MINISTRY OF EDUCATION

BIOLOGY
for Senior High Schools

TEACHER MANUAL

Year 2

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

Biology

for Senior High Schools

Teacher Manual

Year Two

NATIONAL COUNCIL FOR
CURRICULUM & ASSESSMENT
OF MINISTRY OF EDUCATION

BIOLOGY TEACHER MANUAL

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Introduction

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS) curriculum which aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

This Teacher Manual for Biology is a single reference document which covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year Two of the new curriculum. It contains information for all 24 weeks of Year Two including the nine key assessments required for the Student Transcript Portal (STP).

Thank you for your continued efforts in teaching our children to become responsible citizens.

It is our belief that, if implemented effectively, this new curriculum will go a long way to transforming our Senior High Schools and developing Ghana so that we become a proud, prosperous and values-driven nation where our people are our greatest national asset.

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SECTION 1: BIOLOGY AS THE SCIENCE OF LIFE

STRAND: EXPLORING BIOLOGY IN SOCIETY

Sub-Strand: Biology as the Science of Life

Learning Outcome: *Relate the knowledge of the characteristics and life processes of common simple living organisms to their economic importance (Rhizopus, Mosses and Ferns).*

Content Standard: Demonstrate knowledge and understanding of common lower living organisms in the environment.

Sub-Strand: Biology and Entrepreneurship

Learning Outcome: *Apply the knowledge of the basic concepts in Biology to improve crop and animal production.*

Content Standard: Demonstrate knowledge and understanding of some basic concepts in Biology and their application to improve crop and animal production.

Hint

- *Assign Group project work in week 2 to submitted by week 8. See **Appendix A** for more information on the project work.*
- *Give learners their Individual Portfolio Assessment in week 4 to be submitted by week 23. See Appendix **B** at the end of this session for more information on the portfolio.*

INTRODUCTION AND SECTION SUMMARY

In year one, lessons on simple organisms that are protoctists (Amoeba, Euglena and Spirogyra) were discussed. In this section, we shall be discussing the Rhizopus (Fungi), mosses and ferns (plants). These organisms exhibit distinctive characteristics, life processes and varied economic importance. Rhizopus thrives in a moist environment. The ability of Rhizopus to grow rapidly enhances the breakdown of organic matter, thereby playing a crucial role in decomposition cycles. Mosses are bryophytes and are therefore non-vascular plants characterised by their small size and simple structure. Ferns are pteridophytes. They dominate forest floors and contribute to nutrient recycling

within the ecosystem. The section also discusses some basic biology concepts that are practised in agriculture to improve crop and animal production. This forms part of the sub-strand, Biology and entrepreneurship, which was begun in year one of the Biology Teacher Manual.

When this section is completed, learners are expected to demonstrate knowledge on the organisms discussed and their relevance in the ecosystem. Learners are expected to acquire basic knowledge and skills in crop and animal production aimed at enhancing their entrepreneurial skills for life.

The weeks covered by the section are:

Week 1: *Distinctive characteristics and life processes of Rhizopus.*

Week 2: *Distinctive characteristics and life processes of mosses.*

Week 3: *Distinctive characteristics and life processes of ferns.*

Week 4: *Basic concepts in biology and how these can be used to improve crop and animal production.*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Different pedagogies and exemplars are used in in this section in diverse ways as per the needs of learners. These include collaborative learning, talk for learning, group-based learning, project-based learning, and experiential learning. For instance, in project-based learning, learners in groups make observations on various organisms (such as Rhizopus grown on a piece of bread) and share their observations through report writing. Collaborative learning builds in learners the tolerance of the views of other learners and develop the skills of working in a team. This pedagogy also encourages learners to be constructive in their criticisms. Talk for learning builds in learners the courage for public speaking and improves their confidence. Learners in groups learn to appreciate diversity by accepting to work and learn with their peers from diverse backgrounds. Group-based learning also offers learners the opportunity to support one another. Project-based and experiential learning expose the learner to practical hands-on activities which build their biological experiences. In discussing lessons on crop and animal productions, pedagogies to use include experiential and group-based learning. These pedagogies allow the learner to obtain hands-on-experiences and enhance the sharing of ideas among learners with varied backgrounds.

ASSESSMENT SUMMARY

An arrays of assessment modes are employed in discussing lessons in this section. These include both formative assessments such as class tests and quizzes, assignments and projects, group discussions and oral presentations, and direct questions to learners during the learning process. These strategies arouse the interest of the learner, thereby allowing

all learners to effectively contribute to lessons. Summative assessment modes include end of semester exams, standardised tests (often state-mandated exams) and portfolios (compilation of the learners' work over a period). These tests provide a broad-based, comprehensive assessment of the learners' knowledge in lessons discussed from the curriculum. Summative assessments also provide benchmarks and standards for the performances of all learners. This allows consistency in evaluating learners' academic progress across diverse groups of learners. Most importantly, the assessment techniques used in the section take into consideration the interest of learners at all levels, ensuring that each learner can successfully attempt at least parts of the assessments provided. The recommended mode of assessment for each week is:

Week 1: *Observation*

Week 2: *reporting writing – group*

Week 3: *class exercise*

Week 4: *demonstration*

WEEK 1

Learning Indicators

1. *Describe the distinctive characteristics and life processes of some common simple living organisms.*
2. *Discuss the economic importance of some common simple living organisms.*

FOCAL AREA 1: DISTINCTIVE CHARACTERISTICS, LIFE PROCESSES AND ECONOMIC IMPORTANCE OF RHIZOPUS

Distinctive Characteristics and Structure of the Rhizopus

Rhizopus is a fungus that lives on organic matter that is dead and decaying. It survives in a warm humid environment with organic matter as its substrate. Rhizopus is whitish when it starts to grow and develops into a pale greyish mass as it matures, eventually becoming black. It is the common mould on bread, kenkey and fruits.

Figure 1.1: *Bread mould*

The basic structural feature of fungi is the hyphae. Hyphae are microscopic branching threads. Each thread consists of a tube formed from a wall enclosing the cytoplasm and a vacuole. The hyphal walls are made of chitin, an organic nitrogenous compound. The hyphae contain many nuclei distributed throughout the cytoplasm. Sometimes the hyphae are divided into compartments by cross walls. The fungi do not have chlorophyll so they cannot make their food in the way that plants do. They feed on dead or decaying organic matter and are classed as saprophytes. Their hyphae penetrate the dead material and form a branching network called a mycelium. The mycelium is composed of coenocytic (non-septate) hyphae, which are large and multinucleated. The sporangiophore is the hyphae that grows above the surface of the substrate and is responsible for reproduction. It produces asexual spores (sporangiospores) within a spherical structure called a sporangium. The rhizoids are the root-like structures (hypha) that grow into the substrate and anchor the fungus to the substrate and absorb nutrients. The stolons are the horizontal

hyphae that grow on the surface of the substrate leading to spreading. This spreading leads to the growth of new rhizoids and sporangia. There are several species of Rhizopus. One common example is the *Rhizopus stolonifer.*

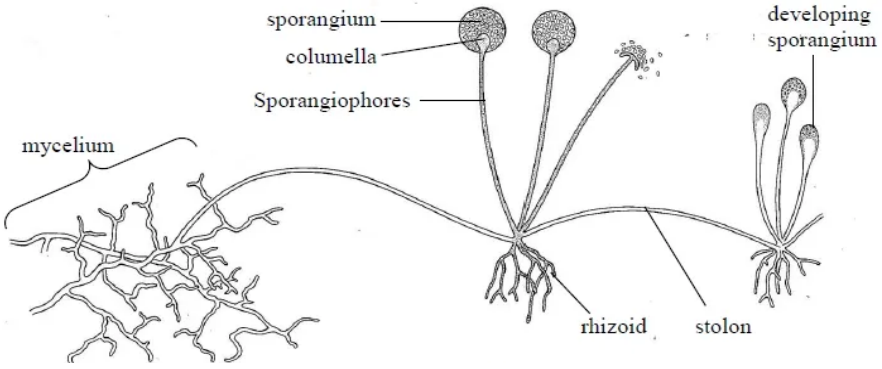


Figure 1.2: *Structure of Rhizopus*

Life Processes of Rhizopus

Rhizopus, like all living organisms, undergoes the seven life processes.

- **Movement:** The hyphae grow and extend through the substrate. This is a form of growth movement. Although the spores do not move, they are dispersed through air or water.
- **Respiration:** They are primarily aerobic, but some species can switch to anaerobic respiration in low oxygen environments.
- **Sensitivity:** Rhizopus responds to environmental stimuli like nutrient availability, light, and humidity. For example, the growth rate of Rhizopus slows down in low temperatures.
- **Growth:** Rhizopus grows rapidly through spore germination and hyphal elongation.
- **Reproduction:** Rhizopus undergoes both sexual (zygospores) and asexual (sporangiospores) reproduction methods.
- **Excretion:** Rhizopus releases metabolic wastes into the environment e.g. ethanol from anaerobic respiration.
- **Nutrition:** The tips of the growing hyphae produce enzymes which digest organic material and absorb the soluble nutrients from the decomposing organic matter through extracellular digestion.

Economic Importance of Rhizopus

- Some Rhizopus species are used in industrial fermentation processes, and in the production of traditional foods in some cultures (e.g. *Rhizopus oligosporus* is used in the production of tempeh).
- Some species of Rhizopus are used in enzyme production and in the production of organic acids (e.g. lactic acid, fumaric acid).

- Rhizopus causes post-harvest losses due to spoilage of fruits and vegetables.
- Rhizopus causes decomposition and recycling of organic wastes in the ecosystem.
- Some species cause diseases (such as mucormycosis, a serious fungal infection which infects immune-compromised individuals).
- Spores of Rhizopus can contribute to indoor air quality problems and trigger allergic reactions.

Learning Tasks

1. Describe the distinctive structural characteristics of the Rhizopus.
2. Describe briefly the life processes carried out by the Rhizopus.
3. Discuss the economic importance of Rhizopus.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning:** In mixed-ability, all-inclusive groups, learners observe the structural characteristics of Rhizopus from videos, textbooks and Rhizopus specimens on slides under microscopes and discuss their observations. Learners listen to their peers and give constructive feedback.
2. **Experiential learning:** Learners individually or in groups grow/culture Rhizopus on food substrates e.g. old bread and kenkey. Learners make observations from the cultures and identify conditions for growth of the structures of Rhizopus. Learners obtain hands-on experiences on the use of practical apparatus like petri dishes, slides, hand lens and microscope.
3. **Project-Based Learning:** Learners in their groups write reports and present their findings on the life processes of Rhizopus. Learners develop a healthy and respectful relationship with one another as they work in teams.
4. **Talk for Learning:** In the class, learners give presentations on the benefits and harmful effects of Rhizopus. Learners learn the act of public speaking and build confidence among themselves through this approach.

KEY ASSESSMENT

Level 1: List the structural characteristics of the Rhizopus

Level 2: Describe the hyphae of the Rhizopus in relation to its position on the substrate.

Level 3: Discuss the life processes of the Rhizopus.

Level 4: Discuss the impact of the presence of Rhizopus in everyday life.

WEEK 2

Learning Indicators

1. *Describe the distinctive characteristics and life processes of some common simple living organisms.*
2. *Discuss the economic importance of some common simple living organisms.*

FOCAL ARE 1: DISTINCTIVE CHARACTERISTICS AND LIFE PROCESSES OF MOSSES

Distinctive Characteristics and Structure of Moss

Mosses are bryophytes found growing on damp soil, on tree bark and bare surfaces of rocks or concretes.

Figure 1.3: *Moss growing on rocks*

Mosses are small plants that lack tissues for transporting water and nutrients. They are described as non-vascular because they do not have true roots, stem, and leaves. Root-like structures called rhizoids anchor them to their substrates and absorb water and nutrients. The leaves are simple, spirally arranged and only a single cell thick with no cuticle, stomata, or internal air spaces. The rhizoids, "stem" and "leaves" together constitute the gametophyte. The gametophyte produces a stalk called seta, with a capsule having a cap called calyptra at its tip. This constitutes the sporophyte.

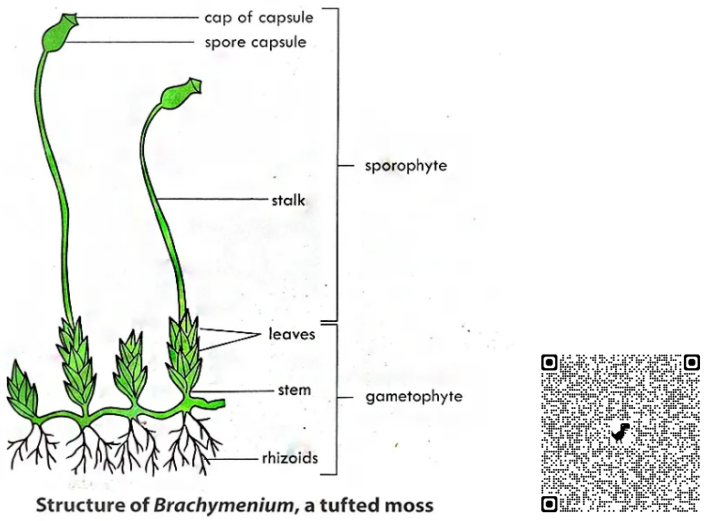


Figure 1.4: *Structure of a tufted moss*

Life Processes of Moss

Mosses, like all living organisms, undergo the seven life processes.

- **Movement:** Growth of the protonema extends through the substrate, and intracellular movement happens by cytoplasmic streaming.
- **Respiration:** Primarily aerobic respiration occurs in mosses.
- **Sensitivity:** They respond to environmental stimuli like nutrient availability, light, and humidity.
- **Growth:** They grow through spore germination and sporophyte formation.
- **Reproduction:** Both sexual (zygote) and asexual (spores) reproduction methods occur. The life cycle of an organism, where asexual spore producing (sporophyte) generation alternates with a sexual gamete producing (gametophytes) generation is described as alternation of generation.
- **Excretion:** Mosses release metabolic waste into the environment.
- **Nutrition:** The cells of the moss are photosynthetic.

Economic Importance of Mosses

- Mosses grow in areas that are bare and are prone to erosion by rain. They are early colonisers on bare land and rocks in ecological succession.
- Mosses are used in carbon sequestration, where they absorb high amounts of carbon dioxide from the atmosphere.
- Mosses are used as traditional medicine to treat a variety of ailments, including respiratory infections, digestive disorders, and skin conditions. For example, the Moss *Sphagnum* is known to be used to treat burns and wounds, while *Polytrichum commune* is used in the treatment of lung infections and coughs.

- Mosses are commonly used in horticulture as a substrate for the cultivation of orchids and other epiphytic plants.
- Mosses have been used as bio-indicators of environmental pollution, particularly for heavy metals.

Learning Tasks

1. Describe the distinctive structural characteristics of the moss.
2. Briefly describe the life processes in the moss plant.
3. Discuss the economic importance of mosses.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning:** In mixed-ability, gender-responsive and all-inclusive groups, learners observe characteristics of moss from within their immediate environment, videos, textbooks, and moss specimens under microscopes and discuss their observations; they learn to make independent observations, listen to their peers, and make constructive comments.
2. **Project-based Learning:** Learners in their groups collect and observe mosses from the environment, laboratory, or watch videos, discuss and write a report, and present their findings on the life processes of mosses to the whole class. Learners develop a healthy and respectful relationships with one another.
3. **Talk for Learning:** Learners in groups (mixed gender/mixed ability) develop and give presentations on the benefits and possible harmful effects of mosses, to the whole class; learners learn the act of public speaking and build on their confidence through this pedagogy.

KEY ASSESSMENT

Level 1: List the structures of the moss plant.

Level 2: Describe the life processes of the moss.

Level 3: Discuss the economic importance of mosses.

Level 4: Examine the benefits of the presence of mosses in the environment.

WEEK 3

Learning Indicators

1. *Describe the distinctive characteristics and life processes of some common simple organisms*
2. *Discuss the economic importance of some common simple living organisms*

FOCAL AREA: DISTINCTIVE CHARACTERISTICS AND LIFE PROCESSES OF FERNS

Distinctive Characteristics and Structure of Fern

Ferns are pteridophytes (vascular plants that reproduce by spores and not seeds). The plant grows in damp and shady environments such as damp soils, forests, swamps, and on other plants. Common species include *Pteridium aquilinum* (bracken fern) and *Plypodium vulgare* (common polypody). The fern body plan is divided into three main parts: frond (leaf), rhizome and sporangium. The fronds are divided into smaller divisions called pinnae. On the underside of the pinnae are the sori, which are clusters of sporangia that produce spores for reproduction. The rhizome is the horizontal underground stem that stores nutrients and produces fronds above and roots below. The roots anchor the plant and absorb nutrients from the soil. Below is a photograph of fern plants growing on a palm tree.

Figure 1.5: *Fern plants growing on a pam tree*

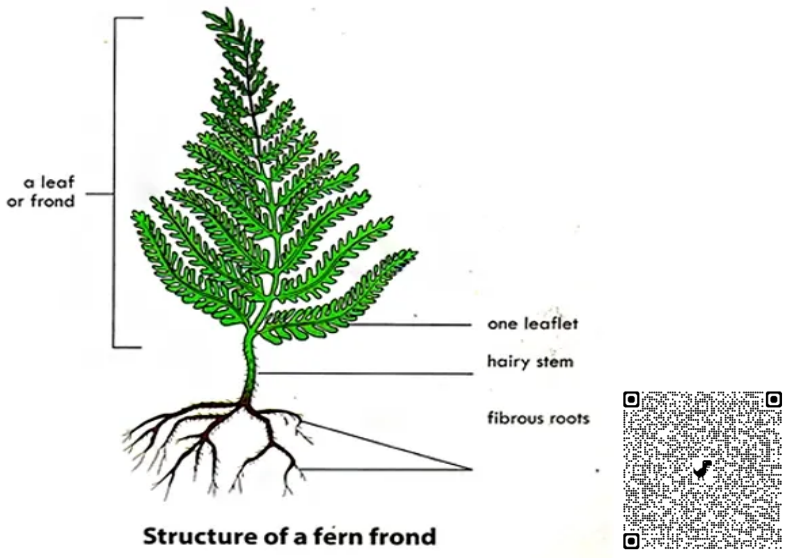


Figure 1.6: *Structure of a Fern frond*

Life Processes of a Fern

- **Nutrition:** Ferns obtain food through their roots and photosynthetic fronds.
- **Reproduction:** The fern shows alternation of generation, where a haploid spore, sexual, gametophyte stage alternates with a diploid asexual sporophyte stage.
- **Respiration:** Ferns undergo gas exchange by simple diffusion through the leaf stomata.
- **Excretion:** Excess salts and other waste materials are removed through their roots.
- **Growth:** They grow throughout their life cycle, from spores to mature plants.
- **Movement:** Ferns perform tropic movements, where they grow towards unilateral sources of stimuli such as water, gravity, and light. The sperm also swims through a film of water to fertilise the egg.
- **Irritability:** Ferns respond to light, gravity, and water.

Economic Importance of a Fern

- Many fern species are grown and used as ornamental plants for indoor and outdoor decorations.
- Some species of ferns are used for medicinal purposes.
- Some species of ferns are used as food in some parts of the world e.g. the tubers of the king fern, *Ptisana salicina* are used as food in New Zealand and the South pacific for preparing traditional meals
- They are useful in eliminating hazardous heavy metals from the soil (e.g. arsenic).

Learning Tasks

1. Describe the distinctive characteristics of the fern plant.
2. Describe the life processes of the fern plant.
3. Examine the economic importance of ferns.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning:** In mixed-ability, gender-responsive and all-inclusive groups, learners observe characteristics of ferns by going on field trips, from videos and textbooks, and discuss their observations; they learn to listen to their peers, share experiences and express constructive criticisms.
2. **Project-based Learning**: Learners in their groups write reports and present their findings on the life processes of the fern, developing healthy and respectful relationships with one another by this means.
3. **Talk for Learning**: Learners design presentations on the benefits and harmful effects of ferns and present their findings in class; learners learn the act of public speaking and build confidence among themselves through this activity.

KEY ASSESSMENT

Level 1: Give the distinctive features identifiable with the fern plant.

Level 2: Describe the life processes of the fern.

Level 4: Examine the impact of the abundance of ferns in an ecological setting.

WEEK 4

Learning Indicators

1. *Identify some basic concepts in Biology and how these can be used to improve crop production.*
2. *Explain some basic concepts in Biology and how these can be used to improve animal production.*

FOCAL AREA: BASIC CONCEPTS IN BIOLOGY AND HOW THESE CAN BE USED TO IMPROVE CROP PRODUCTION

CULTURAL PRACTICES AND ITS IMPORTANCE

Cultural practices are those activities that are carried out in crop production to improve crop yield. Basic biological concepts are embedded in these cultural practices to ensure high productivity. Examples are listed below:

1. **Soil preparation** – This is the first stage in crop production where suitable soil is selected for the intended crops to be cultivated. The choice of soil depends on the knowledge of the soil structure, aeration, and water retention. Soil preparation activities include weeding/ploughing and levelling of the soil. Ploughing aerates the soil and improves water permeability. These activities enhance soil fertility.

Figure 1.7: *Ploughing*

2. **Seed sowing** – This is the stage where viable seeds are selected by farmers for planting in the soil. The seeds may be planted manually (by hand) or mechanically (using a machine or device) in the form of rows (drills) or broadcasting. Seed viability is essential for germination to occur. The choice of seeds depends on the farmer's knowledge in seed viability in biology.

Figure 1.8: *Sowing*

3. **Fertiliser application –** This is the stage where fertilisers are added to the soil to improve fertility and crop production. This includes the use of green manures, composts, and inorganic fertilisers. Green manuring involves mixing or mulching green crops with the soil with the aim of improving the structure of the soil and its fertility. Composting is the practice of converting organic matter into a nutrient-rich soil known as compost.

Figure 1.9: *Fertilizers*

4. **Irrigation –** Irrigation refers to the practice of supplying water to crops to provide sufficient moisture for growth and development. Plants depend on adequate water for photosynthesis, leading to growth and fruit/seed development. Irrigation can be done through water supplied in canals, tube-wells, reservoirs, and wells.

Figure 1.10: *Manual irrigation*

Figure 1.11: *Mechanical irrigation*

5. **Pruning –** This is the practice of selectively removing certain parts of a plant such as branches, buds, or roots to improve its growth and productivity. This process reduces overcrowding (to prevent competition for resources), disease and pest infestations. It also promotes crop yield due to efficient sunlight and air circulation.
6. **Grafting –** This is the technique where tissues from one plant part are inserted into another plant such that their vascular tissues are joined together. An insight into tissue regeneration and genetics promotes this process allowing the development of desirable traits to improve productivity and preservation of varieties in crops.

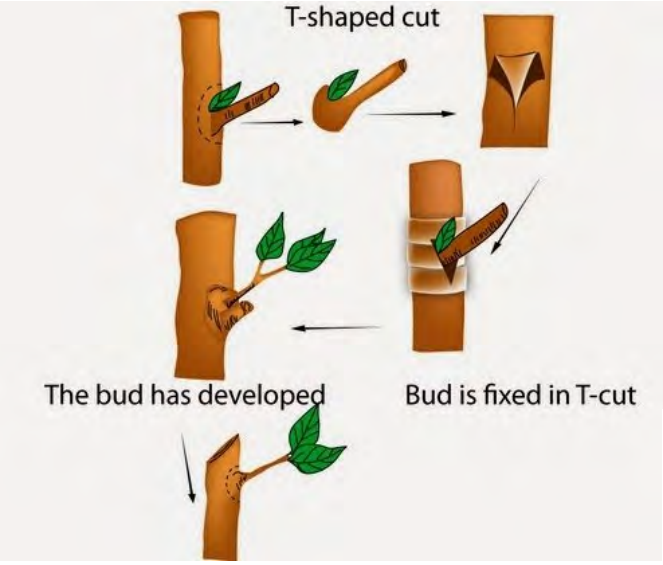


Figure 1.12: *Grafting*

7. **Selective breeding –** This refers to choosing parent organisms with specific traits to produce offspring with desired characteristics. The method results in the production of offspring that have enhanced/desired traits, such as drought and disease resistance.
8. **Pest and disease control –** This involves the methods and strategies used to manage and reduce damage by pests and diseases to crops and livestock. Biological pest control and chemical control methods may be used. The practice reduces crop losses, increases crop yield, and enhances crop quality.

Learning Tasks

1. Describe the activities in cultural practices.
2. Identify the biological concepts found in each of the activities in cultural practices.
3. Discuss the importance of each of the cultural practices in crop production.

PEDAGOGICAL EXEMPLARS

1. **Problem-Based Learning:** Embark on field trips to a nearby farm or observe pictures and videos to identify some activities for improving crop production. Learners connect to real world scenarios, allowing them to assess their thoughts and opinions about the lesson.
2. **Collaborative Learning:** Engage the whole class in discussions on the activities for improving crop production, the benefits, and differences within the various activities; learners acquire the skill of learning from one another and respecting the views of others through class discussions.
3. **Random-Based Group Learning:** In small, random-based groups, learners identify the biological concepts in the activities and relate the basic concepts to real life situations and how these concepts affect productivity: Learners learn to tolerate the views of others by listening to one another and making constructive contributions.
4. **Talk for Learning:** Explain how some practices (biological concepts in crop production) are applied to increase crop production; learners learn from peers that have first-hand experiences on these biological processes.

KEY ASSESSMENT

Level 1: Identify cultural practices in crop production.

Level 2: Explain biological concepts identified in named cultural practices.

Level 3: Discuss how cultural/farming practices can be used to improve crop production.

Level 4: Examine four impacts of cultural practices in crop production.

FOCAL AREA 2: SOME BASIC CONCEPTS IN BIOLOGY AND HOW THESE CAN BE USED TO IMPROVE ANIMAL PRODUCTION

Husbandry Practices and its Importance in Animals

Husbandry refers to the day-to-day care, management, production, feeding, and raising of farm animals. These measures result in healthy animals to increase productivity.

1. **Selective breeding –** This refers to choosing parent organisms with specific genetic traits to produce offspring with desired characteristics. This practice results in animals with desirable traits and increases productivity.

Figure 1.13: *Chicken raised for their meat*

2. **Supplementary feeding –** This is the provision of additional nutrients to animals apart from the normal feed given to them. This provision may be in the form of supplements. The practice enhances growth and improves reproductive performance, thus resulting in increased productivity.
3. **Deworming –** This refers to the administering of drugs to animals to get rid of parasites. The exercise improves the health of animals, leading to increase in growth and weight. It also reduces the spread of diseases among livestock.
4. **Flushing –** This is the technique of increasing the nutrition of breeding female animals before and during breeding seasons to enhance fertility and reproduction.

Figure 1.14: *Reproductive capacity of a Sow*

5. **Marketing/Sale of farm produce** – This is the marketing and selling of agricultural products to earn income for the farmer.

Learning Tasks

1. Describe what is meant by animal husbandry.
2. Identify and discuss the biological concepts found in husbandry practices.
3. Discuss the importance of the practices in husbandry.

PEDAGOGICAL EXEMPLARS

1. **Problem-Based Learning:** Embark on field trips to a nearby farm or observe pictures and videos to identify some basic practices for improving animal production (e.g. selective breeding, deworming, flushing); learners connect to real world scenarios, allowing them to assess their own thoughts and opinions about the lesson.
2. **Collaborative Learning:** Engage the whole class in discussions on the practices involved in animal rearing and their benefits; learners acquire the skill of learning from one another and respecting the views of others through class discussions.
3. **Random-Based Group Learning:** In small, random-based groups, learners relate the basic concepts identified in husbandry practices to real life situations, discussing how farmers go through these activities to increase productivity; learners learn to tolerate one another and make constructive contributions.
4. **Talk for Learning:** Explain how some practices in animal production are applied to increase productivity (e.g. selective breeding, supplementary feeding, flushing, deworming); learners learn from peers or farmers that have first-hand experiences in these practices.

KEY ASSESSMENT

Level 1: Define animal husbandry.

Level 2: Explain biological concepts identified in named animal husbandry.

Level 3: Discuss how husbandry practices can be used to improve production.

Level 4: Examine the impact of husbandry practices on animal production.

Section 1 Review

In this section, we have explored the distinctive characteristics, life processes and economic importance of *Rhizopus*, mosses and ferns. We have learnt that the *Rhizopus* is a fungus that develops on moist environments. We have examined its roles in an ecosystem, paramount of which includes the ability to enhance decomposition due to its rapid growth rate. We have looked at mosses, which are bryophytes, a group of simple plants that lack vascular tissues. Their ability to spread on soils to prevent processes such as erosion promotes soil stability which enhances soil fertility and support the growth of other plants. Ferns are seedless vascular plants which abound on forest floors and grow on other plants. We have examined the economic importance of these organisms that support the building of stable ecosystems. Finally, we looked at biological concepts and practices that are used to improve crop and animal production. We realised, that these practices, when employed in farming, increase crop yield and productivity in the rearing of animals.

APPENDIX A: GROUP PROJECT

Task example: Conduct research on the characteristics, life processes, and economic importance of Rhizopus.

Outline

- Identify and describe the main characteristics (general morphology) of Rhizopus.
- Explain the life processes of Rhizopus including reproduction (both sexual and asexual) and nutrient acquisition (saprophytic nutrition).
- Discuss the economic importance (benefits and harms e.g. role in food spoilage, fermentation, enzyme production) of Rhizopus in industries like food production, medicine, and agriculture.
- Conduct a simple experiment to observe Rhizopus growth on a food substrate (bread or fruit).

Practical Component

Procedure:

- Take a piece of bread or fruit and moisten it slightly with water.
- Place it in a sealed container (e.g. plastic bag) and leave it in warm environment.
- Observe and document the growth of Mold (Rhizopus) over a period of 5-7 days.
- Take note on changes in colour, structure and speed of growth.

Sample Rubric

Criteria	*Excellent (4)*	*Good (3)*	*Satisfactory (2)*	*Needs Improvement (1)*
Accuracy of Information	*The research is comprehensive and scientifically accurate for all three areas (characteristics, life processes, economic importance).* ***Example****: "Rhizopus reproduces asexually via sporangia and sexually through zygospores."*	*The research is accurate but lacks depth in one of the areas.* ***Example****: Includes key points like "Rhizopus grows on bread" but omits details on reproduction.*	*The research has incomplete with significant gaps or generalisations in two of the areas.* ***Example****: Mentions only that it "causes food spoilage."*	*The research is missing critical information for all areas.* ***Example****: Provides vague or incorrect statements, such as "Rhizopus is a plant."*

Criteria	*Excellent (4)*	*Good (3)*	*Satisfactory (2)*	*Needs Improvement (1)*
Depth of Research	*Demonstrates in-depth research, citing specific examples or studies.* ***Example****: "Rhizopus is used in industrial production of lactic acid and alcohol fermentation."*	*Demonstrates good research but lack depth in some areas.* ***Example****: "Rhizopus is used in fermentation but provides no specific industrial examples."*	*Demonstrates limited research, providing only basic or superficial information.* ***Example****: "Rhizopus is important for food production."*	*Demonstrates minimal research, with little or no supporting details.* ***Example****: Repeats general information like "Rhizopus is a fungus."*
Relevance to Economic Importance	*Explains the economic importance with specific examples.* ***Example****: "Rhizopus causes spoilage in stored grains but is also used in enzyme production."*	*Explains economic importance but lacks detailed examples.* ***Example****: "Rhizopus is important for industry and can cause food spoilage."*	*Mentions economic importance with no specifics.* ***Example****: "Rhizopus is important in food production and storage."*	*Fails to address economic importance or provides details.* ***Example****: "Rhizopus is just a fungus that affects food."*
Adherence to Procedure	*Follows all steps in the procedure accurately, including moistening the substrate, sealing it, and placing it in a warm environment.* ***Example****: "Moistened bread was sealed in a plastic bag and kept at room temperature."*	*Follows steps in the procedure, with minor errors or omissions.* ***Example****: "Forgot to moisten the bread but sealed it and placed it in a warm area."*	*Follows only one step, omitting key parts.* ***Example****: "Placed bread in a plastic bag but did not moisten or monitor the environment.*	*Does not follow the procedure.* ***Example****: "Left bread out in open air with no container or moisture added."*
Observation and Documentation	*Observes and documents changes daily with detailed notes on colour, structure, and speed of growth.* ***Example****: "Day 3: Growth turned white with black spots forming."*	*Documents observations but lacks detail or regularity.* ***Example****: "Growth appeared green on Day 5 but no details on earlier days were noted."*	*Limited observations with minimal detail.* ***Example****: "Mold appeared after a few days, but no description of colour or structure."*	*Fails to document observations, or observations are vague and inaccurate.* ***Example****: "Saw some changes, but no notes taken."*

Criteria	*Excellent (4)*	*Good (3)*	*Satisfactory (2)*	*Needs Improvement (1)*
Accuracy of Interpretation	*Accurately interprets the observations, linking them to Rhizopus growth stages.* ***Example****: "The black spots indicate sporangia formation in Rhizopus."*	*Interprets observations accurately but lacks depth or precision.* ***Example****: "The Mold grew and produced black areas."*	*Provides interpretation without scientific depth.* ***Example****: "The bread spoiled with Mold."*	*Provides no interpretation or incorrect conclusions.* ***Example****: "The bread became dirty, not related to Rhizopus.*
Clarity and Organisation	*The information is clearly structured, with separate sections for characteristics, life processes, and economic importance.* ***Example****: Uses headings or bullet points for clarity.*	*The information is well-organised, with minor issues in flow or presentation.* ***Example****: Combines sections but keeps content understandable.*	*The information is organised but lacks clear sections or logical flow.* ***Example****: Ideas are presented in a single paragraph with no structure.*	*The information is poorly organised, making it hard to follow.* ***Example****: No clear separation of topics, and ideas are scattered randomly.*

How to Administer

- Encourage collaboration and teamwork among learners by promoting peer to-peer learning, etc.
- Refer to the Teacher Assessment Manual and Toolkit page 27 for more information on how to administer project work.

Feedback

Provide and use ongoing feedback and guidance to learners.

APPENDIX B: SAMPLE OF PORTFOLIO ASSESSMENT

Task: Throughout the academic year, gather and reflect on your work in biology. This portfolio will demonstrate your understanding, growth, and ability to apply biological concepts. You will use the portfolio to showcase your best work and progress in a range of biology topics, as well as your critical thinking and reflective skills.

Artefacts to be included

A copy of:

1. Individual class exercise in week 3.
2. Group project work in week 2.
3. 1&2 semester mid-semester examination in weeks 6 &18.
4. Debate in week 17.
5. Research work in week 7.
6. Case study in week 8.
7. Infographics in week 9.
8. Individual project work in week 14.
9. End of first semester examination.

Reflection: Write a 1-page reflection that include your understanding of biological concepts and areas you need to improve or need help.

Organisation /structure: The portfolio should be neatly organised with **cover page which entails the learner's name, class, subject and period/date and** a table of contents. Include both digital and handwritten work where applicable.

How to Administer

- Create learner instructions that specify how learners select, gather, reflect, format and submit, etc.
- Refer to the Teacher Assessment Manual and Toolkit page 22 for more information on how to administer portfolio.

Rubrics/ marking Scheme: The portfolio will be assessed based on the following criteria:

Completeness: Inclusion of all required assignments, **20 marks** (2 marks each).

Depth of Reflection: How well learners analysed their own work and learning process and demonstration of biology knowledge and its application such as "this year has been

an enriching period of learning and self-discovery. I have gained a solid foundation in Biology, particularly in understanding the structure and function of living organisms. However, I also recognise that there are areas where I need to continue improving, especially when it comes to retaining complex information and managing my time effectively. Moving forward, I am committed to refining my study techniques and improving my weaknesses to become a more confident and proficient learner" or anything similar. (10 marks).

Presentation: Neatness, organisation, and clarity of the portfolio, score **5 marks**

Submission Deadline: week 23 (**5 marks** for meeting deadline).

Feedback

Mark and record learners' performances and identify those with SEN who may need extra support to help them.

SECTION 2: CYTOLOGY

STRAND: LIFE IN THE FUNDAMENTAL UNIT

Sub-strand: Cell Structure and Functions

Learning Outcomes

1. *Relate the knowledge and understanding of the cell theory and structure to the different types of cells in all life forms.*
2. *Explain the Watson-Crick model of Nucleic acids (the DNA), and their roles in synthesising proteins for building the bodies of living things.*

Content Standards

1. Demonstrate knowledge and understanding of cell structure and functions.
2. Demonstrate knowledge and understanding of the molecular structure of nucleic acids and their importance in synthesis of proteins in living things

Hint

- *Mid-semester examination is to be organised by Week 6. Refer to Appendix C for further information.*
- *Group project work is due for collection in week 8*

INTRODUCTION AND SECTION SUMMARY

Cytology encompasses all lessons on cells. The cell is the fundamental unit (building block) of life. In this section, we discuss the cell theory and the two main types of cells (prokaryotic cells and eukaryotic cells). The structure and functions of the cell organelles were discussed in JHS. The knowledge of cells is relevant in discussing movement of substances in cells. Bulk transport activities (endocytosis and exocytosis) are the main processes that allow the transport of substances across the cell membrane. The section also discusses the Watson - Crick Model of nucleic acids (DNA and RNA), and protein synthesis as it occurs within the cell. These concepts lead to better understanding of the body of organisms and can be applied in areas such as genetics and agriculture to improve health and food production.

The weeks covered by this section are:

Week 5: *Cell theory and Cell structures in relation to their functions*

Week 6: *Application of active transport processes, Endocytosis and Exocytosis (Bulk transport processes)*

Week 7: *The DNA, Watson-Crick model, and the significance of DNA in eukaryotic cell.*

Week 8: *DNA replication and its relevance in living things*

Week 9: *RNA Transcription and its relevance in living things*

Week 10: *Protein synthesis and its relevance in living things*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Concepts in the Section are discussed using a variety of pedagogical exemplars that enhance learning. These include project-based learning, which allows the learner to explore the cell theory and types of cells. Group-based learning allows learners to discuss bulk transport processes such as endocytosis and exocytosis leading to an improved understanding of how substance move within the cells of organisms. Project-based learning through hands-on-projects, such as the creation of models of the DNA to cater for the different learning skills of learners to encourage creativity and critical thinking. Experiential learning to provide learners with laboratory experiences where they can observe cell structures under the microscope or extract DNA samples from cells to deepen understanding and retain knowledge in complex concepts such as nucleic acids and protein synthesis. There will also be collaborative learning strategies, which will include strategies such as selecting mixed-ability and gender-balanced groups to ensure diverse perspective and equitable participation in the learning process by learners with different socio-economic, religious, and cultural backgrounds. Learners will be encouraged to assist one another to foster a supportive learning environment and enforce their own knowledge. Other activities such as think-pair-share and talk for learning will be used in discussing concepts such as the Watson-Crick model of the DNA, and DNA replication and RNA transcription and translation. This will promote teamwork, critical thinking, and communication among learners.

ASSESSMENT SUMMARY

The recommended mode of assessment for each week is:

Week 5: *Concept Mapping*

Week 6: *Mid Semester Examination*

Week 7: *Research*

Week 8: *Case Study*

Week 9: *Infographics*

Week10: Group Assignment

WEEK 5

Learning Indicator: *Apply knowledge of the cell theory and structure to classify and describe the types of cells and relate their structures to their functions.*

FOCAL AREA 1: CELL THEORY AND CELL STRUCTURES IN RELATION TO THEIR FUNCTIONS

The Cell Theory

The cell is the fundamental, structural, and functional unit of life (living things). Cells can exist on their own, as found in unicellular organisms, or as part of multicellular organisms as found in plants and animals. The two primary types of cells are the prokaryotic cells and eukaryotic cells. Prokaryotic cells (bacteria and archaea) lack definite nucleus and membrane bound organelles. Eukaryotic cells (protoctist, fungi, plant, and animal cells) have definite nucleus enclosed in a membrane and contain various organelles.

Robert Hooke (1665) was the first person to observe cells, while examining a thin slice of cork under a microscope. However, in 1674, Anthon van Leeuwenhoek became the first biologist to observe and describe single-celled organisms. The biologists Mathias Schleiden (a botanist), Theodor Schwann (a zoologist) and Rudolf Virchow proposed the cell theory. The three essential components of the cell theory are:

1. All living things are composed of one or more cells.
2. The cell is the basic unit of structure and organisation in living things.
3. All cells arise from pre-existing cells.

The cell theory is especially important because it stresses that the cell is the fundamental unit of life, and this allows biologists to understand the structure and function of all living things. The cell theory forms the bases of several disciplines in Biology, such as genetics, molecular biology, and medicine. Below are diagrams of a bacterium (a prokaryotic cell), a plant cell and an animal cell (eukaryotic cells).

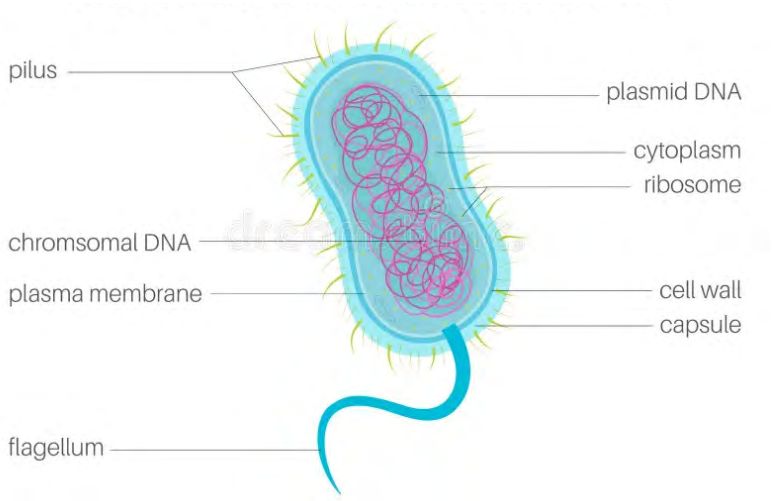


Figure 2.1: *Structure of Bacterial Cell*

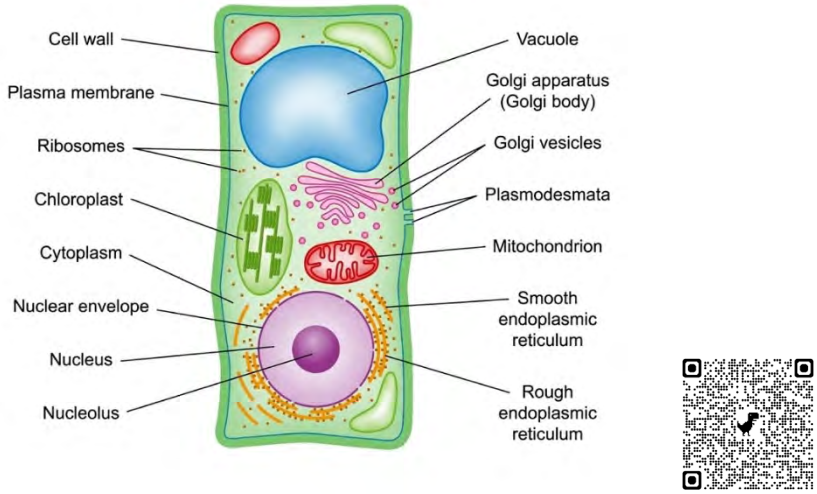


Figure 2.2: *Structure of Plant cell*

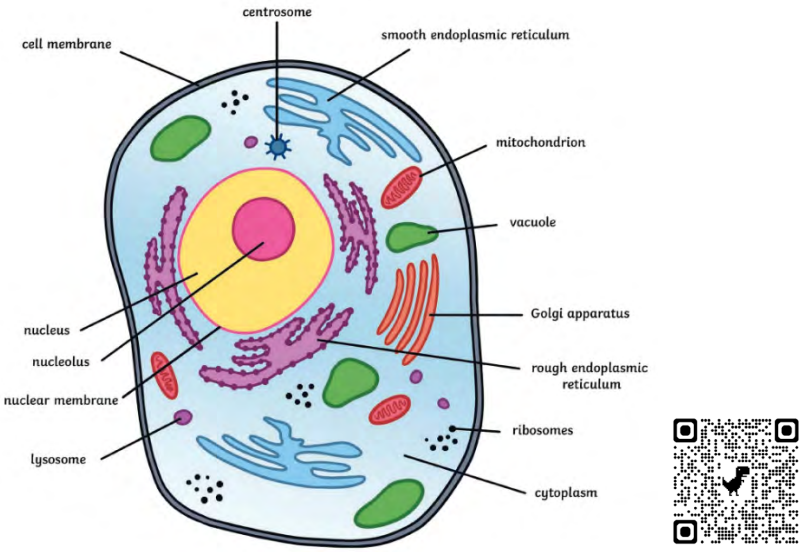


Figure 2.3: *Structure of Animal Cell*

Plant cells are different form animal cells in terms of their shape, the nature of their vacuole, the presence of chloroplasts, etc.

Specialised Eukaryotic Cells and their Adaptations

Specialised cells are cells that have developed adaptations to perform specific functions. They form part of tissues that play crucial roles in the living things.

Some common examples of specialised plant cells are:

- **Epidermal cells:** They form the protective outer layer of plant parts. They are covered with a waxy cuticle or hairs to reduce water loss and protect the plant against pathogens.
- **Palisade mesophyll cells:** These are columnar-shaped cells in the leaf with many chloroplasts that absorb sunlight for photosynthesis.
- **Spongy mesophyll cells:** They are cells that are loosely arranged in leaves to create space for efficient gas exchange.
- **Root hair cells:** These are elongated cells with thin walls that absorb water and nutrients from the soil for plant usage.
- **Root tip cells:** These are cells that continuously divide at the tip of plant roots to ensure growth. They are smaller in size but contain dense cytoplasm for rapid division and differentiation. They have the root cap to protect the dividing cells (meristems).
- **Guard cells**: These are kidney-shaped structures with chloroplasts that control the opening and closing of stomata for gaseous exchange.

Common examples of specialised animal cells include:

- **Muscle cells:** They are elongated cells that contract and relax to bring about movement. They contain several mitochondria to generate energy for movement. The different types are skeletal, smooth, and cardiac.
- **Sperm cells:** These are male gametes for sexual reproduction. They possess adaptions such as streamlined shape and flagellum for swimming, enzyme-filled acrosome at the head region to penetrate the egg, several mitochondria to provide energy for movement, and a condensed haploid nucleus for fertilisation.
- **Egg cell (Ovum):** it is the female gamete for sexual reproduction. It has a large cytoplasm containing several nutrients to support early development into an embryo.
- **Red blood cells (Erythrocytes):** They are specialised cells for transporting oxygen from the lungs to body tissues. They are biconcave in shape, and this feature increases their surface area for efficient gaseous exchange.
- **White blood cells (Leukocytes):** These are specialised cells for defence of the body. They form part of the immune system to defend the body against infections and foreign invaders.

Below are common examples of specialised plant and animal cells.

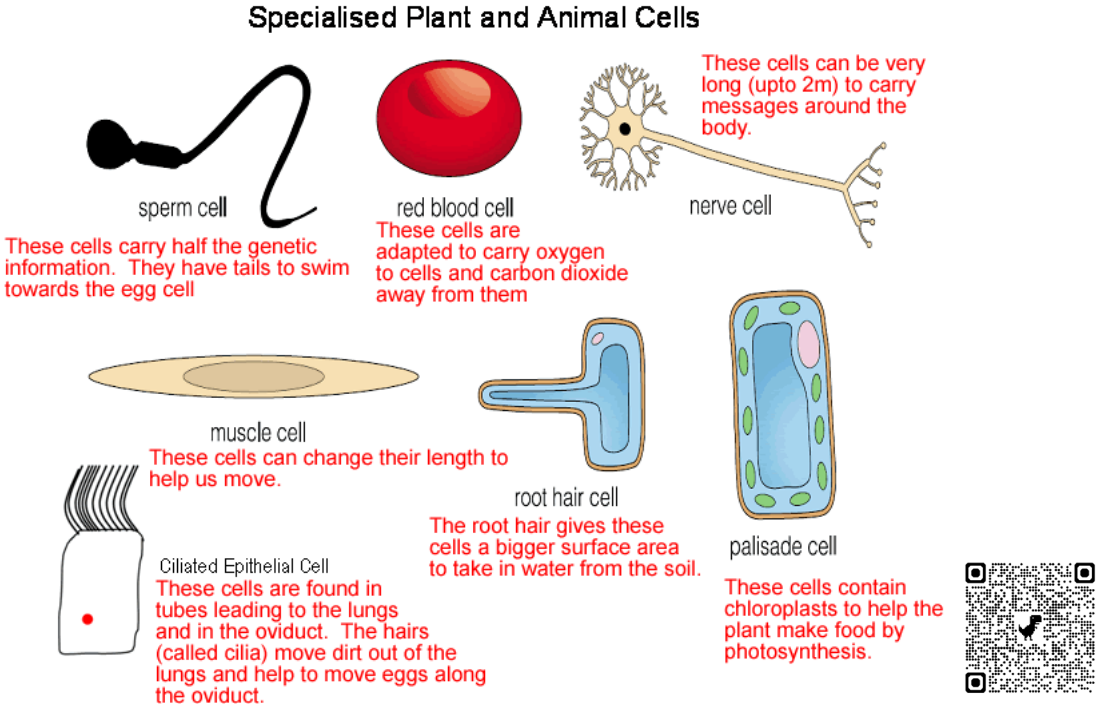


Figure 2.4: *Specialised Cells*

Learning Tasks

1. List the components of the cell theory.
2. Identify the major differences in plant cells and animal cells.
3. Classify specialised cells based on their structure.
4. Depict the functions of specialised cells in relation to their structure.

PEDAGOGICAL EXEMPLARS

1. **Project-based Learning**: In randomly formed mixed-ability groups, research and examine the cell theory, its relevance to the life of organisms, and revise on the functions of organelles (mitochondrion, nucleus, ribosome, endoplasmic reticulum, chloroplast, and Golgi body); learners appreciate the social background of every member as learner groups are constituted randomly.
2. **Building on what others say**: Ask learners to apply knowledge of cell structure to classify and describe cells, and to discuss the functions of various types of cells based on the contributions of others; learners building on the foundations of others realise the efforts and contributions others make, and the essence of teamwork in building a healthy academic environment.
3. **Experiential Learning**: Learners create prototypes of different types of cells using cardboard, play dough, clay, or any other appropriate materials from their immediate

environment; learners develop a positive outlook about themselves as they are allowed to experience creativity by their own thoughts and opinions.

KEY ASSESSMENT

Level 1: List the components of the cell theory.

Level 2: Name three specialised (i) animal and (ii) plant cells and describe their adaptations.

Level 3: compare the plant cell and animal cell.

Level 4: using self-made models, describe the structure of two specialised cells.

WEEK 6

Learning Indicator: *Apply the knowledge of cell structure and functions to the movement of substances in and out of cells.*

FOCAL AREA: APPLICATION OF ACTIVE TRANSPORT PROCESSES, ENDOCYTOSIS AND EXOCYTOSIS (BULK TRANSPORT PROCESSES)

Active Transport

Active transport processes (unlike passive transport processes such as diffusion and osmosis studied in JHS Science) are those where there is movement of molecules against the concentration gradient. This means substances move from a low region of concentration to a high region of concentration and require energy in the form of ATP to do so.

Examples include the sodium-potassium pump that move ions in nerve cells, uptake of water and mineral salts from the soil by the root cells and secretion of enzymes, hormones and antibodies from cells. Active transport occurs through the transport protein pumps in the cell membrane and it involves materials that cannot diffuse across the cell membrane. Cells use active transport to maintain homeostasis.

Endocytosis

This is the process by which cells engulf external substances by enclosing them in a vesicle to bring them into the cell. The steps involved are:

- **Recognition** –This is where the cell identifies the substance outside of itself.
- **Invagination** –This is where the cell membrane folds inward to form a pocket-structure around the substance to be transported.
- **Vesicle formation** –This is where the membrane pocket pinches off to form vesicles with the substance inside the cell.
- **Internalisation** – This is when the vesicle moves into the cell with the substance in it and is transported to various part of the cell.

The type of endocytosis where the cell engulfs small fluid substances, and their dissolved solutes is called pinocytosis (or cell drinking). A typical example is the absorption of nutrients from fluid that passes through the kidney tubules. Phagocytosis is the type of endocytosis where the cell engulfs large particles (such as bacteria, dead cells, and debris) and transport them into its inner space. A common example is when white blood cells (e.g. macrophages) engulf bacteria and other foreign materials and digest them. Phagocytosis is also called cell eating because the cell takes in solid materials.

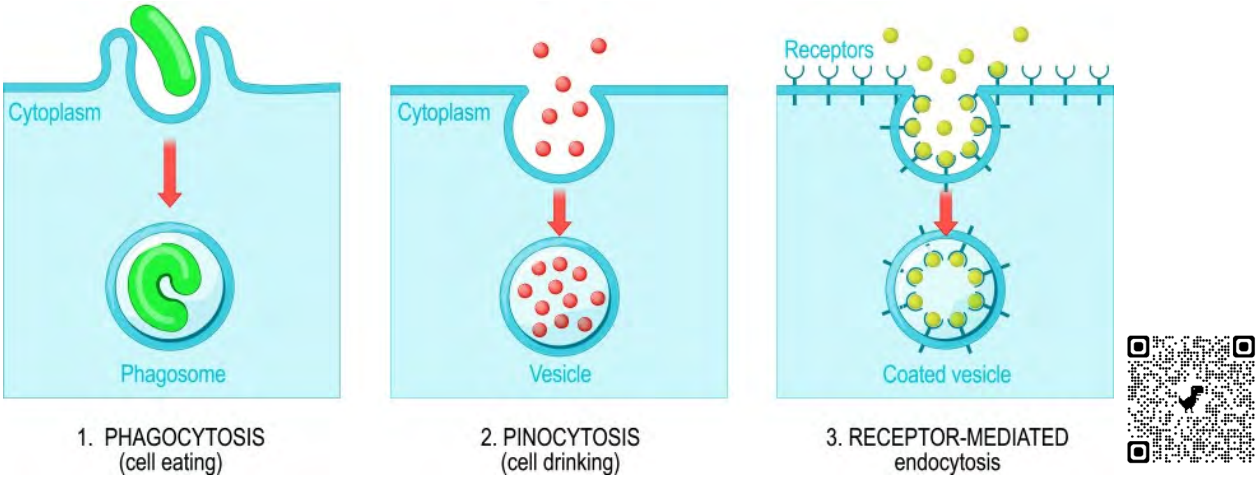


Figure 2.5: *Endocytosis*

Exocytosis

It is the process by which cells expel or give out substances in them. The processes are:

- Vesicle Trafficking – This is where vesicles with the materials to be expelled, move towards the cell membrane.
- Docking –This is where the vesicles align and attach to the cell membrane.
- Fusion – Here, the vesicle joins (fuses) with the cell membrane.
- Release –This is where contents of the vesicles are released outside the cell.

An example is the release of neurotransmitters from nerve cells into the synaptic cleft.

Both endocytosis and exocytosis are required for cellular functions such as nutrient uptake, cell signalling and waste removal.

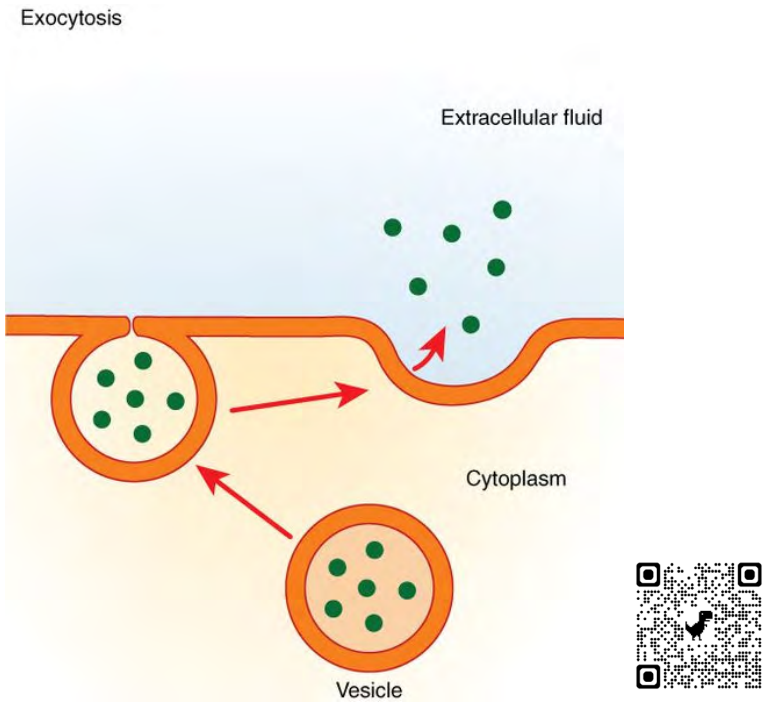


Figure 2.6: *Exocytosis*

Learning Tasks

1. Explain the term active transport and list examples.
2. Describe the essential processes involved in endocytosis and exocytosis.
3. Relate how the structure of the cell membrane would allow active transport to occur.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning**: Engage the whole class in discussions on the concepts of active transport, endocytosis, and exocytosis, their benefits, and differences; learners acquire the skill of learning from one another through class discussions building on what others say.
2. **Experiential learning:** Engage learners in hands-on activities that can help cement their understanding of active transport and bulk transport principles. For example, you might have them create models representing active transport and bulk transport processes or use simulation software to observe how active and bulk transport occurs. Learners develop their 21st century skills and creativity.
3. **Think-pair-share:** In mixed-ability, gender-responsive and all-inclusive groups, learners watch a video on endocytosis, exocytosis, and discuss their observations; they learn to listen to their peers and express disagreements in a constructive manner.

KEY ASSESSMENT

Level 1: List two examples of active transport.

Level 2: Explain how exocytosis occurs.

Level 3: Describe the processes of endocytosis.

Level 4: Describe how endocytosis is of benefit to cells.

Level 4: Compare active transport with osmosis.

Hint

The recommended mode of assessment for this week is Mid-Semester Examination. See Appendix C at the end of this section for further information.

WEEK 7

Learning Indicator: *Describe the Watson–Crick Model of the DNA and state the significance of the model in a eukaryotic cell.*

FOCAL AREA: THE DNA, WATSON–CRICK MODEL, AND THE SIGNIFICANCE OF DNA IN EUKARYOTIC CELL

DNA (deoxyribonucleic acid) is a nucleic acid. Nucleic acids are biopolymers which carry genetic information from living organisms to their progenies (offspring). Nucleic acids store, transmit and express genetic materials in the organism. Nucleic acids were discovered by the Swiss biologist and physician, Friedrich Miescher in 1869. While working with white blood cells from pus, he isolated a substance from the nuclei of the white blood cells, which he named "nuclein," which are now called nucleic acids. DNA and RNA are the two main types of nucleic acids.

The DNA and its Importance

DNA is an organic molecule made up of nucleic acids that carry genetic instructions used in growth, development, functioning and reproduction of living things and viruses. The building block (basic unit) of nucleic acids are the nucleotides.

A nucleotide is made up of three parts:

1. Pentose sugar, a five-carbon sugar (this is deoxyribose in DNA and ribose in RNA)
2. Nitrogenous base: adenine (A), thymine (T), cytosine (C), guanine (G) and uracil(U)
3. Phosphate group/phosphoric acid (a molecule with one phosphorus atom bonded to four oxygen atoms.

Many nucleotides join to form long chains called polynucleotides. Each nucleotide in a polynucleotide is connected to the next by a phosphodiester bond between the phosphate group of one nucleotide, and the pentose sugar of the next nucleotide. DNA is made up of two of these polynucleotide chains which coil around each other to form a double helix. Some common forms of DNA are genomic DNA (found in the nucleoid region of the nucleus of eukaryotic cells, and containing the complete set of genes), mitochondrial DNA (mtDNA, with fewer genes found in the mitochondria for energy production) and chloroplast DNA (cpDNA), found in the chloroplasts of plant and some algae cells, with genes for chloroplast functions in photosynthesis.

The DNA is an essential life molecule

1. It stores genetic information with instructions for development, functioning and reproduction in living things.

2. It transmits genetic information from one cell to another by replicating during cell division.
3. It carries genetic codes that specify sequences of amino acids for protein synthesis.
4. DNA sequences regulate gene expression and are crucial for cellular functions.
5. Changes in genetic sequences of DNA are called mutations, which serve as the basis for evolution and the adaptation of organisms to new environments.

Watson-Crick Model of the DNA

This model was proposed by James Watson and Francis Crick in 1953 by analysing X-ray crystallography data. The essential component in the model as follows:

1. The DNA is composed of two antiparallel strands coiled around a central axis (forming a double helix structure).
2. There is a complimentary base pairing of the nitrogenous bases, where adenine pairs with thymine, and guanine pairs with cytosine (that is, A-T and G-C).
3. The two DNA strands show antiparallel orientation (run in opposite directions, that is, 5' to 3' and 3' to 5', read as *5 to 3* direction, and *3 to 5* direction).
4. A sugar-phosphate backbone is formed by a phosphodiester bond between the pentose sugar and phosphate group.
5. Major and minor grooves are formed from the helical twist between the two DNA strands, and these grooves provide spaces (points of attachment) for enzymes and proteins and other molecules to bind to the DNA.

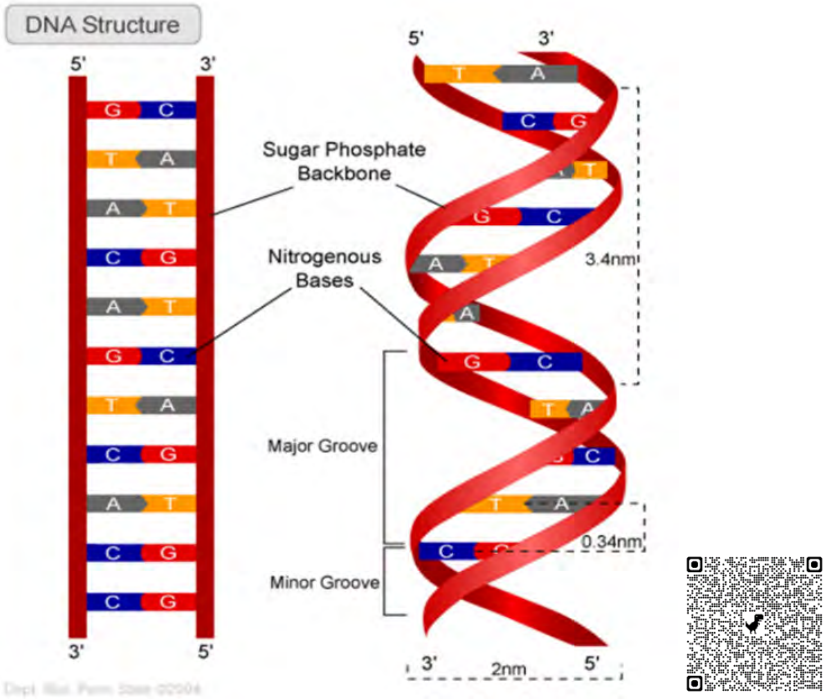


Figure 2.7: *Structure of DNA*

Learning Tasks

1. Describe nucleic acids.
2. Describe the major components of a DNA molecule.
3. Describe the main aspects of the Watson-Crick model of the DNA.
4. Discuss the importance of the DNA molecule in eukaryotic cells.

PEDAGOGICAL EXEMPLARS

1. **Collaborative-Based Learning:** Watch videos and charts on nucleic acids and DNA and draw the Watson-Crick Model of the DNA. Discuss the Model and examine its significance in a eukaryotic cell. Learners in mixed ability and gender groups discuss their observations and independently make their drawings. In doing so, they learn to contribute to team-work.
2. **Project-based learning:** Design models of DNA using sheets of paper, manila card, cardboard, coloured beads, or any other appropriate resources; learners build confidence in learning to be creative, and this raises the awareness of "I can do" within them and their peers.

KEY ASSESSMENT

Level 1: Name the term that describes the basic unit of nucleic acids and name its three components.

Level 2: Briefly describe the events that lead to the discovery of nucleic acids, hence give the components of the DNA.

Level 3: Describe the essential components of the Watson - Crick Model of DNA

Level 4: Discuss the essential roles of the DNA molecule in a eukaryotic cell.

WEEK 8

Learning Indicator: *Examine the processes of DNA replication*

FOCAL AREA: DNA REPLICATION AND ITS RELEVANCE IN LIVING THINGS

DNA Replication

DNA replication is the process by which the cell (and structures within it) make identical copies of its DNA molecules. Replication occurs at the S phase (synthesis phase) of the cell cycle during interphase of cell division. The process occurs in three major phases, which are the opening of the double helix and separation of the DNA strands, the priming of the template strands and the assembly of the two new DNA strands. The detailed activities are as follows:

1. **Initiation** – This is where replication starts at specific sections called origins, on DNA.
2. **Unwinding**–This is where DNA helicase (enzyme) unwinds the DNA double strands.
3. **Stabilization** – This is where single-stranded binding proteins stabilise the separated single strands.
4. **Priming** – The enzyme, DNA primase (DNA polymerase) synthesises short RNA primers on the DNA template to provide a starting point for the synthesis of a new DNA strand.
5. **Elongation** – This is where DNA polymerase adds more nucleotides to the RNA primers to make the new DNA strand longer.
6. **Synthesis of Okazaki fragments** – This is where DNA polymerase synthesises short DNA fragments on the lagging strand.
7. **Removal of Primers and Fragment Litigation** – This occurs when DNA polymerase removes RNA primers and replaces the gaps with DNA. DNA ligase seals the Okazaki fragments on the lagging strand, thereby joining the newly formed DNA fragments into continuous strands.
8. **Termination** – This occurs when DNA replication forks meet specific termination sequences, which then stop the process.

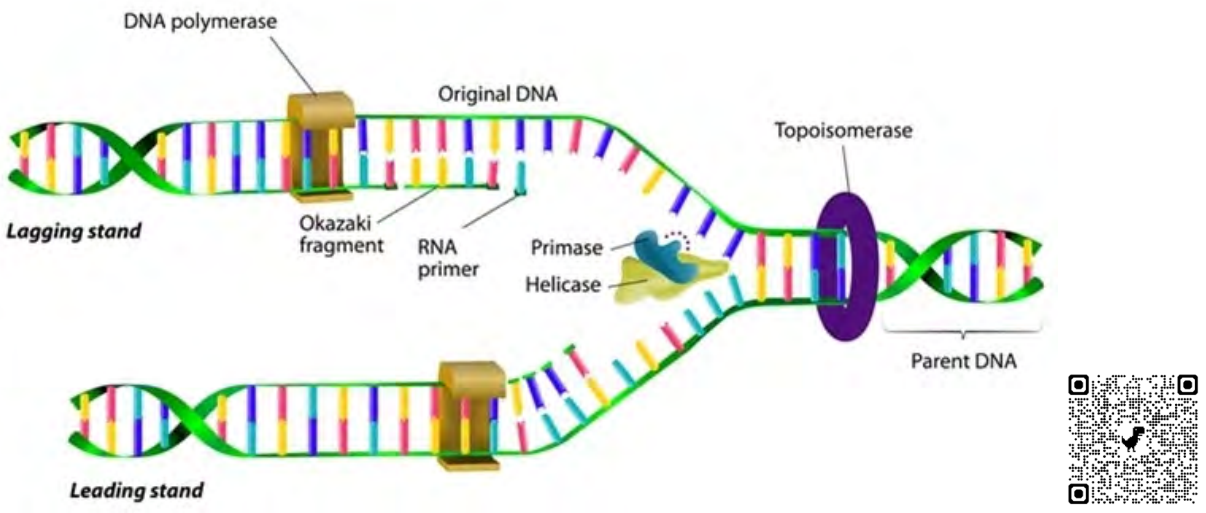


Figure 2.8: *DNA Replication*

Relevance of DNA replication in living things

1. It allows for the transmission of genetic information from generation to generation.
2. It is required for the maintenance and stability of genetic information, as errors in the process may lead to harmful results and changes in the organism.
3. It causes evolution through mutation.
4. It ensures that identical daughter cells produced in mitosis maintain the same set of genetic information for growth, development, and repair of tissues.
5. Replication leads to the production of gametes with half set of chromosomes (genetic material) necessary for sexual reproduction, and genetic diversity.

Learning Tasks

1. What is meant by the term, "DNA replication."?
2. Describe the major phases involved in DNA replication.
3. Discuss the importance of DNA replication for living things.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning:** In mixed-ability groups watch and discuss videos, PowerPoint presentations and simulations on DNA replication; learners acquire the skills of collaborating with one another, respecting each member's views and opinions, and learning to be tolerant.
2. **Task-based learning:** Design a timeline chart or a chronological chart, to describe the nature of DNA replication and the processes and stages involved (e.g., Initiation,

Elongation and Termination); learners attempt to connect with real-world scenarios and boost their confidences to believe themselves and one another.

3. **Talk-for-Learning Approach:** Discuss further, various aspects of replication together with the enzymes involved, and individually present a report on them; learners listen to one another and seek to appreciate their views or use a constructive approach in expressing their feedback.

KEY ASSESSMENT

Level 1: Define the term, 'DNA replication' and outline its importance to living things.

Level 2: Name the major enzymes involved in DNA replication and give the function of each.

Level 3: Describe the various stages in DNA replication.

Level 4: Design a model of the double helix strands of DNA using sheets of paper and use your model to describe DNA replication in detail, including identifying the leading and lagging strands, and their roles in the process (Accept oral or written presentation on how unwinding of the double helix, priming of short strands, and assembling of these strands are brought together to form a new strand).

Hint

- *The mid-semester examination results should be ready for submission to the STP.*
- *Remember to take the group project for scoring.*

WEEK 9

Learning Indicator: *Relate the structure of DNA and RNA molecules to their relevance in living things.*

FOCAL AREA: RNA TRANSCRIPTION AND ITS RELEVANCE IN LIVING THINGS

The RNA Molecule

RNA (ribonucleic acid) is the molecule that carries instructions from DNA to control the synthesis of proteins. It is a polymeric molecule made up of nucleotides, and each nucleotide is formed from a pentose sugar (ribose), nitrogenous bases (adenine A, guanine G, uracil U and cytosine C) and a phosphate group. It is found either in the nucleus or cytoplasm of the cell. There are three main types of RNA. Messenger RNA (mRNA) is a single- stranded RNA molecule that carries genetic information from the DNA to ribosomes, where it serves as a template for protein synthesis. Ribosomal RNA (rRNA) are RNA molecules that combine with ribosomal proteins to form ribosomes. Ribosomes make proteins by translating coded messages in mRNA. Transfer RNA (tRNA) are small RNA molecules which carry (or assemble) amino acids to the ribosomes during protein synthesis. RNA is essential for biological functions such as coding, encoding, regulation and expression of genes.

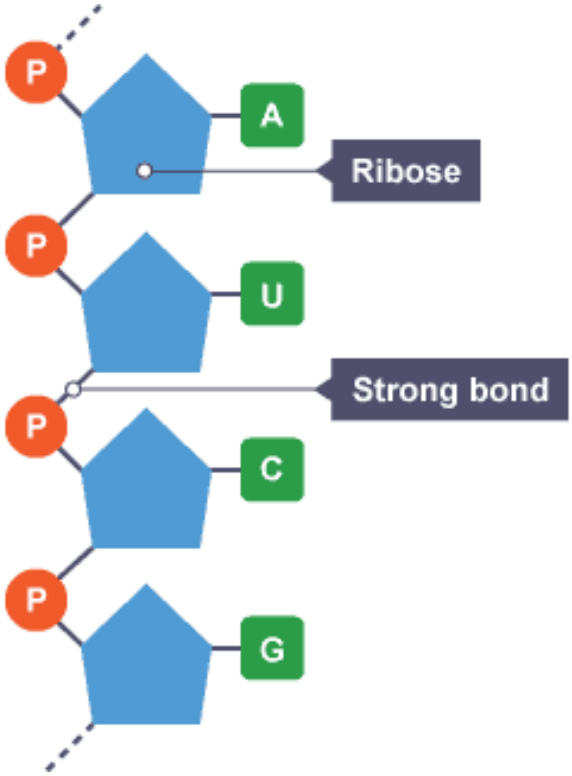


Figure 2.9: *Basic structure of the RNA*

RNA Transcription

RNA transcription refers to the process by which RNA is synthesised from a DNA template within the nucleus of a cell. Transcription involves the production of mRNA, which leads to the formation of rRNA and tRNA, using DNA as a template. The main steps involved in RNA production are given below:

1. **Initiation –** This is where RNA polymerase binds to a specific region (called the promoter) on the DNA. It is the beginning of transcription. The hydrogen bond between the double helix DNA is broken and the RNA polymerase unwinds the portion DNA, exposing the bases of the two DNA strands.
2. **Elongation –** This is where one strand of the DNA begins to produce a complimentary RNA strand by adding free RNA nucleotides in a 5' to 3' direction. Here, RNA polymerase moves along the DNA (the template strand) to elongate the RNA transcript by adding nucleotides that are complimentary with the DNA template strand. The other DNA strand is the coding strand because its base sequence is identical to the mRNA, except for the nucleotide base, thiamine replaced with uracil.
3. **Termination –** This occurs when RNA polymerase encounters a termination code in the DNA sequencing, stopping the process.
4. **RNA Processing –** This is where the primary RNA (pre-mRNA) transcript undergoes several modifications to form mature mRNA. This is mainly with RNA production in eukaryotes.

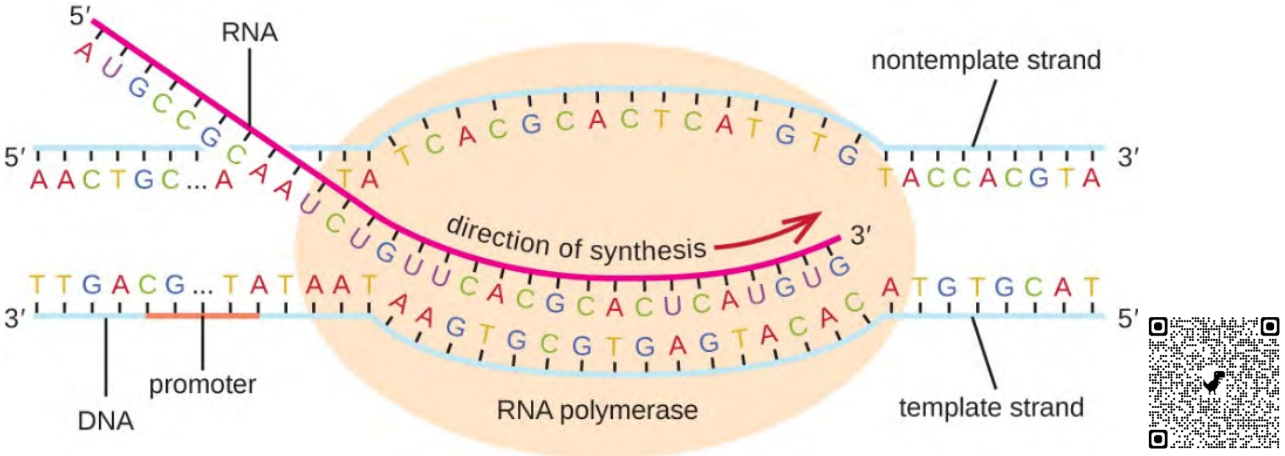


Figure 2.10: *RNA transcription*

Modifications of pre-mRNA to form the mature RNA include **capping** (addition of a 5' cap, a modified guanine nucleotide which protects RNA and enhances ribosome binding), **polyadenylation** (addition of a poly-A tail at the 3' end to protect RNA and help to transport it from the nucleus), **splicing** (the removal of non-coding regions/sequences (introns), and the joining of coding regions/sequences (exons) to form a continuous coding sequence. These modifications ensure that RNA molecules are correctly

synthesised and prepared for protein synthesis and other cellular functions in the organism.

The Relevance of RNA Transcription in Living Things

1. RNA regulates gene expression in eukaryotic cells through processes such as RNA interference (RNAi).
2. The process ensures genetic information transfer in cells. This allows the continuous survival of the cells.
3. RNA molecules (rRNA and tRNA) support cellular functions and homeostasis. They do these by playing essential roles in protein synthesis and metabolism to ensure accurate cellular function and metabolic balance.
4. Understanding RNA transcription is important in developing antiviral drugs and vaccines to manage RNA viral diseases (e.g. hepatitis C, COVID-19, Ebola diseases, HIV, measles and influenza).
5. The process offers deeper insights into evolutionary theories and hypotheses about the origin of life. One typical example of such hypothesis is the RNA world hypothesis, which proposes that RNA molecules were formed as a primary genetic material before DNA and performed both genetic and catalytic functions in early life forms.

Learning Tasks

1. Define RNA and give its composition.
2. Describe the process of RNA transcription in cells.
3. Discuss the relevance of RNA transcription in living things.
4. Create models of RNA molecules using local materials.

PEDAGOGICAL EXEMPLARS

1. **Group-Based-Learning:** In mixed ability, task-based groups, research from journals, textbooks, videos, into how RNA transcription occurs, and the relevant role it plays in the life of living things; Assign different roles to learners within the group to improve learner participation (e.g. group leader, timekeeper). Learners learn to support one another socially and emotionally through teamwork.
2. **Creativity and Talk for Learning**: In task-based groups, learners design models of RNA using sheets of paper, manila cards, cardboard or any other appropriate resources; learners share and discuss their models to the whole class building confidence in learning to be creative and raising the awareness of "I can do" within them and their peers.

KEY ASSESSMENT

Level 1: Define the term RNA and give its components.

Level 2: Briefly describe each of the stages involved in the process of RNA transcription.

Level 3: Examine the importance of RNA transcription in living things.

Level 4: Using self-made models of RNA, discuss how each of the three types of RNA function.

WEEK 10

Learning Indicator: *Describe how proteins are formed in the cell and explain the importance of protein synthesis in living things.*

FOCAL AREA: PROTEIN SYNTHESIS AND ITS RELEVANCE IN LIVING THINGS

The Genetic Code

Genetic information is kept in the DNA by base sequence encoded into a message in mRNA. This encoded genetic message, carried by the four bases A, U, C and G is decoded (translated or converted into meaningful language) by tRNA. The genetic code, therefore, refers to the set of rules by which the sequence of nucleotides in DNA or RNA is translated into amino acid sequence of proteins in living cells. It is made up of a triplet of bases called codons. Codons are located on the DNA and mRNA to specify a particular amino acid during protein synthesis. There are 64 different forms of codons. 61 of these codons can each code for one amino acid. There are 20 different kinds of amino acids that these codons specify.

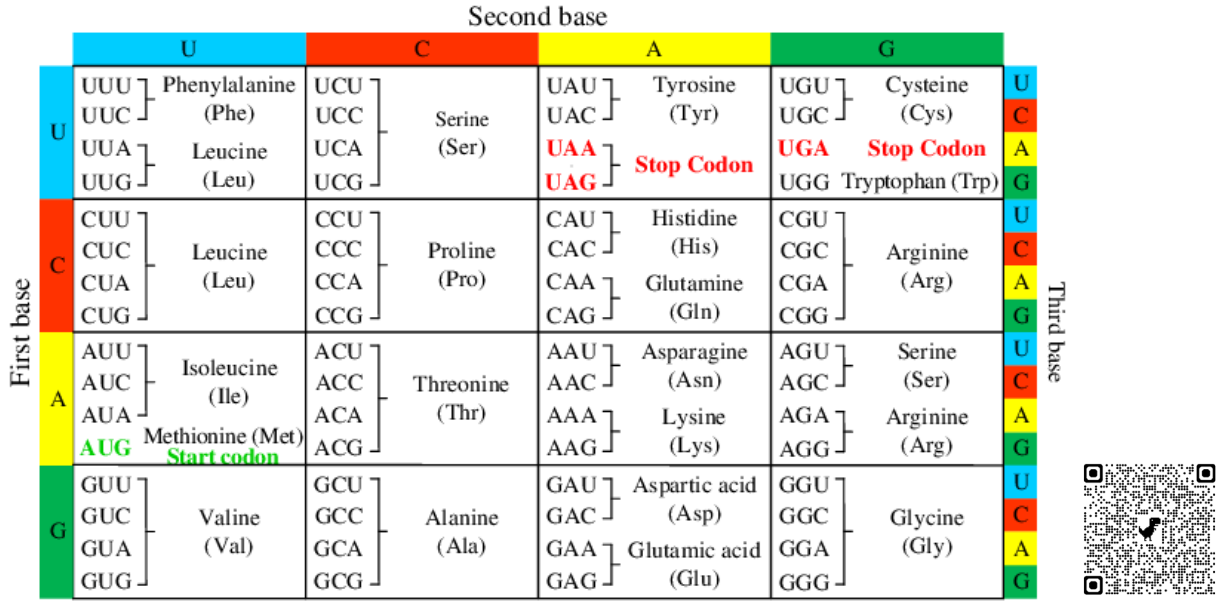


Figure 2.11: *mRNA codons for all amino acids found in human proteins*

Three of the codons UGA, UAA and UAG do not code for any amino acids and are therefore called nonsense codons. Nonsense codons are also referred to as stop codons because they mark the end (termination) of protein synthesis (the polypeptide chains) whenever they occur. A start codon is the codon that initiates or directs the first amino acid to be arranged on the ribosome for protein synthesis. The triplet of bases on tRNA which compliments a codon on the mRNA is called the anticodon. The genetic code is described as universal because a triplet of bases codes for the same amino acid in almost

all organisms. It is also said to be degenerate because each amino acid has more than one codon.

Protein Synthesis and its Mechanism

Protein synthesis is the process by which cells build proteins to be used in the body of an organism for growth and development. Protein synthesis in living things involves two major stages: transcription and translation.

Transcription: This is the process of copying a segment of DNA into mRNA by the enzyme RNA polymerase. Thus, mRNA serves as a temporary copy of the genetic information. It takes place in the nucleus of the cell as described in week 9. The mRNA formed leaves the nucleus into the cytoplasm through the nuclear pores, where it attaches itself to a ribosome.

Translation: This is the stage where the genetic information copied (transcribed) into mRNA is converted into sequence of amino acids to form proteins. It occurs on the ribosomes within the cytoplasm. There are three stages involved:

1. **Initiation:** This is when the ribosome assembles around mRNA, such that an initiator tRNA carries the amino acid (generally, methionine) to bind to the start codon (AUG).
2. **Elongation:** This is where the ribosome adds more amino acid molecules brought by tRNA to the growing polypeptide chain. tRNA picks the amino acids from the cytoplasm to be assembled on the ribosomes.
3. **Termination:** This refers to the stage where the synthesis of a polypeptide chain ends when the ribosome on which protein is being formed encounters a stop codon. When this happens, the newly formed polypeptide chain is released into the cytoplasm, where it joins other chains to form the protein. The ribosomal subunits then disassemble.

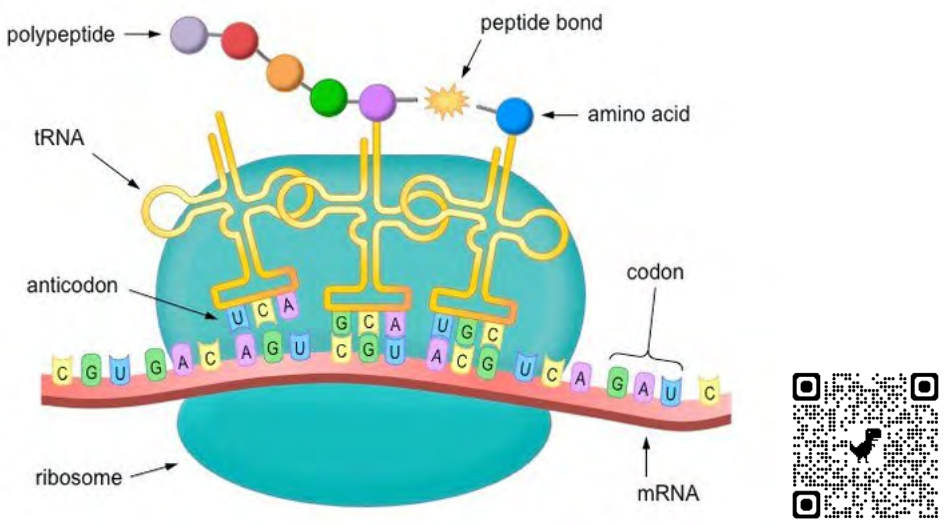


Figure 2.12: *Formation of polypeptide chain (protein)*

Relevance of Proteins to Living Things

- They are essential for growth, development and repair of tissues in living things.
- They are used in the production of enzymes to catalyse biochemical activities.
- They are used in communication between cells (e.g. hormones) and in the regulation of cellular activities.
- Some proteins (e.g. antibodies and cytokines) are required in the immune system to defend the body.
- They are required in transport and storage of materials in cells (e.g. haemoglobin).
- Some are required to maintain cell shape, cell structure and cell motility (e.g. actin and tubulin).

Learning Tasks

1. Explain the role of the genetic code in protein synthesis.
2. Describe the two main processes involved in protein synthesis.
3. Discuss the relevance of protein synthesis in living things.
4. Examine the basic differences and similarities between a DNA and an RNA molecule

PEDAGOGICAL EXEMPLARS

1. **Project-based Learning**: Learners watch video tapes and simulations about protein synthesis and form mix-ability groups to discuss their observations; encourage learners to support others (e.g. learners with hearing impediments, attention deficiencies) in understanding the concepts outlined in the video. Learners in mixed ability groups learn to appreciate the strength and abilities of each member, working together and help one another to achieve results. Link to a video on protein synthesis: https://www.youtube.com/watch?v=gG7uCskUOrA

2. **Diamond Nine Learning Approach**: Challenge learners to work together to evaluate and collectively prioritise nine ideas, opinions or pieces of information on the processes of protein synthesis into what they consider highest to lowest importance. Create a flowchart diagram on the processes involved in protein synthesis and describe the steps involved in each process; This activity encourages rich, focussed discussions as learners are expected to reach a consensus within their group before sharing and justifying their choices with the rest of the class. Application of diamond nine offer learners an open and frank discussion over the topic, encouraging

members to speak, and allowing members to assess the depth of each learner's understanding of the topic and help one another to fully appreciate the lesson.

3. **Talk for Learning**: Make personal notes on processes involved in protein synthesis and their importance to life and discuss this in class; learners reflect over what they can do as individuals, thereby building confidence in them and learning to accept what others can do.

KEY ASSESSMENT

Level 1: Give the two main processes involved in protein synthesis.

Level 2: Describe the processes of translation in protein synthesis.

Level 3: Discuss the relevance of protein synthesis among living things.

Level 4: Discuss why protein synthesis is considered as an essential process in cells.

SECTION 2 REVIEW

In this section, we have explored the cell theory and the two main types of cells. Based on structures, cells were classified in relation to their functions. This knowledge has been applied to bulk transport activities in cells (endocytosis and exocytosis). The DNA, nucleic acids, the Watson-Crick model and its significance in the eukaryotic cell were also considered. DNA replication, RNA transcription, and protein synthesis as it occurs in the eukaryotic cell have been covered and their relevance in living things were also examined. We have learnt that the cell theory is the foundation for pre-eminence for all cells. We have seen the structure of the Watson-Crick model of the DNA, gene coding and how it is transcribed into mRNA and translated to form proteins. Finally, the relevance of protein synthesis in enzyme and hormone production as well as repair of tissues were looked at and linked to the understanding of its importance to life. These applications will be the foundations for further studies in gene synthesis, gene modifications and other areas of research.

APPENDIX C: MID-SEMESTER EXAMINATION

Nature of the Examination: This mid semester examination should cover weeks 1-5 and can consist of only 30 multiple choice questions with different DoK levels.

Duration: Time for the examination should be 45minutes.

Resources needed: Answer booklet, calculator, mathematical set, stationary, printer, pen, pencils, etc.

Sample of MCQs

1. The administration of drugs to animals to get rid of parasites is known as…

A. breeding

B. deworming

C. feeding

D. flushing.

Table 1 – Mid-Semester Table of Specification

Weeks	Focal Area(s)	Type of Questions	DoK Levels				Total
			1	2	3	4	
1	Distinctive Characteristics, Life Processes and Economic Importance of Rhizopus.	Multiple Choice	1	2	1	1	5
2	Distinctive Characteristics, Life Processes and Economic Importance of Moss.	Multiple Choice	2	3	1	-	6
3	Distinctive Characteristics, Life Processes and Economic Importance of Fern.	Multiple Choice	3	3	2	-	8
4	Basic Concepts in Biology and How These Can be used to Improve Crop and Animal Production.	Multiple Choice	1	2	2	1	6
5	Cell theory and Cell structures in relation to their functions.	Multiple Choice	2	2	1	-	5
	Total		**9**	**12**	**7**	**2**	**30**

STRAND: DIVERSITY OF LIVING THINGS AND THEIR ENVIRONMENT

Sub-Strand: Living Organisms

Learning Outcome: *Relate the knowledge of the life processes of grain weevil, butterfly, housefly and honeybee to their economic importance.*

Content Standard: Demonstrate knowledge and understanding of the life processes of grain weevil, butterfly, housefly and honeybee as examples of living organisms (insects) in the environment.

Sub-Strand: Ecology

Learning Outcome: *Explain the features of various tropical habitats and how living organisms are adapted to these habitats.*

Content Standard: Demonstrate knowledge and understanding of major tropical ecological habitats and how living things are adapted to these habitats.

Sub-Strand: Diseases and Infections

Learning Outcome: *Explain immunization, vaccination, and inoculation stating their importance*

Content Standard: Demonstrate knowledge and understanding of immunization, vaccination, and inoculation and their importance.

Hint

- *Week 12 is for End of First Semester Examination. Refer to **Appendix D** for more information on how to administer end of semester examination.*
- *Individual project should be given in week 14 and be submitted by week 20. Refer to **Appendix E** for further information.*
- *Conduct Mid-Semester Examination by week 18. See **Appendix F** for details.*

INTRODUCTION AND SECTION SUMMARY

In year one, identifying living organisms, their populations and the life processes of selected protozoa were examined. In this section, we shall be discussing selected insects' (grain weevil, butterfly, housefly and honeybee) characteristic features, life cycles, economic importance and how to control their populations. These insects are studied to understand the impact they have on plants and animal life in the ecosystem. Grain weevils and houseflies have notable destructive habits like destroying food grains and spreading diseases respectively. Conditions that make them thrive and how to control them will be a key point for discussion. On the other hand, butterflies and honeybees are essential for pollination of flowers, thus leading to discussions on their benefits, and effects of their absence in the ecosystem. The tropical habitats of these organisms are studied in the sub-strand, Ecology. Key features characterising tropical habitats and how organisms are adapted to survive in the habitats are examined. In the other sub-strand, Diseases and infections, basic terminologies are covered. When this section is completed, learners are expected to demonstrate knowledge and understanding of the selected insects, their distinctive features, lifecycle and their relevance in the ecosystem. Learners are expected to acquire basic knowledge on tropical habitats and how living things are adapted to survive in the habitats and basic terms associated with diseases and infections.

The weeks covered by the section are:

Week 11: *Distinctive features, life cycle and characteristics of grain weevil*

Week 12: *Distinctive features, life cycle and characteristics of butterfly*

Week 13: *Distinctive features, life cycle and characteristics of housefly*

Week 14: *Distinctive features, life cycle and characteristics of honeybee*

Week 15: *Characteristic features of a tropical rainforest and adaptations of organisms in tropical Rainforest*

Week 16: *Characteristic features of savanna and desert habitats, and adaptations of organisms in savanna and desert habitats*

Week 17: *Characteristic features of lagoon and estuary habitats, and adaptations of organisms in lagoon and estuary habitats*

Week 18: *Characteristic features of a seashore habitat, and adaptations of organisms in a seashore habitat*

Week 19: *Characteristic features of river, pond and lake habitats, and adaptations of organisms in river, pond and lake habitats*

Week 20: *Diseases and Infections*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Various pedagogies and exemplars are employed in this section to suit the needs of varied learners. In Collaborative Learning learners work in groups, which allows for discussions and arriving at collective decisions. The creativity of learners is ignited as they think through and decide on various ways (concept maps, mind maps, power point presentation, posters) of presenting their work. Presentations after collaboration allow each member to play a role, creating the spirit of teamwork, and socio-emotional forbearances among learners. This prepares the learner for future adventures in academia and for life.

In Project-Based Learning as learners work on a project, (e.g. learners in their groupings identify the habitats of the grain weevil, butterfly, housefly and honeybee, sample them as specimens, and study the various adaptations in their named habitat. Each group presents a written report from their research findings) they learn to be creative and appreciate the contribution of each member. This also develops their cultural identity and global citizenship as learners acquire a sense of identity through the study of various insects that have economic importance within the local community and the larger society.

In Talk for Learning, learners design charts on the various tropical habitats. The learner builds self-confidence as they self-practice the lesson in their own ways; learners appreciate the abilities of their peers as they assess the inputs of every member. As each group makes presentations of their findings and responds to feedback from their peers, introvert members of the group are encouraged to be open and speak as they are assigned roles. Learners express themselves in speech, and team up with members as they embark on ecological trips.

ASSESSMENT SUMMARY

Several modes of assessment are employed in discussing lessons in this section. Formative assessments such as class tests and quizzes, assignments and projects, group discussions and presentations (e.g. orally, PowerPoint, mind map, charts), and direct questions to learners are used during the learning process. These strategies arouse the interest of the learner, thereby allowing all learners to effectively contribute to lessons. Summative assessment modes include end of semester exams, standardised tests (often state-mandated exams) and portfolios (compilation of the learners' work over a period). These tests provide a broad-based, comprehensive assessment of the learners' knowledge as advised in the Curriculum and the Teacher Assessment Manual and Toolkits for Curriculum Trial. Summative assessments also provide benchmarks and standards for the performances of all learners. This allows consistency in evaluating learners' academic progress. Most importantly, the assessment techniques used in the section take into consideration the interest of learners at all levels, ensuring that each learner can

successfully attempt at least parts of the assessments provided. The recommended mode of assessment for each week is:

Week 11: *Discussion*

Week 12: *End of Semester Examination*

Week 13: *Practical Work*

Week 14: *Homework*

Week 15: *Field Trip*

Week 16: *Presentation – Groups*

Week 17: *Debate*

Week 18: *Mid- Semester Examination*

Week 19: *Peer Assessment*

Week 20: *Role-Play*

WEEK 11

Learning Indicators

1. *Identify and describe the distinctive features, life cycle and characteristics of grain weevil, butterfly, housefly and honeybee.*
2. *Discuss the economic importance of selected living organisms (insects)*

FOCAL AREA: DISTINCTIVE FEATURES, LIFE CYCLE, CHARACTERISTICS AND ECONOMIC IMPORTANCE OF GRAIN WEEVIL

The Structure and Distinctive Features of Grain Weevil

Grain weevils are a group of small beetles (Order: Coleoptera) which possess elongated snouts or rostrums used to bore into grains. It mostly infests stored grains such as maize, rice and wheat. Grain weevils are mostly reddish-brown to black adults. The body is made up of hard, shell-like, covering of ridged wing cases. They can fly readily as they have fully developed wings under their wing covers and at times play dead when threatened. Some common examples are the maize weevil (*Sitophilus zeamais*) and the rice weevil (*Sitophilus oryzae*)

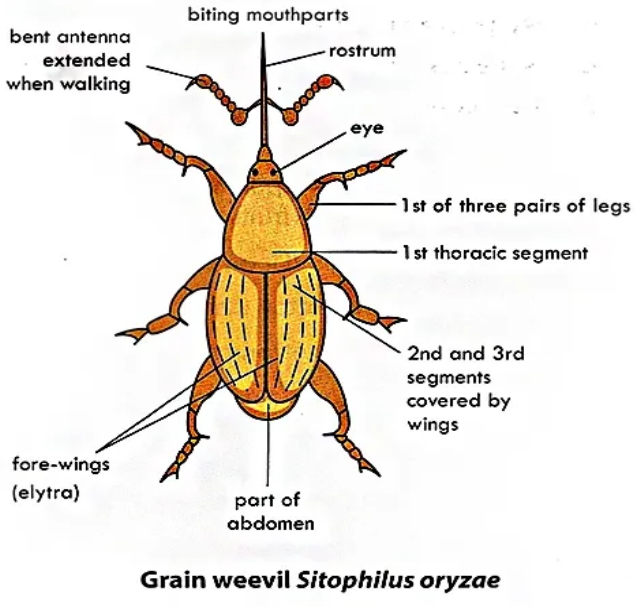


Figure 3.1: *Grain Weevil*

Life Cycle and Adaptations of the Grain Weevil

The grain weevil undergoes complete metamorphosis, where it develops in four distinct stages from the egg, through a larva and pupa stages to the adult. The female lays between 200 to 300 eggs in different grains over its lifetime. The egg is hatched into a white, legless larva called grub which consumes the endosperm (inner food) of grains.

Grubs undergo a series of moulting (ecdysis) to become the pupa within the grain. The pupa develops into the adult. The adult weevil emerges from the grain by chewing its way out, ready to reproduce young ones. The duration of the entire life cycle is between one to two months, depending on environmental conditions, mostly temperature and humidity.

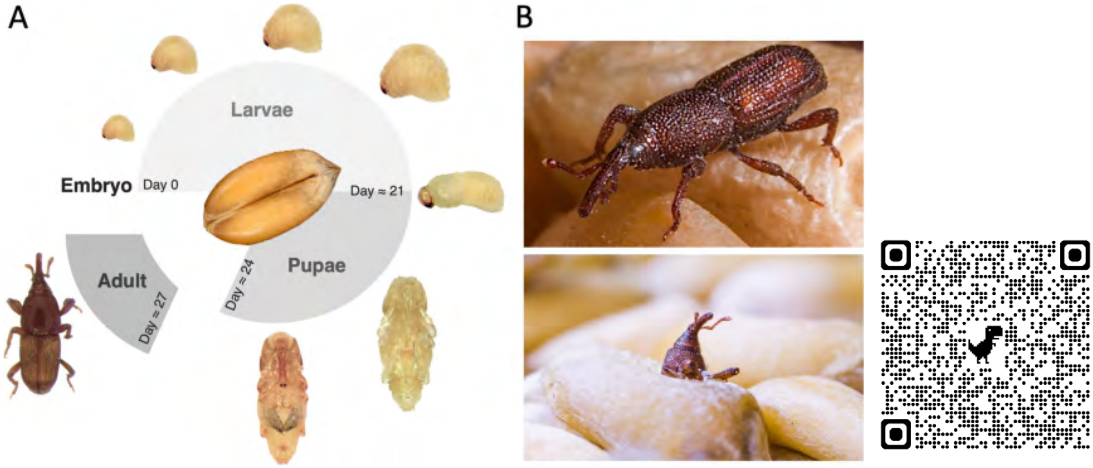


Figure 3.2: *Life cycle of the maize grain weevil*

Economic Importance of Grain Weevil

- It is a major grain pest that causes financial losses to grain farmers and traders.
- Grain weevils reduce the quality and quantity of grains by contaminating them.
- Farmers and traders incur more cost in combating grain weevil infestations.
- They are used in research in pest management and biological control methods.
- They contribute to ecological balance by serving as food for some species such as birds, rodents and other insects.

Control of Grain Weevil

- Grains can be stored in container with tight lid.
- Weevils can be controlled by using pesticides.
- Introducing organisms that are predators of the weevils.
- Early harvest of crop from fields.
- Grains like maize should be dried thoroughly under sunlight or by smoking.

Learning Tasks

1. List and describe the distinctive features of the grain weevil.
2. Describe the life cycle of the grain weevil.

3. Explain the control measures that can be applied to reduce grain weevil infestations.
4. Discuss the economic importance of the grain weevil.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, research from textbooks and related resources, the distinctive features, life cycle and characteristics of the grain weevil. Gender responsiveness and social inclusion in the group addresses the social and emotional needs of each learner, such that each member learns to accept the background of another and seeks to meet their emotional needs for a healthy academic exercise.
2. **Project-Based Learning**: As a project work, learners in their groupings identify the habitat of the grain weevils, sample as specimens, and study the various adaptations. Provide support for learners with emotional challenges (e.g. fear of insects) when assigning roles within the groups. Each group presents a written report from their research findings. Learners learn to be creative and appreciate the contribution of each member in a group project exercise.
3. **Talk for Learning**: Learners discuss the research done on the adaptions of the grain weevil and design charts on the life cycle of the grain weevil. Learners build self-confidence as they organise the information in their own ways; learners appreciate the abilities of their peers as they assess the inputs of every member.
4. **Project-based Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, identify within your locality and discuss, some beneficial and harmful activities of the grain weevils and how to control them (e.g. visit a grain storeroom in the school or close to the school). Each group makes presentation in the form of posters or mind maps, of their findings and responds to feedback from their peers; learners become creative and appreciate diversity in learning experiences as introvert members are encouraged to be open and speak in their assigned roles. Learners acknowledge the need for respecting all living things and their environments.

KEY ASSESSMENT

Level 1: List the distinctive features of the grain weevil.

Level 2: Describe the distinctive and adaptive features of grain weevils.

Level 3: Discuss the phases of development in grain weevils.

Level 4: Examine effects of the grain weevil on grain production and in ecological stability.

WEEK 12

Learning Indicators

1. *Identify and describe the distinctive features, life cycle and characteristics of grain weevil, butterfly, housefly and honeybee.*
2. *Discuss the economic importance of selected living organisms (insects)*

FOCAL AREA: DISTINCTIVE FEATURES, LIFE CYCLE, CHARACTERISTICS AND ECONOMIC IMPORTANCE OF BUTTERFLY

Structure and Distinctive Features of Butterfly

Butterflies are diurnal insects (Order Lepidoptera) characterised by their large, colourful wings and distinctive club-shaped antennae. The body is divided into the head, thorax and abdomen. There are compound eyes on the head for wide field of vision, colour and movement detection. The club-shaped antennae on the head are for detecting chemicals in the air such as the scent of flowers. The mouthparts are modified into a long tube (proboscis) for sucking nectar from flowers. The proboscis in the butterfly is coiled when at rest. On the thorax are two pairs of large, wings covered with tiny colourful scales, and three pairs of legs.

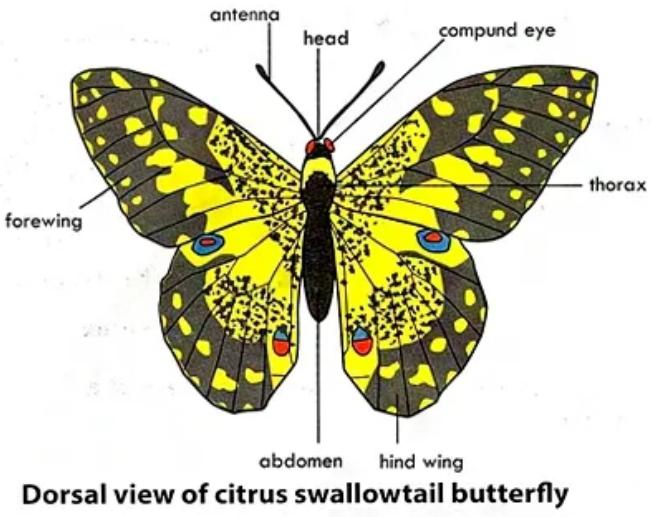


Figure 3.3: *Dorsal view of citrus swallowtail Butterfly*

Life Cycle and Adaptations of the Butterfly

It undergoes complete metamorphosis, with four distinctive stages as the egg, larva (caterpillar) pupa (chrysalis) and adult (imago). The female butterfly lays eggs, each about the size of a pinhead, on the leaves of host plant. The eggs are laid in clusters. The eggs hatch into caterpillars (in one to two weeks) which feed on the leaves of the host plant and grow rapidly into chrysalis. The chrysalis undergoes transformation at the cellular level to form the adult butterfly. Most adult butterflies live for less than one month feeding and searching for a mate.

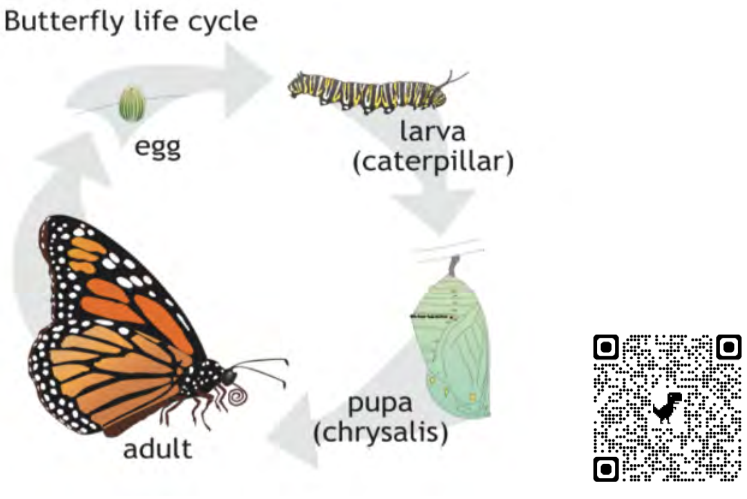


Figure 3.4: *Life cycle of butterfly*

The insect uses its antennae and compound eyes to detect environmental changes and locate food. Butterflies primarily feed on nectar by extracting it from flowers using their proboscis.

Economic Importance of Butterfly

- They are active agents of pollination for flowers, hence important in crop production.
- Butterfly gardens and parks serve as a source of tourism to generate income.
- They are used in scientific research for educational purposes.
- They are bio-indicators of the health and state of the environment, thereby supporting conservation efforts.

Learning Tasks

1. List and describe the distinctive features of the butterfly.
2. Describe the life cycle of butterflies.
3. Explain the measures used to control the population of caterpillars.
4. Discuss the economic importance of butterflies.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, research from textbooks and related resources, the distinctive features, life cycle and characteristics of the butterfly. Encourage learners to help other learners who may struggle with the use of ICT tools, where necessary. Gender responsiveness and social inclusion in a group address the social and emotional needs of each learner, such that each member learns to accept the background of another and seeks to meet their emotional needs.

2. **Project-Based Learning**: As a project work, learners in their groupings identify and visit the habitat of the butterfly, sample as specimens, and study the various adaptations. Learners appreciate the wonder and complexity of nature as each group presents a written report from their research findings. Learners learn to be creative and appreciate the contribution of each member in a group project exercise.
3. **Talk for Learning**: Learners design charts on the life cycle of the butterfly. Learners build self-confidence as they organise the lesson in their own ways; learners appreciate the abilities of their peers as they assess the inputs of every member.
4. **Project-based Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, identify within your locality and discuss, some beneficial and harmful activities carried out by butterflies. Each group makes presentations in the form of a poster or mind map on the butterfly, detailing their benefits, harmful effects and control; learners become creative and appreciate diversity in learning by experiencing different posters and mind maps from peers and respond to feedback.

KEY ASSESSMENT

Level 1: List the distinctive features of butterflies.

Level 2: Describe the distinctive and adaptive features of butterflies.

Level 3: Discuss the phases of development in the butterfly.

Level 4: Discuss the role and impact of butterflies in an ecosystem.

WEEK 13

Learning Indicators

1. *Identify and describe the distinctive features, life cycle and characteristics of grain weevil, butterfly, housefly and honeybee.*
2. *Discuss the economic importance of selected living organisms (insects)*

FOCAL AREA: DISTINCTIVE FEATURES, LIFE CYCLE, CHARACTERISTICS AND ECONOMIC IMPORTANCE OF THE HOUSEFLY

Structure and Distinctive Features of Housefly

The housefly *(Musca domestica)* is small, widespread insect (Order Diptera) characterised by a slightly hairy body with greyish-black colour and distinctive longitudinal lines on the thorax. These insects possess a pair of large, red compound eyes on the head, and proboscis specialised for sponge feeding on liquids or semi liquid substances. On the thorax are located two pairs of wings; one functional wing for flying, and a secondary pair of wings reduced to halteres for balancing.

Life Cycle and Adaptations of the Housefly

Houseflies undergo complete metamorphosis. The female lays up to about 500 eggs in its lifetime. The eggs are laid in moist, decaying organic matter. The fertilised eggs hatch into the larvae called maggots within twenty-four hours. The larvae feed and grow through several instar stages within five to fifteen days to form the pupa with a hardened case in which metamorphosis occur. The adult housefly emerges from the pupa case, ready to reproduce in a few days.

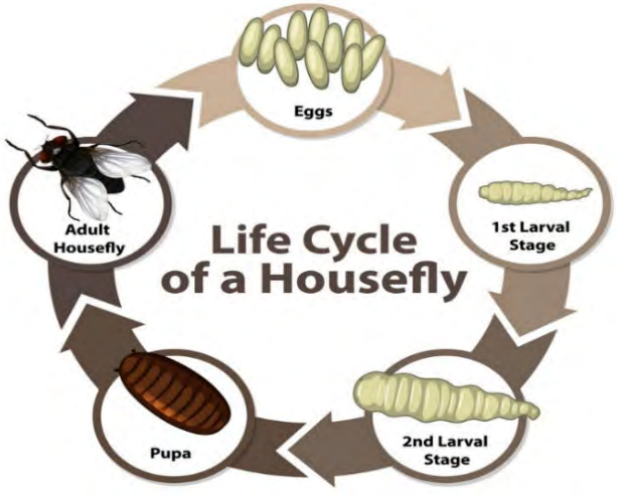


Figure 3.5: *Life cycle of housefly*

Houseflies are highly adaptable insects that develop successfully in all environments. They are found in places with abundant food waste and organic materials such as garbage or refuse dumps, uncovered dustbins, homes, marketplaces and restaurants where they encounter carcasses, garbage and other septic matter. They are intimately associated with humans, our food and utensils. Thus, the housefly is potentially involved in transmission of many serious and widespread diseases such as salmonellosis, typhoid fever, cholera, infantile diarrhoea and amoebic dysentery.

Economic Importance of Houseflies

- They are vectors that carry many pathogens that cause disease such as cholera, typhoid fever and dysentery.
- They may cause food poisoning and contamination by transmitting toxins from one location to another.
- They may stress livestock by their presence and as vectors of animal pathogens, leading to low productivity.
- The larvae (maggots) play active role in decomposition, thereby contributing to nutrient cycling.
- They are being explored for their potential in biotechnology applications, such as for enzyme and biomolecule productions.
- They are used in scientific research for studying genetics, physiology and transmission of diseases.

Control Measures for Houseflies

1. The cultural control method changes the environment to prevent houseflies from developing. The best cultural method is to dispose of any organic matter properly. This includes vegetable or other food by-products, where houseflies might lay eggs.
2. Parasitic wasps and fire ants are used as biological controls to suppress housefly populations naturally.
3. When necessary chemical control measures are used where insecticides can help suppress housefly populations.

Learning Tasks

1. List and describe the distinctive features of the housefly.
2. Describe the life cycle of the housefly.
3. Explain the measures to put in place to control the populations of houseflies.
4. Discuss the economic importance of houseflies.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, research from the environment, textbooks and related resources, the distinctive features, life cycle and characteristics of the housefly. Gender responsiveness and social inclusion in a group address the social and emotional needs of each learner, such that each member learns to accept the background of others and seeks to meet their emotional needs. Learners recognise the responsibility of conserving, protecting and maintaining the quality of the environment.
2. **Project-Based Learning**: As a project work, learners in their groupings identify the habitat of the housefly, sample as specimens, and study the various adaptations. Encourage learners to dispel any cultural ideas on houseflies and consider them as biological specimens and identify the uniqueness of the insect. Learners learn to be creative and appreciate the contribution of each member in a group as they emotionally support each other.
3. **Talk for Learning**: Learners discuss and design charts on the life cycle of the housefly. Learners build self-confidence as they organise their research findings in the charts; learners appreciate the abilities of their peers as they assess the inputs of every member.
4. **Project-based Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, identify within your locality and discuss, some beneficial and harmful activities carried out by the housefly and its control. Each group makes presentations of their findings and responds to feedback from their peers. Encourage learner to appreciate diversity in learning experiences by creating posters or mind maps on the housefly.

KEY ASSESSMENT

Level 1: List the distinctive features the housefly.

Level 2: Describe the distinctive and adaptive features of the housefly.

Level 3: Discuss the phases of development in the housefly.

Level 4: Examine the impact of the housefly on public health within your community.

WEEK 14

Learning Indicators

1. *Identify and describe the distinctive features, life cycle and characteristics of grain weevil, butterfly, housefly and honeybee.*
2. *Discuss the economic importance of selected living organisms (insects)*

FOCAL AREA: DISTINCTIVE FEATURES, LIFE CYCLE, CHARACTERISTICS AND ECONOMIC IMPORTANCE OF THE HONEYBEE

Structure and Distinctive Features of the Honeybee

Honeybees *(Apis species)* are social insects (Order: Hymenoptera) that produce honey and beeswax. They live in colonies, and are grouped as the queen (a single, reproductive female that lays eggs), workers (non-reproductive females that perform various tasks, including foraging and cleaning of the hive) and drones (males that mate with a virgin queen during her nuptial flight). Bees are found in habitats that support growth of flowering plants, such as woodlands, gardens and meadows. The wild honeybees build nests in areas such as the hollows of trees, in and around rock crevices and sheltered areas, but domesticated forms are kept in man-made hives. As found in all insects, its body is divided into three parts as the head, thorax and abdomen. Located on the head region are compound eyes, a pair of antennae and a proboscis for sucking nectar. The thorax bears two pairs of wings and three pairs of legs. There are specialised structures called pollen baskets, which are located on the hind legs for carrying pollen. The workers and queens also have sting for defence.

Life Cycle and Adaptations of the Honeybee

Bees undergo complete metamorphosis. The queen lays eggs in individual cells of the honeycomb. Fertilised eggs become workers (or a new queen) while unfertilised eggs become drones. The eggs hatch into larvae which are feed by the worker bees. Finally, the honeycomb cells are capped over so the larvae can spin their cocoons and pupate in a protected space The pupa grows into the adult bee which emerges from the cell as a queen, worker or drone. The worker bees feed the queen bee with royal jelly at its larval stage.

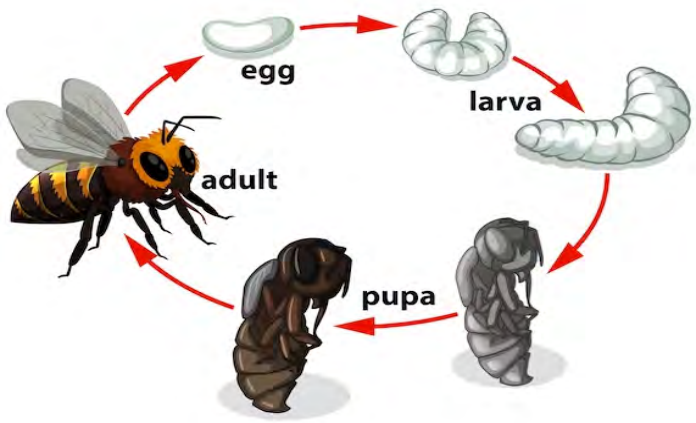


Figure 3.6: *life circle of a honeybee*

Economic importance of honeybees

- They are vital pollinators of crops.
- They produce honey, which is a valuable product with many nutritional and medicinal benefits.
- They produce products that are used in candles, polishes and cosmetics. Examples of these products are beeswax, propolis and royal jelly.
- Bee products are used in apitherapy; the use of bee products for therapeutic purposes (e.g. royal jelly is used as an anti-aging agent while propolis is used in ointment for its known anti-inflammatory effect).
- Bee sting is a nuisance to farmers and may lead to allergic reactions and medical emergencies.

Learning Tasks

1. List and describe the distinctive features of the honeybee.
2. Describe the life cycle of the honeybee.
3. Explain how honeybees are important for sustaining ecosystems.
4. Discuss the economic importance of honeybees.

PEDAGOGICAL EXEMPLARS

1. **Collaborative Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, research from textbooks and related resources, the distinctive features, life cycle and characteristics of the honeybee. Encourage learners to support other learners with learning challenges such as attention deficiencies as they are assigned roles in the group. Gender responsiveness and social inclusion in a group address the social and emotional needs of each learner such that learners accept the background of others.

2. **Project-Based Learning**: As a project work, learners in their groupings identify the habitat of the honeybee, sample as specimens, and study the various adaptations of the honeybee. Each group presents a report from their findings. Learners learn to be creative in their reporting styles and appreciate the roles played by others in the group. The sampling should be done by the teacher in his/her protective wear.
3. **Talk for Learning**: Learners discuss (lead by the group leader) on the life cycle and beneficial and harmful activities carried out by honeybee. Learners build self-confidence as they share their thoughts and confirm information from their research; learners appreciate the abilities of their peers as they assess the inputs of others and tolerate the criticisms from others.
4. **Creative Learning**: In mixed-ability, gender-responsive and all-inclusive tasked-based groups, discuss to design a presentation (in PowerPoints, posters, charts and mind maps) on the beneficial activities carried out by honeybee. Each group makes presentations on the beneficial activities carried out by honeybee and respond to feedback from their peers. Encourage learners to share their ideas for making presentations and appreciate diversity in learning as they experience different poster and mind maps ideas from peers.

KEY ASSESSMENT

Level 1: List the distinctive features of honeybees.

Level 2: Describe the distinctive and adaptive features of honeybees.

Level 3: Discuss the phases of development in honeybees.

Level 4: Discuss the uses of propolis, royal jelly, bee pollen and bee venom.

WEEK 15

Learning Indicators

1. *Describe the characteristic features of a tropical Rainforest, Savannah, Desert, Lagoon, Estuary, Seashore, River, Pond and Lake*
2. *Describe how common tropical organisms are adapted to their habitats.*

FOCAL AREA: CHARACTERISTIC FEATURES OF A TROPICAL RAINFOREST AND ADAPTATIONS OF ORGANISMS IN TROPICAL RAINFOREST

Tropical Rainforest

A tropical rainforest is a type of forest characterised by high rainfall (more than 2000mm annually) with consistent warm temperatures and high biodiversity. Tropical rainforests are well known for their dense vegetation with multiple layers of plants with varying characteristics. These include emergent trees (the highest trees), canopy layers, (the primary layers of rainforest that forms a dense roof of leaves and branches), understory layers (located below the canopies and receiving limited sunlight) and bottom floors (the bottom layers of the rainforest).

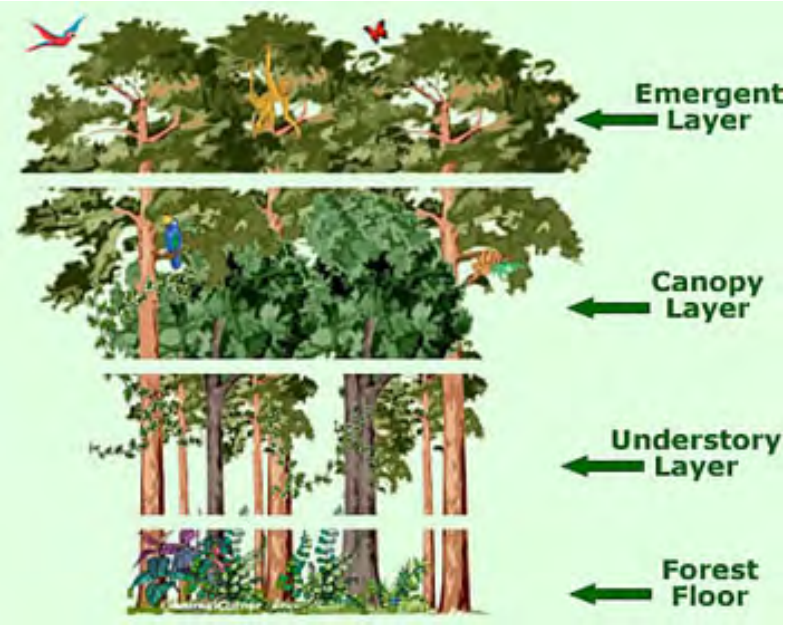


Figure 3.7: *Rainforest Canopy Layers*

The high biodiversity observed in this habitat is due to consistent climatic conditions and abundant resources which create a stable environment that supports a wide variety of species.

Figure 3.8: *Tropical rainforest*

Prokaryotes found here are bacteria that aid in decomposition in the soil, and nitrogen-fixing bacteria in root nodules of plants. Protoctista found are amoebas and flagellates in the soils of the moist and wet regions of the forest. Fungi such as mushrooms and yeast are found in the soil and on dead organic matter. Along with bacteria, they help in the process of decomposition. Plants such as mahogany, rubber and kapok trees, epiphytes such as orchids and bromeliads, several species of ferns at the forest floor and, large woody vines that climb trees (Lianes). The habitat is also home to various animal groups, including mammals such as monkeys, jaguars and sloths, birds such as parrots, sparrows and eagles, reptiles including snakes, lizards and caimans, amphibians such as frogs and salamanders, insects and arachnids including butterflies, ants, spiders and scorpions.

National geographic documentary on rainforests: https://www.youtube.com/watch?v=3vijLre760w

Characteristics of Tropical Rainforests

1. There is high rainfall of over 2000 mm per annum.
2. They maintain warm temperatures between 20–30^{0}C.
3. They maintain a high level of humidity.
4. There is high level of biodiversity.
5. They are characterised by multiple layers of plants.

Adaptations of Plants in Tropical Rainforest

1. Most plants have large leaves with drip tips to shed water and prevent growth of fungi on its surface e.g. mahogany tree
2. Most trees here develop buttress roots to give stability in thin soils and absorb nutrients e.g. kapok tree

3. Epiphytes grow on other plants to access sunlight in dense canopies e.g. orchids, bromeliads
4. Vines and Lianes climb trees to reach sunlight in the upper canopy e.g. pothos (candle vine)

Adaptations of Animals in Tropical Rainforest

1. Many animals develop coloration and patterns as a means of camouflage to avoid predators e.g. sloth.
2. Some animals adapt to living in trees to avoid ground predators e.g. bushbabies
3. Some animals have prehensile tails that allow them to grasp tree branches to move in forest canopies e.g. spider monkey, opossum
4. Some rainforest animals adapt to nocturnal lifestyle to avoid predators. e.g. pangolin

Learning Tasks

1. Describe a typical tropical rainforest habitat.
2. Give examples of different groups of organisms found in a tropical rainforest.
3. Describe the characteristic layers of vegetation of a tropical rainforest.
4. Describe the different adaptations of plants and animals to tropical rainforest habitat.

PEDAGOGICAL EXEMPLARS

1. **Experiential Learning**: Embark on an ecological trip to a tropical rainforest habitat or watch a video (https://www.youtube.com/watch?v=JEsV5rqbVNQ) of a rainforest to observe and identify specific organisms and discuss their adaptations. Learners embrace cultural diversity, appreciation for diversity and complexity in nature by learning from different environments.

2. **Talk-for-Learning Approach**: Discuss in detail the distinctive features of the tropical rainforest and the special adaptations of organisms. Encourage learners to clearly voice out their observations to build their confidence. Learners learn to tolerate and present their views in a more constructive form.
3. **Collaborative Learning**: Work in groups to prepare a Presentation (power point or summarise your points on a cardboard) on a tropical rainforest habitat for critiquing and feedback by the entire class. Group base presentations allow each learner to play a role, creating the spirit of teamwork and socio-emotional forbearance.

KEY ASSESSMENT

Level 1: What is a tropical rainforest?

Level 2: Describe the major characteristics of a tropical rainforest.

Level 3: Discuss the adaptations of the flora and fauna in a tropical rainforest.

Level 4: Examine the process of nutrient cycling in a named tropical rainforest.

WEEK 16

Learning Indicators

1. *Describe the characteristic features of a tropical Rainforest, Savannah, Desert, Lagoon, Estuary, Seashore, River, Pond and Lake*
2. *Describe how common tropical organisms are adapted to their habitats.*

FOCAL AREA: CHARACTERISTIC FEATURES OF SAVANNAH AND DESERT HABITATS, AND ADAPTATIONS OF ORGANISMS IN SAVANNAH AND DESERT HABITATS

Savannah and Desert Habitats

Savannah is a mixed grassland ecosystem made up of different grasses, scattered trees and shrubs. Savannahs found around the equator are called tropical savannahs. There are three types of tropical savannahs across Africa. These are the Guinea Savannah, Sudan Savannah and Sahel Savannah. Generally, the different forms of savannahs are characterised by different types of grasses. Examples of such predominant grasses in different savannahs are the Guinea grass, Bermuda grass, Gamba grass and elephant grass in the Guinea Savannah, the tussock and thatching grasses of the Sudan Savannah and the Drin grass, tussock grass and Bushman grass of the Sahel Savannah. The Savannah experiences a seasonal cycle with distinct wet and dry periods. Organisms found in this habitat include bacteria, fungi such as mushroom (e.g. termitomyces), trees such as acacia, shea trees, palms and baobabs.

Figure 3.9: *The African Baobab*

Animals found in tropical savannahs include lions, elephants, giraffes, antelopes, ostriches, vultures, snakes, termites and grasshoppers.

A documentary on the savannah: https://www.youtube.com/watch?v=xQElFcAXlHU

Deserts are arid areas with extremely low rainfall, extreme temperatures (very hot or cold) and very sparse vegetation. Bacteria in this region are mostly thermophiles, and algae include cyanobacteria in desert crusts. Fungal life includes desert fungi that support nutrient cycling. Plants in this habitat include saguaro, prickly pear, and shrubs such as sagebrush and creosote bush. Common animals in deserts include camels, kangaroos, fennec foxes, rattle snakes, burrowing owls, roadrunner birds, and insects such as ants and Scarab beetles. A documentary on deserts, national geographic: https://www.youtube.com/watch?v=n4crvs-KTBw

Figure 3.10: *The Sahara Desert*

Characteristics of Savannahs and Desert Habitats

The Savannah

1. There is seasonal rainfall with a distinct wet and dry season.
2. The flora is predominantly grasses with scattered drought-resistant trees.
3. Fauna is usually made up of animals adapted to grazing, browsing and seasonal migration.
4. The soils are often nutrient-poor and well drained.

The Desert

1. There is extremely low rainfall less than ten inches in a year with high evaporation.
2. Flora is sparse and often made up of succulent and drought resistant shrubs.
3. The faunas are adapted to extreme temperatures and water scarcity.
4. Desert soils are mainly sandy with minimal organic content, or a rocky land.

Adaptations of Savannah and Desert Organisms

Savannah

1. Some animals use camouflage to hunt and for protection e.g. lions and zebras.
2. Most large mammals in the desert migrate to find water and fresh grazing e.g. wilder beasts
3. Some savannah animals can go long periods without water e.g. giraffes.
4. Savannah plants develop deep roots (tap roots) to access groundwater e.g. acacia
5. Most grasses and savannah trees can withstand periodic fires e.g. elephant grass

Desert

1. Most desert animals are adapted to nocturnal life to avoid excess heat during the day e.g. kangaroo rats, foxes and bobcats
2. Some animals burrow into the soil to escape heat and predators e.g. ground squirrels, African bullfrog, burrowing owls and meerkats.
3. Some animals store fats, and the metabolism of these fats is used to conserve water, e.g. gerbils. Camels also break down (fats stored in their hump) into energy, so that less water is lost from respiration.
4. Many desert plants store much water in their tissues, e.g. cacti and aloe vera
5. Many desert plants have reduced leaves to minimise water loss e.g. Joshua tree
6. Some desert plants have deep and extensive root systems to increase water absorption e.g. welwitschia.

Learning Tasks

1. Describe a typical desert.
2. Give examples of different groups of organisms found in the tropical savannah.
3. Compare the characteristics of a tropical savannah with a desert.
4. Debate on the possibility of reclaiming deserts into forests.

PEDAGOGICAL EXEMPLARS

1. **Experiential Learning**: Embark on an ecological trip or watch videos of tropical savannahs (https://www.youtube.com/watch?v=xQElFcAXlHU) and desert (https://www.youtube.com/watch?v=n4crvs-KTBw) habitats to observe and identify specific organisms and discuss their adaptations. Learners embrace cultural diversity by learning from different environments.

2. **Talk-for-Learning**: Using the activity ball, initiate a discussion by asking questions on the distinctive features of the tropical savannah and desert habitats and the special adaptations of organisms in these habitats and throw the activity ball to a learner for a response. Learners take turns in catching the activity ball and answering questions. Learners learn to tolerate others' views and present feedback.
3. **Collaborative Learning**: Work in groups to prepare PowerPoint presentations (or summarise your points on a cardboard) on tropical savannah and desert habitats for critiquing and feedback by the entire class. Group base presentation allows each learner to play a role, building teamwork and socio-emotional forbearances.

KEY ASSESSMENT

Level 1: How different are tropical savannahs from deserts?

Level 2: Describe the major characteristics of tropical savannahs and deserts.

Level 3: Discuss the adaptations of groups of plants and animals living in tropical savannahs and deserts.

Level 4: Analyse the merits and demerits of living in the tropical savannahs and deserts, hence show how living conditions may be changed or improved to increase biodiversity in these habitats.

Level 4: Analyse and debate on the possibility of reclaiming a desert into a forest.

WEEK 17

Learning Indicators

1. *Describe the characteristic features of a tropical Rainforest, Savannah, Desert, Lagoon, Estuary, Seashore, River Pond and Lake.*
2. *Describe how common tropical organisms are adapted to their habitats.*

FOCAL AREA: CHARACTERISTIC FEATURES AND ADAPTATIONS OF ORGANISMS IN LAGOON AND ESTUARY HABITATS

Lagoon Habitats

Lagoons are shallow bodies of water separated from larger bodies of water such as the seas and oceans by a barrier (e.g. sandbars, barrier islands and coral reefs). Processes leading to the formation of lagoons include sediment deposition, wave action and growth of barrier islands or coral reefs. Generally, lagoons contain a mixture of freshwater and saline water from the sea. Salinity levels may differ depending on the sea and freshwater inflows. During low tide, freshwater mixes easily with water in the lagoon, lowering salinity and during high tide, inflow of the ocean water is high, increasing salinity. Lagoons are rich in biodiversity, and this includes different species of fish, birds, insects and plants, and they serve as the habitat for most breeding species.

The two main types of lagoons are the coastal lagoons, found along coastlines, and separated from the sea by a barrier, and atoll lagoons, which contain a central water body within coral atolls. Examples of lagoons in Ghana are the Benya Lagoon in Elmina, the Korle Lagoon in Accra and Keta Lagoon in Keta. Most lagoons are under threat, as they are subjected to destructive activities such as pollution, eutrophication (excessive enrichment of water bodies with nutrients, leading to algae overgrowth and oxygen depletion) and habitat destruction due to human activities.

Figure 3.11: *Muni coastal lagoon in Winneba, Ghana*

Characteristics of a Lagoon

1. Lagoons have fluctuating salinity and temperature.
2. Lagoons are relatively shallow, a few meters deep
3. Lagoons support a high level of biodiversity
4. The flow of water in a lagoon is slow and sluggish

Adaptions of Organisms to Lagoon Habitats

1. Some have developed specialised osmoregulatory features and mechanisms to tolerate high and low salt concentrations e.g. crabs, oysters, shrimps, mussels, snails.
2. Some have efficient respiratory features and behaviours to survive in hypoxic (low oxygen) conditions (e.g. some organisms move to the surface to breathe)
3. Some burrow into sediments to cope with extreme and changing temperatures e.g. oysters
4. Some lagoon organisms are detritivores or filter feeders, and they capitalise on feeding on the organic matter and nutrients that accumulate in sediments. E.g. snails
5. Some lagoon species produce large numbers of eggs that hatch into larvae that disperse widely to increase the chances of survival.
6. Some have developed camouflage or produce toxins to avoid predators.
7. Some lagoon animal species are highly mobile and move quickly to areas with more favourable conditions when required.
8. Mangroves (coastal ecosystems usually found in tropical and subtropical areas) have special breathing roots (pneumatophores) that are above ground (aerial) and are adapted to absorb oxygen from the air and transport to underground roots and other parts of the plant.

Estuaries

Estuaries are partially enclosed coastal water bodies where freshwater from rivers and streams meets the sea and mixes with saltwater from the oceans. Estuaries are dynamic ecosystems where seawater is brought in by the tides but is diluted by freshwater flowing in from rivers and streams. Like lagoons, they can be partially enclosed by a barrier that protects them from harsh sea waves. Estuaries are areas of transition from land to sea, as well as from freshwater to brackish water. The water has fluctuating salinity, tides and nutrient levels, and its complex circulation pattern is influenced by tides, river inflow and wind. They serve as important habitats for many fish and bird species, including nurseries for young fish and feeding grounds for migratory birds. Estuaries are prone to pollution from agricultural runoffs, industrial discharges and urbanisation. Some examples of

estuaries are the Volta River Estuary near Ada, Rivers Pra and Densu estuaries in the Western and Greater Accra Regions.

Figure 3.12: *River Ankobra meets the sea*

Characteristics of Estuaries

1. Estuaries are usually deeper than lagoons.
2. Estuaries always have an inflow of freshwater from a river/stream.
3. Flow of water into an estuary can be fast and strong.
4. Estuaries have a highly fluctuating salinity.

Adaptions of Organisms to Estuaries

1. Many fishes (e.g. salmons and eels) regulate their internal salt concentrations to allow them to move between freshwater and saltwater.
2. Many species burrow and hide in sediment to avoid predators and harsh conditions e.g. mussels, clams
3. Some have streamlined or flattened bodies to navigate currents and hide in the sediments.
4. Anadromous fish (fish that migrate from saltwater (seas and oceans) to freshwater (e.g. rivers and lakes) use estuaries as a channel for moving into fresh water for spawning e.g. pink salmon.
5. Filter feeders such as oysters and barnacles have specialised feeding structures to filter plankton and detritus from water.
6. The roots of plants such as mangrove, provide habitat and protection for juvenile fish and other aquatic organisms.
7. Seagrasses, found in estuaries, can tolerate high concentrations of salt in their tissues.

Learning Tasks

1. Define lagoons and estuaries.
2. Give examples of different organisms that are found in lagoons and estuaries.
3. Describe the nature of lagoon and estuary habitats.
4. Give the adaptations of different organisms that live in lagoons and estuaries.

PEDAGOGICAL EXEMPLARS

1. **Experiential Learning**: Embark on an ecological trip to a lagoon and an estuary habitat to observe and identify specific organisms and discuss their adaptations (learners living in non-coastal areas can watch videos and documentaries of estuaries).

   https://web.facebook.com/WorldBankAfrica/videos/biodiversityday-spotlight-on-ghana-wetlands-are-crucial-to-both-nature-and-the-c/382357737506897/?_rdc=1&_rdr

   Learners embrace cultural diversity by learning from different environments.

2. **Talk-for-Learning**: Discuss in detail the distinctive features of lagoon and estuary habitats and the special adaptations of organisms in these habitats. Learners learn to tolerate other member's views and present feedback.

3. **Collaborative Learning**: Work in groups to prepare PowerPoint Presentations (or summarise your points on a cardboard) on lagoon and estuary habitats for critiquing and feedback by the entire class. Group based presentation allows each member to play a role, creating the spirit of teamwork and socio-emotional forbearances among one another.

KEY ASSESSMENT

Level 1: Distinguish between a lagoon and an estuary.

Level 2: Describe the main features of a lagoon and an estuary in terms of water content, salinity and living things found in them.

Level 3: Discuss the adaptive features of the living organisms found in a lagoon and an estuary.

Level 4: With specific examples, examine the interferences and the consequent ecological implications of human activities on the lagoons and estuaries across the nation.

WEEK 18

Learning Indicators

1. *Describe the characteristic features of a tropical Rainforest, Savannah, Desert, Lagoon, Estuary, Seashore, River Pond and Lake.*
2. *Describe how common tropical organisms are adapted to their habitats.*

FOCAL AREA: CHARACTERISTIC FEATURES AND ADAPTATIONS OF ORGANISMS AT THE SEASHORE

Seashore Habitats

The seashore habitat refers to the area where the land meets the ocean and encompasses the intertidal zone and adjacent areas influenced by marine conditions. Nutrient levels are often high in seashore habitats due to upwelling and runoffs. The seashore habitat comprises several zones, each with unique characteristic features and organisms.

1. **The supralittoral zone (splash zone)** is the uppermost zone which is submerged only during high tides. This region is generally subjected to salt spray and waves. Organisms living in this zone include lichens, algae, barnacles and periwinkles. Organisms in this zone are adapted to withstand desiccation and extreme temperatures mainly due to the infrequent tidal flooding, and diurnal fluctuations (temperatures swinging from cold to hot during night and day) respectively.
2. **The littoral zone (intertidal zone)** is the area between high and low tide marks. This region is regularly submerged and exposed because of tidal movements. Organisms in this area include seaweeds (algae), mussels, crabs, starfish (sea stars) and sea anemones. These organisms experience frequent fluctuations in temperature, salinity and moisture due to tidal cycles, seasonal variations and diurnal changes.
3. **Sublittoral zone (subtidal zone)** is the part of the seashore which extends from the low tide mark to the edge of the continental shelf. This region is always submerged and is less affected by tidal changes but influenced by wave action and currents. Sea grasses, kelp, different species of fish, sea urchin and coral reefs are the organisms commonly found in this zone. These organisms are adapted to stable aquatic conditions but varying levels of light tolerance.

Figure 3.13: *Sandy Beach at Kokrobite in Ghana*

Adaptations of Organisms to the Seashore Habitat

1. Many seashore animals have shells and exoskeletons to protect them from predators and desiccation.
2. Some have developed anchoring mechanisms (e.g. byssal threads in mussels and tube feet in starfish) to cling to surfaces such as rocks.
3. Some have flattened bodies to reduce wave resistance (e.g. limpets and chitons).
4. Some burrow into the mud to avoid predation and desiccation (e.g. clams and worms).
5. Some move to tidal pools or migrate into deep waters at low tides.
6. Seashore plants develop physical adaptations such as deep roots, thick cuticle and waxy coatings to withstand high tides and waves and to conserve water.
7. Some also develop physiological adaptations such as salt and drought tolerance to survive during excess salinity and water scarcity.

Learning Tasks

1. Define a seashore habitat and give the various zones.
2. Describe the various zones of the seashore.
3. Give examples of different organisms that live in the various zones of the seashore habitat.
4. Give the adaptations of different organisms found at the seashore.

PEDAGOGICAL EXEMPLARS

1. **Experiential Learning**: Embark on an ecological trip to a seashore habitat to observe and identify specific organisms and discuss their adaptations (learners in non-coastal areas can watch and analyse videos and documentaries on seashore habitats. Learners embrace cultural diversity by learning from different environments.
2. **Talk-for-Learning**: Discuss in detail the distinctive features of the seashore habitat and the special adaptations of organisms in this habitat. Learners learn to tolerate other members' views and present their feedback.
3. **Collaborative Learning**: Work in groups to prepare PowerPoint Presentations (or summarise your points on a cardboard) on seashore habitat for critiquing and feedback by the entire class. Group based presentation allows each member to play a role, creating the spirit of teamwork and socio-emotional forbearances among one another.

KEY ASSESSMENT

Level 1: Define the seashore habitat and give the various zones in this habitat.

Level 2: Describe the main features of each of the zones in a seashore habitat, citing examples of some common organisms found in each zone.

Level 3: Discuss the adaptive features of the living organisms found in a seashore habitat.

Level 4: Discuss some of the human related activities on the seashore habitat, and how these activities affect the living things occupying this habitat.

Hint

*The recommended mode of assessment for this week is **Mid-Semester Examination**. See **Appendix F** at the end of this section for further information.*

WEEK 19

Learning Indicators

1. *Describe the characteristic features of a tropical Rainforest, Savannah, Desert, Lagoon, Estuary, Seashore, River Pond and Lake.*
2. *2.Describe how common tropical organisms are adapted to their habitats.*

FOCAL AREA: CHARACTERISTIC FEATURES AND ADAPTATIONS OF ORGANISMS IN THE RIVER, POND AND LAKE

River

A river is a natural flowing watercourse, which is freshwater that flows into an ocean, sea, lake or another river. Generally, a river may originate from a source such as a spring, lakes, rocks and glaciers. Aquatic life forms common in rivers and streams include algae, and plants such as water lilies, reeds and water hyacinth. Animals in this habitat include fish such as salmon, catfish, and African carp; amphibians such as frogs, toads and newts, and invertebrates such as snails, dragonflies, and mayfly.

Adaptations of organisms in rivers and streams:

- Some have streamlined bodies to swim against water current (e.g. fish).
- Some have moist skin to absorb oxygen when on land (e.g. amphibians).
- Some invertebrates in rivers and streams have limbs with hooks to cling to rock surfaces.
- Plants that grow in rivers and stream often have flexible stems that allow them to bend with the water current.

Figure 3.14: *Todzie stream is in Ghana and partly forms the Ghana–Togo border to the Southwest.*

Lakes

A lake is a large body of water surrounded by land. Although lake waters are typically freshwaters, there are lakes that contain saline water e.g. lakes are usually formed from processes such as volcanic activities, tectonic movements and glacial events. They are larger and deeper than ponds. Lakes are thermally stratified (that is, they are in different layers based on differences in temperature) and are in three zones: the littoral or shallow zone, open water zone and the deepwater zone. Plants found in this habitat include water lilies, cattails, and water lettuce. Phytoplankton are also found. Lake fish include perch, pike, catfish, mudfish, and African carp. Birds such as ducks, swans and herons are also common. Some examples of lakes in Ghana are Lake Bosomtwe and Lake Volta.

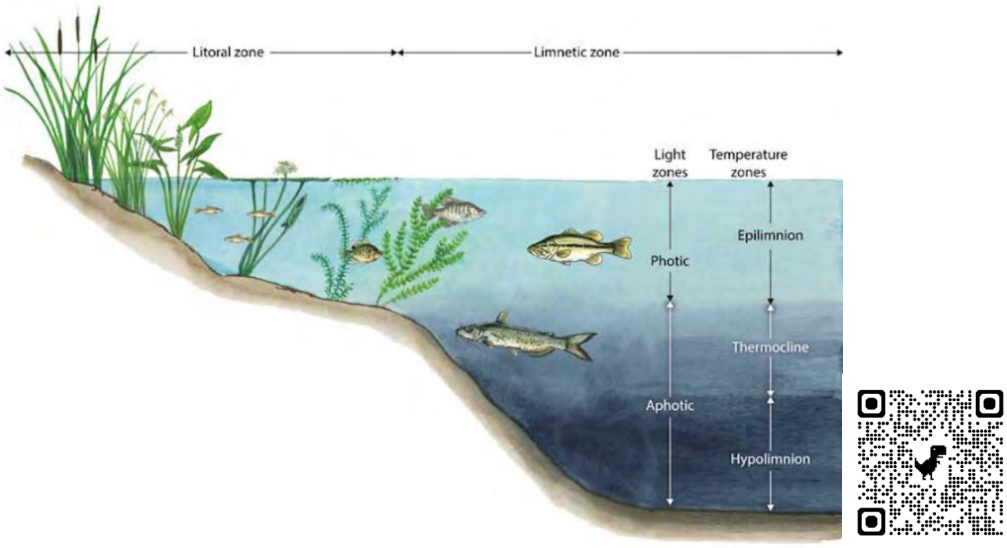


Figure 3.15: *Structure of a lake*

Adaptations of Organisms in Lakes

1. Organisms such as fish contain a swim bladder for buoyancy.
2. Some mammals have thick fur or oily coats to repel water.
3. Lake plants sometimes have air-filled tissues to stay afloat on the water surface to make maximum use of the sunlight, e.g. water lettuce.
4. Insects such as skaters, water beetles, mosquitoes and dragonflies skim over the surface of lakes to find food and also to escape danger.
5. Some spiders such as the diving bell spider take a bubble of air with them underwater to provide enough oxygen for respiration.

Pond Habitat

A pond is a small, shallow body of standing water. There is very little water movement. Due to its shallowness, there is easy penetration of light to the bottom to support aquatic life. Ponds are generally formed from freshwater, although there may be collections of

pockets of seawater at shores (such as tidal pools and rock pools) that may resemble small ponds. Algae populations are common here. Some plant species common in ponds are duckweed, ferns and water lilies. Fish populations in ponds include small species such as the silversides, goldfish and minnows. Some insects found here include water beetles, mosquitoes and mosquito larvae. Frogs and toads are common amphibians found in this water body. Birds found in this habitat include herons and ducks.

Figure 3.16: *Pond*

Adaptations to Pond Habitats

1. Pond fish can regulate and survive in varying oxygen levels and hide in pools under rocks or mud when the pond water dries out.
2. Some insects' larvae have breathing tubes to access surface air. E.g. mosquito larvae.
3. Some pond animals, such as amphibians lay eggs in shallow waters which provides optimal breeding conditions (e.g. warmth, oxygen, food availability and reduced predation) to enhance reproduction, e.g. toads.
4. Pond plants grow rapidly to be able to utilise seasonal conditions (such as the rainfall seasons with increased nutrient levels) for survival.

Learning Tasks

1. Define rivers, lakes and ponds.
2. Describe the nature of a river, lake and pond habitat.
3. Give examples of different organisms that live in the rivers, lakes and ponds of Ghana.
4. Give some examples of adaptations of different organisms that live in the rivers, lakes and ponds of Ghana.

PEDAGOGICAL EXEMPLARS

1. **Experiential Learning**: Embark on an ecological trip to a river, pond (https://www.youtube.com/watch?v=5ERP-Pv_mM8) or lake habitat to observe and identify some aquatic organisms and discuss their adaptations to life in the water. Learners embrace cultural diversity by learning from different environments.

2. **Talk-for-Learning**: Discuss in detail the distinctive features of rivers, ponds and lakes and the special adaptations of organisms in these habitats. Learners learn to tolerate other member's views and present feedback in a constructive form.
3. **Collaborative Learning**: Learners work in groups to prepare PowerPoint Presentations (or summarise points on a cardboard) on river, pond and lake habitats for critiquing and feedback by the entire class. Group base presentation allows each member to play a role, creating the spirit of teamwork and socio-emotional forbearances among one another.

KEY ASSESSMENT

Level 1: Define each of the following: River, lake and pond.

Level 2: Describe the main features each of a river, lake and pond using the following parameters: Formation/source, water current, water depth, size of water body, salinity.

Level 3: Discuss the adaptive features of the living organisms found in rivers, lakes and ponds.

Level 4: Examine the eventual consequences of small-scale mining activities on rivers, streams and related water bodies in the country, hence recommend ways to curb the challenge.

WEEK 20

Learning Indicator: *Distinguish between immunisation, vaccination, and inoculation stating the importance of each.*

FOCAL AREA: DIFFERENCES AND IMPORTANCE OF IMMUNIZATION, VACCINATION AND INOCULATION

IMMUNISATION

Immunisation is the process by which the immune system of a person is fortified against agents that can cause diseases or harm the body. These agents are called immunogens. An immunogen is any substance or agent that stimulate an immune response by triggering the body to produces antibodies or immune cells it. Common examples of immunogens are vaccines, pathogens such as bacteria and viruses. During immunisation, the body's immune system is stimulated to recognise immunogens such as pathogens (disease-causing organisms). This triggers the production of antibodies or immune cells to destroy these pathogens and defend the body against diseases. Although the process can be carried out artificially, it can be achieved naturally through an infection when immunogens such as pathogens first enter the body of the individual.

Steps Involved in Immunisation

1. An antigen is introduced into the body of a person.
2. The immune system of the person recognises the antigen as foreign and attacks it through processes such as the activation of T or B cells, or the production of antibodies.
3. The immune system then creates memory cells that can recognise the antigen.
4. Whenever the same kind of antigen enters the body again, the immune system uses the memory cells to recognise it and antibodies (substances produced by the body to fight against antigens) quickly and effectively attack the antigen.

Although antigens may or may not trigger an immune response, antigens that are intentionally introduced into the body as immunogens are specifically to induce immune response (all immunogens induce immune response but not all antigens, hence all immunogens are antigens but not all antigens are immunogens).

VACCINATION

Vaccination is the act of administering a vaccine into the body to cause the immune system to produce antibodies to protect the body against diseases. A vaccine contains an agent that resembles a disease-causing microbe. Vaccines can be live-attenuated

(containing live but weakened and modified pathogens or mild agents) inactivated subunits vaccines and toxoid (mRNA-based vaccines).

Steps involved in Vaccination

1. A vaccine is created by processes such as attenuation and inactivation.
2. The vaccine is introduced into the body through injection, oral or nasal routes.
3. The body's immune system reacts to the vaccine by producing antibodies and memory cells.
4. With the specific antibodies to fight the pathogen, the body is ready to defend itself against the disease caused by that pathogen.

DIFFERENCES BETWEEN VACCINATION AND IMMUNISATION

1. Vaccination refers specifically to the administering of a specific vaccine to induce immunity, while immunisation refers to the overall process of becoming immune.
2. Immunisation can be achieved by both natural and artificial (through vaccines) means, but vaccination always involves the use of vaccines.

INOCULATION

This is the addition of an agent (such as a pathogen or chemical) to a material. Example is the addition of bacteria to a petri dish containing growth medium. In health practices, inoculation refers to the introduction of a pathogen or an antigen into a living organism to stimulate the production of antibodies to protect the body. In earlier times, the foreign material or antigen was collected from sores developed from smallpox and introduced into healthy individuals to induce immunity. In recent times, inoculation has largely been replaced by vaccination techniques.

Steps Involved in Inoculation

1. The pathogen is first prepared or obtained a sick person by extracting it from the individual.
2. The pathogen is weakened through processes such as heating or introducing them into certain chemicals.
3. The pathogen is introduced into the body, traditionally, through the skin.
4. The body reacts by producing an immune response which involves the production of antibodies.

DIFFERENCES BETWEEN INOCULATION AND VACCINATION

1. Inoculation is an old, health practice often used in reference to the control of smallpox, but vaccination is a modern practice attained using refined and regulated vaccines.
2. Inoculation involves the use of live pathogens or less controlled materials (e.g. crude extracts such as cultures that are not purified and bacterial toxins), but in vaccination, the substance used is highly controlled, attenuated or inactivated pathogens, or components like proteins or mRNA.
3. Historically, inoculation has a higher risk due to the use of live pathogens, but in vaccination, the vaccines are subjected to rigorous and active safety and efficacy measures.

IMPORTANCE OF IMMUNISATION, VACCINATION AND INOCULATION

1. Saving lives: Some of the life-threatening diseases have been eliminated entirely from the face of the earth. e.g. smallpox
2. Preventing future infections: Vaccines are efficient in preventing future infections. Inoculating a vaccine might cause temporary discomfort at first but is always better than future pain and trauma caused by the actual disease. The recommended list of immunizations between the years of zero-six includes safeguarding against life-altering ailments such as Hepatitis B, polio, measles and mumps.
3. Protecting others: Immunization helps protect us from fatal diseases and prevents the individual from being a transmitter of infections. A lot of children who are very young, or have a weakened immune system, and have not been vaccinated will be at higher risk of contracting those diseases. When many people have been inoculated with a vaccine, the disease is unlikely to spread from person to person. This is known as herd immunity or community immunity. Hence, it is essential for us to take the recommended vaccine within an appropriate time.
4. Saving time and money: Families can face heavy financial losses when their members contract a serious life-threatening disease. Days of mental turmoil, accompanied by loss of time and monetary damage, can also take a toll on the family's health.
5. Protecting the foetus: Rubella infection in pregnant women may lead to foetal loss or defects. Vaccination against Rubella in women may protect the foetus during their pregnancy.
6. Eradicating deadly outbreaks: Vaccines have thwarted epidemics of various diseases such as measles, mumps and whooping cough.

7. Decreasing the mortality rate: Vaccination has decreased mortality rates throughout the world. E.g. timely administration of the COVID-19 vaccine accompanied by the booster shot contributed to controlling this contagious disease.

Learning Tasks

1. Define the terms immunisation, vaccination and inoculation.
2. Describe the steps involved in immunisation, vaccination and inoculation.
3. Assign reasons why immunisation, vaccination and inoculation are practiced among humans.
4. Discuss the main differences in immunisation, vaccination and inoculation practices among humans.

PEDAGOGICAL EXEMPLARS

1. **Invitation of Professionals**: Invite a resource person such as the school health nurse for a talk on immunization, vaccination, and inoculation, allowing learners to ask questions after presentation; learners receive first-hand information from professionals, thereby building self-confidence and respect in themselves.
2. **Collaborative/Talk for Learning**: In mixed-ability, all-inclusive groups, learners examine by discussion, the differences and similarities among the various terms discussed in the presentation and make group charts for presentations. Group work builds confidence in learners and introduces respect and emotional support for each member.

KEY ASSESSMENT

Level 1: Define the terms, immunisation, vaccination and inoculation.

Level 2: Describe the main steps involved in each of immunisation, vaccination and inoculation.

Level 3: Discuss the differences observed in the following Health practices and how each is attained: Immunisation and vaccination: Inoculation and vaccination.

Level 4: Examine whether inoculation or vaccination is more acceptable in contemporary times, considering the benefits and risks involved with each practice.

Hint

The individual Project is due for collection and scoring for onward submission to the STP.

Section 3 Review

In Section 3 of this Manual, we have continued our study on the "Diversity of living othings" from lessons learnt in the Year One Teacher Manual. We have studied some invertebrates, which included insects such as the grain weevil, butterfly, housefly and the honeybee. We studied their distinctive features, life cycles and adaptations as well as their economic importance. The study of these organisms gives us insightful understanding of their interactions with other living things and the roles they play in ecosystems. These interactions and roles included, for example, the grain weevil destroying stored grains and causing food shortage, the butterfly pollinating flowers and serving aesthetic purposes, honey bee producing honey and the housefly serving as a vector of many diseases and infections but also producing maggots to

facilitate decomposition. Ultimately, these interactions influence human lives. An aspect of the Section was also dedicated to the study of ecological habitats. These included terrestrial habitats such as the tropical rainforest, savannah and desert. Aquatic habitats studied included the lagoons, estuaries, seashore habitats, rivers, lakes and ponds. Each of these habitats presented a set of unique biotic and abiotic factors to demonstrate the diverse and complex nature of habitats within the environment. Understanding these features is important for the biology learner to explain the dynamism with which ecosystems operate within the biosphere. Finally, the Section ended with discussions on immunisation, inoculation and vaccination, and the steps involved in these health practices as well as their importance, broadening our understanding on how these practices influence our health.

APPENDIX D: END OF FIRST SEMESTER EXAMINATION

Nature of the Examination

This end of semester examination should cover weeks 1-12 and consist of variety of test items across the weeks covered, and can consist of 40 multiple choice questions, 3 essay type items for learners to answer any 2, and 1 compulsory test of practical or practical test with different DoK levels.

Duration: Time for the examination should be 3hours.

Resources needed: Answer booklet, calculator, mathematical set, stationary, printer, pen, pencils, etc.

Sample of Questions

MCQs

1. Knowledge of genetics can be applied to animal production in Ghana by……...

A. controlling the water intake of animals.

B. identifying the best feeding times for animals.

C. providing more space for animals to graze.

D. selecting breeding animals to improve desirable traits.

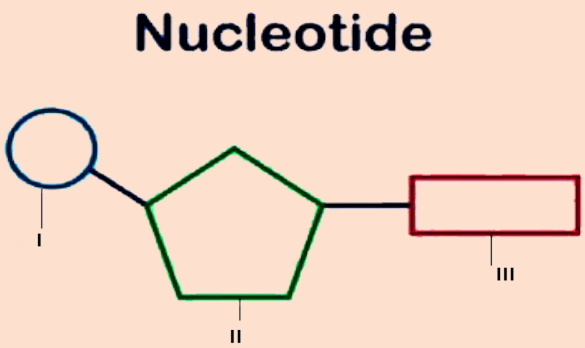
Essay (20 marks)

1.

a. Evaluate the impact of traditional agricultural practices on plant and animal production in Ghana.

b. Compare and contrast the functions of xylem and phloem in vascular plants.

Test of Practical Question (20 marks)



1.

a. correctly label the parts of the nucleotide numbered I-III (**4 marks each**)

b. Identify the two main types of nucleic acids found in living organisms (**2 marks**).

c. Describe 2 basic structural differences between DNA and RNA (**8 marks**), etc

Table 2 – End of First Semester Sample Table of Specification

Weeks	Focal Area(s) End of First Semester Examination.	Type of Questions	DoK Levels				Total
			1	2	3	4	
1	Processes and Economic Importance of Rhizopus.	**Multiple Choice**	1	2	–	–	**3**
		Essay	1	–	–	1	
2	Distinctive Characteristics, Life Processes and Economic Importance of Moss.	**Multiple Choice**	1	1	1	–	**3**
		Essay	–	1	–	1	
3	Distinctive Characteristics, Life Processes and Economic Importance of Fern.	**Multiple Choice**	1	–	1	–	**2**
		Practical	1	–	–	1	
4	Basic Concepts in Biology and How These Can be used to Improve Crop and Animal Production.	**Multiple Choice**	1	1	–	–	**2**
		Essay	–	1	–	1	
5	Cell theory and Cell structures in relation to their functions.	**Multiple Choice**	1	1	–	2	**4**
		Essay	–	1	–	1	
6	Application of types of active transport processes– Endocytosis and Exocytosis (Bulk transport processes)	**Multiple Choice**	1	1	1	–	**3**
		Essay	1	1	–	2	
7	The DNA, Watson-Crick model, and the significance of DNA in eukaryotic cell	**Multiple Choice**	1	1	–	–	**2**
		Essay	–	–	–	1	
		Practical	–	1	–	1	
8	DNA replication and its relevance in living things.	**Multiple Choice**	1	1	–	1	**3**
		Practical	–	1	–	1	
9	RNA Transcription and its relevance in living things	**Multiple Choice**	1	2	–	–	**3**
		Essay	1	–	–	1	
10	Protein synthesis and its relevance in living things	**Multiple choice**	–	1	–	–	**1**
11	Distinctive features, life cycle, characteristics and economic importance of grain weevil	**Multiple choice**	2	2	1	–	**5**
12	Distinctive features, life cycle, characteristics and economic importance of butterfly	**Multiple choice**	1	1	–	–	**2**
	Total		**13**	**18**	**10**	**3**	**44**

APPENDIX E: INDIVIDUAL PROJECT WORK

Project Task: Investigate the Life Cycles and Characteristics of grain weevil, butterfly, housefly, and honeybee and write a report together with pictures of their life cycles.

Submission: Week 20

Resources for Research

- Textbooks: Refer to biology textbooks that cover insect anatomy and life cycles.
- Internet: Use reliable websites, such as educational and scientific platforms, for insect information.
- Documentaries/Documented Observations: Explore online documentaries or nature series that feature insects in their natural habitats.

Project Objectives: By the end of this project, learners will:

1. Independently identify the distinguishing features of grain weevils, butterflies, houseflies, and honeybees.
2. Clearly describe the life cycles of these insects, including all developmental stages.
3. Understand the ecological roles and behaviours of each insect species.
4. Present their findings through a well-organised written report and visual representation.

Project Instructions

1. Insect Selection
   - **a.** Each learner will investigate all four insects: grain weevil, butterfly, housefly, and honeybee.
   - **b.** The student must explore each insect's:
     - Distinctive Features: Body structure, size, colour, wing shape, etc.
     - Life Cycle: Stages of development (egg, larva/nymph, pupa, adult).
     - Ecological Roles: Contributions to or impact on the environment and humans.
     - Habitat and Behaviour: Feeding habits, reproduction, interaction with other organisms.
2. **Research and Data Collection**
   - **a.** Use textbooks, the internet, or any available resources (library, online databases, documentaries) to gather detailed information on each insect.

b. Focus on scientific information and observations about each insect's anatomy, life stages, and their role in nature and human life.

c. Document important findings on:

- **Appearance**: Differences in structure, body parts, and distinctive features.
- **Metamorphosis:** Specific stages of development, including changes during each stage.
- **Ecology:** Role in ecosystems, such as pollination (honeybee, butterfly), pest control (housefly), or crop damage (grain weevil).

3. **Written Report:** The report should be divided into four sections, one for each insect. Include the following:
   - Introduction: A brief overview of insect biology, including what makes insects unique as a group.
   - Individual Insect Descriptions: For each insect, describe the distinctive features, life cycle, and ecological role.
   - Comparison: Discuss similarities and differences between the four insects in terms of their life cycles, features, and impact on the environment.
   - Conclusion: Summarise the key insights gained from the study of these insects in about 4-5 pages long, with each insect covered in detail (roughly one page per insect).

4. **Visual Aids**
   - Create visual representations for each insect's life cycle using drawings, diagrams, or digital tools (e.g., PowerPoint slides, infographics).
   - Label each stage of development clearly (e.g., egg, larva, pupa, adult).
   - The visual aids should be organised and easy to understand, helping to visualise the transformation of the insect through its life stages.
   - These visuals will accompany the report as an appendix or a separate submission.

Submission Requirements

- Report: A detailed, well-organised document covering all four insects.
- Visual Aids: Diagrams or illustrations for each insect's life cycle.

Scoring Criteria

- Content Accuracy: The depth and accuracy of the information provided on each insect's distinctive features, life cycle, and ecological roles, score **20 marks** (**5 marks** for each insect)

- Organisation and Clarity: The report should be well-organised, with clear sections for each insect and logical flow, score **5 marks.**
- Visual Aids: Quality, accuracy, and creativity of the diagrams or illustrations representing each insect's life cycle, score **5 marks.**

APPENDIX F: MID-SEMESTER EXAMINATION

Nature of the Examination: This mid semester examination cover weeks 13-17 and consist of variety of test items across the weeks covered, consisting of 50 multiple choice questions with different DoK levels.

Duration: Time for the examination should be 1 hour.

Resources needed: Answer booklet, calculator, mathematical set, stationary, printer, pen, pencils etc, etc.

Sample of MCQs

1. All the following are economic importance of housefly **Except…**

A. They are vectors that carry many pathogens that cause disease such as cholera, typhoid fever and dysentery.

B. They may cause food poisoning and contamination by transmitting toxins from one location to another.

C. They are vectors that carry pathogen that cause malaria.

D. The larvae (maggots) play active role in decomposition, thereby contributing to nutrient cycling.

Table 3 – Mid-Semester Table of Specification

Weeks	Focal Area(s)	Type of Questions	DoK Levels				Total
			1	2	3	4	
13	Distinctive features, life cycle, characteristics and economic importance of the housefly.	Multiple Choice	4	5	3	-	12
14	Distinctive features, life cycle, characteristics and economic importance of honeybee.	Multiple Choice	3	4	3	-	10
15	Characteristic features of a tropical rainforest and adaptations of organisms in tropical Rainforest.	Multiple Choice	2	4	2	1	9
16	Characteristic features of savannah and desert habitats, and adaptations of organisms in savannah and desert habitats.	Multiple Choice	3	3	2	1	9
17	Characteristic features and adaptations of organisms in Lagoon and Estuary habitats.	Multiple choice	3	4	2	1	10
	Total		15	20	12	3	50

STRAND: SYSTEMS OF LIFE

Sub-Strand: Mammalian systems

Learning Outcome: *Explain how the cardiovascular and excretory systems of humans' function to ensure good health.*

Content Standard: Demonstrate knowledge and understanding of the cardio-vascular and excretory systems in humans.

Sub-Strand: Plant systems

Learning Outcome: *Explain the processes of transportation and photosynthesis in flowering plants.*

Content Standard: Demonstrate knowledge and understanding of transport and nutrition in flowering plants.

Hint

*Week 24 is for End of Second Semester Examination. Refer to **Appendix G** for more information on how to administer end of semester examination.*

INTRODUCTION AND SECTION SUMMARY

In this Section, we continue the study of the "Systems of life", a strand which was begun in Year One. Among the mammalian systems, we shall specifically discuss the cardiovascular and excretory systems. The cardiovascular and excretory systems play essential roles in keeping human health through their interconnectedness. The cardiovascular system comprises the heart, blood vessels and blood tissues for pumping and circulating oxygen, nutrients and other essential materials such hormones throughout the body. It also transports carbon dioxide and metabolic wastes to the appropriate organs to be excreted.

These circulation processes support cellular function and ultimately, homeostasis. The excretory system is made up the kidneys, skin, lungs and liver. These organs generally, remove wastes that are processed by them, or carried to them from various parts of the

body. For example, the kidneys process and remove urine while the skin processes and remove sweat. The excretion of these metabolic wastes is vital to maintaining healthy body. This is because they become toxic when accumulated in the body, eventually harming the cells and causing health challenges to the individual. The interactions of these systems together ensure optimal physiological function that yields stable homeostatic environment to keep a healthy body. Section 4 ends with discussions on transport in plants, and photosynthesis, a fundamental biological process used by plants, algae and some bacteria to convert light energy into chemical energy. Photosynthesis plays a central role in providing the energy for all the ecosystems of the Earth and maintaining atmospheric oxygen levels and removing carbon dioxide to control global warming.

The weeks covered by the Section are:

Week 21: *Discuss the cardiovascular system of humans and relate the parts to their functions*

Week 22: *Discuss the excretory system of humans and relate the parts to their functions in homeostasis*

Week 23: *Explain how substances are transported in flowering plants and state the factors affecting them*

Week 24: *Explain Photosynthesis and the factors affecting it.*

SUMMARY OF PEDAGOGICAL EXEMPLARS

In discussing lessons on the cardiovascular and excretory systems in humans and photosynthesis in plants, a blend of pedagogies including observational learning, experiential and virtual activities, differentiated group project and talk for learning study methods are used to adequately meet individual learning needs, and to ensure a dynamic learning atmosphere. In observational learning, strategies such as the use of engaging videos and interactive diagrams are used to illustrate the cardiovascular system and its functions. These methods and strategies were also used to discuss transport systems in plants. Learners are shown real or animated videos and documentaries of blood circulation and excretion processes. Time-lapsed footages are used to help learners visualise complex processes in photosynthesis. The incorporation of experiential learning engages learners on hands-on activities such as measuring blood pulse and blood pressure, or simulating blood flow models to offer learners better understanding of lessons that would otherwise appear abstract.

Learners are also guided to carry out experiments to investigate the effects of factors such as light, carbon dioxide and chlorophyll on photosynthesis. Differentiated group projects cater for various learning styles as every learner is tasked to participate in an aspect of a group work. Thus, each leaner participates in the learning process. Talk for learning encourages discussions and debates on the processes and importance of

cardiovascular and excretory systems and photosynthesis, and their importance in real world scenarios. GESI and SEL issues are considered, ensuring that groupings, materials and activities are inclusively done to promote equitable learning environment for all learners.

ASSESSMENT SUMMARY

Several assessment modes are used in assessing lessons on the cardiovascular and excretory systems in humans, and photosynthesis in plants. The strategy is to ensure that every learner understands how he or she needs to appreciate these lessons. Formative assessments including interactive quizzes and concept maps allow learners to engage in different learning styles. For kinaesthetic learners, practical and hands-on-activities such as building models of the cardiovascular and excretory systems or conducting experiments to observe the factors that affect photosynthesis enhance their understanding. Group and collaborative assessments are carried out to prepare presentations or posters to explain these systems in humans and photosynthesis in plants. Summative assessments such as multiple-choice questions, short answers in end of semester exams allow the objective evaluation of learners' comprehension of lessons. The assessment will also include project-based exercises. These may require the learner to present their findings through written reports, oral presentations or videos to accommodate diverse abilities and preferences among different learners. The recommended mode of assessment for each week is:

Week 21: *Test of Practical*

Week 22: *Poster Presentation*

Week 23: *Short Quiz*

Week 24: *End of Semester Examination*

WEEK 21

Learning Indicator: *Discuss the cardiovascular system of humans and relate the parts to their functions*

FOCAL AREA: STRUCTURE OF THE CARDIOVASCULAR SYSTEM OF HUMANS AND HOW THE PARTS RELATE TO THEIR FUNCTIONS

The Structure of the Cardiovascular System of Humans

The cardiovascular system (also called the circulatory system) is the system with several organs and tissues for transporting oxygen and nutrients around the body. It also transports waste products such as carbon dioxide and urea from their origins to different excretory organs to be excreted.

How the parts of the structure relate to their functions

1. **The Heart –** This is a muscular organ that pumps oxygenated blood to all parts of the body through pump action and receives deoxygenated blood from all parts of the body. It is made up of four major chambers, the right atrium/right auricle, the left atrium/left auricle, the right ventricle and the left ventricle. The atria and ventricles are separated by a thick muscular wall called the septum. The heart also has several valves which open and close to allow blood to flow.

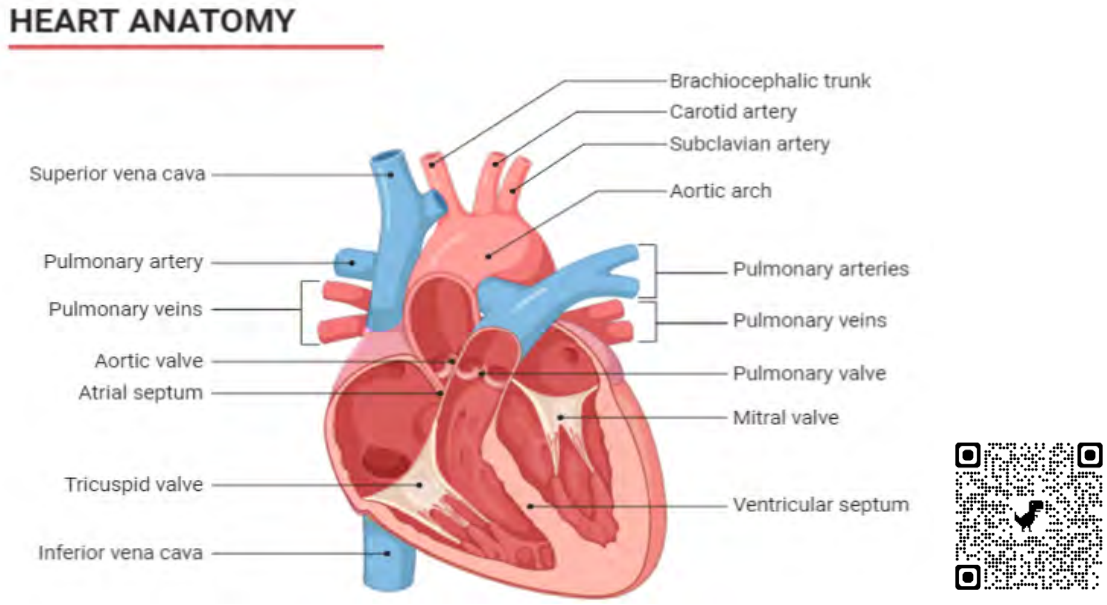


Figure 4.1: *The longitudinal section of the mammalian heart*

Some common diseases and conditions that affect the heart are coronary thrombosis, (a plaque blocks vessels supplying oxygen to the heart), myocardial infarction (heart attack), heart failure (inability of the heart to pump enough blood), myocarditis

(inflammation of heart muscles), endocarditis (infection of the inner lining of the heart and heart valves) and high blood pressure.

2. **Blood vessels –** These are part of the vascular tissue system through which oxygenated blood is carried from the heart to all parts of the body, and deoxygenated blood is brought to the heart. The three main types of vessels for transporting blood in humans and other mammals are the arteries, veins and capillaries. The arteries have thick walls for transporting oxygenated blood from the heart to body tissues (except the pulmonary arteries). The veins have thinner walls, and valves, for transporting deoxygenated blood from the body tissues to the heart (except the pulmonary veins). The capillaries are microscopic vessels with thin walls, usually one cell thick, and allow the exchange of materials (oxygen, nutrients and wastes) between the blood and body tissues.

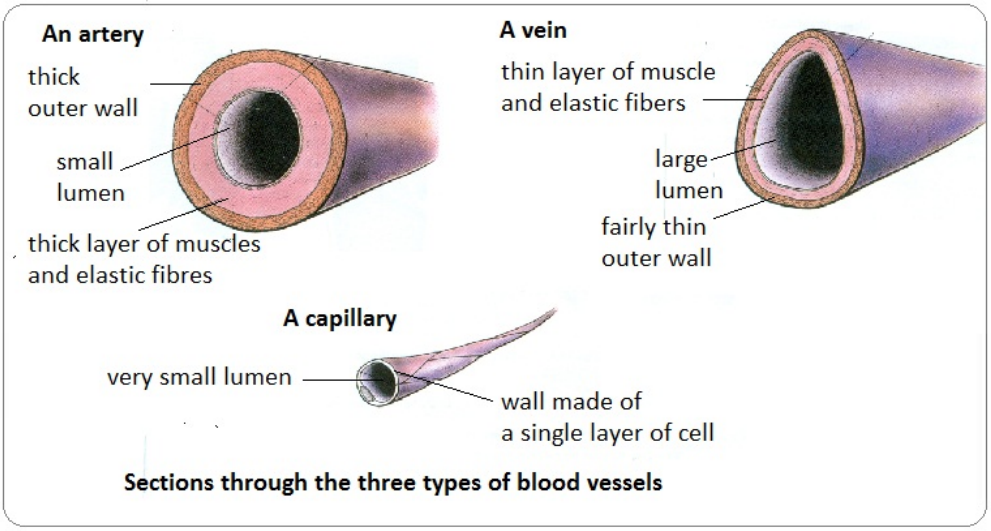


Figure 4.2: *The blood vessels*

Common diseases that affect the blood vessels are atherosclerosis (plaque build-up in the arteries, varicose veins (enlarged/twisted vein), phlebitis (vein inflammation) and telangiectasia (dilated capillaries).

3. **Blood components –** These are liquid (plasma) and solid (corpuscle) portions of the circulatory system that transport materials around the body. The solid parts comprise the red blood cells (erythrocytes), white blood cells (leucocytes) and the platelets (thrombocytes). The red blood cells contain haemoglobin (an iron-containing molecule) for carrying oxygen. The white blood cells form part of the immune system for defence. The platelets are involved in blood clotting during injuries. The liquid portion called plasma, contains water, dissolved food nutrients, dissolved gases, hormones, mineral salts and waste products that are transported around the body.

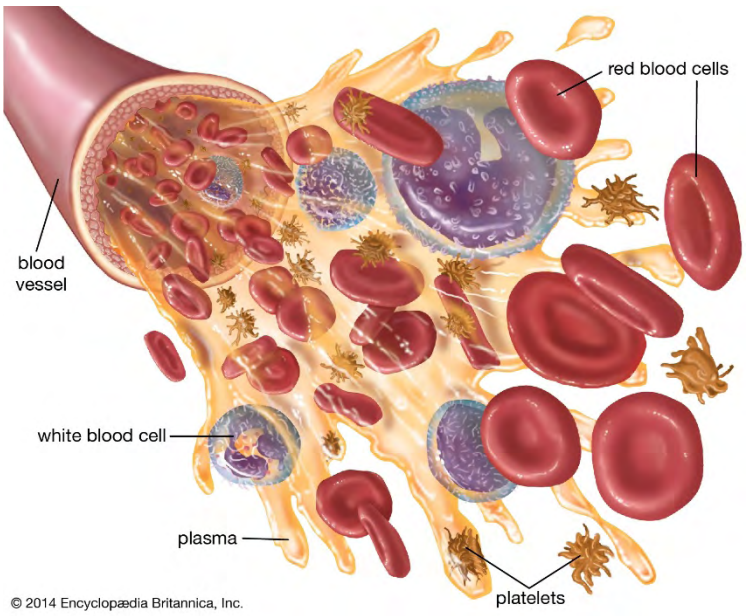


Figure 4.3: *Blood in a blood vessel*

Learning Tasks

1. Name the organs and tissues that form the cardiovascular system in humans.
2. Make labelled diagrams of the parts of the main organs and tissues of the
3. cardiovascular system in humans.
4. Describe the structure and functions of the main organs and tissues that form the
5. cardiovascular system in humans.
6. Discuss some common defects of the organs and tissues of the cardiovascular system in humans

PEDAGOGICAL EXEMPLARS

1. **Observational/Virtual Experiential Learning**: In small, mixed-ability, all-inclusive groups, watch videos (https://www.youtube.com/watch?v=CWFyxn0qDEU), or study charts on the human heart, and relate its structures to their functions. Design a mind map on the cardiovascular system, its parts and the functions of these parts; learners learning in teams are exposed to learners from diverse backgrounds, helping them to support one another culturally, socially and emotionally.
2. **Differential Group Project Learning**: In gender-neutral, all-inclusive, differential groups, obtain cardboards and draw the heart and blood vessels, displaying these diagrams on your classroom walls. Study the diagrams further and construct a summary table on the morphological and physiological differences and similarities

of the blood vessels. Learners take part in group learning, and this ensures tolerance in one another.

3. **Talk for Learning**: Mixed ability groups brainstorm and discuss the effects of a diseased or defective cardiovascular system of humans and how the body functioning is affected. Each group member reflects on his or her contribution in the group to build self-confidence and develop self-acceptance and respect.

KEY ASSESSMENT

Level 1: Name one main organ of the cardiovascular system in humans and give the functions of its parts.

Level 2: Give the three main portion of the solid components of blood and the functions of each.

Level 3: With simple, labelled diagrams, describe the structure of the three types of blood vessel and give the function(s) of each.

Level 4: Discuss any one of the major defects that affect the cardiovascular system of humans, and how this may be avoided or controlled.

WEEK 22

Learning Indicator: *Discuss the excretory system of humans and relate the parts to their functions in homeostasis*

FOCAL AREA: STRUCTURE OF THE EXCRETORY SYSTEM OF HUMANS AND HOW THE PARTS RELATE TO THEIR FUNCTIONS IN HOMEOSTASIS

Excretory System of Humans

The excretory system is responsible for the removal of waste materials from the body, and to regulate water and ion balance. It is made up of organs and structures that perform various functions to ensure that the body is balanced and healthy. The main excretory organs in humans and other mammals are the kidneys, skin, lungs and the liver.

Parts and Structure of the excretory system in humans and their functions

1. **Kidneys –** These are two bean-shaped organs for processing urine. These paired organs are in the upper abdominal region of the vertebral column. Each pair contains millions of basic structural and functional units of the kidney, called nephrons or kidney tubules. The kidneys filter blood, reabsorb essential nutrients and water into the bloodstream, secret materials and process urine to be removed from the body.

   The kidney has several components and accessory organs and structures performing various functions to process and excrete urine from the body. These include the afferent arterioles and efferent arterioles that form a knot in the Bowman's capsule, proximal/first convoluted tubules, loop of Henlẻ, distal/proximal convoluted tubule, collecting ducts, ureter, bladder and the urethra.

   Two main processes involved in urine formation are ultrafiltration and reabsorption. The main components of urine are water (about 95%), nitrogenous compounds (urea, uric acids and ammonia), creatinine (waste produced from creatine by the natural and normal breakdown of muscle tissues) organic and inorganic salts and ions. Blood cells and proteins are not removed due to their large molecular size. Besides processing and removing metabolic wastes, the kidney also regulates blood volume and ensures pH and ion balance by osmoregulation.

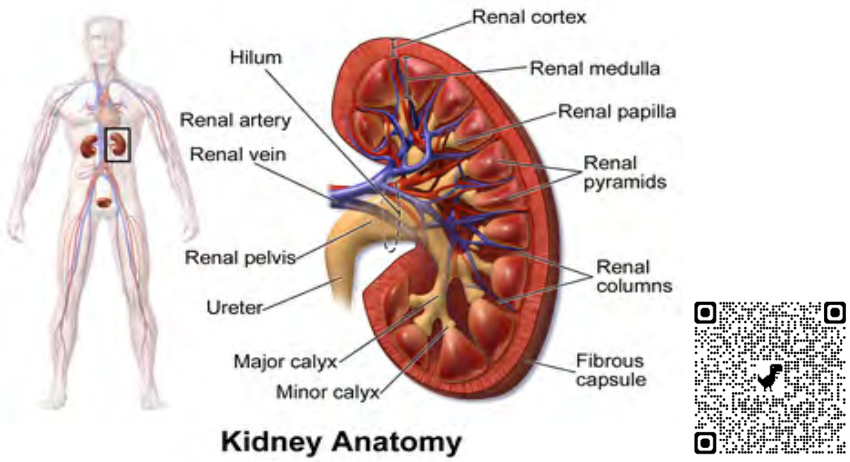


Figure 4.4: *Anatomy of the Kidney*

Some common diseases of the kidney are kidney stones and kidney cancer.

2. **Skin –** The skin is a crucial excretory organ for the removal of waste through the production of sweat. It is continuous, flat layer that covers the entire body. It is composed of three main layers: the epidermis is the outermost layer formed from stratified epithelial cells, and contains blood vessels, nerves, hair follicles and glands; the dermis, which is an inner layer and has the same composition as the epidermis; and the hypodermis; a subcutaneous structure, which is the deepest layer of the skin, primarily composed of adipose and connective tissues. Through the sweat glands, the skin processes sweat and removes it from the body.

   The main components of sweat are water, salts, traces of urea, uric acids and ammonia. The exact composition of sweat may vary due to factors such as diet, level of hydration and the specific physiology of the individual.

   The skin also regulates body temperature. This is evinced by the cooling effect experienced by the body after sweats evaporates from the skin. It also detects stimuli through the numerous nerves scattered within it. It also protects the body and internal organs and tissues from pathogens and mechanical injuries.

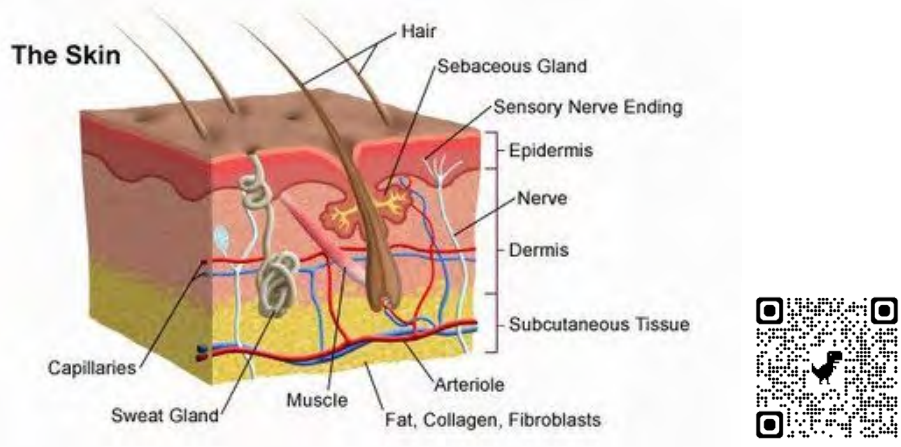


Figure 4.5: *Anatomy of the Skin*

Some common diseases of the skin are acne (a chronic inflammatory skin disease), eczema (atopic dermatitis) and vitiligo (resulting in white patches on the skin).

3. **Lungs –** These are cone-shaped organs with a broad base and a pointed apex primarily responsible for the removal of carbon dioxide. These paired organs are located within the thoracic cavity, at the chest region, extending from the clavicle (collar bones) at the upper side and diaphragm at the lower part above the abdomen. They contain tiny air sacs called alveoli, surrounded by capillaries. Carbon dioxide from body tissues diffuses into the alveoli and is conducted through the bronchioles and bronchi to be exhaled by the trachea system. Excess water in the form of vapour and is also excreted.

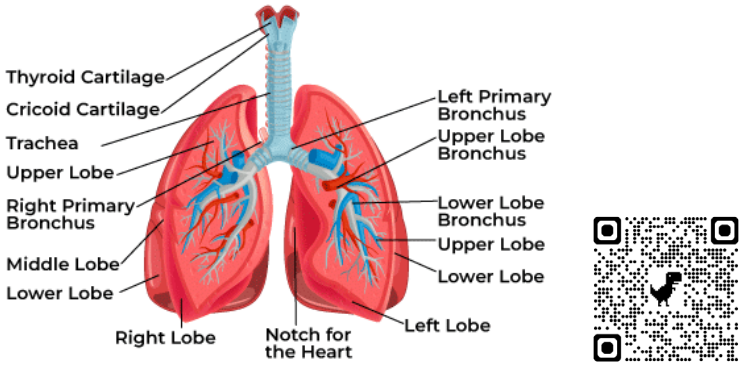


Figure 4.6: *Anatomy of the human lungs*

4. **Liver –** This is a wedge-shaped organ with broad rounded edge, responsible for the production of bile from red blood cells stored in the gall bladder, and deamination and detoxification (breakdown of harmful substances, e.g. drugs and alcohol). The organ performs these functions mainly by specialised cells called hepatocytes (liver cells). Bile is released into the intestine to support food digestion. Bile itself is not a waste (it is a digestive juice). However, it contains bilirubin (a yellowish-orange pigment) which is the waste product from the breakdown of haemoglobin in red blood cells, and this is excreted from the body through egestion with faeces. Deamination is the conversion of ammonia (a toxic by-product from the breakdown of proteins) into urea to be excreted through urine formation.

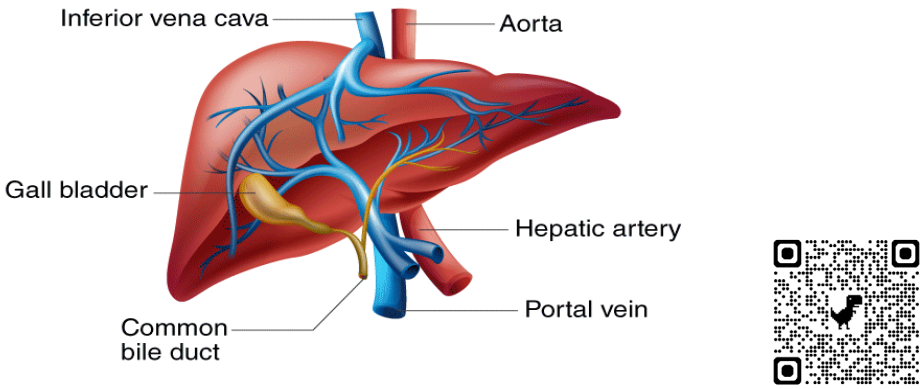


Figure 4.7: *The Humam Liver*

Some common diseases of the liver are cirrhosis, (where the liver tissue is replaced by scar tissue), hepatitis A, hepatitis B, hepatitis C, hepatitis D and hepatitis E.

Learning Tasks

1. Name the four main organs that make up the excretory system
2. Make labelled diagrams of the parts of the main organs of the excretory system.
3. Describe the structure and functions of the main organs of the excretory system
4. Discuss some common defects of the organs of the excretory system in humans.

PEDAGOGICAL EXEMPLARS

1. **Observational/Virtual Experiential Learning**: Study charts, watch PowerPoint presentations or videos (https://www.youtube.com/watch?v=q5qaGHfdmYM) on the excretory system of humans, observing and discussing the organs of excretion. Learners build self-confidence and self-respect as they contribute to group learning.

2. **Differential Group Project Learning**: In gender-neutral, all-inclusive, differential groups, obtain cardboards and draw the liver, kidney, skin and lungs, displaying these diagrams on your classroom walls. Study the diagrams further and construct a summary table on the morphological and physiological differences and similarities of these organs. Learners take part in group learning, and this ensures tolerance in one another.
3. **Talk for Learning**: Mixed ability groups brainstorm and discuss the effects of an excretory organ failure (e.g. the kidney) in the human body; each group member reflects on his or her contribution in the group to build self-confidence and develop self-acceptance and respect.

KEY ASSESSMENT

Level 1: Name the main excretory organs in humans and give the function of each.

Level 2: Draw and label any one of the main excretory organs in humans.

Level 3: Discuss how any one of the excretory organs in humans' processes the waste it produces and give the components of the waste.

Level 4: Examine why it is necessary to avoid waste accumulation in the human body, hence, outline the precautions to be followed to safeguard the health of each of the main excretory organs of the excretory system in mammals.

WEEK 23

Learning Indicator: *Explain how substances are transported in flowering plants and state the factors affecting them*

FOCAL AREA: TRANSPORT OF SUBSTANCES IN FLOWERING PLANTS AND FACTORS AFFECTING TRANSPORT SYSTEM IN FLOWERING PLANTS

Transport of substances in flowering plants

Transport in flowering plants involves the movement of water, mineral salts and organic materials through the vascular tissues (phloem and xylem). The movement of water from the soil to the leaves is called transpiration stream, while the movement of food and other organic materials from the leaves to all parts of the plant is termed as translocation.

Water and mineral transport occur in the xylem. The main cells of the xylem are the xylem vessels, tracheid, xylem parenchyma and xylem fibres. These cells have various adaptations, and function together to facilitate and ensure the efficient transport of water and minerals in the xylem. The process by which plant lose water through their leaves is called transpiration. This occurs through a mechanism called transpiration pull, which refers to the continuous movement of water through the xylem that is drawn upwards from roots to the leaves through. These processes are aided by transpiration (evaporation of water from the leaves), cohesion (attraction among water molecules in the xylem), adhesion (attraction between water molecules and the xylem cells) and tension (negative pressure in the xylem). Dissolved minerals (minerals dissolved in water) from the soil are generally transported by diffusion through the root hairs. However, movement of dissolved minerals from the xylem to the leaves is by mass flow. Mass flow is the bulk movement of substances through a medium by factors such as pressure gradient and concentration gradient. The Casparian strip and pericycle play important roles in the movement of water and mineral salts from the soil through plants.

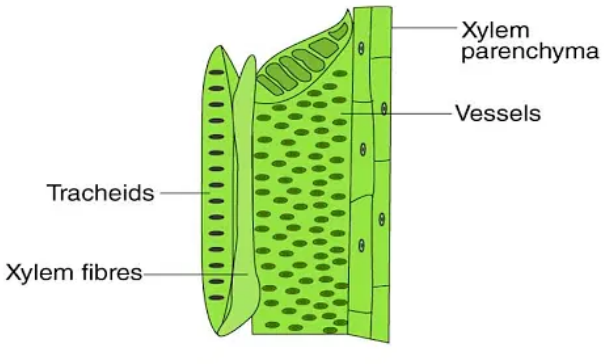


Figure 4.8: *Cells of the xylem*

The phloem is responsible for transporting food and other organic compounds in plants. Organic food materials (usually carbohydrates in the form of sucrose) are translocated from the leaves to all growing areas such as shoot tips, roots, flowers and fruits. Other substances transported are amino acids in dissolved form, small quantities of plant hormones (e.g. auxins, gibberellins and cytokinins) and organic acids including malic and citric acids. These substances are transported in the phloem mainly by mass flow (which ensures long distance transport of materials in the phloem), diffusion and active transport. The bark of trees can be removed in a ringing/girding experiment to show the accumulation of substances in the phloem tissue. The cells that form the phloem tissue are sieve tube, companion cells, phloem parenchyma and phloem fibres.

The main difference between transport of materials in phloem and xylem is that the phloem transport food in bidirectional paths to all parts of the plant, mostly by pressure flow, while the xylem transports water and dissolved mineral upward from roots to the leaves, generally by transpiration pull.

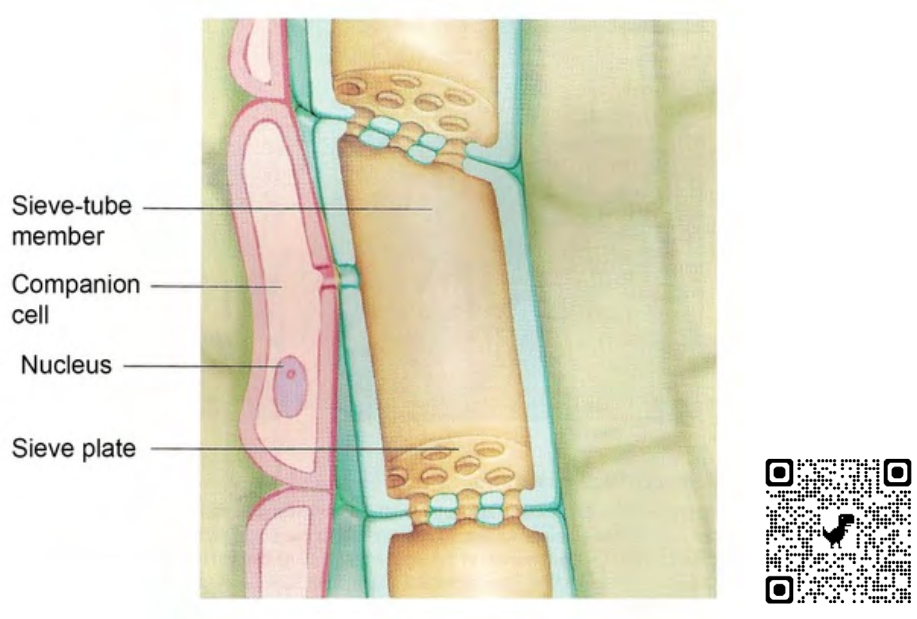


Figure 4.9: *Phloem*

Factors Affecting Transport System in Flowering Plants

Several factors affect the transport system in flowering plants. These can broadly be considered as physiological, morphological and environmental factors.

Physiological factors

These refer to the internal processes of the plant which affect movement of water and nutrients. These include.

- **Rate of transpiration –** The higher the rate of transpiration, the more water and minerals are absorbed from the soil to be transported in the xylem. Higher rate also means enhanced upward movement of water in the phloem with dissolved organic

nutrients such as sucrose. A simple experiment can be performed using the bubble potometer to estimate the rate of transpiration in plants.

- **Root pressure –** The higher the root pressure, the more water is pushed up through the xylem, hence more water uptake. This can be demonstrated experimentally by the root pressure (exudation) experiment, where fluid emergence (exudation) from a cut stem from which the leaves have been removed is measured to determine the level at which root pressure forces water and minerals through the xylem.
- **Photosynthesis –** High rate of photosynthesis increases sugar concentration, thereby causing the movement of these organic compounds through the phloem to other parts of the plant such as the roots and fruits.

Morphological factors

These are the factors that relate to plant structures which influence the absorption and transport of substances in plants. They include

- **Surface area of leaf –** Leaves with larger surface area have higher rate of transpiration, hence higher uptake of water and minerals in the xylem. Presence of stomata on the leaf surface influence water movement in and out of the leaf. The opening and closure of the stomata control the movement of water through leaves by transpiration. Generally, the stomata are located on the lower side of the leaf, or have the stomata concentrated at the upper surface compared to the lower surface. The stomata open to allow water from the plant into the atmosphere and closes to prevent water loss. Again, hairs on the leaves reduce water loss. Some plants also roll their leaves to prevent excessive water loss in dry environments.
- **Structure of xylem vessels** – Those with wider vessels have less resistance to the flow of water within the xylem tissue.
- **Density of root hair:** The higher the density of root hair (the greater the number of root hairs), the higher the surface area and hence better contact with the soil to absorb water and dissolved minerals and transport them through the xylem.

Environmental factors

These are the external conditions which affect the rate of transpiration. Environmental factors affecting water movement in plants are

- **Temperature –** The higher the temperature, the higher the rate of transpiration in the xylem and movement of food materials within the phloem.
- **Light intensity –** The higher the amount of light, the better the rate of photosynthesis to produce sugars, with increased transport of food from the leaves. Light also causes the stomata to open. This increases the rate of transpiration from the leaves, subject to humidity and atmospheric pressure.

- **Humidity –** Low humidity in the environment increases the rate of transpiration, which enhances water movement in the xylem.
- **Availability of water in the soil –** Adequate water levels in the soil facilitates the movement of water through the xylem, and movement of nutrients through the phloem.

Learning Tasks

1. Explain how water, mineral salts and organic compounds are transported in plants and the processes involved.
2. Describe the main types of cells in the xylem and phloem tissues, and how they are adapted to their functions.
3. Discuss the processes that lead to movement of water and minerals from the soil through the roots to all parts of the plants and dissolved organic compounds from the leaves to the roots, shoots, fruits and flowers.
4. Discuss the physiological, morphological and environmental factors that affect movement of substances in plants.

PEDAGOGICAL EXEMPLARS

1. **Talk for Learning**: Based on research from textbooks, the internet and documentaries on transport in flowering plants, engage in a whole class discussion on how substances are transported in flowering plants; learners learn from one another and accept the views of peers or disagree with them constructively.
2. **Individualised Learning**: Individually, write down the key processes involved in the transport of minerals in plants and the factors which influence these processes: Learners learn to work privately and independently, invoking a "can do" attitude in them, and boosting their confidence and morale.
3. **Experiential Learning**: In small groups, conduct the Ring Experiment, using a marked plant in or near the school community; each group prepares a report for class presentation after two or three days; learners gain real-world experiences, thus, becoming confident and appreciating the abilities of peer members.

KEY ASSESSMENT

Level 1: Name the tissues in which water and dissolved minerals, and organic compounds are transported in flowering plants, and the process(es) responsible for this transport.

Level 2: Describe how water and mineral salts, and organic compounds are transported in the phloem and xylem.

Level 3: Describe the adaptive features of the various cells of the phloem and xylem tissues that facilitate the role of these tissues in transporting materials in plants.

Level 4: Examine how one of the following influence the movement of substances in plants: physiological factors, morphological factors and environmental factors.

Hint

Collect the Individual Portfolio this week and score them for onward submission to the STP

WEEK 24

Learning Indicator: *Describe Photosynthesis and the factors affecting it.*

FOCAL AREA: PHOTOSYNTHESIS AND FACTORS AFFECTING PHOTOSYNTHESIS

Photosynthesis

Photosynthesis is the biochemical processes by which green plants and other chlorophyll-containing organisms (e.g. algae and some bacteria) make their own food using light energy. The conditions necessary for the processes are carbon dioxide from the atmosphere, water and minerals salts from the soil, chlorophyll (mainly in the chloroplast in the leaf), and light energy (generally from the sun) absorbed by the chlorophyll. These conditions and factors are experimentally verifiable by conducting simple experiments at the lab. In plants, photosynthesis occurs in the chloroplasts found in leaves. This is because chloroplasts contain the green pigment, chlorophyll, which absorbs light for photosynthesis. Photosynthesis results in the conversion of light energy into chemical energy stored in glucose, a food molecule. The general equation for photosynthesis is

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$$

Photosynthesis releases oxygen and water as by-products. However, much of this water is used by the plant in the process for metabolic activities. The water molecule is split to form molecular oxygen (released into the environment) and hydrogen ions which is used in the synthesis of glucose.

The two main stages in photosynthesis are:

1. The Light Dependent Stage/Light Reactions/Photochemical Stage:
   - **a.** Occurs in the thylakoid membranes of the chloroplast.
   - **b.** Uses light energy to split water molecule to produce oxygen, protons and electrons.
   - **c.** Produces ATP and NADPH (nicotinamide adenine dinucleotide phosphate, an energy rich molecule).
2. The Light Independent Stage/Dark Reactions/Calvin Cycle:
   - **a.** Occurs in the stroma of the chloroplast.
   - **b.** Uses ATP and NADPH (energy molecules) from the light dependent stage to convert carbon dioxide into glucose through a series of enzyme-catalysed reactions.

Factors affecting photosynthesis

- **Light intensity**- The range of light absorbed by plants for photosynthesis is between 400 nm-700 nm. This range is called photosynthetically active radiation. The most important light wavelengths for photosynthesis are 430nm (blue) and 660nm (red) absorbed by chlorophyll a, and 450 nm (blue) and 635 nm (red), absorbed by chlorophyll b. The rate of photosynthesis generally increases with increasing light intensity as light is required in the light dependent stage. However, with an optimum light intensity, additional light does not affect the process.
- **Carbon dioxide concentration** – Generally, increase in carbon dioxide concentration increases the rate of photosynthesis, as CO_2 is required for carbon fixation at the dark phase.
- **Temperature** – Increase in temperature generally increases the rate of photosynthesis, since this speeds up enzymatic reactions. However, beyond an optimum temperature, the rate of photosynthesis decreases because such high temperatures lead to enzyme denaturation, thereby hindering the rate at which photosynthesis occurs.
- **Availability of water** – Insufficient water supply reduces the rate of photosynthesis. This is because when water is less, the stomata close to prevent water loss. Thus, the amount of carbon dioxide entering the leaves also reduces, thereby reducing the rate of photosynthesis.
- **Chlorophyll concentration** – Higher concentrations of chlorophyll increase the rate of photosynthesis due to efficient absorption of sunlight.

Learning Tasks

1. Define photosynthesis and give the conditions required for this process.
2. Write and discuss the equation of photosynthesis, giving the reactants, products and by-products and their importance.
3. Describe briefly the activities that occur at the light and dark stages of photosynthesis.
4. Examine the factors that affect the rate of photosynthesis.

PEDAGOGICAL EXEMPLARS

1. **Observational/Experiential Learning**: In an all-inclusive, mixed-ability groups go out to observe various forms of plants with particular emphasis on their green leaves. Learners build confidence and self-respect through experiential, real world study scenarios, and acknowledge the strength of peers through teamwork to achieve results within a set timeframe.

2. **Talk for Learning**: In a general class, each member discusses their observations as to why plants with many green leaves appear healthier than those with fewer green leaves; by this, learners learn to solve problems independently and build confidence and strength; learners learn the act of public speaking through individual presentations, they learn to perform a task within a given time and learn to respect the contributions of peers to promote healthy academic exercises.
3. **Collaborative Learning**: Examine the processes of photosynthesis through videos(https://www.youtube.com/watch?v=qkRe_OMfwv4), charts and pictures and analyse and discuss reports on the requirements of water, carbon dioxide, chlorophyll and sunlight as necessary conditions for photosynthesis: Learners work together and learn to socially and emotionally support one another in achieving set goals.
4. **Experiential Group Project Learning**: In an all-inclusive, mixed-ability groups, carry out experiments to determine the effect of water, carbon dioxide, chlorophyll and sunlight on photosynthesis: Learners obtain first hand practical experiences in lesson, supporting group members socially and emotionally, and encouraging a "can do" attitude in them to collectively obtain results.

KEY ASSESSMENT

Level 1: Define photosynthesis and write down the equation that represents the process.

Level 2: Discuss briefly, the conditions necessary for photosynthesis to occur.

Level 3: Discuss the major activities that occur at the two main stages in photosynthesis.

Level 3: Describe an experiment to show that a named condition is required for photosynthesis to occur.

Level 4: Analyse the factors that affect the rate of photosynthesis, discussing whether these factors are required in higher or lesser concentrations, or otherwise.

Hint

*The recommended mode of assessment for this week is **End of Second Semester Examination. See Appendix F** for further information.*

Section 4 Review

In this last Section of the Year Two Teacher Manual, we focused on the cardiovascular and excretory systems of humans, transport of substances in plants and photosynthesis. We discussed that the cardiovascular system includes the heart, blood vessels and blood tissues, and these function collectively to transport oxygen, nutrients and other useful substances such as hormones around the body through the pump action of the heart. We also discussed that the system transports metabolic waste products to excretory organs such as the kidneys, skin and lungs to be removed from the body. We have learnt that the removal of these wastes maintains fluid and ion balance, thereby regulating the body's essential health indicators such as blood pH, blood pressure and blood sugar. Altogether, these factors moderate a stable homeostasis to keep the body healthy and strong. The Section ended by furthering our discussion on "Plant systems", a sub-strand under "Systems of life", a study we commenced in the latter part of our lessons in the Year One Teacher Manual.

Transport of substances such as water, dissolved minerals through the xylem, transport of food in the phloem was between 400 nm and 700nm. We have also studied that photosynthesis is not just a biological process important to only plant, algal and some microscopic life forms, but that all components of this activity, including the absorption of carbon dioxide to maintain atmospheric balance, and the release of oxygen as a by-product are all necessary processes required to maintain a stable ecosystem for the survival of all living things on our planet. This affirms the seasoned adage, "When the last tree dies, the last man dies". Understanding the dynamics of photosynthesis is, therefore, a basic requirement for every Biology learner.

APPENDIX G: END OF SECOND SEMESTER EXAMINATION

This end of semester examination should cover weeks 13-24 and consist of variety of test items across the weeks covered, consisting of 40 multiple choice questions 3 essay type items for learners to answer any 2 and 1 compulsory test of practical or practical test with different DoK levels.

Duration: Time for the examination should be 3hours.

Resources needed: Answer booklet, calculator, mathematical set, stationary, printer, pen, pencils etc, etc.

Sample of Questions

1. Which system is responsible for defending the body against infections?

A. Digestive

B. Endocrine

C. Immune

D. Respiratory

Essay Question (20 marks)

1.

a. Give the three main components of blood and the function of each(6 marks).

b. Distinguish between a lagoon and an estuary(4 marks).

c. Discuss the phases of development in the housefly (**10 marks**).

Test of Practical

1.

a. Identify the human organ below and label its parts using the letters A-D **(12 marks).**

b. State three (3) functions of the organ identified above **(6 marks)**

c. Mention any common disease of the organ **(2 marks).**

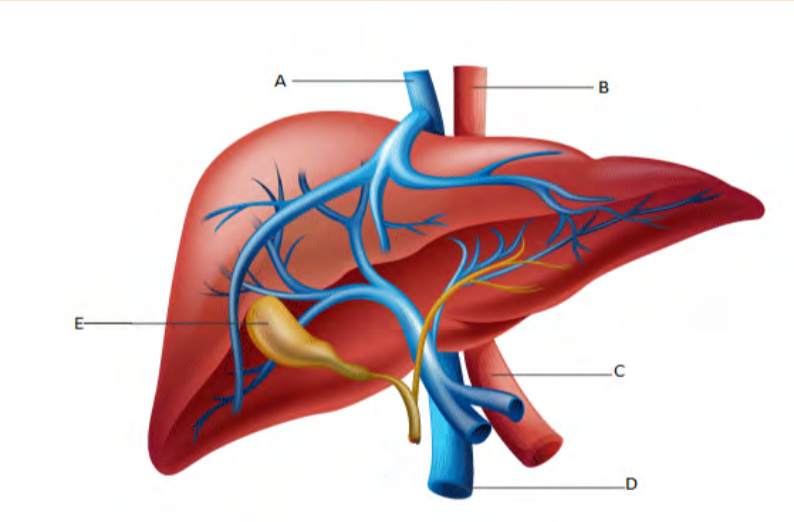


Table 4 – End of Semester Table of Specification

Weeks	Focal Area(s) End of Second Semester Examination.	Type of Questions	DoK Levels				Total
			1	2	3	4	
13	Distinctive features, life cycle, characteristics and economic importance of the housefly.	Multiple Choice	1	1	1	–	3
		Essay	–	1		–	1
14	Distinctive features, life cycle, characteristics and economic importance of honeybee.	Multiple Choice	2	1	1		4
		Essay		–		1	
15	Characteristic features of a tropical rainforest and adaptations of organisms in tropical Rainforest.	Multiple Choice	1	–	1	–	2
		Practical	–	1	–	–	1
16	Characteristic features of savannah and desert habitats, and adaptations of organisms in savannah and desert habitats.	Multiple Choice	1	1	–	–	2
		Essay	–	–	1	–	1
17	Characteristic features and adaptations of organisms in Lagoon and Estuary habitats.	Multiple Choice	1	1	–	1	3
		Essay	–	–	1	–	1
18	Characteristic features and adaptations of organisms at the Seashore.	Multiple Choice	1	1	1	–	3
19	Characteristic features and adaptations of organisms in the River, Pond and Lake.	Multiple Choice	1		1		2
		Essay	1	–	–	–	1
20	Differences and importance of immunisation, vaccination and inoculation.	Multiple Choice	1	1	–	1	3
21	Structure of the cardiovascular system of humans and how the parts relate to their functions.	**Multiple Choice**	**1**	**2**	**–**	**–**	**3**

Weeks	Focal Area(s) End of Second Semester Examination.	Type of Questions	DoK Levels				Total
			1	2	3	4	
22	Structure of the excretory system of humans and how the parts relate to their functions in homeostasis.	Multiple choice	–	1	1	–	2
		Practical	–	1	–	–	1
23	Transport of substances in flowering plants and factors affecting transport system in flowering plants.	Multiple choice	2	2	1	–	5
		Essay	–		1		
24	Photosynthesis and factors affecting it.	Multiple choice	–	2	–	1	3
		Essay	–	1	–	1	1
	Total		13		18		44

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