CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Secondary Education Certificate®
CSEC®

BIOLOGY SYLLABUS

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Content

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Please note that the syllabus has been revised and amendments are indicated by italics.

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Biology Syllabus

♦ RATIONALE

The application of scientific principles and the conduct of relevant research are of significant importance in identifying, assessing and realising the potential of the resources of Caribbean territories. A good foundation in the sciences will enhance the ability of our citizens to respond to the challenges of a rapidly changing world using the scientific approach.

Biology is the discipline in science which seeks to understand the organisation of the organic world through an exploration of the structure and function of life forms at the molecular, cellular, organismal and ecosystem levels, as well as the complex interactions and interdependencies which occur at each of these levels. This knowledge provides the foundation for understanding the opportunities for promoting the well-being of humans and other living organisms in the environment. It generates an awareness of the importance of our biodiversity and the unique role of humans in conserving, protecting and improving the quality of the biological environment for future generations.

The CSEC Biology Syllabus is redesigned with a greater emphasis on the application of scientific concepts and principles. It recognises the need for an understanding of some of the basic principles of Chemistry, Physics and Mathematics, and, therefore seeks to strengthen the inter-relationship with these subjects. It also recognises the inter-relatedness among the topics in Biology, and social and environmental issues. Such an approach is adopted to develop those long-term transferable skills of ethical conduct, team work, problem-solving, critical thinking, and innovation and communication. It encourages the use of various teaching and learning strategies to inculcate these skills that will prove useful in everyday life, while at the same time catering to multiple intelligences and different learning styles and needs. It will provide a sound foundation to pursue the study of Life Sciences and related professions at the post-secondary level.

This syllabus will contribute to the development of the Ideal Caribbean Person as articulated by the CARICOM Heads of Government in the following areas: respect for human life and awareness of the importance of living in harmony with the environment; demonstrates multiple literacies; independent and critical thinking and the innovative application of science and technology to problem solving. In keeping with the UNESCO Pillars of Learning, this course of study will also contribute to a person who will learn how to do, learn to live together and learn to transform themselves and society.

♦ AIMS

The syllabus aims to:

1. develop an understanding of fundamental biological principles and concepts (such as structure and function relationships; unity in diversity; energy transduction), based upon practical and theoretical knowledge of living organisms and the environment;

2. make accurate observations of biological material and phenomena, both in the field and in the laboratory;

3. develop the ability to record information accurately;

4. formulate hypotheses and plan, design and carry out experiments to test them;

5. develop the ability to appraise information critically, identify patterns, cause and effect, stability and change and evaluate ideas;

6. appreciate that although generalisations have predictive value, there are often exceptions to them;

7. develop problem-solving and critical thinking skills;

8. develop an awareness that principles of Chemistry, Physics, Mathematics and other disciplines are necessary for a proper understanding of Biology;

9. recognise the dynamic nature of the interrelationships between organisms and their environment;

10. develop a natural curiosity about living organisms and a respect for all living things and the environment;

11. develop the ability to work independently and collaboratively with others when necessary;

12. apply biological knowledge for further studies as well as in everyday life situations;

13. acknowledge the social and economic implications of Biology;

14. integrate Information Communication and Technology (ICT) tools and skills.

♦ CANDIDATE POPULATION

The syllabus is designed for students intending to pursue further studies in science at the tertiary level as well as for students whose formal study of the subject is unlikely to proceed further.

CANDIDATE REQUIREMENTS

1. Candidates should have been exposed to at least three years of science at the secondary level, which should provide an introduction to basic physical and biological principles.

2. *Candidates should be concurrently studying or have done:*

   (a) *CSEC Mathematics or its equivalent;*

   (b) *CSEC English A (English Language) or its equivalent.*

CLASS SIZE

It is recommended that practical classes accommodate a maximum of **twenty-five** students.

♦ SUGGESTED TIME-TABLE ALLOCATION

It is recommended that a minimum of five 40-minute periods per week, including one double period, be allocated to the subject over a two-year period.

♦ ORGANISATION OF THE SYLLABUS

The syllabus is arranged in three sections, namely:

SECTION A - Living Organisms in the Environment

SECTION B - Life Processes and Disease

SECTION C - Continuity and Variation

♦ SUGGESTIONS FOR TEACHING THE SYLLABUS

It is recommended that Section A be taught first, followed by Sections B and C.

The organisation of each section in the syllabus is designed to facilitate inquiry-based learning and to ensure that connections among biological concepts are established. Teachers should ensure that their lessons stimulate the use of all of the senses in learning as this will help students view science as a dynamic and exciting investigative process.

The general and specific objectives indicate the scope of the content including practical work that should be covered. However, unfamiliar situations may be presented as stimulus material in examination questions.

This syllabus caters to varying teaching and learning styles, with specific attention being drawn to the interrelatedness of concepts. The fourth column entitled, "Skills and Interrelationships" states which specific objectives are best suited for the assessment of Drawing (DR), Observation, Recording and Reporting (ORR), Manipulation and Measurement (MM), Analysis and Interpretation (AI), and Planning and Designing (PD) skills. Whenever possible, a practical approach should be employed, with special attention given to the identification of variables and to the use of controls in biological investigations. Students should be encouraged to use information gathering tools and social networking media to aid investigation and teamwork. The need for repeated investigation and observations to arrive at meaningful conclusions should be emphasised.

Column four also highlights connections between biological concepts and the fields of Chemistry, Physics, Mathematics and other related disciplines. In order to make the course as relevant as possible, students' awareness of the effect of science on society and on the environment should be encouraged. All aspects of the environment: social, biological and physical must be considered in totality.

Greater emphasis should be placed on the application of scientific concepts and principles and less on the factual materials, which encourage memorisation and short-term recall. Every opportunity should be made to relate biological studies to the environment, and to use an ecological approach whenever pertinent. Biological principles should be illustrated by specific local and regional examples. Common names of organisms are acceptable.

The relationship between structure and function, cause and effect, stability and change is to be continually highlighted. Where appropriate, this relationship should be illustrated by the use of annotated diagrams.

The role of the teacher is to facilitate students' learning of accurate and unbiased information that will contribute to a more scientifically literate society that is capable of making educated and ethical decisions regarding the world we live in.

♦ CERTIFICATION AND DEFINITION OF PROFILES

The syllabus will be examined for General Proficiency certification.

In addition to the overall grade, there will be a profile report on the candidate's performance under the following headings:

(a) Knowledge and Comprehension;

(b) Use of Knowledge;

(c) Experimental Skills.

Knowledge and Comprehension (KC)

Knowledge	The ability to: identify, remember, and grasp the meaning of basic facts, concepts and principles;
Comprehension	select appropriate ideas, match, compare and cite examples of facts, concepts and principles in familiar situations.

Use of Knowledge (UK)

	The ability to:
Application	use facts and apply concepts, principles and procedures in familiar and novel situations; transform data accurately and appropriately; use formulae accurately for computational purposes;

Analysis and Interpretation	identify and recognise the component parts of a whole and interpret the relationship among those parts; identify causal factors and show how they interact with each other; infer, predict and draw conclusions; make necessary and accurate calculations and recognise the limitations and assumptions inherent in the collection and interpretation of data;
Synthesis	combine component parts to form a new and meaningful whole; make predictions and solve problems;
Evaluation	make reasoned judgements and recommendations based on the value of ideas, information and their implications.

Experimental Skills – (XS)

Manipulation/Measurement	The ability to: follow a detailed set or sequence of instructions; use techniques, apparatus and materials safely and effectively; make observations and take measurements with due regard for precision and accuracy.
Observation/Recording/Reporting	The ability to: select observations relevant to the particular activity; make accurate observations and minimise experimental errors; report and recheck unexpected results; select and use appropriate models of recording data or observations, for example, graphs, tables, diagrams; record observations, measurements, methods and techniques with due regard for precision, accuracy, and units; present data in an appropriate manner, using the accepted convention of recording errors and uncertainties; organise and present information, ideas, descriptions and arguments clearly and logically in a complete report, using spelling, punctuation and grammar with an acceptable degree of accuracy; report accurately and concisely using scientific terminology and conventions as necessary.

Planning and Designing	The ability to: make predictions, develop hypotheses and devise means of carrying out investigations to test them; plan and execute experimental procedures and operations in an appropriate sequence; use experimental controls where appropriate; modify an original plan or sequence of operations as a result of difficulties encountered in carrying out experiments or obtaining unexpected results; take into account possible sources of errors and precaution in the design of an experiment; select and use appropriate equipment and techniques.

♦ FORMAT OF THE EXAMINATIONS

Paper 01 (1 hour 15 minutes)	An objective test consisting of 60 multiple choice items.
Paper 02 (2 hours 30 minutes)	One compulsory data analysis question, two structured questions and three extended response questions.
Paper 03/1 School-Based Assessment (SBA)	School-Based Assessment will evaluate the achievement of the candidate in the Experimental Skills and Analysis and Interpretation involved in the laboratory and fieldwork. Candidates will be required to keep a separate practical workbook. CXC will require a sample of these for external moderation.
Paper 03/2 Assessment for Private candidates only (2 hours 10 minutes)	Alternate to the School-Based Assessment for private candidates. This paper will examine the same skills as those tested in Paper 03/1. The focus, therefore, will be on Experimental Skills and Use of Knowledge (Analysis and Interpretation).

NOTES ON THE EXAMINATION

1. There will be a combined Question Paper and Answer Booklet for Paper 02.

2. The International System of Units (S. I. Units) will be used on all examinations papers.

WEIGHTING OF PAPERS AND PROFILES

The percentage weighting of each paper and profile is presented in Table 1.

Table 1
Percentage Weighting of Papers and Profiles

PROFILES	***PAPER 1*** *Multiple Choice*	***PAPER 2*** *Structured and Data Analysis*	***PAPER 3*** *SBA*	***TOTAL RAW***	***TOTAL*** *%*
Knowledge and Comprehension	*60*	*36*	*-*	*96*	*48*
Use of Knowledge	*-*	*55*	*10*	*65*	*32.5*
Experimental Skills	*–*	*9*	*30*	*39*	*19.5*
TOTAL %	***60***	***100***	***40***	***200***	***100***

♦ REGULATIONS FOR PRIVATE CANDIDATES

Private candidates must be entered for examination through the Local Registrar in their respective territories and will be required to sit Papers 01, 02 and 03/2.

Paper 03/2 is a practical examination designed for candidates whose work cannot be monitored by tutors in recognised educational institutions. The Paper will be of 2 hours and 10 minutes duration and will consist of three questions. Questions will test the Experimental Skills and Use of Knowledge (Analysis and Interpretation) profiles and will incorporate written exercises and practical activities.

♦ REGULATIONS FOR RESIT CANDIDATES

Resit candidates must complete Papers 01 and 02 and Paper 03 of the examination for the year for which they re-register. Resit candidates may elect not to repeat the School-Based Assessment component, provided they re-write the examination no later than two years following their first attempt.

Candidates may opt to complete the School-Based *Assessment (SBA) or may opt to re-use another SBA score which satisfies the condition below.*

A candidate who re-writes the examination within two years may re-use the moderated SBA score earned in the previous sitting within the preceding two years. Candidates re-using SBA scores in this way must register as "Resit candidates" and provide the previous candidate number.

All resit candidates may enter through schools, recognized educational institutions, or the Local Registrar's Office.

♦ *THE PRACTICAL APPROACH*

The syllabus is designed to foster the use of inquiry-based learning through the application of the practical approach. Students will be guided to answer scientific questions by a process of making observations, asking questions, doing experiments and analyzing and interpreting data. The CSEC Biology Syllabus focuses on the following skills.

1. *Planning and Designing (PD)*

(a) *Ask questions: how, what, which, why or where. (Students must be guided by their teachers to ask scientific questions).*
Observation: Growth of plants are affected by their environment.

Example: Will plants that are grown using organic fertilizers grow taller than those that are grown using inorganic fertilizers?

(b) *Construct a hypothesis; the hypothesis must be clear, concise and testable.*

Example: Plants grown using organic fertilizer will grow taller than those grown using inorganic fertilizer.

(c) *Design an experiment to test the hypothesis. Experimental reports must include the following:*

(i) problem statement;

(ii) an appropriate aim related to the hypothesis;

(iii) list of materials and apparatus to be used;

(iv) observations to be made or measurements to be taken;

(v) precautions to be taken;

(vi) method of controlling variables;

(vii) clear and concise step by step procedure;

(viii) display of expected results;

(ix) use of results;

(x) possible limitations.

2. *Measurement and Manipulation (MM)*

(a) *Student's ability to handle scientific equipment competently.*

The list of equipment is:

(i) Bunsen burner;

(ii) Tripod stand with wire gauze;

(iii) binocular and monocular light microscope;

(iv) measuring cylinders (25-100cm^3);

(v) beaker (50-500cm^3);

(vi) thermometer;

(vii) ruler;

(viii) stop watch/clock;

(ix) balance;

(x) boiling tube;

(xi) test tubes and test tube holders;

(xii) hand lens;

(xiii) syringe.

(b) *Student's ability to take accurate measurements.*

(c) *Student's ability to use appropriate units.*

3. *<u>Observation, Reporting and Recording (ORR)</u>*

(a) *Recording*

Student's ability to record observations and to collect, organise and present data. Observations and data may be recorded in the following format.

(i) *Prose*
Written description of observations in the correct tense.

(ii) *Table (Neatly enclosed)*
<u>Numerical</u>: physical quantities in heading, units stated in heading, symbols, decimal points.
<u>Non-numerical</u>: headings correct, details present.

(iii) *Graph*
Axes labelled, correct scales, correct plotting, smooth curves/best fit lines, key to explain symbols if more than one dependent variable is being plotted.

(b) *Reporting*

Student's ability to prepare a comprehensive written report on their assignments using the following format:

(i) ***Date*** *(date of experiment).*

(ii) ***Aim/Purpose*** *(what is the reason for doing the experiment).*

(iii) ***Apparatus and Materials*** *(all equipment, chemicals and materials used in the experiment must be listed).*

(iv) ***Method/Experimental Procedure*** *(logically sequenced, step-by-step procedure written in the past tense, passive voice).*

(v) ***Results and Observations*** *(see a above: Observation/ Recording/Recording).*

(vi) ***Discussion and Conclusion*** *(see 4 below: Analysis and Interpretation).*

4. *Analysis and Interpretation*

Student's ability to:

(a) *identify patterns and trends, cause and effect, stability and change ;*

(b) *make accurate calculations;*

(c) *identify limitations and sources of error,*
make a conclusion to either support or refute the hypothesis,
compare actual results with expected results based on background/theoretical knowledge if they are different;

(d) *suggest alternative methods or modification to existing methods;*

(e) *analysing and interpreting results and observations and making conclusions.*

5. *Drawing (Dr)*

The following guidelines should be used for drawing.

(a) *The drawing should be placed in a position on the page which will allow for neat and clear labelling.*

(b) *If the drawing/diagram is included in the written material, it should be placed just before this material and should be referred to in your answer.*

(c) *Drawings should be done in pencil. The use of coloured pencils is not recommended.*

(d) *The drawing should be large enough so that all structures can be clearly drawn.*

(e) *The drawing should be correctly proportioned and parts should be accurately positioned.*

(f) *In order to get a smooth, unbroken line when drawing, lift the pencil from the paper as infrequently as possible until the line is completely drawn. This method will help to eliminate haphazard and sketchy lines.*

(g) *When a large number of small structures are present in a specimen, draw only a few of them carefully, showing structural details.*

(h) *Write labels in pencil.*

(i) *Labels should be annotated (that is, accompanied by brief explanatory notes).*

(j) *Label lines should never cross each other and should be horizontal where possible.*

(k) *In drawings where only a few structures are being labelled, all labels should be written on the right of the drawing.*

(l) *Drawings must have a full title and magnification. This is usually written below the drawing and underlined. The title tells the name of the structure or organism and the view from which the drawing was made.*

♦ SECTION A - LIVING ORGANISMS IN THE ENVIRONMENT

SECTION A is designed as an introduction to the rest of the syllabus. It is expected that in the teaching of this section, students will work in groups outside of the classroom in order to study the interrelationships between organisms and their environment and to better facilitate their appreciation of the diversity and complexity of these relationships.

GENERAL OBJECTIVES

On completion of this Section, students should:

1. be aware that there is both diversity and similarity of form in living organisms;
2. understand the importance of the abiotic environment to living organisms;
3. understand that there is interdependence between living organisms and their environment;
4. understand that there is a flow of energy through living organisms within the ecosystem;
5. appreciate the finite nature of the 'worlds' resources *and the significance of recycling materials in nature;*
6. *be aware of the effect of human activities on the environment*;
7. apply the knowledge of the interrelationship of organisms with the environment to identify problems affecting the growth and survival of populations.

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
1.1. *group* living organisms found in a named habitat based on observed similarities and differences;	*Visible characteristics, such as* hairiness, colour, shape, venation, number of legs and wings, and body segmentation of organs found in both plants and animals as appropriate. Common names of organisms and groups are acceptable.	*Nature walks. Organise students in groups to observe organisms (plants and/or animals) in their natural habitat.*	*Skills: ORR; Dr.*
1.2 *classify organisms into taxonomic groups based on physical similarities;*	*Simple classification of all living organisms into the five kingdoms: Plantae, Animalia; Fungi (mushroom), Prokaryotae (Bacteria) and Proctotista (amoeba). Further subdivision of the Animal Kingdom into Phyla, for example, Chordata which*	*Make drawings and construct tables to record observations.*	*Continuity and Variation Skill: Dr.*

SECTION A - LIVING ORGANISMS IN THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
	includes Classes (fish, reptiles, insects, birds mammals). These are further classified to the level of species. Modern classification uses DNA sequences to determine ancestry. Refer to SO A 2.2; B 1.1 *Note: Flowcharts could be included with drawings under Practical activities.*		
2.1 carry out a simple ecological study using the most appropriate collecting and sampling methods;	*Habitats may include terrestrial and aquatic, for example, a tree, wall or small pond.* Features of each habitat. Relationship between organism and habitat – adaptations that enable the organism(s) to survive in that habitat. Relationship between equipment used and habitat and species being investigated.	*Use quadrats to investigate the distribution of species in a particular habitat; estimate the density of a particular species. Calculate average (mean).* *Density = Total No. of organisms per unit area.* Use of pooters, bottles, jars, nets, sieves, quadrats, line and belt transects, mark, release and recapture methods to collect data on organisms from a named habitat.	*Math - Simple statistical analysis.* *Data collection and presentation.* *Skills: ORR; MM; Dr; PD.*
2.2 distinguish between the following pairs of terms: (a) abiotic and biotic factors, (b) niche and habitat,	Ecology – the study of living organisms in their environment. Ecosystem- a community of living organisms sharing an environment. Environment – *the* abiotic (non-living chemical and		*Skill: ORR.*

SECTION A - LIVING ORGANISMS IN THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
(c) population and community, (d) species and population;	physical) and biotic (living) factors. Habitat - the place where a particular organism lives. Niche – the role of an organism in an ecosystem. Species – a group of individuals of common ancestry that closely resemble each other and are normally capable of interbreeding to produce a fertile offspring. Population – members of a particular species living in a particular habitat. Community – all the populations of different species found living in a particular habitat.		
2.3 discuss the impact of the abiotic factors (soil, water, climate) on living organisms;	Importance of soil in providing water, mineral nutrients and oxygen; importance of air in providing various raw materials: oxygen, carbon dioxide, nitrogen. Importance of light and temperature. Refer to SO A 5.1.	*Components of soil – air (O_2) and, water-holding capacity, mineral nutrients, pH and salinity.*	*Chemistry - Elements, mixture and compounds; Oxidation; Decomposition Biodegradable; Recycling; Homeostasis.* *Skills: ORR; MM.*
3.1 identify the relative positions of producers and consumers in food chains;	Construct food chains and simple pyramids.	*Provide a number of organisms from which to construct a food chain and a food web.*	*Interdependence on living organisms.*
3.2 identify *from each habitat, a food chain containing at least four organisms;*	*Terrestrial (arboreal and edaphic) and aquatic (marine and freshwater) habitats.*	*Construct food chains using organisms in each habitat.*	*Energy relations.*

SECTION A - LIVING ORGANISMS IN THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
3.3 identify from each habitat: herbivore, carnivore and omnivore;	Not to be confined to familiar domestic animals.		
3.4 identify from each habitat, predator/ prey relationships;	*Terrestrial arboreal and edaphic) and aquatic (marine and fresh water) habitats. Example of the application of predator relationship. The use of 'Biological Controls'.*		*Link: Predator/Prey Relationships, Natural Selection.*
3.5 construct a food web to include different trophic levels;	Use of examples from the habitat(s) investigated. Students may be required to interpret a food web containing unfamiliar examples.	*Identify different trophic levels in food webs.*	*Energy Flow in an Ecosystem.*
3.6 explain the role of decomposers;	*Role of fungi and bacteria in converting complex compounds to simple substances.*	*Action of mould on bread, production of biogas from domestic organic waste material.*	*Chemistry- Hydrolysis. Enzyme. Nutrient cycling.*
3.7 assess the special relationships among organisms;	*Simple treatment of symbiotic relationships: parasitism, commensalism, mutualism - using local examples, such as lice and ticks on mammals, epiphytes on trees, nitrogen fixing bacteria in root nodules of legumes. Give names of partners.*	*Observations from a large tree. Examine root nodules, on the peanut plant.*	*Evolution Interdependence of living organisms and their environment.* *Skill: ORR.*
4.1 explain energy flow within a food chain or web;	*Simple diagram of non-cyclic energy flow from the sun.*		*Different forms of energy.*
5.1 explain, with examples, the impact of the continual re-use of materials in nature;	*Note the role of decomposers in the Carbon Cycle. Refer to SO A3.6.*		*Nutrient cycling.*

SECTION A - LIVING ORGANISMS IN THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
5.2 discuss the importance of and difficulties encountered in recycling manufactured materials;	Consider biodegradable and non-biodegradable materials, collection, transport and storage; note economic factors.	*Interpret data on waste management and pollution in the Caribbean (See Caribbean Environmental Outlook).*	*Chemistry and Social Sciences.*
6.1 describe the impact of human activities on natural resources;	*Energy, mineral, forest, marine, over population and over fishing.*		*Alternative sources of energy.*
6.2 explain the negative impact of human activity on the environment;	Consider pollution by agricultural practices such as use of chemical fertilizers; products of industrialization and improper garbage disposal. Impact on eco-tourism. *Loss of habitat, species; impact on human health.*	*Research projects. (For example, collect data on use of agricultural chemicals).*	
6.3 assess the implications of pollution of marine and wetland environments;	*Refer specifically to impact on the health of ecosystems, aesthetic and economic benefits to small island states.*	*Research and interpret data on pollution of marine environments in the Caribbean, for example, Coral reefs.*	
6.4 discuss current and future trends regarding climate change;	*Refer to increase in greenhouse gases, rising global temperatures, rising sea levels and ocean acidification. Particular attention should be paid to the vulnerability of small island states to climate change (See Barbados Action Plan).* *http://www.unep.ch/regionalseas/partners/sids.htm.*		*Chemistry- Natural versus synthetic* *Social Science – Impact of human activity.*

SECTION A - LIVING ORGANISMS IN THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
6.5 suggest means by which the environment could be conserved and restored;	Consider effect of the change in practices; example use of natural materials in agriculture, conservation methods, education, monitoring strategies, organic agriculture.	*Research projects. (For example, describe a project involving conservation to include a listing the various strategies).*	
7.1 discuss the factors that affect the growth and survival of populations including human populations.	Include competition for food and space; effects of disease, pests, invasive species, natural disasters.	*Research projects. Analyse graphical data showing effect of different factors on natural populations, for example, giant snail.*	*Skill: AI.*

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.

1. *Construct a poster depicting either a terrestrial, marine or freshwater food web that you would find in your country. Showcase how competition, adaptation, and energy flow play key roles in the process.*

2. *Watch the videos on "Symbiotic Relationships" at PBS.org. http://www.pbs.org/wnet/nature/lessons/symbiotic-strategies/video-segments/1496/. Identify local examples of parasitism, commensalism, and mutualism in the Caribbean.*

3. *Create a PowerPoint presentation, movie or poster on the importance of Marine and Coastal areas in the Caribbean (Interpret data on pages 56-63 in the Caribbean Environmental Outlook). http://hqweb.unep.org/geo/GEO_Regions.asp Identify at least TWO threats to these fragile ecosystems.*

4. *Design a "Wanted" flyer for a criminal!! In this case, the criminal is an invasive species in the Caribbean, for example, the Small Indian Mongoose (*Herpestes auropunctatus*) and Lion fish. Invasive species are considered one of the greatest threats to island biodiversity and habitat loss. See examples of "Wanted Flyers" below: http://science.nature.nps.gov/im/units/pacn/outreach/Invasive_species_trading_cards/NPSA_trading_cards.pdf*

SECTION A - LIVING ORGANISMS IN THE ENVIRONMENT (cont'd)

5. *Discuss the main issues addressed by the 1994 Barbados Action Programme on the sustainable development of Small Island Developing States (SIDS).*

6. *Research the negative effects of climate change on your own community and write a short literary piece (short story, song, or poem) to present to the class.*

7. *Organise a debate regarding the positive and negative impacts of tourism development in your country and discuss the need for and importance of sustainable development in the Caribbean.*

8. *Arrange a debate on high population growth or high consumerism as principal causes of global environmental problems. See reports from the 1992 Rio Conference, the 1994, Barbados Programme of Action. (Note: Caribbean GEO).*

9. *Choose an environmental issue that concerns you (for example, the lack of recycling and the accumulation of plastics in the oceans which result in the death of marine mammals, invertebrates and sea turtles) or watch the video "Losing Paradise" http://www.youtube.com/watch?v=vCanbznET3Y . Write a convincing policy brief to be sent out to business owners, schools, and/or government officials in an effort to tackle this problem.*

10. *Interpret the data on forest cover in the Caribbean as presented in the Caribbean Environment Outlook by the United Nations Environmental Programme (UNEP) and CARICOM. http://hqweb.unep.org/geo/GEO_Regions.asp (Pages 34-38; http://hqweb.unep.org/geo/pdfs/Caribbean_EO_final.pdf).*

11. *Interpret the data on the state of "Waste Management" and "Pollution" in the Caribbean. (See pages 44-48 in the Caribbean Environmental Outlook); http://hqweb.unep.org/geo/pdfs/Caribbean_EO_final.pdf.*

♦ SECTION B - *LIFE PROCESSES AND DISEASE*

The life processes *will largely be illustrated* in humans and flowering plants because these are the two groups with which students are most familiar, and about which they should have some degree of understanding. **Comparisons with other organisms should be included where appropriate**. Details of anatomical structure are used to illustrate the relationships between structure and function.

There should be a focus on the interdependence of the *internal* processes *occurring at the organ and cellular levels* in maintaining the organism in a healthy state.

Diseases common in the Caribbean variously affect the quality of life of its people, the efficiency of its human resources and its economy. The purpose of this aspect of the syllabus is to make students sufficiently aware of the problems and their implications so that they can recognise and deal with them in their own environments.

GENERAL OBJECTIVES

On completion of this Section, students should:

1. know the structure of an unspecialised cell (plant and animal) and appreciate the functions of the main cell structures and of cell specialisation;

2. understand that nutrition is the means by which living organisms obtain their energy and material requirements, and this occurs in different ways;

3. understand that respiration is the means by which energy is made available for carrying out life processes;

4. *understand the role of transport, storage and defense in* living organisms;

5. understand the processes by which living organisms get rid of metabolic waste and regulate body fluid concentration;

6. understand the mechanisms of movement and appreciate its role(s) in living organisms;

7. understand that organisms detect and respond to changes in their external and internal environment;

8. understand that organisms increase in mass, size and complexity during their lives;

9. understand the processes by which life is perpetuated;

10. *appreciate the social and economic importance of disease control in plants and animals.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
1. Cells			
1.1 compare the structure of the generalised plant and animal cells, and selected microbes;	Cell wall, cell membrane, nucleus, cytoplasm, vacuoles, mitochondrion, chloroplast. *Microbes to include bacterium, Protista, for example, amoeba.* *Simple structure of a bacterium to include nucleoid, cell wall, capsule and flagellum.*	Draw and label cells *and cell structures from electron micrographs (mag.x2,000).* *Examine a variety of cells, for example, cells of Allium (purple onion),* Rhoeo discolor*, Elodea, prepared slides of blood cells, nerve cells and skin.* *Construct models using plasticine or other materials found around the home or laboratory.*	*Structure and function relationships* *Skill: Dr.*
1.2 *distinguish between cell wall and cell membrane; mitochondrion and chloroplast;*			
1.3 r*elate the structure of organelles to their functions;*	*Simple treatment of chloroplast; mitochondrion; vacuole; nucleus. For example, nucleus: chromosomes carry genetic information in the form of DNA.* *Refer SO C1.1*		Chemistry - *DNA; proteins, chlorophyll; carbohydrates.*
1.4 differentiate between plant and animal cells;	Reference to plant cells as characterised by the presence of a cell wall, large vacuoles and chloroplasts. Relate structure to function.		

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
1.5 explain the importance of cell specialisation in multi-cellular organisms;	*Examples of tissues from both plants and animals. Consideration that a number of different tissues (for example, epidermis, xylem, phloem) come together to form organs (leaf, stem) and organ systems (transpiration; translocation).* *Refer to SO B.4.7, 4.11.*	*Examine and draw the cross section of a stem or root as seen under the light microscope*	*Hierarchy of cells, tissues, organs; organ systems; organism; population; community, ecosystem.* *Refer to SO A2.2.* *Skills: ORR; DR*
1.6 *explain the processes of diffusion and osmosis;*	*Importance of diffusion and osmosis in transporting substances in and out of cells and from one cell to another in all living organisms. Reference to the cell membrane as a differentially permeable membrane, contrast with cell wall which is freely permeable.*	*Carry out simple investigations to illustrate the movement of particles (molecules and ions).* *Identify every-day instances of these processes occurring.*	*Physics-Osmosis, diffusion.* *Chemistry-Particulate nature of matter; ions.* *Skills: ORR; MM; AI.*
1.7 discuss the importance of diffusion, osmosis and active transport in living systems.	*Cite examples of each process occurring in living organisms. For example, diffusion across membrane of Amoeba, gas exchange across respiratory surfaces, absorption in small intestine, active uptake of mineral ions by plant roots.*		*Physics and Chemistry-Osmosis, diffusion.*
2. Nutrition			
2.1 distinguish among heterotrophic, autotrophic and saprophytic nutrition;	Simple inorganic substances used by plants compared to complex organic substances consumed *by animals and fungi.* *Refer to SO A2.7.*	*Identify sources of food for a named organism for each type of nutrition.*	*Chemistry-Water, nitrogen, carbon dioxide, starch, sugars, protein. Photosynthesis; respiration; decomposers. Energy relations.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
2.2 describe the process of photosynthesis in green plants;	Simple treatment involving an equation to summarize the process; - *the evolution of oxygen as a result of the splitting of water by light energy;* - *the subsequent reduction of carbon dioxide to a carbohydrate;* - *the chloroplast as the site of the reaction;* - *role of chlorophyll;* - *the fate of products (metabolised to provide energy or stored).*	*Test for evolution of oxygen using water plant. Carry out controlled experiments to demonstrate that light and chlorophyll are necessary for photosynthesis; Tests for end products, starch or reducing sugar.*	*Chemistry - Oxidation and reduction.* *Skills: ORR; MM.*
2.3 relate the structure of the leaf of a flowering plant to its function in photosynthesis;	*The external features* and the internal structure of a dicotyledonous *leaf as seen in cross section under the light microscope. Emphasise adaptations for photosynthesis (stomata; intercellular spaces; chloroplasts in palisade layer close to epidermis).*	*Draw and label the external features and internal structure of a dicotyledonous leaf as seen in cross section.*	*Role of water for opening of stomata; diffusion of CO_2.* *Skills: ORR; Dr.*
2.4 explain how environmental factors affect the rate of photosynthesis;	Use green and variegated leaves of hibiscus.	*Investigations to include temperature, water and CO2.*	*Chemistry- Properties of some bio-molecules. Physics-Forms of energy, wavelengths of light; Fluorescent molecules. Skills: ORR; Dr; MM, PD.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
2.5 discuss the importance of minerals in plant nutrition using nitrogen and magnesium as examples;	*Emphasis on the importance of nitrogen in the formation of proteins and magnesium in the formation of chlorophyll.*	*Investigate the effect of the lack of nitrogen on seedlings.*	*Chemistry- Oxidation and reduction.* *Skills: PD; ORR; MM; AI.*
2.6 perform tests to distinguish among food substances;	*Starch, protein, lipids, reducing and non-reducing sugars; chemical and physical properties (solubility) of carbohydrates, proteins, lipids; hydrolysis and condensation (dehydration synthesis).*	*Test for proteins (Biuret), fats (grease spot, ethanol – emulsion tests), starch (iodine), reducing sugars (Benedict's solution). Note the necessity for hydrolysis and neutralisation in testing for non-reducing sugars.*	*Chemistry–Redox solubility, Organic Chemistry- condensation/hydrolysis.* *Skills: ORR; MM.*
2.7 relate the structures of the human alimentary canal to their functions;	*Simple diagrams of the alimentary canal and internal structure of a tooth required.* *Mastication and the role of teeth in the mechanical breakdown of food to be included.*		*Skill: Dr.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
2.8 explain the role and importance of enzymes;	*Inclusion of catalysis. Properties of enzymes, role of digestive enzymes in the mouth, stomach and pancreatic enzymes in the small intestine.*		*Chemistry - Rate of reaction, properties of proteins. Skills: ORR; MM; AI.*
2.9 investigate the effect of temperature and pH on the activity of the enzymes catalase or amylase;	*Candidates may be asked to deduce from tables and graphs the effects of temperature and pH on enzyme activity.*		*Chemistry-Acids and bases rate of reaction; Math - Simple graphs.* *Skills: ORR; MM; AI and PD.*
2.10 describe what happens to the products of digestion after their absorption;	*Simple diagram of villi and role in absorption of products of digestion. Transport to the liver and assimilation to be included, that is, how products are used and what happens to excess. Link to blood sugar control Refer to SO B5.2, 5.3*		*Homeostasis.*
2.11 discuss the importance of a balanced diet in human.	*Components of a balanced diet (including vitamins and minerals and their roles). The results of their deficiency or surplus (malnutrition). The effects of age, sex and occupation on dietary needs. Vegetarianism Dietary recommendations for treating and preventing named deficiency and physiological diseases – diabetes and hypertension.*		*Nutrition/Special diets.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
3. Respiration			
3.1 describe the process of aerobic respiration;	*Involvement of enzymes in releasing energy as ATP. Distinguish between respiration and breathing.* *Simple treatment. A chemical and word equation to show the starting materials and final products of aerobic respiration is required.*		*Chemistry- Endothermic and exothermic reactions. Physics - First and second law of thermodynamics.*
3.2 distinguish between aerobic and anaerobic respiration;	*Include the production of lactic acid in muscle, alcohol and carbon dioxide in plants, production of bio-gas from organic matter.*	*Simple investigations to show the products of anaerobic respiration in yeast.*	*Chemistry- Reactions involved in making bread and in vigorous exercise.* *Skills: MM; ORR; AI.*
3.3 *describe the mechanism of breathing in humans and gaseous exchange in flowering plants;*	*Simple diagrams to show the relationship between the trachea, the bronchi, alveoli and lungs and the diaphragm and ribcage required.* The necessity for a continuous supply of oxygen and the removal of waste products to be included. O*xygen debt.* *Refer to SO B1.7, 3.2.*	Use of model of the thorax. *Note limitations.*	*Physics-Pressure, Diffusion.* *Skills: Dr, AI.*
3.4 identify characteristics common to gaseous exchange surfaces;	*Emphasis on mechanisms for increasing surface area in humans, fish and plants. Refer to SO B1.7.*	*Examine lungs of a mammal, gills of fish and various types of leaves.*	*Skill: Dr.*

SECTION B - LIFE PROCESSES AND DISEASE (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
3.5 *discuss the effects of smoking.*	*For example, nicotine addiction, damage to the lining of the lungs, cancer-causing effects and reduction in the oxygen carrying capacity of the blood. Marijuana addiction, acute chest illness, obstruction of airways (no further details required).*	*Interpret smoking data worldwide and for the Caribbean (cigarette use, death rates, cancer incidence).*	*Drug abuse and health.*
4. Transport			
4.1 explain the need for transport systems in multi-cellular organisms;	*The limitations of simple diffusion. Comparison with single celled organism such as the amoeba. The relationship between surface area and volume.*	*Make models, such as, cubes of different sizes and compare their surface area/volume ratio.*	*Chemistry-Diffusion Mathematics – Calculating area and volume.*
4.2 identify the materials which need to be transported in animals and plants;	*Oxygen, carbon dioxide, hormones, mineral nutrients, glucose and amino acids.*		
4.3 describe *the structure and function of* the circulatory system in humans;	*Structure and function of the heart. Names of blood vessels supplying lungs, kidney, liver, brain, intestine only.*	*Draw diagrams to show differences in the structures of arteries, veins and capillaries. Examine external and internal features of fresh or preserved specimens of mammalian hearts.*	*Skills: ORR; Dr.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/ EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
4.4 relate the structure of the components of blood to their function;	Diagrams of red and white blood cells required.	*Use prepared slides only to show blood cells.* *Do not use fresh samples.*	*Skill: Dr.*
4.5 describe the role of blood in defending the body against disease;	*Include the clotting mechanism; the role of phagocytes and natural immunity.*		
4.6 explain how the principles of immunisation are used in the control of communicable diseases;	*As demonstrated by artificial immunity via vaccines.* *Refer to SO C5.4, 6.2.*		Antigen/antibody, *variation, natural selection .*
4.7 explain how the structure of xylem vessels is suited for their function;	Hollow tubes- non-living with lignified walls; no end walls- allow for a continuous flow of water.		*Physics-Cohesion, adhesion, tension.* *Skill: Dr.*
4.8 discuss the role of the process of transpiration in plants;	*Transpiration stream from roots to leaves to be included.* *Refer to SO B4.2.*	*Observe small herbaceous plant placed in coloured water.*	
4.9 describe the effect of external factors on transpiration;	*Light intensity, temperature, humidity, and air movements should be included.*	*Carry out controlled investigations.*	*Skill: ORR.*
4.10 discuss adaption in plants to conserve water;	*Simple treatment of root length, cuticle thickness, water storage.*	*Observe succulent, xerophytic plants.*	
4.11 explain how the structure of the phloem is suited to its function;	Source←------>→ Sink		*Translocation; storage organs; growing points. Formation of fruits/seeds; germination.*

SECTION B - LIFE PROCESSES AND DISEASE (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
4.12 identify the products stored in plants and animals and the sites of storage;	Roots, stems, leaves, fruits, seeds in plants; the liver, fat deposits in animals to be included. Detailed structure of storage organs not required.	*Carry out food tests for starch, sugars and oil in storage organs.*	*Chemistry-Sugar, starch, fats.* *Skills: MM, AI.*
4.13 discuss the importance of food storage in living organisms.	*Storage as a means of overcoming the need for continuous food intake or manufacture, providing for periods of scarcity, providing for special functions, such as, production of sexual or vegetative reproductive structures, development of embryos.*	*Draw and annotate stages in germinating seeds; Draw buds from plant storage organs (stems and tubers).*	*Physics-Energy. Chemistry-conversion of simple soluble substances to insoluble macromolecules.* *Skill: Dr.*
5. Excretion			
5.1 distinguish between egestion and excretion;	*Undigested material versus bilirubin in faeces, and urea in urine.*		*Metabolism.*
5.2 discuss the importance of excretion in living organisms;	*Implications of toxicity.* For example, carbon dioxide, *heat,* urea, water, oxygen, calcium oxalate and tannins.		*Chemistry-Oxygen, carbon dioxide, water.*
5.3 state how metabolic wastes are excreted from plants and animals;	*Leaf fall, loss of bark and storage in plants;* *lungs, skin, urinary systems in humans to be included.*		
5.4 relate the kidney to its osmoregulatory and excretory functions.	*Highlight structure of the urinary system and kidney tubule; The function of the parts. Mention kidney failure and dialysis.* *Role of ADH in homeostasis.*	*Annotated simple diagrams of the gross kidney structure and that of the nephron to illustrate the production of urine required.*	*Chemistry - Dialysis, Filtration contrast with Osmosis.* *Skill: Dr.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
6. Movement			
6.1 *distinguish between growth movements in plants and movement in animals;*	The distinction should be made between: (a) growth movement as shown by germinating seedlings, Refer to SO B7.2 and B8.1. (c) *Locomotion/whole* movement as illustrated by animals.	*Germinate peanuts or kidney beans or any appropriate seeds.*	*Skills: ORR; Dr; AI; MM.*
6.2 relate the structure of the skeleton to its function in humans;	Functions to include protection, support, locomotion, blood formation.	*Examine a human skeleton.*	*Physics-Centre of gravity.*
6.3 discuss the importance of locomotion in animals;	*Comparison with flowering plants; make reference to role in nutrition and reproduction.*		
6.4 describe the mechanism of movement in a human fore limb.	*The relationship between the bones and muscles of a limb. Behaviour of antagonistic muscles; types of joint, action at moveable joints.* *Draw, label and annotate a simple diagram of the long bone of a fore limb.*	*Simple line drawing to show the relationships. Note origin and insertion of muscles.*	*Physics- Moment of a force, efficiency levers.* *Skill: Dr.*

SECTION B - *LIFE PROCESSES AND DISEASE* (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
7. Irritability			
7.1 define 'stimulus' and 'response';			
7.2 describe the response of:			
(a) *green plants to stimuli;*	*The response of stems and roots of seedlings to light, touch and gravity. Relate observations to the behaviour of plants in natural situations. Refer to SO B6.1; 4.13.* *Role of auxins not required.*	*Carry out controlled investigations; make observations; record and report as appropriate.*	*Physics - Light and gravity.* *Skills: ORR; PD; MM.*
(b) invertebrates to variations in light intensity, temperature and moisture;	*The response of invertebrates* for example, millipedes, earthworms or woodlice.	*Construct simple choice chambers. Record observations.*	
7.3 define receptor and effector;	Sense organs, muscle and glands. Leaf, petiole, apical meristem.	*Reaction to hot objects, insect bites.*	
7.4 explain why the response to stimuli is important for the survival of organisms;	Reference to investigations with green plants and invertebrates in SO B7.2.		*Skill: AI.*
7.5 explain the relationship among the receptor, the central nervous system and the effector;	Emphasis on the coordinating function of the brain and spinal cord and the roles of sensory and motor neurones.		

SECTION B - LIFE PROCESSES AND DISEASE (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
7.6 explain a simple reflex action;	*Use of simple flow diagrams to show the pathway along which the impulse travels in the reflex. Diagrams showing a spinal cord and spinal nerves not required.*	*Investigate changes in pupil size in response to changes in light intensity, using mirrors, or the knee jerk reflex.*	
7.7 describe the functions of the main regions of the brain;	Cerebrum, cerebellum and medulla.	*Use models and charts.*	
7.8 *discuss the physiological, social and economic effects of drug abuse;*	*Include alcohol and one illegal drug. Mention the use and abuse of prescription drugs, for example, diet pills, tranquilisers, steroids, caffeine and analgesics (pain-killers). Refer to SO B7.6, 7.7.*	*Research project. Research and interpret data on drug abuse in your territory.*	*Chemistry-Reactions of alcohol.* *Skill: AI.*
7.9 relate the structure of the human eye to its functions as a sense organ;	Cross section or longitudinal section of the eye required. Role of rods and cones as specialized receptor cells. Refer to SO B1.5.	*Examine dissected eye of a mammal.*	*Physics-Lenses.*

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
7.10 explain accommodation; sight defects and *the* corrections *of each*;	Long and near sightedness; the use of corrective lenses; glaucoma.		*Physics –Light and image.*
7.11 *relate structure of the human skin to its function in temperature regulation and protection.*	Role of skin structures in temperature control as an example of homeostasis is required. *Refer to SO B 5.4.* *Mention skin care and the effect of chemicals. The importance of melanin and SPF (simple treatment only). Discuss the skin bleaching phenomenon.*		*Skills: ORR; Dr.*
8. Growth			
8.1 make deductions from simple investigations designed to demonstrate growth in living organisms;	Examples could involve measuring changes in length, mass or surface area using roots, leaves, or other suitable material or counting the number of leaves in a named plant from seedling to fruiting plant. Include cell division in meristem; Comparison of growth in plants and animals. Refer to Mitosis SO C4.2.	*Conduct simple exercise to investigate patterns of growth.* *Draw and interpret graphs (growth curves, histograms) from given data.*	*Skills: ORR; Dr; MM, AI, PD.*
8.2 describe the structure of a dicotyledonous seed;	*Functions of the seed. Refer. S.O. B. 4.12; 4.13.*	*Draw, label and annotate the external and internal structures of a seed.*	*Skill: Dr.*

SECTION B - LIFE PROCESSES AND DISEASE (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
8.3 describe the processes taking place within a seed during germination.	Include breakdown of food stores and translocation to growing points. Refer To SO B4.12, 8.1.	*Use food tests to compare the food substances found in cotyledons before and after germination.*	*Chemistry-hydrolysis.*
9. Reproduction			
9.1 compare sexual and asexual reproduction;	Explanation that sexual reproduction leads to variation in the off-spring while asexual reproduction is conservative -offspring identical to the parent. *Refer to SO C 4.2-4.6.*		*Genetic variation.*
9.2 describe the structure and function of the reproductive systems in humans;	Male and female reproductive systems. Functions of the various parts.	*Label and annotate given diagrams.*	*Genetic variation and meiosis.* *Skill: Dr.*
9.3 describe the menstrual cycle;	The roles of oestrogen and progesterone and the effect of pregnancy on the menstrual cycle to be included. Include pituitary/gonads.	*Use models, charts.*	
9.4 outline the mechanism for bringing gametes together, their fusion and the development of the embryo in humans;	Include implantation, functions of the amnion, placenta and umbilical cord.		
9.5 discuss the advantages and disadvantages of various methods of birth control;	For example, natural, barrier, hormonal and surgical methods. Consider social aspects.		

SECTION B - LIFE PROCESSES AND DISEASE (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
9.6 discuss the transmission and control of Acquired Immune Deficiency Syndrome (AIDS) and gonorrhoea;	Implications of sexually transmitted infections (STI's). Include causative agents. Mention prevention, treatment and control.	*Research and interpret Human Immunodeficiency Virus (HIV) incidence data in the Caribbean.*	*Genetic variation, mutations, natural selection, evolution.*
9.7 *relate the parts of a flower to their functions;*	Knowledge of: petals, sepals, anther, filament, stigma, style, ovary, ovules, embryo sac, micropyle and carpel required.	*Draw, label and annotate local specimens.*	*Skills: Dr; ORR.*
9.8 compare the structure of an insect pollinated flower and a wind pollinated flower;	Names of pollinating agents required.	*Examine and draw the various parts of an insect and wind pollinated flower.*	*Skills: ORR; Dr.*
9.9 distinguish between the processes of pollination and fertilisation;	Means by which male and female gametes are brought together and their fusion to form the zygote of a flowering plant. Include cross and self-pollination.		
9.10 explain how fruit and seed formation occur after fertilization;	Knowledge of the processes in dicotyledon plants only.		

SECTION B - LIFE PROCESSES AND DISEASE (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
Disease			
9.11 describe fruit structure including adaptations for fruit and seed dispersal.	At least one example of water, wind, mechanical and animal dispersal methods. Mention the importance of dispersal.	*Draw examples of fruits and seeds to show adaptations for dispersal.*	*Physics- Archimedes principle, density.*
10.1 distinguish among pathogenic, deficiency, hereditary and physiological diseases;	Include examples of each.		*Immunity; nutrition; genetics.*
10.2 identify the stages in the life *cycle* of a mosquito;	Include habitat and mode of life of each stage.	*Collect eggs and larvae of mosquitoes. Make observations and drawings of complete metamorphosis.*	*Skill: Dr.*
10.3 *discuss the role of the mosquito as a vector in the transmission of pathogenic diseases;*	Knowledge of malaria, dengue, yellow fever required.	*Collect and analyse data on the incidence of these diseases in the territory.*	
10.4 suggest appropriate methods of control of each stage of the life *cycle* of mosquito;	Refer to SO B10.2		
10.5 discuss the treatment and control of the four main groups of disease;	The role of diet and exercise in controlling physiological diseases: hypertension and diabetes to be included. Knowledge of insulin and glucagon required. Refer to SO B 2.11; 4.5; 9.6.		

SECTION B - LIFE PROCESSES AND DISEASE (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
10.6 discuss the social, environmental and economic implications of disease with reference to both plant and animal diseases.	Emphasize loss of productivity, loss of human life, livestock and agricultural crops. Refer to SO A7.1.	*Display and interpret statistical data from local examples.*	*Social Science.*

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.

1. *Create a 3D model of a plant/animal cell OR write a first person narrative from the perspective of a particular type of cell, for example, "I'm Woody, the plant cell..."*

2. *Carry out simple controlled investigations to monitor the growth of seedlings for a period of one month. Manipulate variables (for example, sunlight, water, nutrients, soil type), take measurements and report the findings.*

3. *Visit the Malaria website from the nobelprize.org and play both the "Mosquito" and the "Parasite" games on the site. Familiarise yourself with the relationship between Plasmodium (the human parasite), the mosquito (the vector) and humans (the host). http://nobelprize.org/educational/medicine/malaria/.*

4. *Work in groups to write short newspaper articles on the human body systems and the diseases that affect each (for example, the reproductive system – STIs, prostate cancer, cervical cancer).*

5. *Interpret health data by investigating the number of persons in your country who suffer from diabetes and cancer. What are the causes, incidence rates and treatments available in your area?*

6. *The Caribbean region is the most heavily affected by HIV/AIDs after Sub-Saharan Africa. Interpret HIV/AIDS data on the Caribbean as given by the United Nations. UNDP Report 2009. AIDS Epidemic Update.* http://data.unaids.org/pub/Report/2009/jc1700_epi_update_2009_en.pdf.

7. *Make educational flyers to post around your town to educate the public on facts and myths about HIV and other STIs.*

8. *Compare the anatomy of an animal of your choice to the anatomy of a human.*

9. *Create posters to highlight the structure and function of a body organ of your choice. The poster should be a creative in describing function associated, diseases and disorders, and whether a person can live without the organ.*

♦ SECTION C - CONTINUITY AND VARIATION

The teaching of Section C should highlight the implications of variation. The simple treatment of meiosis is deliberate; it is important that the consequences of the process be appreciated. Use of this knowledge for improved efficiency in agriculture should be considered.

Note to Teacher: Biological evolution refers to genetic changes in the heritable traits in a population over multiple generations and is distinct from the origins or creation of Life. Scientists agree that evolution is the central-most concept in biology and provides a well-supported explanation for the biodiversity of life and how species adapt to new challenges. In particular, the treatment of evolution in the syllabus is of great importance to Small Island Developing States (SIDS) such as those found in the Caribbean. Our territories are faced with drastic changes due to human activity, overpopulation, limited resources, susceptibility to natural disasters, overfishing, deforestation and other pressures all of which pose a risk to the survival of species. Basic treatment of Biological evolution combined with genetics can enhance awareness and enable students to make more educated decisions regarding the environment. It is noteworthy to mention that in science the word "theory" is generally defined as an explanation that is firmly supported by evidence and widely accepted within the scientific community. Finally, the importance and applications of genetic variation and biological evolution in agriculture, healthcare, technology, and conservation should be noted.

GENERAL OBJECTIVES

On completion of this Section, students should:

1. *understand the "species" concept and the two major forms of speciation*;

2. *understand the importance of genetic variation in species;*

3. *understand the concept of the gene as it pertains to DNA, chromosomes and allele;.*

4. *understand the role of genes and heredity in determining how traits can be altered and inherited by asexual and sexual means;*

5. *understand natural selection, mutation, gene flow, and genetic drift as mechanisms for biological evolution;*

6. *understand the evidence for biological evolution and the importance and applications of biological evolution in terms of healthcare, food technology, forensic science, and conservation biology;*

7. *appreciate the social and ethical implications of genetic engineering.*

SECTION C - CONTINUITY AND VARIATION (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
1.1 distinguish among DNA, chromosomes, genes and alleles;	*DNA (deoxyribonucleic acid) as nucleic acid that contain all genetic information. Gene as a portion/segment of DNA that carries information to produce a specific protein. Chromosome as DNA and protein (histones). Haploid as the 'n' number of chromosomes. Diploid as the '2n' number of chromosomes. Alleles as two or multiple forms of the same gene.*	*Construct models of the structure of DNA and chromosomes.*	*Relationships between gene; allele; DNA; chromosome protein.*
2.1 describe the process of mitosis;	*Emphasis on its importance for maintaining species chromosome number. Mention the replication of chromosomes. Names of stages are not required. Refer to SO B9.1.*	*Construct models.*	*Skill: Dr. Significance of mitosis in growth and asexual reproduction.*
2.2 explain the role of mitosis in asexual reproduction;	*Include at least two examples of asexual reproduction in plants such as sugarcane cuttings and Bryophyllum leaves.*		*Genetic variation - Genotype maintained.*
2.3 explain why asexual reproduction gives rise to genetically identical offspring;	*Cloning as the reproduction of populations of genetically identical individuals.*		*Tissue culture, Human cloning. Ethical issues.*

SECTION C - CONTINUITY AND VARIATION (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
2.4 describe the process of meiosis;	*Simple treatment to include only homologous pairs, crossing over, separation of homologous chromosomes and subsequent separation of chromatids. Names of stages not required.*	*Construct models.*	*Formation of gametes (pollen; ovule; ovum; sperms).*
2.5 state the importance of halving of chromosome number in the formation of gametes;			
2.6 explain the role of meiosis in the transmission of inheritable genetic characteristics;	*Role of crossing over random assortment and recombination in genetic variation (benefits of sexual reproduction).*		
2.7 explain the meaning of the following terms: dominant trait, recessive trait, codominance, genotype, phenotype, homozygous and heterozygous;	*Codominance: blood group inheritance in humans.*		
2.8 explain the inheritance of traits (dominant and recessive genes);	*Examples to include Sickle cell anaemia, and albinism. Genetic diagrams required.*		

SECTION C - CONTINUITY AND VARIATION (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
2.9 predict the results of crosses involving one pair of alleles in the heterozygous, homozygous dominant and recessive conditions;	*Include Punnet squares and pedigree charts to show dominant, recessive and co-dominant traits. Include genotypic and phenotypic ratios. Students should be able to identify the various phenotypic ratios obtained from crossing homozygous and heterozygous parental genotypes.*		
2.10 describe the mechanism of sex determination and inheritance of sex linked diseases in humans;	*Include example of sex linked disease such as haemophilia and colour blindness.*		
3.1 explain how genetic variation arises;	*Sexual reproduction; mutation.*		
3.2 explain why genetic variation is important;	*Variation makes it less likely that a change in environmental conditions will wipe out an entire species.*	*Observe and record plant and animal variations in your community, for example, hibiscus flowers, frogs, fishes, birds. Stress variations within a species, for example, humans and tomatoes.*	*Adaptation.*

SECTION C - CONTINUITY AND VARIATION (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
3.3 distinguish between continuous and discontinuous variation in populations;	*Example: foot size, presence or absence of horns in cattle, pod size, tongue rolling, and leaf size. Mention genetic and environmental effects.*	*Carry out a survey on appropriate characteristics; for example, observe and record the range of variation in a particular feature of any kind of organism.*	*Skills: ORR; PD; AI.*
4.1 define a species;	*Include biological species concept (group of closely related organisms that are able to interbreed and produce fertile offspring). Give examples of species of birds, plants that can inter-breed. When two unrelated species mate, their offspring are not viable or if survive will be infertile, for example, the mule.* *Refer to SO A2.1, 2.2.*		
4.2 describe how new species are formed;	*Two types:* *-Speciation caused by physical geographic separation such as a river forming, colonizing a new island or rise of a mountain range (occurs with loss of habitat or the formation of new habitat);* *–Speciation caused by ecological and behavioral differences such as courtship behaviour/ differences in coloration. Note: Over time, species can also go extinct due to hunting/habitat loss/disease, for example, Caribbean Monk Seal.*	*Make drawings to depict both types of speciation mechanisms.*	

SECTION C - CONTINUITY AND VARIATION (cont'd)

SPECIFIC OBJECTIVES	**CONTENT/EXPLANATORY NOTES**	***SUGGESTED PRACTICAL ACTIVITIES***	***SKILLS AND INTER-RELATIONSHIPS***
Students should be able to:			
5.1 explain how natural selection plays a role in biological evolution;	*Natural selection as a process by which a population retains those genes which makes it adapted to its habitat. Natural selection normally preserves useful adaptations. Relate genetic variation to natural selection (variation provides the template for natural selection to act on).* *Mutation.* *The peppered moth, the Galapagos finches, bacterial resistance to antibiotics, pesticide resistance; the radiation of the Caribbean lizards. Use other local examples. For example, flower coloration: If a goat is attracted to red flowers and eats 75% of red flowers compared to the pink flowers in population, it acts as the selective force that leads to changes in the overall genetic diversity of the plant population.*	*Research how natural selection has played a role in the evolution of cassava plants, sea turtles, and Caribbean lizards.*	
5.2 distinguish between natural and artificial selection;	*Mention plant and animal breeding. Humans select traits to suit their needs. Cite local examples.*		*Agricultural Science*

SECTION C - CONTINUITY AND VARIATION (cont'd)

SPECIFIC OBJECTIVES	CONTENT/EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES	SKILLS AND INTER-RELATIONSHIPS
Students should be able to:			
6.1 describe how genetic engineering can be used to change the traits of an organism;	Changing the traits of one organism by inserting genetic material from a different organism. *Include food production and medical treatment. For example, insulin production and incorporation of beta carotene producing gene in rice for areas that are affected by night blindness.* Refer to SO B2.11; B7.3.		*Agriculture and medicine.*
6.2 discuss the possible advantages and disadvantages of genetic engineering.	*Social, ethical and ecological implications; Fingerprinting, DNA tests, gene therapy, captive breeding programmes.*		

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.

1. *Create a comic book that gives life to the following terms: DNA, chromosome, gene, allele, haploid, diploid, dominant, recessive, co dominance, genotype, and phenotype.*

2. *Take a trip to your local zoo or aquarium to identify local examples of biodiversity in the Caribbean. Discuss why genetic variation is important.*

3. *Discover the truth about and importance of Natural Selection. Navigate through the University of California at Berkeley's site on natural selection, natural selection at work, misconceptions about natural selection, mutations, genetic variation, adaptation and artificial selection. http://evolution.berkeley.edu/evolibrary/article/evo_25.*

4. *The Caribbean is regarded as one of the world's biodiversity "hotspots" (Myers et al. 2000). Interpret data on Biodiversity in the Caribbean presented in pages 51-56 in the Caribbean Environmental Outlook; http://hqweb.unep.org/geo/pdfs/Caribbean_EO_final.pdf. Make a collage showcasing the biodiversity in your country.*

SECTION C - CONTINUITY AND VARIATION (cont'd)

5. *Diversity and adaptations of organisms. Write a research paper on the evolution of domestic dogs from wolves. Video Resources: http://www.pbs.org/wnet/nature/lessons/from-wolf-to-dog/video-segments-dogs-that-changed-the-world/4800/*

6. *Critical thinking problem: A few of months ago, the shed in Mr. Farmer's backyard suddenly became infested with flies. It was sprayed with a solution of insecticide, which killed nearly all the flies. However, sometime later, the numbers of flies increased again. The spraying process with the insecticide was repeated five (5) times, but it was clear that every time spraying was done, the insecticide became less and less effective in killing the flies. Write a short explanation for these observations.*

7. *Research some of the species in the Caribbean are gone extinct (for example, Caribbean Monk Seal, Giant tortoises (Geochelone spp), and some primates). What caused the extinction of these species?*

8. *Write a one-page plea from the viewpoint of an endangered species in your country. Why is this species important and why should it be protected?*

9. *Research the role of natural selection in the evolution of Cassava plants, Sea Turtles, Green Monkeys and Caribbean Lizards in the Caribbean. Summarise the findings on one page.*

APPENDIX I

♦ GUIDELINES FOR THE SCHOOL-BASED ASSESSMENT

RATIONALE

School-Based Assessment (SBA) is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills and attitudes that are critical to the subject. The activities for the School-Based Assessment are linked to the "Suggested Practical Activities" and should form part of the learning activities to enable the student to achieve the objectives of the syllabus.

During the course of study of the subject, students obtain marks for the competencies they develop and demonstrate in undertaking their SBA assignments. These marks contribute to the final marks and grades that are awarded to students for their performance in the examination.

The guidelines provided in this syllabus for selecting appropriate tasks are intended to assist teachers and students in selecting assignments that are valid for the purpose of the SBA. These guidelines are also intended to assist teachers in awarding marks according to the degree of achievement in the SBA component of the course. In order to ensure that the scores awarded by teachers are not out of line with the CXC standards, the Council undertakes the moderation of a sample of SBA assignments marked by each teacher.

School-Based Assessment provides an opportunity to individualise a part of the curriculum to meet the needs of students. It facilitates feedback to the students at various stages of the experience. This helps to build the self-confidence of the students as they proceed with their studies. School-Based Assessment further facilitates the development of critical skills and that allows the students to function more effectively in their chosen vocation and in everyday life. School-Based Assessment therefore, makes a significant and unique contribution to the development of relevant skills by the students. It also provides an instrument for testing them and rewarding them for their achievements.

PROCEDURES FOR CONDUCTING SBA

SBA assessments should be made in the context of normal practical coursework exercises. It is expected that the exercises would provide authentic learning experiences. Assessments should only be made after candidates have been taught the skills and given enough opportunity to develop them. **Eighteen** practicals over the two-year period would be considered the minimum number for candidates to develop their skills and on which to base realistic assessments. **These practicals MUST include all of the following:**

1. *Ecological study.*
2. *Movement at molecular level (diffusion, osmosis).*
3. *Photosynthesis/respiration.*
4. *Food tests.*
5. *Germination.*
6. *Nutrition and diseases.*
7. *Genetics*

Each skill with the exception of Drawing must be assessed **at *least two times*** over the two-year period. Candidates should be encouraged to do corrections so that misconceptions will not persist. As the assessments of certain skills, especially those requiring on-the-spot observation, involve looking at several behaviours or criteria, teachers are advised to select not more than two skills to be assessed in any activity. The practical exercises selected to be used for assessment should make adequate demands on the candidates and the skills assessed should be appropriate for the exercises done. For the assessment of written work, the practical selected should be one that can be completed in the time allotted for the class and the notebooks should be collected at the end of the period.

Candidates who have not been assessed over the two-year period will be deemed absent from the whole examination. Under special circumstances, candidates who have not been assessed at all points may, at the discretion of CXC, have their marks pro-rated (adjusted proportionately).

1. In preparation for an SBA practical, the teacher should:

(a) select tasks which must include the **seven** (7) topics on page 45 and should be related to a given syllabus objective. These tasks may be chosen from the "Suggested Practical Activities" and should fit in with the normal work being done in that class;

(b) list the materials including quantities and equipment that will be needed for each student;

(c) carry out the experiment beforehand, if possible, to ascertain the suitability of materials and the kind of results (observations, readings) which will be obtained, noting especially any unusual or unexpected results;

(d) list the steps which will be required by the candidates in performing the experiment. From this it will be clear to the teacher how the candidates should be arranged in the laboratory, whether any sharing of equipment or materials is necessary, the skills which can be assessed from the practical, and the instructions to be given;

(e) list the skills that may be assessed (for example, observation/recording/reporting, analysis and interpretation). **No more than two practical skills should be assessed from any one activity;**

(f) select the skills to be assessed on this occasion. Skills other than those required for that year should also be included for teaching purposes;

(g) work out the criteria for assessing each skill. This will form the basis of a mark scheme and a checklist.

2. The teacher should carry out the assessment and record the marks.

This is the most critical step in the assessment process. For a teacher to produce marks that are reliable, the marking must be consistent for all candidates and the marks should reflect the standard of performance at the level. The teacher must be able to justify the marks, and this occurs when there is a fixed set of conditions, factors or criteria for which the teacher looks. Marks should be submitted electronically to CXC using the SBA form provided. *The forms should be dispatched through the Local Registrar by the Moderator to reach CXC by 30 April of the year of the examination.*

ASSESSMENT OF PRACTICAL SKILLS

School-Based Assessment will assess skills under the profiles Experimental Skills and Use of Knowledge (Analysis and Interpretation only).

The assessment will be conducted during Terms 1 - 5 of the two-year period following the programme indicated in the Table below.

SBA SKILLS TO BE ASSESSED FOR CXC MODERATION

PROFILE	**SKILLS**	**YEAR 1**		**YEAR 2**			
		NO. OF TIMES SKILLS TO BE ASSESSED	**MARKS**	**NO. OF TIMES SKILLS TO BE ASSESSED**	**MARKS**	***MARKS***	
XS	Manipulation/ Measurement	1	10	1	10	20	70 (30*)
	Observation/ Recording/ Reporting	1	10	1	10	20	
	Planning and Designing	1	10	1	10	20	
	Drawing	1	10	-	-	10	
UK	Analysis and Interpretation	1	10	1	10	20	20 (10*)
	TOTAL	5	50	4	40	90	40*

Weighted mark

Investigative project to be done in Year 2

The investigative project would be assessed for two skills, Planning and Designing and Analysis and Interpretation.

Students who are pursuing two or more of the single science subjects (Biology, Chemistry, and Physics) may opt to carry out ONE investigation only from any of these subjects.

ASSESSMENT OF INVESTIGATION SKILLS

Proposal (Planning and Design)

The maximum marks available for the Proposal is ***10 marks***

The format for this part outlined below:

Observation/Problem/Research question stated	
Hypothesis	*2 marks*
Aim	*1 mark*
Materials and Apparatus	*1 mark*
Method	*2 marks*
Controlled variable	*1 mark*
Expected Results	*2 marks*
Assumptions, Precautions/Sources of error/Limitations	*1 mark*

TOTAL ***10 marks***

Implementation (Analysis and Interpretation)

The maximum marks available for the Implementation ***20 marks***

The format for this part is shown below:

Method	*1 mark*
Results	*4 marks*
Discussion	*5 marks*
Limitation	*3 marks*
Reflection	5 marks
Conclusion	*2 marks*

TOTAL ***20 marks***

REPORTING FORMAT OF INVESTIGATION

PART A THE PROPOSAL (Planning and Design)

Statement of the Problem – Can be an observation, a problem
Hypothesis
Aim – Should be related to the hypothesis
Materials and Apparatus
Method – Should also include variables
Assumptions/Precautions/Possible sources of errors
Expected Results

PART B THE IMPLEMENTATION (Analysis and Interpretation)

Introduction – Background to the problem
Method - Linked to Part A (change of tense)
Results
Discussion – Explanations/Interpretations/Trends
Limitations
Reflections
Conclusion

ASSESSMENT OF INVESTIGATIVE SKILLS

A.	**PLANNING AND DESIGN**		**TOTAL (10)**
	HYPOTHESIS		**2**
	- Clearly stated	*1*	
	- Testable	*1*	
	AIM		**1**
	- Related to hypothesis	*1*	
	MATERIALS AND APPARATUS		**1**
	- Appropriate materials and apparatus	*1*	
	METHOD		**2**
	- Suitable	*1*	
	- At least one manipulated or responding variable	*1*	
	CONTROLLED VARIABLE		**1**
	-Controlled variable stated	*1*	
	EXPECTED RESULTS		**2**
	- Reasonable	*1*	
	- Link with method	*1*	
	ASSUMPTIONS/PRECAUTIONS/POSSIBLE SOURCES OF ERRORS		**1**
	- Any one stated	*1*	
B.	**ANALYSIS AND INTERPRETATION**		
	METHOD		**1**
	Linked to Proposal, Change of tense		
	RESULTS		**4**
	- Correct formulae and equations: *Accurate (2)* *Acceptable (1)*	*2*	
	- Accuracy of data: *Accurate (2)* *Acceptable (1)*	*2*	
	DISCUSSION		**5**
	- Explanation *Development of points:* *Thorough (2)* *Partial(1)*	*2*	
	- Interpretation *Fully supported by data (2)* *Partially supported by data (1)*	*2*	
	- Trends *Stated*	*1*	

LIMITATIONS		**3**
-Sources of error identified	*1*	
-Precautions stated	*1*	
-Limitation stated	*1*	
REFLECTIONS	*1*	**5**
- Relevance between the experiment and real life (Self, Society or Environment)	*1*	
- Impact of knowledge gain from experiment on self	*1*	
- Justification for any adjustment made during experiment	*2*	
- Communication of information (Use of appropriate scientific language, grammar and clarity of expression all of the time (2); some of the time (1)		
CONCLUSION		**2**
- Stated	*1*	
- Related to the aim	*1*	
TOTAL		**(20)**

(Scale down to 10 marks)

EXEMPLAR 1

PART A-THE PROPOSAL

Observation

Ten year old John observed that after his grandfather planted some bean seedlings, he immediately applied a blue liquid to them which he had carefully measured out into the watering can. He asked his older sibling what was the blue liquid their grandfather applied to the seedlings and why did he measure it.

Hypothesis

Increasing the concentration of fertilizer applied to bean seedlings increases the number of leaves produced in the bean seedlings.

Aim: To determine if increasing the concentration of artificial fertilizer increases the number of leaves produced in the bean seedlings.

Materials: Clean washed sand, distilled water, 5 beakers, red beans, 5 plastic trays of the same dimensions, foil trays, 4 measuring cylinders, a liquid fertilizer.

Method

All apparatus will be cleaned and dried before beginning the experiment.

The four trays will be labelled as follows: no fertilizer, ¾ strength, ½ strength, ¼ strength.

Take the fertilizer and make it up to full strength following the manufacturer's instructions. Make up to one litre. Label this full strength.

Make up dilute solutions of the fertilizer as follows.

Measure out 150 ml of the full strength into a beaker. Using a measuring cylinder measure 50 ml of distilled water and add to the beaker. Label this ¾ strength.

Measure out 100 ml of the full strength into a beaker. Using a measuring cylinder measure 100 ml of distilled water and add to the beaker. Label this ½ strength.

Measure out 50 ml of the full strength into a beaker. Using a measuring cylinder measure 150 ml of distilled water and add to the beaker. Label this ¼ strength.

Fill the trays with the washed dried sand. In each tray plant four (4) beans. Each bean should be planted no more than 1 cm below the surface and should be spaced as far away from each other as the container allows.

Saturate the soils in the tray labelled no fertilizer, by adding measured amounts of distilled water until sand is moist. Add the same volume of distilled water to each of the other trays.

To tray labelled no fertilizer add 15 ml of distilled water. To tray labelled full strength measure out 15 ml

and add to tray labelled full strength. Repeat the procedure for the remaining trays. Repeat the addition of the 15 ml of liquid to the appropriately labelled tray for the next ten days. Ensure that the solution is added the same time each day.

Place trays in a bright, well-ventilated area. Observe the trays each day. Record the day on which the beans germinated. Count the number of leaves on each seedling and record in a table. Observations such as the colour of the leaves and stem and the size of leaves can also be recorded.

Expected results

It is expected that the tray containing the full strength fertilizer would have the greatest number of leaves, followed by the ¾ strength, the ½ strength and the ¼ strength. The tray containing no fertilizer should have the least number of leaves.

PART B- THE IMPLEMENTATION

Introduction

Plants take up water and mineral salts from the soil. The mineral salts are required to ensure proper growth of plants. Nitrates, phosphates, potassium, iron, calcium and sulfate are some of the minerals required and they can be found in artificial fertilizers but must be applied in the amounts required by the plant.

The number of leaves produced by seedlings in a given time, changes in length, mass and surface area can be used to demonstrate growth in plants.

In this experiment the relationship between the quantity of fertilizer added and the growth rate of the seedlings will be explored.

Method

All apparatus was cleaned and dried before beginning the experiment.

The four trays were labelled:
1. no fertilizer;
2. ¾ strength;
3. ½ strength; and
4. ¼ strength.

The fertilizer was collected and made up to full strength following the manufacturer's instructions. 500 ml of solution was made up. This was labelled full strength.

Dilute solutions of the fertilizer were made up as follows:

1. 150 ml of the full strength was measured out and poured into a beaker. Using a measuring cylinder;

2. 50 ml of distilled water was measured out and added to the beaker. This beaker was labelled ¾ strength;

3. 100 ml of the full strength was measured out and poured into a beaker. Using a measuring cylinder 100 ml of distilled water was measured out and added to the beaker. This beaker was labelled ½ strength;

4. 50 ml of the full strength was measured out and poured into a beaker. Using a measuring cylinder 150 ml of distilled water was measured out and added to the beaker. This beaker was labelled ¼ strength.

The trays were filled with the washed dried sand. In each tray four (4) beans were planted. Each bean was planted no more than 1 cm below the surface and were be spaced as far away from each other as the container allowed.

The sand in the tray labelled no fertilizer was saturated with distilled water, by adding measured amounts of distilled water until sand was moist. The same volume of distilled water was added to each of the other trays.

To tray labelled no fertilizer 15 ml of distilled water was added. To tray labelled full strength 15 ml of the full strength solution was measured out and added to tray. The procedure was repeated for the remaining trays.

The addition of the 15 ml of liquid to the appropriately labelled tray was repeated for the next ten days. The solution was added the same time each day.

Trays were placed in bright, well-ventilated area. The tray was observed each day. The day on which the beans germinated was recorded. At the end of ten days the number of leaves on each seedling was counted and recorded in a table. Observations such as the colour of the leaves and stem and the size of leaves were also be recorded.

Results

TABLE SHOWING THE EFFECT OF VARIOUS CONCENTRATIONS OF FERTILIZER ON THE GROWTH OF BEAN SEEDLINGS

Tray	Total number of leaves after 10 days	Additional observations
No fertilizer	18	Leaves were small and yellow. Stems were also yellow and were shortest.
Full strength	45	Leaves were large and dark green. Stems were also green and were the tallest.
¾ strength	33	Leaves were larger than those in the tray with ½ strength fertilizer but smaller than full strength. Stems were greener and taller than those in the tray with ½ strength, ¼ strength and no fertilizer
½ strength	27	Leaves were larger than those in the tray with ¼ strength fertilizer but smaller than ¾ strength. Stems were greener and taller than those in the tray with ¼ strength and no fertilizer.
¼ strength	22	Leaves were larger than those in the tray with no fertilizer but smaller than ½ strength. Stems were greener and taller than those in the tray with no fertilizer

Discussion

Plants need the minerals to provide the elements needed to make constituents such as proteins, DNA, chlorophyll and cellulose. Magnesium is an important part of the chlorophyll molecule, required by the

plant to photosynthesize. In the absence of magnesium and hence, chlorophyll leaves are yellow and smaller. Nitrates are required to make amino acids and proteins and DNA. If it is absent, the plant is stunted and the leaves are fewer in number and smaller.

Other minerals such as phosphates, potassium, iron, calcium and sulfate are also required for making DNA, parts of cell membranes, and enzymes for respiration and photosynthesis. In the absence of these chemicals plant growth is slowed, the numbers of leaves produced and the size of these leaves is lessened.

These chemicals are required in specific amounts and that is why when using artificial fertilizers that they be must be applied in the amounts suggested by the manufacturer. Too much fertilizer can also have a negative effect on the growth of the seedlings but this was not investigated in this experiment.

Therefore, it is clear that increasing the concentration of fertilizer applied to bean seedlings increases the number of leaves produced in the bean seedlings. The seedlings have taller, greener stems, with more leaves which are larger and greener.

Conclusion

Increasing the concentration of fertilizer applied to bean seedlings increases the number of leaves produced in the bean seedlings.

Limitations

Every effort was made to reduce experimental error as much as possible. All conditions were kept constant. However, the following may have contributed to experimental error:

1. Whether all four beans in each tray germinated and continued to grow for the ten days of the experiment;

2. Whether the volumes of fertilizer added each day was enough provide the appropriate amounts of minerals required for growth for the ten days and contained enough water to compensate for the water loss due to evaporation.

Reflections

From this investigation, I have a greater appreciation for the importance of minerals for plant growth. I also recognise the importance of following the manufacturer's instructions. I can now appreciate why farmers add fertilizers to increase the yield of the produce and why fertilizers are heavily used in countries/lands where the soils are not very fertile. I also learnt why the production of fertilizer is a billion dollar industry.

This practical is based on Section B Life Processes and Disease, Nutrition, Specific Objectives 2.5 and Growth Specific Objective 8.1

Please note that the demands of the practical can be adjusted depending on the capabilities of the class and the equipment/apparatus available at the school. Instead of counting the number of leaves students could:

1. measure the height of the four stems daily and calculate the average daily height for the four beans for each tray. A graph of average height against day number could be plotted for each tray on the same graph;

2. tag leaves and measure their surface area each day on square paper. The average surface area of the leaves for the four bean seedlings for each tray can be calculated and a graph plotted;

3. histograms could be plotted instead of line graphs;

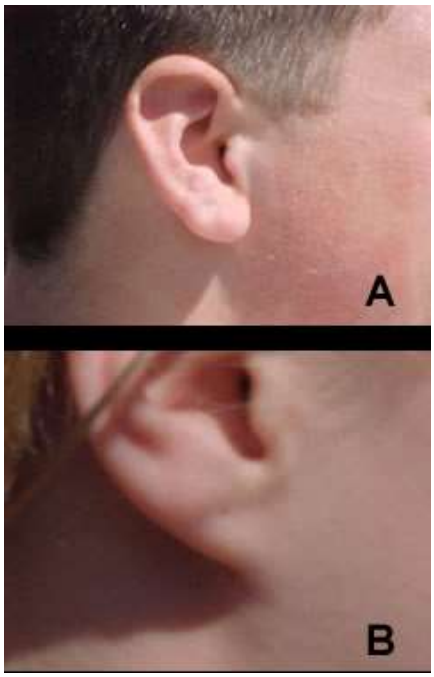
4. germinate more beans using larger trays and calculate the dry mass daily for each tray. A graph can be plotted once again.

EXEMPLAR 2

Part A - THE PROPOSAL

Observation

Mary noticed several similarities and differences among her classmates but was particularly intrigued with the variation in earlobes. Some of her classmates had free hanging earlobes while some had attached earlobes. These observations led her to wonder about the general pattern of inheritance of this trait and how this trait is passed from parents to offspring.



A. Free hanging earlobes

B. Attached earlobes

http://www.windows2universe.org/earth/Life/genetics_puzzle.html

Hypothesis: Students with free hanging earlobes will have both parents with free hanging earlobes, while students with attached earlobes will have both parents with attached earlobes.

Aim: To investigate the pattern of inheritance for free hanging earlobes versus attached earlobes using data from classmates, their siblings and their parents.

Materials: paper; pencil; clip-board.

Method

1. Separate the class into two groups: those with free hanging earlobes and those with attached earlobes.

2. Record the presence or absence of free hanging earlobes versus attached earlobes for yourself, your siblings and your parents.

3. Select five additional classmates at random (if you have free hanging earlobes, select two (2) classmates from the "free hanging earlobes group" and three (3) from the "attached earlobes group". If you have attached earlobes, select two (2) classmates from the "attached earlobes group" and three (3) from the "free hanging earlobes group"). Obtain earlobe information for them as well as their siblings and both of their parents.

4. Record the earlobe information for all six (6) students (include yourself), and their siblings and parents in a table.

5. Analyze the phenotypic information for both groups, assuming that the genes for this characteristic are inherited according to Mendelian genetics. Answer the following questions:

   (a) Did all students with free hanging earlobes have both parents and all siblings with free hanging earlobes?

   (b) Did all students with attached earlobes have both parents and all siblings with attached earlobes?

   (c) Assign genotypes to the parents and use Punnet squares and Mendelian genetics to predict the genotypes of the offspring (students and their siblings). Based on your analysis, are free hanging earlobes a dominant or recessive trait? Why or why not?

Expected Results

It is expected that students with free hanging earlobes will have both parents with free hanging earlobes and all sibling will free hanging earlobes. The same pattern is expected for those students with attached earlobes.

The critical analysis of this study will involve determining the genotype of the students, children and parents based on the phenotypes observed.

PART B- IMPLEMENTATION

Introduction

Genes control the physical appearance of an organism. Genotype represents the hereditary information or exact genetic makeup of an organism for a particular trait. The phenotype is the actual observed property resulting from the expression of those genes as a physical characteristic (For example, free hanging versus attached earlobes). For diploid organisms of which humans are an example, every gene comes in two copies or alternate forms known as alleles, one, which comes from the mother, and one, which comes from the father. The combination of these two alleles is called the genotype and it is this combination that controls our physical characteristics (phenotypes). The common means to express genotypes is to use a capital letter "E" for a dominant allele and a lower case letter "e" to represent a recessive allele.

Some physical traits are considered discrete traits because they are governed by one set of genes. The expression of those traits depends on whether the genotype is homozygous dominant (EE), heterozygous (Ee) or homozygous recessive (ee). In this experiment, the distribution and inheritance of those two discrete traits will be investigated. It will be assumed that only one pair of genes controls the traits free hanging versus attached earlobes and that this gene is inherited according to Mendelian Genetics.

Method

1. The class was separated into two groups: those with free hanging earlobes and those with attached earlobes.

2. The presence or absence of free hanging earlobes versus attached earlobes was recorded for my siblings, my parents and myself.

3. Five additional classmates were selected at random (Given that I have free hanging earlobes, two (2) additional classmates were selected from the “free hanging earlobes” group" and three (3) from the “attached group”. If I had had attached earlobes, 2 additional classmates would have been selected from the “attached group” and three (3) from the “free hanging earlobes group”). Earlobe information for my selected classmates as well as their siblings and both of their parents was collected.

4. The earlobe information for all six (6) students (including myself) and their siblings and parents were recorded in a table.

5. The phenotypic information for both groups was analyzed. The following questions were explored:

   (a) Did all students with free hanging earlobes have both parents and all siblings with free hanging earlobes?

   (b) Did all students with attached earlobes have both parents and all siblings with attached earlobes?

   (c) Assign genotypes to the parents and use Punnett squares and Mendelian genetics to predict the genotypes of the offspring (students and their siblings). Based on your analysis, are free hanging earlobes a dominant or recessive trait? Why or why not?

Results

TABLE 1 -SHOWING EARLOBE INFORMATION FOR THE 6 STUDENTS, THEIR SIBLINGS AND THEIR PARENTS

#	Group 1: Free Hanging	Siblings	Parents	#	Group 2: Attached Earlobe	Siblings	Parents
1.	Michael*	Tyson- *Free*	Mom: *Free* Dad: *Free*	**4.**	Veronica	Ty-*Attached* Mike-*Attached*	Mom: *Attached* Dad: *Attached*
2.	Shawon	Nekisha-*Free* Yohan-*Free*	Mom: *Attached* Dad: *Free*	**5.**	Shantelle	Chris-*Attached* Leonnie-Free	Mom: *Free* Dad: *Free*
3.	Allison	Kevin-*Attached* Jacob-*Attached* Maxine-*Free*	Mom: *Free* Dad: *Attached*	**6.**	Tyson	Tanisha-*Free*	Mom: *Free* Dad: *Attached*

Free- Free hanging earlobes
Attached- Attached earlobes
(*) Represents person conducting the experiment
Note: Not all children with attached earlobes had both parents with attached earlobes, nor did all children with free hanging earlobes have both parents with free hanging earlobes.

TABLE 2 SHOWING COMMENTS BASED ON PHENOTYPE OF PARENTS AND CHILDREN.

#	Student	Comments
1.	Michael	Both of Michael's parents have free hanging earlobes and both children including Michael have free hanging earlobes. This would support free hanging earlobes being a dominant trait. This would support the hypothesis and expected results.
2.	Shawon	Shawon's mom has attached earlobes while her dad has free hanging earlobes. However, all the children have free hanging earlobes. This would suggest that free hanging earlobes are dominant to attached earlobes
3.	Allison	Allison's mom has free hanging earlobes while her father has attached earlobes. However, two of the children have attached earlobes and two of the children have free hanging earlobes. This would indicate that free hanging is dominant but that the parent (mom) with free hanging earlobes would have to be heterozygous (Ee). That is the only way they could have children that are have both free hanging and attached.
4.	Veronica	Veronica's parents both have attached earlobes. Veronica and her two siblings also have attached earlobes. This would support that attached earlobes is recessive and that if both parents have it (ee) then all children will be born homozygous recessive (ee) and have attached earlobes.
5.	Shantelle	Both of Shantelle's parents have free hanging earlobes. However, only one of the three children has free hanging earlobes. Two have attached earlobes. These observations indicate that both parents have to be heterozygous dominant (Ee). This would make it possible that two parents with free hanging earlobes would still be able to have children with free hanging and attached earlobes.
6.	Tyson	Tyson's mom has free hanging earlobes while his dad has attached earlobes. One of the children has free hanging earlobes while the other has attached earlobes. This would indicate that Tyson's mother has to be heterozygous (Ee) and his dad has to be homozygous recessive (ee). That would be the only combination of genotypes that would result in children with attached or free hanging earlobes

PUNNET SQUARES: Based on the observations, we will assume free hanging earlobes to be a dominant trait. Homozygous dominant (AA) as well as heterozygous (Aa) will represent Free Hanging Earlobes; while homozygous recessive (aa) can only represent Attached Earlobes.

1. Possible Genotype of Michael's parents and those of the children.

		DAD: Free	
		E	E
MOM: Free	E	EE	EE
	E	EE	EE

All children would have free hanging earlobes.

2. Possible Genotype of Shawon's parents and those of the children.

		DAD: Free	
		E	E
MOM: Attached	e	Ee	Ee
	e	Ee	Ee

All children would still have free hanging earlobes but their genotype would be heterozygous (Ee). Because free hanging is dominant to attached, having one copy of the "E" would be enough to have children with free hanging earlobes.

3. Possible Genotype of Allison's parents and those of the children.

		DAD: attached	
		e	e
MOM: Free	E	Ee	Ee
	e	ee	ee

Half of the children could have free hanging and half could have attached. The Mendelian ratio would be 1:1.

4. Possible Genotype of Veronica's parents and those of the children.

		DAD: attached	
		e	e
MOM: Attached	e	ee	ee
	e	ee	ee

If both parents are homozygous recessive (ee)/Attached earlobes, then all children would have attached earlobes.

5. Possible Genotype of Shantelle's parents and those of the children.

		DAD: Free	
		E	e
MOM: Free	E	EE	Ee
	e	Ee	ee

If both parents were heterozygous, they would still show free hanging earlobes. However, their children could either display free hanging or attached earlobes. The ratio would be 3:1

6. Possible Genotype of Tyson's parents and those of the children.

		DAD: Attached	
		e	e
MOM:	E	Ee	Ee
	e	ee	ee

If the mom is heterozygous (Ee) and the dad homozygous recessive (ee), then they could have children with free hanging ear lobes or attached earlobes in a ratio of 1:1.

Discussion

Simple dominance is a case where a single dominant allele will mask the expression of a single recessive allele. As such, persons with a physical characteristic only need one parent to show that trait for it to show up in the children. In the case of simple dominance, a person with the dominant trait could either be (EE or Ee) because only 1 of the dominant alleles is necessary to show the trait.

Information on phenotypes of parents can be used to create monohybrid crosses using Punnet squares to determine Mendelian ratios regarding possible expression of traits in offspring. The prediction is simply a matter of listing all the possible combinations of alleles in for a given offspring/child. From these results it will be possible to determine whether free hanging or attached earlobes is a dominant trait.

From the phenotypic data and Punnet square crosses it was clear that our hypothesis was not fully supported. Two parents with free hanging earlobes can still have children with attached earlobes because they could both be heterozygous dominant. A cross between Ee x Ee would result in a 3:1 phenotypic ratio of "Free-Hanging" to "Attached". However, two parents with homozygous dominant genotype EE x EE could only produce children with free hanging earlobes. Two parents with attached earlobes (homozygous recessive alleles) ee x ee could only have children with attached earlobes. Other combinations are also possible, e.g. example, Ee x ee or EE x ee.

Conclusion

"Free Hanging" earlobe is a dominant trait. For a child to have free hanging earlobes, he only needs at least one parent to have free hanging earlobes because the "E" allele masks the "e" allele. For a person to show attached earlobes, he/she would need to get an "e" allele from each parent. Both parents will have to carry the recessive form of the gene, even though both may have 'free hanging' ear lobes

Limitations

Every effort was made to reduce experimental error in this experiment. However, the experiment may be improved by:

1. Including information on grandparents;

2. Also, care must be taken with obtaining accurate information on the phenotype of their siblings and parents, from classmates.

Reflections

From this investigation, I have acquired a better understanding of genetics including genes, alleles, genotype versus phenotype, and Mendelian ratios. I can now appreciate how traits are passed on from one generation to another using information from a simple survey. I now realize that some traits are dominant while others are recessive and that it is our genotype that determines whether a trait will be expressed as a physical characteristic (for example, hair color, freckles, dimples, free hanging versus attached earlobes). This investigation also has applications to the study of genetic diseases, which can also be passed on from parent to offspring. One of the most striking things I learned from this investigation is that both parents can have free hanging earlobes but their child could still be born with attached earlobes. This could apply to cases where parents appear normal but a child is born with a genetic disorder. Overall, this was an interesting practical where I got to apply critical thinking skills to answer questions about heredity.

This practical is based on Section C, Continuity and Variation, Specific Objectives 1.1 and 2.7-2.10.

Note to the teacher: For discrete traits, students don't have to be limited to the ear lobe phenotype. They can use traits including dimples, hairline and, tongue rolling. They can also use data from continuous traits such as height. Also, if the practical is overwhelming with 6 students, it can be done with 4 students.

Safety

Teachers should observe all the following safety precautions before conducting laboratory work:

1. Investigations involving human blood and other fresh human material (for example, cheek cell, saliva) should NOT be conducted;

2. Extreme care should be taken when handling live animals. Wild rodents should not be handled since they pass on disease by biting or through their urine. These diseases include leptospirosis;

3. A fire extinguisher or fire blanket must be readily accessible. Teachers and students should know how to use them. The extinguisher purchased should be appropriate for a biology laboratory;

4. A first-aid kit should be kept in the laboratory and should be checked regularly for *replenishment of supplies;*

5. Corrosive solutions and inflammable solvents (for example, concentrated acids, alcohols) should be clearly labelled as such and handled with great care and should be locked away when not in use.
6. Candidates should know the correct way to light and use a Bunsen burner. Flints rather than matches are safer to use;

7. Electrical equipment and fittings should be regularly checked and serviced. Electrical outlets should be properly labelled (for example, 110v and 220v);

8. A laboratory safety manual *must* be available.

Audio-Visual Aids

The dynamic nature of biology requires the teacher to make use of a variety of resource materials as teaching aids. Audio-visual aids are particularly useful to reinforce and deepen understanding.

Resource materials are available for use with:

1. Film projectors;
2. Slide projectors;
3. Multimedia projectors;
4. CD-ROM and other interactive media.

Cost might prohibit departmental ownership but hardware may be kept in a common pool for use within a school or among a group of schools.

Sources of materials include:

1. Overseas information services, for example, USIS, UNESCO, High Commissions;
2. Tertiary institutions;
3. Government ministries;
4. The media: - television, radio, newspapers;
5. The Internet.

Moderation of School-Based Assessment

The reliability (consistency) of the marks awarded by teachers on the School-Based Assessment is an important characteristic of high quality assessment. To assist in this process, the Council undertakes on-site moderation of the School-Based Assessment, conducted by visiting external Moderators.

During the Term 2 of Year 2, the Moderator will visit. Teachers must make available to the Moderator ***ALL*** *Assessment Sheets (Record of Marks and the report on the Investigation).* ***Teachers are NOT required to submit to CXC samples of candidates' work, unless specifically requested to do so by the Council BUT will be required to submit the candidates' marks electronically.***

The Moderator will remark the skills, and investigation reports for a sample of five candidates, who are selected using the guidelines listed below.

1. Candidates' total marks on the SBA are arranged in descending order (highest to lowest);

2. The candidates scoring the:

(a) highest Total mark;
(b) middle Total mark;
(c) lowest Total mark;
(d) mark midway between the highest and middle Total mark;
(e) mark midway between the middle and lowest Total mark;

are selected to perform some practical skills.

Teachers' marks may be adjusted as a result of the moderation and feedback will be provided by the Moderator to the teachers.

The Moderator may re-mark additional candidates. Where the total number of candidates is five or fewer, the Moderator will remark ALL.

On this visit, the Moderator will also re-mark a sample of the laboratory books of Year 1 candidates, as well as provide assistance and guidance to the teachers of the Year 1 students. A copy of this report must be retained by the teacher, and be made available to the Moderator during the second term of Year 2.

The Moderator will submit the Assessment Sheets, moderation of SBA Sample and the moderation reports to the Local Registrar by April 30 of the year of the examination. A copy of the Assessment Sheets and candidates' work must be retained by the school, until three months after publication, by CXC, of the examination results.

School-Based Assessment Record Sheets are available online via the CXC's website www.cxc.org.

All School-Based Assessment Record of marks must be submitted online using the SBA data capture module of the Online Registration System (ORS). A sample of assignments will be requested by CXC for moderation purposes. These assignments will be re-assessed by CXC Examiners who moderate the School-Based Assessment. Teachers' marks may be adjusted as a result of moderation. The Examiners' comments will be sent to schools. All samples must be delivered to the specified marking venues by the stipulated deadlines.

Copies of the students' assignment that are not submitted must be retained by the school until three months after publication by CXC of the examination results.

Criteria for the Assessment of Each Skill

This syllabus is grounded in the philosophy and methodology of all science disciplines. The teaching strategies that are recommended for its delivery are dictated by the scientist's approach to a task. A problem to be identified will be examined in the light of available evidence and suggestions or hypotheses as to its solution formulated. These will then be tested by repeated practical observations, modified or discarded as necessary, until a hypothesis that does offer a solution is found.

The history of scientific thought shows that new ideas replace old ones that were previously accepted as factual. Students must be made to realise that no solution is final and infallible since modifications are continually made in light of new knowledge and technology.

The following are examples of how to conduct assessments of the *skills listed under Experimental Skills* and Use of Knowledge (Analysis and Interpretation)

TASKS	**ASSESSMENT CRITERIA**
Experimental Skill:	
1. Observation/Recording/Reporting	
Candidates should be able to make observations and record/report them by:	
(a) presenting diagrams of apparatus, models and specimens;	Descriptions, tables or diagrams: Method clearly described, logical sequence of activities, adequate details; tables, diagrams appropriately neat.

TASKS	ASSESSMENT CRITERIA
(b) summarising data, using mean, median and range; by constructing tables, graphs, histograms, maps and pie charts; (c) presenting written reports of investigations. (Candidates are to be encouraged to use all senses or extensions of them, for example, hand lens).	Accuracy of observations/recordings: Significant changes recorded; extent or degree of change recorded; original and final condition compared; condition of control included (if relevant). Format: Aims, apparatus, materials. All present in the correct sequence; correct content under each heading. Language and expression: Correct tense and voice. Few or no grammatical errors.
2. Drawing	
Candidates should be able to: make large, clear, accurate line representations of specimens, with appropriate labeling and annotations.	Clarity: Clean continuous lines of even thickness in pencil with no shading or unnecessary details; reasonable size. Accuracy: Faithfulness of reproduction; structures are typical of specimen; proportions are reasonable. Labeling/Labeling lines: Neat, drawn with a ruler; labeling lines are straight and do not cross one another. There is the inclusion of magnification, view or section where appropriate; there is a title.
3. Manipulation/Measurement	
Candidates should be able to: (a) use basic laboratory equipment with competence and skill, handle selected measuring devices and take accurate readings; (b) prepare biological materials for observation or investigation; (c) handle living things with care.	Extent of facility in using pH paper, thermometer, metre rule, quadrat, measuring cylinder, watch or clock or other timing device, cobalt chloride paper and balances. Correct handling of equipment for collecting specimens.

TASKS	ASSESSMENT CRITERIA
4. Planning/Designing	
Candidates should be able to:	
(a) suggest hypotheses on the basis of observation(s);	Hypotheses should include an identification of the problems on which they are based.
(b) design methods to test their own or other hypotheses.	Inclusion of apparatus and materials to be used; Description of procedures; suggestions of controls where appropriate; Statement of expected results and limitations.
Use of Knowledge:	
5. Analysis and Interpretation	
(a) identify and explain relationships and patterns;	Include labels and annotations of structures.
(b) draw logical conclusions and make predictions from observations and data.	Inclusion of the following: (a) the limitations of the observations and data; (b) the relationship between results and original hypothesis.

Example of Possible SBA Practical for Experimental Skill:

1. Manipulation and Measurement

STEP I - Select an appropriate practical activity, for example:

Investigating osmosis in living tissue (Specific Objective B1.5)

STEP II - Decide what Manipulation and Measurement tasks are appropriate for assessment, for example:

TASKS	**ASSESSMENT CRITERIA**
Experimental Skill:	
Manipulation/Measurement (cont'd)	
Candidates should be able to:	
(a) cut strips of potato each 4cm x 1cm x 1cm;	All peel removed from strips. All four strips of equal dimensions (± 1mm). Edges of strips straight to ensure accurate measurement.
(b) immerse two strips in a dish A containing water and two strips in dish B containing salt solution;	Strips completely immersed in solutions. All strips placed in dishes at the same time.
(c) remove strips after 30 minutes;	Ability to cut strips neatly to given dimensions. Accurate measurement of strips.
(d) dry strips on tissue and measure dimensions.	Handling of apparatus and materials competently.

STEP III - Construct a Mark Scheme based on Assessment Criteria, for example:

Each criterion satisfactorily done (2 marks)

STEP IV - Record Marks

Enter marks in teacher's mark book.

2. Planning and Design

STEP I - Select an appropriate practical activity, for example:

Suggesting an hypothesis and designing an investigation based on the following observation: A farmer notices that the grass is greener in the areas of a field where animals have been tied for grazing.

STEP II - Decide what Planning and Designing skills are appropriate for assessment, for example:

TASKS	ASSESSMENT CRITERIA
Experimental Skill:	
Planning and Design	
Candidates should be able to:	
(a) suggest a suitable hypothesis;	Hypothesis statement relates directly to observation.
(b) state the hypothesis appropriately;	Makes sense (is logical) and testable.
(c) design a suitable investigation to test the hypothesis.	Aim of investigation relates to hypothesis. Materials and apparatus appropriate. Method suitable, includes reasonable control. Attempt made to control other conditions or variables. Size of samples reasonable and procedure repeated for accuracy. Expected results and how they will be interpreted. Limitations noted. Format suitable for planning and design activity.

N.B.: Investigations showing no evidence of planning and design (no observations or hypothesis stated, written in the past tense, and including results and conclusions will not be accepted for SBA.

STEP III - Construct a Mark Scheme based on Assessment Criteria, for example:

Hypothesis acceptable	2 marks
Aim related to hypothesis	1 mark
Materials and apparatus	1 mark
Method suitable	2 marks
Control included	1 mark
Expected result and interpretation stated	1 mark
Limitations noted	1 mark
Suitable format	1 mark

Note different criteria carry different weights. Marks out of a total of less or more than 10 must be converted to the appropriate scale. An acceptable variation of the above mark scheme and how the marks are converted is shown on page 47.

STEP IV - Record marks and enter in teacher's mark book.

N.B.: Practical exercises that may be found in textbooks will not be accepted as Planning and Designing exercises.

Example of Possible SBA Practical for Use of Knowledge:

1. Analysis and Interpretation

STEP I - Select an appropriate practical activity, for example:

Investigate the effect of solutions of different concentrations on carrot tissue (SO. B1.6)

STEP II - Decide what Analysis and Interpretation skills are appropriate for assessment, for example:

TASKS		**ASSESSMENT CRITERIA**
Use of Knowledge:		
Analysis and Interpretation		
Candidates should be able to:		
(a)	establish that there are three strips of carrot of the same dimensions in three (3) different concentrated solutions ;	Background information provided.
(b)	observe the length of the strips after leaving them in the solutions for the same amount of time;	The effect of the different solutions on the strips of carrot.
(c)	discuss the results of the investigation;	Include limitations. Expectations or interpretations.
(d)	draw logical conclusions.	Conclusions based on data. Conclusions related to aim.

STEP III - Construct a Mark Scheme based on Assessment Criteria, for example:

Background information	2 marks
Explanations or interpretation	3 marks
Conclusion	2 marks
Limitations	1 mark
Total	**8 marks**

STEP IV - Record marks

Marks converted to two-point scale.

$$\frac{\text{Students mark}}{8} \times 10$$

Adjusted mark recorded.

Enter marks in teacher's mark book.

Conversion of Marks

Name	Proposed Hypothesis (2)	Suitable method (2)	Reasonable control (1)	Sources of error (1)	Expected results (1)	Logic for inference (2)	Out of 9 marks	Out of 10 marks
V. Allen	2	2	0	0	1	1	6	7
A. Williams	1	1	0	1	1	1	5	6
B. Cuthbert	1	2	1	0	0	0	4	4
J. Moore	2	1	1	1	1	1	7	8
S. Worte	1	1	0	0	1	0	3	3

Conversion from Teacher's Rating Scale to CXC Standard 11-point Scale

V. Allen 6/9 x 10 = 6.67 = 7
A. Williams 5/9 x 10 = 5.56 = 6
B. Cuthbert 4/9 x 10 = 4.44 = 4
J. Moore 7/9 x 10 = 7.78 = 8
S. Worte 3/9 x 10 = 3.33 = 3

Validity and Reliability of Teachers' Marks

The reliability of marks awarded is a significant factor in SBA and has far-reaching implications for the candidate's final grade. Teachers are asked to note the following:

1. the criteria for assessing a skill should be clearly identified. A mark scheme must be submitted with the sample of books sent for moderation. Failure to do this could result in the candidates being unavoidably penalised;

2. the relationship between the SBA marks in the practical workbooks and those submitted to CXC on the SBA forms must be clearly shown. It is important that the marks awarded reflect the degree of mastery of the skills assessed;

3. workbooks should contain all practical work and those exercises used for SBA marks should be clearly identified. At least *ten* exercises should be undertaken;

4. the standard of marking must be consistent, hence the need for a mark scheme;

5. collaboration among teachers especially in the same centre is urged to minimise the discrepancy in the standard of assessment between teachers.

Record Keeping

Each candidate is required to keep a practical workbook containing all practicals done over the two-year period prior to the examination. Those assessed for CXC will be used to determine the standard of marking by the teacher. **A mark scheme must be sent with each set of books.** All practicals should be dated and an index made by the candidates of the practicals done. Those assessed for CXC should be clearly indicated along with the marks awarded for each skill.

Candidates' workbooks should be durable and neatness should be encouraged. The pages should be numbered and all exercises should be dated. The workbook should contain a contents page providing the following information concerning the practicals:

1. page number;
2. date;
3. aim of practical;
4. an indication by an asterisk, of which practicals were assessed for CXC;
5. the skills assessed.

<u>Teachers</u>

An example of the teacher's records follows:

Recording Marks for SBA

TEACHER'S MARK BOOK

SKILLS	OBSERVATION RECORDING/ REPORTING			DRAWING			MANIPULATION/ MEASUREMENT			PLANNING AND DESIGN				ANALYSIS AND INTERPRETATION			TOTAL YR1
NAMES	31/ 11	14 /4	Avg. (10)	2/ 12	23 /2	Avg. (10)	15/ 10	1/ 5	Avg. (10)	15 /1	3/ 3	14/ 5	Avg. (10)	11/ 3	9/ 5	Avg. (10)	50
Allen, Veronica	6	8	7	2	8	5	8	10	9	5	7	8	7	6	7	7	35
Williams, Ann	4	4	4	7	7	7	6	9	8	4	7	7	6	7	9	8	33
Cuthbert, Bryan	5	5	5	3	10	7	9	7	8	6	6	7	6	3	8	6	32
Moore, Jason	9	9	9	2	3	3	0	8	7	8	9	8	8	5	7	6	33
Worte, Stewart	3	6	5	9	0	5	3	5	4	5	8	8	7	4	5	5	26

Note that no special assessment exercises need to be planned. The teachers will, as is customary, be recording periodic "marks" for all students. The difference is that, since these "marks" will now contribute to an assessment external to the school, they need to be more carefully arranged to clearly stated criteria.

CARIBBEAN EXAMINATIONS COUNCIL

SCHOOL BASED ASESSMENT IN BIOLOGY

NAME OF SCHOOL:_____ SCHOOL CODE:_____ YEAR OF FINAL EXAMINATION:_____

NAME OF TEACHER:_____ COUNTRY:

CANDIDATES NUMBERS	CANDIDATES NAMES	YEAR I						YEAR II					GRAND TOTAL 90	REMARKS
		O/R/R	Dr	M/M	A/I	P/D	TOTAL YEAR 1	O/R/R	M/M	A/I	P/D	TOTAL YEAR 2		
		10	10	10	10	10	50	10	10	10	10	40		

TEACHERS'S SIGNATURE:_____ PRINCIPAL'S NAME_____

DATE:_____ PRINCIPAL'S SIGNATURE_____

APPENDIX II

♦ RECOMMENDED MINIMUM EQUIPMENT LIST **(for a class of 25 students)**

Several of the items listed may be produced within the school.

1. 1 Aquarium or glass trough
2. 1 Balance (top pan or triple beam)
3. 25 Beakers 400 cm^3/500 cm3 (graduated)
4. 25 Beakers 250 cm^3 (graduated)
5. 2 Bell jars with bungs
6. 50 Bottles reagent, assorted
7. 3 Buckets, plastic, with covers
8. 15 Burners, Bunsen
9. 1 set Borers, cork
10. Charts and models
    (a) 1 Eye, human
    (b) 1 Skeleton, human
    (c) 1 Skin, human
    (d) 1 System, female reproductive, human
    (e) 1 System, male reproductive, human
11. 100 Coverslips or cover glasses
12. 10 Crucibles with lids
13. 10 Cylinders, measuring, assorted
14. 1 Desiccator
15. 5 Dishes, evaporating, porcelain
16. 25 Dishes, Petri
17. 10 Flasks, conical 250 ml
18. 10 Funnels, filter (assorted)
19. 25 pairs of Forceps
20. 25 Holders, test tube
21. 2 Jars, gas with cover plates
22. 25 Jars, gas with screw-top lids
23. 12 Knives or scalpels
24. 25 Lenses, hand
25. 1 Microscope, dissecting
26. Microscope, light. Magnification x 40 objective, x 10 eyepiece
27. 15 Mirrors, plane
28. Nets for collecting specimens
29. 1 Oven, access to
30. 5 Pooters with spare specimen tubes (not ready made)
31. 2 Potometers (not ready made)
32. 1 Pump, filter
33. Quadrats, assorted
34. Racks, test tube
35. 1 Box Razor Blades, single-edged
36. 1 Refrigerator, small
37. 5 Rules, metre
38. 1 Pair Scissors
39. 1 Pair Secateurs
40. 2 Shelves, beehive
41. 12 Slides, cavity
42. 1 Box Slides, microscope
43. 10 Stands, retort with 20 clamps
44. 15 Stands, tripod
45. 5 Stop Clocks
46. Stoppers or bungs, assorted cork, rubber
47. 2 Tapes, measuring (30 metres)
48. 15 Thermometers, -100 to 110^{O}C (Spirit)
49. 10 pairs of Tongs, crucible
50. 5 Triangles, pipe-clay
51. 2 Troughs, pneumatic, glass
52. 25 Tubes, boiling
53. Tubing, glass, assorted
54. Tubes, test, assorted
55. 2 Tubes, Y-piece connector
56. Tubing, capillary, select lengths
57. Tubing, rubber, normal and heavy wall
58. 15 Wire Gauzes, with insulated centers

♦ RECOMMENDED MATERIAL LIST **(for a class of 25 students for 2 years)**

1. 2½L Alcohol or ethanol
2. Bags, plastic
3. Balloons
4. Bands, rubber, assorted sizes
5. 500 cm^3 Benedict's solution
6. 500g Calcium Hydroxide
7. Cobalt Chloride paper
8. 250g Copper II Sulphate
9. 250 ml Methylene blue solution 1%
9. 2½L Hydrochloric acid (conc.)
10. Indicator, Universal pH paper
11. 250 ml Indicator, Universal pH, solution
12. 250 ml Iodine in potassium iodide (KI) solution
13. Litmus paper, neutral
14. Masking tape
15. Paper, absorbent or cotton wool
16. Paper, filter
17. Plasticine
19. 50 Pipettes, teat (droppers)
18. 1kg Sodium Chloride (table salt)
19. 250g Sodium Hydrogen Carbonate
20. 100g Sodium Hydroxide (pellets)
21. 2½L Spirits, methylated
22. 1 roll Tubing, Dialysis or Visking
23. 1 bottle Vaseline
24. Slides, prepared
    (a) 6 Leaf, T.S.
    (b) 6 Root tip, L.S.
    (c) 6 Dicot Stem, T.S.
    (d) 6 Dicot root, T.S.
    (e) 6 Human blood smear
    (f) 6 Onion tips
    (g) 6 Xylem, T.S.
    (h) 6 Phoem, L.S.
    (i) 6 Frog Blood Smear
25. Skeleton
    (a) 1 Skeleton, mammalian, complete
    (b) Vertebrae
    (c) Girdles
    (d) Long bone
    (e) Skulls
    (f) Teeth

APPENDIX IV

♦ RESOURCE MATERIALS

Texts

Atwaroo-Ali, L.	*CXC Biology*, Oxford: Macmillan Caribbean, 2003.
Bradfield, P. and Potter, S.	*Longman Biology for CSEC*, 2nd edition, England: Pearson Education Limited, 2008.
Kirby, P., Madhosingh, L. and Morrison, K.	*Biology for CSEC*, United Kingdom: Nelson Thornes, 2008.

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Caribbean Environmental Outlook Report
http://hqweb.unep.org/geo/pdfs/Caribbean_EO_final.pdf.

Understanding Evolution – University of California, Berkeley
http://evolution.berkeley.edu/

National Evolutionary Synthesis Center (NESCENT)
http://www.nescent.org/eog/archivednews.php

Biological Sciences Curriculum Study (BSCS)
http://www.bscs.org/curriculumdevelopment/highschool/evolution/

♦ GLOSSARY

WORD/TERM	DEFINITION/MEANING	NOTES
account for	Present reason for action or event	UK
annotate	add a brief note to a label	Simple phrase or a few words only. KC
apply	use knowledge of principles to solve problems	Make inferences and conclusions; UK
assess	present reasons for the importance of particular structures, relationships or process	Compare the advantages and disadvantages or the merits and demerits of a particular structure, relationship or process; UK
calculate	arrive at the solution to a numerical problem	steps should be shown; units must be included; UK
classify	divide into groups according to observable characteristics	UK
comment	state opinion or view with supporting reasons	UK
compare	state similarities and differences	An explanation of the significance of each similarity and difference stated may be required for comparisons which are other than structural; UK/KC
construct	use a specific format to make and draw a graph, histogram, pie chart or other representation using data or material provided or drawn from practical investigations, build (for example, a model), draw scale diagram	Such representations should normally bear a title, appropriate headings and legend; UK, XS
deduce	make a logical connection between two or more pieces of information; use data to arrive at a conclusion	UK
define	state concisely the meaning of a word or term	This should include the defining equation or formula where relevant; KC
demonstrate	show; direct attention to...	KC

WORD/TERM	DEFINITION/MEANING	NOTES
describe	provide detailed factual information of the appearance or arrangement of a specific structure or a sequence of a specific process	Description may be in words, drawings or diagrams or any appropriate combination. Drawings or diagrams should be annotated to show appropriate detail where necessary; KC
determine	find the value of a physical quantity	UK
design	plan and present with appropriate practical detail	Where hypotheses are stated or when tests are to be conducted, possible outcomes should be clearly stated and/or the way in which data will be analyzed and presented; XS
develop	expand or elaborate an idea or argument with supporting reasons	KC/UK
diagram	simplified representation showing the relationship between components.	KC/UK
differentiate	state or explain briefly those differences between or among items which can be used to define the items or place them into separate categories.	UK
discuss	present reasoned argument; consider points both for and against; explain the relative merits of a case	UK
draw	make a line representation from specimens or apparatus which shows an accurate relation between the parts	In the case of drawings from specimens, the magnification must always be stated; KC/XS
estimate	make an approximate quantitative judgement	
evaluate	weigh evidence and make judgements based on given criteria	The use of logical supporting reasons for a particular point of view is more important than the view held; usually both sides of an argument should be considered; UK
explain	give reasons based on recall; account for	KC/UK

WORD/TERM	DEFINITION/MEANING	NOTES
find	locate a feature or obtain as from a graph	UK
formulate	devise a hypothesis	XS
identify	name or point out specific components or features	KC
illustrate	show clearly by using appropriate examples or diagrams, sketches	KC/UK
investigate	use simple systematic procedures to observe, record data and draw logical conclusions	XS
label	add names to identify structures or parts indicated by pointers	KC
list	itemise without detail	KC
measure	take accurate quantitative readings using appropriate instruments	XS
name	give only the name of	No additional information is required; KC
note	write down observations	XS
observe	pay attention to details which characterise a specimen, reaction or change taking place; to examine and note scientifically	Observations may involve all the senses and/or extensions of them but would normally exclude the sense of taste; XS
outline	Give basic steps only	XS
plan	prepare to conduct an investigation	XS
predict	use information provided to arrive at a likely conclusion or suggest a possible outcome	UK
record	write an accurate description of the full range of observations made during a given procedure	This includes the values for any variable being investigated; where appropriate, recorded data may be depicted in graphs, histograms or tables; XS

WORD/TERM	DEFINITION/MEANING	NOTES
relate	show connections between; explain how one set of facts or data depend on others or are determined by them	UK
sketch	make a simple freehand diagram showing relevant proportions and any important details	KC
state	provide factual information in concise terms outlining explanations	KC
suggest	offer an explanation deduced from information provided or previous knowledge. (... a hypothesis; provide a generalisation which offers a likely explanation for a set of data or observations.)	No correct or incorrect solution is presumed but suggestions must be acceptable within the limits of scientific knowledge; UK
test	to find out, following set procedures	XS

KEY TO ABBREVIATIONS

KC - Knowledge and Comprehension
UK - Use of Knowledge
XS - Experimental Skills

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