



REPUBLIC OF BOTSWANA

**BOTSWANA GENERAL CERTIFICATE
OF
SECONDARY EDUCATION**

TEACHING SYLLABUS

BIOLOGY

**Ministry of Education
Department of Curriculum Development and Evaluation**

FOREWORD

The Ministry of Education is pleased to authorise the publication of this senior secondary syllabus which marks a watershed in the development of the public education system in Botswana and signals another milestone of progress in fulfilment of the goals set by the Revised National Policy on Education, Government Paper No. 2 of 1994.

In this era of widespread and rapid technological change and an increasingly inter-dependent global economy, it is essential that all countries foster human resources by preparing children adequately for their future. Survival in the coming millennium will depend on the ability to accommodate change and to adapt to environmental needs and emerging socio-economic trends. It is the wish of government to prepare Botswana for future growth and adaptation to ongoing change in the socio-economic context; specifically the

transition from an agro-based economy to the more broadly based industrial economy which we are aiming at.

The senior secondary programme builds on the Ten Year Basic Education programme and seeks to provide quality learning experiences. It aims to prepare our students for the world of work, further education and lifelong learning. However, secondary education must also pay attention to the all round development of the individual. It should provide not only for the acquisition of those skills needed for economic, scientific and technological advancement. It should also provide for the development of cultural and national identity and the inculcation of attitudes and values which nurture respect for one's self and for others.

Critical to the success of our secondary education programme is the recognition of individual talents, needs and learning styles. Hence, the role of the teacher in the classroom has changed. S/he must be a proficient manager and facilitator; a director of learning activities. S/he should be conscious of students' needs to take on board a measure of accountability and responsibility for their own learning. S/he must also take into account the widening range of ability of the student body and the different levels of achievement which they aspire to. This means active participation for all and the creation of rich and diverse learning environments.

It is important then that we value the students' own experiences, build upon what they know and reward them for positive achievement. At the same time, we must be prepared to offer them guidance and counselling at all levels; assisting them to make the best decisions in

keeping with their own interests, career prospects and preferences. In that way we shall prevail in nurturing at the roots of our system, the national ideals of democracy, development, self-reliance, unity and social harmony.

This syllabus document is the outcome of a great deal of professional consultation and collaboration. On behalf of the Ministry, I wish to record my appreciation and thank sincerely those who contributed to and were involved in the production of this syllabus.



P. T. Ramatsui
Permanent Secretary
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Introduction

Senior Secondary Science is a two-year programme designed for learners who have completed Junior Secondary education. It is designed to provide learners with scientific knowledge, skills and attitudes needed for understanding and responsible participation in the society. It also prepares the learners for tertiary education, vocational training and provides them with foundation skills for employment.

Subjects for the Senior Secondary programme are categorised into groups: core and optional. All the Science subjects fall into one optional group: Sciences. There are four forms of Science offered in the group and learners are expected to choose one of these. These are:

- **Single Science;**
- **Double Science;**
- **Pure Sciences: Biology, Physics and Chemistry;**
- **Human Social Biology (only offered to private candidates)**

The syllabuses have been developed on the assumption that each Science will be allocated 160 minutes per week.

Rationale

The Science Programme for the two years of senior secondary education is expected to facilitate the holistic development of the learner in a global context. The programme intends to instil a sense of appreciation for science and to make sure that the learners can cope in a technologically changing world. The programme will help learners to explore and apply the scientific knowledge, skills and attitudes acquired to address environmental, social, economic and political issues in their day-to-day lives. Through this programme learners will get an opportunity to explore and understand the natural world (life processes, physical phenomena and nature of substances).

Science is an experimental discipline and its method of inquiry allows learners to appreciate the practical impact of science on their lives and society as a whole. The Science programme will equip learners with skills that will be of long term value and encourage them to participate in lifelong learning. In the process the learners will exercise their creativity and develop skills such as critical thinking, innovativeness, communication, analysis, observation, recording, drawing conclusions, making judgement etc.

The syllabuses will also expose learners to the practical applications of Science. This will contribute towards popularising Science and developing an interest in and positive attitudes towards Science among all learners.

The Senior Secondary Science syllabuses recognise the importance of offering key concepts and principles of Science in Physics, Chemistry and Biology to provide learners with a more unified view of the Sciences and awareness of the connections among them and technology.

Aims of Senior Secondary Programme

On completion of the two year secondary programme learners should have: -

- 1. acquired knowledge, developed confidence and ability to assess their personal strengths and weaknesses and be realistic in choosing appropriate career/employment opportunities and/or further education and training.**
- 2. developed skills to assist them in solving technical and technological problems as they relate to day-to-day life situations.**
- 3. developed desirable attitudes and behavioural patterns in interacting with the environment in a manner that is protective, preserving and nurturing.**
- 4. acquired attitudes and values, developed basic skills and understanding to allow for execution of rights and responsibilities as good citizens of Botswana and the world.**
- 5. developed information technology skills as well as an understanding and appreciation of their influence in day-to-day activities.**
- 6. acquired knowledge, attitudes and practices that will ensure good family and health practices, including awareness and management of epidemics (such as HIV/AIDS), that prepare them for productive life.**
- 7. developed pre-vocational knowledge and manipulative skills that will enable them to apply content**

learnt and attitudes and values developed to practical life situations in the world of work.

- 8. developed an understanding of and acquired basic skills in business, everyday commercial transactions and entrepreneurship.**
- 9. developed foundation skills such as problem solving, critical thinking, communication, inquiring, team work / interpersonal to help them to be productive and adaptive to survive in a changing environment.**

Aims of Senior Secondary Science

On completion of the 2 year Senior Secondary Science Programme, each student is expected to have:

- 1. developed the ability to assess personal achievement and capabilities realistically in pursuit of appropriate career/employment opportunities and/or further education.**
- 2. developed manipulative skills to assist them in solving technical and technological problems as they relate to day-to-day life situations.**
- 3. become confident citizens in a technological world to make informed decisions in matters of scientific interest.**
- 4. developed desirable attitudes and behavioural patterns in interacting with the environment in a manner that is protective, preserving, developmental and nurturing.**

- 5. developed an understanding of the applications of science and of the technological, economic, ethical and social implications of these.**
- 6. developed an understanding of the significance of information and communication technology in the day-to-day life situations and the world of work.**
- 7. acquired knowledge, attitudes and practices that will promote good family life and health including awareness and management of epidemics such as HIV/AIDS practices that prepare them for productive life.**
- 8. developed positive attitudes such as open-mindedness, inventiveness, concern for accuracy and precision, objectivity, integrity and initiative towards scientific skills**
- 9. developed an interest in and an enjoyment of science and science related-work.**
- 10. developed an understanding of key concepts and principles of science as they are experienced in everyday life.**
- 11. developed abilities and skills that are relevant to the study, safe practice and application of science (such as experimenting and investigating).**
- 12. developed problem solving, critical thinking, communication, inquiry and teamwork/interpersonal skills to help them to be productive and adaptive to cope in a changing environment.**
- 13. developed an appreciation of the role of science in improving the quality of life.**
- 14. recognised the usefulness of science, and limitations of scientific method.**

15. promoted an awareness that the applications of science may be both beneficial and detrimental to the individual, the community and the environment.

Aims of Senior Secondary Biology

On completion of the 2 year Biology Course, each student is expected to have:

- 1. developed the ability to assess personal achievement and capabilities realistically in the pursuit of biological career/employment opportunities and/or further education.**
- 2. developed manipulative skills to assist them in solving technical and technological problems as they relate to day-to-day life situations.**
- 3. become confident citizens in a technological world, to make informed decisions in matters of Biological interest.**
- 4. developed desirable attitudes and behavioural patterns in interacting with the environment in a manner that is protective, preserving, developmental and nurturing.**
- 5. acquire an appreciation of technology and technological skills including basic skills in handling biological tools and materials.**
- 6. developed an understanding of the application of Biology and of the technological, economic, ethical and social implications of these.**
- 7. acquired biological knowledge, attitudes and practices that will promote good family life and health practices that prepare them for productive life.**

8. developed positive attitudes such as open-mindedness, inventiveness, concern for accuracy and precision, objectivity, integrity and initiative towards biological skills.
9. developed and sustain interest in and an enjoyment of Biology and biological related-work.
10. developed an understanding of key concepts and principles of biology as they are experienced in everyday life.
11. developed abilities and skills that are relevant to the study, safe practice and application of Biology (such as experimenting and investigating).
12. developed problem solving, critical thinking, communication, inquiry and teamwork/interpersonal skills to help them to be productive and adaptive to cope in a changing environment.
13. appreciated the role of Biology in improving the quality of life.
14. recognised the usefulness of Biology and developed an appreciation of the applicability of Biology in other disciplines.
15. developed an appreciation that Biology applications may be both beneficial and detrimental to the individual, the community and the environment.

Recommended teaching methods

The syllabuses encourage a learner-centred approach as emphasised in the curriculum blueprint. This involves laying emphasis on science process skills, problem-solving skills, and the acquisition of hands-

on experience which should increase the participation and performance of all groups e.g. groups of different abilities, learners with special needs, girls, boys. Teachers should approach the teaching-learning process in a learner-centred way. Therefore, it means that the teacher should use a variety of methods to achieve this e.g. inquiry, demonstration, practical work, project work, case study, field trips, discussions, computer guided learning etc.

In order to facilitate a learner-centred approach there should be pre-planning of activities to be done and there should be adequate working space to accommodate these activities.

Teaching methods should expose learners to practical applications of Biology in everyday life. The local environment should be used to provide context to the syllabus. They should present Biology in an interesting and challenging way that should popularise it and encourage learners to opt to pursue Biology and Biology-related fields for careers.

Domains

Biology experiences to be provided to learners should aim to cover the following domains: knowledge and understanding; handling information, application and solving problems; investigation and experimental skills and attitudes in Biology. These domains should provide guidance in assessment the learners.

Learners should be able to demonstrate:-

- 1. knowledge and understanding of**
 - 1.1 concepts, laws, theories and principles of Biology .**
 - 1.2 scientific vocabulary, terminology, convention (including symbols, quantities and units).**
 - 1.3 applications of Biology and of their technological, economic, ethical and social implications.**
 - 1.4 the significance of information and communication technology in the day-to-day life situations and the world of work.**
 - 1.5 good family life and health practices including awareness and management of epidemics such as HIV/AIDS that prepare them for productive life.**

- 2. handling information, application and solving problems to**
 - 2.1. solve problems as they relate to day-to-day life situations including some of a quantitative nature**
 - 2.2. use information to identify patterns, report trends, draw inferences, make predictions and propose hypotheses**
 - 2.3 locate, select, organise and present information from a variety of sources**
 - 2.4 translate information from one form to another**
 - 2.5 manipulate numerical and other data**

- 2.6 present explanations for phenomena, patterns and relationships**

- 3. investigation and experimental skills**
 - 3.1 follow a sequence of instructions**
 - 3.2 use appropriate techniques, apparatus and materials**
 - 3.3 handle instruments, apparatus and materials safely**
 - 3.4 make and record observations, measurements and estimates**
 - 3.5 interpret and evaluate observations and data**
 - 3.6 plan investigations and/or evaluate methods and suggest possible improvements**
 - 3.7 convert acquired skills into creative innovations**

- 4. attitudes in Biology as**
 - 4.1 open-mindedness, inventiveness, concern for accuracy and precision, objectivity, integrity and initiative towards scientific skills**
 - 4.2 respect for life**
 - 4.3 awareness and appreciation for the environment**
 - 4.4 promotion of indigenous Biology and technology**
 - 4.5 recognition of the usefulness of Biology, and limitations of scientific method.**

4.6 promotion of an awareness that the applications of Biology may be both beneficial and detrimental to the individual, the community and the environment.

Assessment

To ensure that learners attain the set aims, the course will be assessed through a variety of continuous assessment techniques. Projects, tests, experiments, surveys etc. will be used. The outcome of these will be used to improve instruction and guide progression.

At the end of the course a terminal examination will be administered. Continuous assessment in the form of coursework will also contribute to certification. Where it is not possible to offer coursework, alternative papers to test the same knowledge, skills and attitudes will be used.

Examination syllabuses will be developed by the examining body to provide teachers with guidelines on objectives to be tested.

Organisation of the syllabus

The syllabus is organised around broad content areas subdivided into topics. Each topic consists of general objectives which give rise to specific objectives. The specific objectives describe what learners are expected to do. These objectives are divided into core and extended. The extended specific

objectives are highlighted in *bold italics*. All learners are expected to follow the core specific objectives. The extended objectives provide more challenging work for those learners able to benefit from it.

Skills For Biological Investigations

Topics	General Objectives	Specific Objectives
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<p>(Through out the course learners should be given opportunities to perform these skills)</p>	<p>apply basic skills for biological investigations:-</p> <ul style="list-style-type: none"> • using and organising apparatus and materials: • applying basic process skills to problem solving • collecting data • handling 	<ul style="list-style-type: none"> - follow a sequence of instructions - understand the working principles of commonly used instruments e.g. microscope - identify apparatus and materials useful for biological activities - practise appropriate safety procedures - apply appropriate techniques in manipulating laboratory equipment and materials - make observations using the senses - identify a problem - plan for an investigation - generate hypotheses to solve a problem - carry out an investigation - collect qualitative and quantitative data - measure and make estimations - accurately record observations - make biological drawings as a record of observations - record data using tables, charts and graphs
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LIVING THINGS

Topics	General Objectives	Specific Objectives
	Learners should	Learners should

<p>Cell processes and maintenance</p>	<p>acquire knowledge and understanding of plant and animal cells</p>	<ul style="list-style-type: none"> - identify different parts of plant and animal cells - identify from fresh preparations or diagrams or on photomicrographs cell surface membrane, cytoplasm, cell organelles: mitochondria, nucleus and ribosomes of an animal cell - identify from fresh preparations and diagrams or on photomicrographs the cell wall, cell surface membrane, sap vacuole, cytoplasm nucleus, chloroplasts and ribosomes of a plant cell - <i>state the functions of the mitochondrion, nucleus, and ribosomes of an animal</i> - examine under the microscope an animal cell (e.g. protozoan) and a plant cell (e.g. moss or onion epidermis) using appropriate staining techniques.
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	<p>acquire knowledge on cell specialisation and organisation.</p>	<ul style="list-style-type: none"> - describe the relationship between cell structure and function using an animal cell and a plant cell as examples - define tissue, organ, system, and organism. - examine under a microscope sections of tissues from any locally available plant and animal material
	<p>acquire knowledge and understanding of the process of diffusion.</p>	<ul style="list-style-type: none"> - define diffusion as movement of molecules from a region where they are at a higher concentration to a region where they are at a lower concentration i.e. down a concentration gradient. - demonstrate diffusion in gases and liquids. - <i>describe how concentration gradient, particle size and temperature affect diffusion rate.</i>

	<p>acquire knowledge and understanding of the process of osmosis and its role in living things.</p>	<ul style="list-style-type: none">- define osmosis (a special form of diffusion) as movement of water molecules from a region where they are at a higher concentration to a region where they are at a lower concentration through a partially permeable membrane.- describe the effect of concentration gradient in the uptake of water by plants.- describe the effect of osmosis on plant tissues, in terms of flaccid cells, turgid cells and plasmolysis- describe the effect of osmosis on animal tissues. [refer to bursting and shrinking]- conduct experiments using solutions of varying concentration to demonstrate the process of osmosis.
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	<p>acquire knowledge and understanding of the process of active and passive transport in living things.</p>	<ul style="list-style-type: none">- <i>define active transport as an energy consuming process in which substances are transferred against their concentration gradient.</i>- <i>define passive transport as a non-energy consuming process in which substances are transferred down their concentration gradient.</i>- <i>distinguish active transport from osmosis and diffusion, which are passive processes.</i>
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Variety of plants and animals	acquire knowledge of characteristics of selected groups of living things	<ul style="list-style-type: none">- <i>discuss the concept of diversity of organisms with examples from Botswana</i>- <i>list at least three main characteristics (structure, nutrition and reproduction) of Protozoa, Viruses, Bacteria, Fungi, Green Algae, Arthropoda, Vertebrates and Angiosperms.</i>- <i>discuss the role of protozoa and mosquitoes in causing malaria</i>- <i>describe control of malaria</i>
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OBTAINING ESSENTIALS OF LIFE

Topics	General Objectives	Specific Objectives
	Learners should	Learners should
Nutrition	appreciate different ways of how organisms obtain their nutrients.	- describe autotrophic and heterotrophic modes of nutrition.
	acquire knowledge and understanding of the structure and functions of a leaf	<ul style="list-style-type: none"> - describe the significance of the cellular and tissue structures of a dicotyledon leaf in terms of: distribution of chloroplasts - photosynthesis; stomata and mesophyll cells - gaseous exchange; vascular bundles - transport - identify and label the cellular and tissue structure of a dicotyledonous leaf, as seen in cross section under the microscope.

	<p>acquire knowledge and understanding of nutrition in plants</p>	<ul style="list-style-type: none">- describe the intake of carbon dioxide and water by plants, the trapping of light energy by chlorophyll, the conversion of light energy into chemical energy, the formation of carbohydrates, their subsequent storage, and the release of oxygen.- state both the word and symbol equation for photosynthesis.- discuss the necessity for chlorophyll, light and carbon dioxide for photosynthesis.- <i>discuss the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis (e.g. in submerged aquatic plants).</i>
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	understand the need for mineral nutrients in plants.	<ul style="list-style-type: none"> - state the importance of nitrogen-containing ions for protein synthesis and magnesium ions for chlorophyll synthesis. - investigate the effect of nitrogen deprivation on plant growth.
	appreciate how diet relates to energy intake.	<ul style="list-style-type: none"> - define balanced diet - explain why diet, especially energy intake, should be related to age and physical activity of an individual.
	acquire knowledge on the procedure of carrying out food tests.	<ul style="list-style-type: none"> - list the chemical elements which make up: carbohydrates, fats and proteins. - describe tests for starch (iodine solution), reducing sugars (Benedict's solution), protein (biuret test) and fats (ethanol)

	<p>acquire knowledge and understanding of enzymes</p>	<ul style="list-style-type: none"> - define the term enzyme - discuss the importance of enzymes in anabolic and catabolic reactions. - describe intra-cellular and extra-cellular enzymes. - investigate and describe the effect of temperature and/or pH on enzyme activity.
	<p>acquire knowledge on parts and functions of the human alimentary canal</p>	<ul style="list-style-type: none"> - using diagrams and models identify the main regions of the alimentary canal and the associated organs: mouth, salivary glands, oesophagus, stomach, duodenum, pancreas, gall bladder, liver, ileum, colon, rectum and anus. - describe the main functions of the identified parts of the alimentary canal in relation to ingestion, digestion, absorption, assimilation and egestion of food, as appropriate.

	<p>acquire knowledge on the physical and chemical processes of digestion</p>	<ul style="list-style-type: none"> - describe chewing and peristalsis - describe chemical digestion in the alimentary canal, the function of typical amylase, protease and lipase in digestion - investigate the action of amylase on starch.
	<p>acquire knowledge on the absorption process and some possible uses of the end-products of digestion.</p>	<ul style="list-style-type: none"> - describe absorption and assimilation. - describe the significance of villi in increasing the internal surface area - state the function of the hepatic portal vein as the route taken by most of the food absorbed from the small intestines. - state that large molecules are synthesised from smaller basic units: starch from simple sugars; proteins from amino acids; lipids (fats and oils) from glycerol and fatty acids - describe the role of the liver in the metabolism of glucose, as a storage organ, deamination and detoxification.

Respiration	acquire knowledge and understanding of respiration	<ul style="list-style-type: none"> - describe respiration as the release of energy from food substances in all living cells.
	acquire knowledge and understanding of aerobic respiration	<ul style="list-style-type: none"> - describe aerobic respiration as the release of a relatively large amount of energy by the break down of food substances in the presence of oxygen. - state the equation for aerobic respiration, using words and symbols. - describe the uses of energy in the body of humans e.g. in muscle contraction, cell division, growth, protein synthesis, active transport, transmission of nerve impulses and maintenance of constant temperature.

	acquire knowledge and understanding of anaerobic respiration	<ul style="list-style-type: none">- describe anaerobic respiration as the release of a relatively small amount of energy by the break down of food substances in absence of oxygen.- state the equation for anaerobic respiration in plants and animals using words and symbols.- <i>describe the production of lactic acid in muscles during exercise.</i>- describe fermentation process as a form of anaerobic respiration- demonstrate the release of energy through anaerobic respiration using yeast.
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	<p>acquire knowledge and understanding of the process of breathing</p>	<ul style="list-style-type: none">- describe the role of the exchange surface of the alveoli in gaseous exchange.- <i>describe the role of the diaphragm, ribs and intercostal muscles in breathing.</i>- investigate the effect of physical activity on the rate and depth of breathing.- identify on diagrams and name the larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries.- describe the effects of tobacco smoke and its major toxic components (nicotine, tar and carbon monoxide) on health: strong association with bronchitis, emphysema, lung cancer and heart disease, and the association between smoking during pregnancy and reduced birth weight
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<p>Transport and circulation</p>	<p>acquire knowledge and understanding of the process of transport in plants.</p>	<ul style="list-style-type: none"> - describe the structure and function of root hairs in relation to their surface area, and to water and ion uptake. - conduct experiments using dyes (stains) to identify vascular tissues in cross sections of stems, roots and leaves of dicotyledons and monocotyledons. - describe the structure and functions of vascular tissues (xylem vessels and phloem tissues) - <i>describe absorption of mineral ions in terms of active transport.</i> - describe absorption of water in terms of diffusion and osmosis.
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	<p>acquire knowledge and understanding of the process of transpiration and translocation</p>	<ul style="list-style-type: none">- define transpiration as loss of water vapour from stomata- discuss factors that affect transpiration- investigate the effect of temperature, humidity and wind on the rate of transpiration.- <i>discuss how transpiration is related to cell surfaces, stomata and intercellular air spaces</i>- describe transpiration stream as a process of water movement through xylem vessels.- define translocation as movement of substances (water, mineral salts, and organic materials) through vascular tissues.- discuss adaptations for controlling transpiration.- demonstrate wilting, a result of excessive transpiration
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acquire knowledge and understanding of the role of the mammalian circulatory system.

- explain why multicellular animals need a circulatory system.
- describe the circulatory system as consisting of tubes (blood vessels) with a pump (heart) and valves to ensure one-way flow of blood.
- describe circulation as consisting of pulmonary and systemic circuits.
- *discuss the difference between the two circuits (pulmonary and systemic) in terms of pressure, direction of blood flow and quality of blood.*
- name and identify the main blood vessels to and from the heart, lungs, liver, and kidney.
- describe the structure and function of the heart .
- compare the structure and function of arteries, veins and capillaries.
- locate pulse points and count the pulse rate
- investigate the effect of physical activity on pulse rate.

acquire knowledge on the different components of blood and their functions.

- **list the components of blood as red blood cells, white blood cells, platelets, and plasma**
- **identify red and white blood cells as seen in diagrams and/or photomicrographs.**
- **describe the functions of blood:**
 - (i) red blood cells - haemoglobin and oxygen transport**
 - (ii) white blood cells - phagocytosis, antibody formation and tissue rejection;**
 - (iii) platelets - fibrinogen to fibrin causing clotting**
 - (iv) plasma - transport of blood cells , ions, end products of digestion, hormones, carbon dioxide, urea, vitamins, plasma proteins.**
- **describe the transfer of materials between capillaries and tissue fluid.**
- **discuss common blood-related diseases e.g. HIV/AIDS, malaria, leukaemia, and anaemia.**
- **discuss how the blood-related diseases can be prevented**

	acquire knowledge and understanding of blood groups and blood transfusions.	<ul style="list-style-type: none">- <i>describe the four blood groups (A, B, AB, O) in terms of antigen present in the blood and antibody production.</i>- <i>discuss blood transfusions in terms of donors and recipients and precautions to be taken.</i>
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CONTROL OF THE INTERNAL ENVIRONMENT

Topics	General Objectives	Specific Objectives
	Learners should	Learners should
Homeostasis	<p>acquire knowledge and understanding of the importance of maintaining a constant internal environment.</p>	<ul style="list-style-type: none"> - define homeostasis as the maintenance of a constant internal environment - locate and name the main organs which maintain a constant internal environment, namely pancreas and liver (blood glucose), kidneys (water content) and skin (temperature). - identify and label on a diagram of the skin: hairs, sweat glands receptors and blood vessels - describe the maintenance of a constant temperature in Man - discuss the co-ordinating role of the brain in maintaining a constant body temperature.

<p>Excretion</p>	<p>acquire knowledge and understanding of the importance of removing waste from the body.</p>	<ul style="list-style-type: none"> - define excretion as the removal of waste products of metabolism and/or toxic materials from organisms. - identify parts of the urinary system: kidneys, ureter, bladder, urethra - describe the functions of kidneys, ureter, bladder and urethra - describe the removal of water and urea through the kidneys - <i>describe dialysis in kidney machines as the diffusion of waste products and salts (small molecules) through a semi-permeable membrane.</i> - draw and label a cross section of a mammalian kidney - discuss the structure and function of the nephron
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RESPONSE AND CO-ORDINATION

Topics	General Objectives	Specific Objectives
	Learners should	Learners should
Nervous system	acquire knowledge of the different organs that are irritated by environmental stimuli	- discuss the principle of detecting change in the environment and responding to it.
	gain knowledge of functional parts of the nervous system and their relationship	- discuss the relationship of sensory (receptor) cells, sense organs and the effector organs - describe the functions of a sensory neurone, a motor neurone and a relay neurone. - draw a labelled diagram of a sensory neurone, a motor neurone and a relay neurone

	<p>appreciate how a reflex action occurs</p>	<ul style="list-style-type: none"> - demonstrate and describe a reflex action - measure and explain reaction time - describe, with the aid of a labelled diagram, a reflex arc.
	<p>understand the general function of the central nervous system</p>	<ul style="list-style-type: none"> - identify and label on diagrams of the human central nervous system the cerebrum, cerebellum, pituitary gland, hypothalamus, medulla and spinal cord. - <i>describe the functions of cerebrum, cerebellum, pituitary gland, hypothalamus, medulla and spinal cord.</i>
	<p>understand how the eye works to bring about vision of objects</p>	<ul style="list-style-type: none"> - describe the gross structure of the eye as seen in front view - draw and label a longitudinal section of the eye - describe the pupil reflex in response to bright and dim light - discuss how the eye produces a focused image of near and distant objects (accommodation)

Hormonal co-ordination	understand and appreciate the function of hormones in body co-ordination.	<ul style="list-style-type: none">- define a hormone as a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs- <i>distinguish between exocrine and endocrine gland</i>- identify and label on diagram the endocrine glands of the human body- name the hormones produced by the glands in the body- discuss the functions of insulin, glucagon, adrenaline, oestrogen, and testosterone hormones.- <i>compare the nervous and endocrine systems</i>- <i>explain the concept of negative feedback.</i>
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	<p>acquire knowledge of the role of hormones in tropic responses of plants</p>	<ul style="list-style-type: none">- define geotropism as the growth response of a plant to gravity- define phototropism as the growth response of a plant to light.- <i>describe geotropism and phototropism in terms of auxin regulating growth.</i>- investigate the effect of removing the apical bud from plant seedlings.- <i>describe the control of plant growth by auxins</i>
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Support, movement and locomotion	be familiar with the functions of bones and how they are related to muscles	<ul style="list-style-type: none">- identify from diagrams, photographs and real specimens, the main bones of the fore-limb (scapula, humerus, radius, ulna) of a mammal.- describe the component bones of the fore-limb of a mammal- describe the type of movement permitted by the ball and socket joint and the hinge joint of the fore-limb- describe the action of the antagonistic muscles at the hinge joint.
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The use and abuse of drugs	understand drugs and their medicinal use	<ul style="list-style-type: none">- define a drug as any substance taken in from an external source to affect or modify chemical reactions in the body- distinguish between medicinal and non-medicinal drugs.- describe the medicinal use of drugs e.g. antibiotics, painkillers, antacids etc.- <i>discuss dependence (emotional and physical) and tolerance of medicinal drugs</i>- discuss allergic reactions to drugs and other substances
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	<p>be aware of the dangers of abusing drugs</p>	<ul style="list-style-type: none"> - explain drug abuse - discuss the dangers of drug abuse e.g. damage to body tissues - find out which drugs are commonly abused in the community e.g. dagga/marijuana, solvents, glue, alcohol - describe non-medicinal (abusive) drugs according to their effect on the central nervous system: depressants, stimulants, hallucinogens - classify a named drug of abuse e.g. dagga/marijuana: dangers of taking the drug, signs of dependence, withdrawal symptoms and popular names - describe the dangers of consumption of alcohol: reduced self-control, depressant, effect on reaction time, damage to liver, social implications
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REPRODUCTION

Topics	General Objectives	Specific Objectives
	Learners should	Learners should
Forms of reproduction	acquire knowledge of asexual and sexual reproduction.	<ul style="list-style-type: none"> - describe asexual reproduction as the process resulting in the production of genetically identical offspring from one parent - give examples of asexual reproduction in plants and animals - describe one commercially important application of asexual reproduction in flowering plants - discuss the advantages and disadvantages of reproducing asexually - describe sexual reproduction as the process involving the fusion of nuclei from two different gametes to form a zygote

Sexual reproduction in flowering plants	acquire knowledge of reproductive parts of flowering plants.	<ul style="list-style-type: none">- identify the sepals, petals, stamens and carpels of one locally available insect-pollinated flower- describe the functions of the sepals, petals, anthers and carpels.- observe using a hand lens the sepals, petals, stamens, and carpels of the flower and draw the parts.
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acquire knowledge and understanding of the processes of pollination, fertilisation and seed dispersal.

- **discuss pollination in terms of types, agents and methods.**
- **compare wind pollinated and insect pollinated flowers using fresh specimens**
- **prepare a slide of the pollen grains from the stamens of a wind and insect pollinated flower and examine them under a microscope**
- **describe the growth of the pollen tube and its entry into the ovule followed by fertilisation.**
- **use a hand lens to identify the anthers and carpels of a locally available wind pollinated flower**
- **examine the structures of a seed (both endospermic and non-endospermic)**
- **describe the structure and function of parts of a seed in terms of embryo, (radicle and plumule) cotyledons and testa**
- **describe modes of seed dispersal**
- **state the advantages of seed dispersal.**
- **investigate the environmental conditions which affect germination of seeds**

Sexual reproduction in mammals	acquire knowledge about human reproductive parts.	<ul style="list-style-type: none">- use a diagram of the male reproductive system to identify testes, scrotum, sperm ducts, prostate gland, seminal vesicle, urethra and penis- describe the functions of the testes, scrotum, sperm ducts, prostate gland, urethra and penis- use a diagram of the female reproductive system to identify ovaries, oviducts, uterus, cervix, bladder and vagina- describe the functions of the ovaries, oviducts, uterus, cervix and vagina- compare the male and female gametes in terms of size, number, mobility and life span
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acquire knowledge about the menstrual cycle.

- **discuss the menstrual cycle.**
- **describe the effects of diet and emotional state on the menstrual cycle**
- **describe fertilisation and early development of the zygote in terms of the formation of a ball of cells which becomes implanted in the wall of the uterus**
- **distinguish between identical and fraternal twins**
- **describe implantation.**
- **discuss the functions of the amniotic sac and amniotic fluid**
- **discuss the functions of the placenta and umbilical cord in relation to exchange of dissolved nutrients, gases and wastes.**
- **describe the special dietary needs of a pregnant woman.**
- **discuss the advantages of breast milk compared to bottle milk.**

	<p>acquire knowledge about the use of a variety of birth control methods.</p>	<ul style="list-style-type: none"> - discuss the following methods of birth control: natural, mechanical, chemical, hormonal and surgical
	<p>acquire knowledge of sexually transmitted diseases and be aware of their prevalence and seriousness.</p>	<ul style="list-style-type: none"> - describe the causes, transmission, symptoms/signs, effects and treatment of gonorrhoea, syphilis and AIDS. - discuss the control of the spread of sexually transmitted diseases. - interpret data to establish prevalence rates of sexually transmitted diseases.

GENETICS, NATURAL SELECTION AND EVOLUTION

Topics	General Objectives	Specific Objectives
	Learners should	Learners should

<p>Inheritance Chromosomes and genes</p>	<p>acquire knowledge and understanding of genes, chromosomes and mutation, and appreciate variation in living things</p>	<ul style="list-style-type: none"> - define gene, allele and chromosome - describe mitosis and meiosis (names and stages not required, restrict only to number of chromosomes) - <i>describe the stages in mitosis and meiosis</i> - discuss relationship between gene and chromosome - distinguish between phenotype and genotype, recessive and dominant - discuss complete, <i>incomplete and co-dominance</i> - describe gene and chromosomal mutation - discuss factors which may lead to mutation - describe differences between continuous and discontinuous variation and give examples of each
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	acquire knowledge and understanding of inheritance	<ul style="list-style-type: none">- describe monohybrid inheritance- predict results of simple crosses with ratios of 3:1 and 1:1 using terms homozygous, heterozygous, F1 and F2 generations- explain why observed ratios differ from expected ratios especially when there are small number of progeny- <i>explain co-dominance by referring to inheritance of the ABO blood group phenotypes (A, B, AB & O)</i>- discuss Mendelian experiments in peas and maize- construct pedigrees for monohybrid crosses- describe a back cross to determine the genotype of a dominant phenotype- discuss the determination of sex in humans- <i>discuss sex linkage</i>
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Natural selection and evolution	acquire knowledge and understanding of the origin of life and its changes	<ul style="list-style-type: none">- discuss effects of variation and competition to the survival of organisms in the environment.- assess the importance of natural selection as a possible mechanism for evolution- describe the role of artificial selection in the production of economically important plants and animals.
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LIVING THINGS AND THE ENVIRONMENT

Topics	General Objectives	Specific Objectives
	Learners should	Learners should
Ecology	acquire knowledge and understanding of the importance of energy flow through ecosystems	<ul style="list-style-type: none">- describe the importance of the sun as the principal source of energy for biological systems- describe the non cyclic nature of energy flow- describe energy transfer through an ecosystem

	<p>appreciate and understand that nutrients are cycled in nature</p>	<ul style="list-style-type: none"> - describe the use and retention of nutrients in the ecosystem - describe the carbon cycle including the roles of photosynthesis, respiration, animal nutrition, decomposers, fossil fuels and combustion - describe the nitrogen cycle in terms of decomposition, nitrogen fixation and absorption
	<p>be aware of the impact of agricultural activities on the environment</p>	<ul style="list-style-type: none"> - discuss how poor agricultural practices result in destruction of the ecosystem e.g. monoculture, excessive use of fertilisers and pesticides, overstocking, deforestation. - discuss the problems which contribute to famine such as unequal distribution of food, natural disasters (such as floods and drought) and increase in population.

	be able to manage problems associated with pollution	<ul style="list-style-type: none">- describe a cause, effect and control of each of the following types of pollution: water, air and land- investigate common sources of pollution in their area and find out ways of reducing or controlling it.
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Conservation	be aware of and appreciate the need to conserve our natural resources	<ul style="list-style-type: none">- discuss reasons for conservation of species with reference to local plants and animals- find out from the local community which plants and animals have become scarce and why.- investigate threatened species (plants and animals) and the need to conserve them (emphasise examples from Botswana)- discuss reasons for recycling of materials including sewage water, paper, bottles and tins.- carryout a project to identify natural resources conserved in Botswana.
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BIOTECHNOLOGY

Topics	General Objectives	Specific Objectives
	Learners should	Learners should

<p>Biotechnology</p>	<p>appreciate biotechnology as an approach to solving day to day problems and its role in the provision of food, fuels, medicines and new materials for industry</p>	<ul style="list-style-type: none"> - define biotechnology as the application of biological organisms, systems or processes to manufacturing and service industries - explain why micro-organisms are used in biotechnology - investigate the role of micro-organisms in food production e.g. bread, <i>madila</i>, <i>chibuku</i>, <i>single cell protein</i> - investigate the role of micro-organisms in fuels and chemicals e.g. biogas, alcohol, biological enzyme washing powders - <i>discuss the role of micro-organisms in genetic engineering e.g. insulin production, crop plant resistance, gene therapy</i> - discuss the role of micro-organisms in the production of medicine such as antibiotics and vaccines - <i>discuss how industry in Botswana can benefit from biotechnology</i>
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