

ANSWERS



Organisation of Plant Tissues and Growth

Formative Practice 1.1

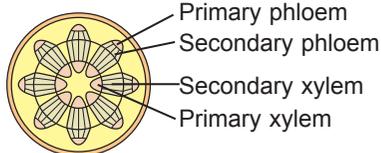
1. Guard cell / Root hair cell
2. • Parenchyma tissue is the simplest living cell and do not undergo differentiation. Collenchyma tissue is made of living cells which mature into cells that are flexible. Sclerenchyma tissues consists of dead cells when matured.
• Parenchyma tissue has the thinnest cell wall. The cell wall of collenchyma tissue is thicker than the parenchyma tissue. The cell wall of sclerenchyma tissue is the thickest among the three ground tissues.
• Parenchyma tissue are involved in photosynthesis, help in the storage of starch and sugar, and involved in gaseous exchange. Collenchyma tissues provide mechanical support and elasticity to plants. Sclerenchyma tissues provide support and mechanical strength to the parts of matured plants.
3. Xylem is made up of dead cells without cytoplasm. Xylem consists of xylem vessels that are elongated, hollow and connected to each other from the roots to the leaves. This enables xylem to transport water and mineral salt to all parts of the plant.

Activity 1.1

1. Zone of cell division, zone of cell elongation and zone of cell differentiation.
2. Zone of cell division has small cells with dense cytoplasm, large nucleus and small vacuoles. The zone of cell elongation has long and wide cells and with large vacuoles. The zone of cell differentiation is made of cells with various shapes and structures that depend on their functions.

Formative Practice 1.2

1. The three zones of cell growth are the zone of cell division, zone of cell elongation and zone of cell differentiation.
2. (a)



- (b) Secondary growth occurs when the vascular cambium divides actively through mitosis. The cells in the cambium ring divide inwards to form new xylem and outwards to form new phloem. The new xylem tissues become secondary xylem and the new phloem tissues become secondary phloem.

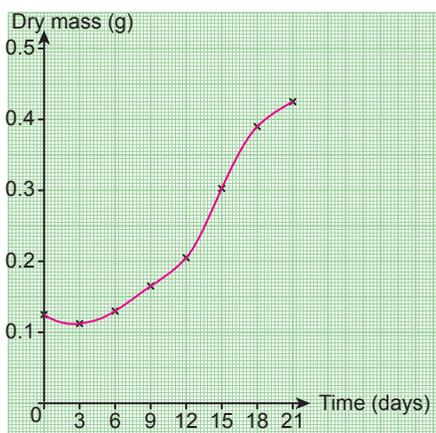
3. The importance of secondary growth:
 - To provide stability to plants by increasing the stem and root diameters to suit the height of plants.
 - To produce more xylem and phloem tissues.
4. The primary growth of woody plants is followed by the secondary growth which increases the diameter or circumference of plant stems. The more growth, the more vascular and cork tissues.

EXPERIMENT !!

Results:

Time (Day)	Dry mass of three seeds or seedlings (g)			Average dry mass of seeds or seedlings (g)
	Seed 1	Seed 2	Seed 3	
0	0.124	0.126	0.125	0.125
3	0.115	0.116	0.115	0.115
6	0.130	0.132	0.129	0.130
9	0.164	0.166	0.164	0.165
12	0.214	0.217	0.213	0.215
15	0.305	0.308	0.301	0.305
18	0.391	0.394	0.386	0.390
21	0.425	0.428	0.421	0.425

Graph of dry mass of maize seed against time (day):



Discussion:

1. The growth curve of the corn seedling is sigmoid curve or S-shaped.
2. At the beginning of the experiment, growth occurs slowly. When the corn plant starts undergoing photosynthesis, the dry mass increases and growth speeds up. When the seedling matures, the growth rate is zero (constant dry mass). The dry mass of the corn plant decreases when it gets older.

Formative Practice 1.3

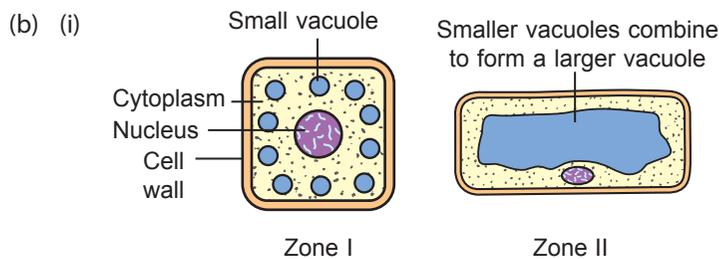
- Plants can be classified based on their lifespan: annual plants, biennial plants and perennial plants.
- Perennial plants. These plants have structures that are adaptable to their the surroundings and temperature change. Most of these plants are able to flower and fruit many times throughout their lives. This is to increase its chances for species survival.
- The growth curve of perennial plant is a series of small sigmoid-curved. A series of sigmoid represents one year of growth. Growth curves are influenced by seasons. During the summer, the rate of growth is high, and during the winter, it is low.

Summative Practice 1

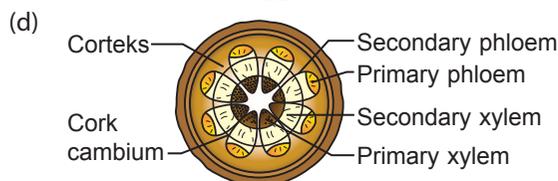
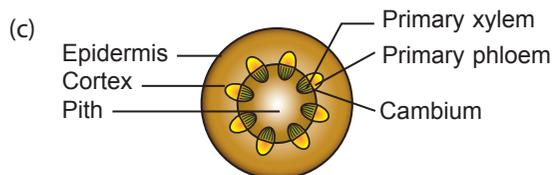
- Tissue A:** Meristematic tissue
Characteristic: Has thin cell walls, large nucleus, dense cytoplasm and small vacuoles.
Function: Young tissue that actively divides through mitosis

Tissue B: Collenchyma tissue
Characteristic: Cells walls made of pectin and hemicellulose
Function: Provides mechanical support and elasticity to plants

Tissue C: Sclerenchyma tissue
Characteristic: Has a very thick cell wall
Function: Provides support and mechanical strength to the parts of matured plants.
- (a) **Zone I:** Zone of cell division
Zone II: Zone of cell elongation
Zone III: Zone of cell differentiation



- (ii) The cells in Zone I have larger nucleus compared to the nucleus found in cells from Zone II. Most cells in Zone I have small vacuoles while cells in Zone II have large vacuoles.



3. (a) Annual plants e.g. watermelon
 (b) P: The dry mass decreases because food stored in cotyledon is used for germination before the leaves emerge to carry photosynthesis.
 Q: There is increase in dry mass. The rate of growth increases rapidly. This is because the plant has carried out photosynthesis.-
 (c) (i) Tissue Z is vascular cambium.
 (ii) Vascular cambium actively divides through mitosis. Vascular cambium cells combine to form a complete ring.
 (iii) The plant will not be able to undergo secondary growth. There will be no formation of secondary xylem and phloem. The diameter of the stem does not increase. Plants cannot get mechanical support and will have a short lifespan.
4. (a) Estimated to be 9 years old.
 The cambium activity is influenced by the seasons. During winter or autumn, there is low light intensity, so the vascular cambium is dormant or inactive leading to smaller secondary phloem and xylem (thick walls, darker rings). During spring or summer, the vascular cambium is active, producing larger secondary phloem and xylem (thinner walls, brighter rings).
- (b) (i) • Secondary growth provides stability to plants by increasing the stem and root diameter to suit the height of plants.
 • Secondary growth provides mechanical support to plants.
 • Secondary growth produces more xylem tissues and phloem tissues.
 • Secondary growth produces xylem and phloem tissues continuously to replace old and damaged xylem and phloem tissues.
 • Secondary growth produces stronger and thicker bark to provide protection to the plants from excessive water loss, physical injuries and disease infections.
 • Secondary growth enables the plants to live longer by increasing the chances of producing seeds and reproducing.
 (ii) Secondary growth does not occur in monocots because they do not have cambium tissue. Ground tissues in monocot stems do not undergo differentiation to form cortex and pith.
5. The acacia is a fast-growing tree and can produce high quality wood for the pulp and paper-making industry. This hardy tree can also grow on poor soil.

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6. The growth of shoot apical inhibits the growth of shoot lateral. When the shoot apical is periodically cut off, this allows shoot lateral to grow actively. This can control the height of the plant.



Leaf Structure and Function

Activity 2.1

1. Monocot leaves have parallel veins while eudicot leaves have network-like veins.
2. Eudicots

Formative Practice 2.1

1. Lamina and petiole
2. To prevent excessive loss of water through evaporation.
3. Upper epidermis, palisade mesophyll, spongy mesophyll, vascular bundle and lower epidermis.
4. Xylem – to transport water and mineral salts absorbed from the roots to the leaves.
Phloem – to transport organic substances produced during photosynthesis from the leaves to other parts of the plants.
5. To allow sunlight to pass through it for photosynthesis.
6. Palisade mesophyll – Contains many and chloroplasts and closely arranged.
Spongy mesophyll – Contains less number of chloroplast and loosely arranged.

Activity 2.2

1. Balloons: Guard cells
Space between the balloons: Stomatal pore
2. The air blown into the balloons.
3. The additional air increases the size of the space between the balloons.
4. To release part of the air that reduces the space between the balloons.

EXPERIMENT 2.1

Results:

Type of leaves	Parts of epidermis layer	Number of stoma
Balsam leaf	Upper epidermis	2
	Lower epidermis	8
Lily leaf	Upper epidermis	1
	Lower epidermis	7

Discussion:

1. Lower epidermis. The lower epidermis is not exposed directly to sunlight. The stomatal opening for absorption of carbon dioxide does not cause excessive loss of water through evaporation.
2. The guard cells for monocots are shaped like dumbbells while in eudicots, they are shaped like beans.

Formative Practice 2.2

1. Respiration – Oxygen is absorbed and carbon dioxide is released
Photosynthesis – Carbon dioxide is absorbed and oxygen is released
2. The humid surroundings causes the size of the stoma to become larger. The excess water vapour in the air reduces the loss of water from the leaf.
3. The stomatal distribution is more packed on the lower leaf surface because the lower leaf is not exposed directly to the sunlight. This can prevent excessive loss of water.
4. To prevent excessive loss of water through transpiration.

EXPERIMENT 2.2

Results:

Surrounding factor		Distance travelled by air bubble in 10 minutes (cm)	Transpiration rate (cm/min)
(a) Air movement	Fast	3.7	0.37
	Slow	1.5	0.15
(b) Light intensity	High	3.3	0.33
	Low	1.1	0.11
(c) Temperature	High	4.1	0.41
	Low	1.5	0.15
(d) Relative air humidity	High	0.7	0.07
	Low	2.4	0.08

Discussion:

1. To prevent air from entering it that causes the release of bubbles into the potometer.
2. The release of water vapour, that represents the transpiration rate
3. High light intensity, high temperature and fast air movement increases the distance travelled by air bubble while a high relative air humidity reduces the distance travelled by air bubble.
4. Transpiration is a process of loss of water from leafy shoot which is shown by the distance travelled by the air bubble in 10 minutes, affected by light intensity, temperature, air movement and relative air humidity.

Formative Practice 2.3

1. Transpiration is a process of water loss in the form of water vapour through evaporation from the plants to the atmosphere. Transpiration occurs in stomatal pore.
2. When the light intensity is high, the temperature of the surrounding also increases. This causes the water vapour in the air to evaporate and there is more space to be filled up by the water vapour that evaporates from the leaf. Hence, the higher the light intensity, the higher the rate of transpiration.
3. Mud that sticks to the lower leaf will close the stomatal pore and this will reduce the rate of transpiration.

Activity 2.3

1. To dissolve chlorophyll.
2. To break down the leaf cells and make chlorophyll extraction easier.
3. Based on the value of R_f , which is the ratio of the distance travelled by the pigment to the distance travelled by the solvent along the chromatogram.

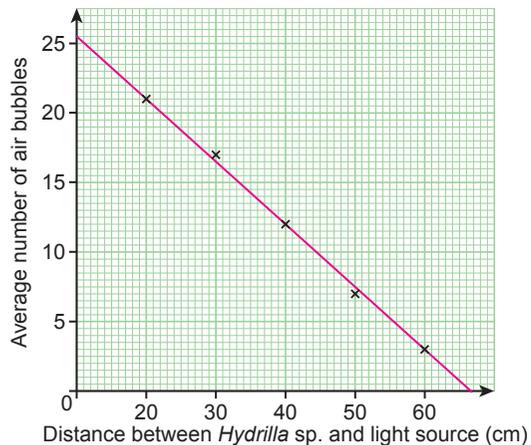
EXPERIMENT 2.3

Discussion:

1. Example of the results for variable being light intensity:

Distance from <i>Hydrilla</i> sp. to light source (cm)	Average of number of air bubbles released in 5 minutes
20	21
30	17
40	12
50	7
60	3

Graph of average number of air bubbles against distance between *Hydrilla* sp. and light source:



2.
 - (a) When light intensity increases, more photons will strike the chlorophyll molecules which will increase the rate of photosynthesis.
 - (b) When temperature increases, the rate of enzyme increases and the rate of photosynthesis also increases.
 - (c) When the concentration of sodium bicarbonate increases, the rate of photosynthesis will increase because of higher concentration of carbon dioxide.

3. A : Manipulated variable: Fix the distance of the bulb from *Hydrilla* sp. at 20 cm, 30 cm, 40 cm, 50 cm and 60 cm
 Responding variable: Count and record the number of air bubbles that released in 5 minutes
 Constant variable: Use the same type and size of plant, *Hydrilla* sp.
- B : Manipulated variable: Immerse test tubes into beakers containing water at 15 °C, 25 °C, 35 °C, 45 °C, 55 °C, 65 °C and 75 °C
 Responding variable: Count and record the number of gas bubbles that can be released in 5 minutes using a stopwatch
 Constant variable: Use the same type and size of plant, *Hydrilla* sp.
- C : Manipulated variable: Using sodium hydrogen carbonate solutions at (0.01 M, 0.02 M, 0.03 M, 0.04 M, 0.05 M, 0.06 M, 0.07 M, 0.08 M, 0.09 M, 0.10 M)
 Responding variable: Count and record the number of air bubbles released in 5 minutes
 Constant variable: Use the same type and size of plant, *Hydrilla* sp.
4. Sodium hydrogen carbonate solution is used to produce carbon dioxide gas which is required for photosynthesis.

Formative Practice 2.4

1. Light intensity, temperature and carbon dioxide concentration
2. At low light intensities, the stomata will close and lower the rate of photosynthesis. At high light intensities, the stomata will open and until it reaches a point. After the point, the rate of photosynthesis does not increase because other factors become limiting factors.
3. Supply of water, bulb with appropriate light intensity, adjustable heater at 25 °C, optimum temperature for enzyme reaction in photosynthesis and carbon dioxide source.
4. Agree. A light-independent reaction requires NADPH and ATP which is produced in a light-dependent reaction.

Formative Practice 2.5

1. Compensation point is the level of light intensity when the rate of respiration equals to the rate of photosynthesis.
2. Before 10 am, as the ficus tree is taller and thus receives higher light intensity.
3. (a) Glucose produced in photosynthesis is fully used for cell respiration in plant.
 (b) No oxygen is released into the atmosphere as it has been fully used for respiration.

Summative Practice 2

1. (a) Petiole is the leaf stalk that connects lamina to the stem of the plant, lamina is the part that involved in photosynthesis.
 (b) Flat and thin to increase the surface area and maximise the exposure of leaf cells towards the Sun. The green colour is the pigment colour for chlorophyll. Chlorophyll absorbs the red and blue light from sunlight for photosynthesis.
2. Chlorophyll absorbs red light whereas carotenoids absorb blue light before moving to chlorophyll to excite the electron in light dependent reaction.

3. (a) Sample C because the lower surface of the leaf is not covered with petroleum jelly. The petroleum jelly prevents water evaporation.
- (b) Sample C because the lower surface of the leaf is not covered with petroleum jelly. Petroleum jelly prevents water evaporation through the stoma. This means the stomatal distribution is higher on the lower surface of the leaf.

(c)

Pudina leaf	Characteristic	Thyme leaf
Abundant	Number of leaves	Few
Abundant	Distribution of stoma on the upper surface of the leaf	Few
Abundant	Distribution of stoma on the lower surface of the leaf	Few
Abundant	Mass of water lost	Few

- (d) The thyme plant because it has fewer stomata that helps to prevent excessive loss of water
4. (a) Graph in Figure 1.2
- (b) At noon, the weather is hot and dry and this reduces the average number of stomata that is open. This in turn reduces excessive loss of water.
- (c) The guard cells do not carry out photosynthesis and are straight.
- (d) Stems or succulent leaves store water, has thick cuticle layers and fibrous roots.
5. (a) Light-dependent reactions and light-independent reactions
- (b) Light-dependent reactions. Light energy is absorbed by chlorophyll to excite electrons or for photolysis.
6. He can switch plastic plants with real aquatic plants. Real plants carry out photosynthesis and release oxygen. This will increase the concentration of dissolved oxygen in the water.
7. (a) The compensation point is the level of light intensity when the rate of respiration equals to the rate of photosynthesis.
- (b) At the compensation point, the amount of oxygen produced is enough for plant respiration, whereas the carbon dioxide produced is enough for photosynthesis.
8. (a) Greenhouse farming
- (b) The cost for construction is high due to the use of heatproof glass, electricity for air conditioner to reduce the temperature to the optimum temperature for growing grapes, at 25 °C to 32 °C.
- (c)
- Use solar panels as our country receives constant sunlight throughout the year.
 - Use LED bulbs which is energy efficient.
 - Replace glass with transparent plastic sheets which is cheaper.



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9. Yes, the rate of transpiration decreases. The rate of absorption of soil water by roots will also reduce due to the less mineral salt intake.
10. Use greenhouses equipped with LED bulbs as the light source required by the crops.



Nutrition in Plants

EXPERIMENT 3.1

Results:

Culture bottle	Nutrient deficiency	Observation
A	None	Seedling grows healthily
B	All (Nitrogen, phosphorus, potassium)	Seedling cannot grow and will die
C	Nitrogen	<ul style="list-style-type: none">• The leaves turn yellow• Stunted growth in seedling
D	Phosphorus	<ul style="list-style-type: none">• The leaves turn dark green with red dots• Stunted growth in roots
E	Potassium	<ul style="list-style-type: none">• The edges on the leaves turn yellow• Growth of seedling is stunted and will die

Discussion:

- Two safety steps:
 - The culture bottle is wrapped with black paper/ black plastic to prevent growth of green algae. Green algae will use the nutrients in the culture solution and will influence the results of the experiment.
 - Knop solution must be replaced every week to ensure that the corn plants receive nutrients.
 - The culture bottle is attached to the air pump to provide oxygen to the roots for respiration.
- The seedling in culture bottle A grows healthily because culture bottle A contains Knop's solution
- The ratio of nitrogen: phosphorus: potassium is 15:15:15 or 12:12:17. Generally, nitrogen gives plants their green colour, phosphorus is essential for root development and potassium is necessary for growth. Plants that have these three elements in the right ratio will be able to absorb other nutrients for growth.

Formative Practice 3.1

- Macronutrients are required by plants in large quantities while micronutrients are required in small quantities.
- Nitrogen, chlorine and zinc.
- Nitrogen stimulates leaf development. Nitrogen is necessary in chlorophyll formation for photosynthesis. Phosphorus stimulates healthy root development. Potassium is involved in development of the whole plant including development of flowers and fruit.
- Roots act as transportation medium that absorb water and nutrients in the soil and transport them to all parts of the plant. The stomata on the leaves absorb carbon dioxide and oxygen from the atmosphere for the use of the plant cells.

Activity 3.2

1. Parenchyma tissue forms the cortex. Parenchyma cells have thin cell walls and large vacuoles.
2. For monocot roots, the xylem and phloem are arranged alternately in a ring. For eudicots, the xylem is in the middle of the root while the phloem is outside the xylem.
3. Eudicot roots undergo secondary growth. Eudicot plants have vascular cambiums that divide through mitosis to form secondary xylem and phloem, while monocot plants do not have vascular cambiums.

Formative Practice 3.2

1. Epidermal tissue, cortex tissue, vascular tissue and endodermis tissue.
2. Adaptations of the epidermal tissue of the root:
 - Epidermal cells are closely arranged
 - Thin cell walls and water-permeable cell membranes facilitate water movement in their roots.
 - There are epidermal cells which form roots hair by elongating towards lateral sides from the outer walls.
 - The root hair cells are not layered with cuticle.
 - The roots hair cells also have big vacuoles to store water and mineral salts.
3. Cortex tissues are between the epidermis and the vascular cylinder in dicot roots and monocot roots. Casparian strips while not all roots in eudicots have Casparian strips.

Activity 3.3

1. Pitcher plant (*Nepenthes* sp.)
2. Die. The Indian willow plant is a parasite plant. Its root can penetrate the stem of the host plant such as mango tree to absorb water and minerals.

Formative Practice 3.3

1. (a) Parasite
(b) Epiphyte
(c) Epiphyte
(d) Carnivore
2. Parasitic plants grow on another plant (host). The roots of parasitic plants will penetrate the host vascular bundles to absorb nutrients (organic substances, minerals and water). For epiphytic plants, they grow on another plant (host). The rate of photosynthesis in epiphytic plants is higher when it gets more sunlight by living on a higher tree without harming the host
3. The growth of the bird-nest fern will be stunted due to lack of water.

Summative Practice 3

1. (a) Manganese, Iron, Boron, Chlorine, Zinc and Nickel
(b) Nitrogen stimulates the development of leaf growth. Phosphorus is important for healthy development of root. Potassium encourages the development of flowers and fruit and stimulates the growth of large and long chilies.

- (c) (i) The chilli plant received excessive fertiliser especially nitrogen.
(ii) Reduce the frequency of fertilising
- 2.
- (a) Epiphytic orchid plants refer to orchids that live on other plants which are the hosts. Epiphytic orchid plants obtain their nutrients by synthesising their own food without harming their hosts.
 - (b) The coconut husks can retain water for the orchid plants. Their roots can hold the husks as a support. The husks can also provide aeration for the respiration of the roots.
 - (c) Source of light. The orchid plants require light for photosynthesis but cannot be exposed to direct sunlight.
 - (d) The orchid's roots need a medium that can improve the drainage and aeration better than soil. If it is planted directly into the ground, the roots may be rotted because of the excessive water.
- 3.
- (a) Hydroponics
 - (b) Water, light, nutrient and air
 - (c) The wick is used to absorb water and nutrient from the nutrient solution. A wet wick ensures that roots receive enough water and nutrients.
 - (d) This method is suitable for herbs and small plants. These type of plants have a fibrous root system to ensure maximum absorption of water and nutrients.
- 4.
- (a) The plant in Photograph 2.1 is a producer in food chains and provide food to consumers in the rainforest ecosystem.
 - (b) The plant in Photograph 2.2 is a parasitic plant that can change the physical environment around them such as water and nutrients in the soil. Its host will absorb more water and nutrients from the soil causing the change in the supply of sources of the surrounding organism. The interaction between the parasitic plants and the host can also maintain the flow of energy and ecosystem balance in tropical rainforests.
 - (c) The plant in Photograph 2.1 has chlorophyll. This plant produces its own food by synthesising complex organic compounds from simple inorganic materials through photosynthesis. The plant in Photograph 2.2 does not have chlorophyll, so this plant unable to carry out photosynthesis. This plant absorbs water and nutrients from the host plant. Its roots penetrate the stem of the host to the vascular bundle.



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5. Organic crops are crops that are free from synthetic fertiliser and artificial hormones. Apart from being chemical-free, organic crops also contains more antioxidants, minerals and vitamins. This is because, organic farming does not use pesticides.



Chapter 4 Transport in Plants

Activity 4.1

1. Xylem tissue
2. The walls of the xylem vessel have uneven lignin thickening to give strength to xylem vessels to prevent them collapsing due to the tension force and pressure changes when water moves through it.

Formative Practice 4.1

1. No. Small plants like moss and algae have large surface areas to absorb water directly from its surroundings.
2. The plant will die as the xylem cannot transport water. This causes the plants to not be able to carry out photosynthesis.
3. Sieve tubes have companion cells that are rich in mitochondria. The mitochondria in companion cells will generate energy (ATP) to be used by sieve tubes.

EXPERIMENT 4.1

1. To ensure roots can absorb water and mineral salts from the soil for the whole night.
2. The sap cell concentration is higher than in the soil water. The water potential in the root cells is higher than the water potential in the soil.
3. Water from the soil diffuses into through the root hair cells through osmosis.
4. The root pressure causes by the difference in water potential enable water to diffuse by osmosis from root across the root hair cells, cortex cells, endodermis cells and pericycle and then to xylem vessel of the root to be transported to all part of the plants. Water is needed by plant for photosynthesis.

EXPERIMENT 4.2

1. To prevent loss of water by evaporation from the surface of the water.
2. Plants release water vapour through transpiration to the surroundings. The roots will absorb water from inside the bottle to replace the water lost from evaporation.
3. The water level in the side tube will drop. The rate of transpiration decreases as the number of leaf lamina is reduced, thus reducing the number of stoma.

Activity 4.2

1. To enable colour changes to be more easily observable.
2. Xylem tissue
3. Most pigment molecules found in textile dye are toxic and too large to move along the xylem vessels. Water transport in the xylem tissues become less efficient.

Formative Practice 4.2

1. Root pressure, capillary action (adhesion and cohesion forces) and transpirational pull.
2. Guttation is a secretion of water droplets through a special structure at the end of leaf veins without involving the stomata caused by a high root pressure. Guttation maintains an effective root pressure. Hence, more water and mineral salts is absorbed by the root.
3.
 - Guttation happens at night and early morning whereas transpiration happens on hot and windy days.
 - Guttation happens in herbaceous plants whereas transpiration happens in all plants.
 - Guttation releases water droplets whereas transpiration released water vapour.
 - Guttation happens through a special structure at the end of the leaf veins whereas transpiration happens through stomata.
 - Guttation happens when root pressure is high whereas transpiration is controlled by the stomatal opening and closing.
4. Agree. The conditions stated causes an increase in evaporation of water through transpiration, thus leading to an increase in transpiration pull.

EXPERIMENT 4.3

Results:

Observation	The beginning of the experiment	After three weeks
(a) Above the ring	Normal	Swells
(b) Below the ring	Normal	Shrinks

Discussion:

1. (a) This prevents the products of photosynthesis such as sucrose from the leaves to the roots.
(b) This prevents water evaporation and protects the trees from mould and pathogens.
2. Phloem tissue
3. The part above the ring swells because the translocation pathways through the phloem has been blocked due to the removed phloem. The part below the ring shrinks because that it does not receive nutrients from the phloem.

Formative Practice 4.3

1. The process of transporting organic substances such as sucrose, amino acids and hormones in the phloem from the leaves to other parts of the plant such as the roots and stem.
2. Translocation helps in transporting photosynthetic products from the leaves to other parts of the plant that need them for growth and respiration such as roots, fruits, tip of shoots or developing flowers. Other than that, translocation also transports excess photosynthetic products to other parts of the plants such as rhizomes, tubers and bulbs.
3. Sucrose is actively transported into the sieve tube. The transport of sucrose into the sieve tube through the companion cell from the leaf reduces the water potential in the sieve tube. This causes water to diffuse from the xylem into the sieve tube via osmosis. The water diffusion increases the hydrostatic pressure in the sieve tube. The increase in the hydrostatic pressure causes the phloem sap to be pushed along the sieve tubes to other organs of the plant. The phloem sap (sucrose) is transported from the sieve tubes to others parts such as stems, roots, shoots, fruits and tubers by active transport. The high water potential in the phloem causes the water to diffuse in order for it to return into the xylem by osmosis. Transpiration pulls water along the xylem vessel against the direction of gravitational pulls.
4. The concentration of sucrose in leaf cells is higher than in sieve tubes. The hydrostatic pressure in the sieve tubes increases, causes the phloem sap (sucrose) to move into the sieve tube actively.
5. An efficient translocation from the leaf to the storage organs such as fruit will increase the size of fruit or the tuber.

EXPERIMENT 4.4

Results:

Glass container	Reading of ammonia in the lake water	
	Beginning of the experiment	End of the experiment
A	3	1
B	3	3

Discussion:

1. To remove all dirt from the roots
2. *Lemna* sp. and *Hydrilla* sp.
3. It disrupts the food chain in aquatic ecosystem.

EXPERIMENT 4.5

Results:

Glass container	Reading of ammonia	
	Beginning of the experiment	End of the experiment
A	3	1
B	3	3

Discussion:

1. To remove the water content and get an accurate mass of dry soil
2. This plant can treat soil by absorbing the ammonia from the soil

Formative Practice 4.4

1. Phytoremediation is one of the treatment methods which uses plants for the purpose of degradation, extraction or elimination of pollute substances from soil and water.
2. (a) To treat waste water by eliminating heavy metals and trap nutrients and microorganisms.
(b) To remove heavy metals from contaminated soil.

Summative Practice 4

1. (a) Xylem tissues are dead cells at maturity as they are hollow and do not have cytoplasm.
(b) To transport water and mineral salts that are absorbed by the roots, to the stems and leaves.
Adaptations:
 - The tissue is hollow to allow water transport.
 - The walls have lignin to provide support and prevent them from collapsing.
 - Arranged longitudinally from end to end to allow water flow.(c) The high number of root hairs increases the surface area for water absorption. This is similar to the high number of villi in small intestine that increases the surface area for nutrient absorption from digested food.
(d) Systemic pesticides seep into plants. When insect pests consume and digest the plant, the chemicals in the pesticide kills it.

2. (a) Sucrose is transported through companion cells from the leaves to the sieve tubes. This reduces the water potential in the sieve tube. Water diffuses into the sieve tube by osmosis and increases the hydrostatic pressure in the sieve tube. The phloem sap is transported from the sieve tubes to other parts such as fruits and tubers.
 - (b)
 1. Expose a balsam plant under sunlight for one hour.
 2. Introduce an aphid to the young stem of the plant.
 3. Observe the aphid with a magnifying glass.
 4. Using a knife, separate the body of the aphid from the stylet once the stylet is embedded into the phloem.
 5. Place a microscope slide at the edge of the stylet to collect the secreted liquid.
 6. Observe the liquid under a light microscope.
3. (a) Phytoremediation
 - (b) Sunflowers
 - (c) Industrial wastes may seep into the irrigation water. The water hyacinth can help to remove the contaminants from the water. Hence, the pumped water used to water the vegetables is free from the contaminants.



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4. The phytoremediation method can be used by planting the water spinach plant as the phytoremediation agent. This plant will absorb the lead from the lake water. Experiment 4.5 on page 91 can be conducted.



5

Response in Plants

Practice Formative 5.1

1. Tropism is the responses of certain parts of a plant such as roots or shoots that respond towards or away from a stimulus.
2. Thigmotropism, hydrotropism, geotropism, chemotropism and phototropism.
3. Positive phototropism ensures leaves get the optimum amount of sunlight to increase the rate of photosynthesis.
4. The mimosa plant is responding to heat, which is themonasty.

Formative Practice 5.2

1. Three phytohormones and their functions:
 - Auxin stimulates cell growth and elongation in roots and shoots.
 - Ethylene stimulates ripening in fruits.
 - Gibberellin stimulates the division and elongation in the stem cells.
2. In the dark, the auxin distribution at the shoot tip is even. The shoot will thus grow straight upwards.
3. Fruit that is overripe will produce more ethylene gas. This gas will cause the other fruits to ripen and spoil quickly.

EXPERIMENT 5.2

Results

Paper bag	Colour of tomatoes		Condition of tomatoes (hard/soft)	
	At the beginning of the experiment	At the end of the experiment	At the beginning of the experiment	At the end of the experiment
A	Green	Green	Hard	Hard
B	Green	Orange	Hard	Soft

Discussion

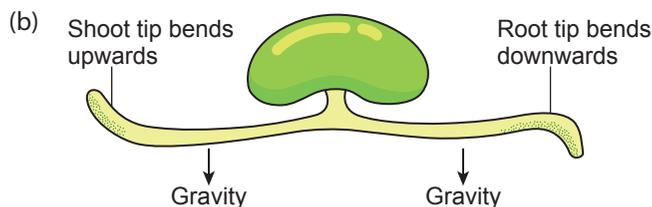
1. The tomato in bag B. The ripe banana releases ethylene gas which speeds up ripening in fruit.
2. A ripe fruit is a natural source of ethylene hormone released in the form of gas.
3. Ethylene gas stimulates cellulase enzymes to hydrolyse the cellulose in cell walls causing ripe tomatoes to soften. Ethylene gas breaks down chlorophyll allowing green tomatoes to turn red when they ripen. Ethylene gas also breaks down complex carbohydrates to simple sugars which sweetens the ripe tomato.

Formative Practice 5.3

1. The use of phytohormones in agriculture:
 - Gibberellin promotes rapid elongation of flower stems.
 - Cytokinins promote cell division and differentiation in tissue culture technique.
 - Auxins produce seedless fruit via parthenocarpy.
2. Hormone X is abscisic acid. When the surrounding temperatures increase, more water will be lost via transpiration through the stomata. This will lead to the concentration of abscisic acid to be high in the leaf, which leads to the closing of stomata and maintain the water content in leaves.

Summative Practice 5

1. (a) Shoot tip: Positive phototropism
Root tip: Negative phototropism



- (c) Due to the pull of gravity, auxin pools at the bottom side of the shoot tip. In shoots, high auxin concentrations causes cells at the bottom to grow faster and also allow the shoot to bend upwards.
 - (d) The nutrient medium contains cytokinin which promotes development of shoots and leaves. Auxin is used to stimulate the growth of roots.
2. (a) Parthenocarpy
(b) Watermelon and grapes
(c) Auxin is sprayed on unpollinated flowers. This stimulates production of seedless fruit without undergoing fertilisation.
(d) Yes. The seedless fruit produced is of higher quality and is larger. The fruit is safer to consume as it is not pollinated by insects and thus does not require the use of pesticides.

3. (a) (i) This method can speed up the ripening of key lime.
 (ii) The colour of the fruit changes from green to yellow and the fruit will also soften. The ripe banana releases ethylene. Ethylene breaks down the chlorophyll (green pigment) in the skin of the key lime fruit, turning it yellow. Ethylene also stimulates cellulase enzyme to hydrolyse the cell walls of key lime to turn the fruit soft.
 (iii) The ripening will be delayed. The lower temperature in the fridge causes the enzymes involved to be less active.
 (b) First method – Vacuum-pack before exporting the fruit. Removal of air or oxygen prevents the production of ethylene. This will delay ripening during the journey.
 Second method – Place the fruit in a refrigerator. Lower temperatures delay the ripening of fruit.

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4. To prevent the use of pesticides, make sure no insects were involved in the pollination process. Fruit can be produced via parthenocarpy. Auxin is sprayed on the stigma to stimulate ovaries to develop into fruit without fertilisation. The fruit produced will be larger and seedless.



Sexual Reproduction in Flowering Plants

Activity 6.1

1. (a) Stamen (filament and anther)
 (b) Carpel (stigma, style and ovary)
2. Bright-coloured petal to attract the pollinating agent.
3. Stamens are below the stigma so that pollens carried by the pollinating agent that fall from the stamens stick to the surface of the stigma.

Formative Practice 6.1

1. (a) A : anther
 B : petal
 C : filament
 D : stigma
 E : ovary
 F : sepal
 (b) A : Has pollen sacs which contain pollen grains (microspores)
 B : Attracts insects and animals
 C : Stalk that holds up the anther
 D : Place where pollination occurs
 E : Female reproductive organ
 F : Protects the flower at bud stage
2. Anther produces male gametes (pollen grains) while carpel produces embryo sac.

Aspect	Male reproductive organ	Female reproductive organ
(a) Name	Stamen	Carpel
(b) Structures which form	Filament and anther	Stigma, style and ovary
(c) Function	Produces pollen grains	Produces embryo sac cell

Activity 6.2

- (a) Produce a three-dimensional image of pollen grains
(b) 3% sucrose solution is a solution that is isotonic to the pollen grain cells. This solution can maintain the shape and size of the pollen grains.

Sketch	Name of plant	Features of pollen grains	Importance
	Hibiscus	Spiky/ with hooks	Easily sticks to insect legs and surface of stigma for pollination
	<i>Mimosa pudica</i>	<ul style="list-style-type: none"> • Sticky • Small 	Easily sticks to insect legs and surface of stigma for pollination
	<i>Lalang</i>	<ul style="list-style-type: none"> • Thin • In a large quantity 	Transferred easily by wind for pollination

Formative Practice 6.2

- (a) Microspore mother cell
(b) Megaspore mother cell
- Produces two nuclei, namely the generative nucleus and the tube nucleus. The tube nucleus forms pollen tube whereas the generative nucleus divides mitotically in the pollen tube to form two male gametes.
- Produces gametes which are haploid
- 3 antipodal cells, 2 polar nuclei, 1 egg cell, 2 synergid cells

Activity 6.4

- To obtain fresh pollen grains and able to germinate.
- Based on student's observations.
- Germination requires the energy supplied by sucrose. The formation of pollen grains do not occur without sucrose.
- The pollen tube is difficult to be observed because it is colourless.

Formative Practice 6.3

- The transfer of pollen grains from the anther to the stigma
- Pollination transfers pollen grains from anther to stigma. The presence of pollen grains on the stigma initiates the fertilisation.
- Tetrad cells are haploid to maintain the number of chromosomes in the zygote after fertilisation.
- Produces two nuclei, namely the tube nucleus that will form the pollen tube and the generative nucleus that will form the male gametes.
- The nucleus of megaspore mother cell with undergo mitosis three times to produce eight nuclei.
- The fertilisation of male and female gametes produces a diploid zygote and transmits genetic information to the next generation. The fusion of the second male gamete with the polar nuclei to form a triploid endosperm nucleus that will develop into the endosperm tissue. This tissue supplies food for seed germination.

Activity 6.6

1. Fruit – ovary, seed - ovule
2. Ovary

Formative Practice 6.4

1. One cell will develop to form the suspensor and another cell will develop to form the embryo.
2. Testa
3. Anchors the embryo to the wall of the embryo sac
4. Plumule grows up to form the shoot while radicle grows down to form the root.
5. Exocarp is a strong and waterproof skin. It protects fruit from water loss and fungal attack.

Formative Practice 6.5

1. Seeds contain embryos that will germinate to form new plants.
2. (a) Cotyledons supply food to seedlings before the presence of leaves for photosynthesis.
(b) Increase the chances for seed germination to ensure the survival of the plant species.
3. Asexual reproduction produces crops that have the same features as the parent, i.e. identical and there is no additional better feature Q. Sexual reproduction produces plants that inherit features from two trees that produce seedlings which are not identical and of better quality.

Summative Practice 6

1. Stimulate the germination of the pollen grains to form pollen tube.
Makes the stigma sticky and allows the pollen grain to stick to it.
2. Meiosis – Produces haploid gamete cells
Mitosis – Increases the number of nucleus to develop into pollen grains
3. The colour of the petals can attract pollinating agents
4. Located inside the petals. This ensures the insects that enter the flower for nectar will come into contact with pollen grains and transfer them to the stigma.
5. *Lalang* has many pollen grains which are light. This feature enable the pollen grains are easily dispersed by the wind.
6. Stored in an airtight container and with the absence of water. The seeds cannot germinate without air and water. This enables seeds to be stored for a long time.
7. No. There is no germination of the pollen grain on the stigma, no formation of pollen tube.
8. Liza. Coniferous trees / gymnosperms do not have flower but have seeds produced by the cone.

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9. Breeding insects such as butterflies and beetles as pollinating agents in the greenhouse. Chances for pollination is higher and increase in the formation of fruits



Adaptations of Plants in Different Habitats

Formative Practice 7.1

- Two adaptive features of halophytes to increase the rate of photosynthesis:
 - Halophytes have leaves with thick cuticle to ensure sufficient water content
 - The root system that branches widely ensures that hydrophytes remain upright in the muddy soil and ensures the plant gets maximum light intensity.
- Xerophytes. The leaves grow on top of the tree to provide shade to the stem so that there is lesser water loss through evaporation. Thorns on stems and leaves are as protection so that no animal makes the plants as their food. The roots grow deep into the soil to obtain water supply for life.

Summative Practice 7

- Halophytes.
 - Problems and adaptations of mangrove trees:
 - Live in soft and muddy soil. To overcome this problem, the root of the mangrove trees branches widely to give support.
 - Water-retaining soil and low oxygen content. Mangrove trees have respiratory roots that grow vertically upwards above the soil surface called pneumatophores. On these roots, there are many pores called lenticels to enable the exchange of gases with the atmosphere.
 - Receive high intensity of sunlight. Leaves covered with cuticle and embedded stoma to reduce water loss to the environment.
 - Oil will make the lenticels clog up, causes the death of the mangrove trees because of not receiving enough oxygen supply for the roots to carry out respiration.
 - Mangrove trees can live in freshwater habitats. Mangrove trees do not need salty water to survive.
- Two features of *Aloe vera* plant: thorny and succulent
 - Xerophytes.
 - The thorns on the leaves protect the *Aloe vera* plant from becoming food to animals. Succulent leaves reduce water loss through evaporation to the environment.
 - Bring the *Aloe vera* plant inside the house. This is because the roots of this plant rot easily when exposed to an abundance of water.



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- Ru, jelutong and coconuts. This is because the needle-shaped and pointed scales leaves can reduce wind resistance, thus prevent the trees from being uprooted when there is a strong wind. Needle-shaped leaves can reduce extreme water loss due to exposure to high light intensity.



Biodiversity

Activity 8.1

Observations:

Kingdom	Number of cells	Structure of cell wall	Presence of chlorophyll	Presence of nucleus	Example of organisms
Archaeobacteria	Unicellular	No peptidoglycan	Absent	Absent	<i>Halobacterium salinarum</i>
Eubacteria	Unicellular	Contains peptidoglycan	Some bacteria have chlorophyll	Absent	<i>Lactobacillus</i> sp.
Protista	Unicellular and multicellular	<ul style="list-style-type: none"> No cell wall for protozoa Cell wall exists for algae 	<ul style="list-style-type: none"> Some protozoa have chlorophyll All algae contain chlorophyll 	Present	<ul style="list-style-type: none"> <i>Paramecium</i> sp. (unicellular) <i>Fucus</i> sp. (multicellular)
Fungi	Unicellular and multicellular	Chitin	No chlorophyll	Present	<ul style="list-style-type: none"> <i>Saccharomyces cerevisiae</i> (Unicellular) <i>Agaricus</i> sp. (multicellular)
Plantae	Multicellular	Cellulose	Contain chlorophyll	Present	<i>Bougainvillea</i> sp.
Animalia	Multicellular	Absent	Absent	Present	<i>Elephas maximus</i>

Formative Practice 8.1

- Does not contain chlorophyll; cell wall made from chitin; produces spores; fungi cells arranged into a network of threads called hyphae. (Any two characteristics)
- Organisms in a domain can be divided into kingdoms which can in turn be divided into phylums. Phylums can be further divided into classes, classes into orders, orders into families and families into genus and finally genuses into species. A species is the smallest group of organisms in the classification system.
- The binomial nomenclature system is introduced by Carolus Linnaeus.
- In the binomial nomenclature system, each organism is given a name made from two parts. The first part is the name of the genus and the second is the name of the species.

Formative Practice 8.2

- Ecosystem diversity refers to the biotic community and ecological process in ecosystems on the land, in the sea and other aquatic environments. Species diversity refers to the variation and variability of organisms on Earth. Genetic diversity refers to the genes variation of an individual within a population and the genes variation between different populations of the same species.

- To show the evolutionary relationship and history of a biological species.
- By making structured and sustainable development plans so that forests are not cut down and deforestation does not occur; avoid products made from animal hide or body parts that are thought to have medicinal value.
- As a source of research and development; A sanctuary for wildlife and endemic life; to maintain environmental temperature; provide food to humans and animals; provide raw materials and medicinal products to humans; generate income for the population and the country (Any two importances)

Formative Practice 8.3

- When outside a living host cell, the virus exists as a crystal and is not considered a living thing because it does not carry out any life processes.
- If the host dies, the parasite can no longer obtain anymore benefits from the host.
- A symbiont is an organism which has a close relationship with another organism (known as the host). There are two types of symbionts, ectosymbionts and endosymbionts. Ectosymbionts are organisms that live outside of host cells while endosymbionts are organisms that live inside host cells.
- Pathogens are microorganisms that spread diseases. Example:

Pathogen	Vector
<i>Vibrio cholerae</i>	Fly
Dengue virus	Mosquito
<i>Salmonella typhi</i>	Cockroach

Summative Practice 8

- Felis catus*
 - In the binomial nomenclature system, domestic cats are given a name consisting two parts, *Felis catus*. *Felis* is the name of the genus and *catus* is the name of the species for domestic cats.
- One male specimen and one female specimen from the two amphibian species are mated together. If the pair can produce a viable progeny, then they are of the same species. If they are unable to produce a viable progeny, then they are not from the same species.
- Fungi have cell walls like plant cells, but the cell wall is made of chitin instead of cellulose. Fungi are not autotroph or photosynthetic because they do not contain chlorophyll. Fungi are not holozoic like animals which eat complex food. Fungi are parasites or saprophytes which digest food outside the hyphae. As the fungi is not autotrophic or holozoic, it is places in a kingdom separate from Plantae and Animalia.
 - Without fungi, the decomposition process does not occur. Organic matter will die and their bodies will crowd the environment. Important nutrients in the dead organisms are not returned to the soil to be reused by plants. Plants will suffer from nutrient deficiency.
- Based on student's answer.
- Plants and animals require nitrogen to build protein. However, both plants and animals cannot absorb nitrogen directly from the atmosphere.
 - Nitrogen-fixing bacteria that live in the root nodules of legumes like *Rhizobium* sp. and free-living nitrogen-fixing bacteria in the soil such as *Azotobacter* sp. fixes the nitrogen from the atmosphere and changes it to ammonium ions (NH_4^+) via ammonification.

- Lightning in a thunderstorm oxidises nitrogen to nitrogen dioxide which dissolves in rainwater to form nitrous acid and nitric acid. Both form nitrate in the soil.
 - Industrial fertilisers provide ammonium fertilisers and nitrates in the soil.
 - When plants and animals die, decomposition is carried out by decomposers such as bacteria and saprophytic fungi. Protein in body tissue will be broken down into ammonium ions (NH_4^+).
 - Ammonium ions are converted into nitrite ions via nitrification by the nitrification bacteria *Nitrosomonas* sp.
 - Nitrite ions will be converted to nitrate ions by the nitrification bacteria *Nitrobacter* sp.
 - The nitrates will then be absorbed by plant roots and used to synthesised proteins. When the plants are eaten by animals, nitrogen gets transferred to animal tissue.
 - Denitrifying bacteria converts nitrates in the soil into nitrogen gas through the denitrification process.
6. • One way to classify organisms found in the herbaceous garden in school is to use a dichotomous key.
- A dichotomous key is a tool to identify organisms based on a pair of discerning characteristics.
 - The steps are as follows:
 - Observe the main physical characteristics of a group of organism so it can be divided into two groups.
 - In each group, find one or more characteristics that can further divide the group of organisms into two smaller groups.
 - Repeat this over and over again until you arrive at one final organism.
 - The characteristic used must be obvious and easy to observe.
 - The classification into two groups must be based on opposite traits.
 - The terms used must be clear.
7. • Termites live in symbiosis with a type of protozoa called *Triconympha* sp.
- This protozoa lives in the intestines of the termite and secretes cellulase enzymes to digest wood (cellulose) which is absorbed by the termites.
 - Termites cannot produce cellulase enzyme.
 - Thus, the best way to exterminate the termites is to exterminate the protozoa.
 - If the protozoa dies, then the termites also die as they cannot obtain nutrients from the wood they eat.
8. Methods to preserve and conserve the biodiversity in Malaysia:
- Replant trees that have been cut down
 - Reduce deforestation
 - Gazette more forest areas as forest reserves
 - To consider the ecosystems when planning development activities
 - Ensure the damage to the environment is minimised when planning an infrastructure
 - To use the laws to penalise those involved in illegal logging, deforestation or illegal poaching



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9. • Crop rotation is an agriculturally sustainable method of planting different types of crops on the same piece of land.
- Legume plants are planted in rotation as this type of plant can put nitrates back into the soil thereby keeping it fertile for other types of plants.
 - High amounts of nitrogen gas in the atmosphere cannot be used directly by plants.
 - Nitrogen-fixing bacteria that live in the root nodules of legumes like *Rhizobium* sp. and free-living nitrogen-fixing bacteria in the soil such as *Azotobacter* sp. fixes the nitrogen from the atmosphere and changes it to ammonium ions (NH_4^+) via ammonification.

- Ammonium ions are converted into nitrite ions via nitrification by the nitrifying bacteria *Nitrosomonas* sp.
- Nitrite ions will be converted to nitrate ions by the nitrifying bacteria *Nitrobacter* sp.
- The nitrates will then be absorbed by plant roots and used to synthesise proteins.
- The roots of legume plants will remain in the soil after the yield has been harvested.
- Leafy green crops which have high nitrogen needs will benefit from the high nitrogen contents of the soil that has been bound there by the legume plants.
- Tuber crops require low amounts of nitrogen. This crop can be planted next after the leafy green crops have been harvested.
- The cycle can be repeated over and over again.



Ecosystem

EXPERIMENT 9.1

Results

Types of seeds / Trays	Height of seedlings (cm)										
	1	2	3	4	5	6	7	8	9	10	Average
Corn / Tray A	40.2	41.3	39.4	40.8	44.2	38.6	43.3	41.4	42.0	40.8	40.8
Paddy / Tray B	36.3	34.7	36.1	35.0	35.1	35.0	36.1	36.3	35.7	36.0	35.63
Corn / Tray C	45.1	44.0	46.3	46.0	46.4	45.8	45.0	45.0	45.7	44.9	45.42
Paddy / Tray C	25.7	26.0	26.3	24.8	25.0	25.3	25.3	26.0	23.8	24.2	25.26

Discussions

1. Tray A – Intraspecific
Tray B – Intraspecific
Tray C – Interspecific
2. Trays A, B and C – Compete to get minerals, water and sunlight
3. Based on students' experiment
4. Based on students' experiment

Formative Practice 9.1

1. (a) A group of similar organisms that can interbreed with each other and produce offspring.
(b) A group of organisms of the same species and live in the same habitat.
(c) Different types of organisms that live in the same habitat and interact with each other.
2. Biotic and biotic components – Grasshoppers eat grass / Birds eat grasshoppers
Biotic and abiotic components – Grass absorb water from the soil / Plants absorb sunlight
3. Aspect refers to the direction in which wind blows and the rays of sunlight.
The mountain slope which receives more rain and sunlight has more abundant plants.
4. (a) As the trophic level increases, the number of organism decreases
(b) As the trophic level increases, the total biomass per unit area decreases
(c) As the trophic level increases, the value of energy decreases

5. (a) Natural barrier towards strong waves and wind blows / Habitat for various animal species.
- (b) The source of income for fishermen who catches sea products / Raw substances for charcoal production.
- (c) A place of resting for migratory birds which attracts tourists.
- (d) A site to carry out ecosystem study.

Activity 9.3

Observations:

Plant species	Quadrat										Total number of species	Density of species (m ²)
	1	2	3	4	5	6	7	8	9	10		
X	3	1	4	2	4	1	5	4	3	3	30	$30 / (10 \times 1 \text{ m}^2) = 3 \text{ individuals / m}^2$

Plant species	Quadrat										Area covered by species	Coverage percentage (%)
	1	2	3	4	5	6	7	8	9	10		
X	0.3	0.2	0.3	0.2	0.3	0.2	0.4	0.4	0.4	0.3	3.0	$3 / (10 \times 1 \text{ m}^2) \times 100 = 30\%$

Discussion:

1. Random distribution. Organisms are in a free pattern in an area.
2. Temperature, light intensity and humidity
3. Frequency: 70%
Density: 3 individuals per metre
Coverage percentage: 30%

Activity 9.4

Observations:

Area	Number of centipedes			Population size
	First capture	Second capture		
		Captured number	Marked number	
Science garden	36	40	12	$\frac{36 \times 40}{12} = 120$

Discussion:

1. Nail polish. Does not harm the organism and causes death / migration to another area.
2. Biotic: Feed on smaller insects; small plants take shelter from sunlight.
Abiotic: Oxygen to breathe; water maintains the humidity of skin; stones for hiding.
3. Oxygen, food, water

Activity 9.5

Discussions

Quadrat	Total coverage of <i>Pleurococcus</i> sp. in every quadrat (cm ²)	Total coverage of <i>Pleurococcus</i> sp. in all quadrat (cm ²)	Coverage percentage of <i>Pleurococcus</i> sp. (cm ²)
P	50	300	$\frac{300 \text{ cm}^2}{5 \times 100 \text{ cm}^2} \times 100$ $= 60\%$
Q	90		
R	40		
S	75		
T	45		

$$\text{Coverage percentage} = \frac{\text{Area covered by } \textit{Pleurococcus} \text{ sp. in five quadrats (cm}^2\text{)}}{\text{Total number of quadrats used (5) } \times \text{ Area of a quadrats (100 cm}^2\text{)}} \times 100$$

Discussions

- (a) T (b) S
- (a) Q (b) R
- The population distribution of *Pleurococcus* sp. is higher in the area of moderate light and temperature distributions because the rate of photosynthesis is the highest.
When the light intensity and temperature are high, the outer layer of tree trunk becomes hot and hydration of *Pleurococcus* sp. cells happens. The growth rate of *Pleurococcus* sp. becomes slower.

Formative Practice 9.2

- Population size is the number of organisms present in a population whereas population distribution is the number of individuals of a species per unit area of habitat.
 - Temperature, water, pH of soil, salt content, mineral content, reproduction place and food supply
 - Clumped – Clumped organisms forming separated groups because of uneven distribution of resources.
Random – Organisms are in a free pattern in an area due to lack of interactions with each other.
Uniform – Organisms scattered all over the area because every individual competes for limited resources in an area.
- Divide the quadrat into smaller square parts of the same size using wires or strings. Small squares which are covered by species either half or more are counted as having coverage whereas lesser than half are ignored.

Summative Practice 9

- Zone 1 – *Avicennia* sp. and *Sonneratia* sp.
Zone 2 – *Rhizophora* sp.
Zone 3 – *Bruguiera* sp.

- (b) (i) Colonisation
(ii) Succession
- (c) Zone 2 will be formed in between the breeding pond and Zone 1.
The species present in the habitat will be undisturbed because the fish pond maintains the natural surroundings. The succession process of Zone 1 will take a longer time.
2. Parasitism between lice and buffalo.
Mutualism between myna and buffalo.
Competition between myna (intraspecific) to seize lice as food.
3. (a) Waterproof paint
- $$\text{Population size} = \frac{(\text{Number of animals in first capture}) \times (\text{Number of animals in second capture})}{\text{Number of marked animals in second capture}}$$
- (b) Population size = _____
- (c) (i) There is no migration in and out of the studied fish species because the pond is a closed habitat.
(ii) There is no dead or hatches of fish fry during the study.
4. Area: Jeram, Kuala Selangor
- There are many raw mangrove woods.
 - Labours can be easily gained from the villagers of the surrounding villages.
 - There are many empty sites to build factories.
 - Good transport system.
 - Nearby to the main towns in which the charcoal will be marketed.

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5. (a) The study is about the aeration and support systems of the mangrove trees.
Involve supervision towards pneumatophore roots, prop roots and buttress roots.
High tide and low tide happen twice a day at the study site.
Some part of the roots are submerged with seawater during high tide.
Needs longer time as estimated by Mrs Haniza.
- (b) Observing and drawing plants species in different zones
Estimating the population of organisms
Listing down the biotic and abiotic components
Constructing food chains and food webs
Taking photographs of mangrove species in different zones

EXPERIMENT 10.1

Results:

Water samples	Time taken for 0.1% blue methylene solution to decolourise (hour)	The rate of water pollution (hour ⁻¹)	BOD level
Tap water	Does not decolourise	-	Lowest
Drain water	1 hours	1	Highest
River water	3 hour	0.3	High
Pond water	2 hours	0.5	High
Well water	Does not decolourise	-	Lowest
Distilled water	Does not decolourise	-	Lowest

Discussions:

- The end of the syringe must reach the bottom part of reagent bottle to avoid the solution from being oxidised by atmospheric oxygen in the reagent bottle.
- The fastest for the 0.1% methylene blue solution to decolourise: Drain water
 - The slowest for the 0.1% methylene blue solution to decolourise: Tap water
- Drain water shows the highest BOD level followed by pond water, river water, well water and tap water. Drain water takes the fastest time to decolourise 0.1% methylene blue solution as compared to the other samples. Drain water contains the lowest dissolved oxygen content as compared to the other samples. This showed that the drain water is the most polluted.
- As a control set
- The faster the time taken to decolourise the 0.1% methylene blue solution, the higher the level of water pollution.

Formative Practice 10.1

- Deforestation, open burning, animal farming, mining, agriculture and combustion (Any three activities)
- The usage of nitrate and phosphate fertilisers causes eutrophication. Algae grow rapidly until they cover up the surface of water. The photosynthesis rate in water becomes low. The content of dissolved oxygen in the water is reduced. Aquatic plants will be deprived of oxygen and finally dies.
- Increase in human activities such as burning of fossil fuels increases the release of greenhouse gases such as carbon dioxide gas. This gas traps heat in the atmosphere, causes an increase in the Earth's temperature.
- With the presence of habitats, aquatic animals are able to reproduce. Aquatic animals such as fish and shrimps are the sources of protein. Rivers can provide working opportunity to the fishermen to increase their source of income.

Formative Practice 10.2

- Ecosystem preservation is an effort to protect the components of an ecosystem so that it can maintain its natural condition.
 - Ecosystem conservation means the efforts of healing environmental resources such as water, forest, energy, air, minerals and others which are used without causing them to extinct.
 - Ecosystem restoration means efforts for renewing and restoring natural ecosystem which are deteriorated, damaged or destroyed due to human activities.
- National park
 - Zoo
- Suggestions of preservation and conservation steps:
 - Suggestion 1: The housing area is built far away from the hillside. This ensures the safety of residents and houses.
 - Suggestion 2: Replant all trees that were cut so that the roots of the trees can grip the soil. This maintains the hillside stability and avoids landslide.
 - Suggestion 3: Plant grass to cover the Earth. This avoids heavy rain from causing soil erosion and rain water to drain soil and mud which causes mud flood.

Formative Practice 10.3

- Four important components of food security: Food availability, food access, food usage and food stability.
- Food entrepreneur needs to prepare enough food with good quality and accommodate the needs of local society especially. The food prepared must meet nutrients requirements and follows the guidelines of GMP and HACCP.
- Steps to save electric in the office:
 - Turn off the lamps when not in use.
 - Use energy-efficient equipment.
 - Set the brightness of computer screen to a suitable brightness.
 - Use rechargeable batteries for wireless telephone and remote control, rather than using regular batteries.
 - Use LED lamps rather than fluorescent lamps.
 - Set the temperature of air-conditioner from 23 °C to 25 °C.(Any five steps)

Formative Practice 10.4

- Green technology refers to the development and application of products, equipments and systems to preserve the environment and nature and minimising or reducing negative impacts from human activities.
- Using energy from renewable sources, such as solar energy.
 - Do activities which can decrease the release of carbon dioxide gas, such as carpooling and using public transport.
- This campaign is able to preserve the environment by increasing the quality of water and soil if plastic substances are not being thrown into soil and water. This can avoid water pollution and save aquatic animals from accidentally eating plastic. With the absence of plastics, there will be no dangerous gases released due to plastic combustion and therefore, there will be no air pollution.

Summative Practice 10

1. (a) Figure 1.1: Greenhouse effects
Figure 1.2: Deforestation
 - (b) Carbon dioxide gas, methane gas, nitrogen oxide gas and chlorofluorocarbon gas. (Any two pollutants)
 - (c) Deforestation activities cause reduction in the number of trees which carry out photosynthesis. This causes an increase in the concentration of carbon dioxide in the atmosphere that will trap more heat in the atmosphere. The temperature of the Earth increases.
 - (d) The effects of activity in Figure 1.1:
 - Excessive heat trapped on Earth which causes climate change.
 - Changes in rainfall distribution and snow.
 - Increase in sea levels due to sea warming and ice melting at the poles.
 - Draught and heat wave happen more frequent.The effects of activity in Figure 1.2:
 - Life loses their natural habitats.
 - Flora and fauna extinction.
 - Loss of rainwater catchment areas.
 - Soil erosion happens which brings landslides and flash floods.
2. (a) Food security is translated as the guarantee of food which refers to the guarantee of food availability, guarantee of food access and guarantee of food usage.
 - (b) Kwashiorkor and other malnutrition diseases.
 - (c) Threats of food security:
 - Food supply shortage which is caused by the inability of domestic food production and supply.
 - Low living standards makes the population unable to afford food.
 - Unclean surroundings and inadequate basic facilities cause low qualities of food and low in nutrients.
 - (d) Government responsibilities:
 - Provides healthy food program such as healthy breakfast program.
 - Provides a safety network program of food security such as Food Bank Program.
 - Organises programs to increase the living standards of people.
 - Gives education to the households about choosing safer and healthier diets and also safer techniques of producing, processing, storing and handling of food.
3. (a) Physical characteristics of Malayan tiger: have reddish or rusty-brownish furs, and grey, brown or black stripes on the body.
 - (b) Malayan tiger extinction causes the dynamic stability of an ecosystem to be affected. Tigers are predators; their absence causes the food chain to be affected. Excess populations of the other predators will cause the extinction of smaller animals.
 - (c) Factors causing the extinction of Malayan tiger:
 - Extensive deforestation for development and agriculture causes the natural habitats of Malayan tigers to destroy.
 - Lack of food sources due to extensive hunting activities towards Malayan tigers' food sources.
 - (d) Steps of preservation and conservation of Malayan tigers:
 - Implementing the Wildlife Protection Act 1922
 - Gazetting forest reserves for maintaining the habitats of tigers.
 - Providing a breeding facility for the tigers in zoo to increase the population of tigers.

21st Century Mind

4. Yes, I agree.
 - Separating (*sisih*) practice can isolate and determine the things that are needed and unneeded. Unneeded things will be disposed off. This ensures a tidier and safer workplace.
 - Arranging (*susun*) practice enables to label, arrange and store things or documents neatly, easier to be taken and keep them at their respective places again. Working operation becomes more systematic and in order.
 - Sweeping (*sapu*) practice, wiping and cleaning the workplace neatly so that there are no dusts and dirt at the surrounding workplace. This ensures a safer and cleaner workplace.
 - Uniform (*seragam*) practice ensures the workplace always in order at all times so that work operation becomes more efficient.
 - Always practice (*sentiasa amal*) able to train the workers to practice this system continuously so that it becomes a quality habit and culture in the organisation.
 - These practices are one of the strategies of sustainability development.



Inheritance

Activity 11.1

1. Monohybrid inheritance
2. (a) Yes
(b) The phenotypic ratio follows the expected ratio of Mendel's First Law, which is 3:1. The dominant phenotype is three times to the recessive phenotypes. This is because the organism characteristic is determined by a pair of alleles which get separated, and then each allele is carried by a gamete. A dominant allele will show its trait when present.
3. To ensure that each bag will always have a total of 100 beads (50 red and 50 white). This is to ensure that the population is not disturbed after each count.
4. By adding more but equal number of each coloured beads.

Formative Practice 11.1

1. Purebreed means that the organism genotype is homozygous; whether it is homozygous dominant or homozygous recessive. The organism carries two similar alleles for each characteristic.
2. Both parents have black fur with Bb genotype.
3. All offsprings are tall (genotype) with Tt genotype.

Formative Practice 11.2

1. Dihybrid inheritance
2. Round and yellow pod, round and green pod, constricted and yellow pod, constricted and green pod

Formative Practice 11.3

- Locus: Specific location of a gene in a chromosome.
 - Allele: An alternative form of a gene for a specific trait that is located on the same locus of a pair of homologous chromosome
- Based on the figure, gene that controls flower colour of pea plant is at the same locus of a homologous chromosome and appear as two alleles, which are P and p. P allele determines purple flower (dominant allele) and p allele determines white flower (recessive allele).

Formative Practice 11.4

- | | | | | |
|-------------------|---|-----------|---|-----------|
| Parent | : | Father | | Mother |
| Genotype | : | $I^A I^O$ | x | $I^B I^O$ |
| Meiosis | | | | |
| Gamete | : | I^A | | I^B |
| Fertilisation | | | | |
| Progeny genotype | : | $I^A I^B$ | | $I^A I^O$ |
| Progeny phenotype | : | AB | | A |
| Phenotypic ratio | : | 1 | : | 1 |

The probability of one unidentical twin with A blood group is $1/4$.

Therefore, the probability of both unidentical twins with A blood group is $1/4 \times 1/4 = 1/16$

- In each birth, the probability to get a boy is $1/2$.
Therefore, the probability to get a haemophilic boy = $1/2 \times 1/2 = 1/4$
- All children can roll tongue, 50% are homozygotes whereas another 50% are heterozygotes.

Summative Practice 11

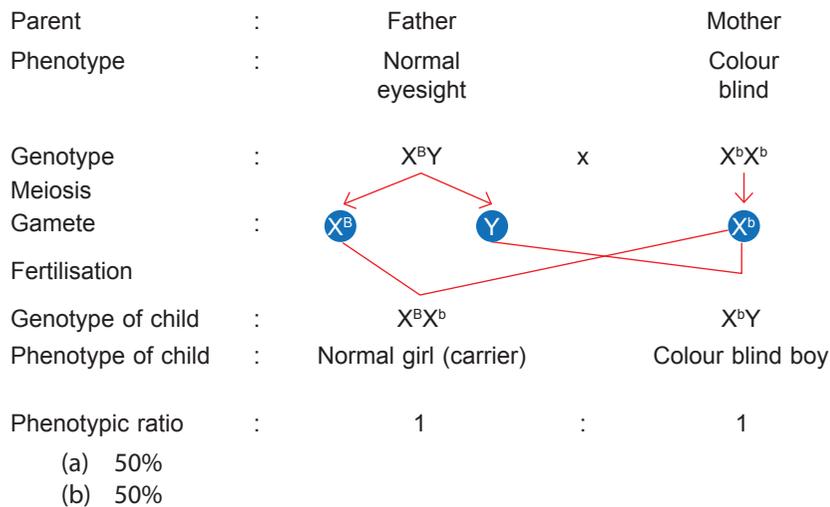
- X: Purple flower, constricted pod
Y: White flower, inflated pod
 - X: P_s
Y: p_S
 - All purple flower, inflated pod
 - $3/16$
 - $9/16$

Gamete	PS	Ps	pS	ps
PS	PPSS	PPSs	PpSS	PpSs
Ps	PPSs	PPss	PpSs	Ppss
pS	PpSS	PpSs	<u>ppSS</u>	<u>ppSs</u>
ps	PpSs	Ppss	<u>ppSs</u>	ppss

Probability $3/16$

- $9:3:3:1$
- During gamete formation, each member of a pair of allele can combine at random with any member from another pair of alleles.

2. Schematic diagram for colour blindness trait:



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- If W represents dominant allele for white face, w represents recessive allele for black face and L represents dominant allele for long horns and l represents recessive allele for short horns.
- White face and long horns phenotype will have $W_L_$ genotype.
- Purebreed parent genotype for white face and long horns is WWLL.
- To obtain purebreed progeny, the progeny has to receive similar genes from both parents.
- To know the parental genotype, it has to be mated with a cattle with purebreed homozygous recessive genotype which has a black face and short horns (wwll).
- Mating : $W_L_ \times wwll$

↓
F₁ generation

F₁ generation that is produced enable us to determine the parental genotypes.

- **Mating 1**
If parent is purebreed (WWLL), mating with purebreed homozygous recessive will produce all progenies in F₁ generation which have white face and long horns.
- **Mating 2**
WWLl x wwll produces progenies with WwLl genotype (white face and long horns) and Wwll (white face and short horns)
- **Mating 3**
WwLL x wwll produces progenies with WwLl genotype (white face and long horns) and wwLl (black face and long horns)
- **Mating 4**
WwLl x wwll produces progenies with WwLl genotype (white face and long horns), Wwll (white face and short horns), wwLl (black face and long horns) and wwll (black face and short horns)
- Therefore, based on the mating outcomes, the breeder cannot use mating approaches 2, 3 and 4 because those mating approaches produce many types of progeny phenotypes.
- The most suitable approach to obtain all progenies with white face and long horns is to follow mating approach 1 because mating outcomes show that the parent is purebreed.

Formative Practice 12.1

1. An organism in a population that has variation possesses characteristic which is adaptable to the environment compared to other organisms within the same population which do not have the variation.

2.

Characteristic	Type of variation
(a) Intelligence	Continuous
(b) Presence of dimples	Discontinuous
(c) Types of hair	Discontinuous
(d) Height	Continuous
(e) Type of earlobes	Discontinuous

3. Genetic factor and environmental factor
4. Sexual reproduction involves fertilisation between male gamete and female gamete. During formation of gamete, cross-linking occurs between homologous chromosomes. Fertilisation between two types of gametes occurs randomly which causes variation in the offspring produced.

EXPERIMENT 12.1

Discussion:

1. Graphs of height and body weight characteristics are in the shape of a bell with normal distribution.
2. Both height and body weight of pupils are continuous variations in which there are differences among pupils in each variation but the differences are not obvious whereas fingerprint pattern is a discontinuous variation in which the differences among pupils are clear and distinct.

Conclusion:

The hypothesis is accepted. Height, body weight and fingerprint pattern of pupils are different.

Activity 12.3

Discussion:

1. PTC taste is a discontinuous variation in which there are groups of pupils who can taste PTC and there are groups which cannot taste PTC.
2. PTC taste is a dominant trait. An individual who can taste PTC has either TT or Tt genotype whereas individual who cannot taste PTC has tt genotype.

Conclusion:

Hypothesis is accepted. Trait for PTC taste can be classified into specific groups.

Formative Practice 12.2

- Inheritance is the transfer of characteristic from parent to progeny or from one generation to the next generation.
 - Characteristic is a physical feature that is inherited or non-inherited.
- Any two human characteristics: Ability to roll tongue / presence of dimples / eye colour / type of hair
- Trait for eye colour: brown / blue

Formative Practice 12.3

- Gene mutation involves change in nucleotide base sequence in DNA molecule of a chromosome whereas chromosome mutation involves change in structure or number of chromosome.
- Eating food which contains mutagen (example, preservative such as benzene) for a long period of time can cause mutation.

Summative Practice 12

- Body mass: Continuous variation
 - Types of earlobes: Discontinuous variation
 -

Continuous variation (Body mass)	Discontinuous variation (Types of earlobes)
Difference in characteristic is neither clear nor distinct	Difference in characteristic is clear and distinct
Normal distribution / bell-shape graph	Discrete distribution / bar graph
Presence of intermediate characteristic	Absence of intermediate characteristic
Has intermediate features	Does not have intermediate features
Influenced by environment factors	Not influenced by environment factors
Characteristic cannot be inherited	Characteristic can be inherited

(Any two characteristics)

- Down syndrome
 - Chromosomal mutation
 - Failure of chromosome 21 to separate during meiosis // occurrence of nondisjunction of chromosome 21. It produces two chromosome 21 in one gamete. When this gamete is fertilised by a normal gamete, a zygote with three chromosome 21 is formed.
 - Trees in plot X are produced from tissue culture / cloning. Therefore, all trees have the same characteristics as their parent. Clones do not show variation in terms of genetics. They have similar resistance towards a disease. If there is an infection, all clones will be wiped out because they cannot survive the disease.
- Thumbprint pattern is an example of discontinuous variation.
 - It is influenced by genetic factor.
 - During gametogenesis / gamete formation, crossing over occurs during prophase I in meiosis
 - Exchange of genetic material / DNA segment occurs at sister chromatids of homologous chromosome pair.

- It produces new genetic combination in gamete.
 - During metaphase I in meiosis, independent assortment of chromosome takes place.
 - Homologous chromosomes are arranged randomly in equatorial plane of cell during metaphase.
 - Separation of homologous pair produces gametes with different genetic combinations.
 - One haploid gamete fertilises at random with another haploid gamete.
 - This will produce a diploid zygote with new combination of genes.
- (b) (i)
- Gene mutation involves change in nucleotide base sequence in DNA molecule of a chromosome whereas chromosomal mutation involves change in structure and number of chromosomes.
 - Types of gene mutation include deletion / insertion / substitution of base in a gene whereas types of chromosomal mutation include duplication / deletion/ inversion / translocation of a chromosome segment.
- (ii)
- Mutations of chromosomes K, L, M and N cause change in chromosomal structures.
 - K is duplication.
 - Part of the chromosome in gene A undergoes duplication.
 - Mutant chromosome has two sets of gene A.
 - L is deletion.
 - Chromosome is cut between gene E and gene F, and F is lost.
 - Mutant chromosome does not have gene F.
 - M is inversion.
 - The segment with D, E and F genes is cut, and the same segment is rejoined but in the opposite direction.
 - N is translocation.
 - Cutting of the chromosome between gene C and gene D; and another chromosome segment with genes X, Y and Z joins at gene C.



21st Century Mind

- A sickle cell anaemia individual possesses haemoglobin S, HbS in red blood cell.
- HbS causes red blood cell to have a sickle cell shape, which is less effective in transporting oxygen as compared to the normal haemoglobin A, HbA found in normal biconcave shape red blood cell.
- Inheritance of sickle cell anaemia is an example of codominance.
- Individual with HbAHbA genotype produces 100% normal haemoglobin.
- Individual with HbSHbS genotype produces 100% sickle cell haemoglobin.
- Individual with HbAHbS genotype produces both normal and sickle cell haemoglobins; and is known as individual with sickle cell trait.
- Most individuals with sickle cell trait are found in parts of the world endemic for malaria; and they are better protected against malaria compared to those with normal red blood cells.
- In life cycle of malaria, merozoites (daughter parasites) develop and reproduce in normal red blood cell.
- However, in red blood cells with a mixture of sickle cells and normal red blood cells, the parasites are killed before the merozoites are released.
- A sickle cell anaemia individual is anaemic but he/she has lower chance of acquiring malaria.



13

Genetic Technology

Formative Practice 13.1

1. Genetic engineering is a gene manipulation technique to modify genetic materials of an organism to produce new combinations of gene.
2. Organism that carries recombinant DNA or foreign gene in all its cells.
3. Effect of GMF on human health.

Formative Practice 13.2

1. By gene therapy method. Damaged genes are removed and replaced with normal genes.
2. Refer to Table 13.2 Contributions of biotechnology to life: Any two contributions.

Summative Practice 13

1. (a) Insulin
(b) Q, R, P, S
(c) 1. Bacteria reproduce rapidly in a short period of time.
2. Bacteria has plasmids which are easy to manipulate in transferring gene / can carry out self-replication.
(d) Vaccine and growth hormone
(e) (i) Suspect number 2. The arrangement of DNA fragment bands of suspect number 2 matches the DNA arrangement obtained from blood sample on knife.
(ii) Yes, because each individual has a unique set of DNA.
(iii) Cannot. Both their DNA sets consist of the same nucleotide sequences. However, both of them can be identified by the differences in their fingerprint patterns.
2. (a) Advantages of GMF to human lives are as follows:
 - Increase the shelf life and quality of food
 - Increase nutritional quality and health
 - Increase quantity of agricultural products
 - Produce crops resistant to herbicides / heavy metals(b) Steps in acquiring and mass producing a bacterial gene:
 - Targeted DNA is isolated from bacterial cell
 - The DNA is cut and inserted into a cloning vector such as plasmid
 - Recombinant plasmid is produced
 - Recombinant plasmid is inserted into a host bacterial cell
 - Bacteria containing the recombinant plasmid is cultured in agar plate
 - Bacterial colony with the recombinant plasmid is identified
 - The bacteria in the selected colony contains plasmid which carry the targeted gene(c) Threat of genetically modified plant towards herbicide to the environment:
 - It is difficult to curb the growth of a plant variety which tolerates herbicide
 - Stronger herbicide will be needed to kill it
 - The plant can mutate to produce stronger variety
 - The gene resistant to herbicide may be transferred from this plant to weed by pollinating agents.

- This situation can create super weed
- New herbicide has to be used to kill the super weed
- Therefore, farmers will have to always use herbicides
- Wide usage of herbicides will threaten the environment



21st Century Mind

3. Justifications:

- Labelling is important to enable consumers to make decision on whether to buy the food with the declared contents.
- According to Food Act 1983 and Food Regulation 1985, food and drinks that are produced by modern biotechnology must state their genetic sources on the wrapper label.
- Statement such as“(name of ingredient) is genetically modified” must be displayed clearly on label to inform consumers.
- The community are anxious to know that the consumption of foreign gene in transgenic plant can cause unknown diseases.
- Another issue is whether GMF is halal.
- The materials used to produce GMF may be obtained from non-halal sources such as pig or unknown animal status.
- Genetic sources which are non-halal and deteriorate human health as well as the environment will not be permitted.

4. Reasons on why humans are interested in elephant tusks:

- Elephant tusk is used to make decorative items and sculptures because it is long lasting, easy to sculpture and non-easily broken.
- Elephant tusk is believed to have medicinal value in some Asian countries.
- Possessing it is seen as a status symbol among the rich in China.

DNA profiling technique:

- DNA profiling technique helps to identify the locations where elephants are hunted for their tusks.
- If elephant tusks were smuggled, DNA profiling of the smuggled ivory can be compared with the DNA profiles from known locations. This will enable identification of the original location of the smuggled ivory. Based on the identification of the location, more stringent monitoring will then be enforced in the location to prevent hunting and smuggling of elephant tusks.