# INTEGRATED SCIENCE

TUTOR'S GUIDE

FOR TTCs


**OPTIONS:** LANGUAGE EDUCATION **(LE)**

&

SOCIAL STUDIES EDUCATION **(SSE)**

# FOREWORD

Dear Tutor,

Rwanda Basic Education Board is honored to present tutor's guide for Integrated Science in Languages Education **(LE)** & Social Studies Education **(SSE)** Option, Year Three of TTC which serves as a guide to competence-based teaching and learning to ensure consistency and coherence in the learning of Integrated Science subject. The Rwandan educational philosophy is to ensure that student-teachers achieve full potential at every level of education which will prepare them to be well integrated in society and exploit employment opportunities.

In line with efforts to improve the quality of education, the government of Rwanda emphasizes the importance of aligning teaching and learning materials with the syllabus to facilitate their learning process. Many factors influence what they learn, how well they learn and the competences they acquire. Those factors include the relevance of the specific content, the quality of tutor' pedagogical approaches, the assessment strategies and the instructional materials available. We paid special attention to the activities that facilitate the learning process in which student-teachers can develop ideas and make new discoveries during concrete activities carried out individually or with peers. With the help of the tutor student-teachers will gain appropriate skills and be able to apply what they have learnt in real life situations. Hence, they will be able to develop certain values and attitudes allowing them to make a difference not only to their own life but also to the nation.

This is in contrast to traditional learning theories which view learning mainly as a process of acquiring knowledge from the more knowledgeable who is mostly the teacher. In competence-based curriculum, learning is considered as a process of active building and developing of knowledge and understanding, skills and values and attitude by the student-teacher where concepts are mainly introduced by an activity, situation or scenario that helps the student-teacher to construct knowledge, develop skills and acquire positive attitudes and values.

In addition, such active learning engages student-teachers in doing things and thinking about the things they are doing and they are encouraged to bring their own real experiences and knowledge into the learning processes. In view of this, your role is to:

- Plan your lessons and prepare appropriate teaching and learning materials.
- Organize group discussions for student-teachers considering the importance of social constructivism suggesting that learning occurs more effectively when the student-teacher works collaboratively with more knowledgeable and experienced people.

- Engage student-teachers through active learning methods such as inquiry methods, group discussions, research, investigative activities and group and individual work activities.
- Provide supervised opportunities for student-teachers to develop different competences by giving tasks which enhance critical thinking, problem solving, research, creativity and innovation, communication and cooperation.
- Support and facilitate the learning process by valuing student-teachers' contributions in the class activities.
- Guide student-teachers towards the harmonization of their findings.
- Encourage individual, peer and group evaluation of the work done in the classroom and use appropriate competence-based assessment approaches and methods.

To facilitate you in your teaching activities, the content of this tutor's guide is self-explanatory so that you can easily use it. It is divided in 3 parts:

The part 1: Explains the structure of this tutor's guide and gives you the methodological guidance;

The part 2: Gives the sample lesson plans as reference for your lesson planning process;

The part 3: Provides the teaching guidance for each concept given in the student book.

Even though this tutor's guide contains the Answers to all activities given in the student-teacher's book, you are requested to work through each question and activity before judging student-teacher's findings.

I wish to sincerely appreciate all people who contributed towards the development of this tutor's guide, particularly REB staff who organized the whole process from its inception. Special gratitude goes to University lecturers, school teachers, illustrators and designers who diligently worked to successful completion of this tutor's guide. Any comment or contribution would be welcome for the improvement of this tutor's guide for the next edition.

**Dr. MBARUSHIMANA Nelson**

**Director General of Rwanda Basic Education Board**

# ACKNOWLEDGEMENTS

I wish to express my appreciation to all the people who played a major role in development of this Integrated Science Tutor's Guide for Languages Education **(LE)** & Social Studies Education **(SSE)** Options, Year Three of TTC. It would not have been successful without active participation of different education stakeholders.

I owe gratitude to different Universities and schools in Rwanda that allowed their staff to work with REB in the in-house textbooks production project. I wish to extend my sincere gratitude to lecturers, teachers and all other individuals whose efforts in one way or the other contributed to the success of writing of this tutor's guide. Special acknowledgement goes to teachers, tutors, illustrators and designers who participated in production of this tutor's guide.

Finally, my word of gratitude goes to the Rwanda Basic Education Board staff particularly those from the Curriculum, Teaching and Learning Resources Department who were involved in the whole process of in-house textbook writing.

**Joan MURUNGI,**

**Head of Curriculum, Teaching and Learning Resources Department**

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# PART I. GENERAL INTRODUCTION

## 1.0. About the tutor's guide

This book is a tutor's guide for Integrated Science subject, Year two in TTC. It is designed to accompany student teacher's book and intends to help tutors in the implementation of competence based curriculum specifically Integrated science syllabus.

As the name says, it is a guide that tutors can refer to when preparing their lessons. Tutors may prefer to adopt the guidance provided but they are also expected to be more creative and consider their specific classes' contexts and prepare accordingly.

## 1.1. The structure of the guide

This section presents the overall structure, the unit and sub-heading structure to help tutors to understand the different sections of this guide and what they will find in each section.

### Overall structure

The whole guide has three main parts as follows:

- **Part I: General Introduction.**

This part provides general guidance on how to develop the generic competences, how to integrate cross cutting issues, how to cater for student-teachers with special educational needs, active methods and techniques of teaching integrated science and guidance on assessment.

- **Part II: Sample lesson plan**

This part provides a sample lesson plan, developed and designed to help the tutor develop their own lesson plans.

- **Part III: Unit development**

This is the core part of the guide. Each unit is developed following the structure below. The guide ends with references.

Each unit is made of the following sections:

- **Unit title**
- **Key unit competence**
- **Prerequisites**

This section indicates knowledge, skills and attitudes required for the success of the unit. The competence-based approach calls for connections between units/topics within a subject and interconnections between different subjects. The tutor will find an indication of those prerequisites and guidance on how to establish connections.

- **Cross-cutting issues to be addressed**

This section suggests cross cutting issues that can be integrated depending on the unit content. It provides guidance on how to come up with the integration of the issue. Note that the issue indicated is a suggestion; tutors are free to take another cross-cutting issue taking into consideration the learning environment.

- **Guidance on the introductory activity**

Each unit starts with an introductory activity in the student-teacher's book. This section of the tutor's guide provides guidance on how to conduct this activity and related answers. Note that student-teachers may not be able to find the right solution but they are invited to predict possible solutions or answers. Solutions are provided by student-teachers gradually through discovery activities organized at the beginning of lessons or during the lesson.

- **List of lessons/sub-heading**

This section presents in a table suggestion on the list of lessons, lesson objectives copied or adapted from the syllabus and duration for each lesson. Each lesson /subheading is then developed.

- **End of each unit**

At the end of each unit the tutor's guide provides the following sections:

- Summary of the unit which provides the key points of content developed in the student-teacher's book.
- Additional information which provides additional content compared to the student-teacher's book for the tutor to have a deeper understanding of the topic.
- End unit assessment which provides answers to questions of the end unit assessment in the student-teacher's book and suggests additional questions and related answers to assess the key unit competence.
- Additional activities **:**( remedial, consolidation and extended activities)**.** The purpose of these activities is to accommodate each student-teacher (slow, average and gifted) based on end unit assessment results.

**Structure of each sub heading**

Each lesson/sub-heading is made of the following sections:

**Lesson /Sub heading title 1: ……..**

- **Prerequisites/Revision/Introduction:**

This section gives a clear instruction to tutor on how to start the lesson.

- **Teaching resources**

This section suggests the teaching aids or other resources needed in line with the activities to achieve the learning objectives. Tutors are encouraged to replace the suggested teaching aids by the available ones in their respective schools and based on learning environment.

- **Learning activities**

This section provides a short description of the methodology and any important aspect to consider. It provides also answers to learning activities with cross reference to student-teacher's book.

- **Exercises/application activities**

This provides questions and answers for exercises/ application activities.

## 1.2. Methodological guidance

### 1.2.1. Developing competences

Since 2015 Rwanda shifted from a knowledge based to a competence-based curriculum for pre-primary, primary and general secondary education. For TTCs, it is in 2019 that the competence-based curriculum was embraced. This called for changing the way of learning by shifting from teacher centered to a learner centered approach. Tutors are not only responsible for knowledge transfer but also for fostering student-teacher's learning achievement, and creating safe and supportive learning environment. It implies also that a student-teacher has to demonstrate what he/she is able to do using the knowledge, skills, values and attitude acquired in a new or different or given situation.

The competence-based curriculum employs an approach of teaching and learning based on discrete skills rather than dwelling on only knowledge or the cognitive domain of learning. It focuses on what learner can do rather than what learners know. Student-teachers develop basic competences through specific subject unit competences with specific learning objectives broken down into knowledge, skills and attitudes. These competences are developed through learning activities disseminated in learner-centered rather than the traditional didactic approach. The student-teachers is evaluated against set standards to achieve before moving on.

In addition to specific subject competences, student-teachers also develop generic competences which are transferable throughout a range of learning areas and situations in life. Below are examples of how generic competences can be developed in Integrated Science:

| **Generic competence** | **Examples of activities that develop generic competences** |
|---|---|
| Critical thinking | • Describe the relationship and interdependence of sciences<br>• Observe, record, interpret data recorded during experiments<br>• Identify and use the applications of integrated science concepts to solve problems of life and society |
| Research and Problem solving | • Research using internet or books from the library<br>• Design a project for making bioplastics<br>• Design a questionnaire for data collection during field visit |
| Innovation and creativity | • Create an experiment procedure to prove a point<br>• Develop a graph to illustrate information<br>• Design a data collection survey/questionnaire<br>• Conduct experiments with objectives, methodology, observations, results, conclusions<br>• Identify local problems and ways to resolve them |
| Cooperation, Personal and Interpersonal management and life skills | • Work in Pairs<br>• Small group work<br>• Large group work |
| Communication | • Organise and present in writing and verbally a complete and clear report of an experiment<br>• Observe, record, interpret the results of a measurement accurately.<br>• Select and use appropriate formats and presentations, such as tables, graphs and diagrams. |
| Lifelong learning | • Exploit all opportunities available to improve on knowledge and skills. Reading scientific journals to keep updated. |

### 1.2.2. Addressing cross cutting issues

Among the changes in the competence-based curriculum is the integration of cross cutting issues as an integral part of the teaching learning process-as they relate to and must be considered within all subjects to be appropriately addressed. The eight cross cutting issues identified in the national curriculum framework are: genocide studies, environment and sustainability, gender, Comprehensive Sexuality Education (CSE), Peace and Values Education, Financial Education, standardization Culture and Inclusive Education.

Some cross-cutting issues may seem specific to particular learning areas or subjects but the tutor needs to address all of them whenever an opportunity arises. In addition, student-teacher should always be given an opportunity during the learning process to address these cross-cutting issues both within and out of the classroom so as to progressively develop related attitudes and values.

Below are examples on how crosscutting issues can be addressed in integrated science:

| **Cross-cutting issues** | **Examples on how to integrate the cross-cutting issues** |
|---|---|
| Inclusive education | Involve all student-teachers in all activities without any bias.<br><br>Eg: Allow a student-teacher with physical disability (using wheelchair) to take notes or lead the team during an experiment. |
| Gender | Involve both girls and boys in all activities: No activity is reserved only to girls or boys.<br><br>Tutor should ensure equal participation of both girls and boys during experiments as well as during cleaning and tidying up related activities after experiments. |
| Peace and Values Education | During group activities, debates and presentations, the tutor will encourage student-teachers to help each other and to respect opinions of colleagues. Conscientiously use of materials during lab experiments to avoid any accidents. |
| Standardization culture | • Some lessons involve carrying out experiments. Instruction should be clear for student-teachers to always check if they are not using expired chemicals or defective apparatus.<br>• In addition, when performing experiments student-teachers have to record data accurately.<br>• For tasks involving calculations, they have to always present accurate results. |

| | |
|---|---|
| Environment and sustainability | • In order to avoid the environment pollution, before, during or after experiments student-teachers avoid throwing away chemicals anywhere; special places or appropriate containers should be used.<br>• Student-teachers also have to be aware of the impacts of the use of hydrocarbons as fuels, halogenoalkanes, and plastics on the environment. |
| Financial Education | When performing experiments, student-teachers are encouraged to avoid wasting chemicals by using the quantities that are just required. They are required to also avoid spoiling equipment and other materials… |

### 1.2.3. Attention to special educational needs specific to each subject

In the classroom, student-teachers learn in different way depending to their learning pace, needs or any other special problem they might have. However, the tutor has the responsibility to know how to adopt his/her methodologies and approaches in order to meet the learning need of each student-teacher in the classroom. Also, tutor must understand that student-teachers with special needs need to be taught differently or need some accommodations to enhance the learning environment. This will be done depending on the subject and the nature of the lesson.

In order to create a well-rounded learning atmosphere, tutor needs to:

- Remember that student-teachers learn in different ways so they have to offer a variety of activities (e.g. role-play, music and singing, word games and quizzes, and outdoor activities).
- Maintain an organized classroom and limits distraction. This will help student-teachers with special needs to stay on track during lesson and follow instruction easily.
- Vary the pace of teaching to meet the needs of each student-teacher. Some student-teachers process information and learn more slowly than others.
- Break down instructions into smaller, manageable tasks. Student-teachers with special needs often have difficulty understanding long-winded or several instructions at once. It is better to use simple, concrete sentences in order to facilitate them understand what you are asking.
- Use clear consistent language to explain the meaning (and demonstrate or show pictures) if you introduce new words or concepts.
- Make full use of facial expressions, gestures and body language.
- Pair a student-teacher who has a disability with a friend. Let them do

things together and learn from each other. Make sure the friend is not over protective and does not do everything for the student-teacher. Both student-teachers will benefit from this strategy

- Use multi-sensory strategies. As all student-teachers learn in different ways, it is important to make every lesson as multi-sensory as possible. Student-teachers with learning disabilities might have difficulty in one area, while they might excel in another. For example, use both visual and auditory cues.

Below are general strategies related to each main category of disabilities and how to deal with every situation that may arise in the classroom. However, the list is not exhaustive because each student-teacher is unique with different needs and that should be handled differently.

**Strategy to help student-teachers with developmental impairment:**

- Use simple words and sentences when giving instructions.
- Use real objects that the student-teacher can feel and handle, rather than just working abstractly with pen and paper.
- Break a task down into small steps or learning objectives. The student-teacher should start with an activity that s/he can do already before moving on to something that is more difficult.
- Gradually give the student less help.
- Let the student-teacher work in the same group with those without disability.

**Strategy to help student-teachers with visual impairment:**

- Help student-teachers to use their other senses (hearing, touch, smell and taste) to play and carry out activities that will promote their learning and development.
- Use simple, clear and consistent language.
- Use tactile objects to help explain a concept.
- If the student-teachers has some sight, ask them what they can see. Get information from parents/caregivers on how the student-teacher manages their remaining sight at home.
- Make sure the student-teacher has a group of friends who are helpful and who allow the student-teachers to be as independent as possible.
- Plan activities so that student-teachers work in pairs or groups whenever possible.

**Strategy to help student-teachers with hearing impairment:**

- Strategies to help student-teachers with hearing disabilities or communication difficulties
- Always get the student-teacher's attention before you begin to speak.
- Encourage the student-teacher to look at your face.
- Use gestures, body language and facial expressions.
- Use pictures and objects as much as possible.
- Ask the parents/caregivers to show you the signs they use at home for communication use the same signs yourself and encourage other student-teachers to also use them.
- Keep background noise to a minimum.

**Strategies to help children with physical disabilities or mobility difficulties:**

- Adapt activities so that student-teacher who use wheelchairs or other mobility aids, or other student-teachers who have difficulty moving, can participate.
- Ask parents/caregivers to assist with adapting furniture e.g. The height of a table may need to be changed to make it easier for a student-teacher to reach it or fit their legs or wheelchair under.
- Encourage peer support friends can help friends.
- Get advice from parents or a health professional about assistive devices.

### 1.2.4. Guidance on assessment

Each unit in the tutor's guide provides additional activities to help student-teachers achieve the key unit competence. Results from assessment inform the tutor which student-teacher needs remedial, consolidation or extension activities. These activities are designed to cater for the needs of all categories of learners; slow, average and gifted learners respectively.

Assessment is an integral part of teaching and learning process. The main purpose of assessment is for improvement. Assessment for learning/ **Continuous/ formative assessment** intends to improve student-teachers' learning and tutor's teaching whereas assessment of learning/summative assessment intends to improve the entire school's performance and education system in general.

**Continuous/ formative assessment**

It is an ongoing process that arises out of interaction during teaching and learning process. It includes lesson evaluation and end of sub unit assessment.

This formative assessment plays a big role in teaching and learning process. The tutor should encourage individual, peer and group evaluation of the work done in the classroom and uses appropriate competence-based assessment approaches and methods.

In Year one textbook, formative assessment principle is applied through application activities that are planned in each lesson to ensure that lesson objectives are achieved before moving on. At the end of each unit, the end unit assessment is formative when it is done to give information on the progress of students and from there decide what adjustments need to be done. Assessment standards are taken into consideration when setting tasks.

**Summative assessment**

The assessment done at the end of the term, end of year, is considered as summative. The tutor, school and parents are informed on the achievement of educational objectives and think of improvement strategies. There is also end of level/ cycle assessment in form of national examinations.

### 1.2.5. Student teachers' learning styles and strategies to conduct teaching and learning process

There are different teaching styles and techniques that should be catered for. The selection of teaching method should be done with the greatest care and some of the factors to be considered are: the uniqueness of subjects, the type of lessons, the particular learning objectives to be achieved, the allocated time to achieve the objective, instructional available materials, the physical/sitting arrangement of the classroom, individual student teachers' needs, abilities and learning styles.

There are mainly four different learning styles as explained below:

**a) Active and reflective learners**

Active learners tend to retain and understand information best by doing something active with it, discussing or applying it or explaining it to others. Reflective learners prefer to think about it quietly first.

**b) Sensing and intuitive learners**

Sensing learners tend to like learning facts while intuitive learners often prefer discovering possibilities and relationships. Sensors often like solving problems by well-established methods and dislike complications and surprises; intuitive learners like innovation and dislike repetition.

### c) Visual and verbal learners

Visual learners remember best what they see (pictures, diagrams, flow charts, time lines, films, demonstrations, etc); verbal learners get more out of words (written and spoken explanations).

### d) Sequential and global learners

Sequential learners tend to gain understanding in linear steps, with each step following logically from the previous one. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it."

## 1.2.6. Teaching methods and techniques that promote the active learning

The different student-teacher learning styles mentioned above can be catered for, if the tutor uses active learning whereby student-teachers are really engaged in the learning process.

### What is Active learning?

Active learning is a pedagogical approach that engages student-teachers in doing things and thinking about the things they are doing. In active learning, learners are encouraged to bring their own experience and knowledge into the learning process.

### The role of the tutor in active learning

- The tutor engages student-teachers through active learning methods such as inquiry methods, group discussions, research, investigative activities and group and individual work activities.
- He/she encourages individual, peer and group evaluation of the work done in the classroom and uses appropriate competence-based assessment approaches and methods.
- He provides supervised opportunities for student-teachers to develop different competences by giving tasks which enhance critical thinking, problem solving, research, creativity and innovation, communication and cooperation.
- Tutor supports and facilitates the learning process by valuing student-teachers' contributions in the class activities.

## The role of learners in active learning

Learners are key in the active learning process. They are not empty vessels to fill but people with ideas, capacity and skills to build on for effective learning. A learner engaged in active learning:

- Communicates and shares relevant information with other learners through presentations, discussions, group work and other learner-centred activities (role play, case studies, project work, research and investigation)
- Actively participates and takes responsibility for their own learning
- Develops knowledge and skills in active ways
- Carries out research/investigation by consulting print/online documents and resourceful people, and presents their findings
- Ensures the effective contribution of each group member in assigned tasks through clear explanation and arguments, critical thinking, responsibility and confidence in public speaking
- Draws conclusions based on the findings from the learning activities.

## Some active techniques that can be used in Integrated sciences

The teaching methods strongly emphasised in the competence Based Curriculum (CBC) are active methods. Below are some active techniques that apply in sciences:

### A. Practical work/ experiments:

Many of the activities suggested in the Integrated science curriculum as well as in the student-teacher's book are practical work or experiments.

Practical work is vital in learning Integrated science; this method gives the student-teacher the opportunity to implement a series of activities and leads to the development of both cognitive and hands-on skills. The experiments and questions given should target the development of the following skills in student-teachers: observation, recording and report writing, manipulation, measuring, planning and designing.

A practical lesson/Experiment is done in three main stages:

- **Preparation of experiment:** Checking materials to ensure they are available and at good state; try the experiment before the lesson; think of safety rules and give instructions to lab technician if you have any.
- **Performance of experiment:** Sitting or standing arrangement of student-teachers; introduction of the experiment: aims and objectives; setting up the apparatus; performing the experiment; write and record the data.

- **Discussion:** Observations and interpreting data; make generalisations and assignment: writing out the experiment report and further practice and research.

In some cases, demonstration by the tutor is recommended when for example the experiment requires the use of sophisticated materials or very expensive materials or when safety is a major factor like dangerous experiments and it needs specific skills to be learnt first.

In case your school does not have enough laboratory materials and chemicals, experiments can be done in groups but make sure every student-teacher participates. You can also make arrangements with the neighbouring science school and take your student-teachers there for a number of experiments.

### Research work

Each student-teacher or group of student-teachers is given a research topic. They have to gather information from internet, available books in the library or ask experienced people and then the results are presented in verbal or written form and discussed in class.

### B. Project work

Integrated science tutors are encouraged to sample and prepare project works and engage their student-teachers in, as many as possible. Student-teachers in groups or individually, are engaged in a self-directed work for an extended period of time to investigate and respond to a complex question, problem, or challenge. The work can be presented to classmates or other people beyond the school. Projects are based on real-world problems that capture learners' interest. This technique develops higher order thinking as the student-teachers acquire and apply new knowledge in a problem-solving context.

### C. Field trip

One of the main aims of teaching Integrated science in Rwanda is to apply its knowledge for development. To achieve this aim, we need to show to students the relationship between classroom science lessons and applied sciences. This helps them see the link between science principles and technological applications.

To be successful, the field visit should be well prepared and well exploited after the visit:

Before the visit, the tutor and student-teachers:

- agree on aims and objectives
- gather relevant information prior to visit
- brainstorm on key questions and share responsibilities
- discuss materials needed and other logistical and administrative issues
- discuss and agree on accepted behaviours during the visit
- Visit the area before the trip if possible, to familiarise yourself with the place

After the visit

When student-teachers come back from trip, the tutor should plan for follow-up. The follow-up should allow student-teachers to share experiences and relate them to the prior science knowledge. This can be done in several ways; either: Student-teachers write a report individually or in groups and give to the tutor for marking. The tutor then arranges for discussion to explain possible misconceptions and fill gaps. Or student-teachers write reports in groups and display them on the class notice board for everyone to read.

### Main steps for a lesson in active learning approach

All the principles and characteristics of the active learning process highlighted above are reflected in steps of a lesson as displayed below. Generally, the lesson is divided into three main parts whereby each one is divided into smaller steps to make sure that student-teachers are involved in the learning process. Below are those main parts and their small steps:

### 1) Introduction

Introduction is a part where the tutor makes connection between the current and previous lesson through appropriate technique. The tutor opens short discussions to encourage student-teachers to think about the previous learning experience and connect it with the current instructional objective. The tutor reviews the prior knowledge, skills and attitudes which have a link with the new concepts to create good foundation and logical sequencings.

## 2) Development of the new lesson

The development of a lesson that introduces a new concept will go through the following small steps: discovery activities, presentation of student-teachers' findings, exploitation, synthesis/summary and exercises/application activities, explained below:

- **Discovery activity**

**Step 1**

- The tutor discusses convincingly with student-teachers to take responsibility of their learning
- He/she distributes the task/activity and gives instructions related to the tasks (working in groups, pairs, or individual to instigate collaborative learning, to discover knowledge to be learned)

**Step 2**

- The tutor let the student-teachers work collaboratively on the task.
- During this period the tutor refrains to intervene directly on the knowledge
- He/she then monitors how the student-teachers are progressing towards the knowledge to be learned and boost those who are still behind (but without communicating to them the knowledge).

- **Presentation of student-teachers' productions**
  - In this episode, the tutor invites representatives of groups to present the student-teachers' productions/findings.
  - After three/four or an acceptable number of presentations, the tutor decides to engage the class into exploitation of the student-teachers' productions.
- **Exploitation of student-teachers's productions**
  - The tutor asks the student-teachers to evaluate the productions: which ones are correct, incomplete or false
  - Then the tutor judges the logic of the student-teachers' products, corrects those which are false, completes those which are incomplete, and confirms those which correct.
- **Institutionalization (summary/conclusion/ and examples)**
  - The tutor summarises the learned knowledge and gives examples which illustrate the learned content.
- **Exercises/Application activities**
  - Exercises of applying processes and products/objects related to learned unit/sub-unit
  - Exercises in real life contexts

- Tutor guides student-teachers to make the connection of what they learnt to real life situations. At this level, the role of tutor is to monitor the fixation of process and product/object being learned.

**3) Assessment**

In this step the teacher asks some questions to assess achievement of instructional objective. During assessment activity, student-teachers work individually on the task/activity. The tutor avoids intervening directly. In fact, results from this assessment inform the tutor on next steps for the whole class and individuals. In some cases, the tutor can end with a homework assignment.

# PART II: SAMPLE LESSON PLAN

**School Name: xxxxxxxxxxxx Teacher's name: xxxxxxxxxxxxxxxxxx**

| Term | Date | Subject | Class | Unit N° | Lesson N° | Duration | Class size |
|---|---|---|---|---|---|---|---|
| II | xxxxxxx | INTEGRATED SCIENCE | Y 3SSE/ LE | 2 | 1 of 7 | 40 min | 40 |
| **Type of Special Educational Needs and number of learners** | | | One student Teacher with Vision impairment will be provided audio<br><br>One student Teacher with Hearing impairment will be assisted by sign language | | | | |
| **Unit title** | | Human reproduction and family planning | | | | | |
| **Key Unit Competence:** | | Explain the role of human reproductive hormones, stages of pregnancy and family planning methods. | | | | | |
| **Title of the lesson** | | Anatomy of female human reproductive organs | | | | | |
| **Instructional objective** | | By using biological diagram of female reproductive system, student – teachers will be able to locate and describe the function of female reproductive organs correctly. | | | | | |
| **Plan for this Class (location: in / outside)** | | Inside | | | | | |
| **Learning Materials (for all learners)** | | Diagram or wall chart of female reproductive system, projector, computer, manila paper, etc. | | | | | |
| **References** | | Beckett, B.S. (1986) Biology a modern introduction, GCSE. Edition<br><br>Sylvia S. Mader (2010) Biology, New York, The McGraw-Hill. 10th Edition | | | | | |

| Timing for each step | Description of teaching and learning activity | | Competences and cross cutting issues to be addressed |
|---|---|---|---|
| | *Tutor provides biological diagram and guides student-teachers in respective groups while Student-teachers observe the female reproductive diagram, shares the ideas and describe each organ and its respective function. Thereafter, the tutor organizes the individual work.* | | |
| | **Tutor's activities** | **Student teacher's activities** | |
| **Introduction**<br>[7 min ] | Introduces the lesson by asking the following questions:<br>i. What are primary characteristics that differentiate a baby girl and baby boy?<br>ii. What are secondary sexual characteristics that differentiate a girl and a boy?<br>iii. How baby girls differ from a woman?<br>Displays the diagram of female reproductive system and ask student-teachers to suggest the title of the lesson of the day.<br>Shares the instructional objective with student-teachers. | Brainstorm the primary characteristics that differentiate a baby girl and a baby boy.<br>Brainstorm the secondary sexual characteristics that differentiate a girl and a boy.<br>Predict the differences between a baby girl and a woman.<br>Observe the diagram of female reproductive system and suggest the title the lesson. | **Communication Skills**<br>Student-teachers develop communication through listening, answering tutor question and following the instruction.<br>**Critical thinking**<br>Student-teachers develop critical thinking while thinking and predicting the differences between a baby girl and a woman |

| | | | |
|---|---|---|---|
| **Development of the lesson**<br>[25 min] | Forms groups using counting methods and ask student teachers to join their respective groups and nominate the team leader and secretary for each group.<br><br>Distributes the worksheet or writes the work on chalkboard.<br><br>**Guiding Worksheet:**<br><br>The diagrams below represent female reproductive system. Observe and use them to:<br><br>  <br><br>Use the diagram indicating the female human reproductive system to locate and suggest the function of the following female human reproductive organs on the diagram: urethra, vagina, uterus, ovaries and oviducts. | Join their respective groups; select the team leader and secretary.<br><br>Manipulate the teaching and learning materials.<br><br>Observe the diagram provided by the tutor<br><br>Follow the instruction and carry out the activity using worksheet.<br><br>Do the activity and ask guidance of the tutor in case they have difficulties.<br><br>Follow guiding worksheet and answer questions on guiding worksheet.<br><br>Write short notes describing the role of female reproductive organs in their respective groups. | **Inclusive education** It is addressed through proving clear guiding worksheet to each group.<br><br>**Communication skill**<br><br>Student-teachers develop<br><br>communication through sharing ideas in groups<br><br>**Critical thinking**<br><br>Student-teachers develop critical thinking through answering questions.<br><br>**Critical thinking**,<br><br>Student-teachers develop critical thinking, creativity and innovation while writing short notes. |

| | | | |
|---|---|---|---|
| | Asks student-teachers to follow the instruction and do the activity using the guidance of worksheet activity.<br><br>Instructs student-teachers to help each other while doing the activity.<br><br>Monitors how the student-teachers do the activities.<br><br>Asks student-teachers to write short notes describing the role of female reproductive organs.<br><br>Asks student-teachers to present the findings.<br><br>Allows each group to present what they have discussed to the whole class.<br><br>Compare the findings of all groups and allow students-teachers to comment other's presentation. | Present their findings to the whole class.<br><br>Ask questions on what they do not understand in the presented findings.<br><br>Guided by tutor, student-teachers make a summary and write it in their notes progressively. | **Gender Education Is addressed**<br><br>through inviting both girls and boys to **make presentation.** and **express ideals** |

| | | | |
|---|---|---|---|
| | Through probing questions, guides student-teachers to mention the female reproductive organs observed on the diagram and help them progressively to write on the chalkboard or flipchart.<br><br>Asks student-teachers to note it in their notebooks. | | |

| | | | |
|---|---|---|---|
| **Assessment**<br><br>**[8min]** | Displays a clear diagram representing a female reproductive system and asks student-teachers to do the related activities individually. Refer to the application activity 1.1 in student-teacher's book. (Consider question 1 and 3).<br><br>Marks the work and provide feedback. | Observe the displayed diagram and attempt related questions individually, thereafter submit the work. | Student-teachers develop research and problem solving and critical thinking through answering questions. Student-teachers develop critical thinking, creativity and innovation while providing answers. |
| **Teacher self-evaluation** | | | |

# PART III: UNITS DEVELOPMENT

# UNIT 1

# BASIC BIOCHEMISTRY OF LIFE

## 1.1. Key unit competence

Explain the cellular respiration and photosynthesis.

## 1.2. Prerequisites

Student-teachers have learnt the following in unit 3 of year one:

- Cell structure

The tutor starts the unit by asking questions related to the structure of chloroplast and mitochondria studied in year one to ensure that student-teachers have good foundation on the structure the organelles.

## 1.3. Cross cutting issues to be addressed

In this unit, the following cross cutting issues will be addressed:

### a) Inclusive education

To address inclusive education, while student-teachers will be conducting learning activities and experiments, instructional information should be given clearly and student-teachers with visual or physical impairment will be involved in learning activities and experiments. They can sometimes use their sense organs for identifying the results and observe the experimental results in order to draw conclusion.

Provide procedure earlier before the experiment so that student-teachers get familiar with them. They can be written on the chalkboard or printed depending on available resources. If you have children with low vision remember to print in appropriate fonts.

### b) Gender education

In all lessons of this unit, design the activities that give equal opportunity to both girls and boys. For example: mixing boys and girls in group work, while setting tasks and when presenting. Gender can be integrated by emphasising on the role of everyone in environmental protection.

Tutors should ensure equal participation of both girls and boys during experiments as well as during cleaning and tidying up related activities after experiments.

**c) Environment and sustainability**

As a tutor, emphasise to the student-teachers that environment must be sustainably protected. This emphasis could be done when you facilitate student-teachers to relate this lesson to environment and sustainability. For effective facilitation, you can ask questions about the interrelation between environment and respiration. From this question, student-teachers will realise the intimate relationship between environment and respiration so that they will take positive side to environment protection for the sustainability of all livings. Then, you can extend their ideas by providing other reasons for environment protection and sustainability like being the source of food which is used during respiration, habitat of producers which produce food need for all living organisms etc.

**d) Financial Education**

Financial education will be addressed when student-teachers will be discussing on the importance of photosynthesis on Earth and how modern agricultural technologies lead to high production from economies of scale since the misuse of them leads to economic depletion as well to other human's effects that will need more money to overcome them in terms of the money that is invested in the process and that will be used to deal with consequences.

Additional questions may be asked at the end of each lesson after student-teacher's presentation of the findings as well as the conclusion for emphasizing on finance as well as environment and sustainability.

## 1.4. Guidance on introductory activity

Tutor introduces using a story telling about cellular respiration and photosynthesis. Bring wall chart of a person making a physical exercise (push up) and Ask student-teachers to answer questions of **introductory activity 1** as designed in Student-teacher's book. The following are hints on the questions asked in the introductory activity:

i. The human body carries out its main functions by consuming food and turning it into usable energy. Immediate energy is supplied to the body in the form of adenosine triphosphate (ATP) through cellular respiration process.

ii. All living organisms require a continuous supply of energy to stay alive, either from the absorption of light energy or from chemical potential energy.

iii. The body activities of pushing up and holding the body mass consume too much energy which is generated by body cells.

iv. The energy required by the body requires aims to live, do everyday activities and cardio exercise such as long distance running, and is generated by a sugar burning process in the body cells known as aerobic respiration. Yes, all parts of the body (muscles, brain, heart, and liver) need energy to work. This energy comes from the food we eat. Once in the bloodstream, glucose from what we eat can be used immediately for energy or stored in our bodies, to be used later.

## 1.5. List of lessons

| # | Lesson title | Learning objectives | Number of Periods |
|---|---|---|---|
| 1 | Cellular respiration | • Define the cell respiration<br>• Explain what happens during the cell respiration;<br>• Describe the role of anaerobic respiration in yeast during bread making.<br>• Compare aerobic and anaerobic respiration. | 2 |
| 2 | Photosynthesis | • Explain the types of nutrition.<br>• Explain the role of light in autotrophic nutrition.<br>• Recall the structure of the leaf in relation to photosynthesis.<br>• Describe the role of chloroplast pigments (chlorophyll a, chlorophyll b, carotene and xanthophylls) in light absorption in the grana. | 2 |
| 3 | Factors affecting the rate of photosynthesis | • Carry out an investigation of limiting factors on photosynthesis.<br>• Explain the term limiting factor in relation to photosynthesis. | 1 |
| 4 | Importance of photosynthesis | • Describe the importance of photosynthesis process on earth. | 1 |
| 5 | End unit assessment | | 1 |

## Lesson 1: Cellular respiration

### a) Learning objectives

- Define the cell respiration;
- Explain what happens during the cell respiration;
- Describe the role of anaerobic respiration in yeast during bread making.

  Compare aerobic and anaerobic respiration.

**b) Teaching resources:** Student-teacher's books, computer and a projector, pictures or illustrations, internet, simulation and animation, etc.

### c) Prerequisites/Revision/Introduction

Student-teachers will learn better process of cellular respiration if they know the need for energy in living organisms, the structure of ATP and other substrate involved in cellular respiration. The tutor can introduce the lesson by asking to the learners the origin of the carbon dioxide we breathe out during the gaseous exchange.

### d) Activity 1.1

**Guidance**

- It is better to give the handout of the activity 1.1 and make groups of 5 to 7 members a day before the lesson to allow student-teachers make research from the library textbooks or search engine
- Provide Flipchart of Manilla paper and marker pens to each group.

So, on the very day of the lesson, select randomly a group to present their findings and allow other groups to comment, supplement of argue. If necessary, tutor consolidates learners' findings and lets them time to write summary of the lesson.

At the end of the lesson development, help student-teachers to summarize the lesson through questions and then write the feedback as being amended on the chalkboard or flipchart and ask student-teachers to note it in their notebooks.

### Answer to activity 1.1

1. i. Respiration, In the cells, in mitochondria

   ii. Mitochondria in eukaryotic cell and mesosome in prokaryotic cell.

   iii. Main ideas are the following:

- During glycolysis (first step in cellular respiration), two molecule of pyruvate are formed from one molecule of glucose. Glycolysis break down glucose and forms pyruvate with the production of two molecule of ATP
- The role of Coenzyme A in the link reaction is the fix the radical acetyl in acetyl-CoA
- Reduced $NAD^+$ and FAD in the Krebs cycle are carriers of protons and electrons which will flow on the cristae of the mitochondria in order to produce ATP.
- The final acceptor of protons and electrons in the respiratory chain is oxygen gas which will be reduced into water molecule.

2.

(a) During baking, yeast is mixed with water and sugar to activate it. The mixture is added to flour to make dough, and left in a warm place. The dough rises as the yeast respires and releases carbon dioxide, which gets trapped in the dough. When the dough is cooked, the high temperature kills the yeast and evaporates any alcohol formed. Air spaces are left where the carbon dioxide is trapped, which gives the bread a light texture.

(b) The yeast respires anaerobically during fermentation producing an alcohol (ethanol) making the drink alcoholic. Carbon dioxide present makes the drink fizzy. The bubbles are due to carbon dioxide produced during fermentation.

(c) Alcohol.

(d) Fermentation process.

## e) Application activity 1.1

To verify student-teachers progress, let student-teachers attempt application activity 1.1. Student-teachers can do this exercise either in the course of this lesson if there is still time or as home work. Make sure you mark the student-teachers' homework. Let student-teachers do individually or in pairs.

## Answer to application activity 1.1

i. A= cytosol, B= mitochondria

ii. Total energy yield= (6+6+2+2+18+4) ATP= 38ATP

iii. Energy produced during cellular respiration is used in different body processes like movement, digestion, transport of nutrients and information (nerve impulse), etc.

iv. The total energy increase as well as the glucose molecule increases and decreases if the molecule of glucose also decreases.

The symptoms were caused by rapid consumption of energy produced during cellular respiration which leads to muscles tiredness. The diaphragm and, to a lesser extent, the intercostal muscles drive respiration during quiet breathing. Additional 'accessory muscles of respiration' are typically only used under conditions of high metabolic demand.

## Lesson 2: Photosynthesis

### a) Learning objectives

- Explain the types of nutrition.
- Explain the role of light in autotrophic nutrition.
- Recall the structure of the leaf in relation to photosynthesis.
- Describe the role of chloroplast pigments (chlorophyll a, chlorophyll b, carotene and xanthophylls) in light absorption in the grana.

**b) Teaching resources:** Student-teacher's books, beakers, computer and a projector, pictures or illustrations, internet, simulation and animation and guiding worksheet.

### c) Prerequisites/Revision/Introduction

Student-teachers learn better this lesson if they know the following:

- Structure of the plant leaf and its function

Tutor introduces the lesson by asking questions about the structure and the functions of leaf that help student-teachers to remember what they have studied in senior two. This will be a good foundation to learn this unit.

### d) Activity 1.2

### Guidance

- Prepare in advance some setups as shown in the student-teacher textbook so as to demonstrate the production and test for oxygen gas produced through the process of photosynthesis.
- Organize student-teachers in groups and provide all materials needed to carry out the activity.
- Allow a volunteer to read the activity 1.2 and let the remaining to answer questions of the activity.
- Let another volunteer test the gas in the test tube from the setup made by the teacher.

- Give about 20 minutes for groupwork so that each group can setup the experiment, collect and test for oxygen gas.
- Allow the whole class to ask questions related to the presented findings.

### Answer to activity 1.2

i. The gas relights the glowing splint

ii. Oxygen

iii. Because in the second inverted test tube filled with water there is no production of gas.

iv. Light dependent step.

### e) Application activity1.2

To verify student-teachers progress, let student-teachers attempt application activity 1.2. Student-teachers can do this exercise either in the course of this lesson if there is still time or as home work. Make sure you mark the student-teachers' homework. Let student-teachers do the work individually or in pairs.

### Answer to application activity 1.2

i. Carbon dioxide and water. / (i) & (ii) Eq $nCO_2 + nH_2O \rightarrow C_6H_{12}O_6 + n\ O_2$

ii. Glucose and oxygen.

iii. If substance 1 and 4 are absent, photosynthesis cannot happen because they act as reagent of the photosynthesis reaction.

iv. Photosynthesis makes the glucose that is used in cellular respiration to make ATP. The glucose is then turned back into carbon dioxide, which is used in photosynthesis. While water is broken down to form oxygen during photosynthesis, in cellular respiration oxygen is combined with hydrogen to form water.

## Lesson 3: Factors affecting the rate of photosynthesis

### a) Learning objectives

- Carry out an investigation of limiting factors on photosynthesis.
- Explain the term limiting factor in relation to photosynthesis.

**b) Teaching resources:** Student-teacher's books, computer and a projector, pictures or illustrations, internet, simulation and animation and guiding worksheet.

### c) Prerequisites/Revision/Introduction

Student-teachers learn better this lesson if they know the following:

- Steps and mechanisms of photosynthesis.

Tutor introduces the lesson by asking questions about the reagent and conditions required for photosynthesis to take place in order to help student-teachers to remember what they have studied in previous lesson. This will be a good foundation to learn this lesson.

### d) Activity 1.3

**Guidance**

- Introduce this activity as homework ending the lesson 2. Hence, each group will get enough time to carry out research.
- Read for the entire class the 2 questions in the activity 1.3. and the ask them to organize in groups and make research from the library
- Next time allow a group to present their findings and other supplement or ask questions.

### Answer to activity 1.3.

1) The beans growing in free environment grow properly due to light absorption and produce a quality yield, the beans growing under the other trees are inhibited and do not get sufficient light for their growth, therefore they give poor yield.

2) Refer to the note in the student-teacher textbook.

- **Temperature**: the reactions of the photosynthesis are enzyme-controlled. Therefore, at lower temperature the enzymes are not activated. The optimum temperature is between 30-40°C. Above this range the rate of photosynthesis will decrease due to the denaturation of the enzymes
- **Light intensity**: No light, not photosynthesis either. There are ranges of wavelength at which the absorption spectrum is optimum for photosynthetic pigments.

- **Concentration of $CO_2$**: is the raw material for photosynthesis. Up to 0.03%, of $CO_2$ the rate of photosynthesis can still increase. Above this concentration, the amount of $CO_2$ is no long limiting factor of photosynthesis.
- **Amount of water**: The photosynthesis rate is low when the soil is dry, it increases when the content of water increases for the terrestrial plants, and for the aquatic plants it remains constant as long as they are fixed in water.

### e) Application activity

Ask student-teachers to work in pair or in group to answer the questions of application activity 1.3. Avail all material, monitor the activity, assess other's work and provide feedback.

### Answer to application activity 1.3

The addition of sodium bicarbonate always causes the increase of bubbles due to the increase of carbon dioxide. Increase in light intensity is in linear relation with increase in rate of photosynthesis; therefore, a graph is plotted showing the effect of light on photosynthesis.

## Lesson 4: Importance of photosynthesis

### a) Learning objective

- Describe the importance of photosynthesis process on earth.

**b) Teaching resources:** Student-teacher's books, computer and a projector, pictures or illustrations, internet, simulation and animation.

### c) Prerequisites/Revision/Introduction

Student-teachers learn better this lesson if they know the following:

- Steps and mechanisms of photosynthesis.
- Factors affecting the rate of photosynthesis.

Tutor introduces the lesson by asking questions about the factors affecting the rate of photosynthesis in order to help student-teachers to remember what they have studied in previous lesson. This will be a good foundation to learn this lesson.

## d) Activity 1.4

**Guidance**

- Organize student-teachers in groups and provide the diagram needed or use student-teacher's book to carry out the activity.
- Guide student-teachers to read and clarifying the key concept as indicated in student-teacher's book.
- Move around the groups guiding, facilitating them and verifying the results obtained.
- Select some groups (1 or 2) to share their answers to the whole class by requesting the group representative to write them on the chalkboard or flipchart. In this practice, ask student-teachers of both sexes to present their ideas.
- Ask other groups to add any ideas on what other groups have presented if they have them.
- Allow the whole class to ask questions related to the presented findings.
- Tutor starts the lesson by briefing the student-teachers about autotrophic organisms and how we are dependent on these for food.

## Answer to activity 1.4

i. The animals receive oxygen gas that they use for respiration and carbohydrates during nutrition. The plants gain carbon dioxide produced by plants during respiration and minerals excreted in different physiological process.

ii. The animals and plants are interdependent in an ecosystem because they depend on each other for basic survival needs like food, protection, shelter and propagation. Plants depend on animals for $CO_2$, (during photosynthesis), animals depend on plants for oxygen and carbohydrates (during breathing and nutrition). Both animals and plants depend on sun, air, water, soil for their growth.

iii. The aquatic plants are food of animals and they produce oxygen during photosynthesis which is used by animals in respiration process.

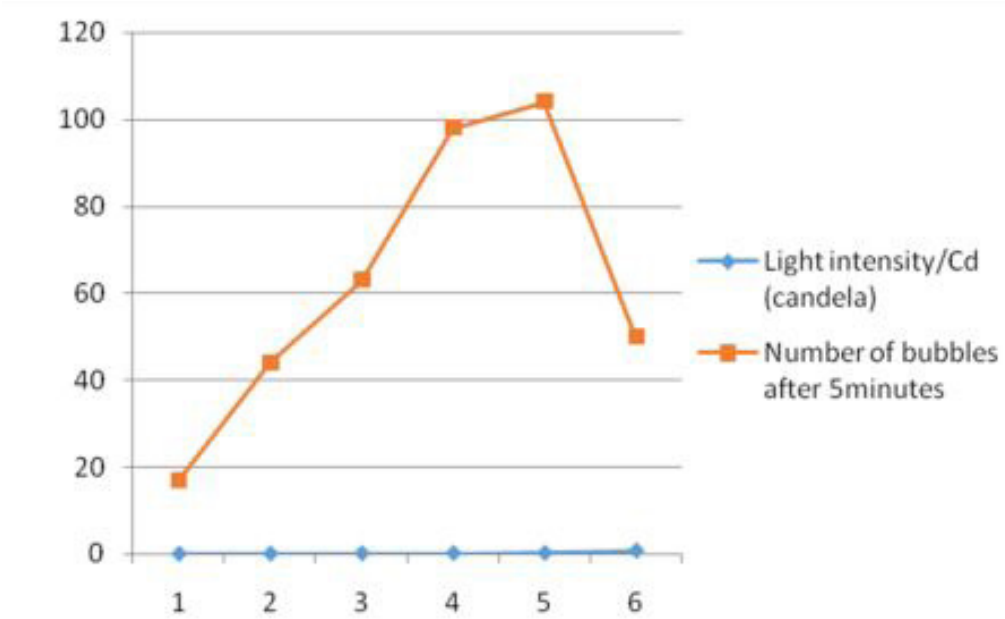
## e) Application activity

Ask student-teachers to work in pair or in group to answer the questions of application activity 1.4. Avail all material, monitor the activity, assess other's work and provide feedback.

**Answer to application activity 1.4**

a) The leaf I has no starch because the Vaseline did not allow diffusion of $CO_2$ gas. Other leaves trapped the light and their stomata on the lower side were not obstructed.

b) (i) Graph showing the number of bubbles with light intensity




ii. The recorded data between 0.25 and 0.75 C shows the decrease of bubbles production which indicates the effect of high light intensity on photosynthesis.

## 1.6. Summary of the unit

Cellular respiration begins in the cytoplasm and, in the case of aerobic respiration, is completed in mitochondria in eukaryotes; it takes place in the cytoplasm of prokaryotes.

Mitochondria possess two membranes: a smooth outer membrane and a highly folded inner membrane that contains many proteins used in cellular respiration. ATP may be formed by substrate-level phosphorylation or oxidative phosphorylation.

Substrate-level phosphorylation does not require oxygen; oxidative phosphorylation does. In substrate-level phosphorylation, a phosphate group is attached to ADP in an enzyme-catalysed reaction. Oxidative phosphorylation is made up of redox reactions involving NAD, FAD, an electron transport chain, the inner mitochondrial membrane, ATPase, and oxygen as the final electron acceptor.

Glycolysis occurs in the cytoplasm. It produces two three-carbon pyruvate molecules from a six-carbon glucose molecule. Glycolysis produces two ATP (net) and two NADH. Pyruvate oxidation occurs in the mitochondria. In the process, a $CO_2$ portion is cleaved from pyruvate and removed from the cell as waste. The remaining two-carbon acetyl group attaches to coenzyme A to produce Acetyl-CoA. In this reaction, two NADH and two $CO_2$ are formed (one for each of the two

pyruvate molecules).

The Krebs cycle occurs in the mitochondrial matrix. It begins when Acetyl-CoA reacts with

oxaloacetate to produce citrate. The two carbon atoms introduced by Acetyl-CoA are removed as two $CO_2$, one ATP molecule is produced by substrate level phosphorylation, one $FADH_2$ and three NADH are produced, and the final step regenerates oxaloacetate.

The electron transport chain, associated with the inner mitochondrial membrane, transports electrons through a series of redox reactions that release the free energy used to pump protons into the mitochondrial intermembrane space, creating an electrochemical gradient that is a source of free energy.

In chemiosmosis, protons move through ATPase complexes embedded in the inner membrane, releasing free energy that drives the synthesis of ATP.

Oxygen is the final acceptor of electrons that pass through the electron transport chain. If oxygen is not available, the Krebs cycle, electron transport, and chemiosmosis come to a halt.

Organisms that are autotrophic can make their own food from inorganic substances with the help of energy. Photosynthesis is the process where the source of energy is light. It is carried out by green plants, algae and some bacteria.

Photosynthesis takes place in green parts of a plant, mainly leaves. Within leaves, chloroplasts in mesophyll cells are the site of photosynthesis.

Photosynthesis has two stages: light reaction and dark reaction. Light reaction is a photo-chemical reaction, in which light energy is absorbed by the pigments present in antenna molecules of light harvesting complex. While, in dark reaction carbon is reduced in the stroma of chloroplast.

Chlorophyll, a molecule is the reaction centre which has two special forms PSI and PSII with absorbance maxima at 700 nm and 680 nm, respectively.

In temperate plants, C-3 cycle takes place with the help of enzyme RUBISCO. The C-3 cycle includes: carboxylation, reduction and regeneration. In some tropical plants, C-4 cycle takes place.

C-4 cycle includes dual carboxylation that takes place in mesophyll cells chloroplast and bundle sheath cell chloroplasts.

Various environmental factors such as light, temperature, carbon dioxide concentration, oxygen concentration and air pollutants are responsible for the plant productivity on account of photosynthesis.

## 1.7. Additional Information for tutors

Cells need substances as well as energy. Not all the organic molecules of food are destined to be oxidized as fuel to make ATP. In addition to calories, food must provide the carbon skeleton that cells require to make their own molecules. Some organic molecules obtained from digestion can be used directly. For example, as previous mentioned, amino acids from the hydrolysis of proteins in food can be incorporated into the organism's specific molecules that are not present as such in food. Compounds formed as intermediates of glycolysis and the Krebs cycle can be diverted into anabolic pathways as the precursor from which the cell can synthesize the molecules it requires.

For example, human can make about half of 20 amino acids in proteins by modifying compounds siphoned away from the Krebs cycle. Also glucose can be made from acetyl-coA. Of course these anabolic pathways do not generate ATP, but instead consume it.

### Guidance on skills Lab

Organize student-teachers in groups and distribute the materials needed for each group. Give them the procedure to follow and guide them to put into practice. Assess the student-teachers work through observing and marking the answers provided by student-teachers.

## 1.8. Answer to End unit assessment 1

1. b 2.c 3.b 4.b 5.b 6.c 7.a 8.d

9. Mitochondrial matrix, mitochondrial matrix and mitochondrial cristae **(D)**

10. X= pyruvate, Y= lactate Z= ethanol

11. a.

| **Item** | **Mesophyll cell** | **Bundle sheath cell** |
|---|---|---|
| PEP Carboxylase | ✔ | **x** |
| rubisco | **x** | ✔ |
| RuBP | **x** | ✔ |
| enzymes of calvin cycle | **x** | ✔ |
| high concentration of oxygen | ✔ | **x** |
| light-dependent reactions | ✔ | **x** |
| contact with air spaces | ✔ | **x** |

b. Photorespiration: rubisco catalyses the combination of RuBP and oxygen; the result is an overall intake of oxygen and loss of carbon dioxide.

12.

a. Limiting factor: one factor, of many affecting a process, that is nearest its lowest value and hence is rate-limiting;

b. Light intensity; light wavelength; concentration of carbon dioxide; temperature;

c. shows that there are two sets of reactions in photosynthesis; a light dependent photochemical stage; a light independent temperature-dependent stage; photochemical reactions are not affected by temperature; at low light intensities, light intensity is the rate-limiting factor; at high light intensities and low temperatures, temperature is the rate-limiting factor;

## 1.9. Additional activities

### 1.9.1. Remedial activities

1. Copy and complete the table below to show how much ATP is used and produced for each molecule of glucose respired in the various stages of respiration.

| | ATP used | ATP produced | Net gain in ATP |
|---|---|---|---|
| Glycolysis | | | |
| Link reaction | | | |
| Krebs cycle | | | |
| Oxidative phosphorylation | | | |
| Total | | | |

2. Until the Krebs cycle, aerobic respiration can be described without mentioning oxygen, the chemical element after which the reaction gets its name. Where in the process does this chemical element take part? What is its importance?

3. (a) Distinguish between metabolic rate and basal metabolic rate.

   (b) Explain how and why metabolic rate changes as we grow older.

**Answer to remedial activities 1**

1. Completed table:

| | ATP used | ATP produced | Net gain in ATP |
|---|---|---|---|
| Glycolysis | -2 | +4 | +2 |
| Link reaction | 0 | 0 | 0 |
| Krebs cycle | 0 | +2 | +2 |
| Oxidative phosphorylation | 0 | +34 | +34 |
| Total | -2 | +40 | +38 |

2. Oxygen enters the aerobic respiration in its final phase, the respiratory chain. Oxygen serves as the final acceptor of electrons. By accepting electrons from the last molecule in the electron transport chain, oxygen allows additional electrons to pass along the chain. As a result, ATP can continue to be synthesized. Oxygen also accepts the protons that were once part of the hydrogen atoms supplied by NADH and FAD2. By combining with both electrons and protons, oxygen forms water as shown in the following equation.

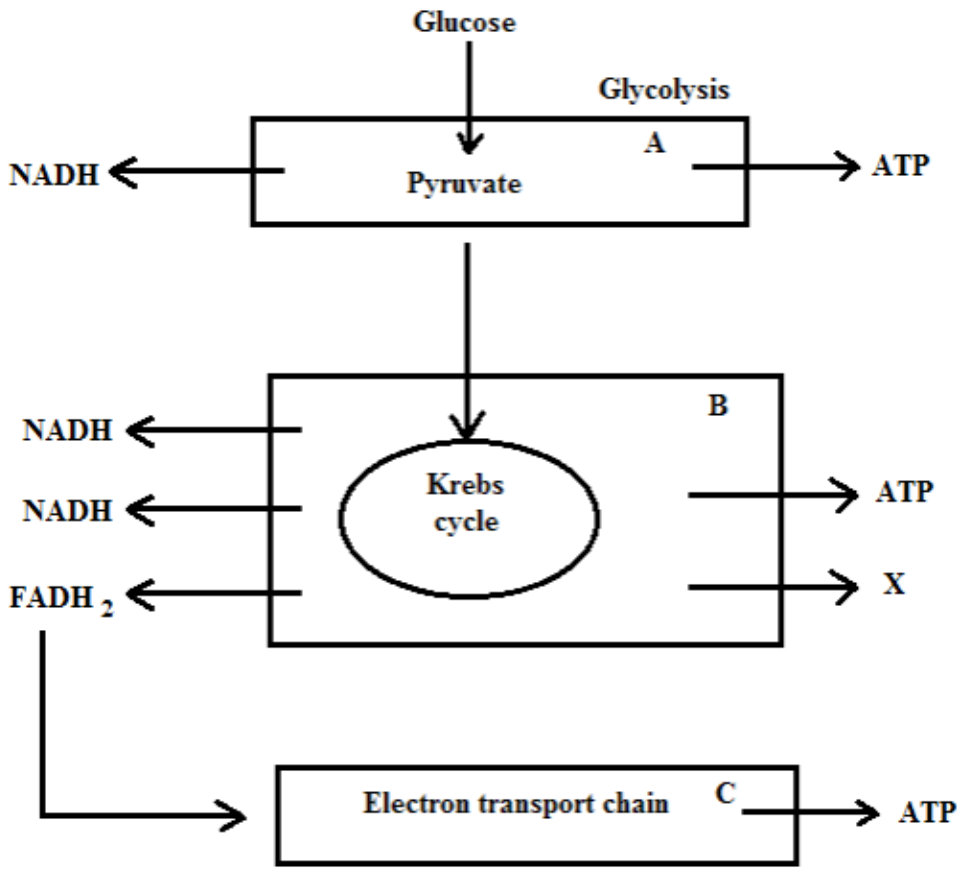
3. (a) Metabolic rate is the amount of energy used by an animal per unit of time while Basal metabolic rate is the amount of energy per unit time that a person needs to keep the body functioning at rest. Some of those processes are breathing, blood circulation, controlling body temperature, cell growth, brain and nerve function, and contraction of muscles.

   (b) Age is one of the most important factors of changes in energy metabolism. It is shown that the decrease in muscle mass relative to total body may be wholly responsible for the age-related decreases in basal metabolic rate. Energy consumption by physical activity also decreases with atrophic changes of skeletal muscle.

### 1.9.2. Consolidation activities

1. Describe the function of the electron transport chain. Where is it located in the mitochondrion?

2. The figure below represents the main stages of aerobic respiration.



a) State precisely where the reaction in boxes A, B and C occur in the cell.

b) What substance is X?

c) A total of 38 molecules of ATP is formed during the complete breakdown of one molecule of glucose. State how many molecules are formed at each stage A, B and C?

**Answer to consolidation activities 1**

1. The function of the electron transfer chain during cellular respiration is to convert the chemical energy potential in oxygen in presence of some substance that can be oxidized to phosphate binding energy in ATP. It takes place in the inner membrane of mitochondria.

2. (a) A= Cytosol B= mitochondria C= mitochondria

   (b) Substance X is FAD

   © Stage A= 2ATP, stage B = 2ATP, stage C = 32 ATP

### 1.9.3. Extended activities

How can the knowledge about fermentation explain the origin of muscle cramps and pains after intense physical exertion?

**Answer to extended activities 1**

A typical fermentation process due to oxygen scarcity happens in the muscle tissue. Under intense use muscles demand too much energy (ATP) and consume much more oxygen to produce that energy. High consumption leads to oxygen scarcity and the muscle cells begin to make lactic fermentation trying to satisfy their energetic needs. In this situation muscle pain, cramps and fatigue are due to the lactic acid released by fermentation.

# UNIT 2

# HUMAN REPRODUCTION AND FAMILY PLANNING

## 2.1. Key Unit competence

Explain the role of human reproductive hormones, stages of pregnancy and family planning methods.

## 2.2. Prerequisites

Student-teachers have learnt the following in previous years:

- Cell structure, specialized tissues and human reproductive system.

The tutor starts the unit by asking questions related to the cell structure, specialized tissues and human reproductive system studied in previous years to ensure that student-teachers have good foundation on the learnt topic.

## 2.3. Cross cutting issues to be addressed

### Comprehensive sexuality education

Comprehensive sexuality education, which is age-appropriate, gender-sensitive and life skills-based can provide young people with the knowledge and skills to make informed decisions about their sexuality and life style. Preparing young people for the transition to adulthood has been one of humanity's greatest challenges with human sexuality and relationships at its core. Few young people receive adequate preparations for their sexual lives. Many young people approach adulthood faced with conflicting and confusing messages about sexuality and gender.

Comprehensive sexuality education supports a right - based approach in which values such as respect, acceptance tolerance, equality, empathy and reciprocity are inextricably linked to universally agreed human rights. A clear message concerning these dangers and how they can be avoided, from right across the curriculum, is the best way to ensure that young people understand the risks and know how to stay healthy.

Comprehensive sexuality education will be addressed through questions that will be asked to student-teachers along this unit and finding out the answers of confusing questions related to reproduction.

**Gender education**

Emphasize to student-teachers that anybody irrespective of their gender can help one another in decision making particularly in family planning and can take decision in terms of birth control regardless to his or her gender.

**Inclusive education**

This unit involves a number of activities on research from different sources and experiments that require the listening and vision. This may be challenging to student-teachers with special educational needs especially children with different impairment. However, the tutor can do the following:

- Grouping student-teachers with special educational needs with others and assigned roles basing on individual student-teacher's abilities.
- Providing procedure earlier before the experiment so that student-teachers get familiar with them. They can be written on the chalkboard or printed depending on available resources. If you have student-teachers with low vision remember to print in appropriate fonts.
- Every important point is written and spoken. The written points help student-teachers with hearing impairment. Speaking aloud helps students with visual impairment
- Remember to repeat the main points of the lessons.

## 2.4. Guidance on introductory activity 2

Ask students to observe and do analysis of pictures given in student-teachers' textbook and discuss about them. After discussion, find out the answer to the questions from the activity 2.and some student-teachers may present their findings to the whole class. Consider the following ideas as student-teachers are answering the introductory activity:

a) The origin of the fetus is the fusion of the male and female gametes during fertilization. The first cell formed is called the zygote. The zygote develops into an embryo and later a fetus.

b) The fetus position observed in mother's uterus on the photo shows that the mother is in the third trimester of pregnancy./ the baby is in a good position for its birth other factors being constant.

c) Family planning is good for social, health and economic purpose but some people may not support it.

## 2.5. List of lessons

| # | Lesson title | Learning objectives | Number of Periods |
|---|---|---|---|
| 1 | Male and female human reproductive systems | • Explain the role of organs in human reproductive system.<br>• Draw the structure of human reproductive system | 2 |
| 2 | Gametogenesis | • Outline gametogenesis in a male and a female human as a process involving mitosis and meiosis.<br>• Interpret chart diagrams of spermatogenesis and ovogenesis.<br>• Appreciate the significance of the process of gametogenesis at puberty as a key characteristic of sexual maturity. | 1 |
| 3 | Menstrual cycle in humans | • Illustrate menstrual cycle in human | 1 |
| 4 | Fertilization and fetal development | • Describe the fertilization process in human and embryo development. | |
| 5 | Role of placenta in the development of an embryo | • Explain the role of placenta in the development of an embryo. Doesn't exist in syllabus | 2 |
| 6 | Physiological changes in females during pregnancy and Parental care | • State maternal physiological changes during pregnancy.<br>• Explain how to maintain health of mother during pregnancy | 1 |
| 7 | Family planning and contraceptive methods | • Identify the methods of family planning.<br>• Explain family planning methods. | 2 |
| 8 | End unit assessment | | 1 |

## Lesson 1: Male and female human reproductive systems

### a) Learning objectives

- Explain the role of organs in human reproductive system.
- Draw the structure of human reproductive system

**b) Teaching resources:** Pictures or illustrations of male and female reproductive system, student-teacher's books, computer and a projector, internet, simulation and animation of structure of human reproductive system.

### c) Prerequisites/Revision/Introduction

Student-teachers have learnt the following in ordinary level:

- Anatomy of human reproductive system and secondary sexual characteristics.

Tutor introduces the lesson by asking questions about the secondary sexual characteristics and organs of male and female reproductive system. This helps student-teachers to remember what they have studied in ordinary level and will be a good foundation to learn this lesson.

### d) Activity 2.1

**Guidance**

Organize student-teachers in groups or in pairs depending on the number of student-teachers in class and o guide them through the following steps:

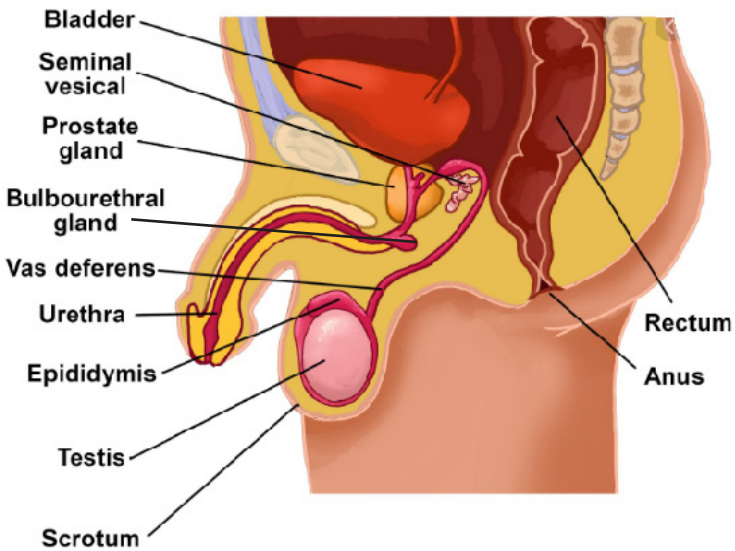
- Bring the chart or illustration of male and female reproductive system. Ask student-teachers t to do the activity 2.1 found in student-teachers' textbook.
- Move around groups guiding and facilitating them.
- Select some groups (1, 2 or 3) to share their answers to the whole class by requesting the group representative to write them on the chalkboard or flipchart.
- Ask other groups to add any ideas on what other groups have presented if they have them.
- Remember to speak loudly so that those with low hearing ability or visual impairment get what you say.
- Remind students to write the summary as the lesson progress.
- Use learners' products and further questions if needed for summarizing and concluding the lesson.
- Extend the lesson by asking student-teachers to relate male and female reproductive systems to real life.

NB You can also dissect both male and female rats and display their reproductive system to be compared with the one on wall charts

## Answer to activity 2.1

a. A: male reproductive system, B: female reproductive system

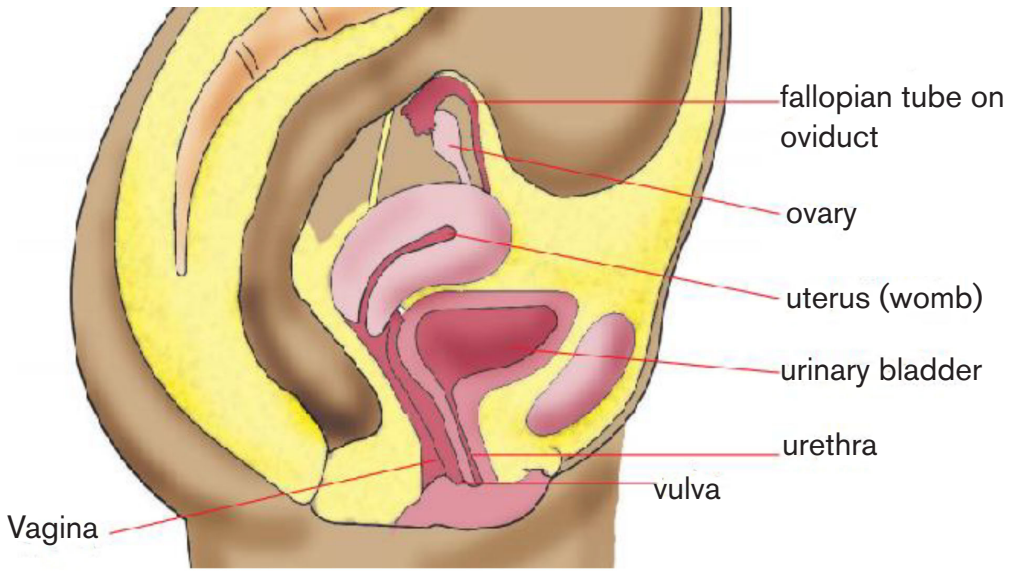
b. Male reproductive organs




Their functions include the following:

| **Testes:** | **Produce sperm cells and sex hormone "testosterone".** |
|---|---|
| | Sites of maturation and storage of sperm. |
| | Carries sperm from the epididymis to its junction with the urethra. |
| | Secretes fructose into the semen, which provides energy for the sperm. |
| | Secretes an alkaline buffer into the semen to protect the sperm from the acidic environment of the vagina. |
| | Secretes mucus-rich fluids into the semen that may protect the sperm from acids in the urethra. |
| | Carries semen during ejaculation and urine from the bladder to the exterior of the body. |
| | Deposits sperm into the vagina during ejaculation |

c. Female reproductive organs




Their functions include the following:

| | |
|---|---|
| Ovaries: | Produce eggs and sex hormone "**estrogen and progesterone**". |
| Oviducts (fallopian tubes): | Carry the ovum from the ovary to the uterus and is a site of fertilization. |
| Fimbria: | Sweep the ovum into the oviduct following ovulation. |
| Uterus (womb): | Pear-shaped organ in which the embryo and fetus develop.<br>Involved in menstruation. |
| Cervix: | Separates the vagina from the uterus.<br>Holds the fetus in place during pregnancy.<br>Dilates during birth to allow the fetus to leave the uterus. |
| Vagina: | Receives penis during copulation and serves as birth canal.<br>Provides a passageway for the sperm and menstruation flow. |

### e) Application activity 2.1

Ask student-teachers to work in pairs to answer the questions of application activity 2.1.

a) Because the diagram shows the male reproductive organs like: penis, testis, etc.

b) 1: Epididymis 2: vas deferens 3: bladder 4: ureter 5: seminal vesicles 6: prostate gland 7: penis 8: urethra

c) Vas deferens (2) is connected to testis where sperms are produced and carry sperms from the epididymis to its junction with the urethra.

Seminal vesicles (5) are connected to vas deferens and urethra and secrete fructose into the semen, which provides energy for the sperm.

Penis can be easily erected and deposits sperm into the vagina during ejaculation.

## Lesson 2: Gametogenesis

### a) Learning objectives

- Outline gametogenesis in a male and a female human as a process involving mitosis and meiosis.
- Interpret chart diagrams of spermatogenesis and ovogenesis.

**b) Teaching resources:** Pictures or illustrations, Student-teacher's book, computer, projector, internet, simulation and animation.

### c) Prerequisites/Revision/Introduction

Student-teachers have learnt the following in previous lesson:

- Function of reproductive organs (testis and ovaries).

Tutor introduces the lesson by asking questions about the functions of reproductive organs particularly testis and ovaries. This helps student-teachers to remember what they have studied in previous lesson and will be a good foundation to learn this lesson.

## d) Activity 2.2

### Guidance

Organize student-teachers in groups or in pairs depending on the number of student-teachers in class and o guide them through the following steps:

- Bring the chart or illustration of spermatogenesis and oogenesis. Ask student-teachers t to do the activity 2.2 found in student-teachers' textbook.
- Move around groups guiding and making clear the key concept.
- Select some groups (1, 2 or 3) or all groups depending on the available time to share their answers to the whole class by requesting the group representative to write them on the chalkboard or flipchart.
- Ask other groups to add any ideas on what other groups have presented if they have.
- Remember to speak loudly so that those with low hearing ability or visual impairment get what you say.
- Remind student-teachers to write the summary as the lesson progress.
- Use student-teacher' findings and further questions if needed for summarizing and concluding the lesson.
- Extend the lesson by asking student-teachers to relate gametogenesis and ovogenesis to what happen in real life.

## Answer to activity 2.2

i. Stage 1: 46 chromosomes stage 2: 23 chromosomes stage 3: 23 chromosomes stage 4: 46 chromosomes stage 5: 46 chromosomes stage 6: 23 chromosomes stage 7: 23 chromosomes stage 8: 23 chromosomes.

ii. **A** represents spermatogenesis because it produces sperm on the diagram.

**B** represents ovogenesis because it produces ovum and polar bodies on the diagram.

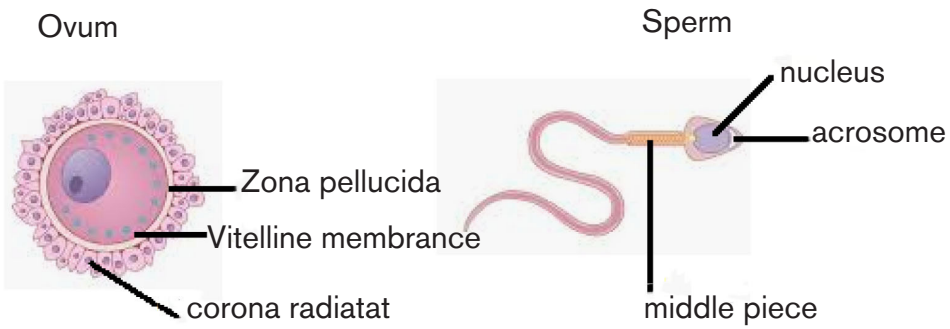
## e) Application activity 2.2

Ask student-teachers to work in pair or in group to answer the questions of application activity 2.2. Monitor the activity, mark the work and provide feedback.

## Answer to application activity 2.2

1. One sperm mother cell produces 4 sperms, therefore four hundred sperm mother cells will produce = 400 * 4 = 1600 sperms. Each sperm has 23 chromosomes.

2.




| Parts | Function |
|---|---|
| Nucleus | Contains hereditary information transmitted from male parent. |
| Acrosome | Contains lytic enzymes which make soft the ovum membrane during fertilization. |
| Middle piece | Contains mitochondria producing energy used by sperm during movement and a single centriole. |
| Zona pellucida | The zona pellucida supports communication between oocytes and follicle cells during oogenesis; protects oocytes, eggs, and embryos during development, and regulates interactions between ovulated eggs and free-swimming sperm during and following fertilization. |
| Vitelline membrane | is a structure surrounding the outer surface of the plasma membrane of an ovum. |
| Corona radiate | The corona radiata is the innermost layer of the cells of the cumulus oophorus and is directly adjacent to the zona pellucida, the inner protective glycoprotein layer of the ovum. Its main purpose in many animals is to supply vital proteins to the cell. |

## Lesson 3: Menstrual cycle in humans

### a) Learning objective

- Illustrate menstrual cycle in human

**b) Teaching resources:** Pictures or illustrations, scenario/story telling on rice sack or wall chart, student-teacher's books, computer and a projector, internet, simulation and animation.

### c) Prerequisites/Revision/Introduction

Student-teachers have learnt the following in previous lesson:

- Function of reproductive organs (testis and ovaries).
- Secondary sexual characteristics
- Endocrine system

Tutor introduces the lesson by asking questions about the secondary sexual characteristics that appear in adolescent stage. This helps student-teachers to remember what they have studied in previous lesson and will be a good foundation to learn this lesson.

### d) Activity 2.3

**Guidance**

Organize student-teachers into groups or in pair and provide to them a scenario or story about human body changes in adolescent. Guide student-teachers through the following steps:

- Ask student-teachers to read scenario and do the activity 2.3 student-teacher's textbook.
- Move around groups guiding and explaining the key concept.
- Select some groups (1, 2 or 3) to share their findings to the whole class by requesting the group representative to write them on the chalkboard or flipchart.
- Ask other groups to add any ideas on what other groups have presented if they have them.
- Remember to speak loudly so that those with low hearing ability or visual impairment get what you say.
- Remind student-teachers to write the summary as the lesson progress.
- Uses student-teacher's findings and further questions if needed for summarizing and concluding the lesson.
- Extend the lesson by asking student-teachers to relate menstrual cycle to sexual reproduction or conception.

### Answer to activity 2.3

1. Follicle stimulating hormone, luteinizing hormone, estrogen and progesterone.

2.

| Hormone | Biological significance |
|---|---|
| Follicle stimulating hormone | • Stimulates the development of a primary follicle<br>• Contributes to the shedding of uterine wall |
| luteinizing hormone | Cause release of mature egg from the ovary |
| Oestrogene | Stimulate further development of mammary glands; inhibit release of FSH and thickening wall of uterus in anticipation of pregnancy. |
| Progesterone | |

3. Progesterone and oxytocin. Find the details in student-teacher's book.

4. Ovulation takes place on 14$^{th}$ day for the women who have menstrual cycle of 28 days and the day varies for the women who are irregular in their menstrual cycle.

### e) Application activity 2.3

Ask student-teachers to work in pair or in group to answer the questions of application activity 2.3. Monitor the activity, mark the work and provide feedback.

### Answer to application activity 2.3

i. Ovulation takes place in step 5 on which follicles show the release ovum.

ii. If pregnancy has not occurred the ovum remains in two days and degenerates. The cycle restarts again.

iii. FSH.

## Lesson 4: Fertilization and fetal development

### a) Learning objective

- Describe the fertilization process in human and embryo development.

**b) Teaching resources:** Pictures or illustrations of fertilization and embryonic development, student-teacher's books, computer and a projector, internet, simulation and animation.

### c) Prerequisites/Revision/Introduction

Student-teachers have learnt the following in previous lesson:

- Gametogenesis and ovogenesis
- Secondary sexual characteristics

Tutor introduces the lesson by asking questions about the secondary sexual characteristics and the structure of sperm and ovum. This helps student-teachers to remember what they have studied in previous lesson and will be a good foundation to learn this lesson.

### d) Activity 2.4

**Guidance**

Organize student-teachers in groups, learning situation or in pair. Give them the illustrations and guide them to do the activity 2.4 as follow:

- Move around groups guiding, monitoring and clearing the key concept.
- Select some groups (1, 2 or 3) to share their answers to the whole class by requesting the group representative to write them on the chalkboard or flipchart.
- Ask other groups to add any ideas on what other groups have presented if they have them.
- Speak loudly so that those who have low hearing ability or visual impairment get what you say.
- Through questions, help student-teachers to summarize the lesson and conclude the lesson
- The tutor can provide additional questions to help student-teachers to understand deeply. Make sure you mark the student-teachers' work and you give feedback to them.

### Answers for activity 2.4

i. A: ovum

ii. B: fertilization. The conditions required for fertilization to take place: mature ovum and sufficient number of sperms. The sufficient number of sperms are involved the releasing of enzyme found in acrosome such as hyaluronidase and protease. These enzymes digest corona radiata (narrow path in the follicle cells) and the zona pellucida (a protective glycoprotein surrounding the plasma membrane of the egg) for easy penetration during fertilization.

iii. Implantation and development of embryo. Find the details in student-teachers' book.

### e) Application activity 2. 4

Ask student-teachers to work in pair or in group to answer the questions of application activity 2.4. Monitor the activity, mark the work and provide feedback.

### Answer to application activity 2.4

a) i. Ovulation

ii. Mitosis

iii. Corpus luteum

iv. Progesterone

b) The letter should be on the oviduct.

## Lesson 5: Role of placenta in the development of an embryo

### a) Learning objective

- Explain the role of placenta in the development of an embryo.

**b) Teaching resources:** pictures or illustrations of developing embryo, student-teacher's books, computer and a projector, internet, simulation and animation.

### c) Prerequisites/Revision/Introduction

Student-teachers have learnt the following in previous lesson:

- Fertilization and fetal development.

Tutor introduces the lesson by asking questions about fertilization and fetal development. This helps student-teachers to remember what they have studied in previous lesson and will be a good foundation to learn this lesson.

### d) Activity 2.5

### Guidance

Organize student-teachers in groups and give each group the illustrations which will be used to do the activity 2.5 as written in student-teachers' book. However, you can add more questions.

Guide the student-teachers while doing activity as follow:

- Move around groups guiding, monitoring and facilitating them.
- Select some groups to share their answers to the whole class by requesting the group representative to write them on the chalkboard or flipchart.
- Ask other groups to add any ideas on what other groups have presented if they have them.
- Speak loudly so that those who have low hearing ability or visual impairment get what you say. Summarize the lesson using brainstorming as the lesson is progressing.
- Student-teachers can do more exercises either in the course of this lesson if there is still time or as home work.

### Answers to activity 2.5

a) A: amniotic fluid, B: uterus, C: umbilical cord, D: placenta.

b) Umbilical cord (C) : part which connect mother to fetus.

c) Substances which pass from the mother to the embryo: oxygen, glucose, amino acids and vitamins due to their need as nutrients for the embryo.

d) One substance which passes from the embryo to the mother: carbon dioxide,

e) Absorbs shocks, protects the fetus, etc.

### e) Application activity 2.5

Ask student-teachers to work in pair to answer the questions of application activity 2.5. Monitor the activity, mark the work and provide feedback.

### Answer to application activities 2.5

a)

| Circulatory system | Blood vessels that carry oxygenated blood |
|---|---|
| Maternal | V |
| Fetal | Y |

The structure **T** is the umbilical cord. After birth, the umbilical cord is cut and tied off.

c) The placenta transfers nutrients such as glucose, amino acids, vitamins, minerals, oxygen which are used in different metabolic reactions of the fetus. It also removes the metabolic waste products such as urea and carbon dioxide.

## Lesson 6: Physiological changes in females during pregnancy and Parental care

### a) Learning objective

- State maternal physiological changes during pregnancy.
- Explain how to maintain health of mother during pregnancy

**b) Teaching resources:** Pictures or illustrations of pregnant women, student-teacher's books, computer and a projector, internet, simulation and animation.

### c) Prerequisites/Revision/Introduction

Student-teachers have learnt the following in previous lessons:

- Menstrual cycle, hormones, fertilization and fetal development.

Tutor introduces the lesson by asking questions about menstrual cycle and fetal development. This helps student-teachers to remember what they have studied in previous lessons and have prerequisites learn this lesson.

### d) Activity 2.6

**Guidance**

- Organize student-teachers in groups and give each group the illustrations which will be used to do the activity 2.6 as written in student-teachers' book.
- Give a handout to each group one or few days before the lesson and instruct them to use human resource (medical personnel), internet or library to answer questions in the activity 2.6.

### Answer to activity 2.6

**a. Physical changes during pregnancy**

- Breast may become large and more tender because of increased level of oestrogen hormone progesterone thus breast gets even bigger to prepare for breast feeding.
- Nipples may stick out more.
- By the end of third trimester, a yellow, watery, pre-milk may leak from nipples.
- Changes in hair and nail growth and texture due to hormone changes.
- Leg cramp caused by fatigue from carrying pregnant weight.
- Feet and ankles may swell because of extra fluid in the body during pregnancy.

**b. Behavioral and physiological changes during pregnancy:**

- Respiration rate rises for increased maternal oxygen consumption which is needed for demand of placenta, uterus and foetus.
- More blood vessels grow and pressure of expanding uterus on large veins causes blood to slow in its return to the heart.
- Rise up and out of pelvic cavity this action displaces the stomach and intestine.
- Physical discomfort such as urinary frequency can be frustrating.
- Fear and anxiety lessen especially when foetal movements are felt.

**c.** Special parental care to pregnant women promotes the health of women and health of their babies before and after birth. Educating mothers about the benefits of good nutrition, adequate rest, good hygiene, family planning and exclusive breastfeeding, immunization and other disease prevention measures aims to develop women's knowledge of these issues so they can make better decisions affecting their pregnancy outcome and never forget the difficulties some women will face in being able to improve their lifestyles.

## e) Application activity 2.6

Ask student-teachers to work in pair to answer the questions of application activity 2.6. Monitor the activity, mark the work and provide feedback.

## Answer to application activity 2.6

1.

| Hormone | Site of secretion | Effect(s) of hormone | |
|---|---|---|---|
| | | Ovary | Endometrium |
| FSH | Pituitary gland | Stimulates the growth of follicles in the ovary | None |
| LH | Pituitary gland | Stimulates the process of ovulation. | None |
| Estrogens | Ovary | None | Stimulates the thickening of the endometrium wall. |
| Progesterone | Ovary | None | Stimulates the maintenance of the endometrium wall. |

The embryo is more susceptible to damage because the organs are being formed (organogenesis) whereas in the fetus the organs have been formed. In the fetus, the organs are increasing in size so not more susceptible to damage of any toxins

## Lesson 7: Family planning and contraceptive methods

### a) Learning objectives

- Identify the methods of family planning.
- Explain family planning methods.

**b) Teaching resources:** Pictures or illustrations of contraceptive methods or real material of contraceptive methods, student-teacher's books, computer and a projector, internet, simulation and animation.

### c) Prerequisites/Revision/Introduction

Student-teachers have learnt the following in previous lessons:

- Anatomy of male and female reproductive organs and birth.

Tutor introduces the lesson by asking questions about anatomy of male and female reproductive organs and birth. This helps student-teachers to remember what they have studied in previous lessons and help to learn this lesson.

### d) Activities 2.7

#### Guidance

Organize student-teachers in groups and give each group the illustrations or real material of contraceptive methods which will be used to do the activity 2.7 as written in student-teachers' book. However, you can add more questions to improve student-teachers understanding.

Guide the student-teachers while doing activity as follow:

Monitor; clarify the key concept until the activity is completed.

After the completion of group work, facilitates them in the following ways:

- Allow groups to present the findings to the whole class.
- If there are some methods which are not mentioned by presenters, ask other groups to add them.
- Permit student-teachers to ask questions to presenters and intervene if they are not able to respond accurately.
- Use student-teachers' findings and further questions if needed for summarizing and concluding the lesson.

- Challenge student-teachers using the other questions to improve understanding and summarize the lesson content.

**Answer to activities 2.7**

a. Natural contraceptive methods: G, artificial contraceptive methods : A, B, C, D, E and F

b. The effectiveness of contraceptive methods depend on everyone needs and the purpose of the used contraceptive methods

**e) Application activity 2.7**

Ask student-teachers to work in pair to answer the questions of application activity 2.7. Monitor the activity, mark the work and provide feedback.

**Answer to application activities 2.7**

1. First fertile period: 27 – 18 = 9 (August 9 + 9 =August 17)

   Last fertile period: 36 – 11 = 25 (August 9 + 25 =September 3)

   The fertile period of Mary will be from 17 August to 3 September 2019

2. i. Contraceptive method that can prevent both STIs and pregnancy is the use of condoms and abstinence. Dual protection may be achieved through either the use of a barrier method such as a male or female condom together with another contraceptive method or through the use of the male or female condom alone. The use of condoms may be effective in preventing transmission of STIs and unwanted pregnancies but they are not 100% effective.

   ii. The choice depends on everyone and the effectiveness of the methods.

## 2.6. Summary of the unit

- **Menstrual cycle** is a monthly cycle that occurs after 28 days unless interrupted by pregnancy. It is monthly discharge of blood process called **menstruation**. This cycle is controlled by four hormones such FSH, LH, oestrogen and progesterone secreted by anterior pituitary gland and ovary respectively. The natural cycle repeats until there is either a pregnancy or the woman reaches menopause (the end of the reproductive phase of a woman's life). It undergoes three phases such as; follicular phase, ovulatory phase and lacteal phase.
- **Oestrus cycle: i**s derived from Latin oestrus meaning sexual desire. The female animal is sexually and receptive to the male.

- **Fertilization** is the union of sperm and egg nuclei to form zygote. It takes place in upper part of oviduct (fallopian tube) after fertilization, zygote travelling down the oviduct (Fallopian tube)) by peristaltic contraction and by beatings of the cilia in wall of the oviduct toward the uterus. As it travels, it divides by mitosis several times to form a ball of cells called a **morula**. The cell divisions, which are called **cleavage**, increase the number of cells but not their overall size. More cell divisions occur, and soon a fluid-filled cavity forms inside the ball of cells. At this stage, the ball of cells is called a **blastocyst**. The blastocyst reaches the uterus and becomes embedded in the endometrium at roughly the 5th – 10th day.
- Once in the uterus the blastocyst burrows into the uterine wall a process called **implantation**. When mother's blood gets contacts with foetal blood vessels, Oxygen and nutrients enters foetus and carbon dioxide from the foetus's blood by diffusion, active transport, and selective absorption between the foetal blood and maternal blood.
- Birth control is the use of various devices, drugs, agents, sexual practices, or surgical procedures to prevent conception or pregnancy. Birth control methods such as intrauterine device, cap (diaphragm), condom, tubal ligation, vasectomy and abstinence are used to prevent pregnancy. Condom may be used to prevent sexual transmitted infections such as: AIDS, Syphilis, Herpes and Gonorrhea.

## 2.7. Additional Information for tutors

In-vitro fertilization is the process of fertilization where an egg is fertilized by sperm outside the body. It involves the fertilization of egg cell outside the body, then artificially implanted in the uterus to produce test tube baby. The process involves monitoring and stimulating of woman's ovulatory process removing ovum (egg) from woman's ovaries and letting sperm to fertilize them in liquid laboratory. The fertilized egg (zygote) undergoes embryo cultured for 2 to 6 days and then transferred to the same or another uterus for successful pregnancy. The embryo is implanted in woman's uterus.

**Advantages of in vitro-fertilization techniques include:**

- **Simplicity:** living organisms are extremely complex functional system with protein molecules, RNA molecules and genes. Therefore, the work of Vitro simplifies system under study to focus on small number of components. Species specificity in human cells in-vitro method can be studied without extrapolation from experimental animal's cellular response.
- **Automation and convenience:** In-vitro method can be automated, high yielding throughout screening methods for testing molecule in pharmacology.

- **In vitro-fertilization** can be used to achieve successful pregnancy but the process usually produces more embryos which some scientists wish for research design to improve our knowledge about disease.

**Guidance on skills Lab**

Organize student-teachers in groups and distribute the materials needed for each group. Give them the procedure to follow and guide them to put into practice. Monitor the activity while learners are performing the experiment. Observe the result of each group and provide feedback. Together with school administration, organize the activity that aims to sensitize other student-teachers and demonstrate them how to use HCG card pregnancy test. Tutor intervenes while answering questions asked by student-teachers if the presenters fail to answer them.

## 2.8. Answers for End unit assessment 2

1. (a)

2. (c)

3. a) a: estrogens, b: FSH, c: progesterone, d: LH

   b) On the 12$^{th}$ day

4. a) Human fertilization is the union of a human egg and sperm, usually occurring in the ampulla of the fallopian tube.

   b) i. The middle piece has a central filamentous core with many mitochondria spiraled around it, used for ATP production for the movement through the female cervix, uterus and uterine tubes.

   ii. Acrosome contains lytic enzymes which make soft the ovum membrane during fertilization.

5. Abstinence and condoms

6.a. Estrogens

   b. A and E.

   c. A: the follicles are not growing because during pregnancy, the FSH hormone secretion is inhibited to prevent the growth of another follicle. E: During the early stages of pregnancy, the corpus luteum continues to produce progesterone which maintains the endometrium wall.

   d. Stage A

e. A: the high levels of estrogens prevent the secretion of FSH which also prevents the growth of another ovarian follicle.

## 2.9. Additional activities

### 2.9.1. Remedial activities

1) From which body layer in embryo does brain develop?

2) List the extra-embryonic membranes.

3) Which membrane forms the foetal side of the placenta?

4) What is the role of: i) relaxin and ii) oxytocin during pregnancy?

5) What is the name given to an embryo when it reaches 8 old weeks?

6) Name the birth control method that is used after sexual intercourse.

7) Which type of birth control method offers some protection against sexually transmitted disease?

**Answer to remedial activities 2**

1) Ectoderm

2) Amnion, York sac, chorion and allantois.

3) Chorion

4) i) relaxes connective tissue in bones of pelvic girdle, ii) Stimulates uterine contraction

5) Foetus

6) Morning after pills,

7) Abstinence and condoms

### 2.9.2. Consolidation activities

1) Describe various hormones secreted by placenta during pregnancy.

2) Some lactating mothers have plenty of milk but it does not flow freely to nipple. They therefore have difficult in breast feeding their babies. Suggest which hormone might lack.

3) What is the function of:

(i) The acrosome reaction and

(ii) The cortical reaction.

4) Describe Features that aid of placenta to transfer materials

**Answer to consolidation activities 2**

1) There are three hormones: Human gonadotrophic hormone, progesterone hormone and oestrogen hormone.

2) Oxytocin.

3) (i) Acrosome reaction enable sperm to penetrate an oocyte.

(ii) Cortical reaction. To form fertilization membrane, preventing further entry of sperm into ovum.

4)

- It provides a large surface area for the exchange
- Maternal blood flows closer to the foetal blood
- Provides a minimal barrier for diffusion and active transport of materials

### 2.9.3. Extended activities

1) Explain why are sperms unable to fertilize an oocyte once one has penetrated?

2) Name two substances that enter the umbilical vein and two substances that leave from the umbilical artery.

3) Explain why does maternal blood never come into direct contact with foetal blood?

4) What is the role of amniotic fluid?

**Answer to extended activities 2**

1) The enzymes of the cortical granules further digest the zona pellucida, making it unable to bind more sperm, while other molecules found in the granules create a new protective layer around the fertilized egg.

2) Two substances that enter the umbilical vein: oxygen, glucose, amino acids, etc.Two substances that leave from the umbilical artery: carbon dioxide and urea.

3) One of the placenta's jobs is to make sure blood from the mother and fetus never mixes. The placenta acts as an exchange surface between the mother and the fetus. Nutrients and oxygen are passed over by diffusion only. If the mother's and fetus's blood mixed, it could be deadly for both of them.

Amniotic fluid protects the developing baby by cushioning against blows to the mother's abdomen, allowing for easier fetal movement and promoting muscular/skeletal development. Amniotic fluid swallowed by the fetus helps in the formation of the gastrointestinal tract.

# UNIT 3

# FERTILIZERS

## 3.1. Key Unit competence

Analyze the components of quality fertilizers and their benefits, effects of misuse and dangers associated with substandard fertilizers.

## 3.2. Prerequisites

Student-teachers have learnt the following in ordinary level:

- Elements and compound

The tutor starts the unit by asking questions related to the structure elements and compound studied in ordinary level to ensure that student-teachers have good foundation.

## 3.3. Cross cutting issues to be addressed

### a) Environment and sustainability

As a tutor, emphasise to the student-teachers that environment must be sustainably protected. This emphasis could be done when you facilitate student-teachers to relate this lesson to environment and sustainability. For effective facilitation, you can ask questions about the interrelation between environment and use of fertilizers. From this question, student-teachers will realise the intimate relationship between environment and fertilizers so that they will take positive side to environment protection for the sustainability of all livings. Then, you can extend their ideas by providing other reasons for environment protection and sustainability like using appropriate quality and quantity of fertilizers.

### b) Inclusive education

To address inclusive education, while student-teachers will be conducting learning activities and experiments, instructional information should be given clearly and student-teachers with visual or physical impairment will be involved in learning activities and experiments. They can sometimes use their sense organs for identifying the results and observe the experimental results in order to draw conclusion.

Provide clear procedure earlier before any experiment so that student-teachers get familiar with them. They can be written on the chalkboard or printed depending on available resources. If you have children with low vision remember to print in appropriate fonts.

### c) Gender education

In all lessons of this unit, design the activities that give equal opportunity to both girls and boys. For example: mixing boys and girls in group work, while setting tasks and when presenting. Gender can be integrated by emphasising on the role of everyone in environmental protection.

Tutors should ensure equal participation of both girls and boys during experiments as well as during cleaning and tidying up related activities after experiments.

### d) Financial Education

Financial education will be addressed when student-teachers will be discussing on the importance of using fertilizers and how modern agricultural technologies lead to high production from economies of scale since the misuse of fertilizers leads to economic depletion as well to other human's effects that will need more money to overcome them in terms of the money that is invested in the process and that will be used to deal with consequences.

Additional questions may be asked at the end of each lesson after student-teacher's presentation of the findings as well as the conclusion for emphasizing on finance as well as environment and sustainability.

## 3.4. Guidance on introductory activity 3

Tutor brings the labeled diagram of fertilizers or brings different real fertilizers and introduces the unit by asking questions about fertilizers. Ask student-teachers to observe labeled diagram of fertilizers or different real fertilizers and answer questions of **introductory activity 3** as designed in Student-teacher's book.

i. Fertilizers are added to the soil to supply nutrients and to improve plants' growth and yield.

ii. They are different depending on their chemical composition. Find the details in student-teacher's book.

iii. Each fertilizer fit with its own plants depending on many factors like plants mineral needs, state of growth, etc.

iv. Yes, if it is not appropriately used. Hazardous chemicals are substances that can cause adverse health effects such as poisoning, breathing problems,

skin rashes, allergic reactions, allergic sensitization, cancer, and other health problems from exposure.

v. When they are not well used, they lead to environmental pollution and have effect on life of living things. Find the details in student-teacher's book.

vi. Read and use correctly fertilizers safety use. For more details, read student-teacher's book.

### 3.5. List of lessons

| # | Lesson title | Learning objectives | Number of Periods |
|---|---|---|---|
| 1 | Classification of fertilizers | • State the major constituents of the fertilizers.<br>• Identify the characteristics of a good fertilizer.<br>• Interpret the labels on the fertilizer containers. | 2 |
| 2 | Use of organic and inorganic fertilizers | • Classify the fertilizers in terms of composition.<br>• State the advantages or disadvantages of using the fertilizers. | 2 |
| 3 | Dangers of the use of the substandard fertilizers | • Identify the effects of misuse of fertilizers and the dangers of substandard fertilizers.<br>• Evaluate the advantages and disadvantages of using fertilizers. | 2 |
| 4 | End unit assessment | | 1 |

## Lesson 1: Classification of fertilizers

**a) Learning objectives**

- State the major constituents of the fertilizers.
- Identify the characteristics of a good fertilizer.
- Interpret the labels on the fertilizer containers.

**b) Teaching resources:** sample of organic fertilizer or compost bin containing organic fertilizer, Samples of inorganic fertilizers in their sacs (containers), books, computer, projector and internet.

### c) Prerequisites/Revision/Introduction

Student-teachers will learn better the classification of fertilizers if they have some skills on cultivation techniques and on the types of plants and give examples of chemical element and compound.

Tutor introduces the lesson by asking questions about chemical element and compound, thereafter asks some example commonly products used in agriculture. This helps student-teachers to remember what they have studied in previous lessons and have prerequisites learn this lesson.

### d) Activity 3.1

**Guidance**

Organize student-teachers in groups and give each group the illustrations or real material of fertilizers which will be used to do the activity 3.1 as written in student-teachers' book. However, you can add more questions to improve student-teachers understanding.

Guide the student-teachers while doing activity as follow:

- Provide each type of fertilizers to each group or the coloured copy of the pictures of the fertilizers. And remind them the safety rules as learnt in Senior one.
- Give time of about 15 minutes for the group discussion under your guide
- After the completion of group work, ask the groups to present the findings to the whole class.
- Ask the student-teachers of other groups to comment on the answers given by the groups.
- Guide learners to find conclusion about the components of fertilizer.

### Answer to activity 3.1

i. DAP: N and P NPK: N, P and K Urea: N Manure: C and minerals

ii. DAP, NPK and UREA are artificial fertilizers (inorganic fertilizers); Manure is natural fertilizers (organic fertilizer)

iii. Other examples: Ammonium sulphate, find other examples in student-teacher's book.

iv. Find the nutrients that plants need in student-teacher's book.

### e) Application activity 3.1

Organize the student-teachers in pair; ask them to read and do the application activity 3.1 in student-teacher's book.

i. Andrew used to combine natural and artificial fertilizers in order to grow well crop and improve yield.

ii. Andrew must read the instruction and follow the advice of sector agronomist on how each fertilizer is used and on which plant species is used.

iii. If a fertilizer is labeled 13-13-13, it means that the fertilizer contains13% by mass N, 13% by mass $P_2O_5$ and 13% by mass $K_2O$.

## Lesson 2: Use of organic and inorganic fertilizers

### a) Learning objectives

- Classify the fertilizers in terms of composition.
- State the advantages or disadvantages of using the fertilizers.

**b) Teaching resources:** sample of organic fertilizer or compost bin containing organic fertilizer, Samples of inorganic fertilizers in their sacs (containers), books, computer, projector, internet and Crops of different types (tubers, leguminous plants, cereals)

### c) Prerequisites/Revision/Introduction

Student-teachers will learn better the use of organic and inorganic fertilizers if they have some skills on cultivation techniques and on the types of plants and give examples of types of fertilizers.

Tutor introduces the lesson by asking questions about types of fertilizers, thereafter asks some example commonly fertilizers used in agriculture. This helps student-teachers to remember what they have studied in previous lessons and have prerequisites learn this lesson.

### d) Activity 3.2

**Guidance**

Organize student-teachers in groups and give each group a story about cultivators of Irish potatoes or provide the illustrations of two plot of land with Irish potatoes crop/video which will be used to do the activity 3.2 as written in student-teachers' book. However, you can add more questions to improve the student-teachers understanding.

Guide the student-teachers while doing activity as follow:

- After the completion of group work, ask the groups to present the findings to the whole class.
- Ask the student-teachers of other groups to comment on the answers given by the groups.
- Guide learners to find conclusion about the use of organic and inorganic fertilizers.
- Permit student-teachers to ask questions and intervene if they are not able to respond accurately.
- Based on student-teachers' ideas, guide student-teachers to find the conclusion. Here, you need to emphasize on the advantages and disadvantages of using organic and inorganic fertilizers.
- Use student-teachers' findings and further questions if needed for summarizing and concluding the lesson.

### Answer to activity 3.2

i. The difference in the harvest is due to inappropriate or non use of fertilizers.

ii. Andrew must use, read the instruction and follow the advice of sector agronomist on how each fertilizer is used and on which plant species is used.

### e) Application activity 3.2

Organize the student-teachers in pair; ask them to read and do the application activity 3.2 in student-teacher's book.

### Answer to application activity 3.2

i. Natural Fertilizers add organic material to the soil that increases its ability to hold water; reduces erosion from water and wind; decreases compaction and crusting of the soil; and raises soil pH while artificial fertilizers provides plants nutrients for growth.

ii. Fertilizers improve crop production by increasing rate of growth of crops, by increasing nitrogen content in the soil, which helps in healthier growth of plants. It also provides vital nutrients in vast quantity, so that the new growing plant does not suffer from any plant disease. The farmer uses specific fertilizer because plants need different nutrients depending on their species and growth.

## Lesson 3: Dangers of the use of the substandard fertilizers

### a) Learning objectives

- Identify the effects of misuse of fertilizers and the dangers of substandard fertilizers.
- Evaluate the advantages and disadvantages of using fertilizers.

**b) Teaching resources:** Books, internet, samples of inorganic fertilizers in their sacs (containers), computer and projector.

### c) Prerequisites/Revision/Introduction

Student-teachers will learn better effective ways of waste management, water and its composition, air composition and pollution, waste materials, the use of organic and inorganic fertilizers, some skills on cultivation techniques and on the types of plants and give examples of types of fertilizers.

Tutor introduces the lesson by asking questions about fertilizers, thereafter asks some example commonly fertilizers used in agriculture. This helps student-teachers to remember what they have studied in previous lessons and have prerequisites learn this lesson.

### d) Activity 3.3

#### Guidance

Organize student-teachers in groups and give each group a diagram illustrating the danger of fertilizers in water. Ask student-teachers to use the diagram and do the activity 3.3. If you have internet connection you may use video. However, you can add more questions to improve the student-teachers understanding.

Guide the student-teachers while doing activity as follow:

- Monitor; clarify the key concept until the activity is completed.
- After the completion of group work, ask the groups to present the findings to the whole class.
- Ask the student-teachers of other groups to comment on the presented findings.
- Permit student-teachers to ask questions and intervene if they are not able to respond accurately.
- Based on student-teachers' ideas, guide student-teachers to draw the conclusion. Here, you need to emphasize on the dangers of using substandard fertilizers.
- Use student-teachers' findings and further questions if needed for summarizing and concluding the lesson.

## Answer to activities 3.3

i. The fishes in water on the above picture are dead and water is looking like green.

ii. The fertilizers used in agriculture seep through the soil into the ground water and other water sources, leading to water contamination.

iii. The advice is to standardize the fertilizer before use; use of chemical fertilizers with coated pellets so that nutrients are released slowly; etc. Find the details in student-teacher's book.

## e) Application activity 3.3

Organize the student-teachers in pair; display or ask them to read the application activity 3.3 in student-teacher's book.

## Answer to application activity 3.3

i. Fertilizers used are not the same. They differ in components composition: NPK 17-17-17 contains17% by mass N, 17% by mass $P_2O_5$ and 17% by mass $K_2O$ while NPK 16-00-00 contains 16% by mass N, 0% by mass $P_2O_5$ and 0% by mass $K_2O$.

ii. NPK 16-00-00 is Sub-standard fertilizer because it does not conform to the required NPK ratio, therefore it lead to the following effect:
   - Soil pollution (basic soil or acidic soil) due to accumulation of ions which are acidic or basic
   - Poor growth of plants
   - Poor harvest
   - Eutrophication

iii. To reduce the effect of substandard fertilizers, different measures can be used like:
   - Standardization of the fertilizer before use.
   - Production of fertilizers in Rwanda, as this will help us to choose good minerals (where necessary) in producing fertilizers.
   - Use of chemical fertilizers with coated pellets so that nutrients are released slowly.

## 3.6. Summary of the unit

There are two main types of fertilizers: organic fertilizers and inorganic fertilizers. Plants need both organic and inorganic fertilizers because soils do not have all types of nutrients in a proper proportion which can fit all plants.

Plants need three types of nutrients: major nutrients, secondary nutrients, and micronutrients. The major nutrients usually are lacking from the soil because plants consume these nutrients in large amounts for their growth and survival. That is another reason inorganic fertilizers have to be supplied to the soil.

Secondary nutrients are nutrients that are enough in the soil, so fertilization is not always needed. Micronutrients are the essential elements for plant growth which are needed but in only very small (micro) quantities.

Using fertilizers is important in order to increase the crop production so that Rwanda can meet the demand in terms of food. However, care should be taken in using fertilizers so that the dangers (acidification of the soil or making them basic; burning of crops; eutrophication) arising from their use are minimized. Special dangers of the use of substandard fertilizers and there we saw that the use of substandard fertilizes may lead to many risks such as increase of eutrophication, burning of crops, etc.

## 3.7. Additional Information for tutors

**Soil management** is an integral part of land management and may focus on differences in soil types and soil characteristics to define specific interventions that aimed to enhance the soil quality for the land use.

Soil management practices are needed to protect and conserve the soil:

- Soils should be set aside (not be exploited for some time) so that nutrients are developed again.
- Avoid repeated use of a fertilizer.
- Use fertilizers to support nutrients of soils.
- Test the soils in order to cultivate plants appropriate to a given land and in order to put appropriate chemical fertilizers in a soil.
- Standardization of fertilizers by Rwanda standard board.
- Use of chemical fertilizers with coatings so that nutrients are released slowly.
- Controlling traffic on the soil surface helps to reduce soil compaction, which can reduce aeration and water infiltration.
- Cover crops keep the soil anchored and covered in off-seasons so that the soil is not eroded by wind and rain.

- Crop rotations for row crops alternate high-residue crops with lower-residue crops to increase the amount of plant material left on the surface of the soil during the year to protect the soil from erosion.
- Nutrient management can help to improve the fertility of the soil and the amount of organic matter content, which improves soil structure and function.
- Tillage is the breaking of soil, such as with a plough or harrow, to control weeds. Reduced-tillage or no-till operations limit the amount of soil disturbance while cultivating a new crop, and help to maintain plant residues on the surface of the soil for erosion protection and water retention.
- Provide the facilities for watering. Example: water dams for irrigation

**Advantages of soil management**

- Maintain soil fertility
- Restore soil fertility
- Make the agricultural process an economic one
- Help increase yield
- Reduce soil erosion

**Correction soil acidity and soil basicity**

- Correcting very acidic soil usually involves working lime into the soil a few weeks before planting
- Correcting alkaline soil involves the addition of gypsum.

**Example:** Ammonium sulphate, $(NH_4)_2SO_4$

$$(NH_4)_2SO_4 \xrightarrow[\text{in the soil}]{\text{Basic matter}} NH_3 \xrightarrow[\text{bacteria}]{\text{Nitrifying}} \text{Soluble nitrates(a re taken up by plants)}$$

**Guidance on skills Lab**

Organize student-teachers in large groups (three groups). Ask student-teachers to select a site for making compost in a school farm. Ask them to mark the area you intend to locate the compost (the minimum area is 0.5m x 0.5m). Give them the procedure to follow and guide them to put into practice. Monitor the activity while student-teachers are performing the activity. Create your own procedure to make follow up and assess the student-teachers achievement. Observe the result of each group and provide feedback. Start the activity early in order to end the year with the end of achievement of the activity.

## 3.8. Answer to End unit assessment 3

### I. Multiple choice

1. (c) Nitrogen fertilizers
2. (b) Eutrophication
3. (a) Nitrous oxide
4. (d) Both (a) and (c)

### II. Open-ended questions

1. ▪ It is a gas and therefore less easy to store (It is stored in form of ammonium salts).
   - It is basic, so it can affect the natural pH of the soil (for short term it makes the soil basic but with time, it will make the soil acidic as is it is transformed into nitrates).
   - Ammonia easily evaporates if directly applied to the soil because it is a gas at room temperature.

2. (a) Advantages of using natural fertilizers:
   - Chemical fertilizers are made with synthetic ingredients designed to stimulate plant growth.
   - Commercial chemical fertilizers have the advantage of predictability and reliability
   - Formulations are blended with accuracy and you can buy different blends for different types of plants; commercial formulated fertilizers allow you to know exactly which nutrients you're giving your plants, rather than guessing at the composition of organic formulas.

   (b) Advantages of using artificial fertilizers
   - The manures add organic matter (**called humus**) to the soil which restores the soil texture for better retention of water and for aeration of soil. For example, organic matter present in the manures increases the water holding capacity in sandy soils and drainage in clay soil.
   - The organic matter of manures provides food for the soil organisms (decomposers such as bacteria, fungi, etc.) which help in making nutrients available to plants.
   - Nutrient release: slow and consistent at a natural rate that plants are able to use. No anger of over concentration of any element, since microbes must break down the material.

3. Two causes of acid soils: inappropriate use of fertilizers, poor waste management, ect.

4. The advantages and disadvantages of the use of organic and inorganic Fertilizers are detailed in student-teacher's book.

5. The effects of misusing Fertilizers and the dangers of substandard fertilizers are detailed in student-teacher's book.

## 3.9. Additional activities

### 3.9.1. Remedial activities

A cultivator needs to cultivate potatoes and he goes to Agrotech to buy NPK fertilizer whose label is 17-00-00.

(a) What is the meaning of this label?

(b) Is the fertilizer convenient for the good harvest of the potatoes?

(c) Which parts of the plant will be more developed?

(d) Give an example of type of crop for which the fertilizer provided can be convenient.

**Answer to extended activity 3:**

a. It means that the fertilizer contains 17% by mass N, O % by mass $P_2O_5$ and 0% by mass $K_2O$.

b. No, because there will be high development of leaves and not roots.

c. Leaves.

d. Corns during in their early time with the development of leaves

### 3.9.2. Consolidation activities

1) How did commercial fertilizer come to be used?

2) Among the major nutrients of plants, which one is responsible for

   i. Promoting the growth of roots (e.g. Irish potatoes?)

   ii. The production of sugars

3) A NPK fertilizer is labeled 13-13-13. Interpret this labeling.

**Answer to consolidation activities 3**

1) When it was discovered that certain nutrients in the soil are lacking, because they are highly consumed by plants for their growth.

**2) (i)** P **(ii)** K

3) If fertilizer is labeled 13-13-13, it means that the fertilizer contains 13% by mass N, 13% by mass $P_2O_5$ and 13% by mass $K_2O$.

### 3.9.3. Extended activities

A fertilizer contains ammonium sulphate sample of 0.500g of fertilizer was warmed with sodium hydroxide solution. The ammonia evolved was absorbed in 100$cm^3$ of 0.100$moldm^{-3}$ hydrochloric acid. The excess hydrochloric acid required 55.9$cm^3$ of 0.1M sodium hydroxide for neutralization. Calculate the percentage of ammonium sulphate in the sample

**Answer to extended activity 3**

The equation for the reaction between

(a) Sodium hydroxide and sulphuric acid:

$$H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + 2H_2O$$

(b) Ammonium sulphate and sodium hydroxide

$$(NH_4)_2SO_4 + NaOH \rightarrow 2\ NH_3 + Na_2SO_4 + 2H_2O$$

(c) Ammonia and hydrochloric acid

$$NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

Mole of NaOH which reacted with excess sulphuric acid

$= 55.9 \times 10^{-3} \times 0.1 = 5.59 \times 10^{-3}$ moles

Moles of HCl = $5.59 \times 10^{-3}$ moles

Total moles of HCl= $100 \times 10^{-3} \times 0.1 = 0.01$ moles

Moles of HCl that reacted = $0.01 - 5.59 \times 10^{-3} = 4.41 \times 10^{-3}$ moles

Moles of $NH_3$= $4.41 \times 10^{-3}$ moles

2 moles of $NH_3 \rightarrow \frac{1 \text{ mole of } (NH_4)_2\ SO_4}{2} \times 4.41 \times 10^{-3} = 2.205 \times 10^{-3}$ moles

The number of moles of $(NH_4)_2SO_4 = 2.205 \times 10^{-3}$ moles

Mass of $(NH_4)_2SO_4$= n x Mm = $2.205 \times 10^{-3} \times 132 = 0.29106$ g

% by mass $(NH_4)_2SO_4 = \frac{0.29106\ g}{0.5} \times 100\% =$ **58.215%**

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