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NCDC takes full responsibility for any errors and omissions in the documents and welcomes suggestions to address them.

FOREWORD

For a long time teachers have been using Uganda National Examinations Board (UNEB) syllabi to plan their teaching schemes. This approach has rendered the curriculum to be largely driven by examination.

Working with relevant subject panels, NCDC has produced the Teaching Syllabi for all the Advanced Level subjects. The subject content in the syllabi has been clarified using appropriate specific objectives. It should be noted that the content in the syllabi has remained largely the same except in a few subjects where it has been updated by removing obsolete and/or irrelevant material. Suitable teaching / learning strategies have been suggested to the teacher and other users.

Teachers will find the syllabi useful in planning the teaching / learning processes. The content therein will go a long way in enhancing the learners' educational experiences and guide the teachers towards successful delivery of meaningful learning experiences.

The teaching / learning strategies suggested in the Syllabi are just a guide to the teacher but are not meant to substitute the rich professional approaches that the teacher may opt to use to deliver knowledge, and to develop understandings, skills, values and attitudes.



Connie Kateeba

DIRECTOR

National Curriculum Development Centre

GENERAL INTRODUCTION

This volume of the Advanced Level syllabi contains three subjects: **Agriculture**, **Biology** and **Chemistry**. There are other volumes containing other Advanced Level subjects. The purpose of this merger is twofold. First, NCDC considered the content relatedness of the subjects and second, the need to avoid extremely voluminous books.

These syllabi have been written in accordance with the National Objectives on Secondary Education. The syllabi content continues from that of the Ordinary Level curriculum. The syllabi have suggested a teaching order, teaching and learning strategies, and assessment strategies. In all cases the syllabi have tried as much as possible to integrate the theory and practicals. This means that the teaching and learning should be done through practical work as much as possible. The purpose is to make the learner acquire the necessary scientific skills.

The use of models or ICT opportunities should be exploited to help the learner visualise concepts which are rather hard or difficult to understand. The teachers are encouraged to help the learners acquire relevant mathematical skills so as to solve quantitative aspects of the subjects, including graphical methods and the use of logarithms.

The **Agriculture** syllabus has five topics: Basic Science, Crop Production, Animal Production, Agricultural Engineering and Farm Mechanisation and Economics. The topics have been coded “I” or “II”, etc in order to differentiate them from the O level syllabus content. These topics are meant to address crucial issues, such as improved agriculture practices, new and appropriate crop and livestock technologies, high value crops, and practical skills.

The **Biology** syllabus comprises 14 topics: Cell Biology; Chemicals of Life; Cell Physiology; Levels of Organisation and Diversity of Life; Ecology; Inheritance and Evolution; Transport; Nutrition; Gaseous Exchange; Respiration; Homeostasis; Coordination; Support and Movement; and Reproduction, Growth and Development. The syllabus places emphasis on understanding, application, analysis and evaluation of Biology concepts relating them to everyday experiences.

The **Chemistry** syllabus has three main sections: Physical Chemistry, Inorganic Chemistry and Organic Chemistry. It is hoped that when teaching topics in the various sections, emphasis will be placed on the application of chemistry in East Africa, particularly in the industries and communities. The suggested teaching and learning strategies are meant to encourage understanding of the basics of chemical behaviour.

Uganda Advanced
Certificate of Education

Biology

TEACHING SYLLABUS

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SECTION I

Introduction

This Biology Teaching Syllabus is a guide to teaching Uganda Advanced Certificate of Education (UACE) Biology course. However, other stakeholders of A level (UACE) may use it, as it is designed to assist the learning process. This teaching syllabus emphasises understanding, application, analysis, synthesis and evaluation of Biology concepts relating them to daily experiences. This necessitates use of a variety of teaching methods like experiments, projects through investigations, surveys, field studies, discussions, research, etc. It is expected to promote learning by providing a guide that requires use of challenging tasks. This encourages discovery, creativity, critical thinking, and team work among the learners.

The syllabus ensures that accurate facts, concepts and knowledge are presented to the learners to allow problem-solving with regard to new Biological situations in the communities for sustainable development.

The teaching syllabus is divided into fourteen topics. Each is sub-divided into sub-topics, arranged in a chronological sequence that presents concepts in a logical way, but not restricting the teaching procedures, and specific objectives.

Purpose of the Teaching Syllabus

A teaching syllabus enables teachers to cover the syllabus content to the appropriate depth required by the academic level standard. The design of this syllabus emphasises the teaching approaches to be used for each sub-topic from among the general approaches given by the syllabus to achieve the general objectives of the syllabus. The periods allocated guide teachers to make effective plans so that they can complete the syllabus within the recommended study period of UACE.

General Objectives

By the end of this course the learners should be able to:

- i) develop an interest in learning Biological natural trends of environment and communities.
- ii) apply Biological knowledge in their day to day life and have the ability to use Biological concepts to solve problems.
- iii) communicate or disseminate accurate Biological facts.
- iv) develop the ability to design and carry out practical investigations, interpret data and write logical, precise and clear reports.
- v) use available resources, local materials and facilities to carry out project work / research to obtain information.

- vi) relate various concepts and explain their relationship to aspects in the environment.
- vii) relate scientific information to prior experiences.
- viii) appreciate the ways by which human beings influence the natural trends of environment and communities.

Target

This Biology teaching syllabus aims at guiding and enhancing teaching strategies for A level teachers of Biology at secondary school.

Teachers are expected to provide detailed content suitable for A level learners within the range indicated in the syllabus and use a variety of methods to enhance the learning process.

Scope and Depth

The following table summarises the teaching sequence for A Level Biology. The topics are designed in a format that ensures that the teacher integrates theory and practical work in the teaching/learning process.

Topic	Sub-Topic	Periods
1. Cell Biology	<ol style="list-style-type: none">1. Cell Structure2. Diversity of Specialised Cells and Tissues3. Chromosomes4. Cell Division5. Protein Synthesis	3
2. Chemicals of Life	<ul style="list-style-type: none">• Acids, Bases and Salts• Water• Structure of Carbohydrates• Structure of Lipids• Structure of Proteins• Vitamins• Enzymes	46
3. Cell Physiology	<ol style="list-style-type: none">1. Movement In and Out of Cells	18

Topic	Sub-Topic	Periods
4.Levels of Organisation and Diversity of Life	1. Diversity of Living things 2. Virus (Akaryotae) 3. Kingdom Monera 4. Kingdom Protocista 5. Kingdom Fungi 6. Kingdom Plantae 7. Kingdom Animalia	56
5. Ecology	1. Components of Environment 2. Concept of Ecosystem 3. Population and Natural Resources 4. Interdependence 5. Effects of Human Activities on Ecosystems	31
6.Inheritance and Evolution	1. Genetics 2. Chromosomes and Genes 3. Variation 4. Population Genetics 5. Origin of Life 6. Mechanisms of Evolution 7. Evidence of Evolution 8. Selection and Speciation	34
7. Transport	1. Necessity for Transport Systems 2. Water as a Medium Plants and Animals 3. Circulatory Systems in Animals 4. Defence against Diseases 5. Vascular System of Flowering Plants	36

Topic	Sub-Topic	Periods
8. Nutrition	1. Autotrophic Nutrition 2. Heterotrophism <ul style="list-style-type: none">• Holozoic Nutrition• Saprophytism• Mutualism• Parasitism	42
9. Gaseous Exchange	1. Principles of Gaseous Exchange Systems 2. Gaseous Exchange in Plants 3. Gaseous Exchange in Animals	24
10. Respiration	1. Respiration	08
11. Homeostasis	1. General Principles of Homeostasis 2. Regulation of Glucose 3. Regulation of Carbon Dioxide 4. Temperature Regulation 5. Excretion 6. Osmoregulation	28
12. Coordination	1. Concepts of Reception and Response in Plants 2. Plant Hormones 3. Response and Behaviour in Animals 4. General Principles of Reception and Response in Animals 5. Nervous Coordination in Animals 6. Hormonal Coordination in Animals	56
13. Support and Movement	1. Support Systems in Plants and Animals 2. Support System in Organisms (practical) 3. Muscles 4. Movement / Locomotion	31

Topic	Sub-Topic	Periods
14. Reproduction, Growth and Development	1. Asexual Reproduction 2. Sexual Reproduction in Animals 3. Sexual Reproduction in Lower Organisms and Plants 4. Growth and Development	48

Time Allocation

Time allocation in this syllabus is built on the assumption that there are ten (10) weeks of effective teaching in a term. A period is 40 minutes of teaching. It is recommended that 12 periods per week be allocated to the teaching of Biology on the school timetable; (eight (8) for Biology theory and four (4) periods for Biology practical work.

How to Use the Biology Teaching Syllabus

This Biology Teaching Syllabus is aimed at providing you with guidance required to teach Biology at Advanced level. The syllabus is a guide therefore, it is not meant to limit your creativity. However, use the available time allocated to cover the content and to assist the learners develop skills and competences required of an A level graduate.

The syllabus has the following features:

a) General Objective(s)

This is a statement of the general learning outcome expected of a learner at the end of the topic.

b) Specific Objectives

These further clarify the scope and depth of content. You should use the specific objectives to plan for the teaching –learning process suitable for the learner at Advanced level. Specific objectives also will guide you in evaluation at the end of concept or learning process.

c) Content

Items in the content column have been listed but should be handled together with the specific objectives to develop a detailed presentation.

d) Teaching Aids

These provide you with guidance, to effectively plan for the learning outcome, but should not restrict the innovations of the teacher.

e) Number of periods per sub-topic

The suggested number of periods for each sub-topic is the guide to enable you cover the work effectively and adequately.

Mode of Assessment***Continuous Assessment (Formative assessment)***

It is recommended that you carry out continuous assessment during the teaching-learning process. The assessment should reflect acquisition of the following testable competences or learning outcomes:

a) *Knowledge of:*

- common principles and generalisation identified in the syllabus.
- trends and sequences of phenomena.
- classification and categorising.
- investigation, procedures and techniques or methods to acquire data.
- conventions and presenting facts accurately.
- ways and means of defining terms, and specifics.

b) *Comprehension: Ability to:*

- translate facts and communicate knowledge accurately in the correct language.
- interpret and explain concepts.
- extrapolate, describe and determine implications, and effects of a phenomenon.

c) *Application:* Ability to use abstract knowledge or situations to solve a problem.**d) *Analysis of:***

- scientific information.
- relationships and interaction of principles /concepts.
- principles, systematic arrangement/organisation and structure of concepts.

e) *Synthesis ability to:*

- develop ideas from experiences / knowledge.
- plan / propose a set of work /activities basing on situations or information provided.
- derive / make deductions from the data provided.

f) *Evaluation of:*

- terms and logical communication of knowledge.
- judgement of external criteria /materials /information.
- evidence, accuracy and consistency of information.

g) *Affective and practical abilities to be developed include:*

- Application of knowledge to practical situations
- Manipulation of the apparatus, performing experiments and integrating with theory
- Making and recording observations accurately
- Demonstrating understanding of observations
- Presentation of data in an appropriate form or selected format
- Drawing conclusions from observations made or responses.
- Assessing suitability of procedure, experiment and observations made in support of the conclusion
- Making drawings of natural structures accurately

Summative Assessment

Uganda National Examinations Board (UNEB) will administer a Biology principal subject examination at the end of the second year of study. The test blue print developed for this examination is based on the curriculum content specifications. UNEB will also provide the examination regulations.

Examination Format

There will be three papers. Papers one and two are theory while paper three is practical.

Paper 1: (2 ½ hours)

The paper will consist of **two** sections: **A** and **B**.

Section **A** will contain **40 compulsory** multiple choice questions based on any part of the teaching syllabus.

Section **B** will contain **six compulsory** short structured answer questions also based on any part of the syllabus.

(Total: **100 marks**)

Paper 2: (2 ½ hours)

The paper will consist of **two** sections: **A** and **B**. **Six** questions will be set as follows:

Section **A**. **One compulsory** question from any major topic (**40 marks**)

Section **B**. **Five** questions; Candidates will **answer only three** questions in this section. Each question carries **20 marks**.

(Total: **100 marks**)

Paper 3: (3¹/₄ hours)

Three compulsory questions will be set. Candidates will be required to answer **ALL** questions.

(Total: **100 marks**)

SECTION II

SENIOR FIVE TERM ONE

Topic 1: Cell Biology

Duration: 36 Periods

Overview

The cell is a basic unit of life. A cell carries out a number of activities including protein synthesis, cell division and it is where the hereditary material is. Specialised cells constitute tissues.

General Objective

By the end of the topic, the learner should be able to describe the structure, function and organisation of cells in an organism.

Sub-Topic 1: Cell Structure and Microscopy

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • identify plant and animal cell structures visible under the light microscope. • draw and label detailed animal and plant cells. • state functions of cell structures as seen under an electron microscope. • distinguish between the plant cell and animal cell ultra structures as visible under the electron microscope. • explain the theory behind the structure of the plasma membrane. • describe the fluid mosaic model of the plasma membrane. 	<ul style="list-style-type: none"> • Structure of the animal and plant cell as seen under a light microscope • Detailed animal and plant cells • Functions of detailed cell structures indicating the interrelationship • Differences between plant cell and animal cell ultra structures • The theory behind the structure of the plasma membrane • The fluid mosaic model-plasma membrane

<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • explain the functioning principles of a light and electron microscope. • prepare temporary mounts of cell and tissue slides. • use simple stains in studying cells and tissues. • identify different plant tissues using different laboratory stains. • determine cell size. • draw and label the different types of epithelial tissues. 	<ul style="list-style-type: none"> • The functioning principles of a light and electron microscope: resolving power, etc • Preparation of temporary mounts of cell and tissue slides • Simple staining methods • Staining plant tissues • Estimation of cell size • Epithelial tissues classification
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Teaching/ Learning Resources

- Cell structures: charts, models, illustrations, photomicrographs, text books, simulations
- Staining reagents: iodine solution, acidified phloroglucinol, methylene blue, Leishman's stain
- Microscopes, slides, cover slips, plastic ruler graduated in millimetres, onion, cheek cells, prepared slides of cells and tissues

Suggested Teaching Procedure

- Discuss the structure and differences of animal and plant cells as seen with the aid of a light microscope.
- Discuss the:
 - differences in the functioning principles of a light and electron microscope.
 - cell structures as seen with the aid of an electron microscope using micrographs and charts.
 - functions of cell structures using models, animations, simulations, etc.
- Guide learners to carry out practical work using the light microscope to study plant and animal cells and tissues.
- Demonstrate the preparation of temporary slides on plant and animal cells and tissues.
- Guide learners to study and examine prepared slides of plant and animal tissues.

- Discuss the structure of the plasma membrane using micrographs and /animations.
- Guide the learners to carry out practical work on estimating the size of a cell.

Assessment Strategy

- Evaluate the topic by giving practical exercises on how to use a microscope as well as oral and written questions on cell structure and functions.

Sub-Topic 2: Diversity of Specialised Cells and Tissues

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • distinguish between prokaryotes and eukaryotes. • explain cell and tissue specialisation. • explain how epithelial tissues are adapted to diversity of functions in the body. • distinguish between the different levels of organisation. • state the advantages and disadvantages of being unicellular. • state the advantages of being multicellular. 	<ul style="list-style-type: none"> • Differences between eukaryotic cells and prokaryotic cells • Specialised cells and tissues:- xylem, phloem, tracheids, sclerenchyma, collenchyma, parenchyma, connective and skeletal tissue • Function and adaptation of epithelial tissues • Levels of organisation: cell, tissue, organ and organ system • Advantages and disadvantages of being unicellular • Advantages of a multicellular state

Teaching/Learning Resources

- Illustrations and handouts
- Staining Reagents: Iodine solution, acidified phloroglucinol, methylene blue, Leishman's stain, microscopes, slides, cover slips, onion, cheek cells, plastic ruler graduated in millimetres, prepared slides of cells and tissues

Suggested Teaching Procedure

- Discuss with illustrations the differences between eukaryotic and prokaryotic cells.
- Guide learners to examine bacteria, plant and animal tissues using a light microscope.
- Discuss levels of organisation.

Assessment Strategies

- Evaluate the topic by giving a practical exercise on identification of plant and animal tissues.
- Give the learners oral questions on tissues and differences between bacteria and viruses.

Sub-Topic 3: Chromosomes

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• describe the composition of chromosomes and structure of nucleotides.• describe the structure of DNA and RNA.• distinguish DNA and RNA.• explain the Watson Crick hypothesis of the nature of DNA.• explain the process of DNA replication.• describe the nature of genes.• describe the structure of the genetic code.	<ul style="list-style-type: none">• Composition of chromosomes and structure of nucleotides• Structure of the nucleic acids DNA and RNA• Differences between DNA and RNA• The Watson- Crick hypothesis of the nature of DNA• DNA replication• Nature of genes• Structure of the genetic code

Teaching/Learning Resources

Models, illustrations, simulations, suitable model materials (wood/ plasticins, toothpicks, ribbons etc) microscopes, electric wires/thread/straws of different colours, prepared slides on mitosis

Suggested Teaching Procedure

- Discuss the structure of the nucleotide and illustrate the structure of nucleic acids (DNA and RNA) using charts, models/ simulations.
- Guide learners to make models of DNA and RNA.

- Discuss the Watson-Crick hypothesis and DNA replication.

Assessment Strategy

- Give a written exercise on the structure of nucleic acids.

Sub-Topic 4: Cell Division and Chromosome Concept

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> • describe mitosis and meiosis. • compare mitosis and meiosis. • explain the significance of changes in the nucleus during cell division. • state the significance of mitosis and meiosis to living organisms. 	<ul style="list-style-type: none"> • Mitosis and meiosis • Comparison of mitosis and meiosis • Significance of the cell division events e.g. formation of the spindle fibres, chiasmata, synapsis, bivalents and movement of chromosomes, etc • Role of mitosis and meiosis in living organisms
(Practical) The learner should be able to: <ul style="list-style-type: none"> • identify stages of mitosis from prepared slides. • draw cells at different stages of mitosis. • prepare models or illustrations of DNA and RNA. 	<ul style="list-style-type: none"> • Cells at different stages of mitosis • Models of the nucleic acids: (DNA / RNA), double helix

Teaching/ Learning Resources

Diagrams illustrating the mitosis and meiosis, animations, prepared slides on root tip, microscopes, and computer aided learning materials

Suggested Teaching Procedure

- Discuss the:
 - phases in mitosis and meiosis by illustrating with diagrams and animations.
 - significance of cell division events.
 - role of cell division in living organisms.

- Guide learners to examine prepared slides showing stages of mitosis in a root tip.

Assessment Strategies

- Give practical work and a written exercise on identification of stages of mitosis and meiosis.
- Give a written exercise on the importance of cell division in organisms.
(See appendix 1: This is an example of Cell Biology practical).

Sub-Topic 5: Protein Synthesis

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• describe the formation of RNA.• describe the process of protein synthesis.• state the role of DNA and RNA in protein synthesis.	<ul style="list-style-type: none">• Formation of RNA (mRNA)• Process of protein synthesis• Role of DNA and RNA in protein synthesis

Teaching/Learning Resources

- Models, illustrations, simulations, charts

Suggested Teaching Procedure

- Discuss the:
 - formation mRNA using models, illustrations, charts and simulations.
 - process of protein synthesis using illustrations.
 - role of DNA and RNA in protein synthesis.

Assessment Strategy

- Give a written exercise on the process of protein synthesis highlighting the role of nucleic acids.

Topic 2: Chemicals of Life

Duration: 46 Periods

Overview

All cells are made up of a variety of substances some of which are organic while others are inorganic. Water forms the largest component and is also a medium for all reactions in a cell. The other substances include acids, bases, salts, vitamins, carbohydrates, lipids and proteins. There are enzymes and nucleic acids which perform a variety of functions.

General Objective

By the end of the topic, the learner should be able to describe the composition, structure, properties and importance of inorganic and organic substances to the life of organisms.

Sub-Topic 1: Acids, Bases and Salts

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> describe properties of acids bases and salts. explain the role of acids, bases and salts in maintaining a stable internal environment for physiological processes. 	<ul style="list-style-type: none"> Properties of acids, bases and salts Functions of acids, bases and salts in organisms
(Practical) The learner should be able to identify salts using quantitative and qualitative analysis.	<ul style="list-style-type: none"> Test for presence of mineral salts in food samples /extracts (refer to inorganic analysis in Chemistry practical)

Teaching/ Learning Resources

Charts, samples of urine/egg yolk /liver extracts, test tubes, 2M nitric acid, silver nitrate solution, dilute ammonium hydroxide, 2M hydrochloric acid, barium sulphate solution, ammonium molybdate solution, platinum wire, conc. hydrochloric acid, potassium hexacyanoferrate(II) solution, filter paper, mortar and pestle, source of heat

Suggested Teaching Procedure

- Ask students to do prior reading on acids, bases and salts. (As an out of class activity).
- Discuss properties of acids, bases and salts.
- Discuss the functions of acids, bases and salts in organisms.
- Guide learners to test for ions in organic materials.

(See Appendix 2 and carry out a test for ions in organic materials).

Assessment Strategies

- Give oral questions on properties of acids, bases and salts.
- Give a written assignment on the functions of acids, bases and salts.

Sub-Topic 2: Water

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• describe the molecular structure of water.• state functions of water.• explain the importance of water as a solvent.• relate the water properties to its role in the life of organisms.	<ul style="list-style-type: none">• Molecular structure of water• Functions of water• Water as a solvent• Role / significance of water in the life of organisms in relation to its properties
(Practical) The learner should be able to: <ul style="list-style-type: none">• test for water.• determine water content in tissues by using dry weight method.• investigate the natural relationship of water and organisms in a habitat (including humans).	<ul style="list-style-type: none">• Testing for water• Measuring water content in tissues• Field study on water habitats. (The natural relationship of water and organisms)

Teaching/ Learning Resources

- Samples of plant organs, weighing balance, heat source /oven, crucibles, dishes, water habitat, cobalt chloride paper/ anhydrous copper sulphate / cobalt thiocyanate paper

Suggested Teaching Procedure

- Discuss the molecular structure, properties and functions of water using illustrations, models and animations.
- Guide learners to test for water and measure water content in tissues. Guide learners to carry out a field survey on water habitats as an out of class activity, either individually or in groups and produce a report.
- Lead a discussion on the survey reports.

Assessment Strategies

- Give a written exercise on functions of water in relation to its properties.
- Give oral questions on natural relationships of water and organisms.

Practical Application

- Consider:
 - i) conservation of water habitats to conserve biodiversity.
 - ii) drinking sufficient quantities of water for normal body function (in humans and other animals).
 - iii) irrigation.

Sub-Topic 3: Structure of Carbohydrates

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> • describe the structure and components of various carbohydrates. • explain the properties of carbohydrates. • explain the functions of carbohydrates in organisms. • describe the condensation of carbohydrates. • describe the hydrolysis of carbohydrates. 	<ul style="list-style-type: none"> • Structure and components of carbohydrates • Properties of carbohydrates • Importance of carbohydrates: monosaccharide's, disaccharides, polysaccharides • Condensation of carbohydrates • Hydrolysis of carbohydrates
(Practical) The learner should be able to: <ul style="list-style-type: none"> • carry out food test for carbohydrates on food samples / extracts. • demonstrate hydrolysis of non-reducing sugars. 	<ul style="list-style-type: none"> • Testing for carbohydrates • Hydrolysis of non-reducing sugars to reducing sugars

Teaching/ Learning Resources

- Illustrations on carbohydrates structures, test tubes, heat sources, food samples/ extracts, water bath/beaker and water
- Reagents: iodine solution, Benedict's solution, dilute hydrochloric (HCl) acid, dilute sodium hydroxide (NaOH) solution

Suggested Teaching Procedure

- Discuss the:
 - composition, properties and importance of monosaccharides, disaccharides and polysaccharides using illustrations.
 - condensation of monosaccharides and hydrolysis of carbohydrates.
- Guide the learners to carry out practical work on tests for carbohydrates and hydrolysis of non-reducing sugars to reducing sugars.

Assessment Strategies

- Give a written exercise on composition, properties and importance of carbohydrates.
- Guide learners to carry out a practical exercise on tests for carbohydrates and hydrolysis of non- reducing sugars.

Sub-Topic 4: Structure of Lipids

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• describe the structure and components of lipid molecules.• state properties of lipids.• explain the functions of lipids in organisms.• describe the structure of steroids.• explain effects of lipids and steroids to organisms• describe the condensation of fatty acids and glycerol to form lipids.• describe the hydrolysis of lipids to fatty acids and glycerol.• compare waxes and lipids.• state the importance of cholesterol in organisms.	<ul style="list-style-type: none">• Structure and components of lipids molecules• Properties of lipids• Importance of lipids in organisms• Structure steroids• Effects of lipids and steroids to organisms• Condensation of fatty acids and glycerol to form lipids• Hydrolysis of lipids to fatty acids and glycerol• Comparison of waxes and lipids• Importance of cholesterol in organisms

(Practical) <ul style="list-style-type: none"> The learner should be able to carry out food tests for lipids on food samples / extracts. 	<ul style="list-style-type: none"> Tests for lipids
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Teaching/ Learning Resources

- Illustrations on lipid structures and effects, test tubes, ethanol, food samples/ extracts, water, opaque piece of paper

Suggested Teaching Procedure

- Discuss the:
 - composition, properties and importance of lipids using illustrations.
 - effects of lipids to organisms.
 - condensation of fatty acids and glycerol. And Hydrolysis of lipids.
- Guide learners to carry out practical work on tests for lipids.

Assessment Strategies

- Give a written exercise on composition, properties and importance of lipids.
- Give a practical exercise on tests for lipids.

Sub-Topic 5: Structure of Proteins

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> describe the structure and components of proteins. describe the properties of proteins. explain the importance of proteins. explain the functions of proteins in organisms. describe condensation of amino acids to form proteins. describe the hydrolysis of proteins to amino acids. explain effects of heat / temperature changes on proteins. 	<ul style="list-style-type: none"> Structure and components of proteins Properties of proteins Importance of proteins Functions of proteins in organisms : buffer, enzymes/catalytic, hormones, structural, growth, carriers etc Condensation of amino acids to form proteins Hydrolysis of proteins to amino acids Effects of heat/temperature on proteins

(Practical)

- | | |
|---|--|
| <ul style="list-style-type: none">• The learner should be able to carry out food tests for proteins on food samples / extracts. | <ul style="list-style-type: none">• Tests for proteins |
|---|--|

Teaching/ Learning Resources

- Illustrations on protein structures, test tubes, heat sources, food samples/ extracts, reagents: 1% copper (II) sulphate solution, dilute sodium hydroxide NaOH solution

Note: Million's reagent is carcinogenic and its use is discouraged.

Suggested Teaching Procedure

- Discuss the:
 - composition, properties and importance of proteins using illustrations
 - condensation of amino acids and hydrolysis of proteins.
- Guide learners to carry out practical work on food tests for protein.

Assessment Strategies

- Give a written exercise on composition, properties, importance and functions of proteins.
- Give learners a practical exercise on test for proteins.

Sub-Topic 6: Vitamins

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> state types of vitamins. state the importance of vitamins in organisms. 	<ul style="list-style-type: none"> Types of vitamins: water soluble and fat soluble, essential and non essential Importance of vitamins in the life of organisms: protection against diseases, formation of coenzymes role in blood clotting and component of visual pigment
(Practical) The learner should be able to: <ul style="list-style-type: none"> test for vitamin C. demonstrate effect of over boiling vegetables. demonstrate the effect of storage on quality of fresh foods. 	<ul style="list-style-type: none"> Test for vitamin C Effect of over boiling vegetables Effects of storage on quality of fresh foods

Teaching/ Learning Resources

- DCPIP, vegetables, beakers, test tubes, droppers, source of heat

Suggested Teaching Procedure

- Ask students to do prior reading on vitamins. (As an out of class activity)
- Discuss properties of vitamins.
- Discuss the importance vitamins in organisms.
- Guide learners to test for: mineral salts in organic materials, vitamin C in vegetables.

Assessment Strategies

- Give a practical exercise on the relative abundance of vitamin C in different food extracts.
- Assess learners on the value of storage conditions on quality of food.

Practical Application

- Consider:
 - i) effect of heating vitamin C and other water soluble vitamins.
 - ii) effect of storage on the quality of fresh food.
 - iii) use of acetic acid/vinegar as salad dressing.

Sub-Topic 7: Enzymes

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• describe the criteria for naming enzymes.• explain the characteristics /properties of enzymes.• state factors that affect enzyme action.• explain the mechanism of enzyme action using the lock and key mechanism and induced fit.• explain the role of enzymes in the organism's life.	<ul style="list-style-type: none">• Criteria for naming enzymes :Use type of substrate, type of reaction• Characteristics/ Properties of enzymes relating to factors affecting enzyme activities : Protein in nature, can be denatured, catalytic /change rates of reactions, work in small amounts, specific to reactions they catalyse, catalyse reversible reactions, can be inhibited, affected by temperature, pH, concentration of substrate and some require coenzymes/ cofactors• Factors affecting enzyme action: pH, temperature, inhibitors, substrate concentration• The enzyme action: lock and key mechanism, induced fit• Role of enzymes in living organisms including inhibition, competitive/non competitive, reversible/non reversible

<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • demonstrate properties of enzyme action in specific temperature, pH range, substrate concentration. • identify enzymes in the different parts of the gut based on their actions on different food substances. • carry out food tests on gut contents. 	<ul style="list-style-type: none"> • Enzyme properties relating to factors (temperature and pH, concentration of substrate) affecting enzymes' activities • Enzymes in the different parts of the gut based on their actions on different food substances • Food tests using the animal gut contents and enzymes
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Teaching/ Learning Resources

- Illustrations , model on the lock and key hypothesis, enzyme extracts, food / substrate extracts, acids, bases, salts and water, universal indicators, thermometers, heat source, incubator, cockroaches (gut), rat/toad, dissecting kits, reagents (depending on the food substrate)

Suggested Teaching Procedure

- Discuss the:
 - naming and properties of enzymes.
 - mode of action of enzymes using illustrations and models.
- Discuss functioning of enzymes, including enzyme inhibitors, allosteric enzymes, cofactors and prosthetic groups.
- Guide the learners to carry out practical work on enzyme properties relating to: factors affecting enzyme activities, food tests on carbohydrates and proteins using enzymes of gut contents.

Assessment Strategies

- Give written exercises on properties and functioning of enzymes.
- Give practical exercises on effects of gut enzymes on food substances.

SENIOR FIVE TERM TWO

Topic 3: Cell Physiology

Duration: 18 Periods

Overview

Materials move in and out of cells by the following processes: - Osmosis, diffusion, active transport, phagocytosis and pinocytosis. Some of these processes require energy while others do not. The materials include water, gases, enzymes, hormones, antibodies, among other solvents and solutes.

General Objectives

By the end of the topic, the learner should be able to:

- i) explain the physiological processes by which materials move in and out of cells.
- ii) explain the role of these processes in the life of organisms.

Sub-Topic 1: Movement In and Out of Cells

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• describe diffusion, osmosis, active transport, phagocytosis and pinocytosis.• state the factors that affect the process of diffusion.• describe the processes of osmosis.• explain the significance of diffusion and osmosis in organisms.• explain how solvents and solutes are exchanged in animal and plant tissues or cells across the cell membrane in relation to its	<ul style="list-style-type: none">• Diffusion and osmosis, active transport, phagocytosis and pinocytosis: exocytosis and endocytosis• Factors affecting process of diffusion• Process of osmosis: including; turgidity, plasmolysis, water potential, osmotic potential, wall pressure• Significance of the processes of diffusion and osmosis in organisms• Exchange of solvents and solutes in plant and animal tissues or cells across the cell membrane in relation to its

structure. <ul style="list-style-type: none"> describe how unicellular organisms obtain water and food. explain the relationship between structure and function of a cell membrane. 	structure <ul style="list-style-type: none"> Ways by which unicellular organisms obtain water and food Relationship between structure and function of a cell membrane
(Practical) The learner should be able to: <ul style="list-style-type: none"> identify habitats with suitable media for organisms' survival. demonstrate use of salt in food preservation. demonstrate use of visking tubing, glass columns, microscope in diffusion and osmosis experiments. demonstrate conditions affecting the rate of diffusion. demonstrate effects of osmosis on the cells/ tissues. 	<ul style="list-style-type: none"> Habitats with suitable media for organisms' survival Use of salt in food preservation Use of visking tubing, glass columns and microscope in diffusion and osmosis experiments Conditions affecting the rate of diffusion Effect of osmosis in living cells/tissues

Teaching/ Learning Resources

- Illustrations on movement of materials in and out of cells, potassium permanganate, methylene blue, water, sucrose solutions, plant organs: (potato tubers/ pawpaw petioles unripe pawpaw fruits, *bidens sp.* stem cuttings.), filamentous algae, slides, microscopes, razor, cellophane / visking tubing, cork borer, knife, onion epidermis / *Tradescantia* / *Zebrina* leaf epidermis

Suggested Teaching Procedure

- Discuss diffusion, osmosis, active transport, phagocytosis and pinocytosis using illustrations and demonstrations.
- Guide learners to carry out practical work on conditions affecting the rate of diffusion and on osmosis in living tissues.

Assessment Strategies

- Give a written exercise on interpretation of data (in table / graph form) on movement in and out of cells.

- Give a practical exercise on movement in and out of cells.

Practical Application

Consider practical application for example:

- i) Avoid exposing living organisms / tissues to concentrated media.
- ii) Food preservation by salting.

Topic 4: Levels of Organisation and Diversity of Life

Duration: 56 Periods

Overview

This topic involves application of biosystematics principles. These include identification, classification and nomenclature. It indicates the relationship among organism basing on their characteristics.

It should be noted that although viruses have non living characteristics they show some characteristics of living things when they are within the living cells of an organism.

General Objective

By the end of the topic, the learner should be able to trace the relationships between groups of organisms.

Sub-Topic 1: Diversity of Living Things

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • explain the principles of taxonomy. • explain the principles of classification. • explain the importance of studying diversity. • list 3 criteria for classifying organisms. • state the hierarchy of classification according to Carl Linnaeus. • distinguish between scientific and local names. • explain the need to conserve 	<ul style="list-style-type: none"> • Principles of taxonomy: identification, classification and nomenclature • Principles of classification: artificial and natural classification • Importance of studying diversity • 3 Criteria for classifying organisms: morphology, anatomy, physiology • Hierarchy of classification according to Carl Linnaeus (kingdom-phylum/ division - class-order-family-genus-species) • Scientific /binomial nomenclature and local names • Importance of conserving

biodiversity.	biodiversity
(Practical) The learner should be able to: <ul style="list-style-type: none">• identify organisms using observable features.• construct simple biological keys.	<ul style="list-style-type: none">• Identification of organisms using observable features• Construction and use of simple biological keys

Teaching/ Learning Resources

Use simple and common organisms or organs (e.g. arthropods, leaves, flowers, fruits, modified stems), charts, , preserved specimens and prepared slides

Suggested Teaching Procedure

- Discuss the:
 - principles of taxonomy and principles of classification using illustrations, charts and specimens.
 - diversity of living things and significance of studying diversity using charts, preserved specimens and organisms in the school compound. Guide the learners to carry out a field study to observe biodiversity and collect some specimens in the school surroundings.
- Guide learners on the construction and use of simple biological keys.

Assessment Strategy

- Give practical exercises on tabulation of observable structural features of organisms and using the features to construct dichotomous keys.

Practical Application

- Consider conservation of biodiversity.

Sub-Topic 2: Viruses (Akaryotae)

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> describe the general structure of a virus. explain characteristics of viruses. describe the economic importance of viruses. outline methods of preventing the spread of viral diseases. 	<ul style="list-style-type: none"> Structure of viruses Characteristics of viruses Economic importance of viruses Methods of preventing the spread of viral diseases

Teaching/ Learning Resources

- Computer aided study materials, charts, diseased plants and animals (CARE).

Suggested Teaching Procedure

- Discuss the structure, characteristics and economic importance of viruses using charts, computer aided study material and specimens of diseased plants and animals.
- Give an out of class activity on prevention of common viral diseases.
- Guide a discussion on viral diseases in the next lesson.

Assessment Strategy

- Give a written exercise on the structure and economic importance of viruses.

Practical Application

- Consider prevention of viral diseases.

Sub-Topic 3: Kingdom Monera

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• make a labelled diagram to show the structure of bacterial cell.• describe characteristics of bacteria.• differentiate between bacteria and viruses.• state the role of bacteria in the environment.	<ul style="list-style-type: none">• Structure of bacterial cell• Characteristics of bacteria: shape, cell wall, reproduction, movement• Differences between bacteria and viruses• Economic importance of bacteria in the environment
(Practical) The learner should be able to: <ul style="list-style-type: none">• draw, label and state the types of bacteria• demonstrate the role of bacteria in the production of dairy products.• identify common bacterial diseases in plants and animals.• demonstrate methods of preventing the common bacterial diseases.	<ul style="list-style-type: none">• Types of bacteria• Role of bacteria in production of dairy products• Common bacterial diseases in plants and animals• Methods of preventing common bacterial diseases

Teaching/ Learning Resources

- Illustrations, computer aided study materials, charts, prepared bacteria cultures from milk, soil and plant part extracts, stains, microscope, incubator, fridge, prepared slides, computer simulations

Suggested Teaching Procedure

- Discuss the characteristics, structure and economic importance of bacteria using illustrations, computer simulations, prepared slides and charts.
- Guide the learners to carry out a field study on economic importance of bacteria as an outside class activity and lead discussion of their findings.

- Describe different types of bacteria using illustrations.

Assessment Strategy

- Give a written exercise on characteristics, structure and economic importance of bacteria.

Practical Application

- Consider:
 - i) prevention of bacterial diseases.
 - ii) role of bacteria in decomposition of organic matter.
 - iii) use of bacteria in the manufacture of dairy products e.g. butter, yoghurt, cheese, ghee.

Sub-Topic 4: Kingdom Protocista

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> • state characteristics of Protocista. • describe the structure of protozoa and algae. • outline the role of protozoa and algae in the environment. • Name common diseases caused by protozoa. • Outline methods of preventing spread of diseases caused by protocists. 	<ul style="list-style-type: none"> • Characteristics of Protocista • Structure of protozoa and algae • Economic importance of protozoa and algae e.g. <i>Amoeba</i>, <i>Euglena</i>, <i>Entamoeba</i>, <i>Paramecium</i>, <i>Trypanosoma</i>, <i>Plasmodium</i> • Common diseases caused by protozoa • Methods of preventing the spread of diseases caused by protocists
(Practical) The learner should be able to: <ul style="list-style-type: none"> • prepare temporary mount of <i>Spirogyra</i> filaments. • draw and label structure of <i>Spirogyra</i> as seen under a light microscope. • identify and draw protozoa from prepared slides. 	<ul style="list-style-type: none"> • Structure of the <i>Spirogyra</i> • Structure of protozoa

Teaching/ Learning Resources

- Computer aided study materials, illustrations, microscope, slides, cover slips, Spirogyra, prepared slides of protozoa

Suggested Teaching Procedure

- Discuss the structure and characteristics of protocists using charts, computer aided study materials and prepared slides.
- Guide learners to observe the structure of Spirogyra as seen with the aid of light microscope.
- Discuss economic importance of the protocists.

Assessment Strategies

- Give a practical exercise on structure of spirogyra.
- Give a written exercise on the economic importance of protocists.

Practical Application

- Consider prevention of diseases caused by protozoa.

Sub-Topic 5: Kingdom Fungi

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• state characteristics of fungi.• state characteristics of <i>Rhizopus</i> or <i>Mucor</i>, yeast, and the mushroom.• state the economic importance of fungi.• name common fungal diseases.• describe the methods of preventing the spread of fungal diseases.• explain the use of yeast in brewing alcohol and bread making.	<ul style="list-style-type: none">• Characteristics of fungi (feeding, reproduction).• Characteristics of <i>Rhizopus</i> or <i>Mucor</i>, yeast, and the mushroom• Economic importance of fungi• Common fungal diseases• Methods of preventing the spread of fungal diseases• Use of yeast in brewing alcohol and bread making

<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • prepare temporary mount of yeast, <i>Mucor/Rhizopus</i>. • draw and label structure of <i>Rhizopus</i> or <i>Mucor</i>, yeast and the mushroom. 	<ul style="list-style-type: none"> • Structures of yeast, <i>Mucor/Rhizopus</i> as seen under the light microscope • Structure of the mushroom
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Teaching/ Learning Resources

- Computer aided study materials, illustrations, charts, and specimens.
- Mould samples, microscope, slides, cover slips

Suggested Teaching Procedure

- Discuss the structure, characteristics and economic importance of fungi using specimens, charts, photographs, and computer aided study materials.
- Guide learners to carry out practical work on mushrooms and temporary mounts of yeast, *rhizopus* or *mucor*.

Assessment Strategies

- Give a written exercise on the structure, characteristics and economic importance of fungi.
- Give a practical exercise on the structure of yeast, *rhizopus* or *mucor*.

Practical Application

- Consider:
 - i) prevention of fungal diseases in plants and animals.
 - ii) mushroom growing.
 - iii) use of yeast in bread making and brewing alcohol.
 - iv) preservation of food by drying to prevent fungal growth.
 - v) prevention of deterioration of natural materials e.g. leather and wood by keeping them dry to prevent fungal growth.

Sub-Topic 6: Kingdom Plantae

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> identify lower plants and higher plants using structural features. name the plant groups to phyla. outline the characteristics and structures of the named plant groups. state the role of plants in the environment. 	<ul style="list-style-type: none"> Structural features of lower plants and higher plants Lower plants: Bryophyta and Pteridophyta (Ferns)/Filicinophyta Higher plants: Coniferophyta, Spermatophyta Characteristics and structures of named plant groups: Bryophyta, Filicinophyta, Coniferophyta, Spermatophyta: gymnosperms and angiosperms to class level Economic importance of plants in the environment
<p>(Practical)</p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> Identify distinguishing structural features of plant groups in lower plants. identify distinguishing structural features of plant groups in higher plants. 	<ul style="list-style-type: none"> Structural features of lower plants: Bryophyta, Pteridophytes/ Filicinophyta Structural features of higher plants: Coniferophyta, Spermatophyta: (gymnosperms, angiosperms)

Teaching /Learning Resources

- Plant specimens, illustrations, computer aided study materials, charts, sample plant organs, hand lenses, microscopes

Suggested Teaching Procedure

- Discuss characteristics and structural features of plant groups.
- Guide learners to do practical work on structural characteristics of the following plants:
 - moss
 - ferns

- coniferous plant
- angiosperms
- Guide the learners to make transverse sections of roots and stems of monocotyledonous and dicotyledonous plants.
- Discuss the economic importance of plants using illustrations and computer aided study materials.
- Guide learners to carry out a research on the role of plants in the habitat.

Assessment Strategy

- Give a written exercise on structure, characteristics and economic importance of plants.

Practical Application

- Consider:
 - i) growing ornamental plants.
 - ii) growth of plants for food, timber, nature conservation, medicine, raw material for crafts, fibre producing plants (sisal, hemp, cotton), etc.

Sub-Topic 7: Kingdom Animalia

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • state characteristics of invertebrates and vertebrates. • state the distinguishing structural features of organisms in different animal phyla. 	<ul style="list-style-type: none"> • Characteristics of invertebrates and vertebrates • Distinguishing structural features of various animal phyla: <ul style="list-style-type: none"> - porifera - coelenterata/cnidaria - platyhelminthes - nematoda - annelida - mollusca - echinodermata - arthropoda down to classes. consider class insecta down to order

<ul style="list-style-type: none"> • explain the role of animals in the environment. • discuss the welfare of domestic and wild animals. 	<ul style="list-style-type: none"> - chordata down to vertebrate classes • Economic importance of the animal groups • Welfare of domestic (consider care and feeding) and wild animals (mention protection and conservation)
<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • classify phylum Arthropoda to class level using structural features. • identify structural features of class Insecta down to order level. • state distinguishing structural features of animals other than Arthropoda. 	<ul style="list-style-type: none"> • Structural features of Arthropoda down to class level • Structural features of class Insecta down to order level • Structural features of animals other than arthropods

Teaching /Learning Resources

- Animal specimens, illustrations, computer aided study materials, photographs, sample organs, hand lenses, light microscope, identification keys

Suggested Teaching Procedure

- Discuss the structural features of animals in the different phyla using specimens, photographs, sample organs, etc.
- Guide learners to carry out practical work using structural characteristics to classify animals.
- Discuss the economic importance of animals using illustrations and computer aided study materials.
- Guide learners to carry out research on animal welfare activities as an out of class activity.
- Then lead a discussion on their findings.

Assessment Strategies

- Give written exercises on structure, characteristics and economic importance of animals.
- Give practical work on construction and use of dichotomous keys.

Practical Application

- Consider:
 - i) welfare of domestic and wild animals
 - ii) use of beneficial insects
 - iii) plant and animal pests and diseases
 - iv) biological control

Topic 5: Ecology

Duration: 31 Periods

Overview

Ecology is the study of the relationship of living organisms with each other and their non living environment. The study of ecology lays a foundation for understanding agriculture, forestry, fisheries, conservation, impact of human activities on the ecosystem and how to remedy these impacts.

General Objectives

By the end of the topic, the learner should be able to:

- i) describe the relationships of organisms with each other and their non living environment.
- ii) explain the impact of humans on the ecosystem and the need for conservation in nature.

Sub-Topic1: Components of the Environment

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">describe the abiotic and biotic components.state abiotic and biotic factors.explain how the components and environmental factors influence the distribution and abundance of organisms in an ecosystem.	<ul style="list-style-type: none">Abiotic components: air, water, soil Biotic components: living thingsAbiotic factors: light, temperature, humidity, atmospheric pressure, rainfall, edaphic factors Biotic factors: competition, predation, biological associationsInfluence of abiotic and biotic components and factors of the environment on distribution and abundance of organisms

(Practical) The learner should be able to: <ul style="list-style-type: none"> • collection of data from field studies. • analyse and interpret data or literature on ecological principles. 	<ul style="list-style-type: none"> • Collection of data on ecological components and factors of an ecosystem • Analysis and interpretation of data or literature on ecological principles
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Teaching /Learning Resources

- Illustrations, computer aided study materials, charts, photographs, school and community natural resources,(choose one or two natural resources for the study)
- Data in form of graphs, tables, charts, photographs, illustrations, CDs, quadrats, string, thermometers, tape measure, dry cobalt chloride paper, hand lenses, pooters, sweep nets, etc.

Suggested Teaching Procedure

- Discuss the abiotic and biotic components and factors using illustrations and computer aided study materials.
- Guide learners to carry out a field study on collection and analysis of data on components and factors of the environment of the organism.
(See Appendix 4 field activity.)

Assessment Strategy

- Give learners an exercise to analyse and interpret data or literature on components and factors of the environment.

Practical Application

- Consider environmental conservation.

Sub-Topic 2: Concept of Ecosystem

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> • describe an ecosystem. • state the types and properties of an ecosystem. 	<ul style="list-style-type: none"> • Ecosystem: definition • Aquatic and terrestrial ecosystems and properties of an ecosystem: feeding relations,

<ul style="list-style-type: none">• explain the ecological factors influencing the life of organisms in an ecosystem.• explain changes in an ecosystem.• describe feeding relations in an ecosystem.• explain energy flow and recycling of nutrients in an ecosystem.• describe biogeochemical cycles.	<p>cycling of materials, succession, climax, and homeostasis of an ecosystem/balance of nature</p> <ul style="list-style-type: none">• Ecological factors influencing the life of organisms in an ecosystem: abiotic, biotic, edaphic• Changes in an ecosystem: ecosystem productivity, succession and climax• Feeding relations: food chains, food webs, ecological pyramids• Recycling of nutrients and energy flow in ecosystems• Biogeochemical cycles: nitrogen, carbon, water
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Teaching /Learning Resources

- Illustrations, computer aided study materials

Suggested Teaching Procedure

- Discuss the concept of the ecosystem using illustrations.
- Guide learners in a field study on the interaction of organisms in a habitat / an ecosystem.

Assessment Strategy

- Give a written exercise to analyse and interpret data related to ecological principles in an ecosystem or habitat.

Practical Application

- Consider practical application, for example, living in harmony with our environment.

Sub-Topic 3: Population and Natural Resources

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> state population characteristics. explain factors affecting population density. describe methods or techniques of estimating populations. explain population growth patterns. explain the terms renewable and non-renewable resources. discuss environmental resistance and “balance of nature”. discuss the importance of natural resources. describe methods of conservation of natural resources. 	<ul style="list-style-type: none"> Population characteristics: density, age structure, sex, growth pattern, birth rate, death rate Population density dependent factors and density independent factors Methods or techniques of measuring and estimating population density Population growth patterns Natural resources types: renewable and non-renewable, importance, conservation Environmental resistance: density dependent factors affecting “balance of nature” Importance of natural resources Methods of conservation of natural resources
<p>(Practical)</p> <ul style="list-style-type: none"> The learner should be able to demonstrate the methods used in estimating populations. 	<ul style="list-style-type: none"> Methods of estimating population: quadrat, line transect, capture-recapture

Teaching /Learning Resources

- Illustrations, computer aided study materials, quadrat, sweep net, string / rope/peg, traps, specimen bottles /containers, beads of different colours, markers, videos

Suggested Teaching Procedure

- Discuss population and natural resources using illustrations and videos.

- Guide learners in practical work on estimating populations using quadrats, line transect.
- Guide learners to estimate a population using capture-recapture method.
(See Appendix 3 simulation of capture-recapture).

Assessment Strategy

- Give written exercise on effect of population increase on natural resources.

Practical Application

- Consider:
 - i) Wise use of natural resources
 - ii) Population control

Sub-Topic 4: Interdependence

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• explain the various interactions of organisms in nature.• state the significance of organisms' interactions in nature.	<ul style="list-style-type: none">• Interactions among organisms and their effects: interspecific and intraspecific relationships between organisms: competition, parasitism, predation, saprophytism, mutualism, commensalism• Significance of organisms' interactions in nature

Teaching /Learning Resources

- Illustrations, computer aided study materials, video, photographs

Suggested Teaching Procedure

- Discuss interactions between organisms using photographs, video, and computer aided study materials.
- Guide learners to carry out a field study on interaction of organisms in a habitat / an ecosystem.

(See Appendix 4 field activity)

Assessment Strategy

- Ask learners to make presentation on interactions between organisms in different habitats / ecosystems.

Sub-Topic 5: Effects of Human Activities on Ecosystems

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • discuss the impact of human activities on an ecosystem. • explain the effects of human activities on ecological components and factors in a habitat. • discuss natural resource utilisation and sustainable development. 	<ul style="list-style-type: none"> • Impact of human activities on an ecosystem • Effects of human activities on ecosystem components and factors in a habitat: <ul style="list-style-type: none"> - interruption of biogeochemical cycles, natural resources imbalances, population imbalances, soil erosion, soil exhaustion, extinction, pollution, speciation. • Natural resources utilisation and sustainable development
<p>(Practical)</p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> • demonstrate conservation practices. 	<ul style="list-style-type: none"> • Natural resource conservation practices: mulching, terracing, crop rotation, afforestation, reforestation, mixed farming, agro forestry, wise use of resources, etc.

Teaching /Learning Resources

- Illustrations, computer aided study materials, videos, photographs, and data.

Suggested Teaching Procedure

- Discuss the effects of human activities on ecosystems using illustrations.
- Guide learners to demonstrate natural resource conservation practices.
- Guide learners to collect information on the effects of human activities on the ecosystems.

Assessment Strategies

- Give a written exercise on effects of human activities on the environment.
- Give a written assignment on data analysis and interpretation.
(See appendix 4b ecology)

Practical Application

- Consider conservation of natural resources

SENIOR FIVE TERM THREE

Topic 6: Inheritance and Evolution

Duration: 34 Periods

Overview

Organisms show variations which may be as a result of the influences of the environment and genetic factors. These variations can be passed on from one generation to another.

Evolution and variation processes are linked because both cause changes in organisms.

General Objective

By the end of the topic, the learner should be able to explain the patterns of inheritance and evolution.

Sub-Topic 1: Genetics

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • explain the concept of inheritance. • define genetics terms. • describe Mendel's investigations on heredity. • explain inheritance of traits using the monohybrid and dihybrid crosses. • explain the two Mendel's laws of inheritance. • discuss the challenges of inheritable disorders. 	<ul style="list-style-type: none"> • Concept of inheritance • Definition of genetics terms e.g. inheritance, gene, allele, chromosome, DNA, trait, etc • Mendel's work on heredity • Monohybrid inheritance and dihybrid inheritance. • Mendel's laws of inheritance: law of independent assortment and law of segregation • Challenges of inheritable disorders

(Practical) The learner should be able to: <ul style="list-style-type: none">• demonstrate monohybrid and dihybrid inheritance.• illustrate a pedigree.	<ul style="list-style-type: none">• Monohybrid inheritance dominant and recessive traits: using uniform money coins/ beads/seeds.• Pedigree study: baldness, early greying of hair, haemophilia, eye colour, sickle cell, albinism
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Teaching / Learning Resources

- Illustrations, charts, computer aided study materials, bean / cow pea seeds, uniform money coins or discs, beads, group of organisms /organs

Suggested Teaching Procedure

- Discuss concept of inheritance and Mendel's work on heredity using illustrations.
- Discuss monohybrid inheritance illustrating with crosses.
- Guide learners to work out dihybrid inheritance illustrating with crosses.
- Discuss challenges of heritable disorders, using relevant examples.
- Guide learners to carry out practical work on monohybrid and dihybrid inheritance using simulations (see appendix 5).
- Guide learners to interpret and illustrate pedigrees.
- Ask learners to gather information on pedigrees as an out of class activity.

Assessment Strategies

- Give written assignment on inheritance of characteristics.
- Give a written assignment on pedigree analysis.

Practical Application

- Consider:
 - i) paternity / maternity tests
 - ii) genetic counselling

Sub-Topic 2: Chromosomes and Genes

Specific Objectives	Content
<ul style="list-style-type: none"> The learner should be able to explain the terms: gene interactions, sex linkage, sex determination, sex limitation, lethal genes and polygenes. explain gene and chromosome mapping. 	<ul style="list-style-type: none"> Terms: <ul style="list-style-type: none"> gene interactions: definition and examples: linkage, multiple alleles, co-dominance, incomplete dominance, dominant and recessive traits, epistasis and complementary genes sex linkage definition, examples and inheritance sex determination: definition and examples in humans sex limitation: definition and examples lethal genes: definition and examples: phenyl ketonuria, neurospora, etc polygene: definition and examples Gene and chromosome mapping

Teaching / Learning Resources

- Illustrations, computer aided study materials

Suggested Teaching Procedure

- Discuss gene interactions using illustrations and examples.
- Work out problems based on gene interactions.
- Discuss gene and chromosome mapping using illustrations.

Assessment Strategies

- Give written exercise on working out crosses based on gene interactions.
- Allow learners to present oral answers on gene interactions.
- Give written exercise on gene and chromosome mapping.

Sub-Topic 3: Variation

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• explain population traits and types of variation.• describe the causes of variation.• define mutation.• describe types and causes of mutations.• distinguish between chromosomal and gene mutations.• explain the significance of mutations.	<ul style="list-style-type: none">• Population traits and types of variations: continuous (quantitative) and discontinuous (qualitative)• Causes of variation: genetic and environmental factors• Definition of mutation• Types of mutations: gene and chromosomal mutation• Causes of mutation: chance, radiation, chemicals• Differences between the chromosomal and gene mutations• Significance of mutations
(Practical) The learner should be able to: <ul style="list-style-type: none">• identify variations in organisms.• collect data on variations among themselves.	<ul style="list-style-type: none">• Variations among organisms• Data on variations among organisms (e.g. sex, height, tongue rolling)

Teaching / Learning Resources

- Illustrations, computer aided study materials, charts, preserved specimens and learners

Suggested Teaching Procedure

- Discuss, with illustrations the types, causes and significance of variation and mutations.
- Guide learners to collect data on variation.

Assessment Strategy

- Give written assignment on interpretation of data on variation.

Practical Application

- Consider selection of better varieties of crops, animals and ornamental plants.

Sub-Topic 4: Population Genetics

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> explain gene frequency in the gene pool of a population. state the Hardy -Weinberg equilibrium. explain how different factors affect the gene frequency in a population. 	<ul style="list-style-type: none"> Gene frequency in the gene pool of a population Causes of changes in gene frequency in a population Hardy-Weinberg equilibrium Factors affecting the Hardy-Weinberg equilibrium: natural selection, non random mating, mutation, migration, population size

Teaching / Learning Resources

- Illustrations, computer aided study materials

Suggested Teaching Procedure

- Discuss the Hardy-Weinberg equilibrium and guide learners to calculate gene frequencies using data from relevant texts.

Assessment Strategies

- Give calculations based on the Hardy-Weinberg equilibrium.
- Give written exercise on factors affecting gene frequencies.

Sub-Topic 5: Origin of Life

Specific Objectives	Content
<ul style="list-style-type: none"> The learner should be able to explain the theories related to the origin of life. 	<ul style="list-style-type: none"> Theories of the origin of life: special creation, spontaneous generation, biochemical evolution

Teaching / Learning Resources

- Illustrations

Suggested Teaching Procedure

- Discuss the theories of origin of life using illustrations.

Assessment Strategy

- Give reading and written assignments on the theories of origin of life.

Sub-Topic 6: Mechanisms of Evolution

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• discuss Lamarck's theory of evolution.• explain Darwin's theory of natural selection.• explain the importance of variation in evolution.• discuss Neo-Darwinism.• explain the causes of present day evolution.	<ul style="list-style-type: none">• Lamarck's theory of evolution of acquired characters through use and disuse• Darwin's theory of natural selection: observations and deductions• Importance of variation in evolution• Neo- Darwinism (present day theory of evolution)• Causes of present day evolution: competition, changes in the environment, sexual reproduction, mutations, gene recombination, industrialisation, effects of drug / chemical resistance, artificial selection, polyploidy

Teaching / Learning Resources

- Illustrations, Computer aided study materials

Suggested Teaching Procedure

- Discuss the mechanisms of evolution using illustrations.

Assessment Strategies

- Give a competitive quiz based on the out of class reading assignment.
- Give written assignment on mechanisms of evolution.

Sub-Topic 7: Evidence of Evolution

Specific Objectives	Content
<p>The learner should be able to</p> <ul style="list-style-type: none"> discuss evidence of evolution. explain the emergence of variations among organisms. 	<ul style="list-style-type: none"> Evolution evidence based on: fossilisation, comparative study of anatomy, embryology, cytology, biochemistry, taxonomy, geographical distribution, vestigial structures, analogous structures, homologous structures Emergence of variations among organisms

Teaching / Learning Resources

- Illustrations, computer aided study materials, photographs of fossils, fossils, videos, charts

Suggested Teaching Procedure

- Discuss changes in living things and emergence of variations among organisms using illustrations.

Assessment Strategies

- Organise a quiz on the terms related to evolution.
- Give written exercise on evidence of evolution.

Practical Application

- Consider resistance to diseases, drugs, pesticides and herbicides.

Sub-Topic 8: Selection and Speciation

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• explain natural selection and artificial selection.• define speciation.• describe allopatric speciation and sympatric speciation.• state the roles of natural selection and artificial selection in speciation.• describe mechanisms related to speciation of organisms. <ul style="list-style-type: none">• explain extinction.	<ul style="list-style-type: none">• Natural selection and artificial selection• Definition of speciation• Allopatric speciation and sympatric speciation• Role of natural selection and artificial selection in speciation• Mechanisms related to speciation: continental drift, migration, adaptive radiation, divergent and convergent evolution, isolation i.e. ecological, reproductive and genetic• Extinction: meaning, causes and effects

Teaching / Learning Resources

- Illustrations, computer aided study materials, charts, photographs

Suggested Teaching Procedure

- Discuss natural and artificial selection using illustrations.
- Discuss isolating mechanisms giving examples.
- Assign groups of learners to read about particular mechanisms of speciation as an out of class activity.
- Guide learners in the presentation of their findings.
- Discuss extinction giving examples.

Assessment Strategies

- Organise a quiz on the terms related to selection and speciation.
- Give a written assignment on the mechanisms of speciation.

Practical Application

- Consider:
 - i) emergence of varieties resistant to diseases, drugs, pesticides and herbicides
 - ii) genetic engineering

(See appendix 6: Genetics)

Topic 7: Transport

Duration: 36 Periods

Overview

The mode of transport of materials largely depends on the size of an organism. Transport systems have additional functions other than movement of materials within the organism. These include protection and support.

General Objective

By the end of the topic, the learner should be able to describe the structure and functioning of transport systems.

Sub-Topic 1: Necessity for Transport Systems

Specific Objective	Content
<ul style="list-style-type: none">The learner should be able to explain the limitations of simple diffusion in the transport process.	<ul style="list-style-type: none">Limitations of simple diffusion process: concept of surface area: volume ratio and its effect on diffusion rate

Teaching / Learning Resources

- Illustrations, computer aided study materials, charts

Suggested Teaching Procedure

- Discuss the necessity for transport systems using illustration or demonstration.

Assessment Strategy

- Allow learners to give oral answers to questions on the need for a transport system.

Sub-Topic 2: Water as a Medium in Plants and Animals

Specific Objective	Content
<ul style="list-style-type: none">The learner should be able to explain the significance of water in transport.	<ul style="list-style-type: none">Significance of water in transport: solvent, medium of transport

Teaching / Learning Resources

- Charts, computer aided materials

Suggested Teaching Procedure

- Discuss the role of water as a medium of transport in plants and animals using illustrations.

Assessment Strategy

- Give a written exercise on the role of water in the transport of materials within organisms.

Practical Application

- Consider oral rehydration, irrigation during dry season, watering animals, ensure sufficient intake of water by humans.

Sub-Topic 3: Circulatory Systems in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • describe types of circulatory systems. • describe the circulatory systems in insects, annelids and mammals. • explain the advantages and disadvantages of open and closed systems in animals. • compare the structure and function of veins, arteries and capillaries. • compare the circulatory systems of fish and mammals. • describe the functioning of the mammalian heart. • explain the response of the heart to 	<ul style="list-style-type: none"> • Types of circulatory systems: open and closed, single and double • Circulatory systems in insects, annelids and mammals • Advantages and disadvantages of open and closed systems in animals • structure and function of veins, arteries and capillaries • Structure of transport systems in fish and mammals • Functioning of the mammalian heart: cardiac cycle, blood pressure changes, myogenic property, control of the heart beat • Response of heart to body

<p>body activities.</p> <ul style="list-style-type: none"> • explain how the heart beat rate is controlled. • relate the action of adrenalin and acetylcholine to the innervation of the heart. • interpret information on the effects of drugs and variation of temperature on the cardiac frequency. • describe the role of blood components in the transport process. • explain the diseases related to the circulatory system. 	<p>activities</p> <ul style="list-style-type: none"> • Control of heart beat rate • Action of adrenalin and acetylcholine on the innervation of the heart • Effects of drugs and temperature variations on the cardiac frequency • Blood constituents and functions • Common diseases of the blood and heart, including, sickle cell anaemia and coronary artery disease
<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • identify structural features of blood vessels. • display and draw major structures of the circulatory systems in insects, toads, and mammals. • describe the insects', toads' and mammals' circulatory system in relation to their functions. • describe the structural adaptations of the muscles of the circulatory system of mammals. 	<ul style="list-style-type: none"> • Structure of blood vessels (veins, arteries, capillaries) • Circulatory systems in insects, toads and mammals: gross structure and fine structure • Insects, toads and mammals circulatory systems in relation to functions • Structural adaptation of cardiac muscle and smooth muscle of the circulatory system of mammals

Teaching / Learning Resources

- Illustrations, computer aided study materials, models, charts, video, prepared slides of blood smear, prepared slides of blood vessels and cardiac muscle, microscopes, dissecting sets/kits, photographs, pins, boards, dishes, animal specimens, dissection guides, chloroform, cotton wool, thread

Suggested Teaching Procedure

- Discuss the:
 - structure, types and functioning of the circulatory system in animals using illustrations.
 - blood constituents and their functions, common diseases of the blood and the heart using illustrations.
- Guide learners to carry out practical work on dissections and microscopy of the circulatory systems.

Assessment Strategies

- Give written exercise on circulatory systems in animals.
- Give practical exercise on dissection, displaying, drawing and labelling blood vessels.
- Give practical work on identifying, drawing and labelling blood cells and blood vessels.

Practical Application

- Consider:
 - i) first aid to stop bleeding.
 - ii) prevention of diseases of the circulatory system and blood.
 - iii) blood transfusion.

Sub-Topic 4: Defence against Diseases

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> • describe the mechanism of blood clotting. • describe immune responses in humans. • state the role of the thymus gland in immunity. • explain the immune responses during blood transfusion. • describe the effects of the Rhesus factor during pregnancy. 	<ul style="list-style-type: none"> • Mechanism of blood clotting • Immune responses in humans: definition, primary, secondary • The role of the thymus gland in immunity • Blood groups and blood transfusion • Effects of the Rhesus factor during pregnancy

Teaching / Learning Resources

- Illustrations, computer aided study materials, models, charts

Suggested Teaching Procedure

- Discuss mechanism of blood clotting, immune responses, the role of the thymus gland using illustrations.
- Explain antigen-antibody reactions using blood groups and the Rhesus factor as an example.

Assessment Strategy

- Give a written exercise on defence against diseases.

Practical Application

- Consider
 - i) immunisation
 - ii) blood transfusion
 - iii) allergy

Sub-Topic 5: Vascular System of Flowering Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• describe the structural and functional adaptations of the vascular tissues to the transport process of materials in monocotyledonous and dicotyledonous plants.• explain the mechanism of transporting materials in plants.• describe the evidence for the path of materials in plants.• describe translocation and uptake of water and mineral salts in plants.• explain the role of transpiration in transport of water and dissolved mineral salts in plants.	<ul style="list-style-type: none">• Structure and functional adaptations of vascular tissues in monocotyledonous and dicotyledonous plants• Mechanism of transporting materials in plants• Evidence for the path of materials in plants• Uptake of water and mineral salts in plants• Role of transpiration in transport of water and dissolved mineral salts in plants

<p>(Practical)</p> <ul style="list-style-type: none"> • interpret data related to transport of materials. • identify types and the pattern of distribution of vascular bundles in plant organs. • stain and make temporary mounts of transverse sections (T.S) and longitudinal sections (L.S) of: stems, roots and T.S of leaves from herbaceous plant organs. • interpret T.S and L.S of stems, roots and T.S of leaves. • draw and label low power plans to show distribution of tissues in T.S and L.S of stems, roots and T.S of leaves. • make high power labelled drawings of vascular tissues in T.S and L.S of stems, roots and T.S of leaves. 	<ul style="list-style-type: none"> • Structure and distribution pattern of the vascular tissues in monocotyledonous and dicotyledonous plants • Transverse (T.S) and longitudinal sections (L.S) of: stems, roots and, T.S of leaves of monocotyledonous and herbaceous dicotyledonous plants • Labelled diagrams of T.S and L.S of stems, roots and T.S of leaves
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Teaching / Learning Resources

- Illustrations, computer aided study materials , models, charts, simple stains, microscopes, slides, cover slips, stems, roots, leaves of herbaceous plants, razor blades, concentrated hydrochloric acid (HCl) and sulphuric acid (H₂SO₄) with phloroglucinol

Suggested Teaching Procedure

- Discuss the structure and functioning of the vascular system of flowering plants using illustrations.
- Guide learners to carry out practical work on structure and distribution of vascular tissues in plant organs.

Assessment Strategies

- Give practical exercises on distribution of vascular tissues in monocots and dicots.
- Give written exercises on vascular systems of flowering plants.

SENIOR SIX TERM ONE

Topic 8: Nutrition

Duration: 42 Periods

Overview

Organisms require food materials that supply them with nutrients. Autotrophs are able to manufacture food materials while the heterotrophs obtain already manufactured food.

General Objective

By the end of the topic, the learner should be able to explain the modes of obtaining nutrients by different organisms.

Sub-Topic 1: Autotrophic Nutrition

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> explain the types of autotrophic nutrition. describe chemosynthesis. describe photosynthesis. describe the structure of chloroplasts. describe the absorption and action spectrum of chlorophyll. interpret experimental evidence for the existence of a light and dark stage in the process of photosynthesis. explain the environmental and internal factors influencing the rate of photosynthesis. interpret experimental results concerning measurements of 	<ul style="list-style-type: none"> Types of autotrophic nutrition: chemosynthesis and photosynthesis Photosynthesis including adaptations of C3, C4 and CAM to different environmental conditions Structure of chloroplasts Absorption and action spectrum of chlorophyll Evidence of the light and dark stages in the process of photosynthesis Environmental and internal factors influencing the rate of photosynthesis (emphasise concept of limiting factors) Data on experimental results concerning measurements of photosynthetic rate

photosynthetic rate. <ul style="list-style-type: none">• explain the importance of autotrophic nutrition in an ecosystem.	<ul style="list-style-type: none">• The importance of autotrophic nutrition in the ecosystem
(Practical) The learner should be able to: <ul style="list-style-type: none">• design and carry out experiments to investigate factors affecting the rate of photosynthesis.• carry out experiments to test for starch production in terrestrial plants and oxygen in aquatic plants.	<ul style="list-style-type: none">• Experiments to investigate factors affecting photosynthesis: light, carbon dioxide, availability of water, chlorophyll, temperature.• Tests for starch in terrestrial plants and tests for oxygen in aquatic plants.

Teaching / Learning Resources

- Illustrations, computer aided materials, data from experiments, aquatic plants, light source, clock, filter funnels, test tubes, heat source, beakers, water, white tiles, iodine solution, ethanol, sodium hydrogen carbonate, tripods, wire gauzes, droppers.

Suggested Teaching Procedure

- Discuss autotrophic nutrition process in plants using illustrations.
- Guide learners to:
 - interpret data on factors affecting photosynthesis.
 - carry out experiments on factors affecting rate of photosynthesis.
 - test for starch in terrestrial plants and oxygen in aquatic plants.

Assessment Strategies

- Give a written exercise on:
 - i) interpreting data collected from experiments on photosynthesis.
 - ii) explaining effects of limiting factors on the rate of photosynthesis.
 - iii) comparing C3 and C4 and CAM plants.

Practical Application

- Consider:
 - i) use of green houses in horticulture
 - ii) importance of trees around homes in purifying air

Sub-Topic 2: Heterotrophism

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> define heterotrophism. state types of heterotrophism. explain the importance of food in the body. 	<ul style="list-style-type: none"> Heterotrophism Types of heterotrophism: holozoic, saprophytism, mutualism, parasitism Food values, diet, and effects of deficiencies
<p>2.1 Holozoic Nutrition</p> <ul style="list-style-type: none"> define holozoic nutrition. describe the processes of digestion, absorption, assimilation and storage of digested food. explain methods of feeding in mammals and insects. explain nutrition in insectivorous plants. relate structures of the alimentary canal to their functions. Explain the role of the nervous and hormonal systems in digestion. 	<ul style="list-style-type: none"> Holozoic nutrition Processes of digestion, absorption, assimilation and storage of digested food Feeding methods in mammals (herbivores, omnivores, carnivores), and insects Plants as heterotrophs (insectivorous plants) Structure and function of the alimentary canal: mouth, stomach, intestine, liver, pancreas The role of the nervous and hormonal systems in the regulation/ control of digestion
<p>(Practical)</p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> open up the animal and display the digestive system. examine, draw and label the major parts of the animals' digestive systems. observe and state structural adaptations of the parts of the digestive system. 	<ul style="list-style-type: none"> The digestive system of cockroach, toad/frog, birds, rat/rabbit/cow/goat Parts of the digestive system Function and structural adaptations of the digestive system parts

<ul style="list-style-type: none">• identify food substances in the different parts of the gut.• Identify enzymes in the different parts of the gut.• identify, draw the different parts that make up the mouth of insects, mammals and toad.• state the functions of mouth parts of insects, mammals and toad.• compare dentition in the animals.	<ul style="list-style-type: none">• Food tests on gut content• Gut extracts actions on different foods• Structure of mouth parts of insects, mammals and toad• Functions of mouth parts of insects, mammals and toad• Dentition in animals
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Teaching / Learning Resources

- Illustrations, computer aided materials, animal specimens, dissecting boards /dish, dissecting set/kit, pins, food test reagents, gut extract (enzymes), gut content(food), chloroform, cotton wool thread, microscopes, slides, cover slips

Suggested Teaching Procedure

- Discuss the holozoic nutrition process in organisms using illustrations.
- Guide learners to carry out practical work on:
 - i) dissecting, displaying and drawing of digestive system parts in cockroach, toad/frog and rat / rabbit /Guinea pig.
 - ii) food tests on gut contents.
 - iii) investigating effect of gut extracts on different foods.
 - iv) identifying mouth parts of animals.

Assessment Strategies

- Give a written exercise on:
 - i) hormonal and nervous control of digestion.
 - ii) interpreting data on action of gut enzymes on different foods.

Practical Application

Consider balanced diet, caring for the teeth and digestive system.

2.2 Saprophytism The learner should be able to: <ul style="list-style-type: none"> • define saprophytism. • describe the importance of fungi and bacteria as decomposers in an ecosystem. • identify the role of saprophytes in the carbon and nitrogen cycles. 	<ul style="list-style-type: none"> • Definition of saprophytism. • Role of fungi and bacteria in the decomposition process • Role of saprophytes in the carbon and nitrogen cycles
(Practical) The learner should be able to: <ul style="list-style-type: none"> • identify bacteria and moulds growing on organic matter. • examine the structure and adaptation of a common mould. • investigate ecological role of saprophytes in a habitat. 	<ul style="list-style-type: none"> • Growth of common bacteria and mould on bread/cow dung • Structure and adaptation of a common mould • Economic importance of saprophytes

Teaching / Learning Resources

- Illustrations, computer aided materials, microscopes, slides, cover slips, bread/cow dung

Suggested Teaching Procedure

- Discuss saprophytism using examples and illustrations.
- Guide learners to carry out practical work on growth, structure and adaptations of moulds.
- Discuss the economic importance of microorganisms using illustrations.

Assessment Strategy

- Give a written exercise on the role of saprophytes in the environment.

Practical Application

Consider:

- storage of leather products, food, timber products, clothes, etc.
- compost manure.
- sewage treatment.

2.3 Mutualism

The learner should be able to:

- | | |
|--|---|
| <ul style="list-style-type: none"> • define mutualism. • describe the role of mutualistic organisms in the nitrogen cycle. • explain the relationships of mutualistic associations in an ecosystem. • discuss the economic importance of mutualistic associations. | <ul style="list-style-type: none"> • Definition of mutualism • Role of mutualistic organisms in the nitrogen cycle • Mutualistic associations between organisms • Economic importance of mutualistic associations |
|--|---|

Teaching / Learning Resources

- Illustrations, computer aided materials

Suggested Teaching Procedure

- Discuss mutualism giving examples.

Assessment Strategy

- Give a written exercise on the significance of mutualistic relationship in an ecosystem.

2.4 Parasitism

The learner should be able to:

- | | |
|--|---|
| <ul style="list-style-type: none"> • define parasitism. • discuss the parasitic mode of nutrition. • explain adaptation of disease causing organisms in plants and animals. • explain the effect of host-parasite relations. • interpret data on effects of parasites on their hosts. | <ul style="list-style-type: none"> • Definition of parasitism • Parasitic mode of nutrition • Adaptations of disease causing organisms in plants and animals • Interrelationship between parasites and hosts of the following: intestinal worms, a tick and one plant parasite • Data on effects of parasites on their hosts |
|--|---|

Teaching / Learning Resources

- Illustrations, computer aided materials, video, data from experiment

Suggested Teaching Procedure

- Discuss parasitism using illustrations and demonstrations.
- Guide learners to interpret data on effects of parasites on their hosts.

Assessment Strategies

- Give a reading assignment on current epidemics caused by parasites, followed by plenary session.
- Give a written exercise on adaptations of named parasites to their mode of life.

Practical Application

- Consider biological control of pests and vectors.

Topic 9: Gaseous Exchange

Duration: 24 Periods

Overview

As organisms become larger they develop gaseous exchange surfaces which are modified to allow efficiency. Some organisms may utilize different gaseous exchange surfaces at different stages of development.

General Objective

By the end of the topic, the learner should be able to explain mechanisms of gaseous exchange in organisms.

Sub-Topic 1: Principles of Gaseous Exchange Systems

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• explain the relationship between size and surface area to volume ratio.• explain the role of diffusion in gaseous exchange.• explain how a respiratory surface is modified to speed up diffusion process.• state the characteristics of a gaseous exchange surface.	<ul style="list-style-type: none">• Relationship between size and surface area to volume ratio principle• Role of diffusion in gaseous exchange process between organisms and their environment across a gaseous exchange surface• Modifications of gaseous exchange surface to speed up diffusion• Characteristics of a gaseous exchange surface

Teaching / Learning Resources

- Illustrations

Suggested Teaching Procedure

- Discuss the principles of gaseous exchange using illustrations.

Assessment Strategy

- Give an oral / written exercise on principles of gaseous exchange systems.

Sub-Topic 2: Gaseous Exchange in Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • explain the mechanism of opening and closure of a stoma. • explain conditions affecting the functioning of stomata. • explain how stomata, lenticels and breathing roots are adapted to their function. • compare gaseous exchange structures of aquatic and terrestrial plants. • relate the differences between the structure of aquatic and aerial leaves to a habitat. 	<ul style="list-style-type: none"> • Mechanism of opening and closure of stoma • Conditions affecting functioning of stomata • Structural adaptation and function of the stomata, lenticels and breathing roots • Comparison of gaseous exchange structures in plants in terrestrial and aquatic habitats • Structural adaptation of aquatic and aerial leaves to a habitat
<p>(Practical)</p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> • identify, draw and label stomata. • examine principles related to control of gaseous exchange in plants. • determine surface area to volume ratio in large and small objects. 	<ul style="list-style-type: none"> • Structures of stomata • Principles related to control of gaseous exchange in plants • Surface area to volume ratio in large and small pieces of plant organs

Teaching / Learning Resources

- Illustrations, computer aided study materials, models, microscope, slides, cover slips, potato/unripe pawpaw, ruler, knife, prepared slides (lenticels)

Suggested Teaching Procedure

- Discuss gaseous exchange in plants.
- Guide learners to carry out practical work on structure distribution, density and functioning of stomata, structure of lenticels, determining surface area to volume ratio.

Assessment Strategies

- Give a practical exercise on structure and functioning of stomata.
- Give a written exercise on theories of stomata opening.

Sub-Topic 3: Gaseous Exchange in Animals

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• describe the characteristics of gaseous exchange surfaces in animals.• explain the efficiency of gaseous exchange surfaces and structures.• explain the significance of the counter current flow system.• describe the role of the brain in controlling breathing.• compare the gaseous exchange surfaces in aquatic and terrestrial animals.	<ul style="list-style-type: none">• Characteristics of gaseous exchange surfaces in animals• Structural adaptation of gaseous exchange surfaces in protozoa, worms, insects, fish, amphibians and mammals• Significance of the counter current flow system• The role of the brain in controlling breathing• Comparison of gaseous exchange surfaces in land and water animals
(Practical) The learner should be able to: <ul style="list-style-type: none">• dissect, display and draw gaseous exchange systems in animals.• collect and analyse data on factors affecting breathing rate in animals.	<ul style="list-style-type: none">• Structure of gaseous exchange systems in tadpoles, toad, fish, insect, and mammal• Factors affecting rate of breathing in animals

Teaching / Learning Resources

- Sample organisms, dissection set/kits, pins, dish/board, chloroform, illustrations, and computer aided study materials

Suggested Teaching Procedure

- Discuss gaseous exchange in lower organisms and animals using illustrations.
- Guide learners to carry out practical work on gaseous exchange systems in tadpoles, toad / frog, fish, insect, mammal.

Practical Application

- Consider:
 - i) diseases of respiratory systems.
 - ii) effect of smoking on lungs.
 - iii) ventilation of buildings, aquaria, etc.

Assessment Strategies

- Give a written exercise on gaseous exchange in animals.
- Give practical exercise(s) on gaseous exchange systems in animals.

Topic 10: Respiration

Duration: 08 Periods

Overview

Energy is released from food by respiration which occurs in all living cells. All living things need usable energy to move, grow, reproduce and repair damaged structures. This energy is obtained through either aerobic or anaerobic processes.

General Objective

By the end of the topic, the learner should be able to explain how living organisms obtain energy from food.

Sub-Topic 1: Respiration

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• explain the relationship between gaseous exchange and respiration.• describe the structure and function of the mitochondrion.• distinguish between aerobic and anaerobic respiration.• describe the role of electron transport system, hydrogen acceptors, acetyl coenzyme A and pyruvic acid.• explain the role of acetyl coenzyme A in the carbohydrate, lipid and protein metabolism.• state the products of respiration.• explain fermentation process.	<ul style="list-style-type: none">• Relationship between gaseous exchange and respiration• Structure and function of mitochondrion• Types of respiration: aerobic and anaerobic• Role of electron transport system, hydrogen acceptors, acetyl coenzyme A and pyruvic acid• Role of acetyl coenzyme A in the metabolism of: carbohydrates, lipids, proteins• Products of respiration: carbon dioxide, energy, ethanol, water, lactic acid• Fermentation process
<p>(Practical)</p> <p>The learner should be able to:</p> <ul style="list-style-type: none">• carry out experiments to demonstrate products of respiration.	<ul style="list-style-type: none">• Products of respiration: carbon dioxide, energy,

<ul style="list-style-type: none"> • carry out experiments to show the effect of temperature and activity on rate of respiration. • carry out experiments and analyse data on factors affecting aerobic and anaerobic respiration processes. • demonstrate fermentation process in yeast cells. 	ethanol, water, lactic acid <ul style="list-style-type: none"> • Factors affecting the rate of respiration: temperature and activity • Factors affecting aerobic and anaerobic respiration processes • Fermentation process: use in yeast cells
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Teaching / Learning Resources

- Illustrations, computer aided study materials, glucose, yeast, water, flask, rubber bung, thermometer, stop clock

Suggested Teaching Procedure

- Review structure of a mitochondrion and discuss respiration using illustrations.
- Guide learners to demonstrate the products of anaerobic respiration.
- Guide learners to carry out experiments to show the effect of temperature and activity on rate of respiration.
- Guide learners to carry out experiments, collect and analyse data on factors affecting aerobic and anaerobic respiration processes.

Assessment Strategies

- Give a written exercise on comparison between aerobic and anaerobic respiration.
- Give oral questions on the process of respiration.
- Give a written exercise on data analysis.

Practical Application

Consider:

- brewing alcohol
- bread making
- ventilation in houses

Topic 11: Homeostasis

Duration: 28 Periods

Overview

Within the body of an organism components of an internal environment are constantly regulated to ensure a stable internal environment. This is done by negative feedback and elimination of wastes.

General Objective

By the end of the topic, the learner should be able to appreciate why and how the internal environment of an organism is kept constant.

Sub-Topic 1: General Principles of Homeostasis

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• explain the significance of a constant internal environment.• state the factors which must be kept constant in the internal environment of the body.• discuss the role of negative feedback mechanism.• explain the feedback mechanism related to the endocrine and nervous systems.• identify the main internal and external causes of changes in the internal environment.• describe the formation, composition and movement of tissue fluid and its relationship to the blood and lymph.	<ul style="list-style-type: none">• Significance of a constant internal environment• Factors which must be kept constant in the body: glucose, temperature, pH, water, ions, respiratory gases, osmotic pressure of body fluids• Role of negative feedback mechanism• Feedback mechanism related to the endocrine and nervous systems in homeostatic activities• Causes of changes in the internal environment• Formation, composition and movement of tissue fluid and its relationship to the blood and lymph
<p>(Practical) The learner should be able to relate organisms' ways of life to their environmental conditions.</p>	<ul style="list-style-type: none">• Adaptation of organisms to different environmental conditions

Teaching / Learning Resources

- Charts

Suggested Teaching Procedure

- Define homeostasis.
- Discuss the:
 - factors which must be kept constant in the internal environment using illustrations.
 - role of the negative feedback mechanism in homeostasis using illustrations.
- Guide learners to do field study on adaptations of organisms to different environmental conditions.

Assessment Strategy

- Give a quiz on the general principles of homeostasis.

Practical Application

- Consider liver diseases and social habits e.g. excessive consumption of alcohol, drug abuse, etc

Sub-Topic 2: Regulation of Glucose

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • describe the role of hormones in sugar regulation. • explain the negative feedback mechanism in the process of blood glucose control. • discuss the causes and effects of blood sugar imbalances in the body. • relate the microstructure of the liver and pancreas to their functions. • discuss the functions of the liver and the pancreas in regulation of glucose in the body. 	<ul style="list-style-type: none"> • Action of insulin, glucagon and adrenalin in blood sugar control. • The negative feedback mechanism in the process of blood glucose control • Causes and effects of blood sugar imbalances in the body • Microstructure of the liver, pancreas and their functions • Role of the liver and the pancreas in glucose regulation

(Practical)

The learner should be able to:

- test urine samples for sugar.
- relate structure of liver and pancreas to their function.
- Identification of sugar in urine
- Histology of liver and pancreas: microstructure and their function

Teaching / Learning Resources

- Charts/ illustrations, computer aided study materials, samples of urine from persons of different range of age and weight. Materials used to test for sugar, sections of pancreas and liver, microscopes

Suggested Teaching Procedure

- Discuss regulation of glucose in the body using illustrations.
- Guide the learners to test for sugar in urine samples from persons of different ranges of age and weight.
- Guide learners to examine sections of the liver and pancreas.

Assessment Strategy

- Give a written assignment on the causes, effects and control of blood sugar imbalances.

Practical Application

- Consider management of diabetes mellitus.

Sub-Topic 3: Regulation of Respiratory Gases

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• describe the regulation of respiratory gases.• discuss the role of feedback mechanism in response to oxygen deprivation.• explain the effects of fluctuations of respiratory gases on the rate of breathing.• explain the role of respiratory centre in the brain in	<ul style="list-style-type: none">• Control of respiratory gases• Role of feedback mechanism in response to oxygen deprivation• Effects of fluctuations in oxygen and carbon dioxide gases on the rate of breathing• Role of medullary centres in controlling respiration and

controlling respiration and blood circulation.	blood circulation
<ul style="list-style-type: none"> describe the different physiological changes that take place during exercise and at high altitude. 	<ul style="list-style-type: none"> Physiological changes that take place during exercise and at high altitude
(Practical)	
<ul style="list-style-type: none"> The learner should be able to determine the rate of breathing at different levels of activity. 	<ul style="list-style-type: none"> Effect of different levels of activity on the rate of breathing

Teaching / Learning resources

- Charts, illustrations, human beings, stop clock

Suggested Teaching Procedure

- Discuss regulation of carbon dioxide in the body using illustrations.
- Guide learners to investigate the effect of physical activities on the rate of breathing.

Assessment Strategies

- Give a written exercise involving interpreting data on the effect of physical activities on the rate of breathing.
- Give a written exercise on adaptation of haemoglobin under different oxygen tensions.

Practical Application

- Consider ventilation of houses

Sub-Topic 4: Temperature Regulation

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> explain the importance of temperature regulation. discuss the morphological, physiological and behavioural adaptations to temperature changes in the environment. describe the responses to cold 	<ul style="list-style-type: none"> Importance of temperature regulation Morphological, physiological and behavioural adaptations to temperature changes in the environment Response to cold and hot

<p>and hot conditions by endothermic and ectothermic animals.</p> <ul style="list-style-type: none">• explain the role of the brain and thermoreceptors in temperature regulation.• describe the different processes in which plants minimise overheating.	<p>conditions by endothermic and ectothermic animals</p> <ul style="list-style-type: none">• The role of the brain: hypothalamus and thermoreceptors in heat regulation.• Temperature control in plants
<p>(Practical)</p> <ul style="list-style-type: none">• The learner should be able to collect and interpret data related to effects of temperature on animal behaviour.	<ul style="list-style-type: none">• Effects of temperature conditions on animal behaviour.

Teaching / Learning resources

- Charts, illustrations, data related to temperature regulation

Suggested Teaching Procedure

- Discuss temperature regulation in ectotherms and endotherms using illustrations.
- Guide learners to collect and analyse data on effects of temperature conditions on animal behaviour as an out of class activity.
- Guide learners to analyse data related to temperature regulation.

Assessment Strategy

- Written exercise on interpreting data related to temperature regulation.

Practical Application

- Consider acclimatisation to different environments

Sub-Topic 5: Excretion

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> describe the structure and role of excretory organs in mammals. describe the structure and function of the nephron. describe the formation of urea and urine. describe excretion process in other organisms. explain excretion in plants. 	<ul style="list-style-type: none"> Structure and functions of excretory organs in mammals: kidney, liver, skin and lungs. Structure and function of the nephron Formation of urea and urine Excretion in other organisms: protoctista, insects, fish, amphibians and birds Excretion in plants
(Practical) The learner should be able to: <ul style="list-style-type: none"> identify and draw sections of parts of kidney. dissect, display, draw and label the urinary system. 	<ul style="list-style-type: none"> Histology of the kidney: cortex, medulla, different regions of the nephron Urinary system of a toad, rat/ rabbit/goat/cattle

Teaching / Learning Resources

- Illustrations, computer aided materials, microscope, prepared slides of kidney sections, insect, rat, and toad, dissecting kit, boards and dishes

Suggested Teaching Procedure

- Discuss excretion using illustrations.
- Guide learners to dissect animals and display urinary structures of an insect, toad / frog and rat/ rabbit / Guinea pig.
- Guide learners to examine and draw sections of kidney using a microscope.

Assessment Strategies

- Assess low power drawings of sections of the kidneys and dissections of urinary systems.

- Give a written exercise on the structure and function of excretory organs in mammals.
- Give oral questions on excretion in protoctista, insects, amphibians, fish and birds.

Practical Application

- Consider:
 - i) kidney failure and transplant.
 - ii) hygiene of the urinary system.

Sub-Topic 6: Osmoregulation

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• describe the role of the brain, endocrine glands and nephrons in osmoregulation.• explain the negative feedback mechanism involving anti-diuretic hormone (ADH).• discuss principles of osmoregulation in organisms living in marine, fresh water and terrestrial habitats.• explain animals' adaptations to varying water availability in their habitats.• explain osmoregulation in plants and how plants are adapted to varying water availability in their habitats.	<ul style="list-style-type: none">• Role of the hypothalamus, pituitary gland, adrenal gland and nephrons in varying osmotic pressure of blood• Role of negative feedback mechanism involving anti-diuretic hormone (ADH)• Principles of osmoregulation in marine, fresh water and terrestrial organisms• Adaptations of animals to varying water availability in habitats• Osmoregulation in plants (xerophytes, hydrophytes, mesophytes, halophytes)

Teaching / Learning Resources

- Illustrations, computer aided materials

Suggested Teaching Procedure

- Discuss osmoregulation in organisms using illustrations.

Assessment Strategies

- Give a written exercise on interpreting data on osmoregulation in organisms.
- Give a practical assignment on comparison of structures for adaptations in plants from different environments.

Practical Application

- Consider sufficient intake of water.

SENIOR SIX TERM TWO**Topic 12: Coordination**

Duration: 56 Periods

Overview

All organisms have the ability to detect and respond to changes in the external and internal environment. Plants and animals have developed control systems that receive stimuli, process them and initiate appropriate responses.

General Objective

By the end of the topic, the learner should be able to explain how organisms perceive and respond to stimuli.

Sub-Topic 1: Concepts of Reception and Response in Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• explain differences between types of plant responses.• describe simple experiments to demonstrate tropisms.• predict tropic responses in experimental situations.• interpret data from experiments on how day length affects the flowering process.	<ul style="list-style-type: none">• Distinguish between types of responses in plants: Tropic, nastic and photoperiodic responses(give examples of plant responses to stimuli)• Simple experiments to demonstrate tropisms• Parts that receive stimuli (meristem, leaves, petals)• Effects of day length on flowering process

Teaching / Learning Resources

- Illustrations, computer aided materials, *Mimosa pudica*, seedlings, clinostats and dark box with window on one side

Suggested Teaching Procedure

- Discuss the stimuli, the part that receives them and response in plants, using demonstrations/ illustrations.
- Guide learners to distinguish between nastic movements and tropisms.
- Guide learners to perform experiments to demonstrate nastic movements and tropisms.

Assessment Strategy

- Give a written exercise on interpretation of data on tropisms and on how day length affects the flowering process.

Practical Application

- Consider:
 - i) floriculture
 - ii) providing support for climbing plants e.g. vanilla, climbing beans, passion fruits
 - iii) not weeding peas

Sub-Topic 2: Plant Hormones

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> • explain how environmental factors affect distribution of plant hormones. • discuss the influence of hormones on plant growth and related processes. • interpret experimental data on the effect of hormones on different growth processes. • explain the economic importance of plant hormones. 	<ul style="list-style-type: none"> • Environmental factors affect distribution of plant hormones • Influence of hormones on plant growth: Role and effects of plant hormones (e.g. auxins, cytokinins, gibberellins, abscisic acid, and ethane) in regulating processes • experimental data on the effect of hormones on different growth processes • Economic importance of plant hormones
(Practical) The learner should be able to: <ul style="list-style-type: none"> • design and perform experiments on effects of plant 	<ul style="list-style-type: none"> • Effects of plant hormones e.g. Auxins / Indole acetic acid (IAA),

hormones on plant growth processes. <ul style="list-style-type: none">• demonstrate the economic importance of plant hormones.	gibberellic acid on different plant growth process: dormancy, weed control, flowering, fruiting etc <ul style="list-style-type: none">• Economic importance of plant hormones
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Teaching / Learning Resources

- Illustrations, computer aided materials, charts, photographs, seeds/seedlings/ plant samples, hormones

Suggested Teaching Procedure

- Guide learners to research in preparation for brainstorming and discussion on the role, effects and economic importance of plant hormones.
- Discuss the role, effects and economic importance of plant hormones using illustrations and demonstrations.
- Guide learners to investigate effects of plant hormones on plant processes using indole acetic acid (IAA).

Assessment Strategies

- Give a written exercise on the effects of plant hormones on plant growth.
- Give a written exercise on the economic importance of plant hormones.

Practical Application

- Consider:
 - i) pruning
 - ii) use of plant hormones e.g. rooting hormone in nurseries to promote uniform sprouting of buds

Sub-Topic 3: Response and Behaviour in Animals

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• explain reflex responses.• explain how types of behaviour result from sequential responses.	<ul style="list-style-type: none">• Reflex responses• Types of behaviour: orientation (kinesis, taxis, territorial, breeding, instinct and migration) learning

<ul style="list-style-type: none"> • relate learning and response (Kinesis and taxis, orientation behaviour) for survival in the environment. • Explain welfare of animals. 	<p>(habitual, conditioned reflex, imprinting exploration, insight, trial and error</p> <ul style="list-style-type: none"> • Learning and responses for survival in the environment • Animal welfare: proper handling of animals in relation to behaviour
<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • demonstrate the welfare of animals. • design and perform experiments on orientation behaviour. 	<ul style="list-style-type: none"> • Practices of animal welfare • Orientation behaviour

Teaching / Learning Resources

- Illustrations, computer aided materials, sample animals, (weevils, millipedes, woodlice, termites), artificial stimuli (electricity, light, etc) or natural stimuli in the environment, choice chamber, calcium chloride, cotton wool, wire gauze

Suggested Teaching Procedure

- Discuss response and behaviour in animals using illustrations.
- Guide learners to investigate responses in animals.

Assessment strategy

- Give a written exercise on interpretation of data on response and behaviour in animals.

Practical application

- Consider:
 - i) storage of products e.g. seeds, timber
 - ii) trapping of grasshoppers, termites

Sub-Topic 4: General Principles of Reception and Response in Animals

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• explain the necessity of responding to internal and external changes in the environment.• describe the types of stimuli.• describe the structure and role of receptor organs in relation to the environmental stimuli.• state the importance of different effectors in organisms.• interpret data derived from experiments on animal responses to particular stimuli and on memory formation.	<ul style="list-style-type: none">• Importance of responses to the internal and external environmental changes• Types of chemical and physical stimuli• Role of simple and complex receptors (including reception mechanisms) in relation to the environmental stimuli• Importance of effectors in organisms• Animal response to particular stimuli and on memory formation
(Practical) The learner should be able to: <ul style="list-style-type: none">• identify sections of: skin, eye, retina, cochlea from prepared slides.• identify locations of different taste buds on the tongue.	<ul style="list-style-type: none">• Structure of: skin, eye, retina, cochlea from prepared slides• Location of taste buds on the tongue.

Teaching / Learning Resources

- Illustrations, computer aided materials, sample animals: toad / frog, cow/ rat/ rabbit/ guinea pig, arthropod, fish, reptile, microscopes, prepared slides of skin, eye, retina, and cochlea
- Solutions of different tastes: sweet, bitter, sour, salty
- Models of: eye, ear, skin

Suggested Teaching Procedure

- Discuss the general principles of reception and responses in animals using illustrations.
- Guide learners to:

- i) observe responses in sample animals.
- ii) examine slides of sections of parts of receptor organs using microscopes.
- iii) perform an experiment to locate different types of taste buds on the tongue.

Assessment Strategy

Give a written exercise on interpreting data on animal responses to particular stimuli and memory formation.

Practical Application

Consider caring for sensory organs.

Sub-Topic 5: Nervous Coordination in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> describe the structure and functioning of a neuron. state the roles of the parts of the nervous system. describe the role of the nervous system in responses. describe the autonomic responses. state examples of autonomic responses. distinguish between the roles of the autonomic and other peripheral nerves. explain the events of generating and transmitting impulses. describe the structure and functioning of the synapse and neuromuscular junction. explain the importance of transmitter substances. 	<ul style="list-style-type: none"> Structure and functioning of a neuron Nervous system structure and function (central: brain, spinal cord and autonomic: cranial nerves, spinal nerves) Role of the nervous system in responses Autonomic responses (simple reflexes, conditioned reflexes) Examples of autonomic responses Role of the autonomic and peripheral nerves Events of generating and transmitting impulses Synapse and neuromuscular junction structure and functioning Importance of transmitter substances

<ul style="list-style-type: none"> explain summation, facilitation and inhibition. 	<ul style="list-style-type: none"> System functions: summation, facilitation and inhibition
<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> observe and record human responses to different stimuli. dissect, display, draw and label the major parts of the insect's / toad's/ frog's, mammal's nervous system below the head. 	<ul style="list-style-type: none"> Reflex actions in human beings Nervous system of a cockroach/toad /frog/rat/ rabbit/Guinea pig

Teaching / Learning Resources

- Illustrations, computer aided materials, samples of animals, stimuli e.g. heat, cold, touch, sound. cockroaches, toad /frog, rat/ rabbit/Guinea pig, dissecting boards /dishes, dissecting set, thread, pins, chloroform, dissecting guide

Suggested Teaching Procedure

- Discuss nervous coordination in animals using illustrations.
- Guide learners to:
 - investigate response of the sample animals (weevils, millipedes, woodlice, termites, humans) to stimuli.
 - dissect, display, draw and label the major parts of the nervous system of a cockroach, toad / frog, rat / rabbit / guinea pig.

Assessment Strategies

- Give a written exercise on nervous coordination.
- Assess the drawings of dissections showing major parts of the nervous system of the sample animals (cockroach, toad/frog, rat/rabbit/guinea pig).

Practical Application

- Consider survival reflexes

Sub-Topic 6: Hormonal Coordination in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> describe the structure and 	<ul style="list-style-type: none"> Structure and function of

function of the endocrine system. <ul style="list-style-type: none"> • explain the principle of negative feedback mechanism of hormonal action. • explain why hormonal balance is necessary for coordinating functions in the body. • explain effects of hormonal imbalances. • compare and contrast the action of the endocrine and nervous systems in the body. 	endocrine system: location of endocrine glands and functions of their secretions <ul style="list-style-type: none"> • Principles of negative feedback mechanism of hormonal action: between pituitary and thyroid • Necessity of hormonal balances • Hormonal imbalances effects: diabetes, goitre, dwarfism, gigantism • Comparison of actions of the hormonal and nervous systems. Refer to: thyroxine, sex hormones, insulin
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Teaching / Learning Resources

- Illustrations, computer aided materials

Suggested Teaching Procedure

- Discuss the:
 - i) location and functions of endocrine glands using illustrations /charts.
 - ii) negative feedback mechanism of hormonal action.
 - iii) effects of hormonal imbalance in mammals.
 - iv) similarities and differences between the structure and functioning of nervous and hormonal systems.

Assessment Strategies

- Give a written exercise on comparison of the hormonal and nervous coordination in animals.
- Give a written exercise on comparison between hormonal control in plants and animals.

Practical Application

- Consider hormonal therapy.

SENIOR SIX TERM THREE

Topic 13: Support and Movement

Duration: 31 Periods

Overview

Living things support themselves and maintain positions in which they can carry out life process. In all organisms the support systems maintain the shape of the body that is essential for consistent and coordinated functioning of its parts. Plant cells are surrounded by a cell wall which confers rigidity and support in turgid cells, whereas multicellular animals are supported and protected by a skeleton. Movement can occur at cell level, organ level and organism level.

General Objective

By the end of the topic, the learner should be able to appreciate the role of support and movement systems in organisms.

Sub-Topic 1: Support Systems in Plants and Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none">• describe the distribution of woody tissues in plants.• describe the support function of woody tissues in plants.• explain the role of cell turgor in non woody plants and hydrostatic skeletons in lower organisms.• explain the role of modified roots leaves and stems in support.• describe the role of secondary growth /thickening in support.• describe the structure and role of skeletons.	<ul style="list-style-type: none">• Distribution of woody tissues in plants• Support function of woody tissues in plants• Importance of cell turgor in non woody tissues and hydrostatic skeletons in protozoa, coelenterates and platyhelminthes• Importance of plant organs modifications of: tendrils, prop roots, clasping roots, buttress roots• Role of secondary growth/thickening in support• Types of skeletons: Hydrostatic, exoskeleton, endoskeleton

<ul style="list-style-type: none"> • compare the different types of skeletons. • describe the micro structure of cartilage and bone and relate their structure to function. • describe the role of limbs as props and vertebral column as girder. 	<ul style="list-style-type: none"> • Structure and role of the skeleton: hydrostatic, exoskeleton and endoskeleton • Micro structure and function of cartilage and bone • Role of limbs as props (for vertical support) and the vertebral column as girder (for horizontal support)
Support Systems in Organisms (Practical) The learner should be able to: <ul style="list-style-type: none"> • observe organisms of different sizes and relate their support systems to their sizes. • identify and draw support structures and tissues in plants and animals. 	<ul style="list-style-type: none"> • Supporting systems and organism's size • Support structures and tissues in plants and animals

Teaching / Learning Resources

- Illustrations, computer aided study materials, models, sample study organisms (plants, earthworms, insects, fish, toads / frogs, mammals, birds), microscopes, prepared slides of cartilage and bone

Suggested Teaching Procedure

- Discuss support systems in plants and animals using illustrations.
- Guide learners to:
 - i) examine prepared slides of cartilage, bone, T.S. stem.
 - ii) observe plant parts modified for support.

Assessment Strategies

- Give a written exercise on relating the structure of support systems in organisms to their functions.
- Give a practical exercise on identifying support structures in plants, invertebrates and vertebrates.

Practical Application

- Consider:
 - i) Proper feeding to ensure proper bone formation

- ii) First aid for fractures
- iii) Good posture
- iv) Diseases of support structures

Sub-Topic 2: Muscles

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• describe the structure of a muscle and a joint.• describe the arrangement and function of muscles and joints.• explain the sliding hypothesis of muscular contraction.	<ul style="list-style-type: none">• Structure of muscles and joints• Arrangement and function of muscles and joints• The sliding filament hypothesis of muscle contraction

Teaching / Learning Resources

- Illustrations computer aided study materials, models, prepared slides of skeletal muscle fibres and T.S. muscle, microscope.

Suggested Teaching Procedure

- Discuss the structure and contraction of skeletal muscle using illustrations.
- Guide learners to examine prepared slides of skeletal muscles and skeletal muscle fibre.

Assessment Strategies

- Give written exercise on mechanism of muscular contraction.
- Assess the drawings of skeletal muscle.

Practical Application

- Consider:
 - i) muscle pull therapy
 - ii) proper warming up before exercise and cooling down after exercise

Sub-Topic 3: Movement / Locomotion

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • explain non-muscular movements in organisms. • describe the arrangement of muscles in fish. • explain how movements and support of fish are brought about in water. • describe support and movement on land. • compare flight in birds and insects. • compare jumping movements in grasshoppers and toads. 	<ul style="list-style-type: none"> • Non- muscular movements or movement without muscles: amoeboid, ciliated, flagella, euglenoid • Arrangement of muscles in fish • Movement and support of fish in water: propulsion, stability • Support and movement on land / muscular skeletal basis of locomotion, propulsion in the: walking tetrapods (mammals), birds and annelids • Flight /movement in air in birds and insects • Comparison of jumping movements in grasshoppers and toads
<p>(Practical)</p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> • observe and explain the relationship between muscles, joints and musculo-skeletal attachments. • observe and describe skeletal modifications in birds. • observe and explain how the support structures are related to the environment of the animal. 	<ul style="list-style-type: none"> • Relationship between muscles, joints and musculo-skeletal attachments: Antagonistic muscles in animals: fish myotomes, pectoral muscles in birds, hind limb muscles and muscles in the pelvic region of amphibians and mammals • Fore limb and sternum modification in birds • Support structures in relation to the environment of the animal

Teaching / Learning Resources

- Illustrations computer aided study materials, models, sample study animals, boards, dishes, pins, chloroform, cotton wool, thread.

Suggested Teaching Procedure

- Discuss movement / locomotion without muscles, movement in water, on land, and in the air, using illustrations.
- Guide learners to carry out dissection to show peripheral muscles.

Assessment Strategies

- Give a written exercise on comparison of flight in birds and insects, jumping movements in grasshoppers and toads /frogs.
- Assess the displaying, drawing and labelling of muscles.

Practical Application

- Consider:
 - i) structural engineering
 - ii) movements in sports and dancing
 - iii) care for the musculo-skeletal system

Topic 14: Reproduction, Growth and Development

Duration: 48 Periods

Overview

Organisms are able to multiply to maintain numbers and avoid extinction. They go through life cycles which ensure continuity of species.

General Objective

By the end of the topic, the learner should be able to describe the processes of reproduction, growth and development in organisms.

Sub-Topic 1: Asexual Reproduction

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> describe the various methods of asexual reproduction in lower and higher organisms. discuss the advantages and disadvantages of asexual reproduction. describe the characteristics of vegetative reproductive parts in a flowering plant. 	<ul style="list-style-type: none"> Methods of asexual reproduction in lower and higher organisms Advantages and disadvantages of asexual reproduction Characteristics of vegetative reproductive parts in flowering plant
<p>(Practical)</p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> demonstrate the asexual reproduction mechanisms in lower organisms. use the vegetative propagation techniques to produce economically important plants. 	<ul style="list-style-type: none"> Asexual reproduction in lower organisms: fragmentation in <i>Spirogyra</i>, budding in yeast, spore formation in <i>Mucor</i> / <i>Rhizopus</i> Vegetative propagation techniques: natural propagation in higher plants Application of artificial propagation in growing improved varieties of plants

Teaching / Learning Resources

- Illustrations, computer aided study materials, activity sheet, charts, samples of organs of plants that reproduce vegetatively (consider food crops, ornamental and medicinal plant species), *Spirogyra*, yeast, *Mucor* / *Rhizopus*, microscopes, prepared slides on budding, fission and sporulation

Suggested Teaching Procedure

- Discuss asexual reproduction in lower organisms and higher plants.
- Guide learner to:
 - i) observe asexual reproduction in lower organisms and write reports as an out of class activity.
 - ii) examine prepared slides on asexual reproduction in lower organisms.
 - iii) examine samples of plant organs that reproduce vegetatively.
 - iv) carry out a field study on natural and artificial propagation methods.

Assessment Strategies

- Give a written exercise on asexual reproduction.
- Assess reports on:
 - i) asexual reproduction in lower organisms.
 - ii) field study on examples of plants growing vegetatively.

Practical Application

Consider:

- i) vegetative production of plants of economic importance
- ii) control of weeds that produce vegetatively

Sub-Topic 2: Sexual Reproduction in Animals

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none">• state the functions of reproductive system structures/parts in animals.• describe the structure and function of gametes.• describe the stages of oogenesis	<ul style="list-style-type: none">• Reproductive system in animals: structure and function(s) of parts• Gamete structure and function• Stages of oogenesis and

<p>and spermatogenesis processes.</p> <ul style="list-style-type: none"> • describe the relationship between stages of gametogenesis and meiosis. • explain the significance of gametogenesis. • describe copulation, fertilisation and implantation. • explain the role of the placenta in the development of an embryo. • explain the physiological changes in females during pregnancy. • explain gestation period and birth. • discuss the events and role of hormones in menstrual cycle. <ul style="list-style-type: none"> • discuss birth control methods and their limitations. • state the causes and ways of prevention of STDs. <ul style="list-style-type: none"> • explain external and internal fertilization. • outline the importance of external and internal fertilization. • explain the homeostatic mechanisms in amphibians and birds before hatching. • distinguish between diploid and haploid parthenogenesis. 	<p>spermatogenesis processes</p> <ul style="list-style-type: none"> • Relationship between gametogenesis to meiosis • Significance of gametogenesis • Copulation, fertilisation and implantation • Role of placenta in the development of an embryo • Physiological changes in females during pregnancy • Gestation period and birth • Events and role of hormones in the menstrual cycle: menstruation, follicular development, ovulation, corpus luteum. And FSH, LH, oestrogen and progesterone. Mention the oestrous cycle • Birth control methods and limitations • Causes and prevention of Sexually Transmitted Diseases (STDs) .e.g. infections by fungal bacterial and viral (HIV and AIDS). • Features of external and internal fertilization • Importance of external and internal fertilization • Homeostatic mechanisms in amphibians and birds before hatching • Parthenogenesis: definition, diploid in aphids, haploid in bees
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(Practical)

The learner should be able to:

- | | |
|---|---|
| <ul style="list-style-type: none"> • prepare or use prepared slides to study structure of gametes. • identify and draw the external features of the cockroach for sex identification. • dissect, observe, draw and label the major parts of the insect's reproductive system • identify and draw the external features of the toad/ frog for sex identification. • dissect, examine, draw and label the major parts of the toad's reproductive system. • relate the structure of reproductive parts to their functions. • identify and draw the external features of the rat /rabbit/ Guinea pig for sex identification. • dissect, examine, draw and label the major parts of the rat's reproductive system. • relate the structure of reproductive parts to their functions. | <ul style="list-style-type: none"> • Structure of gametes
Cockroach • external features for sex identification • Reproductive system of a cockroach • External features of a toad or frog for sex identification • Reproductive system of a toad/frog • Rat/ rabbit/guinea pig external/features for sex identification • Reproductive system of a rat/rabbit/Guinea pig |
|---|---|

Teaching / Learning Resources

- Illustrations, computer aided study materials, microscopes, slides, samples of gametes/ prepared slides of gametes, hand lens, cockroach, toad/frog/rat, rabbit/guinea pig

Suggested Teaching Procedure

- Discuss sexual reproduction in animals using illustrations.
- Guide learners to:
 - i) carry out practical work on reproductive structures (external and internal) of a male and female: cockroach, toad/frog and rat /rabbit/guinea pig.

- ii) examine structure of gametes using microscopes.

Assessment Strategies

- Give a written exercise on sexual reproduction in animals.
- Assess the display, drawing and labelling of reproductive systems and gametes.
- Give a written exercise on comparison of homeostatic mechanisms in birds and mammals until the time of hatching /birth.

Practical Application

- Consider:
 - i) prevention of sexually transmitted diseases
 - ii) population control and family planning
 - iii) maintenance of fertility

Sub-Topic 3: Sexual Reproduction in Lower Organisms and Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • describe the conjugation in lower organisms. • discuss the significance of alternation of generations. • describe the types and structure of flowers. • describe pollination and fertilisation in flowering plants. • explain the events that take place in a flower after fertilization. • describe the types and structure of seeds and fruits. 	<ul style="list-style-type: none"> • Conjugation in lower organisms: <i>Paramecium</i>. and algae • Alternation of generations in Bryophytes and Pteridophytes • Types and structure of flowers : (insect and wind pollinated flowers) • Mechanisms of pollination (self and cross pollination) and double fertilisation in flowering plants. Mention mechanisms to ensure or prevent self pollination • Events in a flower after fertilization • Types and structure of seeds and fruits

<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • relate floral structures to the mode of pollination. • observe and draw pollen grain. • describe floral parts. • Write floral formulae of different flowers. • draw floral diagrams of different flowers. • draw and label structures of different fruits and seeds. • dissect fruits to display and draw arrangement of seeds. • describe the mechanisms of fruit and seed dispersal. • distinguish between endospermic and non endospermic seeds. 	<ul style="list-style-type: none"> • Structures of a flower and inflorescence in relation to pollination • Pollen grain structure in relation to pollination • Arrangement of floral parts in flowers with free petals, fused petals, keel and standard wing, and a grass flower • Floral formulae • Floral diagrams • Types and structure of fruits and seeds • Placentation • Mechanisms of fruit and seed dispersal • Endospermic and non endospermic seeds
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Teaching / Learning resources

- Illustrations, computer aided study materials, prepared slides, microscopes, *Spirogyra*, sample flower types, hand lens, needle/pin, scalpel/razor blade, inflorescences e.g. guinea grass/maize, sunflower/black jack/ banana, *Tridax*, *Bougainvillea*, *Lantana camara*, Flowers e.g. *Hibiscus*, morning glory/sweet potato, *Cassia*, pea/bean family, flower with perianth, samples of fruits and seeds

Suggested Teaching Procedure

- Brainstorm the principles of sexual reproduction.
- Discuss sexual reproduction in lower organisms and plants using illustrations.
- Guide learners to examine the structure of flowers, inflorescences, fruits and seeds.

Assessment Strategies

- Give a written exercise on sexual reproduction in lower organisms and plants.
- Assess learners on identification, drawing and labelling of flowers, inflorescences, fruits and seeds.

Practical Application

- Consider:
 - i) growing of ornamental plants
 - ii) growing fruit bearing plants
 - iii) manufacture of insecticides, perfumes, ph indicators
 - iv) apiculture (beekeeping)

Sub-Topic 4: Growth and Development

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> • define growth and development. • distinguish between growth and development. • explain factors affecting growth. • discuss the parameters of measuring growth in plants / animals. • explain patterns of growth. • interpret data related to the growth process. • explain the role of hormones in plant and animal growth and development. • explain metamorphosis. • describe the types and stages of germination. 	<ul style="list-style-type: none"> • Definition of growth and development • Differences between growth and development • Factors affecting growth: internal and external • Parameters used in measurement of growth in an individual plant /animal: weight, length, height, volume, area • Patterns of growth: isometric, allometric, limited unlimited and intermittent • Role of hormones in growth regulation and control in plants and animals • Metamorphosis in insects and amphibians • Types and stages of germination

<ul style="list-style-type: none"> • explain viability, seed dormancy and changes during germination. • distinguish between primary and secondary meristems. • distinguish between primary and secondary growth. • discuss the role of meristems in plant growth. 	<ul style="list-style-type: none"> • Viability, dormancy and germination of seeds • Primary and secondary meristems in plants • Primary and secondary growth in plants • Role of meristems in plant growth
<p>(Practical) The learner should be able to:</p> <ul style="list-style-type: none"> • Carry out germination of seeds that exhibit epigeal and hypogeal germination. • Demonstrate factors affecting growth. • Examine and draw sections showing apical meristems and secondary thickening in dicotyledonous stems. • Make accurate measurements of growth in an organism and record. • Demonstrate hormonal control of plant growth. 	<ul style="list-style-type: none"> • Epigeal and hypogeal seed germination • Factors affecting growth e.g. temperature, light, water, etc • Apical growth, secondary growth • Parameters of measuring growth • Hormonal control of plant growth

Teaching / Learning Resources

- Charts, computer aided study materials, microscope, slides, cover slips, sample seeds e.g. beans, maize/millet/sorghum/rice, cotton wool, petri dishes, beakers, prepared slides, young soft stems, staining reagents, reagents for food tests

Suggested Teaching Procedure

- Discuss growth and development in plants and animals using illustrations.
- Guide learners to investigate seed germination.
- Guide learners to examine, draw and label meristems.

Assessment Strategies

- Give a practical exercise on identification and drawing of the stages in life cycle of insects and amphibians.

- Give a practical exercise on identification of food content in germinating seeds at various durations of germination.
- Give a written exercise on explanation of changes in food content during germination.

Practical Application

- Consider:
 - i) crop growth and development
 - ii) poultry birds rearing
 - iii) control factors promoting vector growth and development

Appendices

Appendix 1: Cell Biology

Aim

To make temporary slides showing various stages of mitosis in plants

Materials and Apparatus

Onion (*Allium cepa*) or broad beans (*Vicia faba*) that have been grown for 5 - 7 days, (Aceto - alcohol in the ratio of 1: 3 respectively to kill the cells and preserve cell structures), filter paper, watch glass, microscope slides, cover slips, droppers, 1M HCl, source of heat, scalpel blade, microscope and safranin stain.

What to do

Use root tips to show mitosis by following the procedure given below:

1. Place two drops of 1M hydrochloric acid on a microscope slide and add a drop of safranin stain.
2. Cut about 2mm from the tip of an onion/broad bean root and place it in the stain/acid mixture.
3. Warm the preparation over a Bunsen burner flame. **NB. Do not boil.** The acid will help to macerate the cells so that the stain can penetrate more easily.
4. Let it stand for five minutes.
5. Draw off the stain/acid mixture carefully using a piece of blotting paper at the edge of the liquid.
6. Add one drop of safranin stain and place a cover slip over the preparation.
7. Gently tap the cover slip with a pin or tooth pick.
8. Cover the preparation with filter paper and gently squash with your thumb to obtain a thin squash. Take care not to break the cover slip or slide.
9. Remove the filter paper and examine the squashed root tip under a microscope and identify the various stages of mitosis.

Appendix 2: Tests for Minerals in Organic Materials

Test on urine

What to do

1. Obtain a sample of urine. If it is cloudy, filter it. Keep the filtrate.
2. Divide the clear urine or filtrate into four parts.
3. Test each part separately as follows:
 - i) Acidify with 2M nitric acid and then add silver nitrate solution. A white precipitate, soluble in dilute ammonia, indicates CHLORIDE.
 - ii) Acidify with 2M hydrochloric acid and then add barium nitrate solution. A white precipitate indicates SULPHATE.
 - iii) To about 0.5 ml urine add 2-3 ml ammonium molybdate solution. Warm if necessary but do not boil. A yellow, crystalline precipitate indicates PHOSPHATE.
 - iv) Clean a platinum wire by dipping in concentrated hydrochloric acid and heating in a Bunsen flame until the flame is colourless. Dip in urine and hold the wire in the Bunsen flame. Yellow indicates SODIUM.

Test on liver extract

What to do

1. Obtain some juice/blood from liver that has been crushed in mortar.
2. Treat separate samples as follows:
 - i) Filter some of the juice/blood and test for chloride, sulphate and sodium as above (i-iv).
 - ii) To a little filtrate add 2M hydrochloric acid and observe carefully. Small bubbles (of carbon dioxide gas confirm this) indicate BICARBONATE.
 - iii) Boil a little juice/blood with a little concentrated nitric acid. (CARE)
 - iv) Filter and to filtrate add a few drops of potassium hexacyanoferrate (II) solution. A blue colour or precipitate indicates IRON.

Try this test on juice/blood filtrate but do not boil with acid.

Test on egg yolk

1. Boil a little egg yolk with 2M nitric acid then add silver nitrate solution. A white precipitate, soluble in dilute ammonia, indicates CHLORIDE.

2. To about 0.5 ml egg yolk add 2-3 ml ammonium molybdate solution. Warm if necessary but do not boil. A yellow, crystalline precipitate indicates PHOSPHATE

Appendix 3: Estimating Population Density

You can use capture and recapture method to estimate the population of fish in a pond, grasshoppers in a field, birds in a park, flying insects etc.

What to do

- Carry out this simulation activity of capture-recapture technique.

What you need

- i) Hollow Beads(two colours)
- ii) Plastic beakers (500 ml)

Then proceed as follows:

- i) Fill a large beaker with a large number of beads all of the same colour and size.
- ii) Pick or “Capture” a sample of about 50 beads (**N₁**)
- iii) ‘Mark’ the picked or “captured” beads and record. The best way to do this is to stain or exchange them with beads of a different colour.
- iv) Return the marked beads to the beaker i.e. to the “population”.
- v) Thoroughly mix the marked beads in the rest of the “population”.
- vi) Pick again or “recapture” a second sample of beads. The sample should be quite large and random or use a blind fold to ensure randomness.
- vii) Count the total number of beads in the second sample (**N₂**) and the number of marked beads (**N₃**) in this sample.
- viii) Work out the estimated “population”(**P**) of beads in the beaker using the formula below:

$$P = \frac{N_1 \times N_2}{N_3}$$

N₃

Appendix 4: Field Activities

What to do

1. Carry out this activity to show adaptation of organisms to their habitats.
2. Follow the procedure below:
 - i) Select a suitable habitat.
 - ii) Make a list of the physical factors in the habitat, which might affect the life of organisms.
 - iii) Collect and observe several animal and plant species from your habitat.
 - iv) List down the adaptive features of the organisms and explain how each of the features mentioned adapts the organisms to survive in this habitat.
 - v) Observe the organisms and construct suitable food chains and food webs to show the feeding relationship of these organisms. It might be necessary in some cases to dissect the gut and observe the contents. You can also examine the feeding structures to get a clue of what the organism feeds on.

Appendix 5: Ecology

Take an example of the ecology of millipedes.

Millipedes belong to phylum Arthropoda and class myriapoda. They are widely distributed and abundant throughout Africa. They are herbivorous or detritus feeders and most species are nocturnal in habit, spending the day hidden under piles of vegetation or stone or logs.

What to do

- **Follow the procedure below:**

1. Select a model community nearby or set up one using a tank area.
2. Making minimum disturbance, locate the millipedes in the model community or the one that has been set up in the tank area.
3. Record their whereabouts on a rough plan of the tank area.
4. Using standard cobalt chloride paper, investigate the hypothesis that millipedes select places with high moisture content in which to spend the day. Record your results in a suitable way on the plan of the tank area.

Questions

1. How does the millipedes' distribution in this model community compare with any observation that you have made under natural conditions?
2. Have you shown any relationship between moisture content and the places where you found millipedes?
3. What other physical factors might determine the selection of daytime habitats?
4. In the light of this, have you confirmed the hypothesis stated in no. 4 of the procedure?

The problem of interaction of variables is still with us in this investigation. It is quite possible that humidity or moisture has an important effect on millipedes' behaviour but we have not been able to exclude other possible factors. If possible investigate humidity more fully then, you need to carry out laboratory work where one variable can be changed and the rest controlled.

Appendix 6: Genetics

What to do

1. Guide the students to carry out the following activity I: Using beads to illustrate inheritance
2. Divide the class into groups and collect materials needed: Beakers or black Polythene bags (5 per group), blue beads (100), red beads (100), labels.
3. Then follow the procedure below:
 - i) Label 4 beakers 1 to 4
 - ii) Put 50 blue beads into beaker 1.
 - iii) Put 25 blue and 25 red beads into beaker 2 and mix them up thoroughly.
 - iv) Close your eyes and take a bead from each beaker.
 - v) Put the two beads together (offspring).
 - vi) Open your eyes.
 - vii) If the offspring is homozygous (either blue or red) then put it into beaker 3 and if heterozygous then put into beaker 4.
 - viii) Repeat steps 4, 5, 6 and 7 until all the beads have been transferred.

Give the following written exercise:

1. Count and record the number of;
 - i) Homozygous offspring.
 - ii) Heterozygous offspring.
 - iii) What do the beads represent?
 - iv) Name beaker 1, 2, 3 and 4.
2. What conclusion do you make from the results obtained in 9 above?
3. Assume that the characteristic shown by the blue bead is dominant and is represented by B. fill the spaces below 1, 2, 3 and 4 are the beakers:

Parents

Genotype	1.....	2.....
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Gametes
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Offspring (F1)

Genotypes	3.....	4
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Ratio	
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Let students practice the following activity as an out of class assignment:

1. Put 50 blue and 50 red beads into each of the two beakers 1 and 2 and mix them thoroughly.
2. Close your eyes and then take a bead from each beaker.
3. Put the two beads together.
4. If the offspring is homozygous dominant (both blue) put it into beakers 3 and if it is heterozygous put it into beakers 4. If it is homozygous recessive (both red) then put it into beakers 5.
5. Repeat steps 2 and 3 until all the beads have been transferred, a pair at a time into beakers 3, 4, and 5.
6. Now count the number of;
 - i) Homozygous dominant offspring.
 - ii) Heterozygous offspring.
 - iii) Homozygous recessive offspring.
7. What conclusion would you make from the numbers counted?
8. Assume that the characteristic shown by the blue bead is the dominant and is represented by B. Complete the cross below:

Parents

Genotypes 1. 2.

Gametes

Offspring

Genotypes 3..... 4..... 5.....

Ratio

4. Another activity II: on Human Genetics

Give students to carry it out as a research work on phenotypes and genotypes of human traits. State that the following traits are determined by a single gene in humans:

- i) **Widow's peak** - the **W** allele for widow's peak (i.e. a pointed hairline) is dominant to the **w** allele for a straight hairline.
- ii) **Bent little finger**- lay your hands flat on the table and relax them. If the last joint of your little finger bends toward the fourth finger, you have the dominant allele **B**.
- iii) **Attached earlobes** - the **A** allele for free earlobes is dominant to the recessive **a** allele for attached earlobes.
- iv) **Tongue rolling** - the **R** allele allows you to roll your tongue into a U shape, and is dominant to the **r** allele for lack of this ability

- v) **Hitchhiker's thumb**- bend your thumb backwards as far as possible. If you can bend the last joint of the thumb back at an angle of 60 or more, you are showing the recessive allele **h**.
- vi) **Interlacing fingers** – casually fold your hands together so that your fingers interlace. The **C** allele for crossing the left thumb over the right thumb when you interlace your fingers is dominant over the **c** allele for crossing your right thumb over your left.
- vii) **Mid-digital hair**- the allele **M** for hair on the middle segment of your fingers is dominant to the **m** allele for no mid-digital hair. If hair is present on the mid-digit of any finger you have the dominant allele.
5. Let students carry out the above investigations and record the results in the table below.

No .	Characteristic	Your phenotype	Possible genotype	Phenotypes of class	
				Dominant	Recessive
i.	Widow's peak				
ii.	Bent little finger				
iii.	Attached earlobes				
iv.	Tongue rolling				
v.	Hitchhiker's thumb				
vi.	Interlacing fingers				
vii.	Mid-digital hair				

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