is caused by a gene mutation on somatic chromosome responsible for the formation of hemoglobin in blood.
- Recessive homozygous pairing (tt) causes this condition.
- Dominant homozygous (TT) or heterozygous genotypes are healthy.
- But the heterozygous genotype (Tt) are carriers of the disease
- The four 'O' clock flowers (*Mirabilis jalapa*) bear red, white or magenta (pink) coloured flowers.
- Prominent homozygous genotype RR produce red flowers while recessive homozygous (rr) genotype produces white flowers.
- Heterozygous genotype Rr produces magenta (pink) coloured flowers.
- Because the dominant gene (R) is incapable of completely overriding the recessive gene(r).
- This phenomena is known as incomplete dominance.
- The total genetic information bank of an organism is determined by the interaction of all the genes in chromosomes of the respective organism.
- If a quantitative or qualitative change in genetic material of an organism is inherited it is known as a mutation.
- Most mutations are unfavorable
- Mutations could occur spontaneously.
- Some mutations are caused by mutating agents.
- Some such agents are;
 - High energy radiations
 - Certain chemicals
- Mutant genes are mostly recessives and will not be expressed in a heterozygous genotype but could appear after several generations.
- Mutations appear in a phenotype only when it is homozygous for the recessive mutant gene.

(45 minutes)

Criteria for assessment and evaluation

- Explains the instances when hereditary patterns deviates from Mendalian patterns.
- Accepts that marriages between blood relatives increases the risk of inherited diseases
- Analyses the inheritance of hereditary diseases using genotypes.
- Educates other people in the society about reducing the risks of inherited diseases .
- Carries out the given tasks productively by proper preplanning.

Plant varieties

Instructions for the teacher to use the flash card

Flash card

CRIC 65
Bg 406
MI Hot
Tharindu

CRIC 65 : A coconut plant variety which produces a better yield in short time. introduced by the coconut research institute, Lunuwila

Bg 406 :- A variety of improved red rice issued by Batalegoda paddy research centre. Resistant to diseases.

MI Hot :- A chilli variety adapted to low soil water levels, consumable as raw or dried chillies. Introduced by Maha Illupallama agriculture research centre.

Tharindu :-Spherical and red coloured tomato variety with a high yeild . Suitable to cultivate all over Sri Lanka.
You may use varieties suitable for your area.

Instructions for group exploration

Let's observe the importance of genetics

- You are provided with some newspaper cuttings related to genetics.
- Focus your attention to the article assigned to your group among following.
- The headings are;
 - Haemophilia
 - Colour blindness
 - Thalassemia
 - *Mirabilis jalapa* (four o'clock flower)
- Discuss the scientific facts behind the incident discussed in the newspaper article
- Use facts from the text book
- Find other examples relevant to your topic.
- Get ready to present your findings to the class.

Haemophilia

A small boy died of excessive hemorrhage caused by a small injury to the foot from an accident at home. Further investigations carried out by a doctor revealed the following facts.

- His parents have married without a blood-type matching.
- Nobody from the father's side is reported to have symptoms of the disease.
- Some relatives of the maternal side had died of simple injuries.
- Mother or father of the child does not show any symptoms.
- The elder boy or the girls in this family do not have the disease
- There is a 50% chance for the next male baby conceived to inherit this disease.
- There is a probability of 50% of female children in this family to be carriers of the disease and doctor identified the conditions as Haemophilia and explains the scientific background as follows.
- The cause of this condition is a recessive gene linked to the X sex chromosome It is called recessive gene h.
- Sperms or ova could contain X^H or X^h genes according to the genotype of the parents.
- The dead boy should have had X^hY genotype while the elder healthy boy should be of X^HY genotype.
- Daughters of this family could be X^HX^H (healthy) or X^HX^h (healthy-carrier) genotypes.
However the probability factor of a daughter with X^hX^h genotype is extremely rare so far there were none.

Colour blindness

The following facts were found in an article about colour blindness.

- Colour blindness is an inability to differentiate between red and green colours.
- The gene responsible for this colour identification is denoted as C.
- It is linked to X sex chromosome. Females have X^CX^C , X^CX^c , or X^cX^c genotypes while males who have X^CY or X^cY genotypes will show the symptoms.
- Recessive conditions of X^cX^c , or X^cY , genotypes will show the symptoms.
- Heterozygous X^CX^c , genotype are acting as carriers but show no symptoms.
- A marriage between a healthy female (X^CX^C) and a colour blind male (X^cY) will produce
 - healthy male children (sons) and
 - carrier daughters.

- A marriage between a healthy but carrier female (X^cX^c ,) and a colour blind male (X^cY) will produce
 - healthy sons and colour blind sons
 - healthy but carrier daughters and also colour blind daughters
- A marriage between a colour blind female X^cX^c , and a healthy male X^cY will produce
 - Colour blind sons and
 - Healthy but carrier daughters

Thalassemia

The following data is based on a newspaper article regarding the Thalacemia day .

- Certain areas in Sri Lanka have been reported to have a large number of Thalassemia patients.
- Marriage between blood relations are also common in the same areas.
- This disease condition is caused by a mutation in gene of a somatic chromosome. This gene is responsible for coding for Hemoglobin in our blood cells.
- This mutant gene is always recessive.
- Homozygous recessive (tt) caused the disease.
- Homozygous dominant (TT) or heterozygous (Tt) genotypes are not affected by the disease.
- Heterozygous (Tt) genotype acts as carriers.
- Most adults do not show any symptoms.
- Parents with heterozygous genotypes could produce Thalassemic children.
- In a marriage between blood relations if both parents are carriers among their children there may be children with phenotypes.
 - Thalassemic
 - Healthy and
 - Carriers of the disease

Four 'O' clock flowers

A friend gave Shanthi some seeds from a four o'clock flower plant (*Mirabilis jalapa*). The seeds were from a magenta (pink) flower bearing plant. This plant has been obtained by crossing a pure bred white flowered plant with a pure bred red flowered plant.

- The F_1 generation of the cross bred were 100% pink flowers. None were red or white.
- Shanthi's sister who is a grade 11 student explained the above result as follows.
 - If we consider the genotype of red flowers as RR and white flowers as rr,
 - Dominant homozygous condition (RR) produces red flowers.
 - Recessive homozygous (rr) genotype produces white flowers.
 - Heterozygous (Rr) genotype produces pink flowers.
 - When the seeds given to Shanthi were germinated they produced the following phenotypes.
 - Plants with red flowers
 - Plants with white flowers

- Plants with pink flowers.

Competency 4.0 :Investigates the contribution of genetic material for the establishment of biodiversity

Competency Level 4.3 :Examines the factors and process associated with the theory of natural selection

Activity 4.3 :Wonders of Evolution

Time :120 minutes

- Quality inputs :**
- Annex 4.3.1 with the story of " Coelacanth" fish
 - Three copies of instructions for explorations annexed as 4.3.2
 - The Article “Our Battle for Survival” annexed as 4.3.3
 - Text Book
 - Demy papers and pastel

Learning – Teaching process :-

Step 4.3.1: • Get a student to read the story of " Fish coelacanth" to the class.

- Conduct a discussion highlighting on the following factors.
- Coelacanth fish species has survived for about 350 million years without any notable changes.
- This implies that either this fish was so well adapted to long term environmental changes or that the environment it lived did not change much during this time period.
- Organisms undergo constant changes.
- These changes could be external or genetic changes.
- Some changes are favorable while some are unfavorable to the organism.
- Organisms with favorable changes survive better and those with unfavorable changes are eradicated.
- Organisms with favourable characters to overcome environmental challenges will survive.
- Evolution is essential for the survival of organisms.

(15 minutes)

Step 4.3.2:

- Divide the class into three groups.
- Provide each group with instructions for exploration. The article, demy and pastel .
- Assign tasks and employ them in exploration.
- Prepare all groups for a presentation.

(60 minutes)

Step 4.3.3:

- Get each group to present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- The theory of natural selection put forward by Charles Darwin concerning the evolution of organisms is a scientifically accepted theory.
- The Theory of natural selection is based on following principles
 - Over production
 - Competition
 - Natural selection
 - Survival of the fittest
- Over production is when some organisms produce large number of offspring.
- There are many variations among these organisms.
- competition among organisms for food, water, air, living space and reproduction etc controls the number of surviving offspring
- Those who are successful will survive to grow and reproduce while those who fail to fulfill their needs will perish away.
- The survivors are those with more favorable variation for the existing environmental conditions.
- Survival of the fittest is the outcome of successful competition that leaves the organisms with more favorable variations to continue their generations.
- Organisms with unfavorable characters will become extinct.
- This phenomena is known as natural selection.
- In natural selection the environment selects the better suited group of organisms to survive and reproduce.
- Evolution acts on populations and not on individuals.
- Neo Darwinism is the scientific explanation of inheritance of favorable variations through generations using the knowledge of genetics.

(45 minutes)

Criteria for assessment and evaluation

- Explains the principles behind the theory of Evolution by Darwin.
- Appreciates the service rendered by survival of the fittest for the persistence of organisms.
- Highlight on the instance to prove Natural Selection from the given incidents.
- Analyzes incidents from day to day life in different angles to arrive a conclusion
- Gather information from suitable sources .

Annex 4.3.1

Coelacanth speaks to you

Well I am Coelacanth a living fossil. Do you know why? Because I have no difference from my ancient ancestors who lived millions of years ago. Our species has not changed for such a long time. I was first discovered in 1938 in the sea around South Africa by some men. Until then we were considered extinct 70 million years ago. But we are living quietly in the sea at a depth of 200m – 600m.

Most of the other species who shared the space with us in the past are no more or they have changed so much as adaptations to the changing environment conditions, they do not look like their ancestors. They have developed various characters to suit to present conditions. This process took a long time. Organisms more suited for the changing environments replaced those who could not adjust. These variations helped them to conquer aquatic, terrestrial and arboreal environments but we did not change. Now the environment is changing fast because of human activities.

Would I have to change along with the fast changing environment ? or what will happen if we fail to produce a generation with variations favourable to present conditions.? I am worried about our future.



Instructions for group exploration

Wonders of evolution

- Focus your attention on the topic assigned to your group from the headings given in the article "Struggle for survival".
 - Victorious Jack trees
 - Lucky frogs
 - Better future for pandas
- Study the topic given to you.
- Conduct a group discussion highlighting the following concepts described in the text book
 - Overproduction
 - Competition
 - Natural selection
 - Survival of the fittest
- Comment on survival of organisms living in the present using principles of evolution.
- Organisms living today are facing following challenges;
 - Increasing global temperature within a short period
 - Rapid expansion of using agrochemicals
- Get ready to present your findings to the class.

‘Struggle for survival’

Victorious Jak tree

There was a huge jak tree in a garden. Every season this tree bore a lot of fruits. Squirrels, bats and crows consumed the edible parts and a lot of jak seeds were scattered around. Even though most of them germinated many did not grow into healthy plants. Some seeds dropped by bats germinated and grew into healthy plants in the garden. Seeds that were carried away by rain water were trapped in the nearby marshy land but none of them ever germinated.

Later a few jak plants were seen growing in the marshy land some of them were strong and healthy. One day when these plants become trees and produce fruits some of the seeds might not survive the marshy waters, but some seeds will germinate and grow into trees to continue their generations. As time goes on the number of jak plants adapted to grow in marshy environments will increase noticeably.

Lucky frogs

A certain pond was populated with frogs and fish. There were clusters of frog eggs floating in the water. After some time there were a lot of tadpoles swimming in the water. They ate juicy leaves of small aquatic plants. Soon they had consumed all the young leaves. They were in turn prey for the kingfisher, crabs and carnivorous fish in the pond. Some tadpoles managed to survive from the predators by hiding among aquatic plants or in muddy water. Some of them were mud coloured and some were well camouflaged among aquatic plants. So they were always protected from predatory eyes. Many tadpoles found it difficult to find enough food while escaping predators. The few who managed to overcome these challenges grew up to become frogs but some again became prey to other predators. Those who reproduced produced other generations. Some of the progeny possessed the favorable variations of their parents.

“A Better Future for Panda”

Panda is a mammal threatened of extinction. Its natural habitat is bamboo forests in China. They feed only on young bamboo shoots. Because of deforestation the population of bamboo trees in West China are decreasing every year. Compared to other animals pandas reproduce less often and when they do they produce only two cubs at a time. Very often only one cub survives. Therefore pandas are at the verge of extinction. There are some programmes to resolve this problem. One such step is to try and induce panda breeding at *ex-situ* conservation sites. Scientists are happy about the success acquired so far. Some volunteer groups have launched a programme to replant bamboo trees in selected areas.

Meanwhile researchers are trying to find other suitable plants that could be used to feed pandas. If this substitute food is accepted by pandas and if the next generations inherit the new adaptations we will be able to conserve pandas from extinction.

Competency 5.0 :Updates the knowledge on the uses of Biology.

Competency Level 5.1 :Investigates on the contribution of microbial biotechnology in the enhancement of the quality of life.

Activity 5.1 :Amazing biotechnology.

Time :120 minutes

Quality inputs :

- Two copies of instructions for explorations sheets annexed as 5.1.1
- Text Book
- Demy papers and pastel

Learning–Teaching process :-

Step 5.1.1:

- Give the topic “ Uses of microorganisms” to the class.
- Engage them in a brainstorming session with regard to day to day matters in the past and present of the above topic.
- Conduct a discussion highlighting the following points.

- From the distant past man has used microbial activities for productive uses.
- Some examples are curd, toddy, natural vinegar and compost
- With the advancement of technology , microbial biotechnology and molecular biotechnology are used to enhance the quality of life.

(15 minutes)

Step 5.1.2:

- Divide the class into two groups.
- Provide each group with instructions for exploration, demy papers and pastel.
- Assign tasks and employ them in exploration.
- Prepare all groups for a presentation.

(60 minutes)

Step 5.1.3:

- Get each group to present their findings to the class.
- Give the first opportunity to the respective group to elaborate on their findings.
- Get other groups to propose constructive suggestions.
- Review highlighting the following points.

- Some of the advantages of microbial biotechnology are as follows;
 - Biological processes are fast due to their high growth rate and high metabolic rate
 - Easy to grow in large scales
 - Microorganisms can use different kinds of substrates as raw material
 - Raw materials are relatively cheap
- In agriculture, microorganisms are used to produce biological pest controls and to induce nitrogen fixation in root nodules of legumes.
 - *Bacillus thuringiensis* is used as a biological pest control to produce a toxic protein to control insects.
 - *Rhizobium* bacteria living in root nodules of legumes can fix atmospheric nitrogen.
 - Therefore, these bacteria are added to the soil to induce root nodules.
- There are many instances of using microorganisms in industries. Some examples are;
 - Alcoholic beverages industry
 - Vinegar production industry
 - Dairy products industry
 - Bio gas production
 - Bakery industry
 - Metal extraction
 - Antibiotics production industry.
- When producing alcoholic beverages sugar, fruit juices or other carbohydrate bases are used. Glucose in these raw materials is fermented by yeast (*Saccharomyces cerevisiae*) to produce ethanol.
- In vinegar production ethanol produced by fermentation is allowed to be converted to acetic acid (vinegar).
- The microorganisms involved are yeast and bacteria.
- In yoghurt and curd production, lactose in milk is converted to lactic acid by bacteria.
- To produce bio gas methane producing bacteria are used.
- In bakery industry yeast is added to the flour dough. The dough rises because of the CO₂ gas bubbles trapped in the dough.

- Antibiotics like Penicillin can be produced using fungi and bacteria (capable of destroying pathogens.).
- Vaccines like Polio and BCG are produced using microorganisms.
- Microorganisms are used to decompose organic matter to produce compost.
- Decomposer microorganisms are used to clean decomposable organic pollutants from aquatic ecosystems.
- Molecular biotechnology / recombinant DNA technology is used to introduce a gene or genes of other species to a different species to change their characters (genome) of that species.
- Some uses of molecular biotechnology are;
 - Production of human insulin and growth hormone
 - Using genetic engineering to introduce insect resistant, pesticide resistant and virus resistant genes to crops such as corn, cotton & soya crops.
- Producing fruits, animals and crops with larger or better yields.
- Biotechnology can be used to improve the quality of life in an ecofriendly manner.

(45 minutes)

Criteria for assessment and evaluation

- Explains different uses of biotechnology using suitable examples.
- Appreciates the fact that biotechnology can be used to improve the quality of life in an eco- friendly manner.
- Explores the appropriate techniques used in different fields of biotechnology.
- Updates knowledge by collecting more data.
- Educates the society on using science and technology to the advancement and well being of man kind.

Annex 5.1.1

Instructions for exploration

Amazing biotechnology

- Focus your attention to the topic given to your group among the following .
 - Microbial biotechnology
 - Molecular biotechnology
- Identify the field relevant to your group which uses the above technology by reading and referring the text book.
- Explain the many uses of this technology giving examples.
- Discuss the advantages and disadvantages of the above technology under the topic “Biotechnology is ecofriendly”.
- Get ready to present your findings to the class creatively.

Tools for extended teaching – learning process

1.0 Evaluation State :- Term 3 Tool 01

2.0 Competency levels covered :- 1.1, 1.2, 1.3, 1.4

3.0 Subject content covered :-

- Significance of coordination for organisms.
- Proper functioning of sensory organs
- Importance of hormonal coordination
- Plant growth substances and their uses.

4.0 Nature of the tool :- Role play

5.0 Objectives :-

- Exploring the mechanisms of biological processes in living organisms to work efficiently
- To improve effective communication of scientific concepts using aesthetic skills
- To make learning an enjoyable experience.

6.0 Instruction for implementation

For teachers:-

- Divide the class into four groups and assign a competency level
- Get each group to prepare a drama script for maximum limit of 10 minutes.
- Make sure that the subject matter is covered in the script
- Give 2 weeks to practice the role play
- Let each group present the role play in front of the class.

For students :-

- Prepare the role play script ensuring that all members of the group have an important role

- Focus your attention to incidents from day to day life sicknesses that could be included within the relevant content
- Practice thoroughly
- Remember the following facts when presenting the play
 - Communicate the information clearly
 - Be cautious and try to win the attention of the audience
 - Present creatively and attractively

7.0 Format for assessment

Criteria	Name of the student									
• Relevance and correctness of information										
• Proper training/ practising										
• Attractive presentation										
• Contribution to the team/group										
• Following accepted standards/rules										

Indicate proficiency levels as A, B, C or D

- A- Excellent
- B- Good
- C- Average
- D- Should improve

Tools for extended learning – teaching process

- 1.0 Evaluation State** :- Term 3 Tool 02
- 2.0 Competency levels covered** :- 2.1, 2.2, 2.3, 2.4, 5.1
- 3.0 Subject content covered** :-
- Vegetative propagation of plants
 - Sexual reproduction of plants
 - Reproduction in humans
 - Significance of reproduction in maintaining the continuity of life
 - Microbial biotechnology
- 4.0 Nature of the tool :-** Literature survey
- 5.0 Objectives of the tool :-**
- Creating awareness about reproduction of organisms and microbial biotechnology.
 - Learning to learn using different media
 - Exposure to the ideas of the learned society
 - Training to take pleasure by sharing their findings with others.
- 6.0 Instruction for implementation of the tool**
- For teachers:-**
- This is an individual activity
 - About two weeks will be sufficient
 - Divide the subject matter into smaller topics and assign them by drawing lots
 - Direct the students to collect information through different media
- e.g;- Books
- Periodicals
- News papers
- Electronic media
- Internet

- Collect all written papers on the assigned date and give a chance to the class to evaluate them.
- Let the students get all the documents written in one kind of paper and to make a magazine .Write the class name and donate to the school library.

For students :-

- You are assigned to collect latest information from different media and present them creatively in written form
- Use diagrams, pictures and other forms of art to present information.
- Use different sources.
- You have the freedom of using data and information and facts that are not included in the syllabus but are relevant to your topic and are also within the limits of understanding of your age level.
- Choose a suitable topic for your creative document and write your name and class.

7.0 Format for assessment and evaluation

Criteria	Name of student					
• Adequacy of the information						
• Clear communication of ideas						
• Using different communication media						
• Using of pictures and diagrams						
• Creativity (specificity)						

Indicate proficiency levels as A, B, C or D

- A- Excellent
- B- Good
- C- Average
- D- Should improve

Tools for extended learning – teaching process

1.0 Evaluation State :- Term 3 Tool 03

2.0 Competency levels covered :- 3.1,3.2,3.3,4.1,4.2,4.3

3.0 Subject content covered :-

- Levels of organization in the biosphere
- Biotic and abiotic factors affecting the maintenance of an ecosystem
- Flow of energy through an ecosystem
- Environmental conflicts
- Environmental conservation
- Heredity, genetics and evolution

4.0 Nature of the tool :- Seminar

5.0 Objectives of the tool :-

- Creating awareness in organization levels in the biosphere, genetics, heredity and evolution.
- Develop presentation skills.

6.0 Instruction for implementation of the tool

For teachers:-

- Assign the six topics to six small groups
- Instruct them to act as resource persons for the seminar considering the limits of syllabus on the topic assigned to their group.
- Direct each student to present the sub topic assigned to them after the preparation of the presentation
- Emphasize that each group will have only 20 minutes for the seminar

For students :-

- Plan the presentation attractively
- Prepare a short note for the sub topic assigned to each student

- Rehearse the group presentation and edit contents according to the time frame.
- Focus your attention to the following points during the presentation,
 - use relevant demonstrations
 - refer to day to day incidents
 - suggest possible instances where concepts can be practiced.

7.0 Format for assessment and evaluation

Criteria	Name of student						
• Adequacy of the information							
• Preplanning with short notes							
• Proper communication skills							
• Using models and aids							
• Creativity of presentation							

Indicate proficiency levels as A. B. C or D

- A- Excellent
- B- Good
- C- Average
- D- Should improve

Model Questions

01. Malaka was walking to the school. When he saw the bus travelling at breakneck speed coming towards him he jumped into the nearby shop. In a split of a second the bus crashed onto the lamp post with a terrible noise and fell onto the sewage canal. Malaka came out and went to see what happened. He was shocked to see one of his sister trapped inside the bus and shouted for help.

Consider the responses and the organs responsible to adapt Malak to the environment behind this incident.

- i. Make a list of stimuli and responses found in this passage
 - ii. Create reflex arcs for all the responses.
 - iii. Highlight the reflex actions from the arcs.
 - iv. Explain how the sympathetic and parasympathetic nervous systems worked in the situation above.
02. You are provided with one plant each from the list of plants with edible parts. Your challenge is to grow and obtain a better yield in a shorter time considering all the environmental conditions are at optimum levels. The plants are,
- i. Passion fruit
 - ii. Centella (Gotukola)
 - iii. Mango
 - iv. Banana
 - v. Lime
 - vi. Sugar cane

Explain the processes you would adapt for each plant using biological concepts, principle and techniques to overcome the above challenges.

03. An albino mother (lacking melanin pigment in the skin) and a father with a normal skin have three children. Albinism is caused by a recessive gene (m) linked to somatic chromosome.
- i. Write the possible genotypes of this father and mother using symbols.
 - ii. Explain the genetic basis of the following conditions in this family,
 - a. Having an albino daughter
 - b. All the children having normal skin
 - c. Possibility of obtaining an albino child to a non albino son.
 - iii. If the albinism of mother was sex linked, explain the genetics behind (a, b and c) conditions above.

Assessment and evaluation

Assessment and evaluation can be described as processes interconnected, that can be easily employed to identify the competency levels achieved by students during the teaching learning process, in the class room. If an assessment is done properly it would not be difficult for all the students in a class to achieve at least a near proficiency . On the other hand the objective of an assessment is to identify the proficiency levels of students.

During assessment a teacher can guide students in two ways. It is commonly known as feed back and feed forward guidance. Feed back is helping students overcome their weaknesses and inabilities identified during assessments. Feed forward is encouraging their identified skills and strengths for much better performance.

It is necessary that the students identify their proficiency levels with regard to the competency levels in the syllabus. Hence Teachers are expected to evaluate the proficiency levels during assessments and communicate the progresses to students, parents and other parties concerned.

This syllabus given to you is a student – centred, competency – based, activity oriented approach. The core of the transformation role of a teacher is activity based learning for a meaningful life.

This syllabus based on a redeveloped succession of activities is an attempt to co ordinate teaching and learning with assessment and evaluation The teacher will be able to assess the students while they are engaged in group exploration in step two of an activity and to evaluate them during the third step when they present and elaborate their findings.

The teacher is expected to walk around and guide the students and to facilitate them to resolve their difficulties within the classroom during the exploration stage.

Five common criteria are proposed to make the assessment and evaluation easy. The first three criteria are for evaluation of student knowledge, skills and attitudes in the competency given. Last two criteria help them develop life skills necessary for life. A teacher must try to identify all five behavioural changes connected to these criteria. All the students are engaged in an activity and to confirm the development of such behaviour during assessment stage and to evaluate the competency level in the end.

Learning teaching process can be extended by developing the process of assessment and evaluation. First step is to divide the activities given into several groups. Second step is to identify some test types that could create student interest within the syllabus content chosen. The next step is to prepare tools to extend learning – teaching process including instructions for teacher and students. The teacher is expected to introduce these tools to the class at the beginning of each group of activities. Some test types usable to extend the learning teaching process are given below.

- Concept maps
- Wall news papers
- Quizzes
- Portfolios
- Exhibitions
- Questions and answer books
- Presentation of literature reviews
- Field books/ nature diaries
- Practical tests.
- Debates
- Impromptu speeches
- Role plays
- Panel discussions
- Seminars

The third part of this teachers instruction manual is designed to introduce the proposed extended learning – teaching process, assessment points and the tools selected for the purpose. This type of assessment and evaluation during and between activities broaden the learning teaching process and creates an attractive and exciting learning experience for students.