South Sudan

Secondary Biology 4

Teacher's Guide

Secondary Biology has been written and developed by Ministry of General Education and Instruction, Government of South Sudan in conjunction with Subjects experts. This course book provides a fun and practical approach to the subject of Biology, and at the same time imparting life long skills to the students.

The book comprehensively covers the Secondary 4 syllabus as developed by Ministry of General Education and Instruction.

Each year comprises of a Student's Book and Teacher's Guide

The Teacher's Guide provide:

- Full coverage of the national syllabus.
- A strong grounding in the basics of Biology.
- Clear presentation and explanation of learning points.
- A wide variety of practice exercises, often showing how Biology can be applied to real-life situations.
- It provides opportunities for collaboration through group work activities.
- Stimulating illustrations.

All the courses in this secondary series were developed by the Ministry of General Education and Instruction, Republic of South Sudan. The books have been designed to meet the secondary school syllabus, and at the same time equiping the students with skills to fit in the modern day global society.

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Secondary Biology 4 Teacher's Guide

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Teacher's Guide

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South Sudan

SECONDARY 4

Biology

Teacher's Guide

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FOREWORD

I am delighted to present to you this Teacher's Guide, which is developed by the Ministry of General Education and Instruction based on the new South Sudan National Curriculum. The National Curriculum is a learner-centered curriculum that aims to meet the needs and aspirations of the new nation. In particular, it aims to develop (a) Good citizens; (b) successful lifelong learners; (c) creative, active and productive individuals; and (d) Environmentally responsible members of our society. This textbook, like many others, has been designed to contribute to achievement of these noble aims. It has been revised thoroughly by our Subject Panels, is deemed to be fit for the purpose and has been recommended to me for approval. Therefore, I hereby grant my approval. This Teacher's Guide shall be used to facilitate learning for learners in all schools of the Republic of South Sudan, except international schools, with effect from 4th February, 2019.

I am deeply grateful to the staff of the Ministry of General Education and Instruction, especially Mr Michael Lopuke Lotyam Longolio, the Undersecretary of the Ministry, the staff of the Curriculum Development Centre, under the supervision of Mr Omot Okony Olok, the Director General for Quality Assurance and Standards, the Subject Panelists, the Curriculum Foundation (UK), under the able leadership of Dr Brian Male, for providing professional guidance throughout the process of the development of National Curriculum, school textbooks and Teachers' Guides for the Republic of South Sudan since 2013. I wish to thank UNICEF South Sudan for managing the project funded by the Global Partnership in Education so well and funding the development of the National Curriculum, the new textbooks and Teachers' Guides. I am equally grateful for the support provided by Mr Tony Calderbank, the former Country Director of the British Council, South Sudan; Sir Richard Arden, Senior Education Advisor of DfID, South Sudan. I thank Longhorn and Mountain Top publishers in Kenya for working closely with the Ministry, the Subject Panels, UNICEF and the Curriculum Foundation UK to write the new textbooks. Finally, I thank the former Ministers of Education, Hon. Joseph Ukel Abango and Hon. Dr John Gai Nyuot Yoh, for supporting me, in my role as the Undersecretary, to lead the Technical Committee to develop and complete the consultations on the new National Curriculum Framework by 29 November 2013.

The Ministry of General Education and Instruction, Republic of South Sudan, is most grateful to all these key stakeholders for their overwhelming support to the design and development of this historic South Sudan National Curriculum. This historic reform in South Sudan's education system is intended to benefit the people of South Sudan, especially the children and youth and the future generations. It shall enhance the quality of education in the country to promote peace, justice, liberty and prosperity for all. I urge all Teachers to put this textbook to good use.

May God bless South Sudan. May He help our Teachers to inspire, educate and transform the lives of all the children and youth of South Sudan.

Deng Deng Hoc Yai, (Hon.)
Minister of General Education and Instruction, Republic of South Sudan

Contents

Introduction

Book organisation

This teacher's guide is organised into two main sections.

Part 1 is the general introductionsection detailing information on competence-based curriculum and pedagogical issues.

The main elements of Part are:

- **Background information** to the new curriculum- It gives a brief overview of the general requirements of the new South Sudan competence-based curriculum including the guiding principles, the competences the learners are expected to acquire and cross cutting issues to be addressed during learning.
- **Basic requirements for an effective Biology lesson**- It highlights the teacher's and learner's roles for effective teaching and learning of Biology, teaching and learning resources and grouping learners for learning and teaching methods.

  Part 2 provides a unit -to- unit guide to the teacher on how to facilitate learners to acquire the knowledge, skills and attitudes envisaged in each unit. This part is therefore structured into units.

The main elements of each unit guide are:

- **Unit heading**
- Learning outcomes
- **Contribution to learner's competencies**: The section explains how the unit will facilitate the learner to acquire the specified competencies.
- **Cross cutting issues to be addressed:** The section outlines the specific cross cutting issues that will be addresses through infusion as the learners do activities and interact with concepts planned for the unit This is meant to make you conscious and be on the lookout for suitable opportunities throughout the teaching and learning process in the entire unit to address the cited cross cutting issues. Note that a unit may not necessarily address all the cross cutting issues outlined in the curriculum.

- **Teaching methodologies**

  The section lists down the main teaching and learning methods that the teacher can employ in the unit.

- **Background information**

  This section outlines key knowledge, skills, attitudes and values that learners need to have acquired earlier that will facilitate easier acquisition of the new knowledge, skills, attitudes and values envisaged in the unit. It also guides the teacher on how to find out that the learners possess them before they start learning the concepts in the unit, and how to help learners in case they do not possess them.

- **Suggested teaching and learning activities**

  This section provides you with guidance on how to facilitate learners to learn by doing the activities outlined in the learner's book. It also guides you on how to assess the process of learning.

Background information on the new curriculum

The aim of the South Sudan Competence-based Curriculum is to develop in the learners competencies that will enable them interact with the environment in more practical ways.

It clearly defines the knowledge, skills and attitudes that the learner should acquire by doing the specified learning activities.

Learning competences to be attained

Competencies are statements of characteristics that learners should demonstrate, which indicate they have the ability to do something to the required level of performance.

The following are the four competencies envisaged in this curriculum:

1. Critical and creative thinking

Biology lessons and activities facilitate learners to acquire these competencies by giving them opportunities to:

- Plan and carry out investigations, using a range of sources to find information.

- Sort and analyse information and come to conclusions.
- Suggest and develop solutions to problems, using their imaginations to create new approaches.
- Evaluate different suggested solutions.

2. Communication

Biology lessons and activities facilitate learners to acquire these competencies by giving them opportunities to:

- Read and comprehend critically a variety of types and forms of texts during research activities.
- Write reports on scientific investigations and activities.
- Speak clearly and communicate ideas and Biology related information coherently.
- Listen and comprehend scientific facts presented by fellow classmates, group members, teachers and resources persons.
- Use a range of media, technologies and languages to communicate messages, ideas and opinions.

3. Cooperation

Biology lessons and activities facilitate learners to acquire these competencies by giving them opportunities to:

- Work collaboratively towards common objectives when doing activities.
- Be tolerant of others and respectful of differing views, when working together in groups.
- Adapt behaviour to suit different situations.
- Negotiate, respect others' rights and responsibilities and use strategies to resolve disputes and conflicts.
- Contribute to environmental sustainability.

4. Culture and heritage

Biology lessons and activities facilitate learners to acquire these competencies by allowing them to:

- Take pride in identifying the diverse nature of the South Sudan society.
- Build understanding of the South Sudan heritage in relation to the rest of the world.
- Appreciate and contribute to the development of the South Sudan culture
- Value diversity and respect people of different races, religion, communities, cultures and those with disabilities.

Cross-cutting issues to be addressed during learning

These are issues that are of high national priority and hence have been incorporated in the learning process. The three cross-cutting issues should be addressed through the teaching and learning process are:

1. Environment and sustainability

A well-conserved environment is obviously key to our health and survival. It is therefore important for you to make use of the opportunities that arise in the process of teaching and learning Biology through activities to sensitise learners on the importance of conserving the environment. One way is by ensuring that the learners always dispose off the waste materials at the end of an activity in ways that do not pollute the environment.

2. Peace education

Peace is critical for a society to flourish and for every individual to focus on personal and national development.

You need to be in the fore front in educating your learners on the need for peace, for example by encouraging group work in the learners activities and showing them ways of solving interpersonal problems peacefully that occasionally arise during interactions and discussions.

3. Life skills

Learners need to progressively acquire some skills, abilities and behaviours that will help them to effectively deal with the events and challenges of everyday life. Such skills include First Aid, communication skills, conflict resolution, basic ICT skills among others. You should as much as possible facilitate the learners to acquire these skills whenever an opportunity arises in the lesson execution.

Basic requirements for an effective Biology lesson

1. Teacher's role and basic skills for effective Science lesson

The teacher is the most important resource for an effective Biology lesson.

(a) Some key roles of a Biology teacher.

- Organising the classroom to create a suitable learning environment.
- Preparing appropriate materials for learning activities.
- Engaging learners in a variety of learning activities.
- Encouraging and accepting learners' autonomy and initiative.
- Allowing learners' responses to drive lessons and shift instructional strategies.
- Familiarising themselves with learners' understanding of concepts before sharing their own understanding of those concepts.
- Encouraging learners to engage in dialogue, both with you and one another.
- Engaging learners in experiences that pose contradictions to their initial hypotheses and then encouraging discussions.
- Providing time for learners to construct relationships and create metaphors.
- Using a variety of teaching and assessment methods.
- Adjusting instructions to the level of the learners.
- Nurturing learners' natural curiosity.

- Motivating learners to make them ready for learning.
- Coordinate learners' activities so that the desired outcomes can be achieved.
- Assessing learners' activities and suggest solutions to their problems.
- Assist learners to consolidate their activities by summarising the key points learnt.

(b) Key skills a Biology teacher:

- Creativity and innovation.
- Makes connections or relations with other subjects.
- A high level of knowledge of the content.
- Effective disciplining skills to adequately manage the classroom.
- Good communicator.
- Guidance and counselling.

Learners' role in learning Biology

Learning takes place only when the learner acquires the intended knowledge, skills and attitudes. As such, learning is a highly personal and individual process. Thus, a learner must be actively engaged in the learning exercise.

For active participation in learning, the learner should:

- Raise questions about what is observed.
- Suggest solutions to the problems observed.
- Take part in planning investigations with appropriate controls to answer specific questions.
- Carry out investigations to search for answers with the help of materials in search of patterns and relationships while looking for solutions to problems.

- Working collaboratively with others, communicating their own ideas and considering others' ideas.
- Expressing themselves using appropriate Biology terms and representations in writing and talk.
- Engaging in lively public discussions in defense of their work and explanations.
- Applying their learning in real-life contexts.
- Reflecting critically about the processes and outcomes of their inquiries.

Teaching and learning resources

These refer to things that the teacher requires during the teaching process. They include:

- The classroom
- Textbooks
- Wall charts and wall maps
- Materials and apparatus

Various tools and equipment

- Science models
- Resource persons
- Firms such as hydroelectric power stations, engineering firms among others

(a) Classroom as a learning environment

A Classroom generally refers to the place where learning takes place. Learners learn from everything that happens around them, such as the things that they hear, see, touch, taste, smell and manipulate.

Classroom organisation

It is important you make the classroom an attractive and stimulating environment. This can be done by:

- Carefully arranging the furniture in the classroom in an organised way. to allow free movement of learners and you.

- Putting up learning and teaching aids on the walls. Examples are wall charts, pictures and photographs.
- Displaying teaching models.
- Providing objects of examination for example cover slides.
- Having a display corner in the classroom where learners display their work.
- Setting a corner for storing materials so as not to obstruct learners or distract them.
- Spreading out the learners evenly so that they do not interfere with one another's activities.
- Setting up the materials or experiments for the series of lessons or activities going on for a number of days or weeks in a location where they do not interfere with other daily activities.
- Organising the sitting arrangement such that learners face the lighted areas of the room.
- Choosing the most appropriate location for you and the chalkboard such that they are visible to all learners and that you have a good view of all learners in the class.

b) Apparatus and materials

For learners to study Biology through the activity method, a number of materials and apparatus are required. The important role played by materials in learning has been felt for centuries. This is noted for instance in the old Chinese proverb that says:

When I hear, I forget,

When I see, I remember.

When I do I understand.

Since Biology is a highly practical subject, materials help you to convey your points, information or develop skills simply and clearly and to achieve desired results much faster.

Some of the materials that you require for activities and investigations can be collected from the local environment.

Many others can be improvised while some have to be purchased. Whether collected, improvised or purchased, there are certain materials that are valuable to have around almost all the time.

These include:

i) Science kit

A Science kit is a special box containing materials, apparatus and equipment necessary to conduct an array of experiments. The content of the kit depends on the curriculum requirements per level. Most Science kits are commercially available and target particular levels of learners. However, you are encouraged to come up with a kit based on the syllabus requirements.

ii) Models

A model refers to a three-dimensional representation of an object and is usually much smaller than the object. Several models are available commercially in shops. Examples of Biology models include models of body parts, animals among others. These models can be purchased by schools for use during Biology activities.

iii) Resource persons

A resource person refers to anybody with better knowledge on a given field. Examples include health practitioners such as doctors, nurses and laboratory technologists, agricultural extension officers, environmental specialists among others. Depending on the topic under discussion organise to invite a resource person in that area to talk to learners about the topic. The learners should be encouraged to ask as many questions as possible to help clarify areas where they have problems on.

iv) Improvisation

If each learner is to have a chance of experimenting, cheap resources must be made available. Complicated apparatus may not always be available in most schools. Such sophisticated equipment made by commercial manufacturers are usually expensive and majority of schools cannot afford them. You are therefore advised to improvise using locally available materials as much as possible.

vi) Scheduling learning activities and venues

Some of the activities suggested in the learner's book need good planning and scheduling in order to get accurate results. The teacher should therefore think ahead while making the scheme of work so that the prevailing weather pattern and the most appropriate timing are considered.

Grouping learners for learning activities

Most of the Biology activities suggested in the Learner's book are carried out in groups and therefore the teacher should place 2 or 3 desks against each other and then have a group of learners sitting around those desks.

In certain activities, the teacher may wish to carry out a demonstration. In this case, the learners should be sitting or standing in a semicircle, or arranged around an empty shape of letter "U" such that each learner can see what you are doing clearly and without obstruction or pushing. If the learners are involved in individual work, each learner can work on the floor or on the desk or a portion of the desk if they are sharing. In this case, they need not face each other.

Grouping learners for learning has increasingly become popular in recent years. In fact, the shift from knowledge-based to competence curriculum will make grouping the norm in the teaching process.

Learning grouping can be formed based one or a number of the following considerations:

- Similar ability grouping.
- Mixed ability grouping.

- Similar interests grouping.
- Common needs grouping.
- Friendship grouping.
- Sex-based grouping.

Grouping learners in a Biology class has several advantages. They include:

- The individual learner's progress and needs can easily be observed.
- The teacher-learner relationship is enhanced.
- A teacher can easily attend to the needs and problems of a small group.

Materials that were inadequate for individual work can now be easily shared.

- Learners can learn from one another.
- Cooperation among learners can easily be developed.
- Many learners accept correction from the teacher more readily and without feeling humiliated when they are in a small group rather than the whole class.
- Learners' creativity, responsibility and leadership skills can easily be developed.
- Learners can work at their own pace.

The type of "grouping" that a teacher may choose may be dictated by:

- The topic or task to be tackled.
- The materials available.
- Ability of learners in the class (fast, average, slow).

Class size

There is no method or approach to teaching that is appropriate to all lessons. A teacher should, therefore, choose wisely the method to use or a combination of methods depending on the nature of the topic or subtopic at hand.

Teaching methods

There are a variety of possible methods in which a teacher can help the learners to learn. These include:

a) Direct exposition

b) Discovery or practical activity

c) Group, class or pair discussion

d) Project method

e) Educational visit or field trips

f) Teacher demonstration

g) Experimentation or research

The particular technique that you may choose to use is influenced by several factors such as the:

- Particular group of learners in the class.
- Skills, attitudes and knowledge to be learned.
- Learning and teaching aids available.
- Local environment.
- Teacher's personal preference
- Prevailing weather condition.
- Requirements of Biology syllabus

(a) Direct exposition

This is the traditional way of teaching whereby the teacher explains something while the learners listen. After the teacher has finished, the learners may ask questions. However, in a competence-based curriculum, this technique should be used very minimally.

(b) Guided Discovery

In this technique, encourage learners to find out answers to problems by themselves. You do this by:

- Giving learners specific tasks to do.

  Giving learners materials to work with.

- Asking structured or guided questions that lead learners to the desired outcome. Sometimes learners are given a problem to solve and then left to work in an open-ended manner until they find out for themselves.

This is the most preferred method of teaching in the implementation of Competency- Based curriculum.

(c) Group or class discussion or pair work

In this technique, you and learners interact through question and answer sessions most of the time. Carefully select your questions so that learners are prompted to think and express their ideas freely, but along a desired line of thought. The method leads learners from the known to unknown in a logical sequence; and works well with small groups. The method boosts confidence in learners and improves interpersonal and communication skills.

The main disadvantage of this method is that some learners maybe shy or afraid to air their opinions freely in front of you or their peers. It may give them more confident learners a chance to dominate the others.

(d) Project method

In this approach, you organise and guide a group of learners or the whole class to undertake a comprehensive study of something in real life over a period of time such as a week or several weeks.

Learners using the project method of studying encounter real life problems, which cannot be realistically brought into a normal classroom situation. A project captures learners' enthusiasm, stimulates their initiative and encourages independent enquiry. If you are using the project method, ensure that the learners understand the problem to be solved and then provide them with the necessary materials and guidance to enable them carry out the study.

The main disadvantage of this method is that if a project is not closely supervised, learners easily get distracted and therefore lose track of the main objective of their study. Studying by the project method does not work well with learners who have little or no initiative.

(e) Educational visits and trips/nature walks

This is a lesson conducted outside the school compound during which you and the learners visit a place relevant to their unit of study. An educational visit/ or nature walk enables learners to view their surroundings with a broader outlook that cannot be acquired in a classroom setting. It also allows them to learn practically through first- hand experience. In all "educational visit or nature walk lessons", learners are likely to be highly motivated and you should exploit this in ensuring effective learning. However, educational visits are time consuming and require a lot of prior preparation for them to succeed. They can also be expensive to undertake especially when learners have to travel far from the school.

(f) Demonstration lessons

In a demonstration, you or a laboratory technician show the learners an experiment, an activity or a procedure to be followed when investigating or explaining a particular problem. The learners gather around you where each learner can observe what you are doing. It is necessary to involve the learners in a demonstration, for example by:

- Asking a few learners to assist you in setting up the activity.
- Requesting them to make observations.
- Asking them questions as you progress with the demonstration.

This will help to prevent the demonstration from becoming too teacher-centred.

When is a demonstration necessary?

You may have to use a demonstration, for example when:

- The experiment or procedure is too advanced for learners to perform.
- The experiment or procedure is dangerous.
- The apparatus and materials involved are delicate for learners to handle.

UNIT 1 Biochemistry of photosynthesis and respiration

Refer to Learner's Book page 1-39

Learn about	Key inquiry questions
Learners should know the basic elements found in living organisms such as hydrogen (H), carbon (C), Nitrogen (N), Oxygen, (O_2), Sulphur (S), Phosphorus (P), Sodium (Na), Magnesium (Mg), learn the structure of some simple sugars, their molecular formulae and structures, and the structure of some macromolecules. They should review the processes of photosynthesis and respiration and the equations involved, understand the importance of energy for growth and repair, and investigate practically the factors affecting rates of photosynthesis. They should investigate practically leaf structure to understand how gases are exchanged, and the role of stomata and root systems. They should know the importance of respiration in the carbon cycle and the role of enzymes in the Krebbs cycle, and investigate aerobic and anaerobic respiration. Learners should consider the structure of respiratory systems and surfaces in animals (including the significance of surface area to volume ratio), such as lungs in humans, respiratory surfaces in animals in other animals, how materials are exchanged between the animals and their environment, and how this compares and contrasts with plant systems.	• How is photosynthesis important to plants? • How would you describe the stages of photosynthetic reactions? • Why photosynthesis must occur only under specific conditions? • How is the rate of photosynthesis affected by certain factors? • How vital is gaseous exchange for sustaining plant life? • How do plants carry out gaseous exchange? • How does gaseous exchange occur in plants that live in aquatic environments? • How do the stomata control gas exchange in a leaf? • How does gaseous exchange occur in animals? • Why are respiratory surfaces essential in some animals? • How do gaseous exchanges in unicellular organisms occur?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• Compare and contrast the biochemistry of photosynthesis and respiration.	• Design and carry out practical investigations on aspects of photosynthesis and respiration. • Investigate practically the factors affecting rates of photosynthesis • Investigate practically leaf structure to understand how gases are exchanged.	• Appreciate the importance of biochemical processes in photosynthesis and respiration in the carbon cycle. • Value the importance of essential elements in supporting life processes.

Contribution to the competencies:

Critical and creative thinking: As learners learn about the biochemistry of photosynthesis and respiration they will be inspired into thinking critically and creatively as they conduct experiments.

Communication: As work in groups in the laboratory, learners will share their observation and ideas about photosynthetic and respiratory processes.

Co-operation: Through working in groups.

Links to other subjects

Chemistry: Biochemical reactions

Physics: Energy in carrying certain processes

Biology: Physiology, Anatomy

Environment and sustainability: Photosynthesis

Introduction to the unit

Note that the learners have been introduced to photosynthesis and respiration in previous classes. Link learners past knowledge and experience with the concept they will learn in this unit.

The concept in this unit is to enable the learners to compare and contrast the biochemistry of respiration and photosynthesis.

The prime source of energy in the biosphere is sunlight. It is absorbed by chlorophyll molecules found in plants, some Protista and some bacteria. Light is the source of energy to fix carbon dioxide into carbohydrates $(CH_2O)_n$ with the use of water.

$$CO_2\,(g) + H_2O\,(l) \longrightarrow C_6H_{12}O_6(aq) + 6O_2\,(g)$$

The carbohydrates act as food for the plant. This type of feeding is called **autotrophic nutrition**. Sometimes it is referred to as halophytic nutrition. Some bacteria and some Protista feed by the same method. There are two types of autotrophic nutrition, which are:

- **Photosynthesis:** This type of nutrition involves hydration of carbon to form carbohydrates using sunlight as a source of energy.
- **Chemosynthesis**: Hydration of carbon to form carbohydrate involves inorganic compounds, which are oxidized to release the required energy. The inorganic compounds include Hydrogen sulphide (H_2S), Ammonia (NH_3), other ferrous compounds.

More than 99% of autotrophs use photosynthesis instead of chemosynthesis.

Cross cutting issues to be addressed

1. Environmental awareness and sustainability

Let learners know importance of living organism to the sustainability of life in all spheres. Without green plants performing photosynthesis, there would be no way for nature to replace all the oxygen being consumed in processes such as respiration and combustion. Furthermore the levels of carbon dioxide in the atmosphere would increase. Thus, the balance of atmospheric gases is kept stable by photosynthesis and respiration.

2. Peace and values education

Whenever there is a discussion, bring to the attention of the learners the need to accommodate other people's views. Respect of the authority is mandatory; this must be extended to fellow learners. Let them observe discipline at all times.

3. Life Skills

Emphasise to learners the need to take care of plants and conservation of the environment.

Generic competence to be attained

1. Critical and creative thinking

Guide learners to discover on their own as they work in groups. This can also be achieved when learners answer probing questions and do more research on the topic. This competence is also achieved when learners think about their findings in the activities and as they give out their suggestions. Encourage learners to come up with innovative ways. This competence comes as learners participate in pairs and groups work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in-group discussions during presentation by asking questions.

2. Communication

The competence comes as learners participate in pairs and group work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in-group discussion and during presentation by asking questions. The teacher should convey ideas effectively through spoken and written English by applying appropriate grammar and relevant vocabulary.

3. Cooperation

As learners interact in pairs as they engage in discussion. This can also be achieved during presentations; you can allow rational presentation within group members.

Remember: You should allow slow learners to do presentations as well as correct them where they go wrong. Further, advise learners to appreciate the different abilities of their group members.

4. Culture and identity

Learners should be tolerant to cultures of other students and be able to coexist peacefully without stigmatisation.

Assessment criteria

Assess learner's ability to:

- Compare and contrast biochemistry of photosynthesis and respiration.
- Carry out practical investigation on aspects of photosynthesis and respiration.
- Value the importance of essential elements in supporting life processes.

Introduction to photosynthesis

Refer to Learner's Book page 1

Activity 1.1

Refers to Learner's Book page 3
In groups (communication)

1. Start the lesson with activity on page 1 of the Learner's Book. Let learners discuss in pairs the questions as outlined in the activity.
2. Use their discussion to review the process of photosynthesis as earlier learnt.
3. Thereafter introduce Activity 1.1 in the Learner's Book page 3. Group learners into convenient groups per resources availability.
4. Demonstrate before the class the experiment before you guide them in setting up the experiment. Instruct them to follow the procedure laid out in the activity. Assist them when stuck.
5. Caution learners to be careful when handling apparatus and when using the source of heat.
6. Let learners discuss the importance of each of the following steps done.
   a) Boiling the leaf in water.
   b) Heating the leaf in ethanol.
   c) Not boiling ethanol directly over fire.

7. Each group should write a report and do a presentation of their findings.

8. Use their findings to explain the conditions necessary for photosynthesis as they take notes.

Lesson assessment

1. Observe as learners carry out Activity 1.1. Check and assess their use of equipment, cooperation and communication skills.

2. Find out if learners are able to:

   - Describe photosynthesis.
   - Outline the stages needed to taste for starch in a leaf.
   - Find out if photosynthesis process takes place in the leaf.
   - Outline the conditions necessary for photosynthesis to take place.

3. Appraise learner's work using their presentation, individual effort, use of apparatus and answering questions.

1.1 Necessity of chlorophyll, light energy and carbon dioxide for photosynthesis

Activity 1.2

Refer to Learner's Book page 3

In groups (communication)

Lesson planning

- The potted plant must be de-starched before the experiment by keeping it in darkness for a minimum of 10 hours.
- You will make sure that all learners are given equal chances of participation. Females alike should be encouraged to participate in modulating the group.

  1. Put learners into groups of 3 or 4 in the laboratory. Instruct them to follow the procedure laid out in the activity.
  2. Guide learners in the experimental procedure.
  3. Let learners discuss the study questions. Ask them to write a report and present in class.

4. Use their presentation to discuss and compare their findings on the importance of chlorophyll for photosynthesis.

Lesson assessment

1. Observe as learners carry out Activity 1.2. Check and assess their use of equipment, cooperation and communication skills.

2. Find out if learners are able to:

   - To understand the necessity of chlorophyll in photosynthesis.

   - Observe the areas of a variegated, which carried out photosynthesis and those, which did not.

   - Explain why starch is not found in all parts of the leaf

3. Appraise learner's work using their presentation, individual effort and use of apparatus and answering questions.

Activity 1.3

Refer to Learner's Book page 4

Group work

Lesson preparation

- The potted plant must be de-starched before the experiment by keeping it in darkness for a minimum of 10 hours. Then the water plant would be treated as in activity 1.1.

- Pretest the experiment.

- Organise with the technician to use the laboratory.

1. Organise learners to form groups of three or four students.

2. Assist learners in setting up three water plants; one in a dark room, another in a shade, the other in sunlight.

3. Let learners follow procedure laid out in Activity 1.3 in the Learner's Book page 4.

4. They should answer the study questions, write a report and present their findings in class

4. Learners should be able to compare the rate at which oxygen is given out of the water plants in the three conditions. They should also be able to relate light to the number of gas bubble given out.

5. Build on the learner's findings to make them understand the importance of sunlight during the process of photosynthesis as they take notes.

Lesson assessment

1. Observe as learners carry out Activity 1.3. Check and assess their use of apparatus, cooperation and communication skills.

2. Find out if learners are able to:

   - Explain the importance of light in photosynthesis process.
   - Outline the stages taken to prove that light is necessary in photosynthesis
   - Explain why different amount of oxygen is given out in the three water plants exposed to different amount of light.

3. Design specific questions to test the learner's knowledge on the content covered, for example:

   i) Is it possible to replace sunlight?

   ii) What is the use of sunlight in photosynthesis?

   iii) To which form does chlorophyll change sunlight energy?

   iv) Appraise learner's work using their presentation, individual effort and use of apparatus and answering questions.

End products of photosynthesis

Activity 1.4

Refer to Learner's Book page 5

Lesson preparation

- Collect the materials required for the experiment in advance.

- Pretest the experiment beforehand.

1. Ask learners to brainstorm on the end products of photosynthesis in groups.
2. From their answers introduce Activity 1.4 in the Learner's Book page 5.
3. Let learners carry out the procedure as outlined in the book. Instruct learners to use the study questions to discuss and write a report of their findings.
4. Build on their findings to explain end products of photosynthesis as they take notes.
5. Instruct learners to attempt Check your progress 1.1 in the Learner's Book page 7.

Answers to Check your progress 1.1

Refer to Learner's Book page 6

1. (a) Chlorophyll

   (b) Glucose

2. (a) Uneven distribution of starch

   (b) Starch made transported to storage organs

1.2 Limiting factors of photosynthesis

Refer to Learner's Book page 6

1. Organise learners into convenient groups for a discussion activity.
2. Provide learners with reference materials or computers with Internet if available.
3. Let learners do research on limiting factors of photosynthesis.
4. Allow learners to brainstorm among themselves.
5. Each group will choose a representative to do a presentation of their findings.
6. Build on their presentation to discuss limiting factors of photosynthesis as they take notes.

Activities 1.5 and 1.6

Refer to Learner's Book pages 6 and 7

(Group work)

1. Let learners carry out the experiment as suggested in the Learner's Book.
2. Assist learners only when necessary.
3. Use their findings to explain factors that affect the rate of photosynthesis.
4. Instruct learners to attempt Check your progress 1.2.

Lesson assessment

Observation

Check learners' ability to design experiments and carry out investigations on photosynthesis successfully.

Conversation

During discussions listen to learners ideas, opinions and suggestions.

Product

Learners should be able to design and carry out investigations

Answers to check your progress 1.2

Refer to Learner's Book page 9

1. B
2. Other limiting factors set in.
3. Enzymes are proteins therefore are denatured.
4. Increase to a certain level.

1.3 Internal structure of the leaf and its adaptation to photosynthesis

Refer to Learner's Book page 9

Activities 1.7

Refer to Learner's Book page 9

1. Ask learners to review internal structures of a leaf and its adaptation to photosynthesis.
2. Provide them with textbooks and reference materials or computers with Internet connectivity if available. Alternatively let learners visit the school library or public library for the research.
3. Thereafter, have a class discussion from their findings to review the internal structure of a leaf and its adaptation to photosynthesis.
4. Instruct learners top attempt Check your progress 1.3.

Answers to check your progress 1.3

Refer to Learner's Book page 10

1. a) Check for correct labelling

   b) Spongy mesophyll

   c) Minimises water loss

   d) They have air spaces that increases the surface area of the leaf to absorb more carbon dioxide

   e) To allow opening and closing of stomata.

2. A- guard cells

   B- Spongy mesophyll

   C- Palisade mesophyll

3. a) The guard cells are bean-shaped in surface view, while the epidermal cells are irregular in shape. The guard cells contain chloroplasts, so they can manufacture food by photosynthesis (The epidermal cells do not contain chloroplasts).

   b) Cells of the palisade layer contain more chloroplasts than the cells of the spongy mesophyll layer.

4. Vascular bundles contain xylem and phloem. Xylem conducts water and mineral salts from the roots to the leaves. Phloem tissues translocate manufactured food, soluble and organic products of photosynthesis from the leaves to the growing regions/ rest of the plants.

1.4 Importance of photosynthesis

Refer to Learner's Book page 11

1. In pairs let learners have a discussion on the importance of photosynthesis. They will use the suggested questions in the activity.
2. Let learners compare their findings with others in class.
3. Organises a class debate as suggested. Steer the debate to met the lesson objectives.
4. Use learners' findings to explain the process of photosynthesis and its importance as they take notes.
5. Instruct learners to attempt Check your progress 1.4.

Answers to check your progress 1.4

Refer to Learner's Book page 11

1.
   - As photosynthesises, plants provide organic molecules for energy (food) for the entire ecosystem.
   - They produce oxygen, required by most organisms.
   - They provide shelter for many small organisms
   - They help hold soil in place.

2. • Reduce, recycle and reuse
   - Planting trees
   - Use alternative sources of energy.

1.5 The process of photosynthesis

Activity 1.9

Refer to Learner's Book page 12

1. Instruct learners in pairs to study the diagram in the Learner's Book.
2. They should be able to interpret the diagram and use it to answer the study questions suggested.
3. Thereafter use their findings to explain the process of photosynthesis in the light and dark stages as they take notes.

1.6 Chemical compounds which constitute living organisms

Activity 1.10

Refer to Learner's Book page 14

1. Provide learners with reference materials.
2. Instruct learners in groups to carry out a research of chemical compound.
3. They should write a report and present in class.
4. Thereafter use their presentation to explain chemical compounds found in living organism.
5. Ask learners to draw the structures of the chemical compounds in their notebooks.

1.7 Respiration

Activity 1.11 Group work

Refer to Learner's Book page 19

1. Introduce the unit by showing learners a photo about respiration. Engage learners into a discussion about the photo shown in Learner's Book.
2. Engage the learners into a discussion about the photosynthesis.

3. Emphasise to the learners, the importance of respiration and photosynthesis.
4. Organise learners into groups of either two or three.
5. Discuss about types of respiration.
6. Discuss with learners the differences between aerobic and anaerobic respiration.
7. Let learners come up with ideas about what occurs during respiration.
8. Ask for their opinion on what happens during respiration in animals and plants.

Activity 1.12 and 1.13 Class work

Refer to Learner's Book pages 21 and 22

1. Provide learners with charts and chalkboard diagrams of the Glycolysis cycle and the Krebs cycle.
2. Take learners through the cycles pointing out each step.
3. Instruct learners to draw the cycles in their notebooks.
4. Ask learners to attempt check your progress 1.5.

Answer to Check your progress 1.5

Refer to Learner's Book page 24

1. From the food they take.
2. ATP

1. 8 Respiratory system in animals

Activities 1.14, 1.15, 1.16, 1.17, 1.18 and 1.19

Refer to Learner's Book pages 27, 28, 30, 32 and 34

1. Define respiration in human beings.
2. Explain to learners the importance of gaseous exchange in humans.
3. Demonstrate to learner different modes of respiratory systems in animals.
4. Let learners observe amoeba and earth under a microscope to help them

understand how respiration takes place in other animals.

5. Describe respiration in fish to the learners.
6. Describe respiration in humans to the learners.
7. Engage learners in a practical activity involving respiration in human beings as suggested in the activities
8. Using the books available in your school library, the model of the lung and the poster of the respiratory system, let learners describe the location and explain the function of different parts of the respiratory system in human.
9. You may wish them to try to complete this without using their textbooks first, followed by checking and correcting any mistakes with the use of their textbook.

1.9 Gaseous exchange in plants

Activity 1.20

Refer to Learner's Book page 35

1. Organise learners into groups according to availability of resources.
2. Provide them with required materials.
3. Let them carry out the activity as outlined in the Learner's Book.
4. Guide them when necessary.
5. Allow learners to brainstorm among themselves about gaseous exchange in plants.
6. Instruct learners to attempt check your progress 1.6 and 1.7.

Answers to Check your progress 1.6

Refer to Learner's Book page 38

1. The **guard cells** are bean-shaped in surface view, while the **epidermal cells** are irregular in shape
2. Roots need oxygen for respiration.

Answers to Check your progress 1.7

Refer to Learner's Book page 38

1. To transport needs gases into their system and remove unwanted gases from their system.
2. Refer to Learner's Book page 31
3. Yes and No, check for arguments.
4. Check if he or she has an inhaler, then administer.
5. Increases due to more requirement of oxygen by the body.
6. a) Presence of stomata

   b) Has space

   c) Leaf A- mesophyte, leaf B- hydrophyte
7. Oxygen is required for respiration.

UNIT 2 Reproduction and growth in plants and animals

Refer to Learner's Book page 40-121

Learn about	Key inquiry questions
Learners should understand sexual and asexual reproduction by investigating the structure of flowers and vegetative propagation. They should investigate pollination, fertilization, seed germination, fruit formation, and the processes of fruit and seed dispersal, and vegetative reproduction by means of underground storage organs such as bulbs, rhizomes, corms, tubers, suckers and/or runners. They should understand the advantages and disadvantages of sexual reproduction vegetative propagation, artificial methods of vegetative propagation. Learners should compare the principles of reproduction in plants with animals, including asexual reproduction in simple animals and a study the reproductive systems of humans, gamete formation (spermatogenesis and Oogenesis), the menstrual cycle, sexual intercourse, fertilization and pregnancy. Learners should study the development of embryos, the functions of the placenta, stages of birth and parental care, and investigate factors effecting the growth rate in plants and seed germination, and the role of enzymes during seed germination, and seed dormancy.	• How can we differentiate between mitosis and meiosis? • How is each of the following different from one another: asexual reproduction, binary fission, spore formation, and budding? • How are seeds and fruits formed and dispersed? • How are internal and external fertilisations exhibited in living organisms? • How does fertilisation occur in organisms animals? • How would you compare and contrast the process of pollination and fertilization in plants to fertilization in animals? • How would you measure the rate of growth in plants? • How would you predict the significance of water and oxygen in seed germination? And what would you use to assess / evaluate your findings?

They should understand primary and secondary growth in plants as well as know the relationship between plant hormones and growth, and types of growth in animals (i.e. continuous and discontinuous growth), explore on the life cycles of some organisms such as insects e.g. cockroach, amphibians, etc. and the role of hormones.	

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• Detail the processes of reproduction in plants and animals	• Investigate the reproductive features of several flowers to compare the sexual process and observation of gametes. • Design investigations on asexual reproduction in plants and the factors effecting germination and growth. • Investigate the stages of mitosis. • Investigate insect and wind pollinated flowers and relate structure to function. • Collect, classify and dissect fruits and seeds and relate their structure to mode of dispersal. • Study embryo development of hens eggs.	• Appreciate reproduction in plants and animals. • Appreciate the diversity of life in both plants and animals.

Contribution to the competencies:
Critical and creative thinking: The excitement of knowing about the different types of reproduction in plants and animals will provoke learners' critical thinking Communication: As work in groups in the laboratory, learners will share their observation and ideas about reproduction and growth in animals and plants Co-operation: Working in groups
Links to other subjects:
Chemistry: of enzymes and hormones, the reactions they are involved

Introduction to the Unit

The unit provides an introduction on reproduction and early stages of growth in plants and animals. Remind learners what they learnt in Secondary 1 about characteristics of living things. It covers concepts like mitosis and meiosis, which are explained in detail and provide a strong foundation to understanding genetics that is covered in subsequent units. The unit builds on the evolution theory and other works. During lessons its important to use practical examples that relate to every day's life.

Reproduction is how species perpetuate their existence. Growth on the other end is the irreversible increase in size and mass of organisms. Asexual reproduction is a process whereby the single cell divides to form two daughter cells that are identical to the parent cell genetically in a process called mitosis. The nucleus of a single cell divides first into two then the cytoplasm of the cell also splits, forming two new daughter cells. While Sexual reproduction involves the union of a female sex cell and sperm male sex cell that produce an offspring cell that is genetically different the parents' cells. In plants and animals, sexual reproduction is the fusion of a sperm and egg, called gametes, from two different parents to form a fertilized egg called a zygote. The zygote then grows through several stages before it becomes an adult offspring.

Cross-cutting issues to be covered

1. Environment awareness and sustainability

Make learners appreciate that for the eco-system to be at a steady point and sustainable reproduction of both plants and animals must be supported and not interrupted unless absolutely necessary. Also let them appreciate how human activity and pollution can interfere with reproduction.

2. Peace and values

Use the topic particularly on human fertilisation process to discuss the aspect of rape as a crime an infringement of one's rights. Also indicate that proper reproduction contributes to increased productivity that lessens need for conflicts. Emphasise on the need to be discipline at all times.

3. Life skills

Use cost-effective method proposed in the activities to deliver the lesson. Where practical use recyclable products as opposed to disposable one as this will also pass a message of preference for recycling to the learners.

Generic competence

1. Critical and creative thinking

Guide the learners to discover for themselves as they work in groups. This can also be achieved when learners answer probing questions and do more research on the topic by themselves. This competence also comes about as learners think about their findings in the activities and as they give out their suggestions. Encourage learners to come up with innovative ways.

This competence comes as learners participate in pairs and groups work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in-group discussions and during presentations by asking questions.

2. Communication

The competence comes as learners participate in pairs and group work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in group discussion and during presentation by asking questions. The teacher should convey ideas effectively through spoken and written English by applying appropriate grammar and relevant vocabulary.

3. Co-operation

As learners interact in pairs as they engage discussion. This can also be achieved during presentation, you can allow rational presentation within group members.

Remember: You should allow slow learners to do presentations as well and correct them where they go wrong. Further, advise learners to appreciate the different abilities of their group members.

Additional information for the teacher

- Read reference books on classification. This will equip you with the knowledge on classification to be able to tackle this unit effectively.
- Source for eLearning materials such as films, videos, movies and 3D images to effectively teach the lessons on reproduction and growth especially in lower organisms.
- When organising the learners into groups consider gender, special educational needs learners. The groups formed should be well represented to enable the learners appreciate diversity amongst them and learn that we are all gifted differently.

Introduction to reproduction

Refer to Learner's Book page 41

1. Begin the lesson by asking learners probing questions on reproduction in plants and animals. They should be able to answer the questions from their previous knowledge of learning reproduction.
2. Bring learners attention to Fig 2.1 in the Learner's Book page 41. In groups they should study the diagram and discuss. Build from their findings to explain reproduction in plants and animals.
3. Explain that the existing species on the planet want to ensure they remain on the planet through their offspring just like winners always want to continue winning. States that this reality makes them want to reproduce themselves or even have more superior offspring.
4. State that reproduction therefore is a process by which plants and animals produce offspring either through an asexual or a sexual process.

2.1 Asexual reproduction in lower organisms

Refer to Learner's Book page 41

a) Binary fission in amoeba

Activity 2.1

Refer to Learner's Book page 42

1. Remind the learners that there are two ways in which reproduction can occur, sexually and asexually.
2. Ask learners to suggest what asexual reproduction is. Allow them to brainstorm.
3. Some might say that it is the opposite of sexual reproduction others may suggest that it is reproduction without sperms and eggs.
4. Emphasise what asexual reproduction is. Refer to the Learner's Book page 43, that is, it is the formation of an offspring from a single organism or parent without the formation of gametes.
5. Ask learners to suggest various forms of a sexual reproduction.
6. Introduce the word fission by asking them to look it up in their dictionaries.
7. Explain that fission means splitting and that if a single celled organism splits up, then the new parts can be regarded to be new cells or organisms.
8. Emphasise that in binary fission, organisms split into two new organisms. The cells formed grow to become the same size as the original parent cell and are called daughter cells because they too, can undergo binary fission.
9. Ask the learners to suggest examples of single-celled organisms that may be capable of splitting into two new individuals.
10. Refer them to Fig. 2.2 and 2.3 in Learner's Book to study the sequence of illustrations showing binary fission in Amoeba and bacteria.
11. Clarify that as learnt earlier, mitosis is the form of cell division that is responsible for binary fusion. The new organisms or Amoeba formed in this case are identical.

b) Budding in yeast

Refer to Learner's Book page 43

1. Introduce the sub-unit by reviewing classification. Ask learners if they know how yeast differs from other fungi like *Rhizopus* and *Mucor i*n structure.

2. Draw the structure of a yeast cell and remind them how it varies in basic structure with other fungi.

3. Refer to Fig 2.4 in Learner's Book page 43 to explain how yeast cells reproduce.

Asexual reproduction in mucor by spore formation

Activity 2.2

Refer to Learner's Book page 43

1. Introduce the lesson by asking the learners if they remember what *Mucor* and *Rhizopus* are, and what kingdom they belong to as they learnt in Classification.

2. Remind the learners that *Mucor* and *Rhizopus* are fungi and they reproduce by means of spores.

3. Explain to them that spores are reproductive structures that are capable of germinating into new organisms.

4. Carry out Experiment 2.2 in Learner's Book page 43 to study how spores can grow into new organisms on bread when given the right conditions. Ask them to draw and label what they see.

5. Ask the learners to suggest other organisms that they came across in classification that were not fungi but also reproduced by means of spores. They will probably suggest ferns, which they came across in the kingdom Plantae. Clarify that spore-bearing structures found in organisms vary. In *Mucor* and in *Rhizopus*, they are found in structures called sporangia.

6. Remind the learners that spore in ferns are located in structures known as *sori* found on the underside of leaves.

7. Make sure that you go round assisting the learners where they may have a problem especially with use of the microscope or identification of the spores.

8. Instruct learners to attempt Check your progress 2.1 in the Learner's Book page 45.

Lesson assessment

Product

Check if learners are able to describe asexual reproduction.

Answers to Check your progress 2.1

Refer to Learner's Book page 45

1. Through binary fission
2. A - frond/leaf

   B - rhizome

   C - roots

   D - pinna
3. Rhizoids are small branching hyphae that grow downwards from the stolons that anchor the fungus to the substrate, where they release digestive enzymes and absorb digested organic material.

2.2 Asexual reproduction in plants

Refer to Learner's Book pages 45

Activity 2.3

Refer to Learner's Book page 45

- To effectively build on asexual reproduction in lower organisms, carry along the charts and reference materials that will be required during the lesson.
- You will be required to be practical during the lesson. You will conduct a lot of field activities and practical demonstrations.

1. Introduce this sub-unit by using question and answer method. Ask the learners to name various plants and how they produce new plants.
2. From the list of the plants, identify those that reproduce vegetative, then explain the meaning of vegetative reproduction.

3. Outline the plant structures that are involved in vegetative reproduction.

4. Provide the learners with vegetative propagation materials and ask them to identify and describe how each is involved in reproduction.

5. Discuss each material referring to Learner's Book pages 45 - 46. Emphasise on differences between:

   a) Stem tuber and bulbs.

   b) Corm and its plants.

   c) Corm and rhizomes.

6. Bring the learners attention to the illustrations in the Learner's Book pages 46-47 on the various structures involved in vegetative reproduction.

7. Then ask the learner to draw well-labeled diagrams of the vegetative materials.

8. Ask the learners to suggest other types of vegetative propagation materials found within their locality.

Answers to Check your progress 2.2

Refer to Learner's Book page 49

1. Asexual reproduction only involves one organism; sexual reproduction requires both a male and a female.

2. C

3. C

4. Vegetative propagation is especially beneficial to the agriculturists and horticulturists. They can raise crops like bananas, sugarcane, potato, etc that do not produce viable seeds. The seedless varieties of fruits are also a result of vegetative propagation.

5. Same

Artificial propagation

Refer to Learner's Book page 47

Activity 2.4 and 2.5

Refer to Learner's Book pages 49 and 50

1. Introduce the sub-unit by using a class discussion method.
2. Ask the learners to point out what they know about use of artificial propagation in their farms at home. You can do this by asking them what they see being done in sugarcane growing and citrus fruits production.
3. From their responses, explain the meaning of artificial propagation.
4. Teach each method of artificial propagation on its own pointing out the procedure in each case as outlined in Learner's Book pages 48 to 49.
5. In grafting clarity on the difference between rootstock and scion. Use the figures given in Learner's Book page 47.
6. Outline on the importance of artificial propagation in agriculture.
7. Brainstorm with learners the advantages and disadvantages of asexual reproduction in plants. Build on their suggestions to explain this as outlined in Learner's Book page 49.
8. Instruct learners to attempt Check your progress 2.3 in Learner's Book page and 51.

Answers to Check your progress 2.3

Refer to Learner's Book page 51

1. Passing of undesirable genes to offspring
2. Environmental factors play a big role.
3. Allows plants that cannot reproduce sexual to propagate

Sexual reproduction in plants

Refer to Learner's Book page 51

2.3 Structure of a flower

Activity 2.6 *Refer to Learner's Book page 51*

- This topic builds on the concept of reproduction in lower organisms. Therefore collect teaching and learning recourses needed to introduce the subtopic.
- Engage learners in a discussion regarding the structure and functions of plant reproductive organs.

1. Introduce the sub-unit by asking the learners to suggest what sexual reproduction is.
2. Remind the learners that it is the type of reproduction in which male and female gametes are formed. These gametes meet and fuse to form a zygote, which develops into new offspring.
3. Ask learners to suggest if flowering plants produce gametes or not. If they do, where would these gametes be found or formed? Can they name the structures in flowering plants that produce male or female gametes? Do these gametes have names?
4. Allow learners to brainstorm; this helps them review what they learnt earlier. Refer them to Fig. 2.13 in Learner's Book page 52.
5. Allow the learners to carry out Experiment 2.6 in Learner's Book pages 38. Encourage the learners to work in pairs or groups.
6. In this experiment, encourage the learners to identify various structures as reviewed in the generalized flower as they appear and vary in a named insect and wind pollinated flowers. Let them note:
   - Colour
   - Scent
   - Presence or absence of nectaries.
   - Position of stigmas if loosely or firmly attached.

- Position and location of anthers and filaments.

Caution the learners:

- Who might be asthmatic and therefore allergic to pollen grains or strong smells to take care especially when establishing scent in flowers?
- The presence of wasps and bees that visit some flowers because these may sting them.

7. You can then discuss the economic importance of flowers.
8. Instruct learners to attempt Check your progress 2.4 in Learner's Book page 55.

Lesson assessment

Product

Learners should be able to explain reproduction in flowering plants.

Follow-up activity

Instruct learners to construct paper models of different flowers. They can use coloured papers for instance green to represent the calyx.They should cut and model the shapes of the paper to match the shape of the flower and the arrangement of the whorls in the flower. For example some can make the Hibiscus, others the bougainvillea flower.The best and most accurate can be pinned up on the laboratory boards or walls or windowsills in the laboratory or class.

Answers to Check your progress 2.4

Refer to Learner's Book page 55

1. C
2. Anther
3. B
4. Refer to flower diagram Fig 2.13 in the Learner's Book page 52.

   (a) filament (b) stigma (c) petals

5. They are part of the egg apparatus and are thought to help the pollen nucleus reach the egg cell for fertilization

2.4 Pollination

Activities 2.7, 2.8, 2.9 and 2.10

Refer to Learner's Book pages 56, 58, 60 and 61

1. Introduce this sub-unit by reviewing pollen grains and ovules as the structures in which the male and female gametes are located respectively.

2. Organise learner's to carry out Activity 2.7 in Learner's Book page 56. They will do it in groups, write a report and present in class. Use their findings to discuss what pollination is.

3. Ask the learners to suggest how these two structures are brought together. Do they both move to meet or does one move from where it is made to where the other is?

4. The learners will probably say that pollen grains are the ones that are moved from anthers to stigma. At this point, you can define pollination. Clarify that pollination is the process by which pollen grains are transferred from anthers to stigmas of flowers and that it cannot occur by itself. The pollen grains require assistance in this transfer because they are not capable of movement.

5. Introduce the idea of external physical assistance by a so-called "agent" that can bring the pollen grain closer to the structure, which contains the outlets.

6. At this point, you may also distinguish self-pollination from cross-pollination. Refer them to Fig. 2.22 and 2.23 in the Learner's Book page 59 to emphasise their definitions and differences.

7. Ask the learners to suggest possible external factors that can move pollen from the anthers to the stigma. The common ones they will suggest are wind, insects and water.

8. Ask the learners to suggest how wind, insects and water cause pollination. Allow a class discussion on this because ideas are likely to be varied.

9. Clarify that the structures of the pollen vary; for instance, size, weight and position of the anthers and stigma in the flower contribute to the efficiency of the agent in pollination. For example, wind can move pollen from the anthers to the stigma if the pollen is small and light in weight and if the anthers hang out of the flowers for the wind to readily shake them and dislodge pollen. Also, the pollen can be carried by the wind to stigmas if the stigmas are in a position to trap the pollen in the air.

10. Give learners Activity 2.9 in Learner's Book page 60, let them write a report and present it to you for assessment.

11. Instruct learners to attempt Check your progress 2.5 in the Learner's Book page 62.

Assignment

Ask learners to write an essay on pollination and agents of pollination and the importance of insects in the reproduction in some plants.

Additional information

Insect pollinators are useful to farmers in enabling cross - pollination in crops. However, persistent use of pesticides to control harmful insects to crops has resulted in killing useful insects such as bees and houseflies. It is therefore important for the use of pest control methods that do not kill insect pollinators.

Lesson assessment

Observation – check weather learners can use materials and apparatus correctly

Product –learners should be able to describe reproduction in flowers.

Answers to Check your progress 2.5

Refer to Learner's Book page 62

1. Pollination is the transfer of pollen grain to the stigma. Cross and self pollination.

2. To allow cross-pollination to take place easily.

3. There will be low production of the crop.

4. Its stickiness

5. The wastage of pollen grain is less, it does not depend on any other external carrier.

2.5 Fertilisation and formation of fruit and seeds

Refer to the Learner's Book page 62

Activities 2.11 and 2.12 *Refer to the Learner's Book page 62 and 63*

Teach this sub-unit in three sections – fertilisation, seed and fruit formation and differences between fruits and seeds.

(a) Process of fertilisation

1. Introduce this section by asking the learners if they recall the definition of fertilisation. Clarify that it is the fusion of male and female gametes.

2. Ask learners to refer to what they learnt in the structure and function of the pollen grains and the ovules in Learner's Book pages 62 to 63. Explain how pollen grain forms a pollen tube, which grows down the style, deriving nutrients as it grows into the ovary and eventually into the ovule.

3. Emphasise the process of double fertilisation, which is unique in plants (flowering) because of the presence of the two male nuclei that were in the pollen tube.

4. Clarify that depending on the flower; several pollen grains can germinate with each sending down a pollen tube into the ovary. The ovary may in turn have several ovules and these may all be fertilised, for example in bean flower.

5. Emphasise on the formation of the zygote through the egg nucleus fusing with one male nucleus, and the formation of the endosperm through fusion of male nucleus and one of the other polar nuclei in the embryo sac of the ovule.

(b) Seed formation

Refer to the Learner's Book page 63

1. Introduce the unit by reviewing the structure of the ovary in a flower. Refer to Fig. 2.24 in the Learner's Book page 63. Features like the ovary wall, ovule, placenta, ovule stalk and embryo sac should be clear to them. This will help them follow up on the changes that occur to these structures after fertilization takes place and seeds and the fruit forms.

2. Ask the learners what they think a fruit is. They will probably say it is something they eat when ripe. Let them give examples of fruits. Most examples will be common fruits like mangoes, oranges and bananas.

3. Clarify that a fruit is a fertilized ovary. Ask them if a tomato is a fruit? And whether all fruits are edible.

4. Explain what happens to a flower after fertilisation occurs. Emphasise the changes of the ovule into a seed and the development of the ovary into a fruit.

5. Point out the changes from ovule to seed. Explain how the seed eventually loses most of its water and its metabolic activities reduce causing it to become dormant and the advantages of this phenomenon.

6. Explain how the rest of the flower parts like petals and sepals wither and drop off. Clarify the changes that the ovary wall undergoes as the fruit forms.

7. Discuss on the observable differences between a seed and a fruit.

8. Instruct learners to attempt Check your progress 2.6 in Learner's Book page 64.

Follow-up activity

1. Learners can work in groups and prepare a model of the ovule, to review the structures in it.

2. They can also use coloured paper or Manila paper to construct a visual aid showing the process of fertilization in the flower. They should first discuss and agree how to go about the activity before they do it

Lesson assessment

Observation – check weather learners can use materials and apparatus correctly

Product –learners should be able to describe fertilization and seed formation.

Answers to Check your progress 2.6

Refer to Learner's Book page 64

1. Rice, mango

2. When pollen grain lands on the stigma it begins to send out a tube. This tube

then grows down through the style to the ovary. When it reaches an ovule, it releases male cells from the pollen grains. A male cell unites with a female cell in the ovule. This process is called Fertilisation and fertilized ovule is a seed.

3. Refer to Learner's Book page 63, Fig. 2.25.

2.6 Fruit, seed dispersal and germination

Refer to the Learner's Book page 64

Improvisation: You may avail charts showing parts of a fruit and a flow chart on different types of fruits

Activities 2.13 *Refer to Learner's Book page 65*

1. Introduce this section by instructing learners to carry out the experiment as suggested in the Learner's Book.

2. Use the responses from the experiment to outline the various agents of dispersal, types of dispersal, adaptations to dispersal and importance of seed disposal.

3. Explain that if one plant produces many fruits and they all fell beneath the tree, the seeds would grow into many trees in the same place. Ask them if they think this could create a problem? Lead them to understand the consequences of this happening, such as overcrowding and competition of nutrients, water, light and other resources and how some plants may die as a result.

4. Emphasise that seed and fruit dispersal is the movement of seeds and fruits away from their parent plant so that they can grow into new plants, and the importance of dispersal.

5. From Experiment 2.13 in the Learner's Book page 65, ensure they study the structures of the fruits and seeds with the objective of establishing which method of dispersal, would succeed for each seed and fruit. Let them work and discuss in groups. They should record features of the seed or fruits that suit the method of dispersal.

6. Explain that since coconut fruit is fibrous and traps a lot of air, it floats on water when it falls off a coconut tree on the beach next to the ocean.

7. Use the same format to explain how animal and wind dispersal occurs. First ask the learners to suggest how it occurs; from the points they recorded when they observed various fruits and seeds. Conclude by asking the learners to list various methods of fruit and seed dispersal and the adaptations that suit each method.

Assignment

Learners can follow up on the experiments they did in class. You can ask them to identify more fruits and their methods of dispersal around the school. They should make a list of as many plants as they can and identify different types of fruits formed by these plants, and the methods of dispersal that they exhibit.

Lesson assessment

Observation – check weather learners can use materials and apparatus correctly

Product –learners should be able to describe fruit and seed dispersal.

Germination

Refer to the Learner's Book page 68

Activities 2.14, 2.15 and 2.16

Lesson preparation

- Seeds pre-soaked in water and at different stages of development.
- Conical flasks, cotton wool, pyrogallic acid, water.
- Reference materials and textbooks.
- Computer animations and videos.
- Learner's Book.

1. This lesson will involve group work.

   Remember: When grouping learners, you should consider the different abilities and the special needs for various individuals.

2. Obtain the requirements for the practical activity in time.

3. Provide germinated beans or peas and maize for demonstration of epigeal and hypogeal germination.

Improvisation: You may prepare charts showing epigeal and hypogeal germination just in case the seedlings to be used for demonstration do not grow in time.

1. Use a demonstration to introduce the lesson. Ask the learners to observe the seeds at various stages of germination and suggest what they think is taking place inside the seed.
2. Use the points outlined in the Learner's Book page 69 and emphasise on various processes taking place in the seed resulting to germination.
3. Ask the learners to draw the seed at various stages of development
4. Introduce the sub unit by asking learners questions such as what is germination?
5. Let them discuss among themselves to come up with a comprehensive meaning of the word germination.
6. Ask learners what conditions does a seed need to germinate?" They may suggest several factors such as water and oxygen. Help them to carry out Activities 2.14, 2.15 and 2.16 in Learner's Book to investigate conditions necessary for germination.
7. Let each group set up its own experiment. Instruct them to check the experiments, record the results and answer the questions given.
8. After the experiment, ask each group to present its findings to the whole class. Then discuss with the learners the importance of each of the conditions necessary for germination.
9. Use the points outlined in the Learner's Book page 69 to emphasise the importance of moisture in softening seed coat, transport of substances within the various parts of the seed.
10. The importance of oxygen in the process of respiration and the importance of moisture in stimulating optimum enzyme activity.
11. Brainstorm with learners' internal factors that affect germination as they take notes.

12. Thereafter introduce the types of germination i.e epigeal and hypogeal as illustrated in Learner's Book pages 71 and 72 respectively.

13. Instruct learners to attempt Check your progress 2.7 in Learner's Book page 70.

Lesson assessment

Observation – check weather learners can use materials and apparatus correctly

Product –learners should be able to describe the process of germination.

Follow-up activity

Ask the learners to write a report on the number of days different seeds take to germinate once necessary conditions are provided and suggest reasons for the variations.

Answers to Check your progress 2.7

Refer to Learner's Book page 70

1. Germination is the development of a seed into a seedling.

2. Activates the enzymes

3. C

4. B

5. To find favourable grounds, reduce competition.

6. To enable seeds pass through unfavourable weather conditions.

7. a) photosynthesis, food

   b) activate processes

2.7 Seed dormancy

Refer to Learner's Book page 70

1. Ask learners questions such as: *What would happen if you planted a maize seed, a mango seed and a macadamia seed into moist soil and waited for some time?*

2. They may suggest that the maize seed will germinate after several days. The mango seed may take several months to germinate while the macadamia nut

may take even more than one year.

3. Ask them another question such as *Are these seeds viable?* They may suggest that they are viable because even after a long time, they are still capable of germination.

4. Let learners discuss have prevented the two seeds from germinating. Then point out that this is due to seed dormancy. Ask them to refer to the dictionary for the meaning of the word seed dormancy.

5. Use the points outlined in Learner's Book page 70 and 71, discuss with the learners factors that cause seed dormancy. After stating each factor, ask the learners to suggest, how the factor prevents germination from taking place.

6. Instruct learners to attempt Check your progress 2.8 in Learner's Book page 71.

Follow-up activity

1. Get a box and fill it with sand.

2. Select 50 bean seeds of the same type and plant them in the soil in the box.

3. Water the box.

4. Remove all the seeds from the box after six days.

5. Count the seeds that have germinated.

6. Select the seeds that did not germinate. Examine them and suggest reasons as to why they did not germinate.

7. Collect a variety of seeds from the school compound and surroundings.

8. Identify seeds with hard seed coats. Write a report on how their dormancy can be broken down.

Additional information

There are two types of dormancy, **true dormancy** and **relative** or **temporal dormancy**. True dormancy is also referred to as absolute dormancy. It is inhibition of growth, even when all necessary conditions are provided. For instance, a macadamia seed will not germinate even when all optimal conditions necessary for germination

are provided. Relative dormancy is an inhibition that occurs over a short period of time. During this period, germination will not take place even if conditions are favourable for germination. Dormancy is not limited to seeds only. It is also found in buds, flower buds and vegetative parts. For instance, most plants shed their leaves before the dry season and winter so as to conserve water by reducing transpiration. During this time, the buds remain dormant and will only sprout once there is rain. They will then produce foliage leaves and flowers

Answers to Check your progress 2.8

Refer to Learner's Book page 71

1. The state in which seeds are prevented from germinating even under environmental conditions normally favourable for germination.

2. Freezing of seeds, underdeveloped embryo, impermeable seed coat, chemical inhibitors, lack of oxygen.

3. Provide water, air and temperature, use mature seeds

2.8 Reproduction

Refer to the Learner's Book page 71

Sexual reproduction in spirogyra and *Mucor*

Refer to the Learner's Book page 72

Activities 2.17 and 2.18

1. Use discussion method to teach this section, allow the learners to discuss what they understand by the term sexual reproduction. From their responses, outline the meaning of sexual reproduction. Use the points given in Learner's Book page 73.

2. Clarify that in some cases gametes involved can be produced in one individual organism but from different cells. In other organisms the male and female are separate organisms.

3. Introduce the sub-unit by first giving the learners Experiment 2.16 in Learner's Book page 69 on examining slides of *Spirogyra* and *Mucor* undergoing sexual reproduction.

4. Explain to the learners that *Spirogyra* can also reproduce asexually by fragmentation as learnt earlier.

5. Assist the learners to note that filaments lie side by side with projections in contact with each other end to end.

6. Ask the learners to draw and label what they observe.

7. Use the points outlined in the Learner's Book page 72 and 73. Use Fig. 2.34 to describe asexual reproduction in *Spirogyra* and *Mucor*.

8. Discuss with learners the advantages and disadvantages of sexual reproduction. Thereafter compare sexual and asexual reproduction as outlined in table 2.3 in the Learner's Book page 73

9. Instruct learners to attempt Check your progress 2.9 in the Learner's Book page 74.

Answers to Check your progress 2.9

Refer to Learner's Book page 74

1. Refer to table 2.3 in the Learner's Book page 73.

2. D

3. Grass, lion, sugarcane

4. i) Maize, mango, pine

   ii) fern, yeast

5. Refer to Learner's Book page 73

2.9 Sexual reproduction in animals

Refer to Learner's Book page 74

Sexual reproduction in fish, amphibians, insects and birds

Refer to the Learner's Book page 75 to 77

Use discussion to teach this section.The learners have previous knowledge on how organisms reproduce from their previous knowledge.

(a) Reproduction in amphibians

Refer to the Learner's Book page 74

1. Clarify why amphibians need water for reproduction because they carry out external fertilisation.
2. Also clarify on why their eggs are surrounded by a jelly like substance.
3. Refer learners to Fig. 2.35 in the Learner's Book page 74.

(b) Reproduction in bony fish

Refer to Learner's Book page 75

Just like in frogs, emphasise on importance of water because they carry out external fertilisation.

(c) Reproduction in birds

Refer to Learner's Book page 75

1. Point out the importance of an egg surrounded by a hard shell and mass of albumen.
2. Inform the learners that the materials in the egg are food for the young ones that will develop from the zygote.
3. Refer learners to the Fig. 2.36 and 2.37 on pages 75 and 76 of Learner's Book.

(d) Reproduction in insects

Refer to Learner's Book page 66

- Point out that insects lay their eggs on land. They have internal fertilisation. Remind the learners that insects carry out metamorphosis in form of growth.
- Guide the learners in carrying out Experiment 2.19 in Learner's Book page 76 on observing the life cycle of a housefly.
- Instruct learners to attempt Check your progress 2.10 in Learner's Book page 77.

Answers to Check your progress 2.10

Refer to Learner's Book page 77

1. Refer to Learner's Book page 74.

2. Most insects reproduce oviparously by laying eggs, while birds reproduce by internal fertilisation

2.10 Sexual reproduction in human beings

Refer to the Learner's Book page 77

Improvisation: You may arrange to have permanent slides of the male and female reproductive system.

1. Ask the learners if they could suggest what is the role of the reproductive systems in human beings.

2. Let the learners suggest a list of organs in each of the human male and human female systems. Ask them to identify the named parts in the dissected rabbit.

3. Clarify that some structures such as the urethra and penis in males and the vulva in females are also part of the urinary system.

4. For each organ, give details of its structure and its relative position in or on the body. For example, the testes specify that they are positioned outside the body or abdomen, in a sac of skin called the scrotum or scrotal sac. Explain that it is made up of many tubules called seminiferous tubules.

5. Start with the male reproductive organ. Activity 2.20 in Learner's Book page 78. Go through each organ in each system carefully. Note that all the learners need to know at this point is simply the structure of the reproductive system that is, organs and how/where each is located in the system.

6. Once they have understood which organs make up the reproductive system in the male and the female, they are now ready to relate these structures to their specific functions in the system.

7. Clarify that in many males, the skin that covers the glans penis is removed during circumcision. Explain the need for caution by doctors or people who circumcise not to use the same instrument on several individuals due to possible spread of the HIV virus.

8. Use the same approach for the female (reproductive) organs. Discuss one organ at a time, giving its functions and how it is suited to those functions.

9. Instruct learner to attempt Check your progress 2.11 in Learner's Book page 83.

Lesson assessment

Observation – check weather learners can use materials and apparatus correctly

Product –learners should be able to describe sexual reproduction in human beings.

Follow-up activities

1. Put learners in groups of 4 – 5.

2. Ask them to discuss class presentations on the structure and function of the male and the female reproductive system.

3. Let each group make a model or chart or any other visual aid on the two reproduction systems.

4. Ask them to make a 10 minute presentation in summary of the organs in the systems and their functions.

Answers to Check your progress 2.11

Refer to Learner's Book page 83

1. a) Scrotum

   b) Fallopian tube

   c) Vagina

2. Seminiferous tubules - epididymis- vas efferens-vas deferens- sperm duct- urethra

3.

Sperm	Ova
The head contains genetic information and an enzyme to help penetrate the egg cell membrane. The middle section is packed with mitochondria for energy. The tail moves the sperm to the egg.	Each egg cell has a haploid nucleus - containing only half the number of chromosomes of a normal cell nucleus. It has a large cytoplasm , which contains the nutrients and **mitochondria** needed for mitosis (cell division) after fertilisation. And each egg has a special cell membrane, which only allows one sperm to fertilise it.

4. Refer to the Learner's Book page 84 Fig. 2.46.

2.11 and 2.12 The menstrual cycle and sex hormones

Refer to the Learner's Book page 84

1. Introduce this section by leading a discussion on secondary sexual characteristics observed in boys and girls at puberty.

2. Allow the learners to freely point out the changes in both boys and girls.

3. Since they will probably have mentioned menstruation in females as one such change. Ask them to explain what they think it is. Ask them to suggest why it occurs. They will probably be less sure of their answers.

4. Refer to Fig. 2.47 and 2.48 in the Learner's Book pages 86 to 87 and explain the process of menstruation, step by step.

5. This is a unit that confuses most learners because they try to take it in all at once and teachers also tend to teach it all at a go. Menstruation is first clearly defined as the discharge of blood and other materials from the uterus lining. Emphasise that it only takes place if fertilization does not occur.

6. Explain to them that menstruation is the culmination of a series of events, which are under the influence of hormones, and that the events are cyclic.

7. Let them know that the cycle is not fixed in days but ranges from 24 – 35 days and on average it may take 28 days.

8. Emphasise on:
   - Menstruation in which the uterine lining is shed with blood and tissue.
   - The healing and repair of this uterine lining.
   - Ovulation.
   - Thickening of the uterine lining in preparation for implantation.
9. Once they understand the sequence, then emphasise that these changes cannot occur unless some specific hormones are released from certain glands to influence the occurrence of these changes.
10. List the hormones that influence the menstrual cycle on the blackboard and specify the gland, which releases each hormone.
11. At this point, the learners know two important things: The events that occur in the menstrual cycle and the hormones that influence these events.
12. Clarify what happens in each event and which hormone triggers the event and what happens next.
13. Emphasise on how the rising levels of specific hormones stimulate or suppress the release of other hormones, that is, how the hormones interrelate in feedback mechanisms.
14. Discuss with learners how sex hormones interplay during secondary sexual development.
15. Instruct learners to attempt Check your progress 2.12 and 2.13 in the Learner's Book page 86 and 87 respectively.

Lesson assessment

Conversation – listen to learner as they discuss menstrual and sex hormones.

Product –learners should be able to describe the process of menstruation and how sex hormones work.

Follow-up activities

Ask the learners to do some research work in the library to find out the following:

1. Do other mammals other than the human for example goats and cows experience menstruation?

2. Do they have a menstrual cycle?

Additional information

- Learners are usually curious to know if other female mammals experience the menstrual cycle and menstruation as human females do.

- Explain to them that animals like the cow have a sexual cycle that lasts three weeks and in others like rats it occurs in a week. The cycle of events is called the *oestrus cycle.*

- There is no sexual cycle in human males, although the gonads are regulated by hormones identical to those secreted in the female. FSH causes spermatogenesis (sperm formation) while LH(ICSH – interstitial cell stimulating hormone) causes the interstitial cells to secrete male hormones called androgens, for example testesterone which stimulates development of male secondary sexual characteristics.

Answers to Check your progress 2.12

Refer to Learner's Book page 83

1. This is because it is prepared for implantation and supplied with dense network of capillary.

2. B

3. This ensures that the thick endometrium layer in the uterus is maintained and no new follicle develops.

Answers to Check your progress 2.13

Refer to Learner's Book page 87

1. They control reproduction and menstruation.

2. Features that develop during puberty to further distinguish male and female.

3.

Male	Female
• Penis increases in length/diameter; • Prostate, bulbourethral glands and seminal vesicle enlarge, begin to secrete. • Shoulders broaden, muscle mass increase • Hair, hair, everywhere; beard, back, chest, anus • More aggressive, sexual interest awakens • Sebaceous glands secretes sweat • Larynx, vocal cords increase in size and/ or length; voice deepen.	• Size of breast enlarges • Size of uterus increases • Shoulders are narrow, hips broad, thighs converg and arms diverge–broad carrying angle • More scalp hair, less body hair

2.13 Fertilisation and implantation

Refer to Learner's Book page 88

Lesson preparation

1. This lesson will involve group discussions and presentations. You will therefore organise the class as need arises during the lesson.

2. Bring reference textbooks and charts before the beginning of the lesson.

3. Check this https://www.youtube. com/watch?v=btp4jCYZ5K4 if it is working.

1. Introduce this sub-unit by use of discussion on the meaning of fertilisation, implantation, gestation/ pregnancy and placenta.

2. Allow the learners to brainstorm on what they understand by each term.

3. Teach each section after another starting with fertilisation then implantation and then pregnancy.

4. When teaching on pregnancy, expound on the role of placenta and hormones in sustaining pregnancy.

(a) Fertilisation

Refer to the Learner's Book page 88

1. Ask the learners to suggest where in the female reproductive system they think

the sperms meet the egg or ovum. Clarify that they meet in the oviduct (not uterus as some may suggest or ovary).

2. Clarify that when the sperms reach the egg, only one sperm actually fertilises the egg. It does this when its head penetrates the egg membrane and releases its nucleus. Note that the tail does not enter (or the whole sperm does not enter).

3. Explain that this process leads to the formation of a fertilized egg called the zygote, which undergoes a series of cell divisions (mitosis) that make it grow.

(b) Implantation

1. The blastocyst implants into the lining of the uteral wall the endometrium. Emphasise that by this time, the wall of the (endometrium) is thick with many blood capillaries and tissue making implantation possible.

2. Show the learners Fig. 2.51 in the Learner's Book page 89, which shows how a human foetus grows in the uterus.

(c) Role of the placenta during pregnancy

1. Ask the learners to suggest where the implanted blastocyst obtains oxygen and nutrients from if it has to survive and grow into an embryo. They may suggest from the mother or from its surroundings. Refer the learners to page 91 Fig. 2.52 to show how in the early stages of pregnancy, the embryo obtains nutrients through villi.

2. Clarify to the learners that as the embryo grows, a more specialized organ, the *placenta*, develops. Refer to content in Learner's Book page 91-92 to explain the role of the placenta.

3. Emphasise that at no time does the foetal blood mix with the maternal blood. Explain the possible reasons for this, for instance, the baby may have a different blood group from the mother and if they were not separated, agglutination and death of the two can occur.

4. Specify that the placenta can prevent some harmful substances reaching the embryo from the mother's blood but not nicotine from cigarette smoke inhaled by mother and alcohol.

(d) Role of hormones in maintenance of pregnancy

Teach on role of progesterone and oestrogen hormones in sustaining a thickened uterine wall to sustain pregnancy.

Lesson assessment

Follow-up activities

1. Learners can do some research to find out what happens if two ova are released and they are both fertilized. They can also research on fraternal and identical twins and write a short essay.

2. Learners can find out what caesarean sections, breach deliveries and miscarriages are and what causes them. They should write a report and present it to the class.

3. Let them research to find out what antiretroviral drugs are and how they fight against infection of HIV from the mother to the baby.

4. Ask learners to find out what in-vitro fertilization (test-tube babies) is and why it is necessary. Write a short report and present to each other in groups.

Answers to Check your progress 2.14

Refer to Learner's Book page 90

1. Menstruation occurs

2. a) To maintain the haploid state 2n.

   b) The ovum membrane changes to prevent another sperm from penetrating

3. Age, fibroids, diseases such as cancer, smoking, drugs

4. The placenta serves as an interface between the mother and the developing foetus.

2.14 Pregnancy, antenatal care and birth

Refer to Learner's Book page 90

Lesson improvisation: You may prepare charts showing different stages of foetal development

1. Ask probing questions to introduce the lesson. Such questions my include:
   - What is gestation period? (Ans. The period between pregnancy and birth.)
   - The zygote undergoes mitosis to form……..? (Ans: An embryo)
   - How long is the pregnancy period of human being? (Ans: 9 months/40 weeks)
2. Let learners carry out Activity 2.24 in the Learner's Book page 90. Divide them into convenient groups.
3. Instruct them to write a report, which they will present in class.
4. From their presentation, discuss with them the stages of pregnancy, antenatal care and birth as outlined in the Learner's Book page 89 to 90 as they write short notes.
5. Instruct learners to attempt Check your progress 2.15 in Learner's Book page 92.

Lesson assessment

Conversation – listen to learners during discussions

Product –learners should be able to describe the process of fertilisation.

Answers to Check your progress 2.15

Refer to Learner's Book page 92

1. a. Gestation

   b. Endometrium
2. Oxygen, nutrients and drugs
3. Deoxygenated
4. It also helps to keep the temperature consistent. The fluid offers protection from any blows that may come to the uterus area. It may cushion the blow if the mother falls.
5. Drugs, smoking, lack of exercise
6. Refer to Learner's Book page 91.

2.15 Cell division

Refer to Learner's Book page 93

Chromosomes and introduction to cell division

Lesson Preparation

1. This lesson will involve individual work and dissection activity. You will therefore organise the class as need arises during the lesson.

   Remember: When grouping learners, you should consider the different abilities of learners and the special needs for various individuals.

2. Look for slides illustrating mitosis cell division in advance and check the microscope to ensure that all they are in good working condition.

3. Obtain wall charts on mitosis cell division and other materials such as cell models illustrating the behaviour of chromosomes during cell division in advance.

4. Bring pamphlets, handouts, and textbooks for reference in class.

5. Also, ensure that the Internet is working if you have a computer laboratory or any other form of Internet connectivity such as WIFI or modem.

6. Test the link: https://youtu.be/L0kenzoeOM

Teaching aids

1. Prepared slides, microscopes, roots of onion

2. Charts on cell division, textbooks, pamphlets and handouts.

3. Video link: https://youtu.be/YgccVd1dtM

Improvisation: You may come up with your own painted diagrams on mitotic and meiotic cell division drawn on manila papers in case your school does not have the charts.

Learning activities

a) Introduce the unit as explained under guidance on the problem statement above then narrow down to the lesson.

b) Ask probing questions to introduce the lesson. Such questions may include:

   1. What is the use of mitosis cell division?

Ans: It's used in growth, repairing tissue, replacing old cells and vegetative reproduction.

2. What is meiosis cell division?

   Ans: It's a specialised type of cell division that reduces the chromosomes number by half. i.e from diploid number to haploid number.

2.16 Chromosomes

Refer to Learner's Book pages: 94

Activity 2.25

Refer to Learner's Book page 94

1. This is a research activity. Provide learners with the handouts, pamphlets and textbooks and ask them to find out the behaviour of chromosomes during cell division. The following link will be useful. https://youtu.be/ ofjyw7ARP1c

2. Let learners have a brief discussion session on their findings then write summary notes. Correct them as is appropriate. Refer to notes on Learner's Book page 83 on the structure of chromosomes.

Activity 2.26

Refer to Learner's Book page 95

1. This activity is meant to help learners appreciate how replication of chromosomes takes place.

2. Use the twisted wool to make learners understand the process of replication.

3. The learners should observe that from two strands of wool, then end up with four untwisted ropes which is similar to what happens to chromosomes during cell division.

Answers to Check your progress 2.16

Refer to Learner's Book page 96

1. B

2. C

3. D

2.17 Mitosis

Refer to Learner's Book pages 96

Preparation for the lesson

This lesson will involve individual work and dissection activity. You will therefore organise the class as need arises during the lesson.

1. Look for slides illustrating mitosis cell division in advance and check the microscope to ensure that all they are in good working condition.
2. Obtain wall charts on mitosis and meiosis cell division and other materials such as cell models illustrating the behaviour of chromosomes during cell division in advance.
3. Bring pamphlets, handouts, and textbooks for reference in class. Also, ensure that the Internet is working if you have a computer laboratory or any other form of internet connectivity such as WIFI or modem.
4. Test the link: https://en.wikipedia.org/ wiki/Mitosis. In advance test to see if it is working. This link has notes on mitosis cell division. This is part of one of the activities in this lesson.

Teaching aids

- Prepared slides, microscopes, roots of onion
- Charts on cell division, textbooks, pamphlets and handouts.
- Video link: https://youtu.be/YgccVd1dtM
- The diagrams on pages 94 and 95 of Learner's Book.

Improvisation: You may come up with your own painted diagrams on mitotic cell division drawn on manila papers in case your school does not have the charts.

Ask probing questions to introduce the lesson. Such questions may include:

1. What is the use of mitosis cell division?

   Ans: It's used in growth, repairing tissues, replacing old cells and in vegetative reproduction.

2. What is the longest stage in which the cell replicates its organelles?

   Ans: It's the interphase stage.

Activity 2.27 and 2.28

1. This activity is meant to differentiate between the phases of mitosis cell division.
2. Use charts and video to make learners understand the difference between mitosis phases.
3. The learners should outline main phases of mitosis cell division. The phases are interphase, Prophase, Metaphase Anaphase and Telophase.
4. Summarise the lesson by highlighting the key points, which should include main phases of mitosis cell division. Refer to Learner's Book pages: 98 to 102.

Lesson Preparation

1. This lesson will involve individual work, video watching, research work and group activities. You will therefore organise the class as need arises during the lesson.
2. Bring pamphlets, handouts, and textbooks for reference in class. Also, ensure that the Internet is working if you have a computer laboratory or any other form of Internet connectivity such as WIFI or modem.
3. Test the link: https://en.wikipedia.org/ wiki/meiosis. In advance test to see if it is working. This link has notes on meiosis cell division. This is part of one of the activities in this lesson.
4. Obtain wall charts on meiosis cell division and other materials in advance.

Suggested teaching aids

1. Prepared slides, microscopes, roots of onion
2. Charts on cell division, textbooks, pamphlets and handouts.
3. Video link: https://youtu. be/16enC385R0w

Improvisation: You may come up with your own painted diagrams on meiotic cell division drawn on manila papers in case your school does not have the charts.

Answers to Check your progress 2.17

Refer to Learner's Book page 102

1. The cell copies - or ‹replicates› - its chromosomes, and then splits the copied chromosomes equally to make sure that each daughter cell has a full set.

2. A

3. A

4. Two, 10

2.18 Meiosis

Activity 2.29 and 2.30 *Refer to Learner's Book page 103*

- This activity is meant to investigate the stages of meiosis cell division.
- Use the anthers from the flower to prepare a temporary slide and observe stages of meiosis using the microscope. The learners should outline main phases of meiosis cell division. The phases are interphase, Prophase, Metaphase Anaphase and Telophase.
- Summarise the lesson by highlighting the key points, Refer to Learner's Book pages 104 -105.

Answers to Check your progress 2.18

Refer to Learner's Book page 107

1. Meiosis produces 4 non-identical daughter cells; each daughter cell has half the chromosomes as parent cell.

2. A

3. B

2.19 Growth and development in plants and animals

Refer to Learner's Book page 108

Activities 2.31, 2.32, 2.33, 2.34 and 2.35

Refer to Learner's Book pages 96

1. Introduce this section by asking the learners to suggest parts of their bodies where growth takes place. They may suggest that growth takes place in all parts of the body. Then ask them to suggest which parts of plants show growth.
2. Explain to the learners that plants do not grow in all parts. They have specific cell that show division. Inform them that such cells are called meristems.
3. Display charts for the learners to observe positions of meristems in a plant.
4. Discuss with learners the process; types and measurements of growth as outlined in Learner's Book page 109.
5. Put learners into groups for activities in the Learner's Book pages.
6. Thereafter discuss limitations in estimating growth, the growth curve and phases of growth as outlined in Learner's Book page 110 to 111.
7. Ask learners to discuss external and internal factors that affect growth. They should present their findings in class. Use their findings to explain factors that affect growth as they write notes.
8. Instruct learners to attempt Check your progress 2.19 in Learner's Book page 115.

Answers to Check your progress 2.19

Refer to Learner's Book page 115

1. a) The process of increasing in size.

   b) Plant growth occurring throughout a tissue.

   c) Plant growth confined or restricted to a particular location.
2. Reproduction purposes, repair and development
3. Fewer organism, lack of adaptation to environment

4. Sunlight provides the energy needed by plants for photosynthesis.

5. Only the best suited survive

6. Density dependent factors are factors whose effects on the size or growth of the population vary with the population density. There are many types of density dependent limiting factors such as; availability of food, predation, disease and migration.

   Density-independent factors, such as weather and climate, exert their influences on population size regardless of the population's density. In contrast, the effects of density-dependent factors intensify as the population increases in size.

7. No, increase in weight is not permanent

8. After maturity

2.20 Primary and secondary growth

Refer to Learner's Book page 116

1. Introduce the lesson by asking learners probing questions such as:

   a) What are meristems?

   b) Identify areas in a plants body where meristems are found.

   c) State importance of meristems?

2. Review the role of meristems and their positions in the plant body.

3. Use discovery method to guide the learners to carry out Experiments 2.36 in the Learner's Book page 119. Ask the learners to discuss the differences in the seedling before and after the experiment.

4. Use discussion to describe the three zones of growth in a tip of a stem and root. Refer to Fig. 2.73 and 2.74 in the Learner's Book pages 116 , 118 and 119.

5. Clarify on the part of the stem and root that shows the greatest elongation. Point out the processes resulting to elongation of cells in plants.

6. Distinguish to learners' primary and secondary growth patterns in plants as outlined in Learner's Book page 117 to 120.

7. Thereafter explain to learners the difference of growth in plants and animals as illustrated in table 2.5 in Learner's Book page 119.

8. Instruct learners to attempt Check your progress 2.20 in the Learner's Book page 121.

Answers to Check your progress 2.20

Refer to Learner's Book page 121

1. a) In hypogeal germination the epicotyl extends and the cotyledons stay in the ground, whereas in epigeal germination the hypocotyl extends and the cotyledons come out of the ground

   b) The increase in length of the shoot and the root is referred to as primary growth. It is the result of cell division in the shoot apical meristem. Secondary growth is characterised by an increase in thickness or girth of the plant. It is caused by cell division in the lateral meristem.

   c) Plumule is the future shoot of a plant but radicle is the future root of the plant.

2. a) Activate enzymes

   b) Used in aerobic respiration which is a source of energy.

   c) It provides a medium for chemical water reactions in the seed. It transports soluble substances from the endosperm and cotyledon to plumule and radicle for growth. It leaches germination inhibitors, it softens the seed coat

   d) Breaking down materials required for growth

3. Lack of suitable temperature, seeds planted too deep or shallow, seed predators,

4. Protecting the root apical meristem allows for primary growth in the **root**, which paves the way for lengthening of the plant as well as cell specialisation.

UNIT 3 Co-ordination in plants and animals

Refer to Learner's Book page 122-159

Learn about	Key inquiry questions
Learners should investigate chemical co-ordination in plants and hormones such as auxin, ethylene, abscisic acids, and phyto-hormones and their functions. They should develop hypothesis to investigate phototropism in plants and the effect of auxins concentration on the growth of shoots and roots. Learners should investigate the structure of nervous system in vertebrates to understand sensory, integrative and motor functions. They should understand the structure and function of neurons and the concept of synapses, the structure and function of the spinal cord, the peripheral and autonomic nervous systems, their role in co-ordination, and their relationship with sensory organs. They should know the basic parts of the brain and the function of the cerebral hemispheres, hypothalamus, pituitary, cerebellum and medulla oblongata. They should relate muscles types and functions to their connection to the central nervous system. Learners should understand chemical co-ordination in animals and the endocrine system, and relate this to hormone systems in plants. They should explore diurnal and annual rhythms and how drugs such as pain killers and the contraceptive pill work.	• How would you design an experiment to investigate the effect of Auxin concentration on the growth of plant shoot and root system? • How different is the movement of the leaves of the sensitive plant from the movement of a shoot towards light? • How do chemical control and co-ordination occur in plants? • How do Auxins promote the growth of a tendril around a support? • Why is there a need for a system of control and co-ordination in organisms? • How does chemical co-ordination take place in animals? • Why is co-ordination necessary in animals? • How do nerve impulses travel through the body?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• Understand how co-ordination takes place in plants and animals.	• Investigate chemical co-ordination in plants • Investigate the structure of nervous system in vertebrates to understand sensory, integrative and motor functions. • Develop hypothesis and design investigations on the effects of auxins on plant growth.	• Value the importance of plant hormones in plant growth – hence the fruit, vegetables, etc. • Appreciate the commercial application of some plant hormones such as auxins.
Contribution to the competencies: Critical and creative thinking: Investigating the effect of auxins in plant growth will provoke thinking critically therefore students creativity will be stimulated. Communication: They will share and communicate their finds with other groups enhanced. Co-operation: Working together in the lab encourages co-operation and device ways of how to improve growth of certain plant varieties of commercial importance.		
Links to other subjects: Chemistry: enzymes and hormones, the reactions involved in different processes		

Introduction to the unit

The unit primarily focuses on the role of the nervous system in animals and hormones in both plants and animals. It covers topics that will enable the learners to understand how plant shoots and roots are controlled through a hormonal system that determines the rate and direction of growth. The unit also builds the learners investigative and research capability by having them design an experiment and execute it. The knowledge attained in this unit is linked to the one on reproduction by reference to hormonal control and also to agriculture subject by increasing learners understanding of how plants grow.

Cross-cutting issues to be covered

1. Environment awareness and sustainability

Make learners appreciate that for the eco-system to be at a steady point and sustainable reproduction of both plants and animals must be supported and not interrupted unless absolutely necessary. Also let them appreciate how human activity and pollution can interfere with growth of plants and animals.

2. Peace and values education

This is achieved as you bring to the attention of learners the need to accommodate other people's views. Discipline should be observed at all times in study groups since some cases can make learners diverge from the main objectives.

3. Life skills

Learners will be made aware of the economic applications of plant growth hormones like auxins in agriculture, for example, the use of auxins in weed control and breaking.

Generic competence to be attained

1. Critical and creative thinking

Guide learners to discover on their own as they work in groups. This is achieved as learners find out the answers to the questions you give to them. This competence comes as learners participate in pairs and groups work class. Encourage all learners irrespective of their abilities to participate in-group discussions and during presentations by asking questions.

2. Communication

As learners participate in pairs and group work in performing skits and as they perform to the rest of the class. Encourage learners irrespective of their abilities to participate in-group discussion, during presentations and question and answer session.

3. Co-operation

During group discussions and pair work, let learners engage one another by giving a chance for all to participate. This can also be achieved during presentations; you can allow rotational presentation within the group members.

3.1 Coordination in plant

Refer to the Learner's Book page 122

1. Introduce the unit using illustrations in the learners' book page 122, fig 3.1 A and B. Learners have observed such occurrences should be able to point out the kind of response shown by plants.

2. Ask probing questions. Such questions may include: Give examples of:

   a) Stimulus (Ans: light, water, touch, chemicals, gravity)

   b) Response (Ans: tropisms, nastic movements)

   c) Explain the following types of plant responses?

   - Phototropisms (Ans: growth response towards light)
   - Hydrotropisms (Ans: growth response towards water)
   - Thigmotropisms (Ans: Growth response towards touch)

3. Provide learners with materials for Activity 3.1 in the Learner's Book page 123 to investigate gravitropism and phototropism.

4. They should be in groups of four. The experiment will take a couple of days to observe intended results.

5. Instruct them to come up with a report of their findings and present it to the rest of the class.

6. Build on their findings to explain the types of plant responses and their stimuli as they take notes.

7. Instruct learners to attempt check your progress 3.1 in the Learner's Book page 125.

Lesson assessment

Observation – check weather learners can carry out experimental procedure successfully.

Product –learners should be able to describe coordination in plants and animals.

Answers to Check your progress 3.1

Refer to the Learner's Book page 125

1. True

2. a) Hydrotropism

   b) Phototropism

   c) Growth towards light which is useful in photosynthesis.

   d) Auxins

   e) Making the plant grow more quickly or more slowly.

3.2 Role of auxins in controlling shoot growth

Refer to the Learner's Book page 126

1. Learners are already aware of hormones in animals and how they work. They should be able to link the same to plants.

2. Organise learners into groups and provide them with reference book to do research on the role of auxin in controlling shoot growth.

3. Instruct them to write a report, which they will present in class.

4. Build on their reports to explain the various roles of auxins to plant responses.

5. End the lesson by instructing learners to attempt check your progress 3.2 in the Learner's Book 132.

Lesson assessment

Observation – check weather learners can use materials and apparatus correctly.

Product –learners should be able to describe the role of auxin hormone in plants.

Answers to Check your progress 3.2

Refer to Learner's Book page 132

1. Auxins migrate away from some plant part when in contact with solid objects.

2. The shoot or tip

3. B

4. a) Check for correctly drawn graph.

   b) Auxins stimulate shoot elongation and root branching

   c) They selectively act on broad- leafed weeds as plant growth regulators.They are readily absorbed through both roots and foliage and translocate b y p hl oem or xylem to meristematic tissue interfering with cell formation that results in abnormal root and shoot growth.

3.3 Other forms of plant responses

Refer to Learner's Book page 133

1. Organise learners into groups and provide them with reference materials to do research forms of plant responses.

2. Instruct them to write a report and do a presentation on their findings.

3. Have a class discussion from their findings to explain other plant responses. For clarification refer to the outlined points on Learner's Book page 133.

4. End the lesson by instructing learners to attempt Check your Progress 3.3.

Lesson assessment

Product –learners should be able to describe other forms of plants responses.

Answers to Check your progress 3.3

Refer to Learner's Book page 134

1. a) Thigmotropism

   b) A response to non-directional movement of a part of a plant in response to external stimulus.

2. B

3.4 Coordination in animals

Refer to Learner's Book page 134

Activity 3.5

2. This is a discussion activity that will involve learners defining terms in coordination and identifying components of the human nervous system from the charts provided.

3. Let learners have a brief discussion session on the terms defined and what they have identified from the charts and present their work to the rest of the class.

4. Summarise the lesson by highlighting what makes up the central nervous system and the peripheral nervous system.

5. Instruct learners to attempt Check your progress 3.4 in the Learner's Book page 136.

Lesson assessment

Conversation

Assess whether the learning objectives of the lesson were met by asking questions such as:

1. What is the function of the nervous system?

   Ans: To send information or messages to and from the brain and spinal cord to and from other body parts.

2. State the components of the coordinating system in the human body.

   Ans: The Nervous system and the hormonal/Endocrine system.

3. What makes up the nervous system?

   Ans: Central nervous system and peripheral nervous system..

4. Which of the following is the correct definition of irritability?

   A. Part of the body that responds to stimuli.

   B. How an organism detects changes in its environment.

   C. Ability of an organism to detect changes in the environment.

   D. Ability of an organism to detect changes in the environment and respond appropriately.

   Ans: D

Answers to Check your progress 3.4

Refer to Learner's Book page 136

1. For communication internally and externally
2. Nervous system, endocrine system
3. Impulses
4. Refer to Learner's Book page 136

3.5 Structure of the nervous system in vertebrates

Refer to Learner's Book page 136

1. Ask probing questions to introduce the lesson.
2. Organise the learners into groups and let them discuss the functions of the different parts of the brain and present their work to the rest the class.
3. At this point, play the Youtube video and emphasise on the main roles of the parts of the brain.
4. Summarise the lesson by question – answer evaluation. Ask learners to state one function of each part of the brain.
5. Finalise by asking learners to make notes on functions of parts of the brain and "spinal cord" as outlined in Learner's Book page 138 - 142
6. Instruct learners to attempt Check your progress 3.5 in Learner's Book page 142.

Lesson assessment

Product –learners should be able to describe the structure of the nervous system.

Answers to Check your progress 3.5

Refer to Learner's Book page 142

1. A
2. D
3. B

3.6 Structure and function of neurons

Activities 3.7 and 3.8

Refer to Learner's Book page 143 and 145

2. Put learners into groups considering their abilities. Let them carry out this discussion activity.

3. At this point, provide learners with the charts to help them compare structure of the neurons.

4. Let learners draw well labelled diagrams of neurons and write notes on their functions.

5. Summarise the lesson by highlighting features of the motor and sensory neurons that increase the speed of impulse transmission. Clarify using the outlined points on Learner's Book page 143 - 146.

6. Finalise by asking learners to write notes on functions of parts of a neuron.

Answers to Check your progress 3.6

Refer to Learner's Book page 146

1. C

2. C

3. A

3.7 The reflex arc and reflex actions

Refer to Learner's Book pages 146

Activity 3.9 and 3.10

(Refer to Learner's Book pages 146 and 149

1. Let the learners carry out activity 3.8 and discuss.

2. At this point play the YouTube video to aid in the learners understand the concept of the reflex arc. Lead in discussing their findings.

3. Instruct learners to attempt Check your progress 3.7 in the Learner's Book page 150.

Answer to Check your progress 3.7

Refer to Learner's Book page 150

1. B

2. D

3. D

3.8 Chemical co-ordination in animals and the endocrine system

Refer to Learner's Book page 151

1. Introduce the lesson by asking learners probing questions. Such questions may include:

   - What does endocrine mean? (Ans: secrete within or internally into the blood stream.)

   - Pancreas is both endocrine and exocrine? Explain. (Ans; it secretes insulin and glucagon hormones directly into the blood stream and also produces pancreatic juice that is delivered through the pancreatic duct.

2. Let the learners discuss in groups their findings from research activity 3.11 of Learner's Book and present their work to the rest of the class.

3. At this point, you could run the power point presentation and emphasise on the effects over secretion and under secretion of hormones.

4. Organise learners to perform activities 3.12, 3.13 and 3.14 in Learner's Book pages 153 - 158 respectively. They will write a report and present it in class.

5. Summarise the lesson by highlighting the differences between endocrine and nervous system and the role of hormones in regulating growth and physiological processes in the body.

6. End the lesson by asking learners to attempt Check your progress 3.8.

7. Give learners assignment to research and write notes on application of hormones in food production.

Answers to check your progress 3.8

Refer to Learner's Book page 159

1. Transports hormones within the body
2. Iodine is not stored in the body
3. To maintain balance of body functions.

UNIT 4 Homeostasis in plants and animals

Refer to Learner's Book page 160-185

Learn about	Key inquiry questions
Learners should know about the principles of control and feed-back systems and apply this to animals and plants at cellular, organ, and whole organism levels. They should investigate homeostasis in single celled organisms (protozoa) and in multi-cellular organisms such as plants (the role of stomata) the skin and kidney in animals. They should find out about the endocrine system and homeostasis in mammals e.g. water balance, pH, blood sugar control, and temperature regulation, and understand thermoregulation and osmoregulation, the role of skin in thermoregulation, salt and water balance, and osmoregulation and excretion in insects. They should explore the inter-relationships, structure and functions of the organs responsible for excretion and homeostasis e.g. the liver and kidneys; and know how the excretory products and nitrogenous metabolism in animals and plants (ammonia, urea and uric acids) are removed.	• How do animals regulate temperature fluctuation at narrow (limited) range within their body from their environments? • How do single celled organisms regulate water content of the cell? • How would you describe the role of skin in thermoregulation, salt and water balance? • Why the process of homeostasis is necessary for the survival of the organisms? • How would you test for the presence of hydrogen peroxide (H_2O_2) in a medium? • How does the kidney function in regulating blood sugar level in humans? • Why the nitrogenous excretory products such as ammonia, urea and uric acids are not retained in the body of organisms

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• Describe the role and operation of homeostasis in animals and plants.	• Design and carry out investigations on the movement of water across plant and animal cell membranes, make observations and apply this to organ systems. • Closely observe mammalian organ structure and relate this to function and record observations.	• Evaluate and appraise the complexity of homeostatic processes. • Appreciate the role of water, salt, etc. in supporting life.
Contribution to the competencies: Critical and creative thinking: About how organisms' bodies function. Communication: They will work in groups in the laboratory, students will share their observations and ideas about homeostasis in animals. Co-operation: In groups		
Links to other subjects: Chemistry: of enzymes and hormones, the reactions they are involved in		

Introduction to the unit

Homeostasis is the maintenance of a constant internal environment (the immediate surroundings of cells), which is vital for an organism to stay healthy in response to:

- The changing conditions of the external environment.
- The changing conditions of the internal environment Homeostasis is a self-adjusting mechanism involving feedback where the response to a stimulus alters the internal conditions and may become a new stimulus.

Cells depend on the body environment to live and function. Homeostasis keeps the body environment under control and keeps the conditions right for cells to live and function. Without the right body conditions, certain processes (e.g. osmosis) and proteins (e.g. enzymes) will not function properly. Animal organs and organ systems constantly adjust to internal and external changes in order to maintain this steady state.

There are three important aspects of homeostasis.

a) Osmoregulation

b) Thermoregulation

c) Excretion

Cross cutting issues

1. Environmental awareness and sustainability

Let learners know importance of living organism to the sustainability of life in all spheres. Help them understand how important homeostasis is to both plants and animals.

2. Peace and values

Whenever there is a discussion, bring to the attention of the learners the need to accommodate other people's views. Respect for the authority is mandatory; this must be extended to fellow learners. Let them observe discipline at all times.

3. Life Skills

Emphasise to learners the need to be keen when carrying out practical or field activities to avoid destruction of apparatus or field equipment. Where possible improvise devices, this not only saves resources but also teaches learners how to be innovative.

Generic competence

1. Critical and creative thinking

Guide learners to discover for themselves as they work in groups. This can also be achieved when learners answer probing questions and do more research on the topic by themselves. This competence also come about as learners think about their findings in the activities and as they give out their suggestions. Encourage learners

to come up with innovative ways. This competence comes as learners participate in pairs and groups work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in group discussions during presentation by asking questions.

2. Communication

The competence comes as learners participate in pairs and group work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in group discussion and during presentation by asking questions. The teacher should convey ideas effectively through spoken and written English by applying appropriate grammar and relevant vocabulary.

3. Cooperation

Encourage group work or shared assignment because as learners interact in pairs, they engage in discussion. This can also be achieved during presentation; you can allow rational presentation within group members.

4.1 Introduction and definition of homeostasis

Refer to Learner's Book page 160

Activities 4.1, 4.2 and 4.3 *Refer to Learner's Book page 161 and 162*

1. Introduce the unit by telling learners to imagine being outdoor jogging. Ask them why they will sweat after 10 minutes of jogging.

2. Ask all students to stand up and balance themselves on one foot until you tell them to put their other foot down. Encourage them to talk about what they are experiencing with the other students as they keep standing. After bout seven minutes, have them sit back down in their seats. Ask the students what happened to them during this activity? What did they notice? Did it get more difficult to balance as time went on? What did they want to do? Tell the students they just experienced homeostasis. Their bodies were trying to keep them upright maintaining their balance.

3. Ask learners the importance of maintaining constant internal conditions such as temperature, water, sugar and salts.

4. Engage learners in a practical exercise in a classroom. Ask them questions related to maintenance of internal balance.

5. In the classroom ask and engage learners to name some factors that must be kept constant in human bodies.

6. Instruct learners to discuss the suggested activities and resent their findings in class.

Feedback mechanisms

Refer to Learner's Book page 163

Feedback mechanisms are the general mechanism of either nervous or hormonal regulation in animals. Feedback occurs when the response to a stimulus has an effect of some sort on the original stimulus. The nature of the response determines how the feedback is categorised: Feedback can be either positive or negative.

Activities 4.4, 4.5, 4.6, 4.7 and 4.8 *Refer to Learner's Book page 163-167*

1. Introduce the lesson by giving learners examples of feedback mechanisms.

2. Give illustrations of different feedback mechanisms to the learners.

3. Let the learners understand the difference between positive and negative feedback mechanisms.

4. In the laboratory assist learners to carry out the suggested activities in their books.

5. Conduct many other feedback related experiments.

6. Instruct learners to attempt check your progress 4.1

Answers to Check your progress 4.1

Refer to Learner's Book page 167

1. a) Negative feedback occurs when the rate of the process decreases as the concentration of the product increases. Positive feedback occurs when the rate of a process increases as the concentration of the product increases.

   Negative feedback controls the rate of a process to avoid accumulation of a product. The rate of a process will continuously accelerate under positive feedback as long as substrate is available and some other process does not consume the product.

b) Negative -Regulating of body temperature and blood glucose levels.

Positive - onset of **contractions** in **childbirth**.

2. For optimum function of body organs

Homoeostasis in plants

Refer to Learner's Book page 167

Activity 4.9

1. Discuss with learners what influences the opening and closing of stomata.
2. Carry out experiments to demonstrate closing and opening of stomata by the learners.
3. Stomata aperture is regulated in response to the requirements for uptake of carbon dioxide for photosynthesis and conserving water.
4. Explain that stomata have daily rhythms of opening and closing and also respond to changes in environmental conditions to allow diffusion of carbon dioxide and regulate water loss by transpiration
5. Describe the structure and function of guard cells and explain the mechanism by which they open and close the stomata.
6. Thereafter describe the role of abscisic acid in the closure of stomata during times of water stress (the role of calcium ions as a second messenger should be emphasised.

Answer to Check your progress 4.2

Refer to Learner's Book page 169

1. It continuously exchanges oxygen & carbon dioxide with atmosphere.
2. Carbon dioxide
3. There store water in metabolic fats or have mechanisms of minimizing water loss from the body.

4.2 Endocrine system

Refer to Learner's Book page 169

You will introduce learners to endocrine system by guiding them into performing a role-play as below:

- In this activity 4.10, you will divide learners into group of hormones (H) and a group of receptors(R).The hormones group has to find their matching receptors group, and the pair, once matched, performs a given action.
- Create puzzle pieces by cutting shapes out of cardboard and cut them in half, or use pieces from a jigsaw puzzle and label the back (plain) side of them.
- Each pair of puzzle pieces should be labelled: with an H on one half for hormone, and with an R for receptor on the other half.
- Write an action across both pieces, so that it can only be fully read when they are joined together. Possible actions include: jump like a frog, Crow like a cock, mew like a cat, Nod like a gecko etc.

1. Explain the procedure and discuss the specificity of the hormone-receptor interaction to the learners.
2. Pass out puzzle pieces to each one of you, but do not to look at the label on your piece.
3. Scatter throughout the entire classroom and then freeze.
4. Now look at your pieces:
    1. If you are a "receptor" remain frozen in place.
    2. If you are a "hormone" you may now move throughout the classroom.
    3. "Hormone" student must try to match his/her piece with each receptor piece until they successfully find a match.
    5. Once you have all matched your pieces (i.e. found your match), act out together the action written on your puzzle pieces.
    6. Engage the learners on what have learnt from this exercise.

7. Guide learners in carrying out the various activities suggested in the learners' book.

8. Thereafter use their presentations to explain the role of the skin in temperature regulation.

Answer to Check your progress 4.3

Refer to Learner's Book page 172

1. Produces sweat that cools the body.

2. The body needs more oxygen due to a debt.

3. To regulate blood glucose.

4. **Excretion is** a process in which any living organism removes their metabolic waste from the body.While **osmoregulation is** the physiological process that an organism uses to maintain water balance.

4.3 Osmoregulation

Refer to Learner's Book page 176

Activities 4.15, 4.16, 4.17

1. Provide learners with materials required to carry out the activities as suggested in the learner book.

2. Instruct learners to follow the procedures laid out in the activities.

3. Give learners time to resent and discuss their findings to the rest of the class.

4. Instruct learners to attempt check your progress 4.4.

Answer to Check your progress 4.4

Refer to Learner's Book page 185

1. Snake – 15°C, 37°C

2. Yes

3. Refer to Learner's Book page

4. a) at 36°C – dilated, at 4°C - constricted

UNIT 5 Genetics and inheritance

Refer to Learner's Book page 186 - 234

Learn about	Key inquiry questions
Learners should build on prior learning about cell structure, cell divisions, its types and significance and investigate the factors responsible for similarities and variations among the organisms of the same species. They should understand genes, chromosomes and their mechanisms of inheritance and explore Mendel's laws of inheritance (monohybrid and dihybrid inheritances). Learners should develop hypotheses to demonstrate monohybrid inheritance and the concepts of homozygous and heterozygous dominance, and complete and incomplete dominances. They should understand sex determination, sex linkage, allelic interactions and mapping of chromosomes, and the origin of variation and the significance of mutation. Learners should consider the structure of DNA and RNA, the human genome project, genetic engineering and the ethical considerations, and applications in biotechnology, with examples in fields of medicine, agriculture, food technology, animal production.	• How would you trace the origin of genetic variations among the organisms? • What are the theoretical evidences which indicate that genes are the basic unit of hereditary characters? • How would you design an experimental process to confirm Mendel's monohybrid inheritance in pea plants? • How does meiotic cell division cause a reduction in number of the chromosomes from diploid (2n) to haploid (n) during gamete formation? • What are the similarities and differences between Darwin's theory of evolution by natural selection and Lamarck's theory? • What is the role of mutation in evolution? • How do genetic variations occur in organisms? • How do genetic variations contribute in the process of evolution? • How would you distinguish between the inherited and acquired characters in organisms? • How do you apply the concept of genetic engineering in biotechnology? • How do we reconcile the possibilities and ethical considerations of genetic engineering?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• Understand basic genetics and inheritance; modern uses of knowledge of genetics.	• Design investigations on genetic crosses, predict outcomes, analyse results and evaluate them in terms of predictions • Develop hypotheses to demonstrate monohybrid inheritance and the concepts of homozygous and heterozygous dominance.	• Appreciate the wonder of genetics and inheritance the beauty of evolution • Rehearse the potential and ethical considerations of genetics.

Contribution to the competencies:

Critical and creative thinking: Developing hypotheses

Communication and co-operation: Students will work in groups in the laboratory, they will share their observation and ideas about variations in organisms.

Links to other subjects:

Chemistry: structure of DNA, enzymes and hormones, the reactions they are involved in.

Mathematics: calculation of different ratio, determination of the location of genes, percentages (%) of genes on gene map.

Biology: Physiology, Biochemistry and Ecology e.g. influence of environment on the organisms' behaviour and traits.

IT: accessing internet for the recent development in the field of Genetic Engineering & Biotechnology.

Introduction to the Unit

Genetics is the study of inheritance. The genetic changes as well as changes in the environment lead to variation. This topic deals with variation.

Emphasise on the type of variation, characteristics and importance of variation. Variation is any difference between cells, individual organisms, or groups of organisms of any species caused either by genetic differences (genotypic variation) or by the effect of environmental factors on the expression of the genetic potentials (phenotypic variation). Variation may be shown in physical appearance, metabolism, fertility, mode of reproduction, behaviour, learning and mental ability and other obvious or measurable characters

Cross cutting issues

1. Environmental awareness and sustainability

Let learners know importance of living organism to the sustainability of life in all spheres. Help them understand how important homeostasis is to both plants and animals.

2. Peace education

Whenever there is a discussion, bring to the attention of the learners the need to accommodate other people's views. Respect for the authority is mandatory; this must be extended to fellow learners. Let them observe discipline at all times.

3. Life Skills

Emphasise to learners the need to be keen when carrying out practical or field activities to avoid destruction of apparatus or field equipment. Where possible improvise devices, this not only saves resources but also teaches learners how to be innovative.

Generic competence

1. Critical and creative thinking

Guide learners to discover for themselves as they work in groups. This can also be achieved when learners answer probing questions and do more research on the topic by themselves. This competence also come about as learners think about their findings in the activities and as they give out their suggestions. Encourage learners to come up with innovative ways. This competence comes as learners participate in

pairs and groups work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in group discussions during presentation by asking questions.

2. Communication

The competence comes as learners participate in pairs and group work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in group discussion and during presentation by asking questions. The teacher should convey ideas effectively through spoken and written English by applying appropriate grammar and relevant vocabulary.

3. Cooperation

Encourage group work or shared assignment because as learners interact in pairs, they engage in discussion. This can also be achieved during presentation, you can allow rational presentation within group members.

5.1 Inheritance and key terms used in genetics

Refer to Learner's Book page 187.

Activity 5.1 and 5.2

Refer to Learner's Book pages 187 and 188

1. Organize learners into convenient groups.
2. Provide learners with pedigree diagrams.
3. Let learners have a brief discussion session on their findings then write summary notes. Correct them as is appropriate.
4. Allow learners to carry out a survey in class on variations.
5. They will record their findings and do class presentations thereafter.
6. Build on their findings to explain key terms used in genetics as they take notes.
7. Summarise the lesson by highlighting the key points.
8. Instruct learners to attempt Check your progress 5.1.

Answer to Check your progress 5.1

Refer to Learner's Book page 190

1. Inheritance
2. Nucleus
3. Pedigree
4. 23
5. First generation refers to the offsprings that are produced after crossing the parental genotypes while second generation is the crossing of the first generation offspring.
6. C

5.2 Monohybrid inheritance

Refer to Learner's Book page 191

Activity 5.3

1. Put learners into groups considering their abilities. Let them carry out this activity independently.
2. Provide learners with the required materials for the activity.
3. They should be able to follow the procedure in the Learner's Book to carry out the activity.
4. Allow each group to choose one representative to do a class presentation of their findings.
5. Ask the class to challenge each presentation.
6. Use their findings to explain monohybrid inheritance as they take notes.
7. Instruct learners to attempt Check your progress 5.2.

Answer to Check your progress 5.2

Refer to Learner's Book page 194

1. Mendel's law of independent assortment states that the alleles of two (or more) different genes get sorted into gametes independently of one another.

2. homozygous, heterozygous

3. A

4. A

5.

Male/ female	T	t
T	Tt	tt
T	Tt	tt

The phenotypic and genotypic ratio is 1:1

5.3 Hybrid and test cross

Refer to Learner's Book page 195

1. Introduce the lesson by posing questions such as:

   - What is a hybrid?

   Answer: A hybrid is an offspring that is produced after a cross of two pure line parents.

2. At this point take the learners through hybrid and test cross by highlighting practical examples as described in the Learner's Book.

3. Take the example provided in the Learner's Book on identifying the F_1 generation of a cross between a white fur rabbit and a black fur female rabbit. Draw the cross diagram on the chalkboard and explain the results.

4. Use this opportunity to distinguish between homologous recessive and homologous dominance.

5. Pose several other examples of such crosses to the learners and cross them to draw the cross diagram in their notebooks.

6. Go around the classroom assessing Student's results.

7. Summarise the lesson by highlighting common mistakes you have identified from the genetic crosses.You may also identify a challenging question to be worked out by a gifted learner.

5.4 Complete dominance, incomplete dominance and co-dominance

Refer to Learner's Book page 198

1. Ask probing questions to introduce the lesson. Such questions may include: In a certain species of plants, the gene for red colour of flowers and the gene for white colour of flowers are both dominant. State the genotypes of pure breeding:

   (i) White flowered plant.

   (ii) Red flowered plant. *Ans (i) WW (ii) RR)*

2. Why would the phenotypes of dominant alleles be represented in the offspring? *(Ans: since both alleles are dominant and are expressed equally in the phenotype.)*

3. This is a discussion activity on identifying traits controlled by co - dominant alleles.

4. Provide learners with work sheets.

5.
   - Let the learners write notes on co-dominance.
   - Summarise the lesson by highlighting the difference between co-dominance and incomplete dominance.
   - Instructing learners to do Check your progress 5.4.

Answers Check your progress 5.3

Refer to Learner's Book page 200

1. Refer to Fig. 5.5
2. Refer to Learner's Book page 199
3. A
4. A and B
5. AB – A and B, A-A
6. Refer to Learner's Book page 199

5.5 Genetic material

Refer to Learner's Book page 201

1. Introduce the lesson by asking the learners to recall the lesson on genetic materials.
2. At this point describe the structure of chromosomes and assist the learner in distinguishing between autosomes and heterosomes.
3. Organise learners in groups of five and ask them to research on the components of DNA.
4. Ask the learner to present their findings in groups.
5. At this point, draw the structure of the DNA on the chalkboard and describe the role of DNA in protein synthesis.
6. Take the learners through types of RNA and explain each in detail.
7. Let the learner identify the differences between DNA and RNA and note the differences in their books.

   - Summarise the lesson by describing the sex chromosomes.
   - Ask the learner to attempt Check your Progress 5.5 in their notebooks.

Answers Check your progress 5.4

Refer to Learner's Book page 206

1. Alleles -each of two or more alternative forms of a gene that arise by mutation and are found at the same place on a chromosome.

2. **DNA** is a long polymer with deoxyriboses and phosphate backbone. Having four different nitrogenous bases: adenine, guanine, cytosine and thymine. **RNA** is a polymer with a ribose and phosphate backbone. Four different nitrogenous bases: adenine, guanine, cytosine, and uracil.

3. DNA –double stranded, RNA – single stranded.

4. Autosomes

5.6 Sex determination in Human beings

Refer to Learner's Book page 207

Activity 5.4

2. Let the learners present their research work of activity 5.4 to the rest of the class.

3. Explain to the learners using a genetic cross how sex is determined in humans and indicate the chance of getting either a boy or girl.

1. Summarise the lesson by highlighting the fact that a man determines sex of a child since they can either pass X or Y unlike females who can only pass X; let the learners take summary notes.

Answer to Check your progress 5.5

Refer to Learner's Book page 208

1. Tendency of a characteristic to be linked to a gene.

2. Refer to Learner's Book page 207

3. Pair of alleles

5.7 Sex linkage

Refer to Learner's Book page 208

1. Ask probing questions to introduce the lesson. Such questions may include;

    - What is haemophilia? (*Ans. Also called the bleeder's disease is a genetic condition where the blood takes abnormally long to clot due to absence of certain clotting factors*).

    - Why is haemophilia more common in males than females? *(Ans: The recessive allele for haemophilia is located on the X chromosome; males have only one X chromosome, hence there cannot be carriers.They can either be hemophiliac or normal. Females on the other hand have two X chromosomes hence they have higher chance of being carriers or normal)*

2. At this point, you can introduce the lesson writing on the board the possible genotypes associated with haemophilia and by highlighting how the trait is transmitted from their parents.

3. Carry out a genetic cross to illustrate inheritance of haemophilia. Engage learners in question answer to ascertain level of understanding.

4. Give learners worksheets and select questions for them to attempt individually

5. Summarise the lesson by highlighting the effects of haemophilia to an individual.

6. Finalise by giving a talented learner a challenging question to work out to the rest of the class.

Answer to Check your progress 5.6

Refer to Learner's Book page 211

1. Haemophilia is a rare condition that affects the blood's ability to clot.

2. X

3. C

4. Half

5. Aquater

6. XcY

5.8 Variations among organisms

Refer to Learner's Book page 211

1. Organise learners to form groups of four. Learners should discuss about the different characteristics they have.Ask them to note these characteristics in their notebooks.

4. Ask them to identify the causes of such differences. Let them research on such variations that are caused by the environment and those caused by genes.

5. Use the contributions done by learners to point out more variations including blood groups, sex, gum colour etc. Explain to learners that these differences are known as variations. Genes or the environment can cause them.

6. End the lesson by instructing learners to attempt Check your progress 5.8.

Answers to Check your progress 5.7

Refer to Learner's Book page 214

1. A

2. B

3. Genetic variation is the variation in alleles and genes, both within and among populations while phenotypic variation is a type of Variation can be due to inheritance and also to environmental factors such as climate and diet.

4. Climate, diet and diseases.

5.9 Continuous and discontinuous variations

Refer to Learner's Book page 214

Activity 5.7, 5.8 and 5.9

1. Organise them into groups of five.

2. Let learners measure the heights of fellow class members and record in a table format.

3. Show them how to present the information collected into frequency and range table. Assist them to answer the study questions and the calculations involved.

4. Thereafter have a class discussion on characteristics that show continuous variation and discontinuous.

5. Have a class discussion on characteristics of discontinuous variations as they take notes.

6. Learners should discuss about the different between continuous and discontinuous variation. Ask them to note these characteristics in their notebooks.

7. End the lesson by instructing learners to attempt Check your progress Test 5.9

Answers to check your progress 5.8

Refer to Learner's Book page 219

1.

Continuous variations	**Discontinuous variations**
Weight, length of fore arm, height	Gender, blood groups

2. C

3. A

4.

Continuous variations	**Discontinuous variations**
This is a type of variation where there is a range of values.	This is the type of variation that has distinct groups for organisms to fall into.

5.10 Mutations

Refer to Learner's Book page 219

1. Learners are already conversant with using a mobile phone especially texting.
2. Ask them their experience and if they have ever send a text to a wrong recipient or a wrong text. What was their experience?
3. Relate the activity to mutation of genes in the DNA and explain to learners how mutations occur and its causes.
4. End the lesson by instructing learners to attempt Self-evaluation Test 5.10 on page 229.

Answers to Self-evaluation Test 5.9

Refer to Learner's Book page 221

1. D
2. A
3. True

5.11 Evolution

Refer to Learner's Book page 221

Activity 5.11 *Refer to Learner's Book page 222*

1. Let learners watch a film or a documentary of evolution. After the activity organise learner into groups of four.
2. Instruct each group to create their own experiments that demonstrate natural selection. Basically, they will need some items to represent the generations as well as a tool to weed out the "fittest."
3. Encourage learners to be creative.
4. They should be able to write directions for their experiment as well as demonstrate it if time allows. As they are demonstrating, they should be able to verbally explain how natural selection works 5.

   Assign a short writing exercise. Tell learners to write one to two pages on a species. They can fictionalise the species; describe the species' advantages and

how it may have changed over millions of years to adapt to the environment.

6. Learners can be as creative as they wish. For instance, if they want to create a deer with extra-long legs, the situation could be that food became higher, or that they had to run faster to get away from predators. Instruct learners to do the following:

   - Describe the species in the beginning.

7. Explain how it changed from generation to generation. Describe in detail the variation in heritable characteristics; how some characteristics gave individuals an advantage over others, and how this affected reproduction and future populations.

   Papers should show how the proportion of individuals that have advantageous characteristics would increase. Show learners different forms of these.

8. Thereafter, have a class discussion on natural selection as they take notes.

9. End the lesson by instructing learner to attempt Check your progress 5.10 on page 226 of the Learner's Book.

Answers to Check your progress 5.10

Refer to Learner's Book page 226

1. B

2. The occurrence of two or more clearly different morphs or forms, also referred to as alternative phenotypes, in the population of a species.

3. Lack of necessary genetic variation, constraints due to history.

5.12 Genetic engineering

Refer to Learner's Book page 227

1. Introduce the topic by asking learners to read the story in the Learner's Book page 227.The story will enable them understand how gene technology is applied in various fields.

2. Let learners discuss the story they have read using the study questions.

3. Using their findings explain what is gene technology.Organise a visit to a crop field or an animal farm around the school.Assist learners prepare questionnaire for activity 5.12 on page 229 of Learner's Book.

4. Instruct learners to write a report and present it to the rest of the class

5. Organise learners into groups.Then provide learners with computers having internet connectivity or reference materials to do research on genetic engineering.

6. Thereafter have a class discussion on genetic engineering as they take notes.

7. In Activity 5.13, organise learners into groups of four and provide them with study materials to observe industrial manufacture of insulin.

8. Let them carry out the activity then compare their findings with the rest of the class.

9. Build on their findings to explain the process of insulin manufacture and other examples of gene technology application.

10. Organise learners into groups of four. Let them discuss the advantage and disadvantages of GMO. Encourage learners to work as a team as they share duties,ideas and openly share their views.This will improve their team work, communication and interpersonal skills. Let learners contribute to the discussion.Correct these learners where they go wrong.

11. Build on their findings to explain the on advantages and disadvantages of GMOs as you cite examples.

12. End the lesson by asking learners to attempt Check your progress 5.12 .

Answers to check your progress 5.12

Refer to Learner's Book page 234

1. B

2. C

3. True

4. C

UNIT 6 Adaptation and Evolution

Refer to Learner's Book pages 235 - 256

Learn about	Key inquiry questions
Learners should investigate the theories of origin of life and common descent as explained by the different theories of evolution (chemical and biological). They should find out about the history of evolutionary thought, heredity, variation (mutation, sex and recombination and, gene flow), the mechanisms of evolution (natural selection, genetic drift); and the outcomes of evolution (adaptation, co-evolution, speciation and extinction). Learners should consider adaptation to changes in climate and environment and the Darwin notion of natural selection and survival of the fittest. Learners should investigate the evidence from fossils and geological periods human evolution, the social and cultural applications. They should learn about and describe forms of adaptations: physiological, morphological, anatomical and behavioural, and the essential conditions leading to those changes.	• How does the theory of evolution explain the beginning of life? • How would you explain the diversity of life forms? • How do you justify the need to know about organisms adaptations? • How can you explain the evidence of organic evolution? • How is divergent evolution different from convergent evolution? • How does evolution work on small scale? • How does evolution lead to the tree of life? • How do new species evolve? • How does evolution work on a grand scale?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• Describe how organisms are adapted to their environment, selection, evolution and evidence for it.	• Investigate fossil evidence, make observations and records to create hypotheses about evolutionary change.	• Appreciate the origin and beauty of life and diversity of life forms. • Value and preserve the remains (fossils) of organisms.
Contribution to the competencies Critical and creative thinking: Evaluating evidence in investigations Communication and co-operation: Discussion of how humans evolved is usually heated so communication is improved.		
Links to other subjects History Geography		

Introduction to the Unit

This content is about adaptation and evolution. Remind learners what they learnt about diversity of living organisms and environmental interactions and climate change in secondary Book 2.

Make them understand that at secondary 4, they must have basic understanding of biology and diversity of living things and how climate change is responsible for adaptations.

Evolution is essential to our curriculum and to scientific literacy. To understand the big picture of biology, students need to understand life on Earth in terms of its history and its future — the changing life forms and ecosystems that have arisen and changed over billions of years, as well as the mechanisms that have brought about those changes.

Remind learners that evolution is the theme that unifies all the different fields of biology. Emphasise to learners the links among evolution, biodiversity, DNA, and genetics. Today, the modern synthesis combines Charles Darwin's theory of evolution by natural selection with Mendelian genetics and the findings of population biology. In genetic terms, *evolution* occurs not to individuals, but to populations, and is defined as a change in the allele frequency in a population's gene pool. The fact that evolution occurs in populations (not individuals) must be emphasised.

Remind learners how important evolution is to the advance of biology as a discipline.

Cross cutting issues

1. Environmental awareness and sustainability

Let learners know importance of living organism to the sustainability of life in all spheres. Without green plants performing photosynthesis, there would be no way for nature to replace all the oxygen being consumed in processes such as respiration and combustion. Furthermore the levels of carbon dioxide in the atmosphere would increase. Thus, the balance of atmospheric gases is kept stable by photosynthesis and respiration.

2. Peace and values education

Whenever there is a discussion, bring to the attention of the learners the need to accommodate other people's views. Respect of the authority is mandatory; this must be extended to fellow learners. Let them observe discipline at all times.

3. Life Skills

Emphasise to learners the need to be keen when carrying out practical or field activities to avoid destruction of apparatus or field equipment.

Generic competence to be attained

1. Critical and creative thinking

Guide learners to discover on their own as they work in groups. This can also be achieved when learners answer probing questions and do more research on the topic. This competence is also achieved when learners think about their findings in the activities and as they give out their suggestions. Encourage learners to come up with innovative ways. This competence comes as learners participate in pairs and groups work and present their work to the rest of the class. Encourage all leaners

irrespective of their abilities to participate in-group discussions during presentation by asking questions.

2. Communication

The competence comes as learners participate in pairs and group work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in-group discussion and during presentation by asking questions. The teacher should convey ideas effectively through spoken and written English by applying appropriate grammar and relevant vocabulary.

3. Cooperation

As learners interact in pairs as they engage in discussion. This can also be achieved during presentations; you can allow rational presentation within group members.

4. Culture and identity

Learners should be tolerant to cultures of other students and be able to coexist peacefully without stigmatisation.

6.1 Meaning of Biological evolution

Refer to Learner's Book page 236

1. Introduce the learners by telling them to imagine how living organisms behave and even forage for food.

2. Ask learners what they understand by the word evolution. Give them real life example of changing technologies e.g. communication.

3. Show learners some photos depicting how human have evolved. Ask them about what they think humans will look like millions of years from now. Do they in agreement with the theory that human were once ape-like? Let them discuss in class.

4. Organise for class tour to a museum or an ancient town. Observe all the ancient objects including tools. This is for activity 6.1.

5. Let the learners appreciate the art collection at the local museum. If available, let them identify some old forms of art and natural history.

6. Let the learners compare the ancient bone structures at the museums and the current ones including those from animals such as cow, goats, dogs etc. Ask them whether the bones look alike? If not encourage them to give ideas why that is so.

7. While back in class, let the learners watch a movie about origin of life. Encourage them to ask questions related to the movie they have just watched.

8. Watch the movie provided on this link: https://www.youtube.com/watch?v=8SgnnV8nV9g_

   a. Relate your experience to the evolutionary history

9. What can it tell you about evolution

6.2 Theories about origin of life

Refer to Learner's Book page 238

1. Let each learner gave an account how life came about.

2. Divide learners into groups.

3. You will then engage learners in a discussion about the origin of life from a religious point of view.

4. Let each group present arguments supporting their opinions about the origin of life.

5. Let the learner compare various theories including theological beliefs about evolution.

6. Seek learners' opinion whether they agree with theories of creation other than own family point of view.

7. Let learners discuss chemical theory of evolution.

8. Ask them whether they believe that life arose from chemical reactions that gave rise to biomolecules such as proteins and nucleic acids?

9. Imagine what the situation would be like if you perform a simple experiment and instead a living organism arises as a result?

10. Share with the learners some aspects of environmental conservation and how important evolution is to the continuity of life on earth.

Answers to check your progress 6.1

Refer to Learner's Book page 240

1. Helps us solve biological problems that impact our lives, to know more about life.

2. Special creation, organic evolution, materialistic evolution, spontaneous creation

3. Refer to Learner's Book page 239

4. Refer to Learner's Book page *239*

6.3 Evidence of natural selection

Refer to Learner's Book page 240

This section examines evidence for evolution across many scientific disciplines paleontology, molecular biology, anatomy, and physiology and how this evidence is helping to determine evolutionary relationships between species.

1. Divide students into groups; let each group create stories related to the evidence.

2. Engage the students in analogy scenarios such as those given in Activity 6.2 in learner book. This makes them understand what evidence is about.

3. Mention all the evidences supporting organic evolution e.g. morphological evidences, Embryological evidences, Paleontological evidences, and Molecular evidences.

4. The evidences supporting organic evolution are derived from a number of fields of Biology.

5. Prepare various limbs of mammals e.g. cow, cat, dog, bat as an indicator of morphological evidence. Ask every leaner to identify the bones provided. Let learners compare their functionalities.

Mechanisms of evolution and Natural selection

Refer to Learner's Book page 244

This sub section looks at two key theories that will help in explaining the theories of evolution. Namely, Darwins theory and Lamark's theory of evolution.

Various theories about the mechanism of evolution have been proposed; some of them such as Lamarck's theory of "Inheritance of acquired characters" and DeVries' theory of 'mutation' are now of historical importance only. **Darwin's theory of Natural selection** still holds ground but was modified with progress in genetics and developed into the **Modern synthetic theory** which is regarded as the most valid theory of evolution.

1. Read to the learners the Larmark's and Darwin's theories of evolution. Find out their views about Lamark and Darwin's theories.
2. Using illustrations, demonstrate how a structure when in constant use can improve performance. Give examples of long distance runners whose lungs can endure 2 hours of constant running.
3. Tell learners the meaning of Inheritance of Acquired Characteristics in their own words Use in context new vocabulary.
4. Express opinions. Gather information from different books.
5. Show pictures of body builders to the learners. Ask them what has made body builders look different from non-body builders.
6. Explain to learners what modern theory of evolution is about.
7. Explain to the learners what natural selection is about.
8. Show images of various breeds of dogs. Engage learners on how this was achieved.
9. Explain to learners what Darwin-Wallace theories about natural selection are about as they take notes.

Answers to Check your progress 6.2

Refer to Learner's Book page 247

1. The available body of facts or information indicating whether a belief or proposition is true or valid.
2. Paleontological Evidences, Nature of Fossils, missing links, Embryological Evidences
3. The record of the occurrence and evolution of living organisms through geological time as inferred from fossils.

6.4, 6.5 and 6.6 Convergent and Divergent Evolution

Refer to Learner's Book page 251

Activities 6.4, 6.5, 6.6 and 6.7

1. Instruct learners to carry out the activities as suggested.
2. Let learners write a report and do a class presentation.
3. Allow learners to compare their findings with other groups.
3. Build on their presentation to explain convergent and divergent evolution as they take short notes.

UNIT 7 Support and movement in plants and animals

Refer to Learner's Book page 257-293

Learn about	Key inquiry questions
Learners should investigate the necessity of support and movement in plants and animals so they can survive in a changing environment. They should build on knowledge of cell structure, organisation, and tissue distribution of monocotyledon and dicotyledon plant organs. They should investigate plant responses to stimuli such as tropism, taxes and nasties, and understand plant growth hormones and photoperiodism and thigmotropism, and how this leads to movement. Learners should understand the structures involved in supporting and moving animals e.g. exo- and endo-skeletons and investigate bone structure and tissue in vertebrates, how muscles and joints work as levers, feathers, flight and streamlining of birds and fish, and the types of movements performed by or within animals e.g. pseudopodia, cilia or flagella and how movement occurs in multi-cellular invertebrates such as earthworms. They should understand the growth and repair of bones in mammals and the significance of exercise in humans for bone and muscle strength.	• How would you distinguish between monocotyledon and dicotyledonous plants? • How do you acknowledge the need for support and movement in plants and animals? • Why do mammals exhibit both axial and appendicular skeletons? • How do you rate the importance of muscles and their functions in maintaining the posture and locomotion in mammals? • How would you describe the disorders of the skeletons and their origins? • How would you apply the synthetic growth hormones for commercial purposes? • How would you distinguish the principal structures used for support and movement between plants and animals? • What are the advantages of all the various responses to external stimuli by plant?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• Understand how support is provided and movement takes place in plants and animals.	1. Design investigations and develop hypotheses about phototropism and geotropism in shoots and roots (radicles), make observations, record results and make judgement. • Investigate the microscopic structure of the vascular system in plant roots, stems and shoots and the structure and function of bones in animals with different forms of movement.	2. Appreciate the beauty of plants and mammalian internal structures

Contribution to the competencies

Critical and creative thinking: examining different skeletal structures of mammals

Communication: they will work in groups in the laboratory and will share their observation and ideas about different structures responsible in supporting movement in mammals.

Links to other subjects

Arts: drawing skeletal structures, shapes of tissue of the skeletons , feathers etc.

Biology: Physiology, Anatomy

IT: accessing internet for recent development in Biology.

Introduction to the Unit

Learner have already learnt about plants and animals movement before. In this unit make learners understand how support is provided and movement takes place in plants and animals.

All animals have skeletons of one sort or another. Mammals, birds, reptiles, amphibians and fish have bony skeletons. These skeletons come in all shapes and sizes, but they also share common features. The skeleton is the part of the body that forms the support structure of an organism. There are mainly three different skeletal types: the exoskeleton, which is the stable outer shell of an organism, the hydro skeleton and the endoskeleton, which forms the support structure inside the body.

Cross cutting issues

1. Environmental awareness and sustainability

Let learners know importance of living organism to the sustainability of life in all spheres. Without green plants performing photosynthesis, there would be no way for nature to replace all the oxygen being consumed in processes such as respiration and combustion. Furthermore the levels of carbon dioxide in the atmosphere would increase. Thus, the balance of atmospheric gases is kept stable by photosynthesis and respiration.

2. Peace and values education

Whenever there is a discussion, bring to the attention of the learners the need to accommodate other people's views. Respect of the authority is mandatory; this must be extended to fellow learners. Let them observe discipline at all times.

3. Life Skills

All learners should be encouraged to participate during lessons and group activities. Through such activities they gain requisite life skills.

Generic competence to be attained

1. Critical and creative thinking

Guide learners to discover on their own as they work in groups. This can also be achieved when learners answer probing questions and do more research on the topic. This competence is also achieved when learners think about their findings in the activities and as they give out their suggestions. Encourage learners to come up with innovative ways. This competence comes as learners participate in pairs and groups work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in-group discussions during presentation by asking questions.

2. Communication

The competence comes as learners participate in pairs and group work and present their work to the rest of the class. Encourage all learners irrespective of their abilities to participate in-group discussion and during presentation by asking questions. The teacher should convey ideas effectively through spoken and written English by applying appropriate grammar and relevant vocabulary.

3. Cooperation

As learners interact in pairs as they engage in discussion. This can also be achieved during presentations; you can allow rational presentation within group members.

4. Culture and identity

Learners should be tolerant to cultures of other students and be able to coexist peacefully without stigmatisation.

7.1 What is support and movement in plants and animals?

Refer to Learner's Book page 257

Activity 7.1 and 7.2 *Refer to Learner's Book page 259 and 260*
Group activity

1. Provide learners with diagrams, charts and pictures of different plants and animals. Alternatively give the computer with Internet connectivity.
2. Let learners do some research on support and movement in plants and animals.
3. They should answer questions like why the need for support and movement in plants and animals.
4. Use the activity suggested in the Learner's Book to probe learners' knowledge.
5. Provide learners with materials required for the activities. Let them carry out the activities as suggested in the Learner's Book.
6. Ask learners to present their findings in class as you correct.
7. Use their findings to explain the need for support in plants and animals.

Activity 7.3 and 7.4 *Refer to Learner's Book page 262 and 264*

1. Learners will use materials provided to carry out the suggested experiments to study the role of support in young plants and old plants.
2. Each group will come up with diagrams on the support structures of plant.
3. Build on their findings to explain the role of support in plants as they take notes.
4. Instruct learners to attempt check your progress 7.1.

Answer to Check your progress 7.1

Refer to Learner's Book page 265

1. Transport
2. Thigmotroism
3. Turgor pressure

7.2 Support and movement in plants

Refer to Learner's Book page 265

1. Introduce the unit by asking learners what they do when it is too hot or cold. Tell them their action constitutes a response while the hotness or coldness is the stimuli.

   Explain further that plants also exhibit stimuli. Plants do not move, only their parts respond to such by either growing towards or away.

2. Tell learners that plants mainly respond to two stimuli among many others i.e. light and gravity. For them to understand the need for tropism in plants introduce Activity 7.5. Let them do a research with reference materials you will provide.
3. In Activity 7.5 provide the learners with plants sensitive to touch. They will observe the plants for some days and record their observations.
4. Discuss with them their findings; explaining why no matter where the plant is placed in a dark room with an open window the plants will always grow towards the open window.
5. Take the learners out into the school field or surrounding farms.

6. Let them identify plants that respond to touch and structures some plants use for support.

7. Instruct them to make a drawing of the observed plant.

8. Tell the learners to make a report on their findings and present it to the class.

9. Build on learners' fieldwork findings and explain to them the meaning of thigmotropism and its importance.

Answer to Check your progress 7.2

Refer to Learner's Book page 266

1. Gravitropism

   i-poitive

   ii-positive

7.3 Support and movement in animals

Refer to Learner's Book page 266

1. Introduce the unit by asking learners to suggest reasons why some houses collapse during construction or thereafter.

2. Tell learners that constructing a house especially storied building requires a strong support structure. Most constructors use steel structure to support the house.

3. You can also site the frame that supports the roof of the classroom as an example of a support structure.

4. Tell them that the support structure holds the building together. In the same way organisms must have a support structure to hold its body parts together.

5. Introduce Activity 7.9 and let learners do a research on the need for support structures in organisms.

6. From their findings, discuss the need for support structures in organisms as they take notes.

7. Tell learners that there are three types of skeletons. You will tackle each separately.

8. Let learners do Activity 7.10 to learn about exoskeletons in insects. Guide them through the experiment. Caution them to be careful with the equipment used.

9. Provide learners with a sharp knife, hand lens and a preserved cockroach. Let them carefully observe the external structure of the skeleton of a cockroach.

10. Let them note down what they think about the firmness and rigidity of the exoskeleton.

11. Using a sharp knife let the learners cut across the thorax of the specimen. Let them observe the attachment of muscles to the exoskeleton.

12. Let learners make an outline of the exoskeleton and label it. Thereafter discuss their findings.

14. Using a pair of forceps let the learners hold the specimen while observing its body. Tell learners that the body of an earthworm has a fluid that supports it hence a hydro skeleton.

15. Ask learners if they eat fish and why they should very careful not to pierced or chocked by the bones.

16. Ask learners why they think fish has bones, they should also name other organisms that have bones within their body.

17. From their response discuss with them the importance of each skeleton.

7.4 Mammalian skeleton

Refer to Learner's Book page 280

1. Begin the lesson by Activity 7.14. Provide wall chart of unlabelled diagrams of the human skeleton or animal skeleton to the learners.

2. In pairs, let them discuss parts that make up central and peripheral skeleton. Ask the learners to label the following parts.

   - Skull
   - Ribcage/thoracic cage

- Vertebral column
- Upper limb
- Lower limb
- Shoulder/pectoral girdle

3. Provide learners with a model of the human skeleton. Let them individually identify and name the different parts of the human skeleton. Let them refer to a wall chart or the diagram of the in their textbook.
4. Organise learners in groups of five. Let learners model a human skeleton as directed. Guide them through the activity.
5. Let them draw and label the major bones from the central and peripheral skeleton. You will guide them on this activity.
6. For Activities 7.15 and 7.16. Organise learners into groups and provide each group with a different bone of the central skeleton. Each group will observe in rotation the different bones.
7. During the activity instruct learners to draw their observations then compare their diagrams with the ones on the wall charts. Let them label the diagrams.
8. Thereafter discuss with the learners the various bones of the central skeleton they have observed, their features, adaptations and use. Remind learners that the skeleton structure of mammals is similar.
9. Guide learners in activities 7.17, 7.18 and 7.19 in identifying the bones of the human body.
10. Instruct learners to attempt Check your progress 7.3

Answer to Check your progress 7.3

Refer to Learner's Book page 293

1. The axial Skeleton is the central core of the body and the appendicular skeleton forms the arms and legs.

2. Advantages of exoskeleton

- Excellent protection of vital organs, tough

Disadvantages of exoskeleton

- Heavy, least flexible, skeleton doesn't grow, when molting organism is defenseless.

Advantages of endoskeleton

Does protect vital organs, grows with individual, flexibility is improved, lighter than exoskeleton

Disadvantages of endoskeleton

Less protection than exoskeleton, bones break, less flexible than "no skeleton."