MINISTRY OF EDUCATION

BIOLOGY

For Senior High Schools

TEACHER MANUAL

YEAR 1 - BOOK 2

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

BIOLOGY

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Teacher Manual

Year One - Book 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), Senior High Technical School (SHTS) and Science, Technology, Engineering and Mathematics (STEM) Curriculum. It 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 Book Two of the Teacher Manual for Biology covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year One of the new curriculum. It contains information for the second 12 weeks of Year One. Teachers are therefore to use this Teacher Manual to develop their weekly Learning Plans as required by Ghana Education Service.

Some of the key features of the new curriculum are set out below.

Learner-Centred Curriculum

The SHS, SHTS, and STEM curriculum places the learner at the center of teaching and learning by building on their existing life experiences, knowledge and understanding. Learners are actively involved in the knowledge-creation process, with the teacher acting as a facilitator. This involves using interactive and practical teaching and learning methods, as well as the learner's environment to make learning exciting and relatable. As an example, the new curriculum focuses on Ghanaian culture, Ghanaian history, and Ghanaian geography so that learners first understand their home and surroundings before extending their knowledge globally.

Promoting Ghanaian Values

Shared Ghanaian values have been integrated into the curriculum to ensure that all young people understand what it means to be a responsible Ghanaian citizen. These values include truth, integrity, diversity, equity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership and responsible citizenship.

Integrating 21st Century Skills and Competencies

The SHS, SHTS, and STEM curriculum integrates 21st Century skills and competencies. These are:

- **Foundational Knowledge:** Literacy, Numeracy, Scientific Literacy, Information Communication and Digital Literacy, Financial Literacy and Entrepreneurship, Cultural Identity, Civic Literacy and Global Citizenship
- **Competencies:** Critical Thinking and Problem Solving, Innovation and Creativity, Collaboration and Communication
- **Character Qualities:** Discipline and Integrity, Self-Directed Learning, Self-Confidence, Adaptability and Resourcefulness, Leadership and Responsible Citizenship

Balanced Approach to Assessment - not just Final External Examinations

The SHS, SHTS, and STEM curriculum promotes a balanced approach to assessment. It encourages varied and differentiated assessments such as project work, practical demonstration, performance assessment, skills-based assessment, class exercises, portfolios as well as end-of-term examinations and final external assessment examinations. Two levels of assessment are used. These are:

- Internal Assessment (30%) – Comprises formative (portfolios, performance and project work) and summative (end-of-term examinations) which will be recorded in a school-based transcript.

- External Assessment (70%) – Comprehensive summative assessment will be conducted by the West African Examinations Council (WAEC) through the WASSCE. The questions posed by WAEC will test critical thinking, communication and problem solving as well as knowledge, understanding and factual recall.

The split of external and internal assessment will remain at 70/30 as is currently the case. However, there will be far greater transparency and quality assurance of the 30% of marks which are school-based. This will be achieved through the introduction of a school-based transcript, setting out all marks which learners achieve from SHS 1 to SHS 3. This transcript will be presented to universities alongside the WASSCE certificate for tertiary admissions.

An Inclusive and Responsive Curriculum

The SHS, SHTS, and STEM curriculum ensures no learner is left behind, and this is achieved through the following:

- Addressing the needs of all learners, including those requiring additional support or with special needs. The SHS, SHTS, and STEM curriculum includes learners with disabilities by adapting teaching and learning materials into accessible formats through technology and other measures to meet the needs of learners with disabilities.
- Incorporating strategies and measures, such as differentiation and adaptative pedagogies ensuring equitable access to resources and opportunities for all learners.
- Challenging traditional gender, cultural, or social stereotypes and encouraging all learners to achieve their true potential.
- Making provision for the needs of gifted and talented learners in schools.

Social and Emotional Learning

Social and emotional learning skills have also been integrated into the curriculum to help learners to develop and acquire skills, attitudes, and knowledge essential for understanding and managing their emotions, building healthy relationships and making responsible decisions.

Philosophy and vision for each subject

Each subject now has its own philosophy and vision, which sets out why the subject is being taught and how it will contribute to national development. The Philosophy and Vision for Biology is:

- **Philosophy**: The next generation of scientists can be empowered through observation, curiosity, innovation, and exposure to practically related concepts and opportunities that leverage hands-on activities in a learner centred environment.
- **Vision:** Biology learners equipped with 21st Century Skills and Competencies to explore, understand, and apply creative and critical thinking processes in nature inspired-situations for the conservation and sustenance of life and the environment.

SUMMARY SCOPE AND SEQUENCE

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1.	Exploring Biology in Society	Biology as the Science of Life	4	4	5	1	1	2	-	-	-
		Biology and Entrepreneurship	1	1	3	1	1	2	1	1	4
2.	Life in the Fundamental Unit	Cell structure and Functions	1	1	2	2	2	5	5	5	7
		Movement of substances in living organisms	1	1	3	1	1	1	-	-	-
3.	Diversity of living things and their Environment	Living Organisms	3	3	3	3	4	6	1	1	2
		Ecology	5	5	7	1	1	2	2	2	4
		Diseases and infections	1	1	1	1	1	2	1	1	2
4.	Systems of life	Mammalian Systems	1	1	2	1	1	2	1	1	4
		Plant Systems	1	1	3	1	1	2	1	1	4
Total			**18**	**18**	**29**	**12**	**13**	**24**	**13**	**13**	**29**

Overall Totals (SHS 1 – 3)

Content Standards	**41**
Learning Outcomes	**42**
Learning Indicators	**84**

SECTION 5: ECOLOGY (CONTINUED)

Strand: **Diversity of Living Things and their Environment**

Sub-strand: Ecology

Content Standards:

1. Demonstrate knowledge and understanding of ecological terms and the significance of ecological concepts.
2. Demonstrate knowledge and understanding of how the living and non-living components of the environment interact to ensure the sustenance of life.
3. Demonstrate knowledge and understanding of the use of ecological devices and methods such as the quadrat, pitfall trap, pooter, and Lincoln's index to study populations of organisms.
4. Demonstrate knowledge and understanding of methods of determining energy flow in an ecosystem.
5. Demonstrate knowledge and understanding of energy flow and efficiency in an ecosystem with emphasis on ecological pyramids.

Learning Outcomes:

1. *Apply the knowledge of ecological terms to describe the concept of ecology.*
2. *Explain how the living and non-living components of the environment interact to ensure the sustenance of life.*
3. *Show how various simple ecological tools can be used to estimate the populations of species in each habitat.*
4. *Explain the relevance of direct counting, gut examination and radioactive/tracer methods of determining the flow of energy in an ecosystem.*
5. *Explain the methods of determining and comparing the efficiency of energy flow in pyramids of numbers, biomass and energy.*

INTRODUCTION AND SECTION SUMMARY

Ecology, a vital branch of Biology, is the study of the intricate relationships between living organisms and their environment. It explores interactions among plants, animals, microorganisms and abiotic factors like air, water and soil. Learners grasp ecological terms significance and understand how living and non-living elements sustain life and employ tools like quadrats and methods such as Lincoln's index to estimate species populations. They learn to utilize ecological devices and methods to study populations and explain energy flow in ecosystems through direct counting, gut examination and radioactive techniques. Learners compare energy flow efficiency in pyramids of numbers, biomass, energy and study ecosystem dynamics. This knowledge aids in developing sustainable agriculture systems, resource management, biodiversity conservation, and addressing climate change, to ensure the health and stability of ecosystems for future generations.

The Section Continuation covers the following weeks:

Week 13: The methods of determining pyramids of numbers, biomass and energy, and compare the efficiency of energy flow in them.

SUMMARY OF PEDAGOGICAL EXEMPLARS

This section advocates for practical learning experiences such as nature walks and field trips, along with field and laboratory activities. It emphasizes pedagogical methods including individual-based and experiential learning, inquiry-based learning, critical thinking and problem-solving. Communication, collaboration, group-based learning, leadership and personal development are encouraged through diverse roles within groups. Cultural identity and global citizenship are promoted by relating learned concepts to various ecosystems worldwide. Digital literacy is fostered through the use of technology to explore ecosystems. Safety precautions are stressed for both field and laboratory activities, with support provided for learners with special educational needs. Overall, the approach aims to provide learners with hands-on experiences, critical thinking skills, cultural awareness and technological proficiency in ecology.

ASSESSMENT SUMMARY

Assessments in this section are mainly formative oral questions and responses, quizzes and observation checklists to guide learner understanding and progress. The assessments have been prepared to accommodate all levels of the depth of knowledge (DoK) of learners. Complex assessments such as projects, scientific writings and presentations and experiential design tasks have been given as mixed-ability group work to deepen the understanding, critical and analytical thinking skills of all learners where the highly proficient ones serve as support for the others. Additional support must be given to learners with special education needs (SEN), through extended time, simplified instructions and less complex alternative formats of assessments to support the SEN learner to also demonstrate his or her knowledge and skills in ecology effectively. The assessments in this section suit the learning needs of all learners, so each can fully appreciate ecology. With these diverse assessment modes, all learners are assured of showcasing their understanding of ecology and its application in everyday life.

Week 13

Learning Indicator: *Explore the methods of determining pyramids of numbers, biomass and energy, and compare the efficiency of energy flow in them.*

Theme or Focal Area: Discuss the Relevance of Each of The Methods Used in Determining Energy Flow in An Ecosystem

The relevance of these methods lies in their ability to offer complementary insights into the flow of energy in an ecosystem:

1. **Comprehensive understanding**: By combining direct counting, gut examination, and radioactive/tracer methods, researchers can obtain a more comprehensive understanding of energy flow. Direct counting provides population-level data, gut examination offers insights into feeding relationships, and radioactive/tracer methods provide precise information on energy transfer rates and paths.
2. **Ecosystem structure and function**: Studying energy flow helps in understanding the structure and functioning of ecosystems. It reveals the relationships between different species and their roles, in understanding trophic cascades and predicting the consequences of disturbances. In conclusion, direct counting, gut examination, and radioactive/tracer methods are valuable tools for ecologists to study and determine the flow of energy in ecosystems. By combining these techniques, scientists gain a more holistic understanding of energy transfer and ecosystem dynamics, which is essential for ecological research, conservation efforts and sustainable management of natural resources.
3. **Impact of environmental changes**: Monitoring energy flow in an ecosystem allows researchers to assess the impact of environmental changes, such as climate change or the introduction of invasive species. Changes in energy flow can indicate disruptions in ecological balance and potential threats to the stability of the ecosystem.
4. **Management and conservation**: Understanding the flow of energy helps in making informed decisions for the management and conservation of ecosystems. It aids in identifying keystone species.

Learning Tasks

1. Match at least two least two techniques used to study and determine the flow of energy with their corresponding relevance. Support all learners during the matching task. Limit content expectation to matching of at least two techniques used to study and determine the flow of energy with their corresponding relevance.
2. Compare at least two different techniques used to study and determine the flow of energy in an ecosystem. Ask leading questions to guide learners to succeed in their explanations.
3. Relate the impact of environmental changes and management conservations to the flow of energy in an ecosystem. Ask learners who understand the concept to provide peer tuition to their peers. Provide talented learners with pictures, textbooks and specimens of organisms from different habitats to use for the tuition.

Pedagogical Exemplars

- The teacher should stagger the instruction level of difficulty, starting first from a basic level, through intermediate to an advanced level to cater for the varying needs of learners. The following approach could be adopted:

- Employing task-based learning, place learners in all-inclusive groups to match at least two techniques used to study and determine the flow of energy in an ecosystem with their corresponding relevance. Support should be provided to learners experiencing difficulty.
- Using brainwriting strategy, ask learners to create a chart on the advantages and disadvantages of the various methods of determination of energy flow and use the charts in class presentations. Learners can describe the relevance of at least two different techniques used to study and determine the flow of energy in an ecosystem
- Using the Television Talk Show strategy, ask learners to connect the impact of environmental changes and management conservations to the flow of energy in an ecosystem. Ask probing questions to guide learners to provide the required information to peers.

Key Assessment (DoK)

Level 1: Match three techniques used to study and determine the flow of energy in an ecosystem with their corresponding relevance. Accept at least two techniques used to study and determine the flow of energy in an ecosystem with their corresponding relevance.

Level 2: Analyse the advantages and disadvantages of each of the methods of determining the flow of energy in an ecosystem. Give sound reasons why you will prefer a particular method over the other beyond the advantages and disadvantages of each of the methods.

Accept at least two advantages and disadvantages of each of the methods of determining the flow of energy in an ecosystem and any one reason why the learner will prefer a particular method over the other beyond the advantages and disadvantages of each of the methods.

Section Review

In this section, learners have covered fundamental aspects of ecology, including defining key terms such as ecology, ecosystem, habitat and factors like biotic and abiotic elements. They also identified and studied a variety of ecological habitats. Weeks nine through to twelve saw a progression from understanding interdependency in habitats to studying ecological tools for population estimation and methods for determining energy flow within ecosystems. Discussions in week twelve focused on the relevance of different energy flow determination methods, and energy flow. These lessons equip learners to understand ecological concepts as they apply to different habitats. Such skills are vital for advising ecologists and contributing to environmental management, particularly in Ghana. Moreover, the acquired knowledge and skills prepare learners for further studies and eventual integration into the workforce, enhancing their capability to analyse and contribute to ecological research and environmental conservation efforts.

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SECTION 6: DISEASES AND INFECTIONS

Strand: **Diversity of Living Things and their Environment.**

Sub-Strand: Diseases and Infections

Content Standard: Demonstrate knowledge and understanding of the life cycles of common disease-causing organisms and their effects on humans.

Learning Outcome: *Apply the knowledge of the life cycles of common disease-causing organisms to control or prevent their effects on humans.*

INTRODUCTION AND SECTION SUMMARY

Treating diseases and disease-causing organisms is a major financial drain to the nation. This section will introduce learners to common diseases such as water-borne, airborne, food-borne, and vector-borne diseases, their causative organisms, mode of transmission and preventive measures. Learners must know about these diseases so that seasonal diseases such as cholera, malaria, and other vector-borne diseases can be reduced through simple means such as attitudinal changes as a result of education. Further, with the knowledge gained about these diseases, their transmission and control, learners can also help prevent zoonotic infections from pets. Learners can make informed choices about the transmission of food and water-borne diseases like typhoid. The section is designed to help learners share knowledge gained with family and friends, ensuring that preventing the spread of diseases is a collective responsibility.

The week covered by the section is:

Week 14: Discuss common disease-causing organisms, their transmission, their effect on humans and the measures which could be taken to reduce or prevent their spread.

SUMMARY OF PEDAGOGICAL EXEMPLARS

This section offers learners a unique experience of blending theory knowledge with practical experience using knowledge gained to solve everyday problems in the environment. Varied pedagogies can be employed to ensure learners gain the required knowledge and concepts at the end of the section. Project-based learning is a technique that will be used in the teaching-learning process to help learners gather data on diseases, their mode of transmission, signs and symptoms, and control/preventive measures. As learners discuss amongst themselves some of the most efficient ways to control the spread or cure of some of the diseases studied, they develop the ability to think critically and solve problems. A skill much needed in adult life and the world of work. Learners realize science is about investigations, solving problems in our environment and making our day-to-day life easy and meaningful. Grouped-based learning offers learners the opportunity to develop communication and collaborative skills they need to coexist and tolerate the views of their peers, so improving their social life.

Enquiry based approach is a strategy that will be employed to deepen learners curiosity and getting them to continue learning about diseases even after the section ends.

SUMMARY OF ASSESSMENT

Assessment is a key feature and tool in ensuring knowledge, concepts and skills learners need have been acquired. The inclusive and diverse nature of the classroom demands a careful and conscious process in assessment making sure all learners' needs are met. Assessment strategies used in this section cover all levels of DoK (Levels 1 - 4). This makes it possible for learners approaching proficiency,

proficient learners and highly proficient learners to make progress. The assessment strategy carefully aligns the learning outcomes, content, learning indicators and pedagogies. Assessment in this section is used in diverse ways, as a tool to foster learning, and diagnose problem areas for remediation purposes.

Week 14

Learning Indicator: *Discuss how common diseases are transmitted within the environment and the causes, symptoms and control/preventive measures taken to check these diseases.*

Theme or Focal Area: Discuss Some Common Diseases Based on the Causative Organisms, their Transmission Cycle, Effects and Control/Prevention.

Waterborne Diseases

- **Causes:** Contamination of water sources with pathogenic micro-organisms, typically from faecal matter of infected individuals or animals.
- **Examples:** Cholera, Typhoid fever, Hepatitis A.
- **Symptoms:** Diarrhoea, vomiting, fever, abdominal pain, jaundice (in the case of Hepatitis A).
- **Control/Preventive Measures:** Access to safe drinking water, proper sanitation and waste management, regular monitoring and treatment of water sources, boiling or treating water before consumption.

Airborne Diseases

- **Causes:** Inhalation of airborne droplets or dust particles with the pathogens released from infected individuals.
- **Examples:** Influenza, Tuberculosis, COVID-19.
- **Symptoms:** Respiratory symptoms, fever, cough, shortness of breath.
- **Control/Preventive Measures:** Wearing masks, proper ventilation, maintaining physical distance, isolating infected individuals, vaccination (where available), and hand hygiene.

Vector-Borne Diseases

- **Causes:** Transmission of pathogens through the bites of infected vectors, such as mosquitoes, ticks, and fleas.
- **Examples:** Malaria, Dengue fever, Lyme disease.
- **Symptoms:** They vary depending on the disease but may include fever, body aches, rash, and joint pain.
- **Control/Preventive Measures:** Insecticide-treated bed nets, vector control programs, use of repellents, proper waste disposal to eliminate breeding sites for vectors.

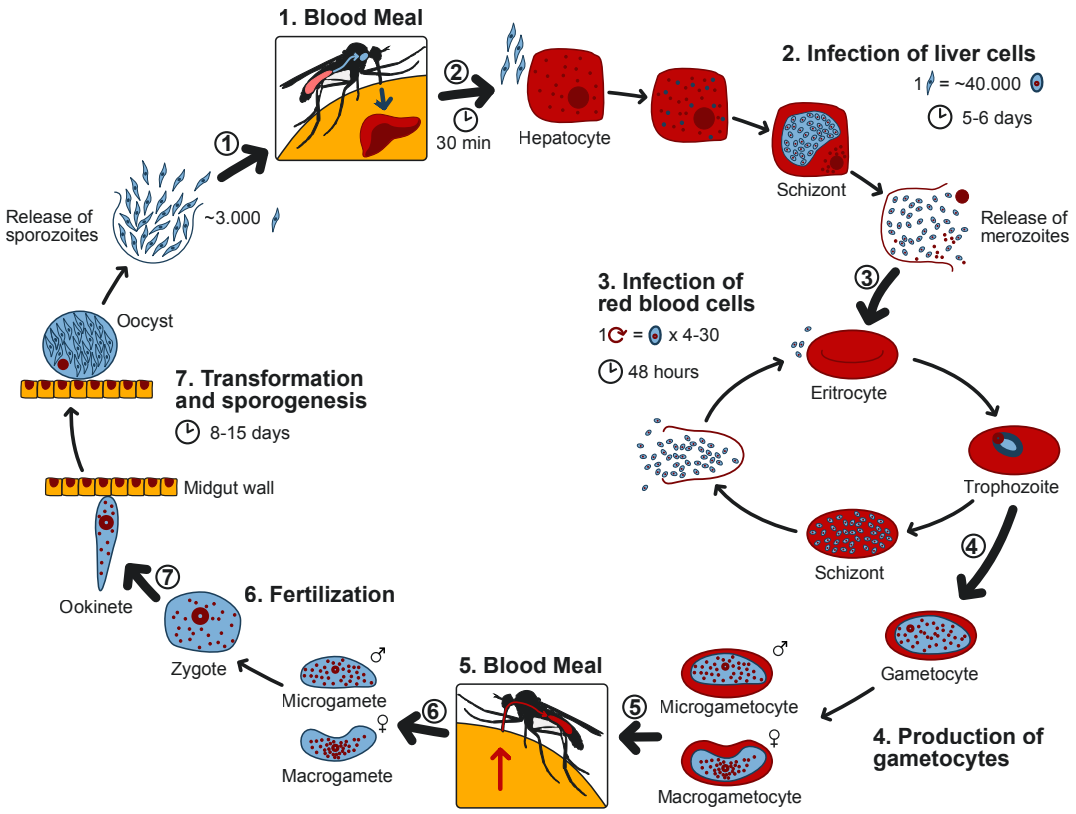
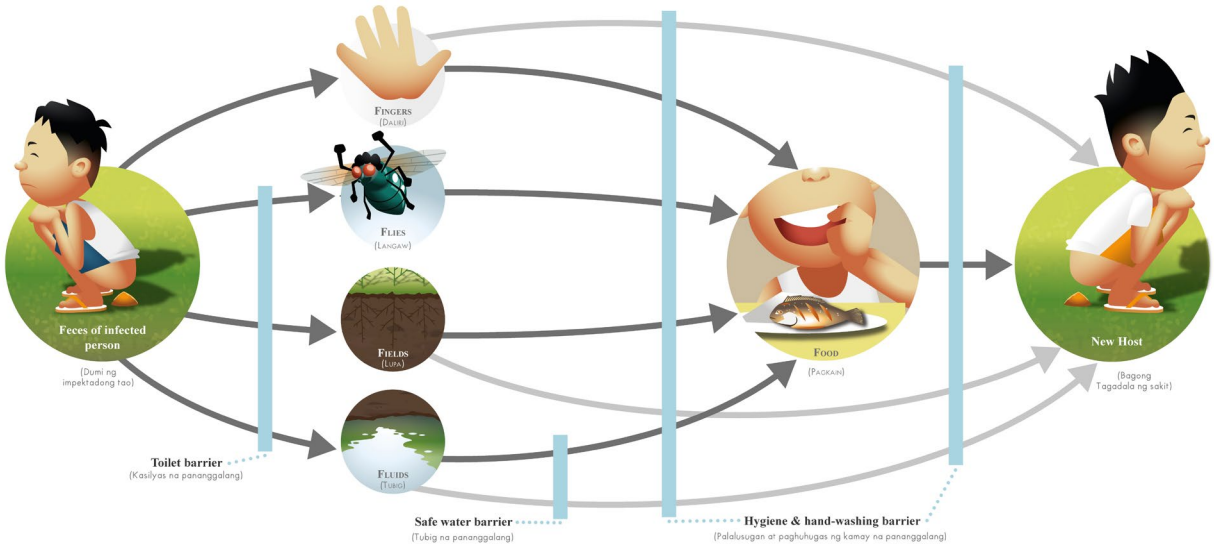


Diagram showing the transmission cycle of malaria

Food-borne Diseases:

- **Causes:** Consumption of contaminated food, often due to poor food handling and sanitation practices.
- **Examples:** Salmonella infection, E. coli infection, Norovirus.
- **Symptoms:** Nausea, vomiting, diarrhoea, abdominal pain.
- **Control/Preventive Measures:** Safe food handling practices, proper cooking temperatures, hand washing, avoiding consumption of raw or under-cooked foods, and regular inspection of food establishments.



Zoonotic Diseases

- **Causes:** Transmission of diseases from animals to humans, either through direct contact or through vectors.
- **Examples :** Rabies, Avian Influenza, Zika virus.
- **Symptoms:** They vary depending on the disease but can range from mild to severe and life-threatening.
- **Control/Preventive Measures:** Vaccination of animals, avoiding contact with wild or sick animals, controlling vectors, and maintaining good hygiene when handling animals.

Soil-borne Diseases

- **Causes:** Contamination of soil with pathogens, often due to poor sanitation or improper disposal of faecal matter.
- **Examples:** Hookworm infection and tetanus (caused by *Clostridium tetani*).
- **Symptoms:** Depending on the disease, symptoms may include gastrointestinal discomfort/ pain, skin problems, and muscle stiffness (in the case of Tetanus).
- **Control/Preventive Measures:** Proper sanitation and waste disposal, wearing protective footwear in areas with contaminated soil, and vaccination (in the case of Tetanus).

Learning Tasks

1. Describe the following with some examples of each
   - i. Vector-borne diseases
   - ii. Food-borne diseases
   - iii. Airborne diseases
   - iv. Zoonotic diseases
   - v. Soil-borne diseases

   Limit content expectation to the correct description of any two types of the diseases listed.
2. Develop a complete transmission cycle for malaria and cholera. Extend content expectation to the development of at least three stages in the transmission cycle of the pathogen.
3. Describe signs/symptoms of some diseases listed in Task 1 above. Extend content expectation to the description of at least three diseases.
4. Discuss possible control /preventive measures needed to stop the spread of disease. Extend content expectation to the various control/preventive measures needed to prevent the spread of at least three diseases.

Pedagogical Exemplars

The teacher should consider the following activities:

- In mixed ability, gender-balanced groups learners use the think-pair-share approach to categorize diseases based on their mode of transmission and give three common examples of each type of disease.
- Learners use group learning to develop creative ways of using concept maps to show the transmission cycles for malaria and cholera.
- Learners use talk for learning to deliberate and communicate in teams over the control/preventive measures of common diseases.

Key Assessments (DoK)

Level 1: Describe briefly each of the following:

i. Vector-borne diseases

ii. Food-borne diseases

iii. Airborne diseases

iv. Zoonotic diseases

v. Soil-borne diseases

Accept at least any three correctly described.

Level 2: Name three diseases that are commonly transmitted through contaminated water. Accept oral/written responses for three waterborne diseases listed.

Level 3: Explain how waterborne diseases are transmitted and provide an example. Accept oral/written responses for the transmission cycle of a waterborne disease.

Level 4: Discuss at least two ways to prevent the transmission of any three of the following diseases:

i. Malaria

ii. Cholera

iii. Typhoid

iv. COVID-19

vi. Rabies

Accept control/preventive methods needed to prevent the spread of any three of the diseases listed.

Level 5 Explain with reasons why malaria is more prevalent in the rainy season in the topics and suggest how to control its spread. Accept any two reasons given for high malaria cases in the rainy season and their control measures.

Level 6: If a community is experiencing a high incidence of waterborne diseases, what steps would you recommend to mitigate this issue? Accept oral/written responses for at least four control/preventive measures recommended.

Level 7: Discuss the health implications of the following activities relating to soil-borne disease.

i. Children eat their snacks without washing their hands after playing in the garden.

ii. Allowing children to play with unvaccinated pets (e.g. dogs or cats)

Accept any two health implications correctly deduced from the scenario in i and ii above.

Level 8: Design a comprehensive disease prevention program for a densely populated urban area that has been experiencing outbreaks of airborne disease. Your programme should address the root cause of these outbreaks and propose sustainable solutions. Accept written responses for at least three correct prevention strategies and one sustainable solution for the airborne diseases mentioned.

Section Review

The Section introduced learners to selected diseases such as malaria, cholera and typhoid. It also dealt with the causative organism or agent, signs and symptoms, life cycle and control/ preventive measures.

Learners realised that one of the most effective ways to control the spread of such diseases is to break the transmission cycle. Learners learned about different types of diseases under the following headings: airborne, waterborne, foodborne, soil-borne and zoonotic diseases.

Interactive pedagogies were employed to ensure the lesson was very practical and relevant to learners. Since knowledge exists within the context of every learner, learners were guided to enhance their own unique knowledge consistent with what the scientific community accepts to be right.

Assessments covered in the section induced learners to think critically. This targets the direct beneficiaries (learners) and indirect beneficiaries (people in the community) to help stop the spread of diseases in Ghana and the world in general.

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SECTION 7: MAMMALIAN SYSTEMS

Strand: **Systems of Life**

Sub-Strand: Mammalian Systems

Content Standards: Demonstrate knowledge and understanding of the morphology of mammals.

Learning Outcomes: *Describe the morphology of mammals and relate the structures to their functions.*

INTRODUCTION AND SECTION SUMMARY

Mammalian systems are made up of several organs and tissues which work together to support life functions in mammals. At the core of these organ systems is the vertebrate body plan, which has features such as bilateral symmetry, a segmented vertebral column with the spinal cord, and many specialised internal organs that play specific roles. Among the various systems in mammals are the musculoskeletal system, digestive system, excretory system, nervous system, reproductive system, endocrine and exocrine systems, and cardiovascular system. Mammals also possess an immune system that defends them against pathogens and invaders of the body. Generally, mammals exhibit thermoregulatory mechanisms to maintain internal body temperature and ensure successful metabolic processes. Over the years, mammalian systems have evolved to adapt to diverse environments, which allow these organisms to thrive in various habitats within the earth's biosphere.

The weeks covered in this section are:

Week 15:

1. Relate some external organs/features of mammals to their functions
2. Relate some internal organs/features of mammals to their functions
3. Relate the sensory organs (Ears, Eyes, Nose, Tongue and Skin) of mammals to their functions

Week 16: Describe and compare the digestive systems and associated organs of herbivores, carnivores and omnivores

SUMMARY OF PEDAGOGICAL EXEMPLARS

The section focuses on mammalian organ systems. These systems combine to form the mammalian organism. In attempting to understand how these systems behave and function, several pedagogies and exemplars have been employed. Learners are put in mixed ability groups, gender-responsive groups, and social-inclusive groups to ensure that each learner develops essential skills and proficiencies such as team spirit, respect for learners from all backgrounds and a non-discriminatory gender mindset. Pedagogies such as experiential learning, group learning and collaborative learning strategies have been used to assist the learner in understanding how the systems of mammals work together to promote the survival and continuity of the diverse mammalian species that have evolved on the earth. For instance, experiential learning through models and laboratory systems at the school will help learners to appreciate the various organs and structures in mammals, and their locations. These learning strategies also make the learner a confident and independent thinker, as he or she experiences the various phases of learning techniques which makes him or her knowledgeable in the various mammalian systems.

Week 15

Learning Indicator: *Relate the external and internal features of mammals to their functions.*

Theme or Focal Area: Relate Some External Organs/Features of Mammals to their Functions

1. **Fur/Hair:**

   Function: Insulation and protection. Fur helps mammals regulate body temperature by trapping warm air close to the skin. It also serves as a protective layer against harsh environmental factors such as rain or snow. In some mammals it serves as camouflage of predators or their prey. And in some cases, the colour and density/length of hair gives out signals of gender or status. E.g. the lion's mane.

2. **Mammary Glands (Mammary Papillae/Nipples):**

   Function: Lactation. Mammary glands produce milk, a rich source of nutrition for young mammals. Nipples allow offspring to nurse, promoting maternal care and increasing survival chances.

3. **Limbs and Appendages:**

   Function: The structure of limbs and appendages varies among mammals based on their mode of action. For instance, terrestrial mammals have limbs optimized for walking, running, swimming, fighting, obtaining food, climbing, gliding or flying, while marine mammals have evolved flippers for swimming.

4. **Teeth and Jaws:**

   Function: Feeding. Different mammalian teeth types (incisors, canines, premolars, molars) are specialized for various diets. Herbivores have teeth adapted for grinding plant material, while carnivores have sharp teeth for holding and killing prey and crushing bones.

Learning Tasks

1. Provide a list of some external organs and structures that are associated with mammals. Limit content expectation to structures that are external and can be observed from the exterior.
2. Describe the functions of some external organs and structures found in mammals. Limit responses to description of functions of the various features found in the external part of the mammalian body
3. Explain how external morphological features of mammals coordinate their functions to ensure the survival of the mammals.

Response content should focus on how the various external organs of mammals function together to ensure survival; for example, the limbs are used to move the body around to find food essential items such as food, which is broken down by the teeth.

Pedagogical Exemplars

Consider the following pedagogies:

- Experiential Learning**:** Learners in mixed-ability, all-inclusive groups, are to critically observe, discuss and write down their findings on the external features of a mammal. (e.g., Albino rat, rabbit or guinea pig.) presented to them at the lab. Learners experience lessons in real life scenarios and therefore obtain better understanding in lessons.

- Research-Based Learning**:** Learners are assigned in groups to research external mammalian features and describe their functions. All learners participate in one aspect of the project or another. Thus, there is a better understanding of content among them.
- Talk for Learning**:** Learners in groups discuss their findings from research and share information through various group presentations. Learners improve their public speaking as they interact among themselves and observe their strengths and weaknesses in their delivery and improve over this.

Key Assessment (DoK)

Level 1: Name and provide the common features/organs located at the external part of mammals. Accept at least three external organs/features /structures of mammals and their functions.

Level 2: Compare the limb structure of a named terrestrial mammal and a named marine mammal, and explain how each is suited to their mode of movement. Accept comparison and explanation of limbs of land-based mammals (e.g. sheep) with the flippers of aquatic mammals such as dolphins and whales.

Level 3: Devise a plan for a conservation program aimed at protecting a specific endangered mammal species by considering its unique external and internal features, habitat, and diet requirements. Accept conservation methods and practices such as avoiding hunting/poaching, criminalising the commercialisation and trading of endangered mammals and providing a healthy and safe habitat for endangered mammals.

Theme or Focal Area: Relate Some Internal Organs/Features of Mammals to their Functions

Some internal organs in mammals and their functions include the following:

1. **Four-chambered heart:**

   Function: Efficient circulation.

   The four-chambered heart keeps oxygenated and deoxygenated blood separate, allowing mammals (and birds) to have a more efficient circulation system which supports their high metabolic demands.

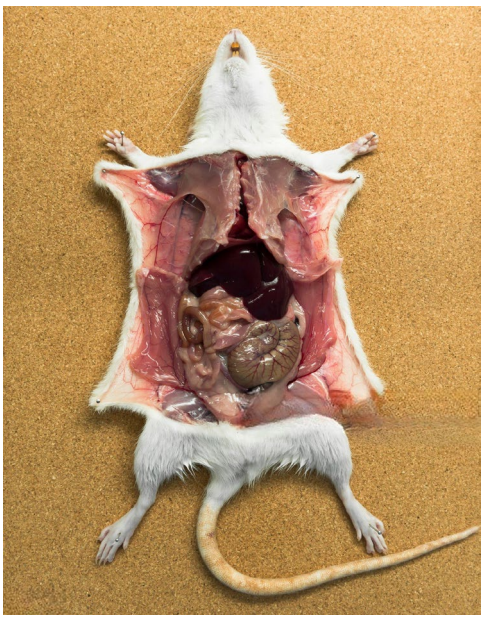


Diagram of a dissected albino rat showing some internal organs

6. **Diaphragm:**

   Function: Breathing.

   The diaphragm is a muscle that aids in the process of breathing by contracting and relaxing. This changes the pressure in the thorax, bringing about the expansion and contraction of the lungs, thus facilitating the exchange of oxygen and carbon dioxide for respiration.

7. **Complex digestive system:**

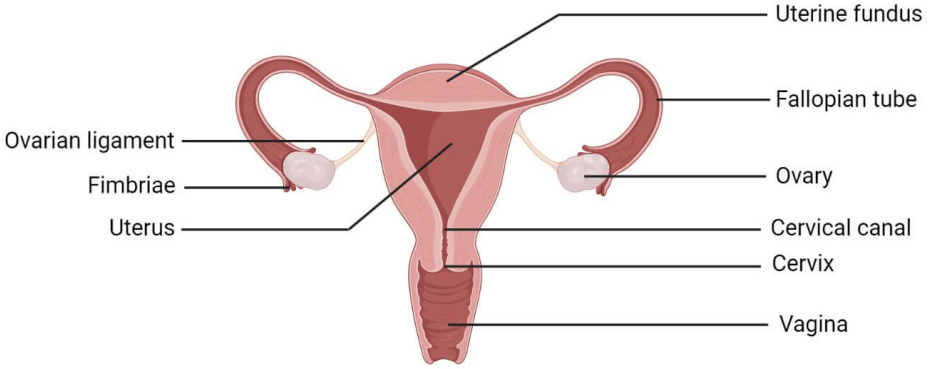
   Function: Efficient nutrient extraction.

   Mammals have a specialized digestive system with different chambers (e.g., stomach, small intestine, large intestine) that allow for efficient breakdown and absorption of nutrients from their diverse diets.

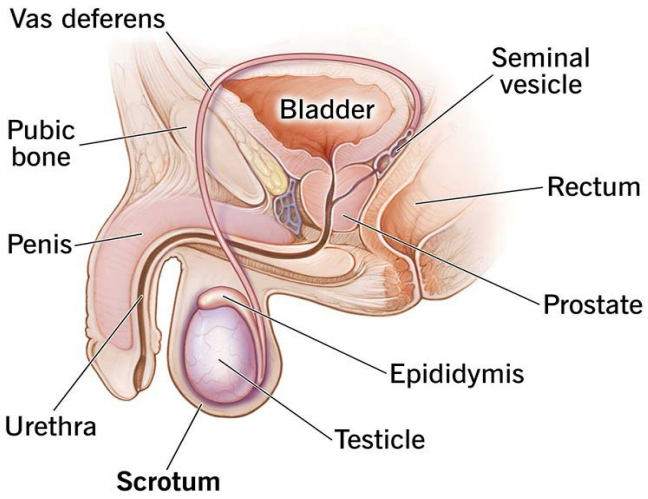
8. **Reproductive system:**

   Function: Reproduction and maternal care.

   Mammals have evolved diverse reproductive strategies, including internal fertilisation and viviparous (live) birth. Mammalian reproductive organs include the testes, scrotum and penis in males, and structures such as the uterus or womb, fallopian tubes, the vagina and the vulvas among females. The reproductive system plays a crucial role in ensuring the survival and development of offspring.



(a)



(b)

Diagrams of female (a) and male (b) reproductive systems

5. Well-developed brain:

Function: Cognitive abilities and complex behaviours. Mammals generally have a larger and more complex brain compared to other animal groups, which supports advanced cognitive functions, problem-solving, and sophisticated social behaviour.

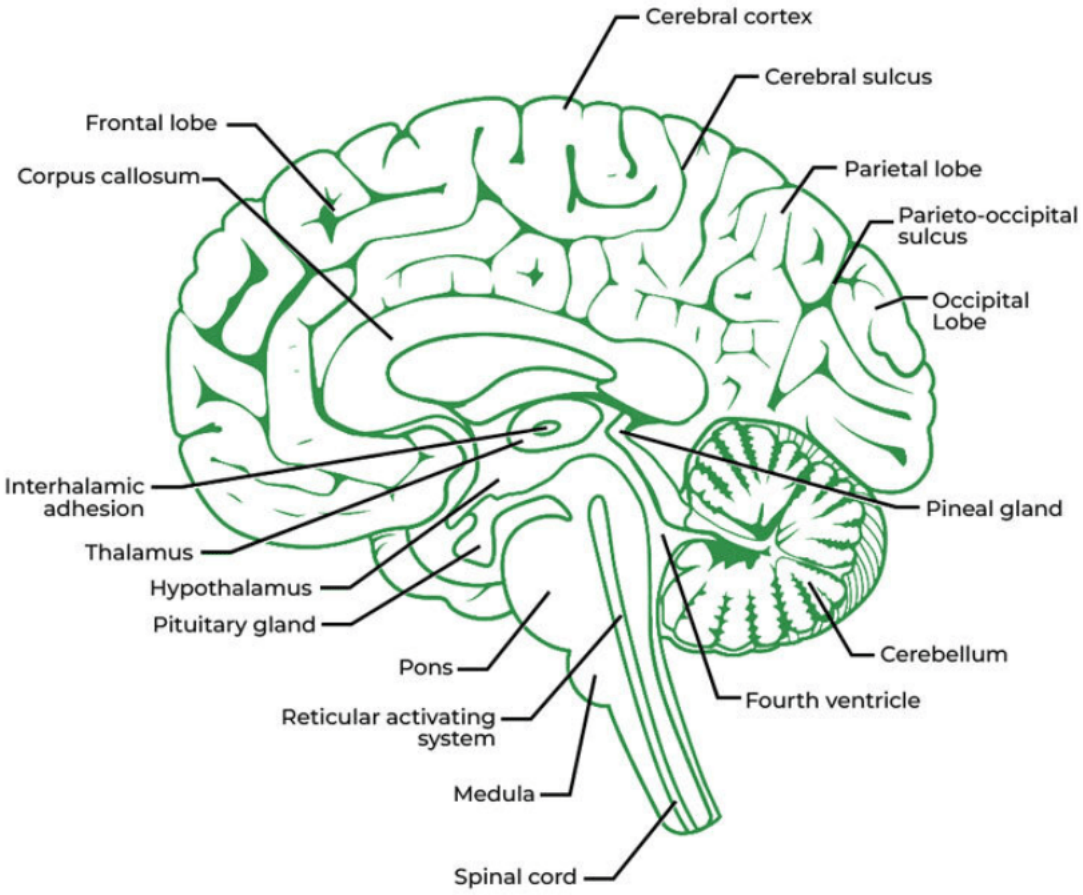


Diagram of the mammalian brain

6. Kidneys:

Function: Filtration of blood and elimination of waste materials. Mammalian kidneys are well-equipped to filter blood and regulate water balance, allowing efficient excretion of waste products and maintenance of internal homeostasis.

Learning Tasks

1. List some internal organs of mammals and give the function of each.Limit content to a list of at least five internal organs of mammals and provide their functions.
2. Explain why mammals have larger and more complex brain systems than other animals. Limit content expectation to mammals possessing the ability of advanced cognitive functions, critical thinking ability and problem-solving.
3. Describe the adaptive features of the internal organs of mammals that allow them to perform their functions successfully. Limit content expectation to listing at least three internal organs of mammals and at least two adaptive features of each, and the role of these features in the functions of the associated organ.

Pedagogical Exemplars

- Using demonstrative learning, learners in mixed-ability groups watch a video on how dissection is done on a mammal. The teacher pauses the video periodically to explain, or the teacher carries out the sectioning of a small mammal or a model in the lab to demonstrate dissection in mammals. Learners gain deeper understanding as they experience lessons in virtual learning or in real time.
- Using explorative learning methods, the teacher asks learners in mixed-ability groups to examine the dissected mammal/model to identify some common internal organs such as the heart, intestines, kidneys and lungs. Learners become inquisitive and desire to explore to know more.
- Learners in groups use talk for learning to discuss and write down the functions of the internal organs of the mammal dissected, and make an annotated diagram of at least two of the organs identified. Learners learn effective communication through discussion with peers.
- Using inquiry-based learning, ask learners to research from books and online resources to find more information on the organs they have studied. Learners become independent thinkers and build confidence.

Key Assessments (DoK)

Level 1: Name some internal organs that are found in mammals and give the function(s) of each. Accept a list of at least five organs and at least one function of each organ.

Level 2: Describe the features of the mammalian heart which allow it to perform its functions effectively. Accept the description of the various adaptive features of the heart, such as being four-chambered, the presence of a septum, muscular ventricles and the presence of valves, and the functions of these features.

Level 3: Discuss ways in which mammals have adapted successfully to life on earth, by comparing them with other vertebrate groups.

Theme or Focal Area: Relate the sensory organs (Ears, Eyes, Nose, Tongue and Skin) of Mammals to their Functions:

1. Mammals have well-developed sensory organs to gather information about their surroundings.

   Function: Perception of the environment.

   Eyes are adapted for vision; ears for hearing, and for balance; the nose for detecting scents; the tongue for detecting taste, and the skin for detecting touch, temperature and pain.

Learning Tasks

1. Name the five sensory organs in mammals and give the function of each. Limit content to the names of at least three sensory organs, and provide one function of each.
2. Describe the adaptive features of the sensory organs, and the roles they play in the effective functioning of the sensory system. Limit content to at least one sensory organ and those features of adaptation that makes it function effectively.
3. Discuss how the sense organs in mammals coordinate to protect the body of the mammal.

Limit content expectation to how the five sense organs (the ear, eye, nose, tongue and skin) function in a coordinated manner for perception and protection of the mammalian body against external threats.

Pedagogical Exemplars

- Using experiential learning techniques, ask learners in mixed-ability groups to identify at least one sense organ on the human body and describe how it works.
- Use talk-for-learning to ask learners in groups to describe the nature and roles of the sense organs identified on the body. This technique improves communication, as the learner learns good manners in group discussions, and also allows the learner to develop positive self-esteem.
- Use the presentation learning method to ask learners in mixed-ability groups to make presentation on the nature, adaptive features and functions of at least one sense organ in mammals. Describing the nature, features of adaptation and role(s) of the sense organ used in group presentations enables learners to share roles, thereby ensuring active participation of learners at all levels and from all backgrounds.

Key Assessments (DoK)

Level 1: List the five sense organs in mammals and give the role(s) of each.

Accept a list of at least three sense organs with their functions.

Level 2: Explain why the functions of the sense organs are crucial to the survival of a named mammal

Accept at least three functions of the sense organs and how they aid the survival of the named mammal.

Level 3: Discuss some processes and activities that may impair the sense organs in mammals and disrupt their proper functions.

Accept discussion of at least one process of each of the sense organs that may be harmful to its functions or prevent its proper functioning.

Level 4: With a specific example, describe how information is channeled through a specific sense organ to the brain.

Accept the description of how information is channeled from the external environment, through a named sense organ until it reaches the brain (for example, how sound is transmitted from the pinna through the inner ears unto the brain, or how stimuli such as pain, cold or heat is transmitted from sensory receptors in the skin through a series of systems into the brain).

Week 16

Learning Indicator: *Compare the digestive systems and associated organs of different groups of mammals.*

Theme or Focal Area: Describe the Digestive Systems and Associated Organs of Herbivores, Carnivores and Omnivores

The digestive system and associated organs of some mammals based on their feeding habit include the following:

1. **Herbivores**

   Diet: Herbivores primarily consume plant material, such as leaves, grasses, and fruits.

   Digestive System Adaptations:

   Long Digestive Tracts: Herbivores typically have longer digestive tracts to allow more time for the breakdown of complex plant fibres and the extraction of nutrients.

   Large Caecum or Rumen: Many herbivores have a specialized fermentation chamber, such as the caecum (in rabbits) or the rumen (in ruminant mammals like cows and sheep). These chambers contain symbiotic micro-organisms that help digest cellulose and other complex carbohydrates found in plant material.

   Associated Organs:

   Large and Complex Stomach: Herbivores often have a large stomach with multiple compartments to aid in the fermentation and breakdown of plant material.

   Well-Developed Colon: The colon in herbivores plays a crucial role in absorbing water and nutrients from the digested material before excretion.

2. **Carnivores**

   Diet: Carnivorous mammals are animals that primarily consume flesh of other animals.

   Digestive System Adaptations:

   Shorter Digestive Tracts: Carnivores have relatively shorter digestive tracts compared to herbivores because animal protein is easier to digest.

   Simple Stomach: Carnivores generally have a simpler stomach structure compared to herbivores, as their diet consists of more easily digestible nutrients.

   Associated Organs:

   *Increased Stomach Acid Production: C*arnivores have a higher concentration of stomach acid, which aids in the breakdown of proteins and bone, and destroys harmful bacteria commonly present in meat.

   Reduced Caecum: Many carnivores have a smaller or less developed caecum since their diet does not rely heavily on fermentation.

3. **Omnivores:**

   Diet: Omnivores consume both plant and animal material, combining aspects of both herbivores and carnivores.

   Digestive System: Moderately Long Digestive Tracts: Omnivores often have intermediate-length digestive tracts, reflecting their diverse diet.

   Flexible Diet Adaptations: Omnivores have evolved to be more flexible in their feeding habits, allowing them to adapt to a broader range of food sources.

   Associated Organs:

Generalist Stomach: Omnivores usually have a stomach capable of handling both plant-based and animal-based diets.

Variable Caecum Size: The caecum size in omnivores can vary depending on the species and their dietary preferences.

Note: It is important to note that within each group, there can be significant variations in digestive systems based on specific adaptations and ecological niches. These adaptations highlight the remarkable diversity and adaptability of mammals to their respective environments and dietary choices.

Learning Tasks

1. Define the terms, herbivore, carnivore and omnivore and give examples. Limit content expectation to a brief definition of the terms and providing at least one example of each.
2. Describe the main digestive organs and their features of adaptation among herbivores, carnivores and omnivores. Limit content to identifying and describing the organs used in digestion of food in herbivores, carnivores and omnivores, and describing the specific adaptive features of these organs that allow them to perform their functions effectively.
3. Discuss the differences and variations in the digestive system of herbivores, carnivores and omnivores. Limit content to identifying and describing the major differences that are observed in the digestive system among the three groups of mammals, and how these variations make each group unique.
4. Examine the diversity and adaptability levels of mammals in their specific habitat and their nutritional adaptability. Limit content expectation to discussing the diverse species of mammals, and how these are adapted to various specific habitats based on their choices of diet to the adaptive features of their digestive systems.

Pedagogical Exemplars

1. In task-based**,** mixed-ability and gender-responsive groups, learners are provided with three different species of small mammals to dissect under the guidance of the teacher: By this, all learners get actively involved in the lesson, and provide support and explanations of lessons among themselves.

NB: *The teacher must ensure all laboratory safety protocols are observed by learners during dissections.*

2. In experiential learning method**,** and under guidance of the teacher, learners separate and group the various organ identified in these specimens, and try to group these organs into their respective organ systems: Learners experience the study in real time and become well acquainted with the lessons taught. This boosts their confidence.
3. Learners use talk for learning to discuss the nature, shape and functions of the various internal organs identified. This strategy improves learners' communication and public discussions.
4. Learners use enquiry-based learning to research from available textbooks, online sources and library resources to obtain more information about the dissected organs and the systems to which they belong: Learners develop independent learning skills and become independent thinkers.

Key Assessments (DoK)

Level 1: Name the three major groups of mammals based on their dietary preferences and briefly define each of them with examples. Accept herbivores, carnivores and omnivores with their general definitions, and at least one example.

Level 2: Compare the length of the digestive tracts in herbivores, carnivores, and omnivores. How do the lengths relate to their dietary preferences?

Accept features of the lengths that allow efficient time of digestion in herbivorous mammals, which are plant-eating, carnivores which are flesh-eating and omnivores which feed on both plant and animal materials.

Level 3: Propose potential challenges in nutrition likely to be faced by omnivores in a rapidly changing habitat where animal diversity keeps decreasing. How might their digestive system adapt over a period of time to overcome these challenges?

Accept at least two challenges (e.g. reduced animal protein, reduced access to balanced diet, changes in gut microbe composition and increased competition for limited resources). Accept at least two ways the digestive system might adapt to these changes (e.g. increased efficiency in plant digestion, adjustment of microbe composition and populations in the gut)

Level 4: Discuss the potential impact of climate change and its effect on the feeding habit and survival of any of the following groups of mammals: a) herbivores b) carnivores c) omnivores. Accept discussion of at least two potential changes for each mammalian group (e.g. feeding habit changes, migration shift for herbivores, prey availability, increased competition and conflicts among carnivores and dietary flexibility and competition and resource-sharing among carnivores).

Section Review

In this section learners have received lessons in the morphology of mammals. Learners have covered the general features and characteristics identified in all mammals. They have also learnt about some of the anatomy, both internal and external, of mammals. They have been taken through lessons in dissection, and have likely carried out a practical dissection of a mammal. Learners studied the sense organs of mammals (ear, eye, nose, tongue and skin) and their functions, and how these assist these mammals to survive. Learners have also learnt about the three groupings of mammals based on diet preferences: herbivores, carnivores and omnivores. They have discussed the distinctive features of each group, and the adaptive features and variations in their digestive system which make them suitable in their dietary choices. The lessons equip learners to have a better understanding of the diverse species of mammals on earth, and to be able to identify them in their various groups based on nutritional choices. Consequently, it is expected that learners will have a better understanding of various aspects of mammal morphology and their way of life.

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SECTION 8: PLANT SYSTEMS

Strand: **Systems of life**

Sub-strand: Plant Systems

Content Standard: Demonstrate knowledge and understanding of the morphology, growth and development of flowering plants

Learning Outcomes: *Describe the morphology of flowering plants and explain how these are related to their growth and development.*

INTRODUCTION AND SECTION SUMMARY

Flowering plants, or angiosperms, are major components of many ecosystems, and are important in agriculture and biodiversity. Studying them is crucial for conservation, crop enhancement, and understanding their ecological, medicinal, and aesthetic significance. These plants are divided into two classes: Monocotyledoneae and Dicotyledoneae. Monocotyledons, exemplified by grasses and lilies, exhibit characteristics like parallel leaf veins and flower parts in multiples of three, while dicotyledons, such as cocoa and beans, typically feature netlike leaf veins and flower parts in multiples of four or five. Dicotyledons possess a taproot system, stem vascular bundles arranged in a ring, and reticulate (network) venation in leaves, while monocotyledons have fibrous roots, scattered vascular bundles in the stem, and parallel leaf venation. Some dicots can undergo secondary growth, making them woody, whereas monocots remain herbaceous. Understanding factors promoting their healthy growth, like soil quality, water availability, temperature, light, and gardening and farming techniques, is important. This knowledge is interdisciplinary, connecting with subjects like Agriculture, Home Economics, Business, and Art and Design. Learners at the end of this section are expected to demonstrate knowledge and understanding of the morphology, tissue organization and functions of flowering plants, as well as the factors that promote their healthy growth and increased crop production.

The weeks covered by the section are:

Week 17: An introduction to the morphology of flowering plants.

Week 18: Identify features that distinguish angiosperms from other plants

Week 19: Compare the morphology of dicots and monocots

Week 20:

a. Describe the internal structures and functions of a monocotyledonous root
b. Describe the internal structures and functions of a monocotyledonous stem

Week 21: Describe the internal structures and functions of a monocotyledonous leaf

Week 22:

a. Describe the internal structures and functions of a dicotyledonous root
b. Describe the internal structures and functions of a dicotyledonous stem

Week 23: Describe the internal structures and functions of a dicotyledonous leaf

Week 24: Identify the factors that affect the growth and development of flowering plants

SUMMARY OF PEDAGOGICAL EXEMPLARS

A variety of pedagogies are introduced to ensure that learners of all levels are fully involved in lessons. Among the pedagogies used are experiential learning techniques, project-based approaches, group learning, talk for learning, and digital literacy learning approaches that will assist the learner to fully understand and appreciate lessons on flowering plants, their morphology, arrangement and functions of internal tissues. Other exemplars are field trips to observe and sample some flowering plants in the school compound. In their natural habitats, hands-on exploration of the various morphological features of flowering plants allows learners to get personal experience and understanding of the growth and development of angiosperms. Group-based and experiential learning allows learners to discuss what they learned from video, field trips, or teacher presentations to build self-confidence. Learners also learn to criticize their peers' opinions on flowering plants and express disagreement in constructive ways during the learning process.

The pedagogical exemplars were carefully selected to take into account the interest of learners with special education needs so that they are adequately catered for and encourage the essential 21st century skills and competencies required to transform the learner into a global citizen.

ASSESSMENT SUMMARY

Assessments in lessons on flowering plants are mainly in formative oral questions and responses, quizzes, concept maps, and observation checklists to guide learner understanding and progress. Assessment of morphology, arrangement and functions of the internal tissue has been prepared to accommodate all levels of learners. Additionally, learners with special education needs (SEN) are catered for through the use of several educational strategies such as time extension and differentiated learning. This is to be achieved through extended time, simplified instructions, and less complex alternative formats for assessments to support the SEN learner in demonstrating his or her knowledge and understanding of flowering plants effectively. Thus, assessments in the lessons have been formed to be GESI responsive, to suit the learning needs of all learners, and to make the biology learner appreciate fully the lessons on flowering plants. With these diverse assessment modes, all learners are assured of showcasing their knowledge and understanding of flowering plants and their significance in different ecosystems and everyday life.

Week 17

Learning Indicator: *Distinguish between the external and internal features of monocotyledonous and dicotyledonous plants and relate plant structures to their functions.*

Theme or Focal Area: Discuss the Morphology of Flowering Plants.

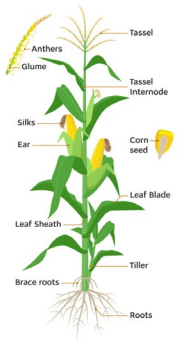
Flowering plants

Flowering plants are plants that produce flowers and fruits. They are called angiosperms (meaning "seeds enclosed within fruits"), and they belong to the division, Angiospermophyta.

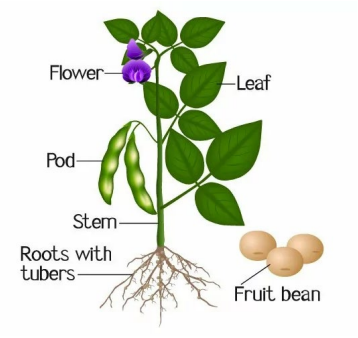
They include plant groups such as all forbs (flowering plants without woody stems), grasses and grass-like plants, a large group of broad-leaved trees, shrubs, vines and most fresh-water aquatic plants.

Diagrams of some flowering plants are shown below.

i. Pineapple Plant



ii. Maize Plant



iii. Soya bean Plant

iv. Water Lettuce

v. Flamboyant Tree

vi. Water Lily

Learning Tasks

1. Identify features common to flowering plants. Limit content expectation to the identification of morphological features common to flowering plants.
2. Compare the morphological features that distinguish monocotyledons from dicotyledons. Extend content expectation to at least five features that distinguish monocotyledonous plants from dicotyledonous plants.
3. Outline the importance of up to five different angiosperms in their named habitats. Extend content expectation for up to five angiosperms in named habitats.

Pedagogical Exemplars

- **Task-Based Learning:** In mixed-ability gender-responsive and all-inclusive tasked-based groups, learners sample different flowering plants from their immediate environment, and carefully observe and write down features that are common to monocotyledonous and dicotyledonous groups. Learners appreciate real-life situations by undertaking project assignments in their immediate environment.
- **Collaborative Learning:** In groups**,** design and present PowerPoint presentations on the morphological adaptations, similarities and differences between monocotyledonous and dicotyledonous plants to the entire class. By carrying out this task, learners work together, build self-confidence and believe that their thoughts and opinions are valued.
- **Individual-based Learning:** Sample flowering plants from the immediate environment, and create a poster on monocotyledonous and dicotyledonous plants, focusing on the features that are common to both groups of plants. Learners listen to their peers' opinions and accept constructive criticism.

Key Assessments (DoK)

Level 1: List any six features that distinguish monocotyledonous from dicotyledonous, hence, state the extent to which these two groups of flowering plants differ in each factor.

Level 2: Name two examples each of a monocot and dicot plants. Describe how one of them is adapted to a named habitat for successful living.

Level 3: Study the collection of the flowering plants you have sampled during the class tours of the school compound.

a. Identify the names of at least six specimens collected.

b. List the set of morphological features each share with:

i. Flowering plants

ii. Monocotyledons

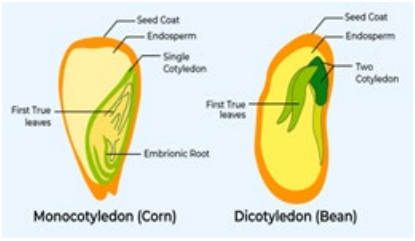
iii. Dicotyledons

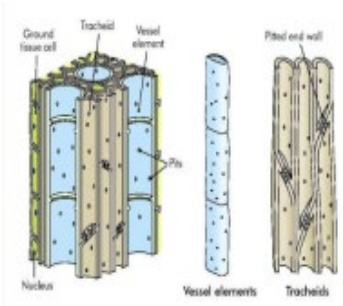
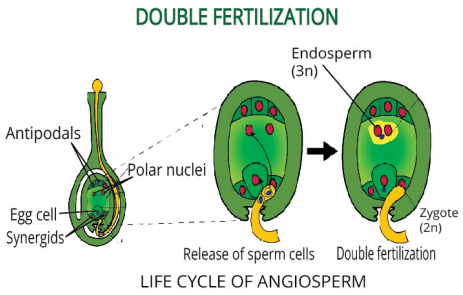
Week 18

Learning Indicator: *Distinguish between the external and internal features of monocotyledonous and dicotyledonous plants and relate these plant structures to their functions.*

Theme or Focal Area 1: Identify Features that Distinguish Angiosperms from Other Plants

Angiosperms comprise over 90% of plant species on Earth. Some features that distinguish angiosperms from other plants and make them the most diverse and dominant group of plants are given in the table below.

Feature	Description	Image
Possess flowers	These are the reproductive organs of flowering plants which are not found in any other seed plants.	A flower of a flamboyant. The odd pale petal, also known as the standard petal, has 'honey guides' which help insects find their way to the nectaries. 
Possess an endosperm	The endosperm is formed after fertilization but before the zygote divides, and it provides food for the developing embryo, the cotyledons, and sometimes the seedlings.	
Possess enclosed seeds	Angiosperms have seeds enclosed within a fruit. The fruit develops from the ovary of the flower and protects the seeds while they develop.	Peas (seeds, from ovules) inside the pod (fruit, from fertilized carpel) 

Feature	Description	Image
Possess xylem and phloem tissues	They possess xylem and phloem, specialized tissues that transport water, nutrients, and sugars throughout the plant.	
Some possess structures for vegetative propagation	Vegetative propagation is propagation without sex. i.e. asexual reproduction	Vegetative propagation of leaf of *Bryophyllum* 
They exhibit double fertilization	This involves the fusion of one sperm cell with the egg cell to form the embryo, and another sperm cell combining with two polar nuclei to form the triploid endosperm. This process is not found in other plant groups.	 LIFE CYCLE OF ANGIOSPERM

Learning Tasks

1. Obtain samples of flowering plants. Limit content expectation to the collection of angiosperms only.
2. Use sample plants to identify features common to monocotyledonous and dicotyledonous plants. Extend content expectation to similarities between monocotyledonous and dicotyledonous plants.
3. Describe each feature identified. Extend content expectation to the description of all features identified.
4. Use sample plants and pictures to identify general features that distinguish angiosperms from other plants. Extend content expectation to differences that exist between angiosperms and other plants.

Pedagogical Examplars

The teacher should consider the following activities:

- Guide learners to a safe place within the immediate school environment to collect sample flowering plants. Teacher should be present throughout the collection period to ensure the safety of all learners. Give clear instructions to enable learners to pick the right flowering plants.
- Using sample plants and pictures support whole-class discussion on how angiosperms differ from other plants.
- Using enquiry-based approach put learners into mixed ability gender balanced groups and allow them to use their 'Student facts and observation form' to note the similarities they have observed between the two types of flowering plants they have found. Create a poster on monocotyledonous and dicotyledonous plants, focusing on the features that are common to both groups of plants. Learners listen to their peers' opinions and accept constructive criticism. Learners use samples of flowering plants to identify general features of angiosperms that distinguish them from other plants.

Key Assessments (DoK)

Level 1: List three examples each of monocotyledonous and dicotyledonous plants. Accept written response for any three examples of monocotyledonous/dicotyledonous plants listed in task one above.

Level 2: Describe four similarities between monocotyledonous and dicotyledonous plants. Accept oral/written response for any four similarities made.

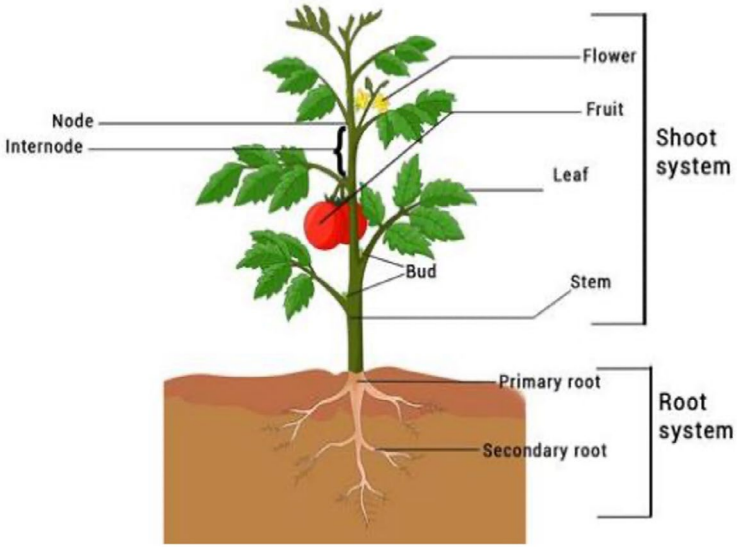
Level 3: Identify and discuss at least six characteristics of angiosperms that make them different from other plants. Accept oral/written response for any six characteristics that differentiate angiosperms from other plants.

Week 19

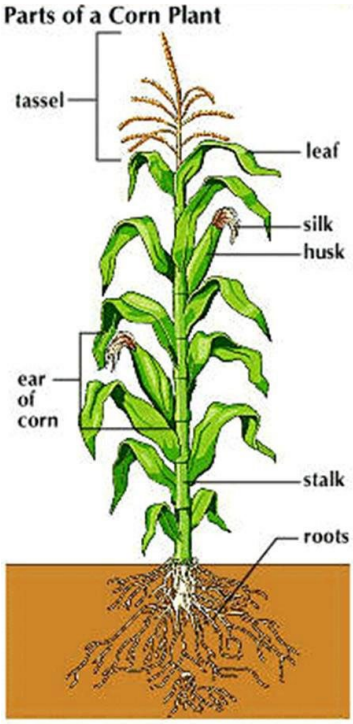
Learning Indicator: *Distinguish between the external and internal features of monocotyledonous and dicotyledonous plants and relate the plant structures to their functions.*

Theme or Focal Area: Identify Morphological Features that Distinguish Monocotyledonous Plants from Dicotyledonous Plants

Compare the morphology of the two Classes of Flowering Plants



i. Dicotyledonous Plant



ii. Monocotyledonous Plant

- There are two broad classes of angiosperms/flowering plants. These are the monocotyledonous plants and dicotyledonous plants
- Examples of monocotyledonous plants are palm trees, pawpaw, cocoyam, grains and cereals such as maize plants, millet, rice, and grasses.
- Dicotyledonous plants include cow pea, soya bean, mangoes, oranges, cashew, and cocoa.

Major differences between monocotyledonous and dicotyledonous

Monocots	Dicots
Embryo consists of a single cotyledon	Embryo consists of two cotyledons
Flower parts are present in multiples of three	Flower parts are present in multiples of four or five
Major leaf veins are parallel	Major leaf veins are reticulated
Stem vascular bundles are scattered	Stem vascular bundles are in the form of a ring
Roots are adventitious	Roots develop from radicle
Example: Rice, Wheat, Maize	Example: Beans, Water lily, Cinnamon

Learning Tasks

1. List five external features of monocotyledonous plants.
2. Summarise your understanding of the two broad classes of angiosperms.

Pedagogical Exemplars:

The teacher should consider the following activities.

- Using a collaborative learning strategy, randomly assign learners to groups, to design and present PowerPoint presentations on the morphological adaptations, similarities and differences between monocotyledonous and dicotyledonous plants to the entire class. By carrying out this task, learners work together in a whole class discussion, build self-confidence and believe that their thoughts and opinions are valued.
- Using think-pair-share, ask learners to think pair and share their answers to questions on a task card and given to learners in their groups. Learners are given about 15 minutes to think through the questions, pair up with peers and subsequently share their varied views on questions based on morphological adaptations, similarities and differences between monocotyledonous and dicotyledonous plants.

Key Assessments (DoK):

Level 1: List at least five external features of monocotyledonous plants.

Level 2: List at least five external features of dicotyledonous plants.

Level 3: Describe five ways in which monocotyledonous plants and dicotyledonous plants differ

Week 20

Learning indicator: *Relate the tissues of the leaf, stem, and roots of monocotyledonous and dicotyledonous plants to their functions.*

Theme or Focal Area: Describe the Internal Structures and Functions of a Monocotyledonous Root

Internal structures of the monocotyledonous root

The internal structures of a monocotyledonous root consists of the following parts and structures from outside to inside:

- *Epidermis:* It is the outermost protective layer of compact parenchyma cells with no intercellular spaces. The piliferous layer of the epidermis is thrown into finger-like projections known as root hairs. The root hairs are tubular and unicellular and help to increase the surface area of the root for the absorption of water and mineral salts.
- *Cortex:* The cortex consists of thin-walled rounded or oval-shaped multi-layered parenchyma cells with intercellular spaces. Starch grains are abundantly present in this layer.

Functions of the cortex are food storage, protection from injuries, and conduction of water and minerals to inner tissues.

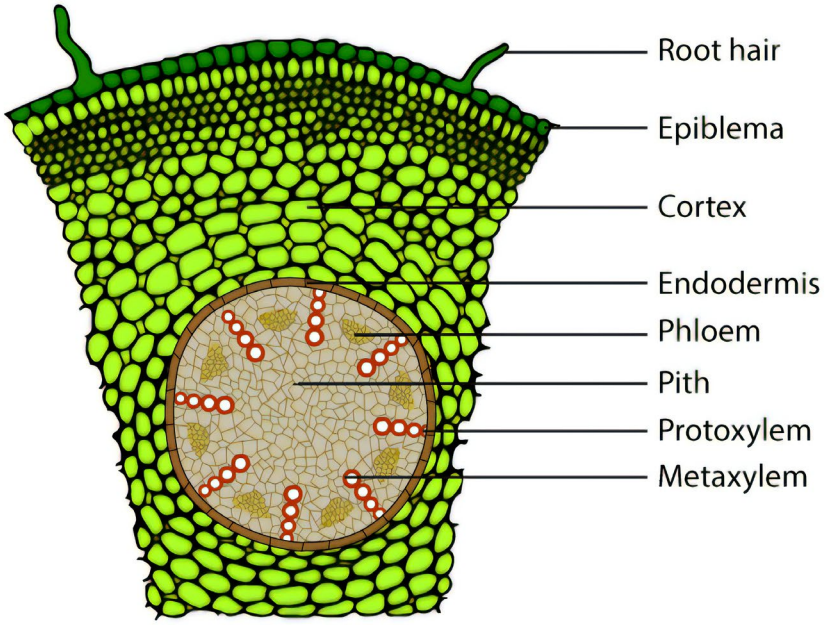


Diagram of the T.S. of monocotyledonous root

- *Endodermis:* It is the innermost layer of the cortex and is composed of a single layer of barrel-shaped compact cells lacking intercellular spaces. The transverse walls of endodermal cells are thickened with an internal strip of suberin and lignin. These thickenings are called Casparian strips. The Casperian strips control the movement of substances from the cortex into the vascular cylinder also known as the stele.
- *Vascular cylinder/stele:* This comprises of the tissues that are present inside the endodermis. It includes the pericycle and vascular tissues.
- *Pericycle:* It is composed of single-layered sclerenchyma cells and gives rise to the lateral roots.
- *Vascular system:* The vascular system consists of alternating strands of xylem and phloem.

The xylem and the phloem are separated by a layer of sclerenchyma conjunctive tissue.

In between the xylem and the phloem bundles (conducting tissues) is found the cambium. There is also the presence of many-layered parenchyma or sclerenchyma tissues. They help in the storage of food and mechanical support.

Learning Tasks

1. Identify the various internal structures of monocotyledonous roots. Limit content expectation to the identification of the internal structures of monocotyledonous roots only.
2. State at least one function for each of the parts identified in task one above. Extend content expectation to stating at least one function of each of the parts identified in task one above.
3. Draw and label the (tissue map) of the L.S and T.S of a monocotyledonous root. Extend content expectation to the drawing and labeling of the L.S/T.S of monocotyledonous root.

Pedagogical Exemplars

The teacher should consider the following activities.

- Using group-based and experiential learning: In mixed-ability and task-based groups, watch videos/pictures/charts or presentations on the internal tissues of flowering plants. Learners at the group level discuss what they learned from the various presentations to build self-confidence and they learn to critic their peers' opinions and express disagreement in constructive ways enhancing tolerance for others.
- Obtain monocotyledonous plants, make thin sections of parts such as the roots and use a microscope to critically observe and compare the internal structures. In pairs create a poster on an A4 sheet, showing the various structures of monocotyledonous roots and their functions. Submit your final posters for a gallery walk or whole class exhibition. By conducting these group activities, learners appreciate real-life situations. Working together builds self-confidence and team spirit among learners.

Key Assessments (DoK)

Level 1: List at least four internal structures from the outermost to the innermost structure of a monocotyledonous root. Accept oral/written responses for any four internal structures orderly written.

Level 2: Describe at least six internal structures of monocotyledonous roots of flowering plants. Accept oral/written responses for at least six internal structures discussed.

Level 3: Describe the functions of all the internal structures of monocotyledonous roots. Accept oral/written responses for the discussion of the functions of at least six internal structures of monocotyledonous roots.

Theme or Focal Area: Describe the Internal Structures and Functions of a Monocotyledonous Stem.

The internal structure of a monocotyledonous stem has vascular bundles near the outside edge and scattered throughout the stem. The parenchyma tissue lies between the vascular bundles. There is no pith region in the internal structure of the monocotyledonous stem. The structures and tissues are arranged as follows:

Epidermis: It is the single outermost layer composed of small, thin-walled, somewhat barrel-shaped parenchymatous cells that are tightly packed without intercellular species. It is externally covered with a thick cuticle. A few stomata are present on the epidermis. Usually, trichomes or epidermal hairs are lacking.

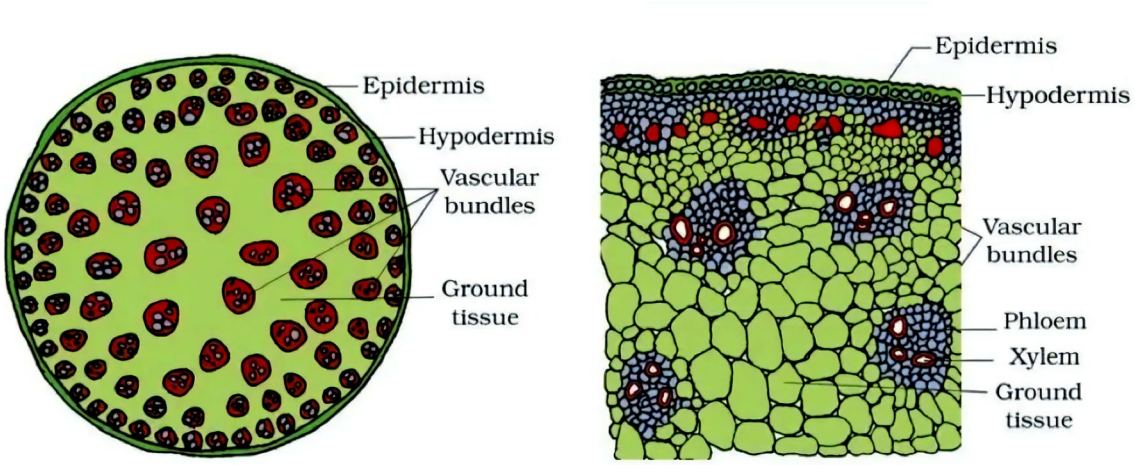


Diagram of the transverse section (T.S.) of a monocotyledonous stem

- *Cortex:* It lies below the epidermis. The cortex is composed of the following regions:
- *Hypodermis:* It lies just below the epidermis. It is comprised of two to three layers of thick-walled lignified sclerenchymatous cells, without intercellular spaces. It helps in mechanical support.
- *Ground tissue:* It contains a continuous mass of thin-walled, round parenchymatous tissue which lies below the hypodermis. Intercellular spaces are present. Cells are rounded or polygonal in shape. There is no differentiation of general cortex, endodermis, pericycle, pith, and rays. Vascular bundles are irregularly spaced in this region.
- *Vascular bundles:* Vascular bundles are irregularly scattered in the ground tissues. Vascular bundles occurring in the peripheral region are smaller in size and compactly arranged. In contrast, those occurring towards the central region are larger in size and widely placed. All the vascular bundles have similar structure. Each vascular bundle consists of xylem towards the centre.
- Xylem tissue consists of tracheids, xylem vessels, xylem fibres and xylem parenchyma. Its main functions are to conduct water and mineral salts from the roots to the leaves and also for structural support and storage of some organic materials.
- Phloem tissue lies outside the xylem and is partly present near the metaxylem vessels. It is composed of sieve elements, companion cells and phloem fibres and phloem parenchyma. The phloem conducts organic food from the sites of photosynthesis to other parts of the plant.

Learning Tasks

1. Identify the various internal structures of a monocotyledonous stem. Limit content expectation to the identification of the internal structures of a monocotyledonous stem only.
2. State at least one function for each of the parts identified in task one above. Extend content expectation to stating a function of each of the parts identified in task one above.
3. Draw and fully label a tissue map of the T.S (transverse section) and L.S (longitudinal section) of a monocotyledonous stem. Extend content expectation to the drawing and labelling of the T.S. and L.S, of a monocotyledonous stem.

Pedagogical Exemplars

The teacher should consider the following activities:

- Using group-based learning, place learners in mixed-ability and task-based groups to watch videos/pictures/charts or presentations on the internal tissues of flowering plants. Learners in their various groups discuss what they learned from the videos/pictures/charts and presentations to build self-confidence, think critically and, they learn to evaluate their peers' opinions and express disagreement in constructive ways, enhancing tolerance for others.
- Using group-based and experiential learning**,** provides learners with young monocotyledonous plants. Learners make thin transverse sections of the stem and use a microscope to critically observe and study the internal structures. In pairs create a poster on an A4 sheet, showing the various structures of the monocotyledonous stem and the function of each part. Learners submit their final posters for a gallery walk or whole class exhibition. By conducting these group activities, learners appreciate real-life situations. Working together builds self-confidence and team spirit among learners.

Key Assessments (DoK)

Level 1: List at least four internal structures of a monocotyledonous stem from the outermost to the inner most structure. Accept oral/written response for any four orderly listed internal structures of a monocotyledonous stem.

Level 2: Describe at least six internal structures of a monocotyledonous stem. Accept oral/written response for at least six internal structures described.

Level 3: Describe the functions of all the internal structures of a monocotyledonous stem. Accept oral/written response for description of the functions of at least six internal structures of a monocotyledonous stem.

Level 4: Compare and contrast the T.S of monocotyledonous stem to the L.S of monocotyledonous root. Accept oral/written response for at least three similarities and three differences observed.

Week 21

Learning Indicator: *Relate the tissues of the leaf, stem, and roots of monocotyledonous and dicotyledonous plants to their functions.*

Theme or Focal Area: Describe the Internal Structures of a Monocotyledonous Leaf

The leaf of a monocotyledonous plant comprises the following tissues and structures:

1. **Epidermis:** This is the outermost layer of the leaf, and it is found on both the upper and lower surfaces. It has the following features:
   a. It consists of a single layer of parenchyma cells without intercellular spaces.
   b. The cells are covered with a protective layer called the cuticle.
   c. Stomata are present on both the upper and lower epidermis layers.
   d. Some large, thin-walled parenchyma cells are found on the upper epidermis and are known as bulliform cells. Bulliform cells help in leaf curling when there is water shortage, thus reducing water loss due to evaporation.
   e. Beneath the undifferentiated mesophyll tissue is a single layer of epidermis called the lower epidermis, located on the lower (abaxial) surface of the leaf.
   f. Cells of the lower epidermis are cubic or barrel-shaped and closely arranged with minimal intercellular spaces.

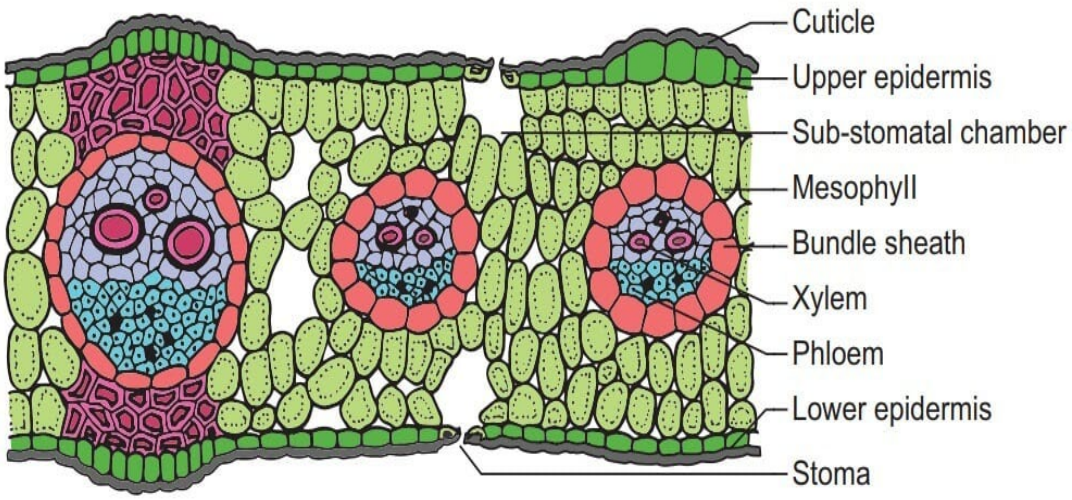


Diagram of the T.S. of monocotyledonous leaf

Note: The number of stomata on the lower epidermis is normally the same as in the upper epidermis. Gas exchange occurs through the stomata of both the upper and lower epidermis via diffusion. Just above the stomata of the epidermal layers on both surfaces, air spaces and sub-stomatal chambers are present. These air spaces act as reservoirs for:

i. Carbon dioxide to be used for photosynthesis

ii. Water vapour to help reduce excessive transpiration

2. **Mesophyll Cells**: They are masses of cells found between the upper and lower epidermis. They possess the following features:
   a) Unlike dicotyledonous leaves, there is no differentiation between palisade and spongy parenchyma.

b) The cells in the mesophyll are parenchyma and are irregularly arranged with intercellular spaces.

c) These cells contain chloroplasts for photosynthesis.

3. **Vascular Bundles**: Numerous vascular bundles are present in the leaf. They have the following features:
   a) Some bundles are small, while others are large.
   b) Each bundle consists of xylem and phloem and is surrounded by a sheath of parenchyma cells called the bundle sheath.
   c) The vascular bundles are conjoint, collateral, and closed, with xylem located towards the upper epidermis and phloem towards the lower epidermis.
4. **Vascular System**: This is formed from multiple vascular bundles in parallel arrangements. The central vascular bundle is the largest. They show the following characteristics:
   a) The vascular bundles are conjoint, collateral, and closed.
   b) Each bundle is surrounded by a double-layered bundle sheath. The outer layer of the bundle sheath consists of thin-walled cells, while the inner layer is composed of thick-walled cells.
   c) Sclerenchyma patches are found on the upper and lower surfaces of large vascular bundles, closely associated with the epidermal layers (although there is no such association between sclerenchyma and small vascular bundles). They provide mechanical support and strength to the plant.
   d) Xylem is located towards the upper surface, while phloem is located towards the lower surface.

Functions of the monocotyledonous leaf

1. Photosynthesis**:** The chloroplasts present in the palisade parenchyma cells are responsible for capturing sunlight and converting it into chemical energy through photosynthesis. This process produces glucose, which serves as the primary source of energy and carbon compounds for the plant.
2. Transpiration: The stomata facilitate transpiration: the loss of water vapour from the plant. Transpiration aids in the regulation of temperature, nutrient uptake, and the transport of water and minerals from the roots to the leaves.
3. Storage: Some monocotyledonous leaves, such as those of onion plants, are modified to store nutrients, enabling the plant to survive adverse conditions or periods of dormancy.
4. Protection: The epidermis and cuticle provide protection against mechanical injuries, pathogens, and excessive water loss. Additionally, some monocotyledonous leaves have adaptations like spines or thorns, acting as deterrents against herbivores.

Adaptations of a monocotyledonous Leaf

Monocotyledonous leaves have evolved several adaptations to thrive in diverse environments:

1. Parallel Venation: Unlike dicotyledonous leaves with reticulate (net) venation, monocotyledonous leaves exhibit parallel venation, where veins run parallel to each other. This arrangement maximizes the surface area available for photosynthesis and ensures efficient nutrient distribution.
2. Long and Narrow Shape: Many monocotyledonous leaves are long and narrow and lie close to vertical. This minimizes the surface area exposed to direct sunlight, which helps to reduce water loss through transpiration and prevents overheating, particularly in hot and arid environments.

3. Thick Cuticle: Monocotyledonous leaves often possess a thicker cuticle compared to dicotyledonous leaves. The thick cuticle acts as a barrier, reducing water loss and protecting the leaf from excessive evaporation, especially in dry and windy conditions.
4. Sunken Stomata: In some monocotyledonous species, the stomata are found in sunken cavities, known as stomatal crypts. This adaptation provides additional protection against water loss by creating a humid microclimate that reduces transpiration rates.
5. Presence of Bulliform Cells: These are specialised cells found in the upper epidermis of many monocotyledonous leaves. These cells are responsible for leaf rolling or folding, which helps reduce the leaf's surface area and minimize water loss during periods of drought or heat stress.
6. Sheathing Leaf Base: Monocotyledonous leaves often have a sheathing leaf base, where the leaf wraps around the stem. This adaptation provides structural support to the leaf and prevents excessive movement, reducing the risk of damage from wind or physical stress.

Learning Tasks

1. Name the internal structures found in a monocotyledonous leaf. Limit content expectation to naming at least two internal structures of a monocot leaf and giving at least one function of each.
2. Describe the internal structures of a monocotyledonous leaf. Limit content expectation to describing at least one structure of a monocot leaf and its internal components.
3. Discuss the adaptations of a monocotyledonous leaf to its functions. Limit content to discussing and providing at least two main internal structures of a monocotyledonous leaf, and their significance to the general survival of the plant.

Pedagogical Exemplars

- Using individualised learning techniques, each learner researches from their textbooks, and other books from the school library and online sources at the ICT centres to find information about the internal structures of a monocot leaf. This makes the learner an independent, confident researcher and thinker.
- Learners in mixed ability groups use collaborative learning to bring together the information gathered, and discuss the internal structures of the leaf of a monocot plant. Through this technique, learners acquire team-spirit, and learn to support, respect and appreciate one another's capabilities.
- Learners use talk for learning to discuss the internal structures of a monocot leaf and related topics such as its functions and adaptations. Learners discuss in group lessons to improve on their communication skills and general conduct in groups, and with the public at large.
- Learners use group discussions and presentations to share information and findings from their research with inputs from the teacher, and under the teacher's guidance. By this technique, fast learners support slow learners, and teacher inputs and guidance ensures that the learners obtain accurate information about the internal structures of a monocot leaf, their functions and adaptations.

Key Assessments (DoK)

Level 1: Name some common parts of the internal structures of a monocotyledonous leaf and give their functions.

Accept at least the names of two internal structures of the monocot leaf and at least one function of each.

Level 2: Describe the various features of the parts of the internal structures of a monocotyledonous leaf. Accept the description of at least two parts of the internal structures of a monocotyledonous leaf, and describe at least one main feature of each.

Level 3: Discuss the adaptations of the leaf of a monocotyledonous plant to its functions. Accept the identification of at least two adaptations, and discuss their nature and how they help to support the leaf to perform its function.

Level 4: Evaluate the significance of the presence of specialised cells (e.g. bulliform cells) in a monocotyledonous leaf in relation to habitat adaptation. Accept discussion of at least two specialised cells in monocot leaves and the description of their functions within its habitat.

Week 22

Learning Indicator: *Relate the tissues of the leaf, stem, and roots of monocotyledonous and dicotyledonous plants to their functions.*

Theme or Focal Area: Discuss the Internal Structure and Functions of a Dicotyledonous Root

The dicotyledonous root shows the following distinct region in its transverse section:

1. Epiblema
2. Cortex
3. Endodermis
4. Pericycle
5. Vascular bundles
6. Pith

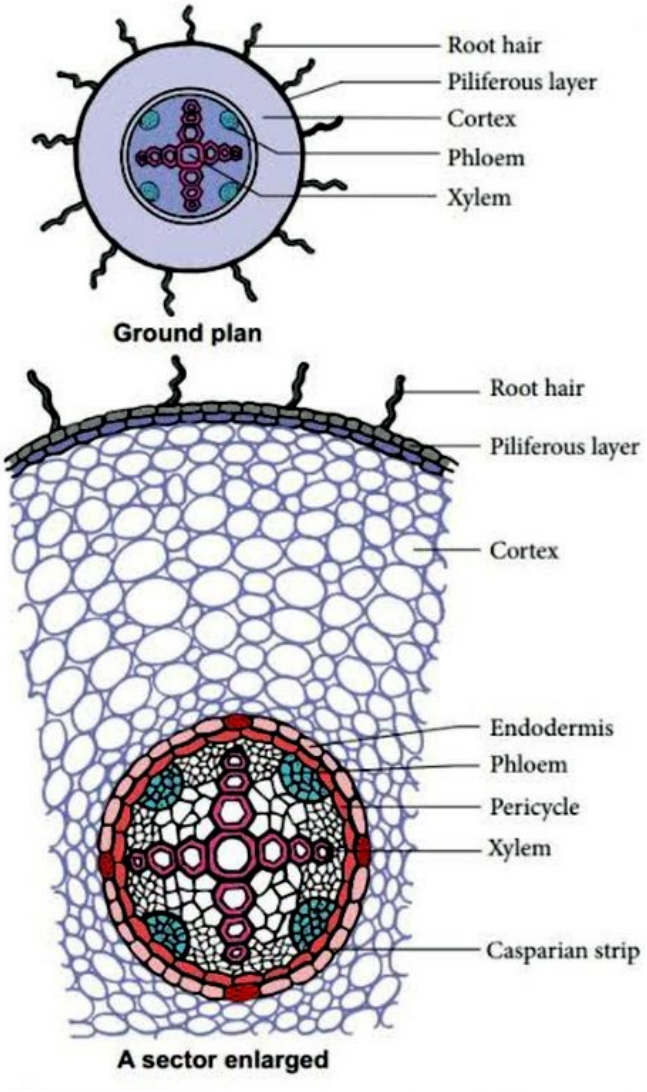


Diagram of the T.S. of dicotyledonous root

Parts, Functions and adaptations of Dicotyledonous Root

- *Xylem tissue:* This transports water and mineral salts absorbed by the root from the soil to other parts of the plant for photosynthesis and metabolism.
- *Phloem tissue:* This transports sugars and organic materials from the leaves to other parts of the plant for growth. Both the xylem and phloem tissues are arranged in a central core to ensure efficient transport of water, minerals and nutrients.
- *Endodermis:* This has the Casparian strip which regulates movement of water and nutrients into the vascular tissues, and prevents harmful substances from entering the plant.
- *Pericycle:* This contains meristematic (dividing) cells which give rise to lateral roots that branch from the main roots to absorb more water and mineral salts from the soil.
- *Cortex:* This stores carbohydrates and other essential nutrients, and acts as a reservoir for energy that provides support and protection for the internal tissues in the dicot root.

Learning Tasks

1. List the internal structures of a dicotyledonous root, and give their functions. Limit content expectation to at least two internal structures and at least one function of each.
2. Describe the adaptations of the internal structures of a dicotyledonous root and how they contribute to the survival of the plant in general. Limit content to at least two internal structures of a dicot root and at least one function of each structure.
3. Compare the differences and similarities between the internal structures of a dicot root and a monocot root. Limit content to at least three differences between the internal structures of the root of a dicot and monocot plants.

Pedagogical Exemplars

- Learners use research-based learning to find information about some common internal structures of a dicotyledonous root. This learning method boosts the confidence of the learner as he or she learns how to gather information.
- Use learners in mixed ability groups to bring learners together and examine the internal structures of a dicot root. Through this technique, learners develop team spirit, and learn tolerance and acceptance of one another's views.
- Learners use talk for learning to discuss the internal structures of a dicot root and related lessons on its functions and adaptations. Learners discuss in groups to improve on their communication skills, general conduct in groups and with the public at large.
- Learners use group presentation learning to share information and findings from their researches with inputs from the teacher, and under the teacher's guide. This technique ensures that there is a shared responsibility, so that every learner has a role to play in the team. Fast learners also support slow learners, and teacher's input and guidance ensure that the learner obtains accurate information about the internal structures of a dicot root, their functions and adaptations.

Key Assessments (DoK)

Level 1: List the internal structures of a dicot root, and give their functions.

Accept at least two features of the internal structure and at least one function of each feature.

Level 2: Describe the adaptive features of the internal structure of a dicot root.

Accept at least two adaptive features of the internal structures of a dicot root.

Level 3: Discuss the main differences between the internal structures of monocot and dicot roots. Accept discussion on at least two differences and two similarities of the internal structures of a monocot and dicot root.

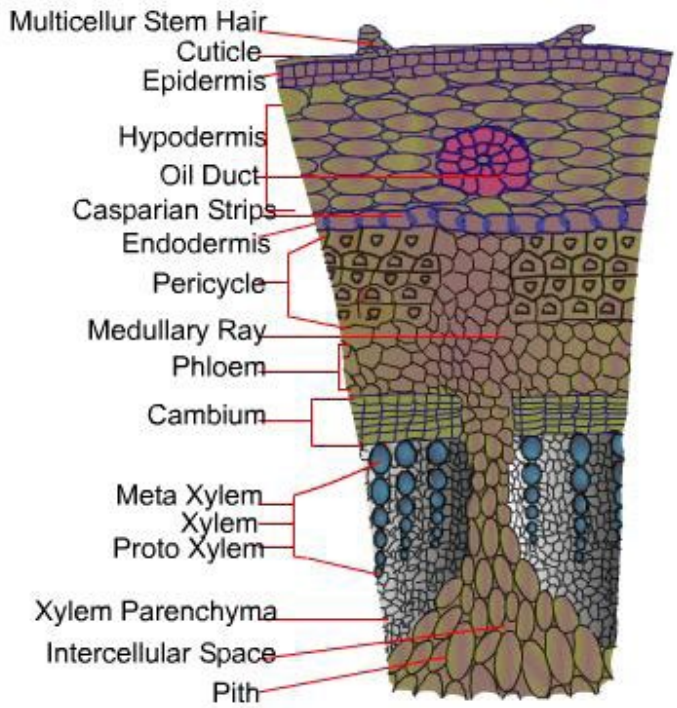
Level 4: Evaluate the appropriateness of growing dicot plants in predominantly sandy soils mixed with loam, and predominantly clayey soil mixed with loam.

Limit discussion to the inability of dicot roots to grow well in sandy soils as they are unable to hold deep-rooted crops, and the ability of clayey soils to hold better, deep rooted plants in the soil.

Theme or Focal Area: Discuss the structure, functions and adaptations of a Dicotyledonous stem

Dicot stems have several internal structures with various adaptations that allow them to support growth and development:

1. Epidermis: This forms the outermost layer of cells that protects the stem from mechanical injuries and water loss. It may have stomata for gaseous exchange.
2. Cortex: It is a region made up of parenchyma cells to provide support, store food and undertake lateral transport of water and nutrients.
3. Vascular bundles: These are structures arranged in a ring around the stem. They contain the xylem for the upward transport of water and mineral salts, and the phloem for the transport (translocation) of food nutrients (mainly sugars and other organic compounds).
4. Xylem tissue contains specialised cells such as vessel elements, tracheids, fibres and parenchyma cells that are adapted for water transport in the stem.
5. Phloem tissue is made up of specialised cells such as sieve tube elements, companion cells, phloem fibres and phloem parenchyma cells which are adapted for nutrient transport.
6. Pith: This is located at the centre of the stem. It has parenchyma cells for the storage and transport of nutrients. It also provides the plant with support.



labelled diagram of the Transverse Section (T.S.) of Dicotyledonous Stem (Sunflower)

Learning Tasks

1. List the internal structures of a dicotyledonous stem, and give their functions. Limit content expectation to at least two internal structures and at least one function of each.
2. Describe the adaptations of the internal structures of a dicotyledonous stem and how they contribute to the survival of the plant in general. Limit content to at least two internal structures of a dicot stem and at least one function of each structure.
3. Compare the differences and similarities between the internal structures of a dicotyledonous stem and a monocot stem. Limit content to at least three differences between the internal structures of the stem of a dicot and monocot plant.

Pedagogical Exemplars

- Learners use research-based learning to find information about some common internal structures of a dicotyledonous stem.
- This learning method boosts the confidence of the learner as he or she learns how to gather information.
- Use learners in mixed ability groups to bring learners together and examine the internal structures of a dicotyledonous stem. Through this technique, learners develop team spirit, and learn tolerance and acceptance of one another's views.
- Learners use talk for learning to discuss the internal structures of a stem, its functions and adaptations. Learners discuss in groups to improve on their communication skills and general conduct in groups and with the public at large.
- Learners use group presentation learning to share information and findings from their research with inputs from the teacher, and under the teacher's guide. This technique ensures that there is a shared responsibility, so that every learner has a role to play in the team. Fast learners also support slow learners, and teacher's input and guidance ensure that the learner obtains accurate information about the internal structures of a dicot stem, their functions and adaptations.

Key Assessments (DoK)

Level 1: Name two internal structures of a dicotyledonous stem, and give their functions. Accept at least two features of the internal structure and at least one function of each feature.

Level 2: Describe the adaptive features of the internal structure of a dicot stem. Accept at least two adaptive features of the internal parts/structures of the dicot stem.

Level 3: Discuss the main differences between the internal structures of monocot stem and dicot stem. Accept discussion on at least two differences and two similarities of the internal structures of a monocot stem and dicot stem.

Level 4: Examine how the specialised adaptations in the xylem and phloem tissues of a dicotyledonous stem contribute to the total efficiency of water and nutrient transport, and how these adaptations compare and contrast with those found in a monocot stem.

Week 23

Learning Indicator: *Distinguish between the external and internal features of monocotyledonous and dicotyledonous plants and relate plant structures to their functions.*

Theme or Focal Area: Discuss the Internal Structures and Functions of the Dicotyledonous Leaf

Most leaves have certain common features like a covering of an epidermal layer on each surface. The ground tissue that occurs between the two epidermal layers is called mesophyll. Vascular bundles, commonly known as veins, are embedded in the mesophyll. The structure and characteristics of each of these layers differ greatly for different leaves.

The internal structure of a dicotyledonous leaf shows these regions with the following features:

1. *Epidermis* –It is the outermost covering of the leaf that forms the boundary between theatmosphere and underlying mesophyll.

   The upper epidermis and the lower epidermis sandwich the mesophyll tissues. Both the upper and lower epidermis are covered by a cuticular layer. It consists of compactly arranged thin-walled parenchyma cells without chloroplasts. The lower epidermis of most dicotyledonous leaves has guard cells that control the opening and closing of the stomata.

   Usually, the upper epidermis is thickly cuticularized. The lower epidermis contains numerous stomata, whilst the upper epidermis has no stomata.

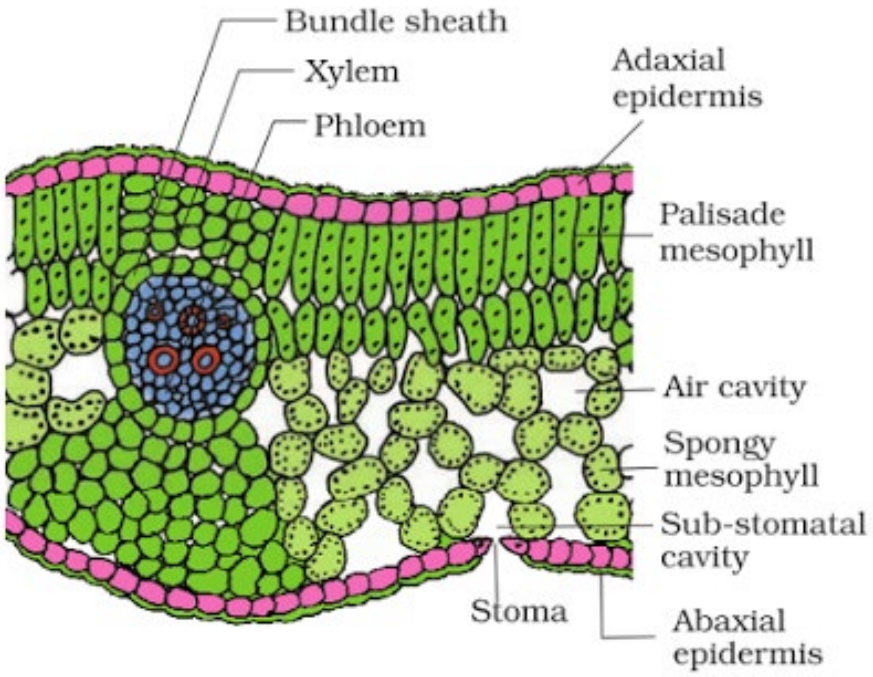


Diagram of the T.S. of a dicotyledonous leaf (Mangifera indica)

2. *Mesophyll* – This is the ground tissue between the upper and lower epidermis. It is differentiated into palisade mesophyll and spongy mesophyll tissues.
   i. Palisade mesophyll lies towards the upper epidermis and consists of one, two or three layers of elongated cells, densely packed with intercellular spaces and many chloroplasts. This ensures efficient gas exchange and photosynthesis.

ii. Spongy parenchyma lies towards the lower epidermis and is made from loosely arranged, irregular, thin-walled parenchyma cells with large intercellular spaces, air cavities and fewer chloroplasts. This maximises efficient gas exchange for photosynthesis.

3. *Vascular bundles* – The vascular bundles contain the xylem, phloem and cambium tissues. The xylem lies toward the upper epidermis and the phloem towards the lower epidermis, and the cambium cells divide actively to produce new cells. A single mid-vein vascular bundle is large and is attached to many smaller vascular bundles or veins as they are called. Collenchyma may also be associated with bundle sheath cells. Xylem consists of vessels and tracheids both of which are non-living. The xylem tracheids and vessels help in the conduction of water and minerals and mechanical supports while the parenchyma helps in lateral transport. Phloem tissue is living tissue consisting of sieve tubes, companion cells and some parenchyma packing cells. The phloem companion cells and sieve tubes help in conduction of food materials, and phloem parenchyma helps in lateral conduction and storage of food materials.

Learning Task

1. Name two or more internal structures found in a dicotyledonous leaf and give one function of each. Limit content expectation to naming at least two internal structures of a dicotyledonous leaf and giving at least one function of each.
2. Link the adaptations of a dicotyledonous leaf to its functions. Limit content to providing at least two main internal structures of a dicotyledonous leaf, and their significance to the general survival of the plant.

Pedagogical Exemplars

- Using collaborative learning, place learners in mixed-ability gender-responsive and all-inclusive groups and ask them to research from their textbooks, library, the internet and other relevant sources, the tissue map of the internal structures of a dicotyledonous leaf. Each group makes PowerPoint presentations on an aspect of the internal structures of the dicotyledonous leaf. By carrying out this task, learners work together, build self-confidence and believe that their thoughts and opinions are valued. The teacher should ensure all members of the group contribute to the research and class presentation and also give support to learners with special needs.
- Using experiential learning, put learners into mixed-ability gender-responsive and all-inclusive groups, guide them to prepare a wet mount of the T.S. of a young dicotyledonous leaf and observe their section under a light microscope. Learners discuss their observations and make a labelled drawing of their observations under low power.

NB: *All safety precautions must be strictly adhered to when preparing the wet mount and handling the light microscope.*

Key Assessments (DoK)

Level 1: Name some of the parts of a dicotyledonous leaf.

Accept the names of at least four correct internal structures of the dicotyledonous leaf.

Level 2: Describe the arrangement of the internal parts of a dicotyledonous leaf as seen under the light microscope. Accept the correct description of the arrangement of at least two parts of the internal structures of a dicotyledonous leaf.

Level 3: Describe the adaptations of the dicotyledonous leaf to its functions. Accept at least two adaptations correctly described.

Level 3: Evaluate the significance of the presence of guard cells in a dicotyledonous leaf. Accept a description of two important aspects of the significance of the guard cells to gas exchange and retention of water vapour.

Level 3: Describe, with the help of diagrams, the mechanism of the opening and closing of stomata. Accept a correct description of the mechanism of the opening and closing of stomata with diagrams.

Week 24

Learning Indicator: *Distinguish between the external and internal features of monocotyledonous and dicotyledonous plants and relate these plant structures to their functions.*

Theme or Focal Area: Identify the Factors that Affect Growth and Development in Flowering Plants

Factors that affect growth and development in flowering plants

1. Four primary factors affect plant growth: light, water, temperature and nutrients.
2. Changing any of these four factors can cause changes in plant growth, resulting in poor or improved growth.
3. A good understanding of these factors will make you a good farmer or gardener.

Light

Plants have evolved throughout time in different locations throughout the world. Some plants have evolved in tropical locations under the canopy of large trees while others have evolved on exposed slopes of harsh mountain ranges.

Thus, plants have adapted to different types/colours of light and different light intensities. Many plants cannot adapt easily to new conditions. So, it is important to understand the type of light that specific plants need and provide this for them to ensure quality growth in your garden or in the field.

Sunlight that is strong during the hot seasons will encourage fruiting and flowering. During the dry season, or when daylength decreases in certain parts of the world, many plants will begin shedding their leaves.

When choosing plants to grow, it is important to make sure that you have an area in mind to plant them so that they get the amount of sunlight that they require each day. The length or period of time each day during which a plant receives light is called the photoperiod.

Water and nutrients

To survive, plants need water. Most plants are made up of nearly 90 percent water. Without the appropriate amounts of water, plants will be stressed and eventually die. Even plants that live in the desert such as the cactus need water, they just need less of it than other types of plants.

Water provides plants with nourishment and hydration. Water that is in the soil will dissolve minerals and other elements of the soil. When the plants absorb this water through their roots, they will also be picking up these nutrients which will travel to the cells of the plant.

Humidity (water vapour in the air) can also help to encourage plant growth by reducing water stress on the plant.

However, providing too much water can also cause plants to die, as it deprives the roots of oxygen. It is important that you look up information about how much water your plants need and be sure to provide them with the correct amount in order to promote healthy growth.

Most vegetable gardens even those that are in elevated garden beds or in fabric grow bags should be provided with a regular and appropriate supply of water. If it has rained enough during the week, you may not need to water your plants.

A photo of a gardener watering crops

Temperature

Temperature plays an important role in plant growth. Warm temperatures generally encourage germination and subsequent growth. A warmer temperature will stimulate chemical reactions inside the cells of a plant, and this will speed up respiration, transpiration, and the photosynthesis process.

Plant growth will be slower during cooler periods.

Soil texture and quality

One of the problems that gardeners and farmers often face is that the soil that they use has an imbalance or lack of nutrients. All the macro and micronutrients need to be present in order for plants to grow well.

One of the best ways to ensure proper plant growth is by using natural compost or manure in the soil. This will add the missing nutrients to the soil as well as providing valuable structure to the soil, to help it hold water and stop it turning to dust and blowing away.

Using inorganic fertilizer may not provide the plant with all essential nutrients and will not bind the soil. In fact, many inorganic fertilizers only contain phosphorous, potassium, and nitrogen and will not have the other micro and macronutrients that promote plant growth.

If you have diseased plants, they are likely to be missing micro or macronutrients. For example, blossom rot that is found on tomato plants is often caused by a lack of calcium. Just like people, plants that do not have a healthy supply of appropriate nutrients are less likely to thrive.

Good gardening and farming practices

For example, regular crop rotation and the addition of water, manure and compost creates healthy plants which grow well and provide good quality produce for the population.

Learning Tasks

1. List at least five factors that are essential for the growth and development of flowering plants.
2. Explain why these factors are necessary for the growth and development of healthy plants. Limit content expectation to the description of at least four factors
3. Describe at least four good gardening/farming practices that are necessary for healthy plant growth and increased crop production.

Pedagogical Exemplars

- Using inquiry-based learning, learners research the factors that affect the growth and development of flowering plants. Learners learn to work independently, develop self-confidence and believe that their thoughts and opinions are valued.
- Using experiential learning, guide learners to conduct experiments to demonstrate the effects of factors such as temperature, light, water, soil texture and quality on the growth and development of flowering plants. Learners learn ways of managing new and stressful experiences as an individual while respectfully consulting peers and teachers in collaborative studies when in need. Each group is given a timeline to make presentation of their key findings to the whole class.

Key Assessments (DoK)

Level 1: List at least five factors that are essential for the growth and development of flowering plants.

Level 2. Describe how one of these factors affects the growth of a crop plant of your choice

Level 3: Submit a written report on your key findings of an investigation on one factor necessary for the growth and development of seedlings in your classroom or school environment. E.g. light, water, temperature or artificial fertilizer.

Section Review

In this section, learners studied the morphology of flowering plants and what distinguished them from other major plant groups. They then compared monocotyledonous and dicotyledonous plants, looking at the internal features of roots, stems and leaves and learning about the differences between them, and the ways in which they enabled the plants to survive and adapt to different environments.

In the final week they identified the factors which affect plant growth and how gardeners and farmers make best use of this knowledge to grow healthy and productive crops.

The knowledge, attitude and skills acquired by learners from this section will assist learners to develop the best understanding of the morphology of flowering plants and be able to explain how these are related to their growth and development in farm and garden. The knowledge acquired from this section will also help learners prepare for further studies, adult life and the world of work.

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