



CARIBBEAN EXAMINATIONS COUNCIL

CAPE[®] Biology

**SYLLABUS
SPECIMEN PAPER
MARK SCHEME
SUBJECT REPORTS**

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CAPE® Biology Free Resources

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Biology

Biology is the scientific study of living organisms. The study of this subject leads to an understanding and appreciation of the concepts of life at all levels and hence to a greater respect and reverence for life. The interconnected web of life and the unique role of the human species are integral to the dynamic value of the biosphere. The CAPE Biology Syllabus prepares students to acquire knowledge about how to protect, sustain, conserve and improve the variety of life in the ecosphere. It also provides a foundation for persons wishing to pursue careers in biological, environmental, agricultural, medical, paramedical and applied science.

Unit 1: Biomolecules, Reproduction and Development

- Module 1 Cell and Molecular Biology
- Module 2 Genetics, Variation and Natural Selection
- Module 3 Reproductive Biology

Unit 2: Bioenergetics, Biosystems and Applications

- Module 1 Bioenergetics and Conservation
- Module 2 Biosystems Maintenance
- Module 3 Applications of Biology



CARIBBEAN
EXAMINATIONS
COUNCIL

Caribbean Advanced
Proficiency Examination®

SYLLABUS

BIOLOGY

CXC A10/U2/17

Effective for examinations from May–June 2019



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CAPE[®]

CXC A10/U2/17

Introduction

The Caribbean Advanced Proficiency Examination® (**CAPE**®) is designed to provide certification of the academic, vocational and technical achievement of students in the Caribbean who, having completed a minimum of five years of secondary education, wish to further their studies. The examinations address the skills and knowledge acquired by students under a flexible and articulated system where subjects are organised in 1-Unit or 2-Unit courses with each Unit containing three Modules. Subjects examined under **CAPE**® may be studied concurrently or singly.

The Caribbean Examinations Council offers three types of certification at the **CAPE**® level. The first is the award of a certificate showing each **CAPE**® Unit completed. The second is the **CAPE**® Diploma, awarded to candidates who have satisfactorily completed at least six Units, including Caribbean Studies. The third is the **CXC**® Associate Degree, awarded for the satisfactory completion of a prescribed cluster of eight **CAPE**® Units including Caribbean Studies, Communication Studies and Integrated Mathematics. Integrated Mathematics is not a requirement for the **CXC**® Associate Degree in Mathematics. The complete list of Associate Degrees may be found in the **CXC**® Associate Degree Handbook.

For the **CAPE**® Diploma and the **CXC**® Associate Degree, candidates must complete the cluster of required Units within a maximum period of five years. To be eligible for a **CXC**® Associate Degree, the educational institution presenting the candidates for the award, must select the Associate Degree of choice at the time of registration at the sitting (year) the candidates are expected to qualify for the award. Candidates will not be awarded an Associate Degree for which they were not registered.



Biology Syllabus

◆ RATIONALE

Science plays a major role in the evolution of knowledge. It empowers us to use creative and independent approaches to problem-solving. It arouses our natural curiosity and enables us to meet diverse and ever expanding challenges. It enhances our ability to inquire, seek answers, research, and interpret data. These skills *use the scientific method which* lead to the construction of theories and laws that help us to explain natural phenomena and exercise control over our environment. Science is, thus, an integral component of a balanced education.

The life sciences involve the study of living organisms and their life processes. Biology is at the core of the life sciences and allows for the examination, investigation and recording of the diverse forms of life. The study of Biology leads to an understanding and appreciation of the concept of life at all levels and hence, to a greater respect and reverence for life. The interconnected web of life and the unique role of the human species are integral to the dynamic nature of the biosphere. Students of Biology should recognise the enormous responsibility which must be undertaken to ensure the continuity of life in all its forms. It is incumbent that student use this knowledge to protect, sustain, manage, conserve and improve the variety of life in the ecosphere. Additionally, the study of Biology prepares students for careers in biological, agricultural, environmental, medical, paramedical and applied sciences.

The CAPE® 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, teamwork, problem-solving, critical thinking, innovation, and communication. It encourages the use of various student-centred teaching-learning strategies to inculcate the knowledge and competencies 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.

The most important natural resource in the Caribbean is its people. If the Caribbean is to play an important role in the new global village and survive economically, a sustained development of the scientific and technological resources of its people is essential. 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; demonstration of 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, on completion of the study of this course, students will learn to do, learn to be and learn to transform themselves and society.



◆ AIMS

The syllabus aims to:

1. enable students to acquire a body of knowledge and develop an understanding of biological concepts and principles;
2. promote an understanding of how new information can contribute to the reformulation or rejection of earlier models and concepts;
3. recognise the scope of Biology at all levels from the molecular level to that of body systems and entire ecosystems;
4. facilitate the development of the ability to communicate scientific information in a logical and structured manner;
5. develop an understanding of the scientific method and the ability to apply it to solving problems, both in academic and non-academic settings;
6. *assist in the development of critical thinking, analytical, and practical skills;*
7. encourage students to appreciate the impact of biological knowledge on society and its relevance to ethical, economic, environmental and technological issues;
8. develop the ability to apply biological knowledge and skills to relevant Caribbean situations and issues;
9. develop the ability to work independently and collaboratively with others;
10. promote an appreciation of the significance and limitations of science in relation to social and economic development; and,
11. promote the integration of Information Communication and Technology (ICT) tools and skills.

◆ SKILLS AND ABILITIES TO BE ASSESSED

The skills students are expected to develop on completion of this syllabus, have been grouped under three main headings:

1. Knowledge and Comprehension;
2. Use of Knowledge; and,
3. Experimental Skills.

1. Knowledge and Comprehension (KC)

- (a) Knowledge – the ability to identify, remember and grasp the meaning of basic facts, concepts and principles.



(b) Comprehension

The ability to:

- (i) select appropriate ideas, match, compare and cite examples of facts, concepts and principles in familiar situations; and,
- (ii) explain familiar phenomena in terms of theories, models, laws and principles.

2. Use of Knowledge (UK)

(a) Application

The ability to:

- (i) use facts, concepts, principles and procedures in unfamiliar situations;
- (ii) transform data accurately and appropriately;
- (iii) use common characteristics as a basis for classification; and,
- (iv) use formulae accurately for computations.

(b) Analysis and Interpretation

The ability to:

- (i) identify and recognise the component parts of a whole and interpret the relationships between those parts;
- (ii) identify causal factors and show how they interact with each other;
- (iii) infer, predict and draw conclusions; and,
- (iv) make necessary and accurate calculations and recognise the limitations and assumptions of data.

(c) Synthesis

The ability to:

- (i) combine component parts to form a new meaningful whole; and,
- (ii) make predictions and solve problems.

(d) Evaluation – the ability to make reasoned judgements and recommendations based on the value of ideas and information and their implications.

3. Experimental Skills (XS)

(a) Observation, Recording and Reporting

The ability to:

- (i) make accurate observations and minimise experimental errors;
- (ii) recognise, identify and interpret biological materials both microscopically and macroscopically;
- (iii) record observations, measurements, methods and techniques with due regard for precision, accuracy and units;
- (iv) record and report unexpected results;
- (v) select and use appropriate modes of recording data or observations, for example, graphs, tables, diagrams and drawings;
- (vi) present data in an appropriate manner, using the accepted convention of recording errors and uncertainties;
- (vii) 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; and,
- (viii) report accurately and concisely using scientific terminology and conventions as necessary.

(b) Manipulation and Measurement

The ability to:

- (i) follow a detailed set or sequence of instructions;
- (ii) make measurements with due regard for precision and accuracy;
- (iii) handle chemicals and living organisms with care;
- (iv) cut, stain and mount sections and make temporary mounts;
- (v) set up light microscope for optimum use both under low power and high power;
- (vi) use the stage micrometer and eyepiece graticule for accurate measuring; and,
- (vii) assemble and use simple apparatus and measuring instruments.

(c) Drawing

The ability to:

- (i) make clear, accurate line representations of specimens, with no shading or unnecessary details;
- (ii) produce *illustrations* with clean continuous lines of even thickness;
- (iii) label *illustrations* accurately and use label lines which do not cross each other or carry arrowheads or dots;
- (iv) annotate *illustrations* appropriately and accurately;
- (v) make illustrations which are large enough to display specific details; and,
- (vi) calculate the magnification of the *illustrations*.

Note: A drawing is used to illustrate a three-dimensional representation of a specimen whereas a diagram illustrates the surface view of a section cut through the specimen.

(d) Planning and Designing

The ability to:

- (i) identify problems, make predictions, develop hypotheses and devise means of carrying out investigations to test the hypotheses;
- (ii) plan and execute experimental procedures and operations in an appropriate sequence;
- (iii) use experimental controls where appropriate;
- (iv) modify an original plan or sequence of operations as a result of difficulties encountered in carrying out experiments or obtaining unexpected results;
- (v) take into account possible sources of errors and danger in the design of an experiment; and,
- (vi) select and use appropriate equipment and techniques.

Planning and Designing skills may be assessed through the use of fieldwork.

◆ PREREQUISITES OF THE SYLLABUS

Any person with a good grasp of the Caribbean Secondary Education Certificate (CSEC®) Biology and Chemistry syllabuses, or the equivalent, should be able to pursue the course of study defined by this syllabus. However, successful participation in the course of study will also depend on the possession of good verbal and written communication skills.



◆ STRUCTURE OF THE SYLLABUS

The subject is organised in two Units. A Unit comprises three Modules each requiring 50 hours. The total time for each Unit, is therefore, expected to be 150 hours. Each Unit can independently offer students a comprehensive programme of study with appropriate balance between depth and coverage to provide a basis for further study in this field.

Unit 1: Biomolecules, Reproduction and Development

Module 1	-	Cell and Molecular Biology
Module 2	-	Genetics, Variation and Natural Selection
Module 3	-	Reproductive Biology

Unit 2: Bioenergetics, Biosystems and Applications

Module 1	-	Bioenergetics and Conservation
Module 2	-	Biosystems Maintenance
Module 3	-	Applications of Biology

It is recommended that of the approximately 50 hours suggested for each Module, a minimum of 20 hours be spent on laboratory-related activities, such as conducting experiments, making field trips and viewing audio-visual materials.

◆ SUGGESTIONS FOR TEACHING THE SYLLABUS

The organisation of each module 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 the senses in learning as this will help students view science as a dynamic and exciting investigative process. Although the units are presented in a sequential manner, teachers are encouraged to utilise a thematic approach in the implementation of the syllabus.

The general and specific objectives indicate the scope of the content and include suggested practical activities that should be covered. Explanatory notes are provided to the right of some specific objectives. These notes provide further guidance to teachers as to the level of detail required. Suggested *Practical Activities* indicate those areas of the syllabus that are suitable for practical work. However, practical work should not necessarily be limited to these suggested activities, since 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. 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 platforms to aid investigation and teamwork. The need for repeated investigation and observation to arrive at meaningful conclusions should be emphasised.

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. Opportunities should



be provided for relating biological studies to the environment and to use an ecological approach whenever pertinent. Biological principles should be illustrated by specific local and regional examples. The use of scientific names to identify organisms is preferable.

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/drawings.

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

◆ 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 analysing and interpreting data. The **CAPE®** 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) state expected results (*format of table expected*);
- (ix) use of results; and,
- (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 (25-100cm³);
 - (v) beaker (50-500cm³);
 - (vi) thermometer;
 - (vii) ruler;
 - (viii) stop watch/clock;
 - (ix) balance;
 - (x) boiling tube;
 - (xi) test tubes and test tube holders;
 - (xii) hand lens; and,
 - (xiii) syringe.
- (b) Student's ability to take accurate measurements.
- (c) Student's ability to use appropriate units.

3. Observation, Reporting and Recording (ORR)

- (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)
Numerical: physical quantities in heading, units stated in heading, symbols, decimal points.
Non-numerical: 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: Recording).
- (vi) **Discussion**
- (vii) **Conclusion** (*should be related to the Aim*).

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;
- (d) make a conclusion to either support or refute the hypothesis;
- (e) compare actual results with expected results based on background/theoretical knowledge if they are different;
- (f) suggest alternative methods or modification to existing methods; and,
- (g) analyse and interpret results and observations and making conclusions.

5. Drawing (Dr)

The following guidelines should be used for drawing:

- (a) The *illustrations* should be placed in a position on the page which will allow for neat and clear labelling.
- (b) If the *illustration* is included in the written material, it should be placed just before this material and should be referred to in your answer.
- (c) *Illustrations* should be done in pencil. The use of coloured pencils is not acceptable.
- (d) The *illustration* should be large enough so that all structures can be clearly drawn.
- (e) The *illustration* 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 *illustrations* where only a few structures are being labelled, all labels should be written on the right of the drawing.
- (l) Biological *illustrations* must have a full title and magnification. This is usually written below the drawn item and underlined. The title tells the name of the structure or organism and the view from which the *illustration* was made.

Note: A diagram should clearly indicate the following:

- *tissues present;*
- *the position of the tissues in the organ relative to each other; and,*
- *the proportion of the tissues relative to each other in the section.*

◆ **UNIT 1: BIOMOLECULES, REPRODUCTION AND DEVELOPMENT**
MODULE 1: CELL AND MOLECULAR BIOLOGY

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the chemical structure of water, carbohydrates, lipids and proteins and their roles in living organisms;
2. understand that cells are the basic units of living organisms, grouped into tissues and organs;
3. relate cell organelles to their functions;
4. understand the Fluid Mosaic Membrane model and the movement of substances into and out of cells; and,
5. understand the mode of action of enzymes.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

1. Aspects of Biochemistry

Students should be able to:

- | | | | |
|------|---|---|---|
| 1.1. | discuss how the structure and properties of water relate to the role that water plays as a medium of life; | Water as a most suitable solvent in relation to its essential roles in transport: cellular and systemic levels. | <i>Compare solubility of substances in liquids of different polarities.</i> |
| 1.2. | <i>discuss that macromolecules are polymers made up of their individual monomers and formation and breakage of bonds;</i> | | |
| 1.3. | explain the relationship between the structure and function of glucose; | Exact molecular ring structure in full. <i>Distinguish between the structures of alpha and beta glucose.</i> | |
| 1.4. | explain the relationship between the structure and function of sucrose; | Exact molecular ring structure in full. | |

UNIT 1

MODULE 1: CELL AND MOLECULAR BIOLOGY (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Aspects of Biochemistry (cont'd)

Students should be able to:

- | | | | |
|-------|---|--|---|
| 1.5. | discuss how the molecular structure of starch, glycogen and cellulose relate to their functions in living organisms; | Molecular structure: types of bonds; chain and ring structure where appropriate; 3D nature; hydrolysis and condensation reactions; relate structure to properties. | |
| 1.6. | describe the molecular structure of a triglyceride and its role as a source of energy; | Without going into detail, the student should be made aware of the relationship between triglycerides and obesity. | |
| 1.7. | describe the structure of phospholipids and their role in membrane structure and function; | Relate structure to properties and hence to function. | |
| 1.8. | describe the generalised structure of an amino acid, and the formation and breakage of a peptide bond; | | |
| 1.9. | <i>carry out tests for reducing and non-reducing sugars, starch, lipids and proteins;</i> | <i>Benedict's test, KI/I₂ test, emulsion test, Biuret test.</i> | <i>Investigate and compare quantitatively reducing sugars and starch.</i> |
| 1.10. | compare the different levels of protein structures; and, | Primary, secondary, tertiary and quaternary. | |
| 1.11. | outline the molecular structure of haemoglobin, as an example of a globular protein, and of collagen, as an example of a fibrous protein. | Ensure that the relationships between their structures and functions are clearly established. | |



UNIT 1

MODULE 1: CELL AND MOLECULAR BIOLOGY (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
2. Cell Structure and Functions		
Students should be able to:		
2.1. compare the structures and functions of typical animal and plant cells as seen under the light and electron microscope;	Differences between electron and light microscope and between resolution and magnification. Rough and smooth endoplasmic reticulum, Golgi body, mitochondria, ribosomes, lysosomes, chloroplasts, cell membrane, nuclear envelope, centrioles, nucleus and nucleolus.	Clear <i>diagrams</i> required. Describe and interpret <i>diagrams</i> and electron micrographs of the structure of membrane systems and organelles of typical animal and plant cells.
2.2. describe the structure of a prokaryotic cell;		<i>Electron micrograph of prokaryotic cell.</i>
2.3. compare the structure of prokaryotic cells with that of eukaryotic cells; and,	The basis of the endosymbiotic development of eukaryotic cells. <i>Can mention plants, animals, fungi and protista.</i>	
2.4. explain the concepts of tissue and organ using the dicotyledonous root and stem.	Use of transverse section of a dicotyledonous root and stem to illustrate tissues including parenchyma, xylem and phloem. The root is used as an organ.	Make plan and <i>detailed diagrams</i> to show the distribution of tissues within an organ of the dicotyledonous root and stem. The use of live specimen is encouraged, for example, <i>Coleus</i> .

UNIT 1

MODULE 1: CELL AND MOLECULAR BIOLOGY (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
3. Membrane Structure and Function		
Students should be able to:		
3.1. explain the Fluid Mosaic Membrane model of biological membrane structure; and,	The roles of phospholipids, cholesterol, glycolipids, protein and glycoproteins. Diagrams are required.	
3.2. explain the processes of diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis.	Emphasis on the distinction between diffusion and osmosis; and active and passive processes. Diagrams are required. No calculations will be set on water potential.	Investigate the effects on plant cells immersion into solutions of different water potentials, <i>for example, red onion epidermal cells.</i>
4. Enzymes		
Students should be able to:		
4.1. explain that enzymes are globular proteins that catalyse metabolic reactions;	Definition of metabolism, anabolism and catabolism required.	
4.2. explain the mode of action of enzymes in terms of an active site, enzyme and/or substrate complex, lowering of activation energy and enzyme specificity;	Properties of enzymes. <i>Lock and key hypothesis, and</i> Induced-fit hypothesis.	



UNIT 1

MODULE 1: CELL AND MOLECULAR BIOLOGY (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
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Enzymes (cont'd)

Students should be able to:

- | | | | |
|------|--|--|---|
| 4.3. | explain the effects of pH, temperature, enzyme concentration, and substrate concentration on enzyme action; and, | Construction and interpretation of graphs. | Investigate the effects of temperature and substrate concentration on enzyme-catalysed reactions, and explain these effects. <i>For example, use yeast and respiration. Use of virtual labs (see link below).</i> |
| 4.4. | discuss the effects of competitive and non-competitive inhibitors on enzyme activity. | Use of succinic dehydrogenase, <i>antabuse</i> and <i>organophosphates</i> as examples of enzyme inhibitors. | |

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. Allow students to use laboratory exercises to reinforce concepts taught rather than as a separate activity.
2. Encourage students to incorporate the use of online resources, such as videos, to visualise concepts.
2. Allow students to use multimedia and 3-dimensional models to assist in conceptualising cell and/or molecular structure.
3. *Allow students to view models of macromolecules using the molecular visualisation software.*
4. *Allow students to use virtual labs to illustrate enzymatic activity.*

UNIT 1

MODULE 1: CELL AND MOLECULAR BIOLOGY (cont'd)

RESOURCES

- Boyle, M., Senior, K. *Biology*. London: Harper Collins Publishers, 2008.
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- Clegg, C J *Biology*. London: Hodder Education, 2014.
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- Ramesar, M., Jones, M., Jones, G. *Biology Unit 1*. London: Cambridge University Press, 2011.

WEBSITES

Biology Mad: www.biologymad.com/

Xtreme Papers: www.xtremepapers.com/

http://glencoe.mheducation.com/sites/dl/free/0078802849/383930/BL_11.html virtual lab - investigating the effect of pH and substrate concentration on enzyme activity

<http://www.biotopics.co.uk/jsmol/glucose.html>

UNIT 1

MODULE 2: GENETICS, VARIATION AND NATURAL SELECTION

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the structure of nucleic acids and their roles in protein synthesis and nuclear division;
2. understand the behaviour of chromosomes, nucleus and cytoplasm in mitotic and meiotic cell division and their importance for stability and variation in a species;
3. understand the patterns of inheritance;
4. understand selected aspects of genetic engineering and its medical, agricultural, environmental, ethical and social implications; and,
5. understand the genetic basis of variation and its importance in natural selection.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

1. Structure and Roles of Nucleic Acids

Students should be able to:

- | | | |
|------|---|---|
| 1.1. | compare the structure of RNA and DNA; | Draw a nucleotide using shapes; recognise (not draw) the structural formulae of nucleotides, ribose, deoxyribose, pyrimidines, purines; nature of hydrogen bonds. |
| 1.2. | explain the importance of hydrogen bonds and base pairing in DNA replication; | Recognition of the significance of 5' and 3'; semiconservative replication; genetic code. |
| 1.3. | describe the roles of DNA and RNA in protein synthesis; | Different types of RNA (tRNA, rRNA and mRNA) and their respective roles. Initiation, transcription, translation, termination. |

UNIT 1

MODULE 2: GENETICS, VARIATION AND NATURAL SELECTION (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
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Structure and Roles of Nucleic Acids (cont'd)

Students should be able to:

- 1.4. explain the relationship between the sequence of nucleotides and the amino acid sequence in a polypeptide; and,
- 1.5. explain the relationship between the structure of DNA, protein structure and the phenotype of an organism.

2. Cell Division and Variation

Students should be able to:

- 2.1. describe the relationship among DNA, chromatin, and chromosomes;
- 2.2. describe with the aid of diagrams, the stages of mitotic cell division;
- 2.3. explain the importance of DNA replication for maintaining genetic stability;
- 2.4. discuss the role and importance of mitosis in growth, repair and asexual reproduction;

Inclusion of interphase.

Observe the stages in the cell cycle and make annotated *diagrams* from prepared slides, and/or a freshly prepared *squashed* root tip to show the stages of mitosis.

UNIT 1

MODULE 2: GENETICS, VARIATION AND NATURAL SELECTION (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
Cell Division and Variation (cont'd)		
Students should be able to:		
2.5. describe with the aid of diagrams, the processes involved in meiotic cell division;	Students should be familiar with the terms: homologous chromosomes, haploid and diploid. Inclusion of crossing over, alignment of chromosomes at metaphase, random segregation at anaphase. Names of the intermediate stages of meiosis not required.	Construct models to demonstrate chromosome behaviour in meiosis. Pipe cleaners, plastic wire, embroidery thread, Bristol board may be used for modelling chromosome behaviour in meiosis – biodegradable materials not recommended.
2.6. discuss how meiosis contributes to heritable variation;	Comparison with the process of mitosis.	Use prepared slides of testes <i>and/or anther</i> to demonstrate the stages of meiosis.
2.7. explain why sexually produced organisms vary in characteristics;		
2.8. describe gene and chromosome mutations;	Include the types of gene and chromosome mutations.	
2.9. discuss the implications of changes in DNA nucleotide sequence for cell structure and function in sickle cell anaemia;		
2.10. explain how mutation brings about genetic variation; and,	Not limited to: sickle-cell anaemia, cystic fibrosis, PKU and Down Syndrome.	
2.11. explain why heritable variation is important to selection.		



UNIT 1

MODULE 2: GENETICS, VARIATION AND NATURAL SELECTION (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
3. Patterns of Inheritance		
Students should be able to:		
3.1. use genetic diagrams to solve problems involving monohybrid and dihybrid crosses;	Gene, allele, dominant, recessive, codominant, homozygous, heterozygous, sex linkages, codominance, multiple alleles, and dominant epistasis. Candidates should understand the ratios.	Analyse seed samples of peas for Mendelian dihybrid ratio.
3.2. analyse the results of a genetic cross by applying the Chi-square test; and,	Formulae will be given. Set out data in tabular form.	
3.3. determine whether the difference between the observed and expected ratio is significant using the results of the Chi-square test.	The concept of probability. Explanation of the use of 0.05 confidence limits and the null hypothesis.	
4. Aspects of Genetic Engineering		
Students should be able to:		
4.1. outline the principles of restriction enzyme use to “cut” sections of DNA and ligase enzyme to “paste” DNA together;	Restriction enzymes as “molecular scissors” and ligase enzyme as “molecular glue”. Importance of these classes of enzymes in development of R-DNA technology. <i>Mention advanced genome editing tools, such as CRISPR-Cas9.</i>	

UNIT 1

MODULE 2: GENETICS, VARIATION AND NATURAL SELECTION (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
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Aspects of Genetic Engineering (cont'd)

Students should be able to:

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|------|--|---|
| 4.2. | explain the basic steps involved in recombinant DNA (rDNA) technology; | <i>An overview of the process including the isolation of genes; cloning of genes; vectors. Use examples including insulin production.</i> |
| 4.3. | discuss the successes and challenges of gene therapy in modern medicine; and, | Concept of gene therapy. Use case study examples including cystic fibrosis. |
| 4.4. | discuss the implications of the use of genetically modified organisms on humans and the environment. | Medical, agricultural, ethical and social implications. |

5. Natural Selection

Students should be able to:

- | | | |
|------|---|--|
| 5.1. | explain how environmental factors act as forces of natural selection; | Examples such as resistance to antibiotics, <i>Biston betularia</i> (peppered moth), <i>the Trinidadian guppies</i> and <i>the Dominican anole</i> . |
| 5.2. | explain how natural selection may be an agent of constancy or an agent of change; | Directional, disruptive, and stabilising selection; knowledge of appropriate graphs is required. |
| 5.3. | discuss natural selection as a mechanism of evolution; | Darwin's theory, its observations and conclusions. |

UNIT 1

MODULE 2: GENETICS, VARIATION AND NATURAL SELECTION (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
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Natural Selection (cont'd)

Students should be able to:

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|------|--|--|
| 5.4. | discuss the biological species concept; and, | Discussion of the limitations of this concept, for example, in breeding. |
| 5.5. | explain the process of speciation. | Isolating mechanisms – reproductive, geographic, behavioural and temporal, allopatric and sympatric speciation with reference to two named examples. |

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. Allow students to attempt several exercises with the mathematical aspects of Biology in order to gain familiarity and to appreciate the levels of significance.
2. Have students conduct review of literature on biodiversity and conservation, *and make presentation to the class.*
3. Invite resource personnel to do presentation on plant biotechnology.
4. Engage students in a discussion of how humans use artificial selection to create, for example, domesticated animals, different breeds of dogs, chickens that lay a lot of eggs, Barbados Blackbelly sheep, and Jamaica Hope.

UNIT 1

MODULE 2: GENETICS, VARIATION AND NATURAL SELECTION (cont'd)

RESOURCES

Teachers and students may find reference to the following resource materials useful. The latest editions are recommended.

Boyle, M., Senior, K.	<i>Biology</i> . London: Harper Collins Publishers, 2008.
Bradfield, P.	<i>AS Level Biology</i> . Essex: Pearson Education Limited, 2001.
Clegg, C. J.	<i>Biology</i> . London: Hodder Education, 2014.
Durant, Claire	<i>Biology for CAPE® Examinations</i> . London: Macmillan Education, 2013.
Fosbery, R., LaPlace, S. and McPherson, L.	<i>CAPE Biology, A CXC® Study Guide</i> . Oxford University Press, 2012.
Ramesar, M., Jones, M., Jones, G.	<i>Biology Unit 1</i> . London: Cambridge University Press, 2011.

WEBSITES

Gene Therapy Case Studies: <http://learn.genetics.utah.edu/>

Conservation International Website <https://www.conservation.org/>

<http://darwin-online.org.uk/>

<https://www.nap.edu/read/5787/chapter/1>

National Geographic Magazine website <https://www.nationalgeographic.com/magazine/>

PBS Evolution website www.pbs.org/wgbh/evolution/darwin/

Video and/or Television materials such as those found on the Discovery Channel

<https://merlot.com/>

<https://www.nap.edu/catalog/5787/teaching-about-evolution-and-the-nature-of-science>

UNIT 1
MODULE 3: REPRODUCTIVE BIOLOGY

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand sexual and asexual reproduction in plants; and,
2. understand sexual reproduction in humans.

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
<p>1. Reproduction in Plants</p> <p>Students should be able to:</p>		
<p>1.1. describe the structure of the anther and the formation of pollen grains;</p>	<p>Annotated diagrams required.</p>	
<p>1.2. describe the structure of the ovule and the formation of the embryo sac;</p>	<p>Annotated diagrams required.</p>	<p>Make drawings of the anther and embryo sac from prepared slides.</p>
<p>1.3. explain the sequence of events from pollination to fertilization;</p>	<p>Annotated diagrams required.</p>	
<p>1.4. explain how cross-fertilization is promoted;</p>	<p>Non-synchronous maturation of stamens (protogyny) and carpels (protandry), separate sexes (dioecy), insect pollination, self-incompatibility, and sterility.</p>	
<p>1.5. discuss the genetic consequences of sexual reproduction;</p>	<p>Self-fertilization and cross fertilization.</p>	
<p>1.6. explain the significance of double fertilization in the embryo sac;</p>		

UNIT 1

MODULE 3: REPRODUCTIVE BIOLOGY (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Reproduction in Plants (cont'd)

Students should be able to:

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|------|---|--|
| 1.7. | discuss the development of the seed and the fruit from the embryo sac and its contents, the ovule and the ovary; and, | Types of fruits not required. |
| 1.8. | <i>discuss the advantages and disadvantages of asexual reproduction.</i> | Explanation of the term asexual reproduction. Relate binary fission, budding, asexual spore formation, fragmentation to asexual reproduction in plants, for example, ginger, meristems, hormone stimulation, details of the processes involved in tissue culture and the production of cuttings. |

2. Sexual Reproduction in Humans

Students should be able to:

- | | | | |
|------|---|---|---|
| 2.1. | describe the structure and function of the male and female reproductive systems; | Annotated diagrams required. | Make drawings from prepared slides of the mammalian ovary and testis. |
| 2.2. | explain gametogenesis and the role of hormones in this process; | The differences between the secondary oocyte and ovum. Include oogenesis and spermatogenesis. | |
| 2.3. | discuss how the structure of the ovum and the sperm facilitate their functional roles in the fertilization process; | Comparison of the structure of the ovum and the sperm. Use annotated diagrams. | |



UNIT 1

MODULE 3: REPRODUCTIVE BIOLOGY (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
Sexual Reproduction in Humans (cont'd)		
Students should be able to:		
2.4. describe the basic process of fertilization;	How and where the process occurs.	
2.5. describe implantation as it relates to reproduction;	Relate to the menstrual cycle in Specific Objective 2.6.	
2.6. <i>discuss the importance of hormones in the menstrual cycle;</i>	Emphasis on the principle of negative feedback mechanisms.	
2.7. discuss how knowledge of human reproductive anatomy and physiology has been applied to the development of contraceptive methods;		
2.8. explain the structure and functions of the placenta;		
2.9. discuss the functions of the amnion; and,		
2.10. discuss the possible effects of maternal behaviour on foetal development.	<i>The role of nutrition, the influence of alcohol and cigarette smoking, use of legal and/or illicit drugs. Pre-natal monitoring programs.</i>	

UNIT 1

MODULE 3: REPRODUCTIVE BIOLOGY (cont'd)

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. Have students examine a range of floral structures in order to appreciate the variation in pollination methods.
2. Invite resource personnel to do presentation on human reproduction, *pre-natal care*, and *substance abuse*.
3. Arrange visits to appropriate family planning centres, biotechnology Labs, plant propagation stations and tissue culture units.

RESOURCES

Teachers and students may find reference to the following resource materials useful. The latest editions are recommended.

Boyle, M., Senior, K.	<i>Biology</i> . London: Harper Collins Publishers, 2008.
Bradfield, P.	<i>AS Level Biology</i> . Essex: Pearson Education Limited, 2001.
Carrington, S	<i>Wild Plants of Barbados</i> . London and Basingstoke: Macmillan Press Limited, 2007.
Clegg, C J	<i>Biology</i> . London: Hodder Education, 2014.
Durant, Claire	<i>Biology for CAPE® Examinations</i> . London: Macmillan Education, 2013.
Fosbery, R., LaPlace, S. and McPherson, L.	<i>CAPE Biology, A CXC® Study Guide</i> . Oxford University Press, 2012.
Ramesar, M., Jones, M., Jones, G.	<i>Biology Unit 1</i> . London: Cambridge University Press, 2011.
Taylor, D.	<i>Growth Development and Reproduction</i> . Cambridge: Cambridge University Press Advanced Sciences, 2001.

UNIT 1
MODULE 3: REPRODUCTIVE BIOLOGY (cont'd)

WEBSITES

Biology Mad: <http://www.biologymad.com/>

Xtreme Papers: <http://www.xtremepapers.com/>

◆ **UNIT 2: BIOENERGETICS, BIOSYSTEMS AND APPLICATIONS**
MODULE 1: BIOENERGETICS AND CONSERVATION

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the process of photosynthesis, its role in transforming light energy and the effects of the limiting factors on plant productivity;
2. understand the process of cellular respiration and its role in producing Adenosine Triphosphate (ATP);
3. understand energy flow and nutrient cycling in ecosystems and their role in maintaining the stability of these ecosystems;
4. appreciate the ecosystem as a dynamic system involving different types of interactions between biotic and abiotic components;
5. understand how different types of diversity contribute to overall biodiversity; and,
6. develop an appreciation of conservation practices.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

1. Photosynthesis and ATP Synthesis

Students should be able to:

- | | | | |
|------|---|--|--|
| 1.1. | relate the structure of a dicotyledonous leaf, a palisade cell and a chloroplast to their roles in the process of photosynthesis; | Annotated diagrams required. | <i>Make diagrams</i> from prepared slides of a transverse section of a dicotyledonous leaf, and a palisade cell. |
| 1.2. | explain the process of photophosphorylation with respect to photosynthetic electron transport; | ATP's functions as the universal energy "currency" in all living organisms. Include the role of pigments, electron carriers and the establishment of proton gradients across thylakoid membranes in the process. | |

UNIT 2

MODULE 1: BIOENERGETICS AND CONSERVATION (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Photo Synthesis and ATP Synthesis (cont'd)

Students should be able to:

- 1.3. outline the essential stages of the Calvin cycle involving the light independent fixation of carbon dioxide;

The conversion of light energy into chemical energy of ATP, the reduction of NADP and the evolution of oxygen as a by-product should be noted. No biochemical detail is required. Knowledge of C4 plants not required. Include the fixation of carbon dioxide by ribulose biphosphate to yield phosphoglyceric acid (glycerate-3-P) and the subsequent conversion to triose phosphate and other carbohydrates. Emphasise the roles of ATP and NADP.

- 1.4. discuss the concept of limiting factors in photosynthesis; and,

Design and/or investigate the effect of limiting factors on the rate of photosynthesis.

- 1.5. discuss how knowledge of these limiting factors can be applied to the improvement of plant productivity.

Light intensity and carbon dioxide concentration. Green house technology, wilting, *hydroponics*, growth chambers.

UNIT 2

MODULE 1: BIOENERGETICS AND CONSERVATION (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
2. Cellular Respiration and ATP Synthesis		
Students should be able to:		
2.1. explain the sequence of steps in glycolysis;	Explanation of the stepwise breakdown of glucose in cellular respiration; Names of enzymes not required. Include the initial phosphorylation of glucose, lysis into two 3-carbon compounds and the subsequent production of pyruvate, a small yield of ATP and reduced NAD. Recognition of simplified structural formulae intermediate.	
2.2. describe the structure of a mitochondrion, relating its structure to its function;	Include annotated diagrams.	
2.3. state the fate of pyruvate in the cytosol when oxygen is available;	Pyruvate enters the matrix and is converted to acetyl CoA via oxidative decarboxylation.	<i>Design and/or</i> investigate the rate of oxygen uptake during respiration using a simple respirometer.
2.4. explain the significance of the Krebs cycle in ATP formation;	Explanation of the Krebs Cycle. Details of structures of intermediates not required. Emphasise production of NADH and FADH ₂ ; oxidation and decarboxylation.	

UNIT 2

MODULE 1: BIOENERGETICS AND CONSERVATION (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Cellular Respiration and ATP Synthesis (cont'd)

Students should be able to:

- 2.5. explain the process of oxidative phosphorylation with reference to the electron transport chain; and, *Including the roles of hydrogen and electron carriers; the proton gradient, the synthesis of ATP using ATP synthase and the role of oxygen. No details of the carriers are required. A summary of ATP production should be known.*
- 2.6. compare the fate of pyruvate in the absence of oxygen in animals and yeast. *Fermentation allows for the regeneration of NAD so that glycolysis can continue in the absence of oxygen. Include the concept of oxygen debt in mammals; and note that lactate can be converted back (oxidised) to pyruvate when oxygen is again available. Include commercial uses of yeast.*

3. Energy Flow and Nutrient Cycling

Students should be able to:

- 3.1. discuss the efficiency of energy transfer between trophic levels; *Revision of the terms: ecosystem, habitat, ecological niche, food chains and food webs. Emphasise the advantages of the food web.*
- 3.2. discuss the concept of biological pyramids; *Including the limitations of the pyramids of numbers, biomass and energy. Construct pyramids of energy using quantitative data.*

UNIT 2

MODULE 1: BIOENERGETICS AND CONSERVATION (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Energy Flow and Nutrient Cycling (cont'd)

Students should be able to:

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|------|--|---|
| 3.3. | describe how nitrogen is cycled within an ecosystem; and, | The role of microorganisms. |
| 3.4. | explain how energy flow and nutrient cycling are important for ecosystems to remain self-sustaining units. | Distinction between energy flow and nutrient cycling within an ecosystem. |

4. Ecological Systems, Biodiversity and Conservations

Students should be able to:

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|------|---|--|--|
| 4.1. | discuss how ecosystems function as dynamic systems; | Use of a named example. Include biotic and abiotic factors and the interactions between them. Mention the terms competition, predation, mutualism, commensalism, and parasitism. | <i>The use of models to study ecosystems, for example, mesocosm.</i> |
| 4.2. | explain the concept of biodiversity; | Discussion of genetic diversity, species diversity and ecosystem diversity. | |
| 4.3. | discuss the importance of the maintenance of biodiversity; | Intrinsic, direct and indirect values, including medicine, natural products, tourism. | |
| 4.4. | discuss how species diversity is related to the stability of an ecosystem; and, | Discussion of factors important to maintaining species diversity. Use regional examples. | |
| 4.5. | explain how <u>in situ</u> and <u>ex situ</u> conservation methods are used to maintain biodiversity. | Protected areas and reserves, seed banks, botanic gardens, zoos, sperm banks, embryo banks. | |

UNIT 2

MODULE 1: BIOENERGETICS AND CONSERVATION (cont'd)

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in Practical Activities outlined below.

1. Have student conduct review of the general principles of oxidation, reduction and electron flow.
2. Incorporate the use of charts and creation of concept maps rather than excessive biochemical details.
3. To assist students in appreciating ecosystem dynamics, use multimedia presentations and online resources such as Nature, National Geographic and Discovery.
4. *To demonstrate biodiversity and conservation in the form of large-scale, man-made biomes, refer students to the Eden Project in the United Kingdom.*
5. Organise fieldtrips or fieldwork to include the use of sampling techniques and measurement of abiotic factors.
6. Engage students in discussion on the human impact on biodiversity and conservation.
7. *Arrange visits to reserves, seedbanks or botanical gardens. Please note that all of these facilities play key roles in plant conservation.*
8. *Use animations and other online resources to help students visualise various processes.*
9. *Use of Global Artificial Photosynthesis (GAP) and its role in environmental sustainability.*
10. *Compare the species diversity of two habitats using biodiversity indices.*

RESOURCES

Teachers and students may find reference to the following resource materials useful. The latest editions are recommended.

Durant, Claire

Biology for Cape Unit 2, A CXC® Study Guide.
Oxford University Press, 2014.

Reiss, M. and Chapman, J.

Ecology: Principles and Applications. Cambridge:
Cambridge University Press, 2003.

UNIT 2

MODULE 1: BIOENERGETICS AND CONSERVATION (cont'd)

WEBSITES

<https://www.savethemanatee.org/>

<https://www.ramsar.org/>

<https://www.wetlands.org/>

http://www.grupojaragua.org.do/index_english.html

<https://www.nap.edu/read/9589/chapter/1>

Highered McGraw Hill Animations -

<http://highered.mheducation.com/olc/dl/120060/ravenanimation.html> - *Chapters 9 and 10*

UNIT 2
MODULE 2: BIOSYSTEMS MAINTENANCE

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the mechanisms by which plants absorb minerals and water and the impact of environmental factors on these mechanisms;
2. understand translocation in relation to structure of the phloem;
3. understand the organisation, structure, transport function, and internal control mechanisms of the mammalian circulatory system;
4. understand and apply the concept of homeostasis and hormonal action using named examples;
5. understand the role of the kidneys as excretory and regulatory organs and their impact in common disorders; and,
6. understand the role of the nervous system in systems maintenance.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

1. The Uptake and Transport of Water and Minerals

Students should be able to:

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|------|--|--|--|
| 1.1. | explain the uptake of ions by active transport in roots; | Emphasis on the role of the endodermis. | |
| 1.2. | describe the entry of water into plant roots in terms of water potential; | | |
| 1.3. | relate the structure of xylem vessels to their function; | Inclusion of transport and support roles. | Make <i>diagrams</i> from prepared slides of xylem vessels. |
| 1.4. | <i>explain</i> the ascent of water in plants; and, | Root pressure, capillarity, cohesion, adhesion and transpiration pull. Include the role of stomata in transpiration. | <i>Wet mounts of celery placed in coloured fluid could be observed. Use Coleus epidermal peels to visualise stomata.</i> |
| 1.5. | <i>discuss</i> the impact of environmental factors on the rate of transpiration. | Light and air movements. Root pressure, capillarity, cohesion, adhesion. | <i>Design an activity to investigate the effects of environmental factors on</i> |

the rate of transpiration.

UNIT 2

MODULE 2: BIOSYSTEMS MAINTENANCE (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
2. Transport in the Phloem		
Students should be able to:		
2.1. relate the structure of sieve tubes and companion cells to their function;	Label pertinent features in an electron micrograph of a sieve tube and companion cell.	Make <i>diagrams</i> of sieve tubes and companion cells from prepared microscope slides.
2.2. explain how phloem loading in the leaves occurs against a concentration gradient; and,		
2.3. discuss the mass (pressure) flow hypothesis as a possible mechanism of translocation.	Experimental evidence for and against this hypothesis.	
3. The Circulatory System of Mammals		
Students should be able to:		
3.1. <i>describe the structure of the heart, arteries, veins, capillaries, erythrocytes, and leucocytes, relating their structures to their functions</i>	<i>Use fresh or preserved specimens (to emphasise the 3-D structure); prepare annotated drawings.</i>	<i>Make drawings of whole mount and/or longitudinal sections of the heart. Prepare diagrams of arteries, veins, erythrocytes, and leucocytes from prepared microscope slides.</i>
3.2. explain the cardiac cycle and its initiation;		
3.3. discuss the internal factors that control heart action;		
3.4. discuss factors affecting blood pressure;	Definition of the terms blood pressure and pulse.	<i>Measurements before and after exercise.</i>

UNIT 2

MODULE 2: BIOSYSTEMS MAINTENANCE (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

The Circulatory System of Mammals (cont'd)

Students should be able to:

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|------|---|---------------------------|
| 3.5. | explain the role of haemoglobin in oxygen and carbon dioxide transport; | Flow charts not required. |
| 3.6. | describe oxygen dissociation curves for adult haemoglobin; and, | Interpretation of data. |
| 3.7. | explain the significance of the effect of carbon dioxide on oxygen dissociation curves (Bohr Effect). | |

4. Homeostasis and Hormonal Action

Students should be able to:

- | | | | |
|------|--|--|---|
| 4.1. | discuss the concept homeostasis; | Receptors, effectors, set point, feedback, and homeostatic equilibrium. Emphasise the dynamics of feedback mechanisms. | |
| 4.2. | outline the general principles of hormonal action in animals; | Ductless glands in animals; target cells and receptors. | |
| 4.3. | explain how insulin and glucagon regulate blood glucose concentration; | | |
| 4.4. | discuss the commercial use made of ethylene in supplying market-ready fruit. | Mention the gaseous nature of ethylene and its effect on respiration. Types of fruits not required. | <i>Simple experimental with relevant control using fresh fruit only versus fresh and ripening fruit to demonstrate the effect of ethylene (ethene) on fruit ripening.</i> |

UNIT 2

MODULE 2: BIOSYSTEMS MAINTENANCE (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Homeostasis and Hormonal Action (cont'd)

Students should be able to:

5. The Kidney, Excretion and Osmoregulation

Students should be able to:

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|------|--|--|--|
| 5.1. | explain the need to remove nitrogenous and other excretory products from the body; | Revision of the formation of urea. | |
| 5.2. | describe the gross structure of the kidney and the detailed structure of the nephron and associated blood vessels; | Annotated diagrams required. | Make <i>diagrams</i> of sections of the kidney from prepared sides. |
| 5.3. | explain the function of the kidney in terms of excretion and osmoregulation; and, | <i>Include the role of ADH. Mention the clinical significance of glucose and protein in the urine.</i> | <i>Student investigation of prepared solutions simulating urine samples of different compositions. Appropriate activity for Planning and Design.</i> |
| 5.4. | discuss the clinical significance of the presence of glucose and protein in the urine. | | |

6. Nervous Co-ordination

Students should be able to:

- | | | | |
|------|---|------------------------------|--|
| 6.1. | describe the structure of motor and sensory neurons; | Annotated diagrams required. | |
| 6.2. | explain the role of nerve cell membranes in establishing and maintaining the resting potential; | | |

UNIT 2

MODULE 2: BIOSYSTEMS MAINTENANCE (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
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Nervous Co-ordination (cont'd)

Students should be able to:

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|------|---|--|
| 6.3. | describe the conduction of an action potential along the nerve cell membrane; | The value of myelinated neurons in increasing the speed of transmission. |
| 6.4. | explain synaptic transmission; and, | Structure of cholinergic synapse. Annotated diagrams required. |
| 6.5. | outline the role of synapses. | |

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in teaching and learning activities listed below.

1. Ask students to make slides of transverse and longitudinal sections of stems, roots and leaves from living tissue, selected by the students to investigate their microscopic structure.
2. Allow students to use binocular microscopes to examine root hairs and stomata.
3. Set up experiments on transpiration in both cut stems and potted plants to show methods and results.
4. Allow students to take blood pressure measurements, and investigate the effect of exercise, rest, excitement, and temperature on blood pressure.
5. Use models of the heart and kidney to help students to conceptualise 3-dimensional structures.
6. Encourage students to make scaled models of xylem, phloem, sections of Bowman's Capsules, nephrons, alveoli, arteries, veins and blood components.
7. Use multimedia, and visit Websites using keywords and keep a record and or bookmarks of useful sites.
8. Allow or assist students to take photographs of microscope slides and make presentation slides.

UNIT 2

MODULE 2: BIOSYSTEMS MAINTENANCE (cont'd)

RESOURCES

Teachers and students may find reference to the following resource materials useful. The latest editions are recommended.

Bradfield, P.	<i>A2 Level Biology</i> . Essex: Pearson Education Limited, 2001.
Durant, Claire	<i>Biology for Cape Unit 2, A CXC® Study Guide</i> . Oxford University Press, 2014.
Jones, A., Reed, R. and Weyers, J.	<i>Practical Skills in Biology, 3rd Edition</i> . New Jersey: Pearson Prentice Hall, Pearson Education Limited, 2016.
Indge, B.	<i>Data and Data Handling for AS and A2 Biology</i> . London: Hodder and Murray Publishers, 2003.
Morgan, S.	<i>Practical Work for Biology</i> . London: Hodder and Stroughton, 2002.

JOURNALS

Time, Newsweek, Nature, Discover

ELECTRONIC SOURCES

Insight Media Video & CD Rom Catalogue

WEBSITE

www.insight-media.com



UNIT 2

MODULE 3: APPLICATIONS OF BIOLOGY

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the terms 'health' and 'disease';
2. understand the principles of immunology;
3. be aware of the principles underlying social and preventative medicine; and,
4. understand biological and social implications of substance abuse.

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
1. Health and Disease		
Students should be able to:		
1.1. discuss the meaning of the term 'health';	Focus on the physical, mental and social aspects of health.	
1.2. explain the categories of disease or illness; and,	Physical, mental, social, chronic, infectious, degenerate, inherited, self-inflicted, deficiency, with an example of each. Diseases will fit into more than one category.	<i>Model the transmission of communicable or social diseases by using a hands-on simulation.</i>
1.3. analyse data involving incidence and mortality rates of disease.	Explanation of the meanings of incidence and mortality rates; students should interpret and analyse data, and draw conclusions and or make predictions.	

UNIT 2

MODULE 3: APPLICATIONS OF BIOLOGY (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
2. Immunology		
Students should be able to:		
2.1. define the term, “immune response”;		
2.2. distinguish between the humoral and the cell-mediated immune responses;	<i>Include the sequence of events involved in each response.</i>	
2.3. explain the role of memory cells in long-term immunity;	T- and B- memory cells.	
2.4. compare the origin and maturation of B- and T-lymphocytes;	Include the types of T-cells and their function (refer to HIV); B-cells and their function.	
2.5. describe the mode of action of phagocytes;	Revision of phagocytosis; include role of mast cells and histamine production; complement; phagocytes as antigen-presenting cells.	
2.6. relate the molecular structure of a typical antibody molecule to its function;	Use of labelled diagram of typical antibody showing its ‘Y- shaped’ structure; include the function of the various parts; specificity of antibody to antigen.	
2.7. state what is meant by a monoclonal antibody;		
2.8. describe the use of monoclonal antibodies in diagnosis and treatment;	The anticancer drug, MabThera; details required of the use of monoclonal antibodies in pregnancy testing.	

UNIT 2

MODULE 3: APPLICATIONS OF BIOLOGY (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
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Immunology (cont'd)

Students should be able to:

- | | | |
|-------|--|---|
| 2.9. | distinguish between active and passive immunity, natural and artificial immunity; and, | <i>Include examples for each type.</i> |
| 2.10. | explain the role of vaccination in providing immunity. | <i>Mention the successes and challenges of the use of vaccines to reduce the incidence of diseases.</i> |

3. Social and Preventative Medicine

Students should be able to:

- | | | | |
|------|---|--|--|
| 3.1. | discuss the causative relationship among diet, obesity and diabetes; | Revision of the concept of a balanced diet; Body Mass Index (BMI); Type 1 and Type 2 diabetes. | |
| 3.2. | describe the effects of fats on the cardiovascular system; | Atherosclerosis, coronary heart disease, hypertension and stroke. Details of plaque formation. | |
| 3.3. | discuss the consequences of exercise on the body and the benefits of maintaining a physically fit body; | Long-term and short-term consequences; relate benefits to the prevention of chronic diseases; refer to VO ₂ max and cardiac efficiency. | Investigate the immediate effects of exercise on the body. |
| 3.4. | describe the mechanisms of infection for viral diseases and their causative agents; | Mention AIDS and dengue fever (in the Caribbean context). Include processes of infection, the biology of the virus; length of incubation period; replication of the disease-causing organisms. | |



UNIT 2

MODULE 3: APPLICATIONS OF BIOLOGY (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Social and Preventative Medicine (cont'd)

Students should be able to:

- 3.5. *explain the modes of transmission of HIV and dengue virus;*
- HIV: mention lifestyle, sexual intercourse, sharing needles or syringes, mother to child during pregnancy, birth or breastfeeding.*
- Dengue *virus*: the vector is *Aedes aegypti*.
- 3.6. discuss reasons for the regional distribution of Acquired Immune Deficiency Syndrome (AIDS), diabetes and cancer;
- AIDS: roles of lifestyle, ease of travel, cost of drugs, and lack of education on the spread of the virus.
- Diabetes: include the effects of diet, obesity, and prenatal malnutrition.
- Cancer: include roles of environmental hazards, food additives, viruses, genetic factors; implications of symptom awareness and failure to seek treatment in management of the disease.
- 3.7. assess the impact of communicable and non-communicable diseases regionally; and,
- Include social and economic issues. Use named examples.

UNIT 2

MODULE 3: APPLICATIONS OF BIOLOGY (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

SUGGESTED PRACTICAL ACTIVITIES

Social and Preventative Medicine (cont'd)

Students should be able to:

- 3.8. discuss the roles of social, economic and biological factors in the prevention and control of viral infections.
- Infections including but not limited to AIDS and dengue fever.

4. Substance Abuse

Students should be able to:

- 4.1. discuss the meaning of the term, "drug abuse";
- Emphasise that both legal and illegal drugs can be abused.*
- 4.2. distinguish between psychological and physical dependence;
- 4.3. describe the short-term and long-term consequences of alcohol consumption on the nervous system and the liver;
- Short-term – fatty liver, hepatitis; long-term – cirrhosis, cancer, impaired nervous transmission, demyelination, dehydration of the brain cells.
- 4.4. discuss the social consequences of excessive alcohol use; and,
- Drinking and driving, aggressive behaviour, intra-family violence, family breakdown and petty crime; Include a definition of 'a unit of alcohol'; Daily Alcohol Limits (DAL) – safe limits (that is, blood and breath limits) for driving.

UNIT 2
MODULE 3: APPLICATIONS OF BIOLOGY (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES	SUGGESTED PRACTICAL ACTIVITIES
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Substance Abuse (cont'd)

Students should be able to:

- | | |
|---|--|
| 4.5. describe the effects of the components of cigarette smoke on the respiratory and cardiovascular systems. | Passive smoking; effects of nicotine, tar and carbon monoxide on cilia, oxygen uptake, mucus secretion; development of hyperplasia, emphysema, chronic bronchitis, cancers including lung cancer; vasoconstriction, increase in number of erythrocytes, increase in blood viscosity, formation of blood clots. |
|---|--|

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in teaching and learning activities listed below.

1. Encourage students to read and use current information in this particular area, since it is constantly changing.
2. Arrange visit to centres of excellence, such as a field station, hospital or research institute from which students can gain practical experience in these areas.
3. Allow students to view documentaries and make group presentations which deal with these issues.
4. Invite resource personnel to speak on concepts and issues discussed in this module.
5. Encourage involvement in school and/or community projects to assist in raising awareness of social and preventative medicine.
6. *Review and analyse current statistical data on HIV and AIDS in the Caribbean.*
7. *Review and analyse current statistical data on dengue in the Caribbean.*
8. *Model the transmission of a communicable or social disease by using a 'hands on' simulation.*

UNIT 2

MODULE 3: APPLICATIONS OF BIOLOGY (cont'd)

RESOURCES

Teachers and students may find reference to the following resource materials useful. The latest editions are recommended.

Durant, C.

Biology for Cape Unit 2, A CXC® Study Guide.
Oxford University Press, 2014.

WEBSITES

UNAIDS (2016) 'The Prevention Gap Report'

http://www.unaids.org/sites/default/files/media_asset/2016-prevention-gap-report_en.pdf

UNAIDS (2014) 'The Gap Report'

http://files.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2014/UNAIDS_Gap_report_en.pdf

UNAIDS (2016) 'AIDSinfo'

<http://aidsinfo.unaids.org/>

UNAIDS (2013) 'Global Report: UNAIDS Report on the global AIDS epidemic 2013'

http://files.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2013/gr2013/UNAIDS_Global_Report_2013_en.pdf

Avrett, S (2012) 'Men Who Have Sex with Men and HIV in the Anglophone Caribbean: A Situation Review'. Arlington, VA: USAID's AIDS Support and Technical Assistance Resources, AIDSTAR-One, Task Order 1

https://aidsfree.usaid.gov/sites/default/files/humanrights_msm.pdf

http://www.paho.org/hq/index.php?option=com_docman&task=doc_view&gid=23710&Itemid=270

◆ OUTLINE OF ASSESSMENT

EXTERNAL ASSESSMENT (80%)

Paper 01 (1 hour 30 minutes)	Forty-five multiple-choice items, 15 from each Module.	40%
Paper 02 (2 hours 30 minutes)	Three compulsory structured essay questions, one from each Module. Each question is worth 30 marks.	40%
Paper 032 For private candidates only (2 hours)	Three questions, one from each Module, as follows: (a) a practical-based question to be executed by the candidate; (b) a question based on data analysis; (c) a data analysis/a planning and design exercise.	20%

SCHOOL-BASED ASSESSMENT (20%)

The School-Based Assessment will consist of selected practical laboratory exercises and one research project in any Unit of any of the **CAPE®** Sciences (Biology, Chemistry or Physics).

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 Term 2/3, the Moderator will visit the centre. Teachers must make available to the Moderator **ALL** Assessment Sheets (Record of Marks), **ALL** lab books, Mark Schemes and the project or evidence of the project when marks have been transferred from another Unit/subject. **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 re-mark the skills and projects (if the marks for the projects are not transferred marks) for a sample of five candidates, who are selected using the following guidelines.

1. Candidates' total marks on the SBA are arranged in descending order (highest to lowest).
2. The sample comprises the work of 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; and,
 - (e) mark midway between the middle and lowest Total mark.
3. *The moderator will re-mark the lab practical activities for the other skills (ORR, AI and PD) that are recorded in the five candidates' lab books as well as the research projects where applicable. Feedback will be provided by the Moderator to the teachers.*

*Where the total number of candidates is five or fewer, the Moderator will re-mark the skills for **ALL** the candidates.*

The Moderator will submit the moderated marks (moderation of SBA Sample form), the moderation feedback report and the External Moderator report to the Local Registrar by 30 June of the year of the examination. Candidates' marks may be adjusted as a result of this exercise. A copy of the Assessment Sheets and all candidates' work must be retained by the school for three months after the examination results are published by CXC®.

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).

ASSESSMENT DETAILS

Each Unit of the syllabus is assessed as outlined below.

External Assessment by Written Papers (80% of Total Assessment)

1. Paper 01 consists of 45 multiple-choice items. There will be a combined question paper and answer booklet for Paper 02.
2. S.I. Units will be used on all examination papers.
3. The use of silent, non-programmable calculators will be allowed in the examination. Candidates are responsible for providing their own calculators.
4. Data not specifically required to be recalled, defined or stated will be made available for this examination.

Paper 01 (1 hour 30 minutes – 40% of Total Assessment)

1. Composition of the Paper

This paper will consist of 45 multiple-choice items, 15 from each Module. All questions are compulsory and knowledge of the entire Unit is expected. The paper will assess the candidate's knowledge across the breadth of the Unit.

2. **Mark Allocation**

The paper will be worth 45 marks, which will be weighted to 90 marks.

3. **Question Type**

Questions may be presented using diagrams, data, graphs, prose or other stimulus material.

Paper 02 (2 hours 30 minutes – 40% of Total Assessment)

1. **Composition of Paper**

This paper will consist of three questions, one from each module.

Questions on this paper test all three skills KC, UK and XS.

Knowledge of the entire Unit is expected.

2. **Mark Allocation**

The paper will be worth 90 marks, 30 marks per question *and distributed across the question sub-parts*.

3. **Question Type**

Questions will be presented in *structured essay format*. *The questions will test the skills of KC, UK and XS*. Answers are to be written in the question booklet.

School-Based Assessment (20%)

School-Based Assessment 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 associated with the subject. *Students are encouraged to work in groups*.

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

School-Based Assessment provides an opportunity to individualise a part of the curriculum to meet the needs of students. It facilitates feedback to the student at various stages of the experience. This helps to build the self-confidence of students as they proceed with their studies. School-Based Assessment also facilitates the development of the critical skills and abilities emphasised by this CAPE® subject and enhances the validity of the examination on which candidate performance is reported. School-Based Assessment, therefore, makes a significant and unique contribution to both the development of relevant skills and the testing and rewarding of students for the development of those skills.

The Caribbean Examinations Council seeks to ensure that the School-Based Assessment scores that contribute to the overall scores of candidates are valid and reliable estimates of accomplishment. The

guidelines provided in this syllabus are intended to assist in doing so.

Award of Marks

The following skills will be assessed through the laboratory practical activities:

1. Analysis and Interpretation.
2. Manipulation and Measurement.
3. Observation, Recording and Reporting.
4. Planning and Designing.
5. Drawing

The candidates are also required to do a research project in any one Unit of the **CAPE®** Sciences. In each Unit, a total of 9 marks are to be allocated for each skill, and 9 marks for the project, as indicated in the Table below.

Table 1
School Based Assessment Skills

Skill	Unit 1	Unit 2
Observation, Recording and Reporting	9	9
Manipulation and Measurement	9	-
Analysis and Interpretation	9	9
Planning and Designing	-	9
Drawing	9	9
Project*	9	9
TOTAL	45 marks	45 marks

Teachers are required to provide criteria which clearly indicate how they award marks.

Please note that candidates will be required to do **one research project in any Unit of any of the **CAPE®** Sciences (Biology, Chemistry or Physics) in the first sitting, and can use that mark for the other Units of the Sciences. So for example, a candidate may do a project in Unit 2 Physics in the first sitting, get a mark out of 9 and then (transfer) use that mark for Unit 1 Physics, Units 1 and 2 Chemistry and Units 1 and 2 Biology. Group work is allowed and encouraged.*

Each Module will carry a maximum of 15 marks.

Each candidate's total School-Based Assessment mark for any Unit should be divided in three and allocated to each Module equally.

Fractional marks should not be awarded. Wherever the Unit mark is not divisible by three, then

- (a) when the remainder mark is 1, it should be allocated to Module 1; and,
- (b) when the remainder is 2, one of the marks should be allocated to Module 2 and the other mark to Module 3.

Appropriate practical exercises for assessing any skill may be selected from any Module in the relevant Unit.

RESEARCH PROJECT

Objectives of the Research Project

The research project will allow students to:

1. *appreciate the use of the scientific method for discovery of new knowledge and to the solution of problems.*
2. *communicate accurately and effectively the purpose and results of research.*
3. *analyse relevant literature.*
4. *apply experimental skills and theory to the solution of problems.*
5. *synthesise information based on data collected.*
 - (a) *The research project should focus on at least one specific objective in the Unit. It can be from one or more modules within the Unit.*
 - (b) *The project must not exceed 1,500 words. The word count does not include: Tables, References, Table of contents, Appendices and Figures. Two marks will be deducted for exceeding the word limit by 200 words.*
 - (c) *Collaborative work is encouraged. Where collaborative work is done, group sizes must not exceed six (6) persons per group. The teacher is expected to use the group mark for the project and add it to the marks for the other skills for each individual candidate within the group.*
 - (d) *The report should be typewritten and double-spaced using 12pt font and should contain the following:*
 - (i) *Statement of Problem.*
 - (ii) *Rationale.*
 - (iii) *Research questions/Hypotheses.*
 - (iv) *Review of Literature.*
 - (v) *Methodology (paragraph format).*
 - (vi) *Presentation of Data collected from Research.*
 - (vii) *Discussion of findings.*

- (viii) Recommendations.
- (ix) Conclusion.
- (x) Bibliography (Referencing style from Communication Studies).

CRITERIA FOR MARKING THE RESEARCH PROJECT

1.	<i>Statement of Problem</i>		(2)
	<ul style="list-style-type: none"> • <i>Problem identified and clearly stated (Problem identified but not clearly stated)</i> 	2 (1)	
2.	<i>Rationale/Statements of Purpose of Investigation</i>		(1)
	<ul style="list-style-type: none"> • <i>Clearly states reason for project, for example, the benefits (Justifies solutions for the problem)</i> 	1	
3.	<i>Research Questions/ Hypotheses</i>		(3)
	<ul style="list-style-type: none"> • <i>Clearly stated research questions/hypotheses (no more than two)</i> • <i>Testable</i> • <i>Variables clearly stated</i> 	1 1 1	
4.	<i>Critical review of literature (Analysis and evaluation of appropriate literature)</i>		(7)
	<ul style="list-style-type: none"> • <i>In text citation using consistent format</i> • <i>At least four sources cited</i> • <i>Credible and relevant sources (scholarly articles) cited</i> • <i>Analysis of information from sources, for example, Who, what...</i> <ul style="list-style-type: none"> - <i>Comparison of information from sources cited</i> - <i>Accurate analysis of information from sources</i> - <i>Final synopsis of the literature</i> - <i>Personal reflection in relation to the area researched</i> 	1 1 1 1 1 1 1	
5.	<i>Methodology</i>		(3)
	<p><u><i>For Non-Experimental Research only</i></u></p> <ul style="list-style-type: none"> • <i>Clearly outlines method(s) of collecting data (Method only stated)</i> • <i>Methods chosen supported by literature review OR alternative method justified</i> <p><u><i>For Experimental Research only</i></u></p> <ul style="list-style-type: none"> • <i>Clearly describes method used</i> • <i>Repetition</i> • <i>Appropriate use of apparatus and materials</i> 	2 (1) 1 1 1 1	
6.	<i>Presentation of data collected from research</i>		(3)

	<ul style="list-style-type: none"> • <i>Appropriate format for presentation of data</i> • <i>Use of tables, graphs/figures</i> • <i>Properly annotated (Titles of tables at top; titles of figures at bottom of figure; Biological illustrations labelled...)</i> 	1 1 1	
7.	<i>Discussion of Findings</i>		(8)
	(a) <i>Analysis of Data</i>		
	<ul style="list-style-type: none"> • <i>Accurate identification of trends/relationships</i> • <i>Indicate differences in trends/relationships</i> 	1 1	
	(b) <i>Interpretation of Findings</i>		
	<ul style="list-style-type: none"> • <i>Discussion of results in terms of literature reviewed</i> • <i>Clearly points toward answering of research questions (points toward answering of research questions but somewhat unclear)</i> • <i>Supported by the data presented</i> • <i>At least TWO limitations of the research conducted (ONE limitation stated)</i> 	1 2 (1) 1 2 (1)	
8.	<i>Recommendations</i>		(2)
	<ul style="list-style-type: none"> • <i>At least two recommendations based on and supported by findings (One recommendation based on and supported by findings)</i> <i>Award zero if recommendations are not related to purpose or supported by findings</i> 	2 (1)	
9.	<i>Conclusion</i>		(2)
	<ul style="list-style-type: none"> • <i>Conclusion clear and based on findings</i> • <i>Conclusion relates to the purpose of the project</i> 	1 1	
10.	<i>Communication of information</i>		(3)
	<ul style="list-style-type: none"> • <i>Few grammatical errors or flaws and good use of appropriate technical terms</i> • <i>(Several grammatical errors or flaws and poor use of appropriate technical terms)</i> • <i>Information communicated in a logical manner</i> 	2 (1) 1	
11.	<i>Bibliography</i>		(2)
	<ul style="list-style-type: none"> • <i>At least four cited sources referenced</i> • <i>Written using a consistent referencing style</i> 	1 1	
12.	<i>Exceeding the word limit by more than 200 words</i>		(-2)
Total			36

SCHOOL-BASED ASSESSMENT – GENERAL GUIDELINES FOR TEACHERS

1. Each candidate is required to keep a laboratory workbook which is to be marked by the teacher. Teachers are also expected to assess candidates as they perform practical exercises in which Manipulation and Measurement skills are required.
2. A maximum of two skills may be assessed by any one experiment.
3. The maximum mark for any skill will be 9. The mark *awarded* for each skill assessed by practical exercises should be the average of at LEAST TWO separate assessments *for MM, AI and PD*. *Only one mark is required for ORR*. In each Unit, total marks awarded at the end of each Module will be 0 to 15.
4. Candidates who do not fulfil the requirements for the School-Based Assessment will be considered absent from the whole examination.
5. Candidates' laboratory books should contain all practical work undertaken during the course of study. Those exercises which are selected for use for the School-Based Assessment should be clearly identified. The skill(s) tested in these selected practical exercises, the marks assigned and the scale used must be placed next to the relevant exercises.
6. Teachers' criteria and breakdown of marks for assessing a skill must be clearly stated and submitted with the laboratory books.
7. The standard of marking should be consistent.
8. The relationship between the marks in the laboratory books and those submitted to **CXC**[®] in the ORS should be clearly shown.

◆ REGULATIONS FOR PRIVATE CANDIDATES

1. Candidates who are registered privately will be required to sit Papers 01, 02 and 032. Detailed information on Papers 01, 02 and 032 is given on page 49 of this syllabus.
2. Paper 032 will constitute *20 per cent* of the overall assessment of the candidates' performance on the Unit.

◆ REGULATIONS FOR RESIT CANDIDATES

1. *Candidates may reuse any moderated SBA score within a two-year period. In order to assist candidates in making decisions about whether or not to reuse a moderated SBA score, the Council will continue to indicate on the preliminary results if a candidate's moderated SBA score is less than 50 per cent in a particular Unit.*
2. *Candidates re-using SBA scores should register as "Re-sit candidates" and must provide the previous candidate number when registering.*

3. *Resit candidates must complete Papers 01 and 02 of the examination for the year in which they register.*

◆ ASSESSMENT GRID

The Assessment Grid for each Unit contains marks assigned to papers and to Modules and percentage contribution of each paper to total scores.

<i>Paper</i>	<i>Module 1</i>	<i>Module 2</i>	<i>Module 3</i>	<i>Paper Total (Weighted Total)</i>	<i>% Weighting of Papers</i>
<i>Paper 01</i>	15 (30)	15 (30)	15 (30)	45 (90)	40
<i>Paper 02</i>	30	30	30	90	40
<i>Paper 031/2</i>	15	15	15	45	20
<i>Module Totals</i>	60	60	60	180 (225)	100
<i>Weighted Module</i>	75	75	75	225	100

◆ RESOURCES

The following is a list of books and other printed material that might be used for CAPE Biology. The list is by no means exhaustive. Each student should have access to at least one text.

Texts

Clegg, C.J. and Mackean, D.J. *Advanced Biology – Principles and Applications*. London: John Murray, 2000.

Supplementary Texts and Teachers' Guide

Anon *Preliminary Biology Study Guide*. University of the West Indies, Barbados: Distance Education Centre, 1997.

Bradfield, P. *AS & A2 Level Biology*. Essex: Pearson Educational, 2001.

Cadogan, A. and Best, G. *Environment and Ecology: Biology Advanced Studies*. Glasgow and London: Nelson Blackie, 1992.

Chapman, J. L. and Reiss, M. *Ecology*. Cambridge: Cambridge University Press, 1992.

Huxley, A. *Green Inheritance*. London: Gaia Books, 1992.

Fosbery, R., Jones, M. and Taylor, D. *Advanced Biology, Volume 1 and 2*. Cambridge: Cambridge University Press, 2002.

Jones, M., Fosbery, R. et al *AS Level and A Level Biology*. Cambridge: Cambridge University Press, 2003.

Kent, M. *Advanced Biology*. Oxford: Oxford Press, 2000.

Margulis, L. and Schwartz, K. *Five Kingdoms*. New York: W.H. Freeman and Company, 1998.

Odlum, E.P. *Ecology: A Bridge Between Science and Society*. Sunderland, USA: Sinauer Associates, 1997.

Raven, P., Johnson, G., Singer, S., et al *Biology, 7th Edition*. Boston, MA: McGraw Hill, 2005.

Toole, G. and Toole, S. *New Understanding of Biology for Advanced Level*. Cheltenham: Stanley Thornes Publishers Limited, 1997.



Reference Books for Field Study

Plant Identification

- Barlow, V. *The Nature of the Islands*. Dunedin, Florida: Cruising Guide Publications, 1998.
- Fournet, J. and Hammerton, J. *Weeds of the Lesser Antilles and or Mauvaises herbes des petites Antilles*. INRA, Paris/CARDI, 1994.
- Nellis, D. *Seashore Plants of South Florida and the Caribbean*. Sarasota: Pineapple Press, 1994.
- Whittaker, M. *Medicinal Plants of St Kitts and Nevis Part 1*. Basseterre, St. Kitts: College of Further Education, 1992.

Animal Identification

- Raffaele, H.A., Wiley, J., Garrido, O., Keith, A. and Raffaele, J. *A Guide to Birds of the West Indies*. New Jersey: Princeton University Press, 2003.
- Stirling, P. *Butterflies and Other Insects of the Eastern Caribbean*. London: Macmillan Caribbean, 1986.
- Stokes, F. *Divers and Snorkeler's Guide to the Fishes and the Sea Life of the Caribbean*. Florida, Bahamas and Bermuda, Philadelphia: Academy of Natural Sciences of Philadelphia, 1984.
- Sultry, L. *Seashell Treasures of the Caribbean*. London: Macmillan Caribbean, 1986.
- Sutty, L. *Fauna of the Caribbean – Last Survivors*. London: Macmillan Press, 1993.

◆ GLOSSARY OF EXAMINATION TERMS

KEY TO ABBREVIATIONS

KC - Knowledge and Comprehension

UK - Use of Knowledge

XS - Experimental Skills

WORD	DEFINITION	NOTES
Analyse	Examine in detail	UK
Annotate	Add a brief note to a label	Simple phrase or a few words only, KC
Apply	Use knowledge and or principles to solve problems	UK
Assess	Present reasons for the importance of particular structures, relationships or processes	UK
Calculate	Arrive at the solution to a numerical problem	KC/UK
Cite	Provide a quotation or reference to the subject	KC
Classify	Divide into groups according to observable characteristics	UK
Comment	State opinion or view with supporting reasons	UK
Compare	State similarities and differences	An example of a significance of each similarity and the difference stated may be required for comparisons which are other than structural, UK
Construct	Use a specific format to make and or draw a graph, histogram, pie chart or other representations 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

WORD	DEFINITION	NOTES
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 and or formula where relevant; KC
Demonstrate	Show; direct attention to ...	KC
Describe	Provide detailed factual information of the appearance or arrangement of a specific structure or sequence of a specific process	Description may be words, drawings or diagrams or an appropriate combination. Drawings or diagrams should be annotated to show appropriate detail where necessary; KC
Design	Include planning and presentation with appropriate practical detail	UK/XS
Determine	Find the value present with appropriate practical detail	Where hypotheses are stated or when tests are to be conducted, possible outcomes should be clearly shown and/or the way in which data will be analysed and presented; UK/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 or Distinguish	State or explain briefly those differences between or among items which can be used to define the items or place them into separate categories	KC/UK

WORD	DEFINITION	NOTES
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 case of drawings from the specimens, the magnification must always be stated; KC/UK/XS
Estimate	Make an approximate quantitative judgement	UK
Evaluate	Weigh evidence and make judgements based on given criteria	The use of logical supporting reasons for a particular point is more important than view held; usually both sides of an argument should be considered ; UK
Explain	Give reasons based on recall; account for	KC/UK
Find	Locate a feature or obtain as from a graph	UK
Identify	Name specific components or features	KC
Illustrate	Demonstrate clearly using appropriate examples or diagrams	KC
Interpret	Explain the meaning of	UK
Formulate	Devise hypotheses	UK
Label	Add names to identify structures or parts indicated by pointers	KC/XS
List	Itemise without detail	KC
Measure	Take accurate quantitative readings using appropriate instruments	XS

WORD	DEFINITION	NOTES
Name	Give only the name of	No additional information is required; KC
Note	Record observation	XS
Observe	Pay attention to details which characterise a specimen, reaction or change taking place; to examine and note scientifically	Observation 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 exercise	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, record; data may be depicted in graphs, histograms or tables; XS
Relate	Show connections between; explain how one set of facts or data depends on others or are determined by them	UK
Sketch	Make a simple freehand diagram showing relevant proportions and any important details	KC/UK/XS
State	Provide factual information in concise terms outlining explanations	KC
Suggest	Offer an explanation deduced from information provided or previous knowledge (... a hypothesis; provides 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

WORD	DEFINITION	NOTES
Test	To find out, following set procedures	XS
Use	Implies the need to recall and apply in order to come to a conclusion	UK

Western Zone Office
28 September 2017



CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Advanced Proficiency Examination®
CAPE®



BIOLOGY

Specimen Papers and Mark Schemes/Keys

Specimen Paper: - Unit 1 Paper 01
Unit 1 Paper 02
Unit 1 Paper 032
Unit 2 Paper 01
Unit 2 Paper 02
Unit 2 Paper 032

Mark Scheme and Key: - Unit 1 Paper 01
Unit 1 Paper 02
Unit 1 Paper 032
Unit 2 Paper 01
Unit 2 Paper 02
Unit 2 Paper 032

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

BIOLOGY

SPECIMEN 2017

TABLE OF SPECIFICATIONS

Unit 1 – Paper 02

Module	Question	Specific Objective	Content	Cognitive Level Marks			Total
				KC	UK	XS	
1	1	1.9, 1.2, 4.4, 1.10, 1.11, 2.2, 2.3, 2.1, 3.1, 3.2	Food tests; Enzyme activity; Structure and function of prokaryotic and eukaryotic cells	10	15	5	30
2	2	2.6, 4.1, 4.2, 4.4, 5.4, 5.4	Meiosis I; R-DNA to produce insulin; Isolating mechanisms	10	15	5	30
3	3	2.2, 2.6, 2.3, 2.7	Hormones; Fertilization; Contraception	10	15	5	30
Total				30	45	15	90

Unit 1 – Paper 032 (Alternative to SBA)

Module	Question	Specific Objective	Content	Cognitive Level Marks			Total
				KC	UK	XS	
1	1	Practical	Module 1	0	5	10	15
2	2	Data Analysis	Module 1	0	5	10	15
3	3	Planning & Design	Module 2	0	-	15	15
Total				0	10	35	45

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

BIOLOGY

SPECIMEN 2017

TABLE OF SPECIFICATIONS

Unit 2 – Paper 02

Module	Question	Specific Objective	Content	Cognitive Level Marks			Total
				KC	UK	XS	
1	1	1.4, 3.1, 3.3, 3.4, 4.3, 4.5	Drawing and interpreting a graph; N ₂ cycle; Conservation of forests	10	15	5	30
2	2	2.1, 2.3, 3.1, 3.3	Detailed drawing of a cell; Translocation; Transport in humans	10	15	5	15
3	3	3.3, 2.1, 2.2, 2.4, 2.5, 2.9, 2.10	VO ₂ MAX; Immune system; Vaccination	10	15	5	30
Total				30	45	15	90

Unit 2 – Paper 032

Alternative to SBA

Module	Question	Specific Objective	Content	Cognitive Level Marks			Total
				KC	UK	XS	
1	1	Practical	Module 2	0	5	10	15
2	2	Data Analysis	Module 1	0	-	15	15
3	3	Planning & Design	Module 3	0	5	10	15
Total				0	10	35	45



CANDIDATE – PLEASE NOTE!

PRINT your name below and return this booklet with your answer sheet. Failure to do so may result in disqualification.

TEST CODE **02107010**

SPEC 2017/02107010

**CARIBBEAN EXAMINATIONS COUNCIL
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®**

**SPECIMEN PAPER
MULTIPLE CHOICE QUESTIONS
FOR**

BIOLOGY

UNIT 1 – Paper 01

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 minutes to answer them.
2. In addition to this test booklet, you should have an answer sheet.
3. Do not be concerned that the answer sheet provides spaces for more answers than there are items in this test.
4. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.
5. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

Which of the following metal atoms is present in a haemoglobin molecule?

- (A) Iron
- (B) Copper
- (C) Calcium
- (D) Magnesium

Sample Answer



The correct answer to this item is “Iron”, so (A) has been shaded.

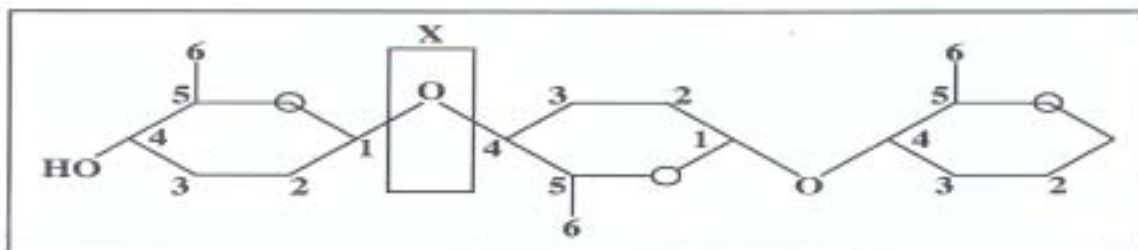
6. If you want to change your answer, erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.
8. You may do any rough work in this booklet.
9. Figures are not necessarily drawn to scale.
10. The use of non-programmable calculators is allowed.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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1. Water provides a constant external environment for many aquatic organisms. The specific property of water which allows for this is its
- (A) high heat capacity
 - (B) high heat of vaporisation
 - (C) high surface tension
 - (D) high heat of fusion

Item 2 refers to the diagram below.

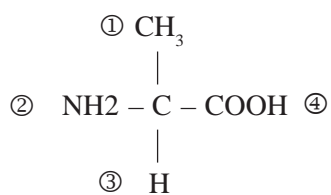


2. The 3-unit molecular structure shown above is found in which of the following polymers?
- (A) Glycogen
 - (B) Cellulose
 - (C) Starch
 - (D) Collagen

3. Which of the following numbers represent the correct number of fatty acid residues normally present in a phospholipid molecule?

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Item 4 refers to the amino acid alanine which has the following molecular formula.



4. Which of the following functional groups must combine to form a peptide bond?
- (A) 1 and 2
 - (B) 3 and 4
 - (C) 2 and 4
 - (D) 2 and 3

5. Which of the following types of bonds is responsible for stabilizing the secondary structure of a protein?

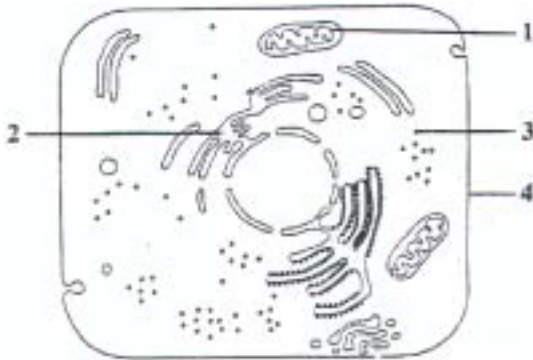
- (A) Disulphide
- (B) Hydrophobic
- (C) Ionic
- (D) Hydrogen

6. Which of the following molecules shows the characteristics listed below?

- I. The triple helices are linked by covalent cross links.
- II. They are polypeptides in the form of three helices.
- III. Every third amino acid in each helix is glycine.

- (A) Collagen
- (B) Glycogen
- (C) Haemoglobin
- (D) Glycoprotein

Item 7 refers to the diagram below which shows the ultrastructure of a eukaryotic cell.



7. Which of the following cell structures, labelled 1, 2, 3 and 4, is involved in the synthesis of lipids and steroids?

- (A) 1
- (B) 4
- (C) 2
- (D) 3

Item 8 refers to the following structures found in cells.

- I. Cell wall
- II. Cell Membrane
- III. Centrioles
- IV. Golgi Apparatus

8. Which of the following combinations are features common to BOTH plant and animal cells?

- (A) I and II
- (B) II and IV
- (C) II, III and IV
- (D) II and III

9. All of the following characteristics are typical of prokaryotes EXCEPT

- (A) they contain both ribosomes and a nucleus
- (B) their average diameter ranges between 0.5 - 10 μm
- (C) they have circular DNA
- (D) they are mainly unicellular

10. Xylem can MOST accurately be described as a tissue because it

- (A) consists of more than one type of cell
- (B) consists of vessels conducting mainly water and mineral salts
- (C) is impregnated with lignin
- (D) provides mechanical support for plants

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Item 11 refers to the figure below which shows part of the cell-surface membrane of a red blood cell.



11. Molecule Z acts as a carrier to transport selected substances across the membrane. Which of the following substances is MOST readily transported by this carrier molecule?

- (A) Fructose
- (B) Water
- (C) Glucose
- (D) Carbon-dioxide

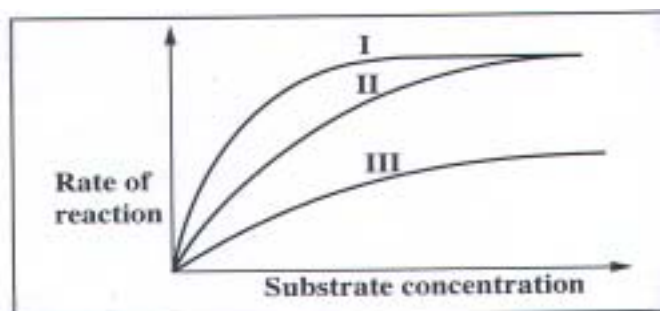
12. Na^+ and K^+ cannot pass freely into a cell across the phospholipid bilayer because

- (A) they are repelled by the charged cytoplasm
- (B) they are too large to pass
- (C) of the hydrophobic nature of the layer
- (D) they are moving against a concentration gradient

13. Amylase found in germinating seeds is incubated with starch at 25°C and pH 2. When a sample is removed after five minutes and mixed with a solution of iodine in potassium iodide solution, the mixture turns to a blue-black colour. The MOST likely explanation for this observation is

- (A) all the starch has been hydrolysed to maltose
- (B) a specific inhibitor of the amylase is present
- (C) amylase does not catalyse the hydrolysis of starch at 25°C
- (D) the pH is too low for the reaction to proceed quickly

Item 14 refers to the graph below which shows the rate of an enzyme catalysed reaction with and without inhibitors.

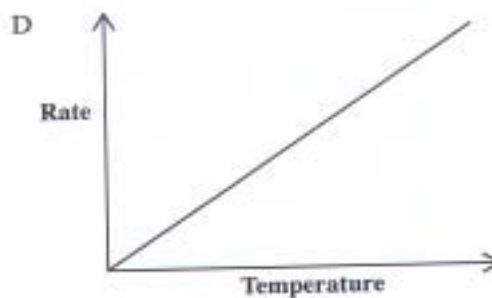
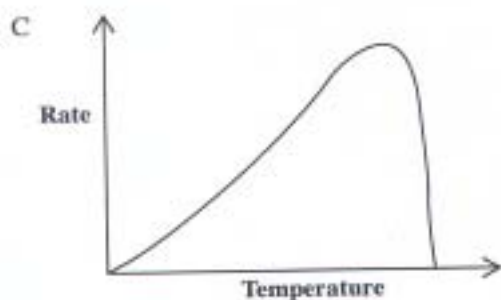
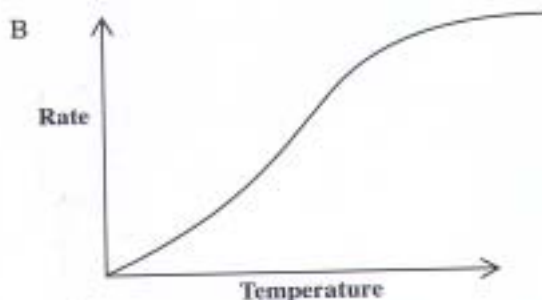
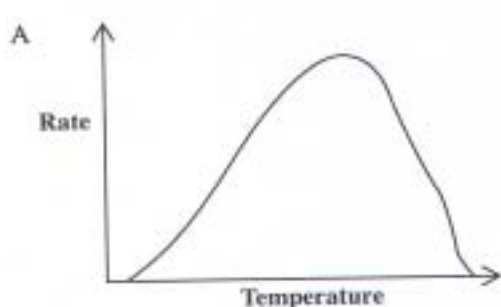


14. Which of the following sequences describes the types of reaction shown by Graphs I, II and III?

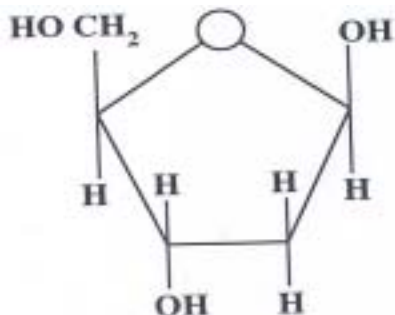
- | | Graph I | Graph II | Graph III |
|-----|-----------------------|---------------------------|---------------------------|
| (A) | Competitive inhibitor | Non-competitive inhibitor | No inhibitor |
| (B) | Competitive inhibitor | No inhibitor | Non-competitive inhibitor |
| (C) | No inhibitor | Competitive inhibitor | Non-competitive inhibitor |
| (D) | No inhibitor | Non-competitive inhibitor | Competitive inhibitor |

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15. Which of the following graphs BEST illustrates the effect of temperature on an enzyme controlled reaction?



Item 16 refers to the following diagram.



16. Which of the following molecules contains the monosaccharide shown above?

- (A) Glycogen
- (B) RNA
- (C) Cellulose
- (D) DNA

17. Which of the following molecules are required to activate amino acids for attachment during translation in protein synthesis?

- (A) tRNA and ATP
- (B) mRNA and ATP
- (C) mRNA, rRNA and ATP
- (D) tRNA, mRNA, rRNA and ATP

18. The MAXIMUM number of amino acid molecules which can be coded for by the triplet code is

- (A) 3
- (B) 20
- (C) 60
- (D) 64

19. Which of the following statements is true of homologous chromosomes?

- (A) They consist of two identical chromatids.
- (B) They move to the same pole during nuclear division.
- (C) They have the same sequence of genes.
- (D) They have the same sequence of bases.

Item 20 refers to diagrams which show the stages in the first division of meiosis.

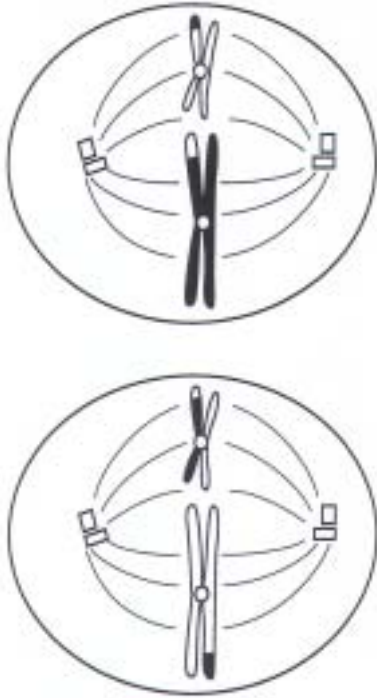


20. Which of the following sequences represents the correct sequence of events?

- (A) 3 2 4 1 5
- (B) 5 2 4 1 3
- (C) 3 2 1 4 5
- (D) 2 3 4 1 5

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Item 21 refers to the following animal cell during meiosis II.



21. Which of the following stages of meiosis II is shown in the diagram above?

- (A) Prophase
- (B) Metaphase
- (C) Anaphase
- (D) Telophase

22. Which of the following features correctly describe advantages of asexual reproduction to a species?

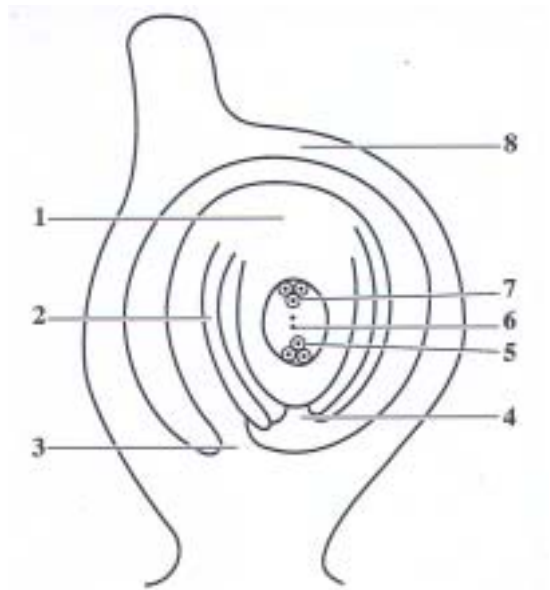
- I. Only one parent is required
- II. Self pollination is not dependent on wind or insects
- III. Rapid multiplication of the species
- IV. The offspring are genetically identical

- (A) I and IV
- (B) I, III and IV
- (C) I, II and IV
- (D) I, II, III and IV

23. In flowering plants, meiosis occurs in the

- (A) embryo sacs
- (B) ovules
- (C) pollen mother cells
- (D) ovary walls

Item 24 refers to the diagram below showing a fertilised ovule and carpel.



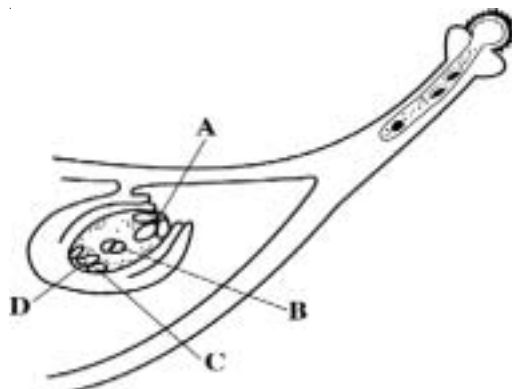
24. Which of the following represents the structures which will become the

- I. embryo
- II. testa
- III. micropyle of the seed

	I	II	III
(A)	6	2	3
(B)	7	8	1
(C)	6	1	7
(D)	5	2	4

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Item 25 refers to the diagram below which shows a germinating pollen grain and a mature ovule.



25. The nucleus which fuses with the male nucleus to form the zygote is

- (A) A
- (B) B
- (C) C
- (D) D

Item 26 refers to the following stages in the development of human sperm.

- I. Spermatid
- II. Spermatogonium
- III. Primary Spermatocyte

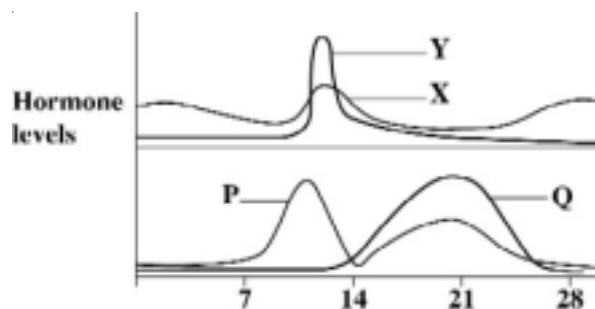
26. Which of the following combinations is the correct order of sperm formation?

- (A) I, II, III
- (B) II, III, I
- (C) II, I, III
- (D) I, III, II

27. The function of interstitial cells (cells of Leydig) is the production of

- (A) oestrogen
- (B) progesterone
- (C) follicle stimulating hormone
- (D) testosterone

Item 28 refers to the diagram below which shows the levels of various hormones involved in the menstrual cycle in human females.



28. Which ONE of the following is the most accurate deduction that can be made from the diagram?

- (A) Q at high concentrations stimulates Y.
- (B) P at high concentrations stimulates Y.
- (C) P at low concentrations stimulates X.
- (D) Q at low concentrations inhibits X.

29. The MAIN function of the placenta in humans is that it

- (A) protects the embryo
- (B) separates foetal and maternal blood
- (C) allows exchange of materials between foetus and mother
- (D) supports the embryo

30. All of the following are able to cross the placenta EXCEPT

- (A) *E. coli* bacterium
- (B) Human Immuno-Deficiency Virus
- (C) carbon monoxide
- (D) alcohol

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In tomatoes: R - red fruit (dominant)
r - yellow fruit
T - tall plant (dominant)
t - short plant

Both genes are on different chromosomes.

31. A tomato plant homozygous for allele R reproduces. The number of copies of this allele which will be found in the male gamete of this plant is

- (A) 1
- (B) 2
- (C) 4
- (D) 8

32. The characteristic of inflated pea pods is controlled by one allele of a particular gene. The other allele results in constricted pods.

Half the pollen grains of a heterozygous pea plant show the characteristic of inflated pods because alleles separate at meiosis during

- (A) anaphase I and anaphase II
- (B) metaphase II and anaphase II
- (C) prophase I and prophase II
- (D) metaphase I and anaphase I

33. A woman who is heterozygous for sickle cell anaemia, marries a man who is also heterozygous for sickle cell. The probability that their third child will carry a sickle cell allele is

- (A) 25%
- (B) 50%
- (C) 75%
- (D) 100%

34. The genotype of human zygotes will differ from that of both parents and grandparents.

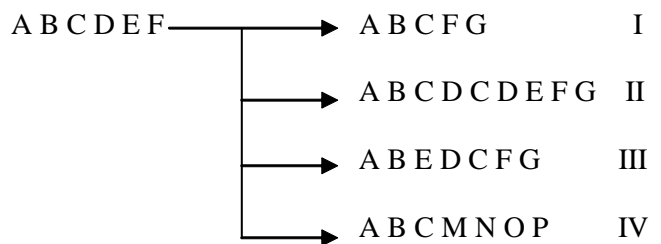
Which of the following occurrences does NOT contribute to this variation?

- (A) Chiasmata occurring during meiosis
- (B) Mutation of genes
- (C) Presence of recessive genes
- (D) Random combination of gametes

35. The coding DNA triplet for glutamic acid is CTT. This mutates to CAT in sickle cell haemoglobin. The complementary mRNA codon for sickle cell anemia is

- (A) GAA
- (B) GTC
- (C) GTT
- (D) GUA

36. Which of the following chromosomal mutations, labelled I - IV, is correctly identified?



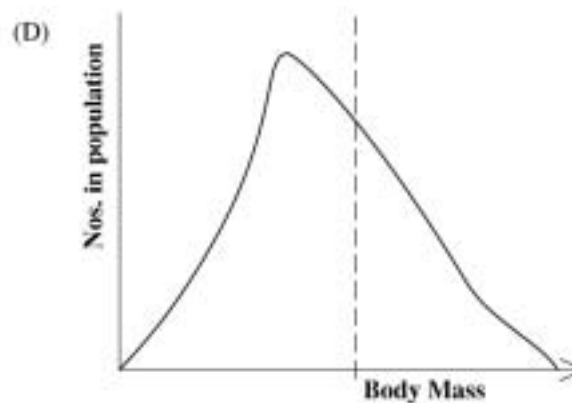
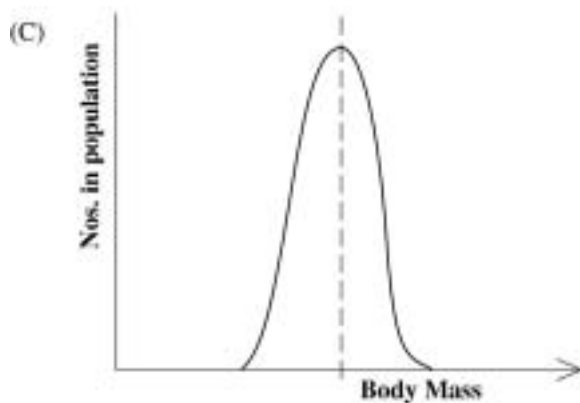
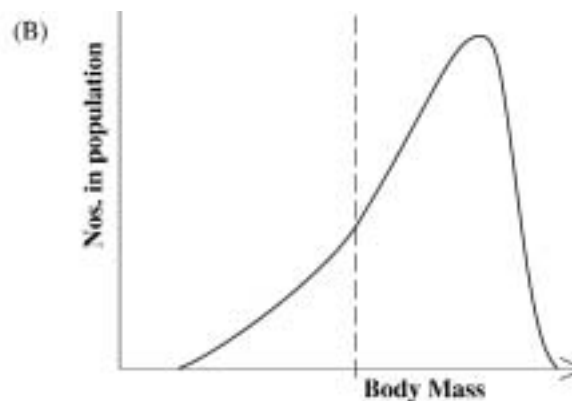
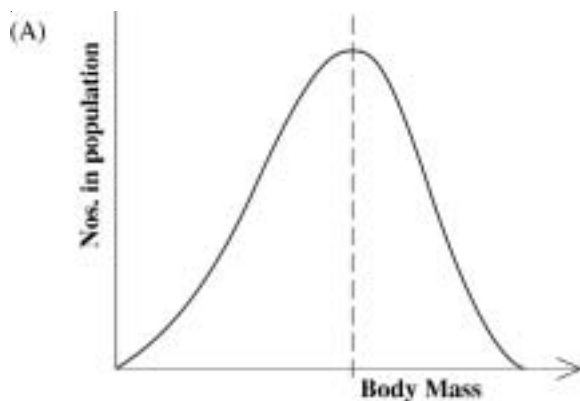
- (A) I - duplication
- (B) II - translocation
- (C) III - inversion
- (D) IV - deletion

37. In which of the following events is variation NOT involved?

- (A) Segregation of chromosomes at anaphase
- (B) Chiasma formation in chromosomes
- (C) Structural changes in chromosomes
- (D) Pairing of X and Y chromosomes

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38. In a population which displays wide variation in body mass, which of the following graphs BEST displays natural selection for this characteristic?



39. Which of the following BEST explains the type of natural selection exhibited by the peppered moths living in a polluted area?

- (A) Stabilizing selection
- (B) Selection pressure
- (C) Directional selection
- (D) Disruptive selection

40. Which of the following features can be BEST used to determine whether sexually reproducing flowering plants, from separate populations, are members of the same species?

- (A) They have the ability to cross-fertilize.
- (B) They have the ability to cross-pollinate.
- (C) They have the ability to produce viable seeds.
- (D) The viable seeds can produce fertile gametes.

41. Which of the following sequences illustrates the correct hierarchical order for the classification of living things?

- (A) Class, order, family, genus
- (B) Genus, order, class, family
- (C) Family, class, order, genus
- (D) Order, family, genus, class

Item 42 refers to the following classification scheme illustrating taxonomic levels.

Animalia
 Chordata
 Mammalia
 Rodentia
 Muroidea
 Rattus
 rattus

42. Which of the following is the correct name for the family to which this organism belongs?

- (A) Chordata
- (B) Mammalia
- (C) *Rattus*
- (D) Muroidea

43. When purebreeding white-seeded wheat plants were crossed with purebreeding red-skinned wheat plants, all of the F₁ generation had pink seeds.

The F₁ plants were self-pollinated producing plants with a phenotype ratio of

1 red seeded : 2 pink : 1 white seeded.

The number of genes controlling seed colour in this cross is

- (A) 2
- (B) 4
- (C) 1
- (D) 3

44. In which of the following taxonomic groups will all the organisms be MOST similar to each other?

- (A) Family
- (B) Kingdom
- (C) Genus
- (D) Order

45. Ex situ conservation methods for plants could be practised by all of the following methods EXCEPT

- (A) establishing botanic gardens
- (B) keeping them in arboreta
- (C) cultivating them in protected areas of their habitat
- (D) establishing seed banks

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

Listing of Form Section Data
Caribbean Examinations Council (CXC)

Test: **CAPE BIOLOGY (U1)** (MC ITEMS) Form: **02107010-SPEC2017**

Version No: **1**

Item No.	Key	Syllabus Reference	Profile	Module
1	A	1.1	P1	M1
2	B	1.4	P1	M1
3	B	1.6	P1	M1
4	C	1.7	P2	M1
5	D	1.8	P1	M1
6	A	1.9	P2	M1
7	C	2.2	P1	M1
8	B	2.4	P2	M1
9	A	2.5	P1	M1
10	A	2.6	P1	M1
11	C	3.1	P2	M1
12	C	3.2	P2	M1
13	D	4.3	P2	M1
14	C	4.4	P1	M1
15	C	4.3	P2	M1
16	D	1.1	P1	M2
17	A	1.3	P2	M2
18	D	2.1	P1	M2
19	C	1.4	P2	M2
20	A	2.5	P2	M2
21	B	2.6	P1	M2
22	B	3.1	P2	M2
23	C	3.2	P1	M2
24	D	3.5	P1	M2
25	A	3.6	P1	M2
26	B	4.3	P2	M2
27	D	4.5	P1	M2
28	B	4.7	P2	M2
29	C	4.10	P1	M2
30	A	4.12	P2	M2

Listing of Form Section Data
Caribbean Examinations Council (CXC)

Test: **CAPE BIOLOGY (U1)** (MC ITEMS) Form: **02107010-SPEC2017**

Version No: **1**

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34	C	2.1	P2	M3
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41	A	3.2	P2	M3
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SPEC 2017/02107020



TEST CODE 02107020

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CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BIOLOGY

UNIT 1 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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Module I

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

1. (a) (i) Students are given five test tubes containing either water, 0.25% sucrose solution, 1% sucrose solution, 1% glucose solution or starch solution. They perform tests for reducing sugar, non-reducing sugar and starch. By the end of the experiment, all the labels have fallen off the test tubes.

Given the results in Table 1, identify the solution that is in EACH test tube and give a reason for answer.

TABLE 1: RESULTS OF TESTS

Test Tube Number	Benedict's solution	Benedict's solution, dilute HCL, Sodium Bicarbonate	Iodine Test
1	Remains blue	Blue-green colour change	Yellow-brown colour
2	Blue-green-yellow-orange colour change	Blue-green-yellow-orange colour change	Yellow-brown colour
3	Remains blue	Blue-green-yellow-orange colour change	Yellow-brown colour
4	Remains blue	Remains blue	Yellow-brown colour
5	Remains blue	Remains blue	Blue-black colour

Test Tube 1

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Test Tube 2

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GO ON TO THE NEXT PAGE

Test Tube 3

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Test Tube 4

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Test Tube 5

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[5 marks]

- (ii) Explain the reaction occurring in Test Tubes 1 and 3 to allow for the colour change in Column 3.

Name of reaction

Explanation

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[2 marks]

- (b) (i) Figure 1 compares the enzyme activity for amylase on starch with and without the addition of an inhibitor. What type of inhibitor was most likely added to the enzymatic reaction represented by Curve A?

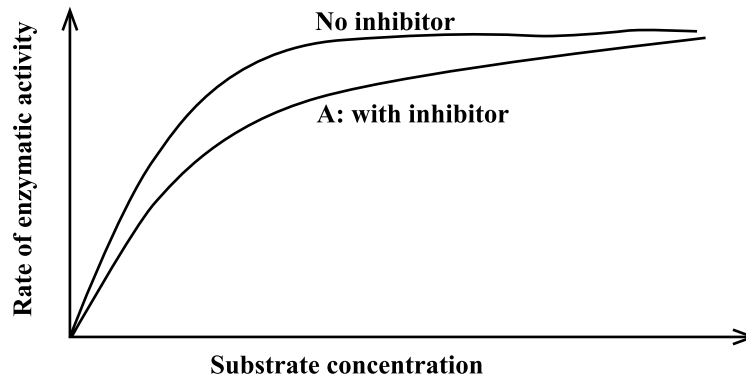


Figure 1: Graph showing enzymatic activity with and without an inhibitor

[1 mark]

- (ii) Although enzymes can be classified as globular proteins, not all globular proteins, for example, haemoglobin, are enzymes. Using your knowledge of protein structure, describe THREE protein structural levels present in haemoglobin. Include in your description, the bonds present at EACH structural level.

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[6 marks]

- (iii) Haemoglobin is a major component of red blood cells, which are examples of eukaryotic cells. A student makes the following observations of two given cell types:

Observations

Cell 1 contains DNA, ribosomes, cell membrane and cell wall

Cell 2 contains DNA, ribosomes, Golgi apparatus, rough endoplasmic reticulum, cell membrane and cell wall.

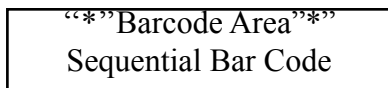
From these observations, indicate the cell that is prokaryotic and the cell that is eukaryotic.

Prokaryotic

Eukaryotic

[1 mark]

GO ON TO THE NEXT PAGE



(iv) State the function of EACH of the following structures:

Ribosomes

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Golgi apparatus

.....

Rough endoplasmic reticulum

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[3 marks]

(c) The structure and composition of the cell membrane govern cell transport, the model for which is referred to as a fluid mosaic membrane (FMM) model. A beaker has a cell encased by a cell membrane only. A solution containing water molecules (higher water potential than in the cell), potassium ions (lower concentration than in the cell) and glucose (higher concentration than in the cell) is poured into the beaker. With reference to the FMM model, explain how these substances are taken up by the cell.

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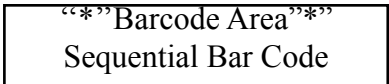
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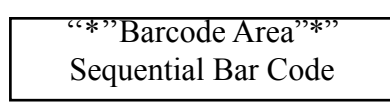
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Module 2

2. (a) Figure 2 shows four stages of Meiosis I in developing anther cells.

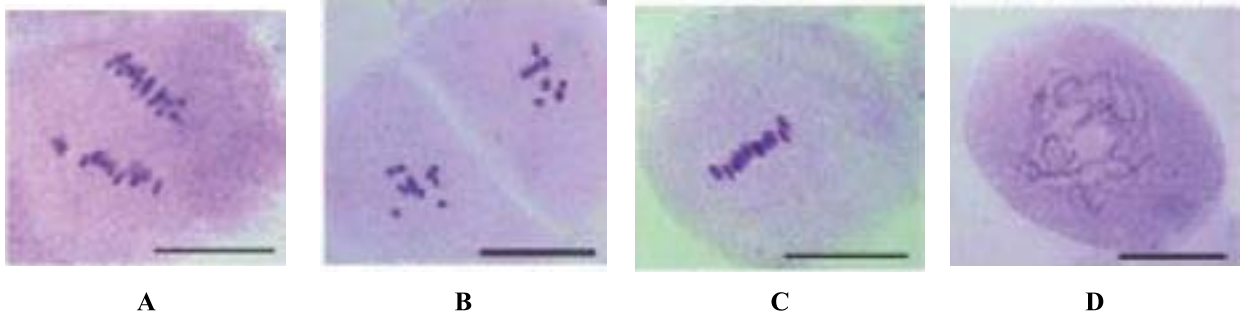


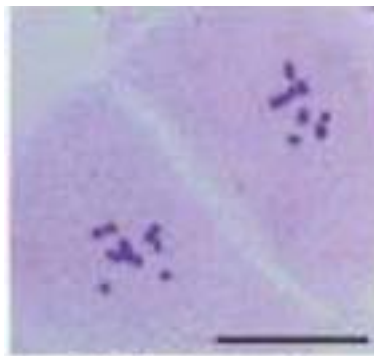
Figure 2. Stages of Meiosis I in developing anther cells.

Source: J Exp Bot. 2012 Sep;63(14): 5323–5335

(i) Order the images to illustrate the sequential steps in the process.

..... [1 mark]

(ii) Label the structures in Stage B.



Stage B

[3 marks]

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- (iii) Indicate the stage at which crossing-over events can occur, and explain how crossing-over events lead to genetic variation.

Stage at which crossing over can occur

Crossing over and variation

[5 marks]

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Advantages

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[8 marks]

- (c) R-DNA technology is an artificial process that can introduce changes in organisms. Some changes, however, can occur naturally over time. Using named examples, discuss the isolating mechanisms that arise in populations which may lead to them becoming two different species.

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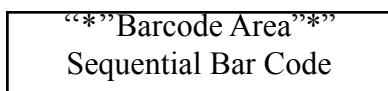
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Module 3

3. (a) Table 2 is an incomplete table for four hormones in the human body. Complete the table by writing the correct information in each column.

TABLE 2: HORMONES IN THE HUMAN BODY

Hormone	Individual	Site of Production	Target Organ	Action
Follicle-stimulating hormone (FSH)	Male			
FSH	Female			
Lutenising hormone (LH)	Male			
LH	Female			
Oestrogen	Male			
Oestrogen	Female			
Progesterone	Male			
Progesterone	Female			

[8 marks]

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- (b) Figure 3 shows the structure of a human oocyte. Write annotations for the parts labelled 1, 2 and 3.

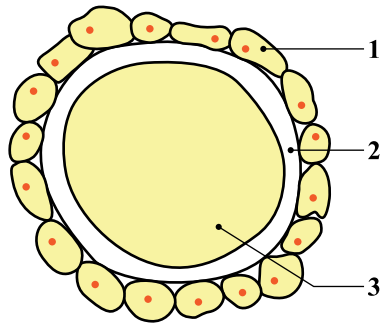


Figure 3. Cross section of a human ovary

1

2

3

[3 marks]

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(c) A couple wants to have children but not immediately after marriage.

(i) For pregnancy to take place, fertilization must occur but the vagina is a hostile environment for sperms. Explain how sperms overcome the structural and adverse conditions to fertilize the egg.

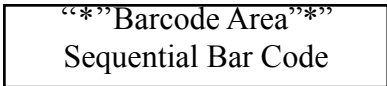
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[7 marks]

(ii) Identify FOUR contraceptive methods that may be suitable for the couple, and using your knowledge of the human reproductive system, discuss the structural and physiological means by which they prevent fertilization.

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[12 marks]

Total 30 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

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BIOLOGY

UNIT 1 - Paper 02

KEYS AND MARK SCHEME

MAY/JUNE 2018

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

Question 1 Sp. Obj. 1.9, 1.2, 4.4, 1.10, 1.11, 2.2, 2.3, 2.1, 3.1, 3.2

(a) (i) **Test Tube 1:** 0.25% sucrose. It was positive for non-reducing sugar but negative for reducing sugar and iodine test, like Test Tube 3. However, the colour change was less intense than Test Tube 3.

Test Tube 2: 1% glucose. It was positive for reducing sugar and non-reducing sugar test and negative for iodine test.

Test Tube 3: 1% sucrose. It was negative for reducing sugar and iodine, and positive for non-reducing sugar. The colour change more intense than Test Tube 1.

Test tube 4: Water, negative for all tests

Test tube 5: Starch. It was positive only for the iodine test which means starch was present.

1 mark for each = 5 marks

[5]

(ii) The process of **hydrolysis** took place in these test tubes

1 mark

Breaking of glycosidic bonds found in sucrose changes sucrose from a non-reducing sugar into a reducing sugar allowing colour change to occur because of the presence of the Benedict's solution.

1 mark

[2]

(b) (i) The type of inhibitor is **competitive 1 mark**

[1]

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

- (ii) Primary structure: chain of polypeptide, sequence of amino acids held together by peptide bonds.

2 marks (1 mark if no mention of peptide bonds)

Secondary structure: alpha helices and beta sheets held together by hydrogen bonds

2 marks (1 mark if hydrogen bonds or alpha helices or beta sheets are missing)

Tertiary structure: three-dimensional structure, folding of alpha helices and beta sheets into a 3-D structure or subunit held together by hydrogen bonds, covalent bonds, ionic bonds, disulphide bridges, van der waal forces.

2 marks (1 mark if less than 3 types of bonds are mentioned)

Quaternary structure: multiple subunits or tertiary structures coming together to make a functional protein held together by hydrogen bonds, covalent bonds, ionic bonds, disulphide bridges, van der waal forces.

2 marks (1 mark if less than 3 types of bonds are mentioned)

Any 3 levels = 6 marks **[6]**

- (iii) Prokaryotic - Cell 1
Eukaryotic - Cell 2

1 mark for both correct **[1]**

- (iv) Ribosomes: site of protein synthesis

Golgi apparatus: involved in packaging of substances for transport in the cell, modifies substances from the endoplasmic reticulum

Rough endoplasmic reticulum: protein synthesis

1 mark each = 3 marks **[3]**

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

(c) Fluid mosaic model

1. Structure of the cell membrane is a bilayer of phospholipids whose orientation results in a layer of hydrophobicity between regions of hydrophilic interactions **(1)** and includes glycolipids, cholesterol, protein, glycoprotein **(1)** and its fluidity, allowing movement of components **(1)**.
2. Given the fact that water, potassium ions and glucose are all polar molecules, they cannot simply diffuse through the membrane due to the hydrophobic region. **(1)**
3. Therefore, there is a need for proteins **(1)** whether as pumps, channels or carrier proteins within the membrane to aid with transport of these molecules into the cell. **(1)**
4. Water is moving from an area of high potential to an area of low potential, thus it will move via passive transport, in particular osmosis **(1)**, and to facilitate this a protein channel is needed/ aquaporin. **(1)**
5. Potassium ions will be moving from an area of low concentration to an area of high concentration, thus active transport is going to take place, meaning that there is a need for ATP **(1)**. To facilitate this, a protein pump is required. **(1)**
6. Glucose is moving from an area of high concentration to an area of low concentration, therefore facilitated diffusion is going to occur. **(1)** To facilitate this movement, either a carrier protein or a protein channel can be used for its transportation. **(1)**

[12]

Total 30 marks

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

Question 2. Sp. Obj.2.6, 4.1, 4.2, 4.4, 5.4, 5.4

(a) (i) D → C → A → B **1 mark** [1]

(ii) Labelling of Stage B

Labels should show

- cell plate (center)
- cell wall (outer)
- chromosomes

1 mark each

[3]

(iii) Crossing over can occur at Stage D (prophase) **1 mark**

Crossing over and variation

- Homologous chromosomes pair and wind around each other.
- Where two chromatids touch each other, the DNA breaks and sections are exchanged between non-sister chromatids. This is called crossing over.
- Crossing over results in chromosomes that are part maternal in origin and part paternal
- This gives different combinations of alleles of different genes - variation.

1 mark each = 4 marks

[5]

(b) R-DNA process

1. Isolation of genes: DNA is removed from a host source. (The insulin gene (INS) coding for insulin production is extracted from a sample of human DNA).
2. Enzyme restriction: circular plasmid DNA from a bacterium is "cut" via an endonuclease enzyme that breaks the DNA phosphate backbone making it linear.
3. Ligation: the "pasting together" of (different source) fragments of DNA forming the recombinant DNA molecule... using the ligase enzyme, the human insulin gene is then combined with the linear plasmid DNA and is re-circularized.
4. Uptake of plasmid: uptake of DNA by an organism (bacterium)... the new recombinant DNA is taken-up by other bacteria to facilitate replication of the plasmid.

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

5. Cloning: the subsequent growth (ideal conditions) allows for high production of multiple copies of the new plasmid (R-DNA molecule) and production of the gene product ... insulin.

1 mark each = 5 marks

Advantages

1. More efficient process in that higher yields are obtained
2. More cost effective / less expensive
3. No animals have to be slaughtered (cattle, pigs, salmon)
4. Faster, less tedious and less difficult process

Any 3 = 3 marks

[8]

(c) Isolating mechanisms

1. Temporal - individuals do not mate because they are active at different times of the day or during different seasons. This may have resulted from resource limitations or changes over time.
2. Behavioural / reproductive - potential mates meet but they do not mate due to strict behavioural complexities e.g. mating dances or vocalisations. This may occur where mate choice is not a limitation.
3. Geographical / ecological - Individuals prefer to mate in their desired habitat and therefore do not meet individuals of other ecological preferences. This may happen, for example, when new food sources become available in the habitat. Also, Physical changes in landscape may result in physical barriers which may separate populations.
4. Mechanical - structural differences mean that sex organs of males and females of different species are incompatible.

3 marks for each mechanism fully discussed

1 mark for correct examples

[13]

Total 30 marks

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

Question 3. Sp. Obj.2.2, 2.6, 2.3, 2.7

(a)

Hormone	Individual	Site of Production	Target Organ	Action
Follicle-stimulating hormone (FSH)	Male	Anterior pituitary gland	Testes	Stimulates Sertoli cells to develop sperm cells
FSH	Female	Anterior pituitary gland	Ovary	Stimulates oogenesis
Lutenising hormone (LH)	Male	Anterior pituitary gland	Testes interstitial cells	Stimulates interstitial cells to secrete testosterone
LH	Female	Anterior pituitary gland	Ovary follicle	Stimulates release of secondary oocyte at ovulation
Oestrogen	Male	Testes interstitial cells	Testes and epididymis	Regulates spermatogenesis and sperm maturation in epididymis
Oestrogen	Female	Follicle in ovary	Uterus	Stimulates repair and growth of endometrium; stimulates growth and

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

				development of primary and secondary sexual characteristics
Progesterone	Male	Testes	Seminiferous tubules	Helps regulate sperm production; increases sperm motility
Progesterone	Female	Corpus luteum in ovary	Uterus	Maintains endometrium

1 mark for each correct row = 8 marks

[8]

(b) Structure of oocyte

1. Follicle cells - form a protective layer around the oocyte
2. Zona pellucida - a clear jelly-like protective layer through which spermatozoa must penetrate
3. Oocyte - contains chromosomes which still have to complete their meiotic divisions

1 mark for each part annotated = 3 marks

[3]

(c) (i) Fertilization

1. The pH of the vagina is low and tends to kill sperms. They are able to move as a mass through the cervix because the semen coagulates immediately after ejaculation.
2. The sperms must travel a far distance to the ovarian end of the oviduct. They are aided by the contractions of the cervix, uterus and oviduct.
3. During the fertile period, the cervical mucus forms channels for the mass of sperms to swim through.
4. Sperms must go through a process called capacitation - glycoproteins are removed from the outer surface and the membranes become more permeable to calcium ions
5. The calcium ions increase their motility, and help the release of enzymes from the acrosome.
6. The enzymes digest a pathway through the follicle cells to the surface membrane of the oocyte.

BIOLOGY

UNIT 1 - PAPER 02

MARK SCHEME

7. The membranes of the sperm and oocyte fuse.

1 mark each = 7 marks

[7]

(ii) Contraceptives

1. Barrier - condom/femidom placed over the penis/into the vagina which prevents sperms from entering the vagina during intercourse
2. Diaphragm/cap - placed over the cervix to prevent sperms from entering the cervix
3. Intrauterine device - releases progesterone which prevents implantation of the fertilized egg (controls the lining of the uterus)
4. Spermicides - chemicals that destroy the sperms to prevent them from reaching the egg
5. Contraceptive pill - contains one or both ovarian hormone to prevent ovulation

3 marks for each of 4 methods = 12 marks

[12]

Total 30 marks

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BIOLOGY - SPECIMEN PAPER

UNIT 1 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
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Answer ALL questions.

Write your answers in the spaces provided in this booklet.

Please begin Question 1 FIRST.

1. You are to carry out a simple investigation into the effect of different concentrations of a sucrose solution on the tissue of the cucumber fruit. Read the instructions that follow carefully before beginning.

You are provided with the following:

- 0.1 M, 0.2 M, 0.3 M, 0.4 M, 0.5 M of a sucrose solution
- cucumber (unpeeled)
- 5 petri dishes

Remove ten, 2 cm deep sections that are 5 cm long from the cucumber provided, as shown in Figure 1 (i) and (ii) below.

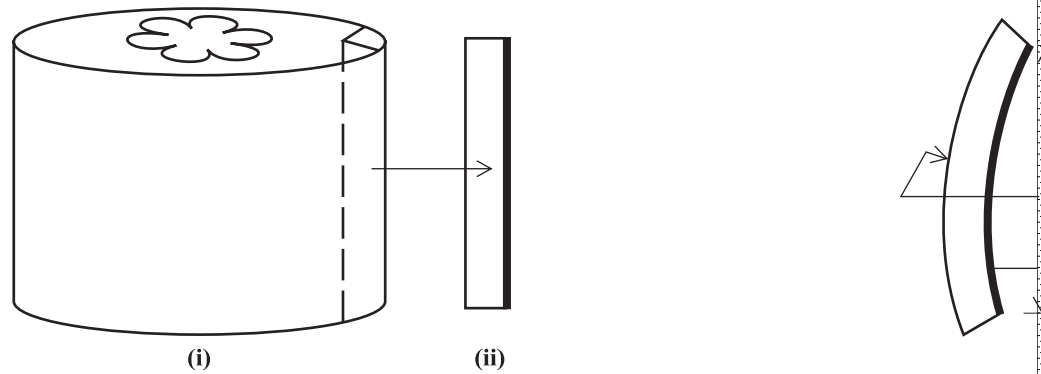


Figure 1. Sections cut from a cucumber

Each strip should have a tough covering of cuticularized epidermis, while the inner part is composed of cortical parenchyma cells.

As soon as the strip is cut out of the cucumber, it bends backwards as shown in Figure 2.

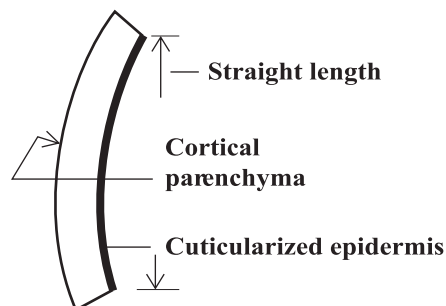


Figure 2

Measure the straight length of the epidermal strips and record the results.

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Place TWO (2) strips in each of the five petri dishes and treat as follows:

Petri Dish	Treatment
A	cover with sucrose solution 0.1 M
B	cover with sucrose solution 0.2 M
C	cover with sucrose solution 0.3 M
D	cover with sucrose solution 0.4 M
E	cover with sucrose solution 0.5 M

The cucumber strips should be completely submerged in the solutions.

Cover each petri dish and leave for 30 minutes.

CONTINUE WITH THE REST OF THE EXAMINATION IN THE MEANTIME

After the 30 minutes have elapsed, measure the straight lengths of the strips in Petri Dish A and find the average length. Repeat for the other strips in the remaining petri dishes.

- (a) Construct a table to show your results which will include the following: sucrose concentrations, initial length of strips, final length of strips and average length of strips in each concentration.

[6 marks]

GO ON TO THE NEXT PAGE

- (b) Which sucrose solution has a water potential CLOSEST to that of the cucumber?

..... [1 mark]

- (c) Construct simple line drawings of the strips in sucrose solutions of concentrations:

(i) 0.1 M

[2 marks]

(ii) 0.5 M

[2 marks]

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- (d) (i) State PRECISELY what happens to the cortical cells in the 0.1 M sucrose solution.

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[2 marks]

- (ii) State PRECISELY what happens to the cortical cells in the 0.4 M sucrose solution.

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[2 marks]

Total 15 marks

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2. (a) The rates of enzyme-catalysed reactions can be influenced by the pH at which they occur. Table 1 shows the relative reaction rates for salivary amylase and arginase at different pH values.

(i) On the grid provided on page 9, plot a graph of the relative rates for BOTH salivary amylase and arginase.

[5 marks]

TABLE 1: REACTION RATES FOR TWO ENZYMES

pH Values	Relative reaction rates	
	Salivary amylase (units)	Arginase (units)
4.5	2.2	0
5.0	5.0	0
5.5	8.0	0.2
6.0	13.0	1.0
6.5	17.0	4.0
7.0	18.0	7.0
7.5	16.0	9.0
8.0	11.0	11.8
8.5	6.0	13.5
9.0	2.0	16.0
9.5		18.0
10.0		17.8
10.5		15.0
11.0		14.0

(ii) Using the graph, determine the optimal pH for

• arginase activity [1 mark]

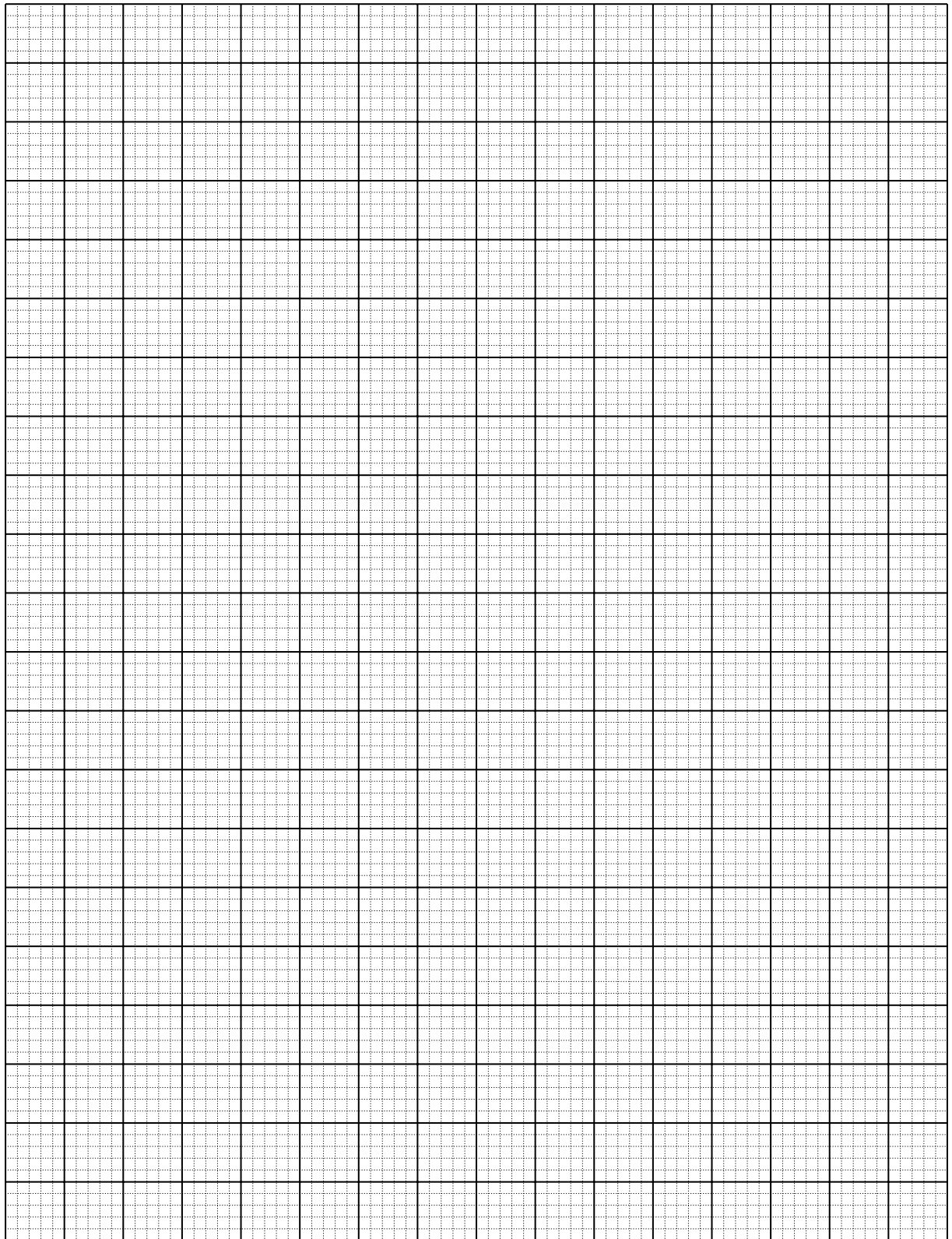
• salivary amylase activity [1 mark]

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- (iii) Compound X is a substance that has two parts, Part 1 and Part 2. Part 1 can be digested ONLY by arginase and Part 2 ONLY by salivary amylase. Both enzymes are required for the complete digestion of compound X.

Determine the optimal pH at which BOTH of these enzymes together digest compound X.

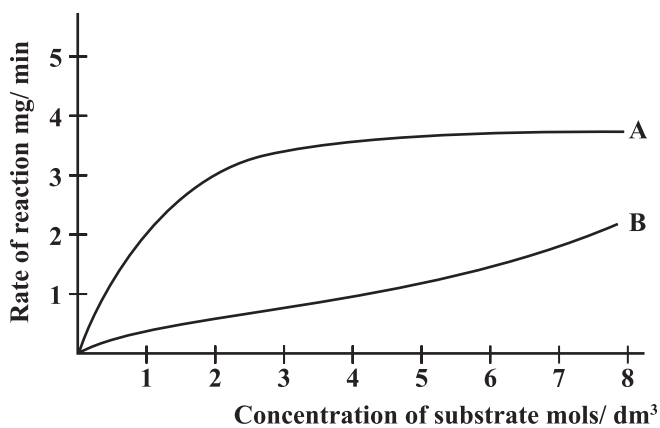
..... [1 mark]

- (iv) Explain the results obtained for salivary amylase at pH 5 and 7.

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[3 marks]

(b)



- (i) Which graph line represents the enzyme-catalysed reaction?

..... [1 mark]

GO ON TO THE NEXT PAGE

(ii) Give ONE reason for your answer in 2 (a) (i).

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[2 marks]

(iii) At what concentration of substitute is the rate of reaction MAXIMAL?

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[1 mark]

Total 15 marks

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3. A laboratory technician prepared two glucose solutions of different concentrations for a laboratory practical exercise the following day. The technician was called away and when he returned he realised he had not labelled the bottles.

Design an experiment that could help the technician to determine which of the solutions prepared is the more concentrated, if a 1 M solution of glucose from which the following dilution could be prepared: 0.75 M, 0.5 M, 0.25 M.

- (a) List the apparatus that would be required.

.....
.....
.....
.....

[3 marks]

- (b) List the reagents that would be needed.

.....
.....
.....
.....

[2 marks]

- (c) List the steps that should be taken to make a coloured standard.

.....
.....
.....
.....
.....
.....
.....
.....
.....

[4 marks]

GO ON TO THE NEXT PAGE

DO NOT WRITE IN THIS AREA

- (d) Provide a table showing how the results for the coloured standard should be presented.

[3 marks]

- (e) How would the coloured standard be used to determine which solution is more concentrated?
List the steps:

.....

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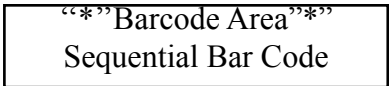
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[3 marks]

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.



C A R I B B E A N E X A M I N A T I O N S C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

2017

BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

Question 1.

(a) Construction of suitable columns.

Table should look similar to table below.

Sucrose Concentration	Strips	Initial Straight Length	Final Straight Length	Average Length
0.1	1			
	2			
0.2	3			
	4			
0.3	5			
	6			
0.4	7			
	8			
0.5	9			
	10			

Title - 1 mark

Construction of table - 2 marks

Final straight lengths for strips in various concentrations:

0.1M - straight length should decrease very significantly

0.2M - straight length should decrease marginally

0.3M - no significant change in length

0.4M - straight length should increase significantly

0.5M - straight length will decrease

5 average lengths correct - 3 marks

4 average lengths correct - 2 marks

3 average lengths correct - 1 mark

<3 average lengths correct - 0 marks

UK	XS
	3
	3

BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

Question 1. (continued)

(c) (i) Diagrams to show how the cucumber strips would look after 30 minutes.

0.1M - emphasis on cortical parenchyma

Cells splitting - 1 mark

Correct line representation - 1 mark

(ii) 0.5M - emphasis on cuticularized epidermis

Carving outwards - 1 mark

Correct line representation - 1 mark

- (d) (i)
- The 0.1M solution has a higher water potential than the cell sap of the cortical cells of the strip.
 - The water from the solution passes into the cells by osmosis.
 - The cortical cells expand with turgidity.
 - Their increased size causes the inelastic epidermis to be curved back.

3 correct points - 2 marks

2 correct points - 1 mark

1 correct point - 0 marks

UK	XS
	2
	2
2	

BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

Question 1. (continued)

- (d) (ii)
- Solution 0.5M has a lower potential than the cortical cell sap.
 - Water moves by osmosis from the cortical cells into the bathing solution.
 - The cell vacuole is reduced in volume.
 - The tissue becomes flaccid and draws the inelastic epidermis inwards.
- 3 correct points - 2 marks**
2 correct points - 1 mark
1 correct point - 0 marks

UK	XS
2	

BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

Total 18 marks

5	10

Syllabus Objectives: 3.2, 3.3 - Module 1

Question 2.

UK	XS
----	----

BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

(a)	(i)	X- and Y-axes correct and properly labelled	1
		Points plotted correctly for <u>salivary amylase</u>	1
		Points plotted correctly for <u>arginase</u>	1
		Curve smoothly drawn for <u>salivary amylase</u>	1
		Curve smoothly drawn for <u>arginase</u>	1
	(ii)	Optimal pH Arginase 9.5 - 10.0 pH	1
		(Any point in this range - 1 mark)	
		Optimal pH Salivary amylase 6.5 - 7.0 pH	1
		(Any point in this range - 1 mark)	
	(iii)	7.6 - 8.4 range	1
		(Any point in this range - 1 mark)	
	(iv)	<ul style="list-style-type: none">pH affect the primary structure of enzymes.At pH 7, active site has the correct conformation shape and substrate - enzyme complex can form.At pH 5, conformation of active site is altered - enzyme substrate complex can no longer form.	3
		3 points - 3 marks	
(b)	(i)	Graph line A	1
	(ii)	<ul style="list-style-type: none">Rate of reduction shown in graph line A is higher than that for graph line B.Rate of reduction increases as substrate concentration increases and then levels off.Active sites become saturated.	2
			1

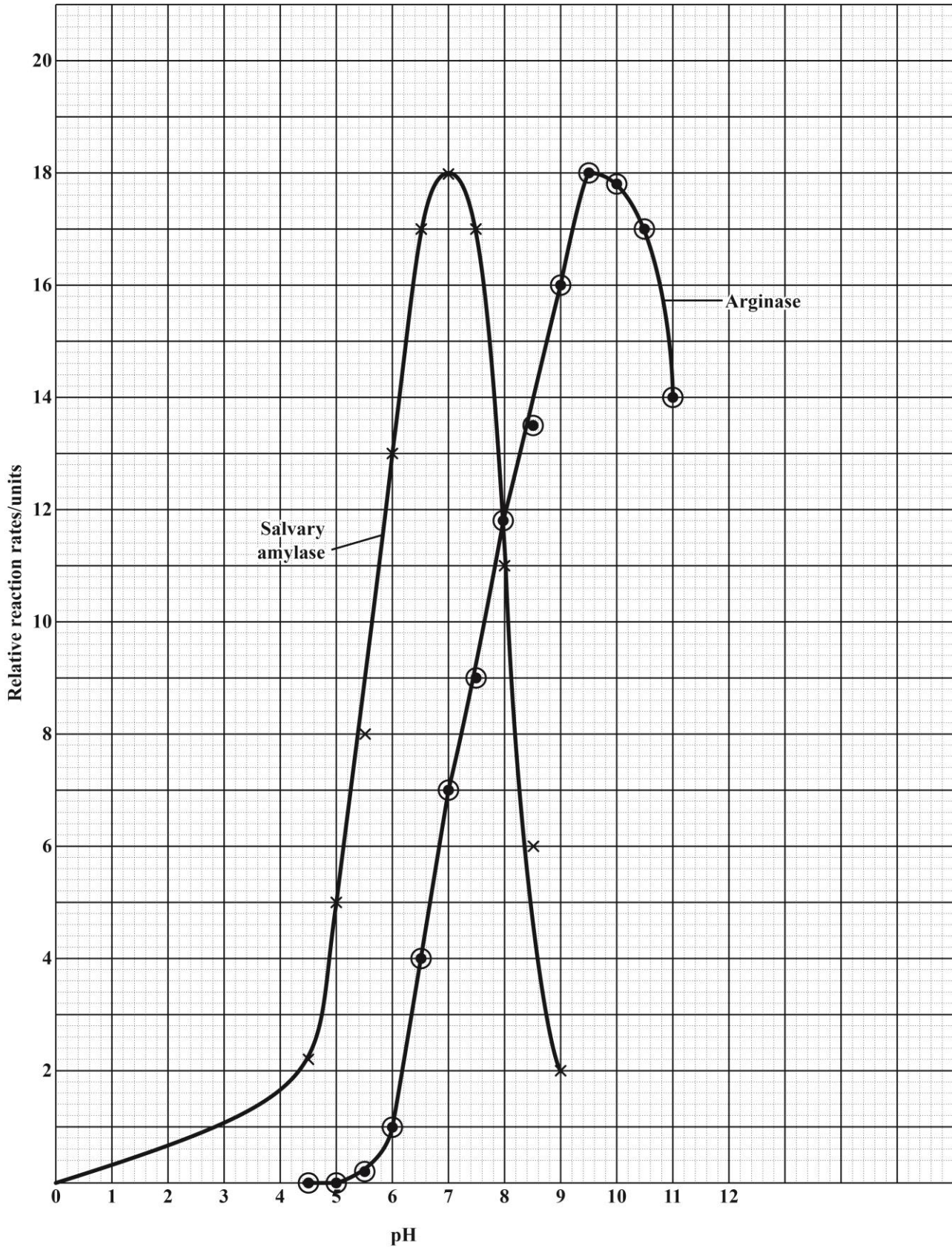
BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

Question 2. (continued)

Graph



BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

Question 3.

(a) Apparatus required:

- Measuring cylinders
- Beakers
- Test tubes
- Test tube holders / test tube racks
- Syringes / pipettes
- Bunsen burner or water bath

4 points - 3 marks

3 points - 2 marks

2 points - 1 mark

(b) Reagents required:

- Benedict's solution
- Distilled water
- Glucose

3 points - 2 marks

1 point - 1 mark

(c) To make 0.75M glucose solution

- Place 25 cm³ of distilled water in a measuring cylinder.
- Use a syringe (or pipette) to draw up 75 cm³ of the 1M glucose solution. Add to the 25 cm³ of water in the measuring cylinder.
- Place mixture in a labelled beaker.
- To make the other dilutions repeat the procedure above using the ratios given below:

0.5M → 50 cm³ 1M glucose solution: 50 cm³ distilled water.

0.25M → 25 cm³ 1M glucose solution: 75 cm³ distilled water.

UK	XS
	3
	2
	1
	1

BIOLOGY

UNIT 1 - PAPER 032

MARK SCHEME

Total 12 marks

-	12

Syllabus Objectives: 1.10, 1.11



CANDIDATE – PLEASE NOTE!

PRINT your name below and return this booklet with your answer sheet. Failure to do so may result in disqualification.

TEST CODE **02207010**

SPEC 2017/02207010

**CARIBBEAN EXAMINATIONS COUNCIL
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®**

**SPECIMEN PAPER
MULTIPLE CHOICE QUESTIONS
FOR**

BIOLOGY

UNIT 2 – Paper 01

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 minutes to answer them.
2. In addition to this test booklet, you should have an answer sheet.
3. Do not be concerned that the answer sheet provides spaces for more answers than there are items in this test.
4. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.
5. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

Which of the following is NOT a form of energy storage?

- (A) ATP
- (B) Lipid
- (C) Alcohol
- (D) Lactic acid

Sample Answer



The correct answer to this item is “ATP”, so (A) has been shaded.

6. If you want to change your answer, erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.
8. You may do any rough work in this booklet.
9. Figures are not necessarily drawn to scale.
10. The use of non-programmable calculators is allowed.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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1. ATP is often described as the 'universal energy currency of cells'. An important feature of ATP is that it

- (A) takes part in a limited number of reactions of metabolism
- (B) is used only where it is made
- (C) couples catabolic and anabolic processes.
- (D) is released in large amounts

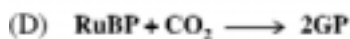
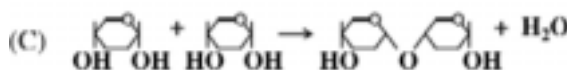
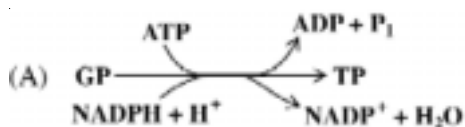
2. When non-cyclic photophosphorylation occurs

- (A) light energy in the green region of the spectrum is absorbed
- (B) carbon dioxide is fixed
- (C) oxygen is produced
- (D) NAD is reduced

3. The products formed at the end of stage 1 in the light dependent reactions of photosynthesis are

- (A) oxygen, ATP and NADP
- (B) oxygen, ATP and reduced NADP
- (C) water, ATP and NADP
- (D) water, ATP and reduced NADP

4. In which of the following reactions of photosynthesis is the first carbohydrate formed?



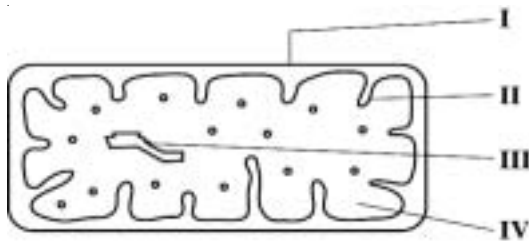
5. The knowledge of the limiting factors which affect the rate of photosynthesis of a particular plant species CANNOT be used directly to

- (A) produce disease resistant plants
- (B) increase the food yield of the plant
- (C) control environmental stress
- (D) control flowering and fruiting

6. Glycolysis requires glucose, the appropriate enzymes and

- (A) reduced NAD
- (B) ATP
- (C) pyruvate
- (D) acetyl co-enzyme A

7. The diagram below represents a mitochondrion. Which of the labels I to IV indicate the sites of Krebs Cycle and the Electron Transport Chain?



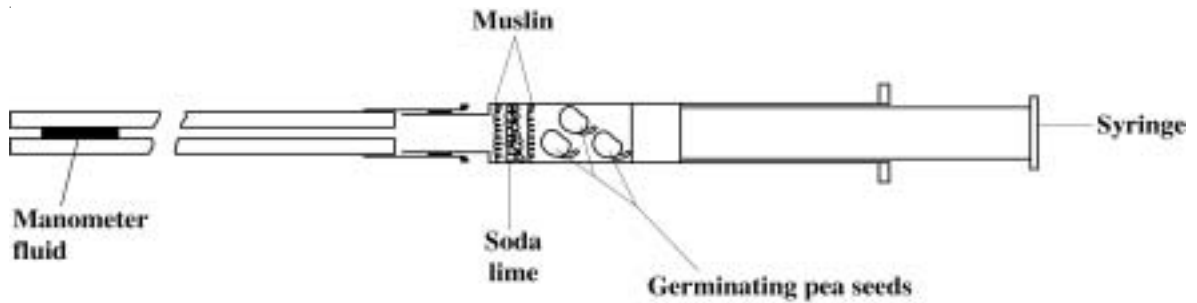
8. Pyruvate produced by glycolysis can only become part of the Krebs cycle if it is first converted to

- (A) NADH
- (B) ethanol
- (C) acetyl-coenzyme A
- (D) citrate

	Krebs Cycle	Electron Transport Chain
--	-------------	--------------------------

- | | | |
|-----|-----|-----|
| (A) | I | II |
| (B) | II | III |
| (C) | III | IV |
| (D) | IV | II |

9. The diagram shows a simple respirometer.



10. Which of the following is NOT a function of anaerobic respiration in yeast?

- (A) Generation of reduced NAD
- (B) Continuation of glycolysis
- (C) Generation of ATP
- (D) Production of carbon dioxide

11. Which of the following BEST describes an ecological niche?

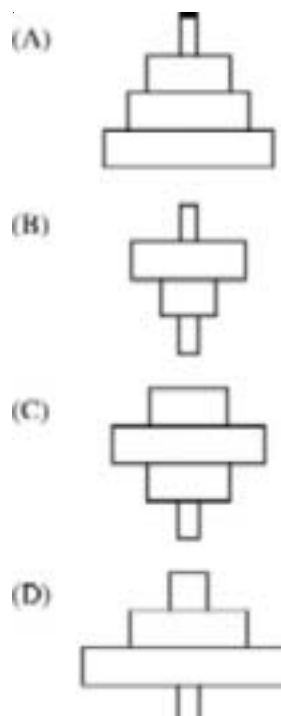
- (A) The relationship between the species and the other organisms in the habitat
- (B) The functional role that the organism plays in its habitat
- (C) The habitat that provides food for the organism
- (D) The habitat that provides the most suitable environmental conditions for the organism

12. Which of the following is considered as a limit to the number of trophic levels in a food chain?

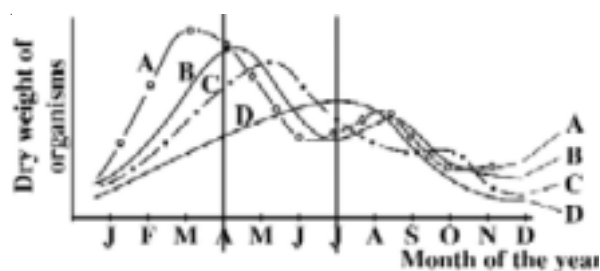
- (A) The diversity of species in the ecosystem
- (B) A high percentage of the energy consumed is converted to heat
- (C) Some of the energy consumed is lost in faeces and urine
- (D) The net productivity of the ecosystem

13. Tree → caterpillars → insectivorous birds → snakes.

Which of the following diagrams represent a pyramid of numbers for the food chain shown above?



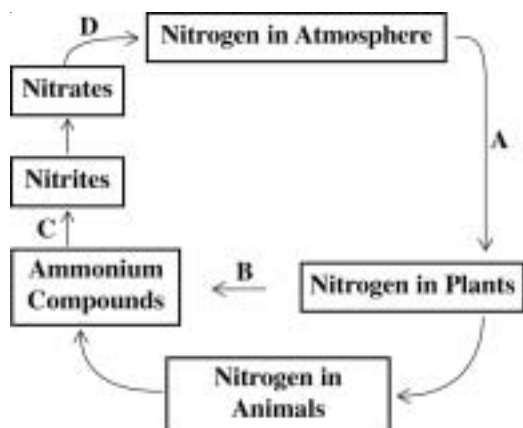
Item 14 refers to the following graph which represents biomass of organisms over a period of time.



14. If all four trophic levels are represented, which graph would identify plankton?

- (A) A
- (B) B
- (C) C
- (D) D

Item 15 refers to the following diagram which represents part of the nitrogen cycle.



15. Nitrifying bacteria are MOST active at

- (A) A
- (B) B
- (C) C
- (D) D

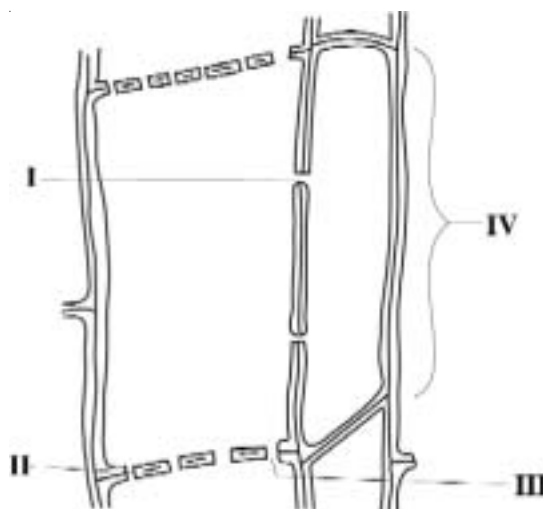
16. Which of the following is NOT a characteristic feature of xylem vessels?

- (A) No end walls
- (B) Cells end to end
- (C) Thick cellulose cells walls
- (D) No cell contents (hollow)

17. Root pressure, capillarity, cohesion and adhesion all contribute to

- (A) the movement of sucrose along the phloem
- (B) the ascent of water in xylem vessels
- (C) the mass flow of nutrients along sieve elements
- (D) the loss of water via the leaves

Item 18 refers to the figure below showing an outline of some of the cells from the phloem of a mango tree.



18. Which of the following correctly identifies the structures numbered I to IV?

- | | I | II | III | IV |
|-----|-------------|-------------|-------------|----------------|
| (A) | Sieve pore | sieve tube | plasmodesma | companion cell |
| (B) | Plasmodesma | sieve plate | sieve pore | sieve tube |
| (C) | Plasmodesma | sieve plate | sieve pore | companion cell |
| (D) | Seve plate | sieve pore | sieve tube | plasmodesma |

GO ON TO THE NEXT PAGE

19. Which of the following statements provides the BEST explanation of why sucrose rather than glucose is transported by the phloem?

- (A) Sucrose passes through plant cell surface membranes more easily.
- (B) Sucrose is a disaccharide and is more easily converted to starch.
- (C) Sucrose is a non-reducing sugar and so it is less reactive.
- (D) Sucrose synthesis does not require ATP.

20. The Mass Flow Theory of the transport of organic solutes in the phloem postulates that

- (A) sucrose diffuses from mesophyll cells into the phloem along a concentration gradient
- (B) sucrose moves by osmosis into the phloem when water ascends the xylem into the leaf
- (C) Sucrose is actively pumped by mesophyll cells directly into the phloem against a concentration gradient
- (D) sucrose is actively pumped by companion cells mediating between mesophyll cells and phloem against a concentration gradient

21. In which of the following phases of the cardiac cycle is a pulse generated?

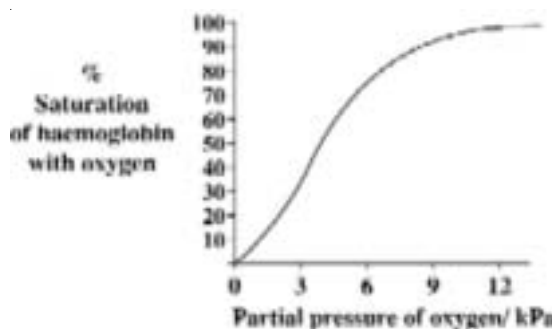
- (A) Atrial systole
- (B) Atrial diastole
- (C) Ventricular systole
- (D) Ventricular diastole

22. Which of the following correctly identifies the mammalian blood cell shown in the diagram below?



- (A) macrophage
- (B) red blood cell
- (C) neutrophil
- (D) lymphocyte

23. The graph below shows the oxygen dissociation curve for human haemoglobin.



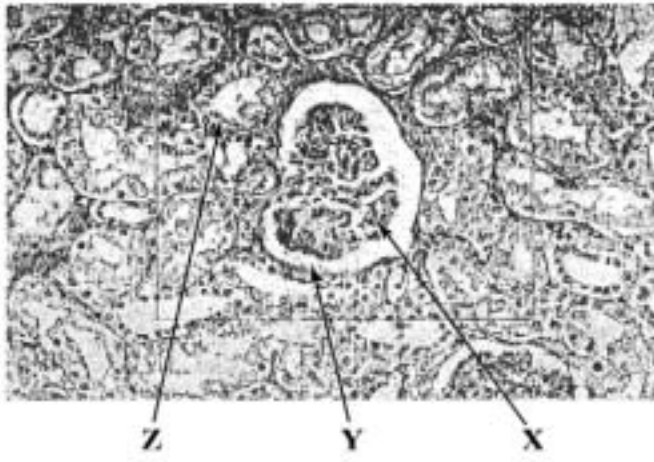
Which of the following ranges of partial pressures of oxygen would be found in pulmonary arteries?

- (A) Between 0 and 3 kPa
- (B) Between 3 and 6 kPa
- (C) Between 6 and 9 kPa
- (D) Between 9 and 12 kPa

24. Which of the following is NOT a function of the liver?

- (A) Production of plasma proteins
- (B) Metabolism of fat
- (C) Control of blood sugar
- (D) Storage of Vitamins B, C and D

Item 25 refers to a micrograph of part of the cortex of the kidney.



25. Which of the following correctly identifies X, Y and Z?

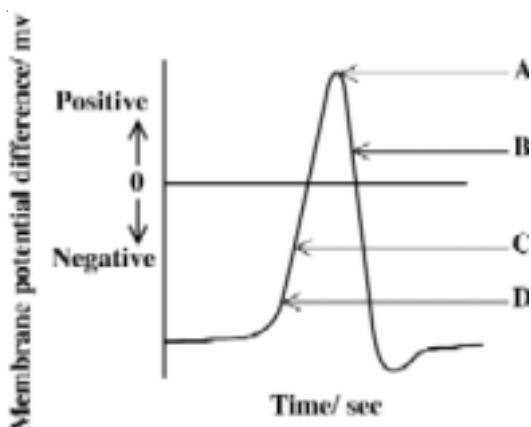
- | | X | Y | Z |
|-----|--------------------------|--------------------------|--------------------------|
| (A) | Glomerulus | distal convoluted tubule | renal capsule |
| (B) | Distal convoluted tubule | renal capsule | glomerulus |
| (C) | Glomerulus | renal capsule | distal convoluted tubule |
| (D) | Renal capsule | Gomerulus | distal convoluted tubule |

GO ON TO THE NEXT PAGE

26. Which of the following indicates the site and mechanism for the reabsorption of glucose into the blood capillaries from a human kidney nephron?

	Site	Mechanism
(A)	Collecting duct	Active transport
(B)	Distal convoluted tubule	Passive diffusion
(C)	Glomerulus	Selective reabsorption
(D)	Proximal convoluted tubule	Active transport

Item 27 refers to the diagram below.



27. The diagram shows the changes in membrane permeability when a stimulus is applied to a neurone. In which region of the action potential A, B, C or D, do sodium ions begin to move in?

28. In a cholinergic synapse, calcium ions (Ca^{2+}) are involved in the transmission of nerve impulses by:

- (A) generating an action potential of +40mv in the postsynaptic knob
- (B) depolarizing the presynaptic knob by entering the neurone
- (C) restoring the resting potential of the neurone by leaving the cell
- (D) triggering the release of neurotransmitter from the synaptic vesicles

29. Which of the following combinations correctly identifies characteristics of both glucagon and insulin?

	Insulin	Glucagon
(A)	Raises blood sugar produced by beta cells	Lowers blood sugar produced by alpha cells
(B)	Reduces blood sugar Produced by alpha cells	Raises blood sugar produced by beta cells
(C)	Reduces blood sugar Produced by beta cells	Raises blood sugar produced by alpha cells
(D)	Raises blood sugar Produced by alpha cells	Reduces blood sugar produced by beta cells

30. Which three of the following combinations correctly describes the features which are typical of endocrine communication?

- I. Transmission is slow
- II. Response is slow
- III. Response is reversible
- IV. Response is widespread

- (A) I, II and III only
- (B) I, III and IV only
- (C) II, III and IV only
- (D) I, II and IV only

GO ON TO THE NEXT PAGE

31. As women pass 50 years of age they require less iron and more calcium in their diets. Which statement provides the BEST explanation for this?

- (A) Blood cells are more readily broken down and must be replaced.
- (B) Women at that age need to replace calcium lost during child bearing years.
- (C) Menstruation is gradually reducing, and bone loss is increasing .
- (D) Less active women would NOT require as many blood cells to be manufactured.

32. During starvation, the FIRST reserve used by the body to maintain energy levels is

- (A) stored glycogen
- (B) protein in muscle
- (C) vitamins stored in liver
- (D) stored fat

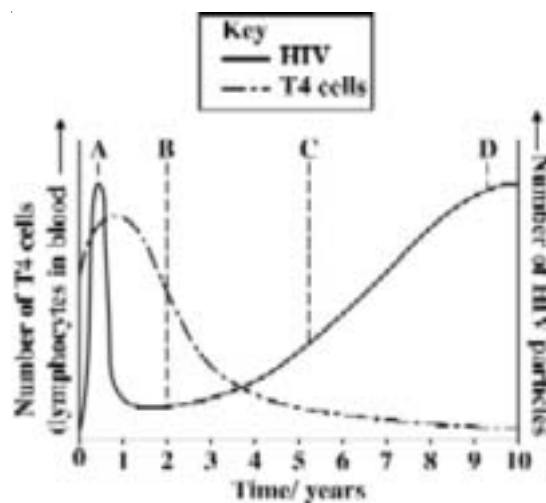
33. A student investigates the immediate effects of exercise on the body and records the following results

Time	Pulse/beats min ⁻¹	Systolic blood pressure/mm Hg
At rest	60	110
5 mins	75	130
10 mins	80	165

Which of the following is the percentage change in blood pressure after 10 minutes of exercise?

- (A) 45%
- (B) 50%
- (C) 55%
- (D) 60%

34. The graph shows the development of an infection with human immunodeficiency virus (HIV) over a period of 10 years.



The patient is MOST likely to first show symptoms of AIDS at point

- (A) A
- (B) B
- (C) C
- (D) D

35. Which of the following is NOT a mode of transmission of the human immune deficiency virus (HIV)?

- (A) Intimate sexual contact
- (B) Contamination with infected blood
- (C) Mother's breast milk to her baby
- (D) Mosquito saliva and transfer of blood

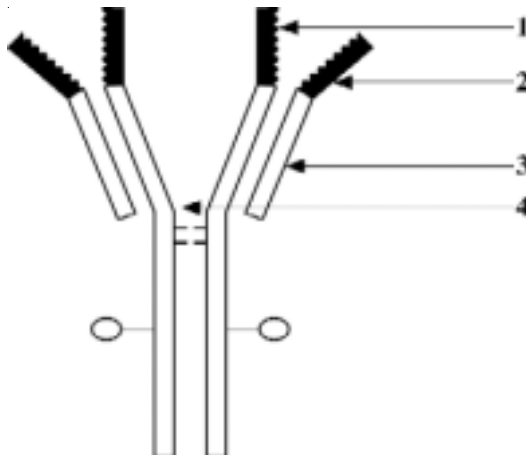
36. Which of the following is the human body's first line of defence against invading pathogens?

- (A) The production of antibodies
- (B) The production of antigens
- (C) The ingestion of pathogens by B-lymphocytes
- (D) The ingestion of pathogens by phagocytes

37. Cells that divide and give rise to lymphocytes are called stem cells. In which of the following structures of the human body do these stem cells carry out their division?

- (A) Bone marrow
- (B) Spleen
- (C) Thymus
- (D) Lymph nodes

Item 38 refers to the following diagram which illustrates an antibody molecule.



38. The two labels which represent the antigen binding site and the region which gives flexibility in binding to antigens are

- (A) 1 and 3
- (B) 2 and 3
- (C) 3 and 4
- (D) 1 and 4

39. Which of the following options best describes the type of immunity that results from taking an oral vaccine for polio?

- (A) Active natural immunity
- (B) Passive natural immunity
- (C) Active artificial immunity
- (D) Passive artificial immunity

40. A monoclonal antibody is

- (A) a small quantity of several antibodies
- (B) made by one particular type of B-lymphocyte
- (C) made by fusing a lymphocyte with a somatic cell
- (D) produced by T cells after exposure to one particular antigen

41. Long term exposure of the liver to high concentrations of alcohol eventually results in liver failure. This is due to the development of the disease called

- (A) Cirrhosis
- (B) Multiple sclerosis
- (C) Atherosclerosis
- (D) Arteriosclerosis

42. The table below shows the effects of three components of tobacco smoke (X, Y, Z) in humans.

X	Y	Z
Lung cancer	Constriction of arteries	Reduces the oxygen – carrying capacity of blood
Mucus secretion high	Release of adrenaline	Combines with haemoglobin

Which of the following correctly identifies X, Y and Z?

	X	Y	Z
(A)	Tar	Carbon monoxide	Nicotine
(B)	Tar	Nicotine	Carbon monoxide
(C)	Nicotine	Carbon monoxide	Tar
(D)	Carbon monoxide	Tar	Nicotine

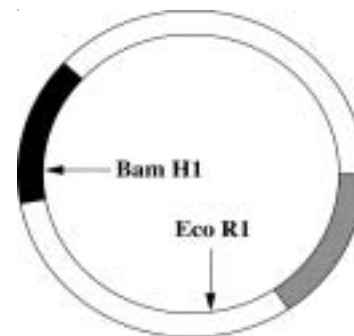
43. What is the name of the enzyme used to produce sections of DNA from messenger RNA for use in genetic engineering?

- (A) DNA polymerase
- (B) Reverse transcriptase
- (C) Restriction endonuclease
- (D) RNA polymerase

44. Which of the following DNA molecules can be sectioned by using a restriction enzyme with a recognition site of AATT?

- (A) GCTTGCATAAGC
CGAACGTATTCG
- (B) CATGGCATGGCA
GTACCGTACCGA
- (C) AGTTCAGGTACC
TCAAGTCCATGG
- (D) TACCGTTAAGCT
ATGGCAATTTCGA

Item 45 refers to the diagram below showing a map of a plasmid showing the positions of recognition sequences of two restriction enzymes.



45. In an experiment to use this plasmid as a vector for the human insulin gene, for which of the following reasons would the genetic engineer choose the Bam location to cut this plasmid?

- (A) The insulin gene is not complementary to the Eco RI restriction site
- (B) Bam HI makes a staggered cut
- (C) To allow identification of the recombinant plasmid
- (D) The gene for tetracycline resistance is needed for the expression of the insulin gene.

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

Listing of Form Section Data
Caribbean Examinations Council (CXC)

Test: **CAPE BIOLOGY (U2)** (MC ITEMS) Form: **02207010-SPEC2017**

Version No: **1**

Item No.	Key	Syllabus Reference	Profile	Module
1	C	1.2	P1	M1
2	C	2.3	P1	M2
3	B	2.3	P1	M1
4	A	2.4	P1	M1
5	A	2.6	P2	M1
6	B	3.2	P2	M1
7	D	3.3	P1	M1
8	C	3.5	P1	M1
9	D	3.7	P2	M1
10	D	4.3	P2	M1
11	B	5.2	P2	M1
12	B	6.1	P2	M1
13	D	6.3	P1	M1
14	A	6.3	P2	M1
15	C	6.5	P1	M1
16	C	1.3	P1	M2
17	B	1.5	P1	M2
18	C	2.1	P2	M2
19	C	2.5	P2	M2
20	D	2.5	P2	M2
21	C	3.7	P1	M2
22	C	3.9	P1	M2
23	A	3.12	P2	M2
24	D	4.2	P1	M2
25	C	5.3	P2	M2
26	D	5.4	P1	M2
27	D	6.3	P1	M2
28	D	6.4	P1	M2
29	C	7.2	P2	M2
30	D	7.3	P2	M2

Listing of Form Section Data
Caribbean Examinations Council (CXC)

Test: **CAPE BIOLOGY (U2)** (MC ITEMS) Form: **02207010-SPEC2017**

Version No: **1**

Item No.	Key	Syllabus Reference	Profile	Module
31	C	2.1	P1	M3
32	A	2.2	P1	M3
33	B	2.4	P2	M3
34	C	2.6	P2	M3
35	D	2.7	P1	M3
36	D	2.10	P1	M3
37	A	2.12	P1	M3
38	D	2.14	P2	M3
39	C	2.16	P2	M3
40	B	2.17	P2	M3
41	A	2.21	P1	M3
42	B	2.23	P2	M3
43	B	3.1	P1	M3
44	D	3.2	P2	M3
45	C	3.5	P2	M3

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BIOLOGY

UNIT 2 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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Module I

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

1. (a) The graph in Figure 1 shows the effect of light intensity on photosynthesis at 0.1% carbon dioxide concentration in Elodea, an aquatic waterweed.

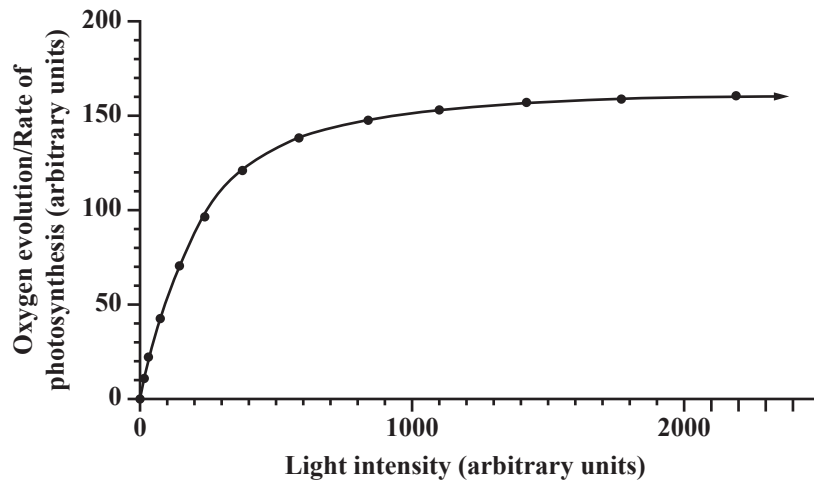


Figure 1. Graph showing the effect of light intensity on the rate of photosynthesis

Image modified from <http://www.cell.com/cms/attachment/533960/3680628/gr2.gif>

- (i) On the graph in Figure 1, draw the effect of light intensity on photosynthesis at 0.03% carbon dioxide concentration. [1 mark]
- (ii) A class carries out an experiment to study the effect of carbon dioxide concentration on the rate of photosynthesis. The students place a 5 cm length of *Nymphaea*, another waterweed, in varying concentrations of sodium bicarbonate in a lit area and record the number of bubbles that evolves from the plant in one minute. Table 1 shows the data obtained.

On the grid provided on page 5, plot a graph of the results in Table 1.

Note: Concentration of sodium hydrogen carbonate/concentration of carbon dioxide on the x- axis and rate of photosynthesis or average number of bubbles evolved per minute on the y-axis. [4 marks]

GO ON TO THE NEXT PAGE

TABLE 1: DATA OBTAINED IN EXPERIMENT

Concentration of NaHCO₃ solution (%)	Average Number of Bubbles Evolved per Minute
0.05	0
0.10	12
0.15	22
0.20	40
0.25	44
0.30	45

A large grid of graph paper, consisting of 20 columns and 20 rows of small squares, intended for recording experimental data.

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- (iii) During photosynthesis, light energy is converted into chemical energy. Outline TWO differences between the movement of energy and nutrients through an ecosystem.

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[4 marks]

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(b) Figure 2 shows a simplified nitrogen cycle.

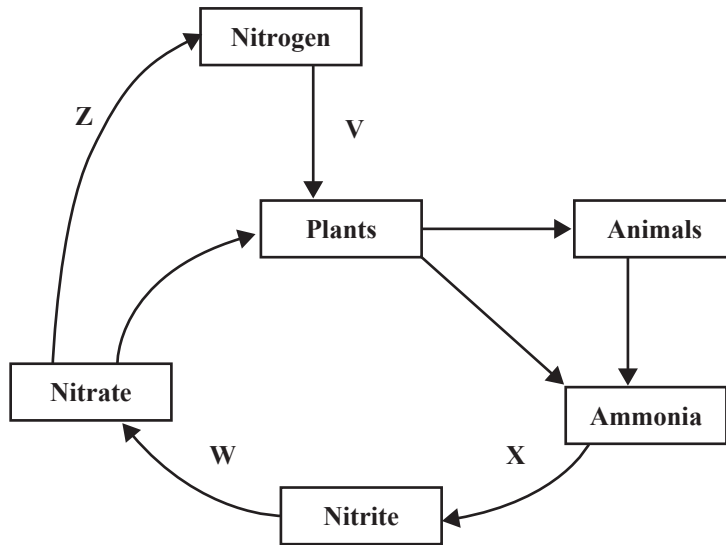


Figure 2. Simplified nitrogen cycle

<http://www.hyndland-sec.glasgow.sch.uk/websites/schsecHyndland/UserFiles/image/Biology.jpg>

(i) State the roles of Microorganisms V and Z in the nitrogen cycle.

V

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X

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[2 marks]

(ii) Many different relationships exist in ecosystems. With reference to named organisms, explain how parasitism differs from mutualism.

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[4 marks]

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Module 2

2. (a) Figure 3 is an image from a prepared slide of *Cucurbita* stem showing a cross section through phloem tissue highlighting a circular area within the image.

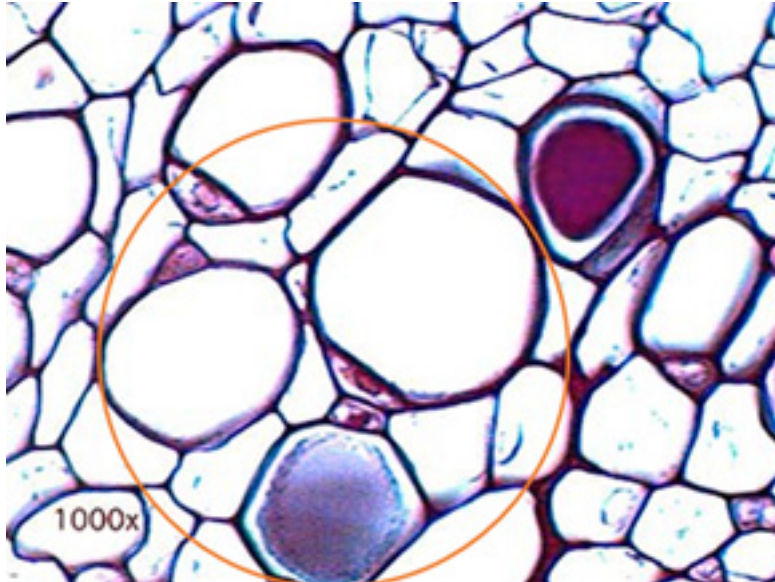
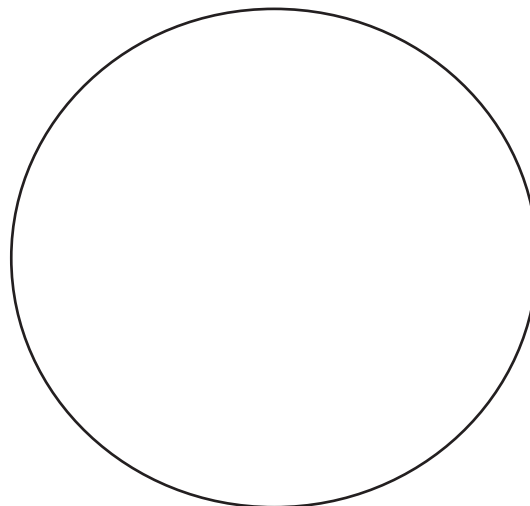


Figure 3. Cross section through phloem tissue

http://botit.botany.wisc.edu/botany_130/anatomy/Cells_tissues/1000x.html

- (i) In the circular area provided below, make a detailed diagram of the circular area highlighted in Figure 3. Label **THREE** key features. **[5 marks]**



GO ON TO THE NEXT PAGE

- (ii) Explain the mechanism that drives translocation in plants.

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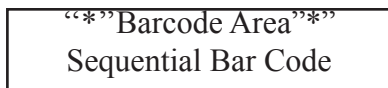
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[6 marks]

- (b) Unlike plants, the heart provides the driving force for the transport system in animals. In the space provided below, draw a labelled diagram of the mammalian heart. Include in your drawing the structure of the heart's chambers and valves.

[5 marks]

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Area with horizontal dotted lines for writing.

[14 marks]

Total 30 marks

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Module 3

- 3. (a) (i) State the name of the major carbohydrate stored in muscle tissue to provide a ready respiratory substrate.

[1 mark]

- (ii) Clarify the relationship between the presence of lactic acid in the muscle tissue and the oxygen debt.

[1 mark]

- (iii) Light exercise creates little demand on the rate of breathing and heart output but as exertion and duration increase, both breathing movements and heart output intensify. When the body is exercising at its maximum capacity, oxygen consumption is at its highest. This state is called VO₂ max. It is measured as the volume of oxygen in cubic centimetres, used per kilogram of body mass per minute.

$$VO_2\text{max} = O_2 \text{ cm}^3\text{kg}^{-1}\text{minute}^{-1}$$

A sports laboratory is equipped with a stopwatch, a weighing scale, appropriate tubing and a gas analyser to measure oxygen consumption.

Explain the procedures and the calculations used to calculate the VO₂ max of an athlete.

[5 marks]

GO ON TO THE NEXT PAGE

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- (iv) A 35-year-old individual signed up for a 25-month endurance-training programme. Table 2 summarizes the physiological changes in the individual before, during and after the training period.

TABLE 2: PHYSIOLOGICAL CHANGES IN THE INDIVIDUAL UNDERGOING ENDURANCE TRAINING

	Pre-training	15 months	25 months
Body weight (kg)	79	73	78
Maximum ventilation (L/min)	184	200	198
Maximum cardiac output (L/min)	16.6	17.2	18.5
VO ₂ max cm ³ kg ⁻¹ minute ⁻¹	80	90	100
Stroke volume (ml)	100	60	119

Calculate the percentage increase in VO₂ max attained by the 35-year-old individual at the end of the 25-month period.

[1 mark]

(b) Physical exercise is not the only contributor to good health. The immune system of the body actively provides protection from various diseases.

(i) Compare the mode of action of plasma cells and phagocytes in fighting infections.

Plasma cells

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Phagocytes

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[4 marks]

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CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BIOLOGY

UNIT 2 - Paper 02

KEYS AND MARK SCHEME

SPECIMEN PAPER

BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 1 **Specific Objectives: 1.4, 3.1, 3.3, 3.4, 4.3, 4.5**

(i) Plot same shape, but lower plateau **[1 mark]**. **[1]**

(ii) Plotting graph

- Title
- Plot 4 of 5 points correctly to get the mark
- Axes correctly labelled with units
- Scale/Plot takes up at least half of the grid

4 marks

(iii) Differences between movement of energy and nutrients

1. Energy flows through and is converted from one form to another vs nutrients recycled.
2. Energy lost while flowing through ecosystem.
3. Unidirectional flow of energy (multidirectional for nutrient cycling)
4. Finite nature of nutrients vs. continuous supply of energy.
5. Nutrient cycles between abiotic and biotic components/ energy flow through organisms.

2 marks each for any full comparison = 4 marks
(1 mark for partial)

[4]

(b) (i) V - Fixing nitrogen into the plants (*Rhizobium* bacteria)
Z - Denitrifying bacteria converting nitrate to nitrogen gas
1 mark each **[2]**

(ii) Parasitism vs mutualism

1. Named examples for each relationship **(2)**
2. Parasitism: indicate how host is harmed and how parasite benefits **(1)**
3. Mutualism: indicate how both organisms gain from the interaction **(1)**

4 marks

[4]

BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 1 cont'd

(c) Rainforest

1. Poverty reduction/Livelihood (Income generating activity) provides employment for local people;
2. Foreign exchange earner - ecotourism site.
3. Food security.
4. Raw material for industrial processes - new medicines/materials could be found from organisms growing in the wild;
5. Recreation.
6. Sacred and spiritual value - cultural importance of species to indigenous groups.
7. Ecosystem value - depletion or degradation of natural resources and the threat to sustainable development.
 - conservation of components of life support systems;
 - conservation of endangered and threatened species;
 - disruption of ecosystems could lead to soil erosion/flooding /weather pattern changes;
 - disruption of water cycle/nutrient cycles;
8. Intrinsic value - right to exist; existence value beyond usefulness to humans.
9. Research and teaching
10. Aesthetical value

Any 5 points well developed 2 mark each = 10 marks

Protected forests

Definition of in situ or statement that protected areas involves in situ conservation

Positive

1. Requires no advanced technology
2. Protected areas can later be used as attractions to raise funds for further conservation efforts

Drawbacks

1. Difficult to monitor large areas of land
2. Can be expensive
3. Requires legislation
4. Large areas of protected lands could be used for other purposes

1 mark for definition or recognition of protected areas as in situ method

Any two positive 2 marks

Any 2 drawbacks 2 marks

[15 marks]

Total 30 marks

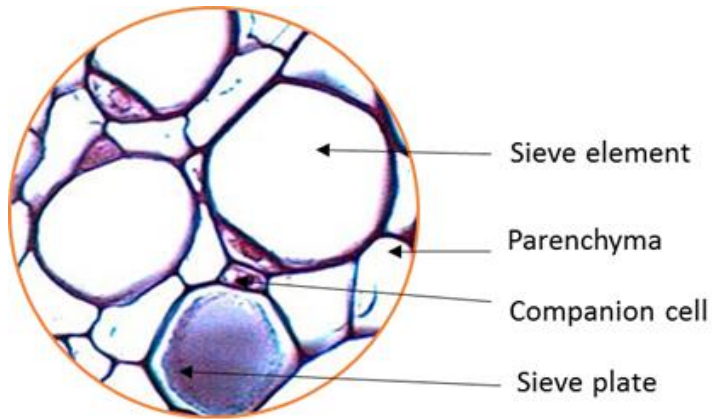
BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 2 Specific Objectives: 2.1, 2.3, 3.1, 3.3

(a) (i)



- Diagram representative - 1 mark
- Acceptable proportions - 1 mark
- Any three correct labels - 1 mark each

[5 marks]

(ii) Translocation in plants

1. Phloem loading at source
2. Movement due to pressure gradient
3. Unloading at sink

For each point with full explanation - 2 marks
(Partial explanation - 1 mark)

[6 marks]

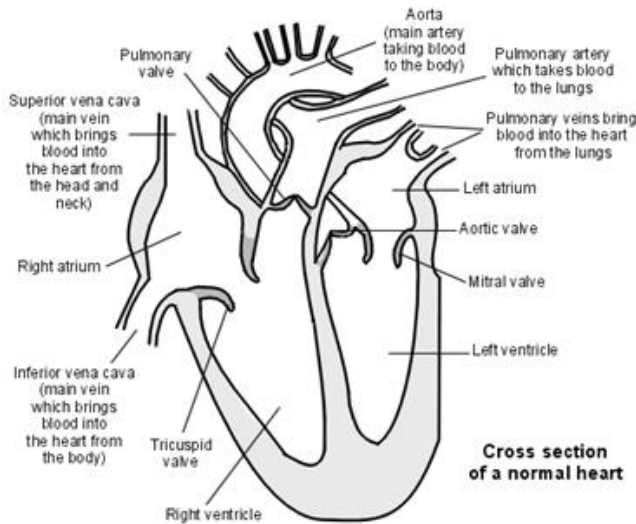
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UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 2 cont'd

(b) Drawing of the heart



<https://userscontent2.emaze.com/images/688d237b-f946-4ac5-9217-eafa0d068781/82295c69-0bd1-4aae-82bb-c82dad81f489.qif>

- Appropriate diagram - **1 mark**
- All chambers correctly labelled - **2 marks**
(1-2 errors or omissions - 1 mark)
- All valves correctly labelled - **2 marks**
(1-2 errors or omissions - 1 mark)

[5 marks]

(c) Circulation

Heart adaptations

1. Heart is a muscular pump that forces blood through the system; cardiac muscle is resistant to fatigue (cells have large numbers of mitochondria)
2. Double circulatory system (pulmonary and systemic); ensures that oxygenated blood is delivered to the systemic system at high pressure/lower pressure is needed in the pulmonary system
3. Presence of valves: atrio-ventricular and semi-lunar valves - allow one way circulation
4. Stimulus to contract comes from within heart (myogenic) -SAN, AVN, Purkyne fibres - ensures that the ventricles contract after the atria and from base upwards

Any 3 points well discussed - 2 marks each = 6 marks
(incomplete discussion - 1 mark each)

BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 2 cont'd

Adaptations of blood vessels (7-8 marks)

- Arteries have thick walls with large amount of elastic tissue - allows walls to withstand high pressure of blood from heart
- Small arteries and arterioles have large amount of smooth muscle in walls - allows constriction, which can divert blood from one area to another
- Smooth endothelium (inner lining) in blood vessels - allows free blood flow (lower resistance); reduces the risk of blood clots
- Veins have relatively large lumen (low resistance) and valves (not present in arteries) - valves allow one-way flow of blood to the heart - necessary due to the low pressure of blood in veins
- Capillaries have very thin wall (one cell thick and flattened) and tiny lumen diameter - allows rapid transfer of substances by diffusion between blood and tissues / tiny lumen brings blood close to tissues
- All organs have extensive network of capillaries - ensures that interchange of substances occurs in all tissues.

**Any 4 points well discussed - 2 marks each = 8 marks
(incomplete discussion - 1 mark each)**

14 marks

Total 30 marks

BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 3 Specific Objectives: 3.3, 2.1, 2.2, 2.4, 2.5, 2.9, 2.10

- (a) (i) Carbohydrate - glycogen **1 mark** [1]
- (ii) The oxygen debt is the deficit in oxygen required to oxidize the accumulated lactic acid to pyruvate. **1 mark** [1]

(iii) Procedure for calculating $VO_2\text{max}$

1. Determine the weight, in kilograms of the athlete.
2. Exercise the athlete to maximum exertion.
3. Over a 60-second period, measure the oxygen consumption in cm^3 (or any acceptable answer to achieve the O_2 consumption in 1 minute).
4. Divide the oxygen consumption in one minute by the kilograms to find the O_2 used per kilogram.
5. That gives the volume of O_2 in cm^3 per kilogram⁻¹ per minute⁻¹.

5 marks

[5]

(iv) Calculating $VO_2\text{max}$

$$[(100-80)/80] *100 = 25\%$$

Correct answer, even without working, 1 mark

[1]

(b) (i) Plasma cells

1. Formed from B-cells (by differentiation).
2. Secrete/synthesize antibodies (against specific antigens).
3. Each type of plasma cell produces a single type of antibody.
4. The antibody agglutinates/traps/inactivates the antigen.
5. They are "effector" cells - carry out the "end reaction" of the immune response.
6. They increase in number rapidly during an infection, and decrease after the antigen is controlled.

Phagocytes

1. Are amoeboid cells produced in the bone marrow and they circulate in the blood.
2. They move rapidly to the site of an infection.
3. They can squeeze through capillary walls and directly invade the infection site.
4. They engulf antigens (large proteins/bacteria etc. < 250 nm).
5. They digest and kill the pathogens in a cellular vesicle.
6. They remove alien/foreign molecules which may cause harm to that organ, e.g. lung, liver.

Any 2 comparisons = 4 marks

[4]

BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 3 cont'd

(ii) B-lymphocytes

1. B-cells originate in bone marrow from stem cells by mitosis.
2. Mature in bone marrow.
3. Genes are rearranged to give many (10 million) varying protein codes.
4. These variants code for different antibody surface receptors.
5. Each B-cell is programmed to express just one type of surface receptor during maturation.
6. The range of B-cells will have an immense number of different receptors.
7. Hence, there will be a B-cell with receptor for any/every antigen.

5 points - 3 marks

3-4 points - 2 marks

1-2 points - 1 mark

[3]

T-lymphocytes

1. Form in bone marrow from stem cells by mitosis.
2. Migrate to thymus.
3. Differentiate genotype to form thousands of variants.
4. Variant genes code for specific surface receptors.
5. T-cells have a wide range of individual surface receptors.
6. T-cells have the body's own antigens presented to them by MHC.
7. If a T-cell binds with and reacts with one of the body's own protein it is killed.
8. This prevents having T-cells that attack the body's own cells, i.e. an autoimmune attack in the body by its own.

5 points - 3 marks

3-4 points - 2 marks

1-2 points - 1 mark

[3]

(c) Active immunity

1. The immunity that results from the production of antibodies by the immune system in response to the presence of an antigen.
2. The result of the response of the body to an antigen/infection, which has long-term effects.
3. Immunity in an organism resulting from its own production of antibodies or lymphocytes.

Any one = 1 mark

BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 3 cont'd

Vaccine

1. A preparation containing antigenic material and used to increase immunity.
2. A substance used to stimulate the production of antibodies and provide immunity against one or several diseases.
3. A preparation of killed microorganisms, living attenuated organisms, or living fully virulent organisms that is administered to produce or artificially increase immunity to a particular disease.

Any one = 1 mark

Examples

Polio, measles, mumps, rubella, Tuberculosis, Small Pox, influenza, chicken pox, shingles, tetanus

Any two correct examples, including any not listed = 2 marks

Successes

1. Vaccines are among the most effective means of preventing disease, disability and death in infants, children, adolescents and adults.
2. Diseases can be eliminated locally without global eradication of the causative microorganism. E.g. measles which had been eliminated in 4 of 6 WHO regions
3. Caribbean territories have made great strides in reducing and eliminating morbidity and mortality caused by Vaccine Preventable Diseases.
4. Has led to the eradication of smallpox
5. Some vaccines are highly effective and give lifetime protection
6. There is an excellent safety record with vaccines. Less reactogenic vaccines have been developed.
7. Vaccination programmes are cheaper than providing therapeutic drugs. This, along with reduced morbidity and mortality, translates into long-term savings and possible economic growth.
8. Reduces the need for antibiotics, thus helps to prevent the development of antibiotic resistance.
9. "Herd protection" of the unvaccinated occurs when a sufficient proportion of the group is immune.
10. Unless an environmental reservoir exists, an eradicated pathogen cannot re-emerge, unless inadvertently or purposely reintroduced by humans

BIOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 3 cont'd

11. Protection against related diseases. Vaccines will also protect against diseases related to the targeted disease. For example, measles vaccination protects against multiple complications such as dysentery and bacterial pneumonia.
12. Cancer prevention. Reduction of the incidence of cervical cancer is expected with the use of HPV vaccines.
13. Safer travel and mobility between territories

Any 4 points = 4 marks

Challenges

1. Eradication requires high levels of population immunity in all regions of the world over a prolonged period with adequate surveillance in place.
2. Some individuals do not respond well or do not respond at all to vaccinations. i.e. the vaccine is ineffective in them.
3. There are no vaccines to the common cold due to antigenic variation (multiple strains).
4. The influenza virus mutates regularly to give different antigens. Therefore, there have to be constant changes to the vaccine.
5. Anti-vaccination campaigns. Usually associated with the perception that the MMR vaccine causes autism.
6. Fear of needles
7. The costs associated with setting up vaccination programmes.
8. Difficulty in reaching remote areas
9. Lack of proper surveillance to accompany the vaccination efforts.
10. Globalization and increased travel

Any 4 points = 4 marks

[12]

Total 30 marks

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BIOLOGY - SPECIMEN PAPER

UNIT 2 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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Answer ALL questions.

Write your answers in the spaces provided in this booklet.

Please begin Question 1 FIRST.

You are provided with two specimens, A and B.

1. (a) Make a labelled drawing of Specimen A.

[6 marks]

(b) (i) Investigation of stomatal density of Specimen B.

Procedure:

- Spread a thin layer of nail varnish over the lower surface of Specimen B
- Allow to dry
- Peel off the thin replica with a fine forceps.
- Lay it on a slide and add a cover slip (it may be mounted in water if you choose).
- Count the number of stomata in a given field of view and repeat THREE times in different areas.
- Obtain a mean value.
- Record your results in the table below.

Count 1	Count 2	Count 3	\bar{x}

- Calculate the number of stomata per cm². Show your working.

Stomatal density

.....
[5 marks]

GO ON TO THE NEXT PAGE

- (ii) Would you expect stomatal density to be the same on the upper surface of Specimen B? Explain your answer.

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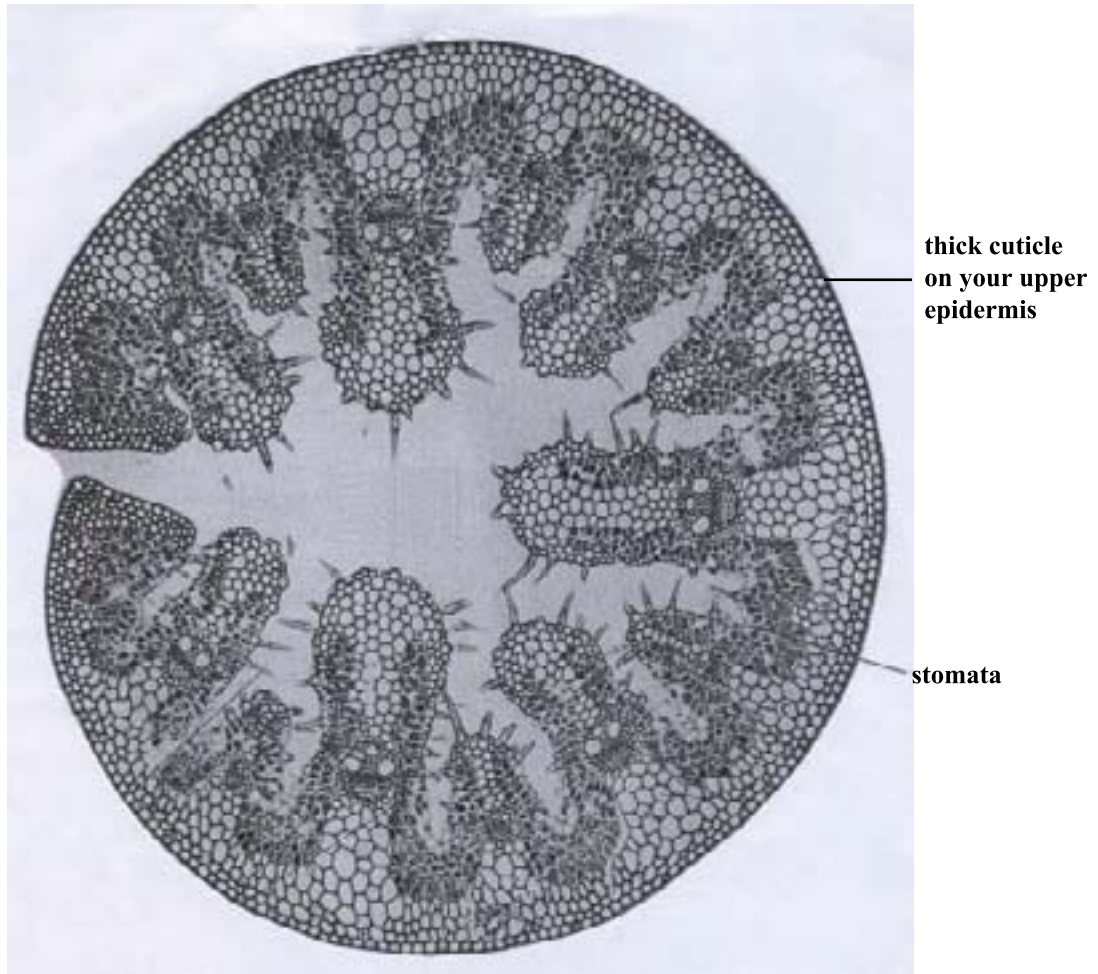
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[2 marks]

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(c) Figure 1 shows a transverse section of a leaf.



List, with explanations, THREE features of the leaf shown in Figure 1 that show how the plant is adapted to a dry environment.

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[3 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

2. You are provided with the following apparatus and materials.

- Water bath
- Thermometer
- Elodea shoot
- Test tubes
- Sodium hydrogen carbonate solution
- Apparatus for measuring gas
- Meter rule
- 100 W lamp

Use the apparatus above to plan and design an experiment to test the following observation:

Water plants evolve large volumes of gas when placed in a well illuminated area.

(a) Suggest a suitable hypothesis based on the observation given.

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[2 marks]

(b) Write a suitable aim based on the hypothesis.

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[1 mark]

GO ON TO THE NEXT PAGE

(ii) Design an appropriate table to show how the results could be presented.

[4 marks]

(e) What limitation could be expected from an experiment of this nature?

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[1 mark]

Total 15 marks

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3. Table 1 contains data on the typical birth-weights of babies over a period of 10 years. The mortality of babies, in relation to birth-weight is shown in Table 2.

TABLE 1. TYPICAL BIRTH-WEIGHT (AS A PERCENTAGE) OVER 10 YEARS

Birth-weight of babies (lbs)	% of babies	
0-1 1-2 2-3 3-4	} pre-drawn on histogram	
4-5		2
5-6		9
6-7		18
7-8	14	
8-9	5	
9-10 10-11 11-12	} pre-drawn on histogram	

TABLE 2: PERCENTAGE MORTALITY OF BABIES IN RELATION TO BIRTH-WEIGHT

Birth-weight of babies (lbs)	% mortality
3	60
4	30
5	7
6	2.5
7	1.5
8	2
9	3
10	6
11	15

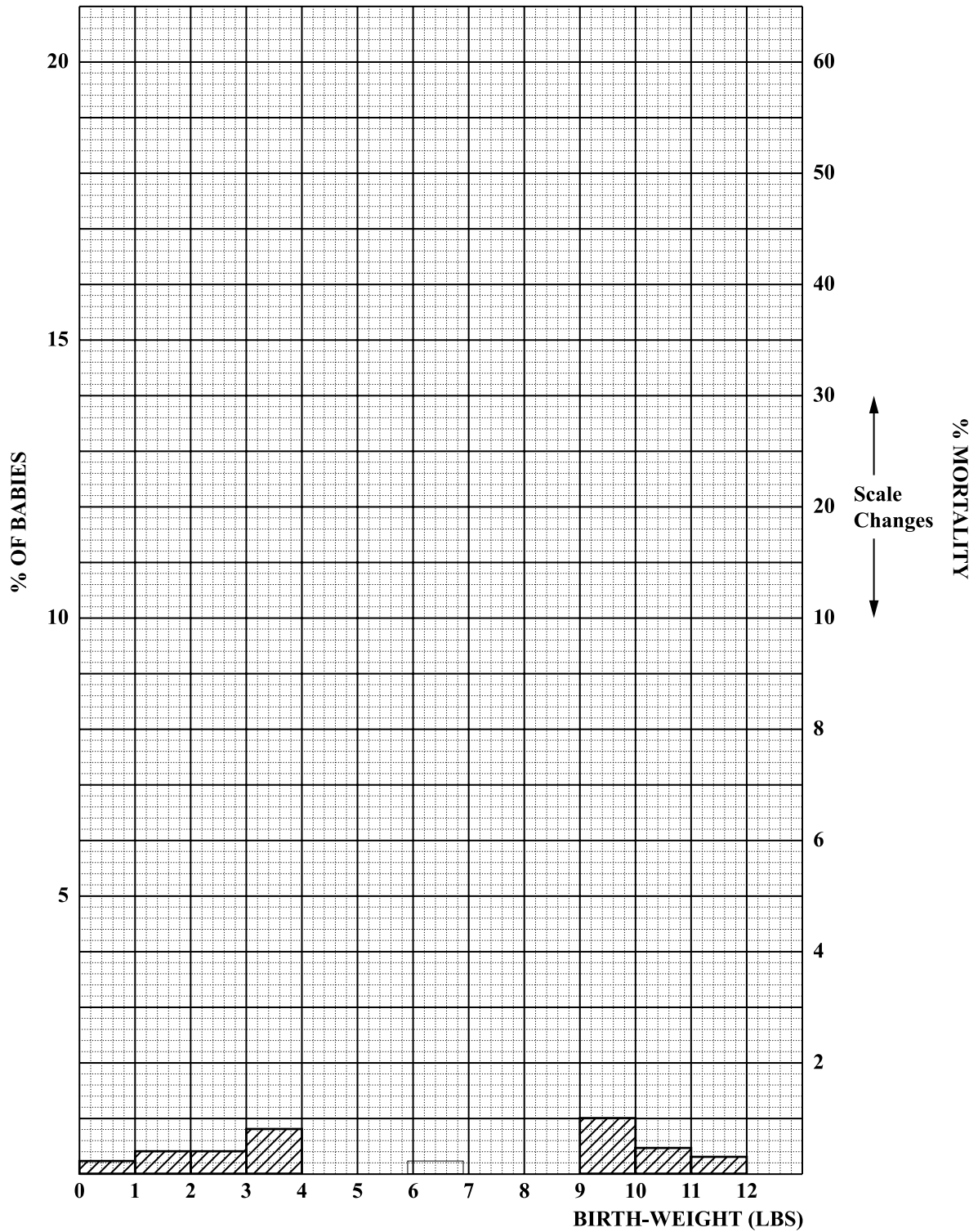
Use the data in Tables 1 and 2 above to answer questions (a) (i) and (ii).

- (a) (i) On the grid provided in Figure 2 on page 12, complete the **histogram** of the typical birth-weight of babies over a 10-year period. (**Note** that portions of this histogram have been pre-drawn).
- (ii) Also on Figure 2, construct a **graph** of the percentage mortality of babies in relation to birth-weight. (Use a best-fit line).

[5 marks]

GO ON TO THE NEXT PAGE

BIRTH-WEIGHT/ % MORTALITY



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- (b) Using quantitative information from the graphs drawn on **page 12**, comment on the effect of birth-weight on percentage mortality.

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[3 marks]

- (c) State ONE effect the observations made in (b) have on the gene pool controlling the birth-weight of the foetus.

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[1 mark]

- (d) In terms of Natural Selection, what type of selection is operative in (c)?

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[1 mark]

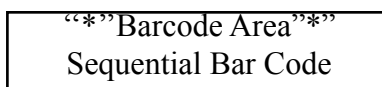
- (e) Two special groups, the Masai and the Pygmies have different anthropomorphic measurements. The Masai people are typically over six feet in height, white and tall. Pygmy people rarely exceed 4' 8" in height.

Draw TWO additional graphs on Figure 2 as follows:

- (i) A graph line to represent the expected percentage mortality of babies in relation to birth-weight born to Masai.
- (ii) A graph line to represent the expected percentage mortality of babies in relation to birth-weight born to Pygmies.

[2 marks]

GO ON TO THE NEXT PAGE



- (f) Pig litters range in size from about three to eighteen piglets per litter. The average number of piglets surviving in litters was determined three and six weeks after birth. Figure 3 shows the results of the investigation.

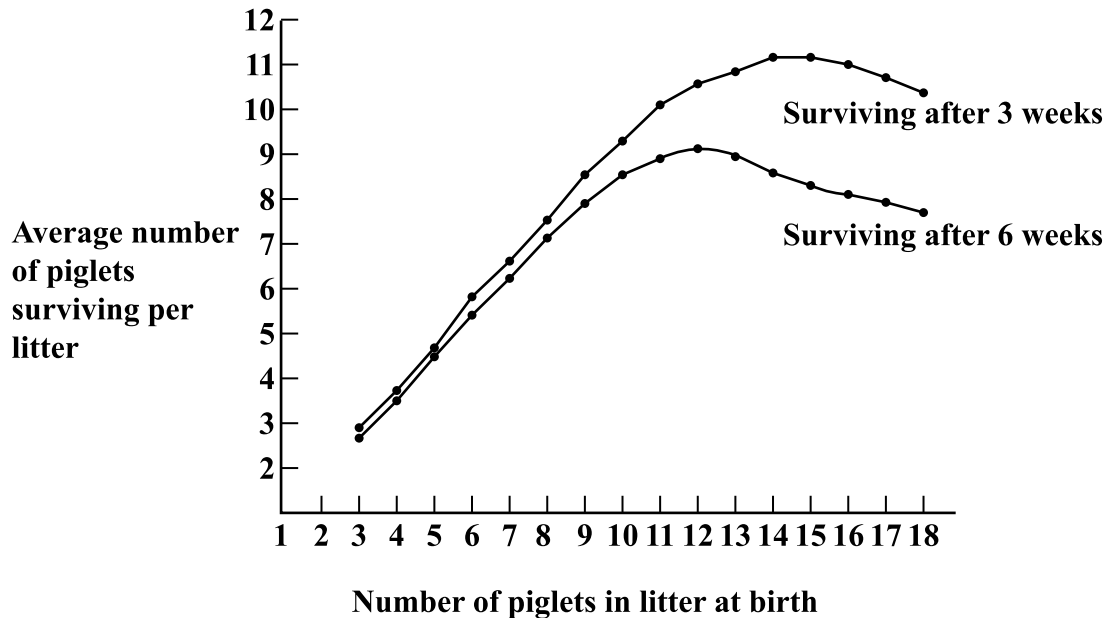


Figure 3. Litter size and piglet survival

Adapted from Problems in Animal Physiology, John Murray. 50, Albemarle St. London W1X 4BD, M.K. Sands, 1975.

- (i) Complete Table 3 to show the difference in survival of piglets in the two litters.

TABLE 3. LITTER SIZE AND SURVIVAL IN PIGS

Number of Piglets in Litter at Birth	Average Number of Piglets Surviving After 3 weeks	Average Number of Piglets Surviving After 6 weeks
3		
9		
15		

[3 marks]

GO ON TO THE NEXT PAGE

- (ii) Use the data from Figure 3 to suggest, with a reason, the optimum litter size for maximum survival.

.....

.....

.....

.....

[2 marks]

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

DO NOT WRITE IN THIS AREA

02207032/CAPE/SPEC/KMS 2017

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BIOLOGY

UNIT 2 - Paper 032

KEYS AND MARK SCHEME

SPECIMEN PAPER

CAPE BIOLOGY

UNIT 2 - PAPER 032

MARK SCHEME

Question 1.

(a) Specimen A: slide of lower epidermis of a leaf (whole mount)

- Clear accurate line representation of specimen
- Clean continuous lines of even thickness
- Use of label lines that do not cross
- Accurate labelling
- Features correctly proportioned
- Magnification given
- Title given

(b) (i) Specimen B: dicotyledonous leaf

- Mean correctly calculated
- Calculation of stomatal density
- Use of appropriate units

(ii) • No
 • Because it is a dicotyledonous leaf

- (c)
- Leaf rolled - to reduce transpiration rate
 - Stomata on lower epidermis not exposed to dry atmosphere
 - Presence of hairs trap H₂O - creating humid environment
 - Humid conditions in interior result in reduced transpiration.
 - Thick cuticle to reduce water loss across epidermis

Any point - 1 mark up to a maximum of 3 marks

UK	XS
	5
	2
	2
	1
1	
1	
3	
5	10

CAPE BIOLOGY

UNIT 2 - PAPER 032

MARK SCHEME

Specific Objectives: 1.5, 1.6 - Module 2

Question 2.

- (a) • Mention of light being necessary for the process of photosynthesis, therefore in well illuminated areas, large amounts of oxygen will be released.
- Increase in availability of light increases the rate of light dependent and hence light independent stages.

Statement relating directly to observation - 1 mark

Testable hypothesis - 1 mark

- (b) • To investigate the effect of light intensity on the rate of photosynthesis.

Suitable and related to hypothesis - 1 mark

- (c) • Suitable and logical sequence (can be enhanced with diagram).
- Controls included, i.e. parallel experiment set up with light source placed at one constant distance throughout experiment.
- Attempts to control conditions
 - use of NaHCO₃ to ensure sufficient CO₂
 - use of thermometer to check for changes in temperature. Replace water if change noted.
- Duration of investigation.
 - length of time elapse before volume of gas is measured for each light intensity.
- Number of trials stated - to ensure reproductively of experiment.

Present tense MUST be used. - 1 mark

UK	XS
	2
	1

CAPE BIOLOGY

UNIT 2 - PAPER 032

MARK SCHEME

	6
--	---

1 mark for each point correctly done
1 mark x 5 points - 5 marks

Past tense - 1 mark

UK	XS
----	----

Question 2. (continued)

(d) (i) As distance from lamp decreases/increases THEN volume of gas SHOULD increase/decrease.

Future tense MUST be used - 1 mark
Future tense NOT used - 0 mark

	1
--	---

- (ii)
- Table must have title.
 - 3 columns, distance from lamp, light intensity, volume of oxygen.
 - Units must be shown, at least for lamp distance and volume of oxygen.
 - Distances from lamp must be shown in increasing or decreasing order.

Example of table showing the effect of light intensity on rate of photosynthesis.

Distance of Lamp cm	Light Intensity	Volume of O ₂ cm
80		
40		
20		
10		
5		

1 mark for EACH point - 4 marks

	4
--	---

(e) • Amount of light in room, not given off from lamp can affect results when distance from lamp is great.

Limitation stated and explained - 1 mark

	1
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CAPE BIOLOGY

UNIT 2 - PAPER 032

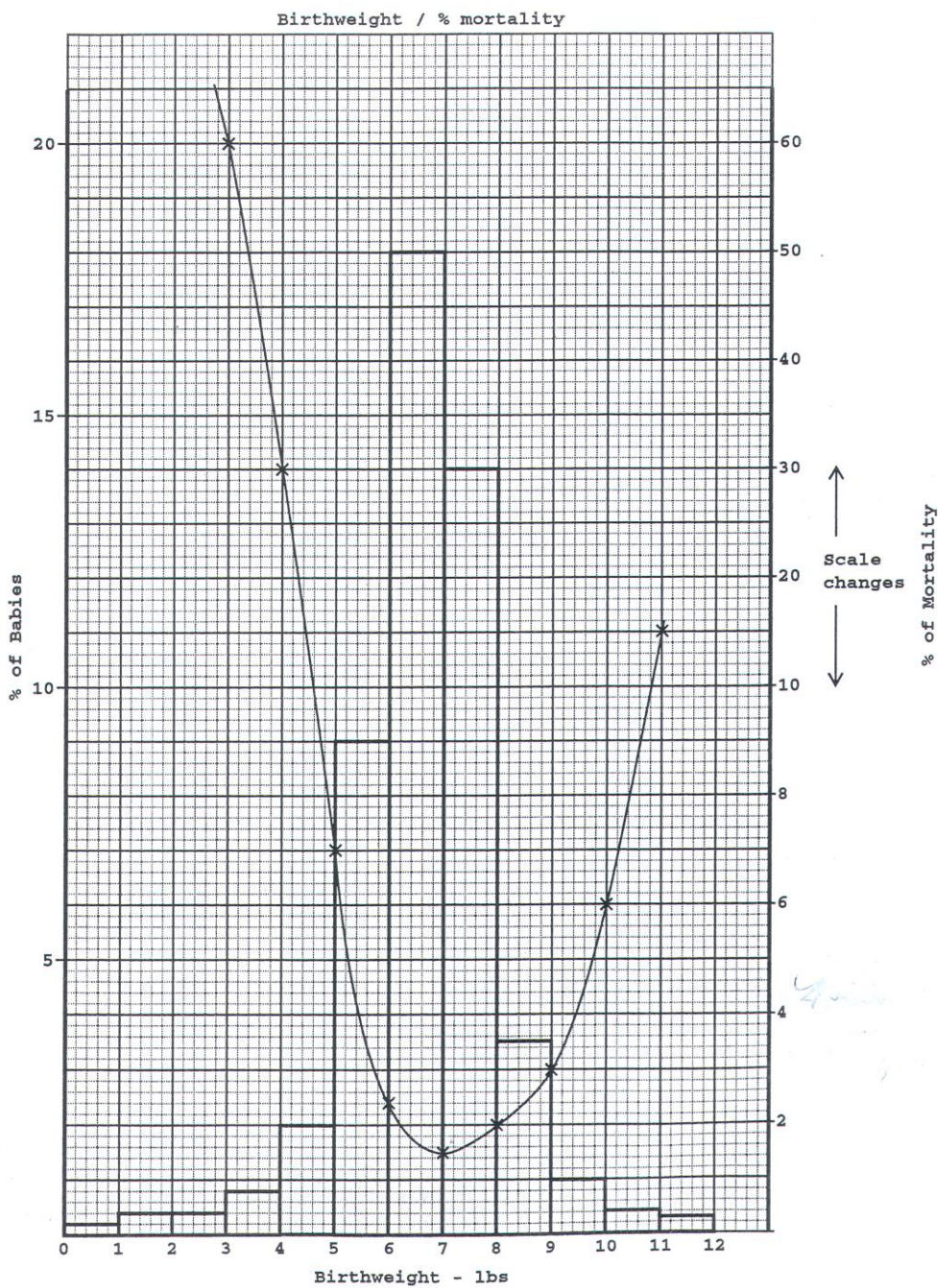
MARK SCHEME

-	15
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Specific Objectives: 1.6 - Module 1

Question 3.

(a)



Histogram: 4 - 5 bars well drawn - 3 marks
 3 bars well drawn - 2 marks

UK	XS

CAPE BIOLOGY

UNIT 2 - PAPER 032

MARK SCHEME

**Graph: All points correct, well drawn - 2 marks
1 error or poorly drawn - 1 mark**

4 marks from Histogram + 2 marks from graph = 6 marks

	5
--	----------

Question 3. (continued)

- (b) • Babies of 6 - 7 lbs (which constitute 18% of births) have the lowest mortality (2.5 and 1.5%).
- Babies of 3 - 4 lbs have the highest percentage mortality of 90%.
- Babies of 11 lbs also show high % mortality of 15%.

3 correct points, using data from the table - 3 marks

- (c) • The next generation would receive more genes associated with mean birth-weight.
- Fewer genes for very low, or high birth-weight would be passed to the next generation.

Any one correct point - 1 mark

(d) Directional

Correct - 1 mark

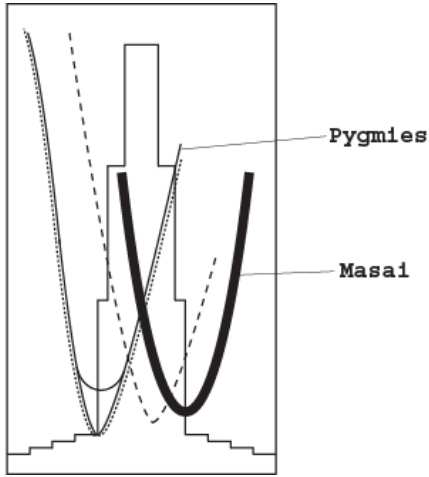
(e) (i) & (ii)

UK	XS
3	
1	
1	
	2

CAPE BIOLOGY

UNIT 2 - PAPER 032

MARK SCHEME



Labelled and correctly placed graphs - 1 mark each

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Question 3. (continued)

(f)	(i)	No.	3 wks.	6 wks.	
		3	(2.8)	(2.7)	both correct - 1 mark
		9	(8.2)	(7.8)	both correct - 1 mark
		15	(11)	(8)	both correct - 1 mark

Correct figures are in brackets - allow very slight variations

(ii) 11 - 12 piglets per litter. These piglets have the maximum survival after 6 weeks.

Correct number with reason - 2 marks

UK	XS
	3

CAPE BIOLOGY

UNIT 2 - PAPER 032

MARK SCHEME

5	10

Specific Objectives:

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION**

MAY/JUNE 2004

BIOLOGY

BIOLOGY

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2004

GENERAL COMMENTS

There was an increase in the number of candidates writing the Caribbean Examinations Advanced Proficiency Exams in Biology in 2004. The number of candidates writing the examination rose from 891 in 2003 to 1416 in 2004. These comprised 410 Unit 2 candidates compared with 333 in 2003, and 1006 Unit 1 candidates, compared with 558 in 2003.

Teachers and candidates are reminded that there is reading time of 15 minutes in addition to the one and a half hour exam period in Paper 1 in both Units. Candidates need to make better use of this time, not just for gaining an extra 15 minutes writing time, but to peruse and assess the paper and decide which questions are preferred and the order in which to answer them. Candidates do not have to answer in the sequence 1 - 9. They can choose their best topics first.

Alternatively they may wish to flip through the paper tackling the KC (knowledge and comprehension) portions of each question first, and then return to the more challenging UK (use of knowledge) portions later, as time permits. At present in Paper 01, candidates spend too much time on Modules 1 and 2, and leave little time for Module 3. It would be valuable for them to spend even five minutes to evaluate the main topic of each question and plan an answering sequence that enables them to pick up easy marks.

Furthermore, candidates should note the value of each portion of a question. Marks are generally allotted on the basis of one mark for one good point with an explanation, expansion or statement to clarify it. If two marks are available, the mark scheme will obviously require two explanations, or perhaps four listed items. In CAPE examinations where, at present, no extra marks are gained by excellence in prose, candidates can do well by learning their facts in list/statement form, collecting rewards on a mark per point basis. For a

Paper 02, Section 2 Essay answer, a minimum of one factual, comprehensive sentence **per point** is to be aimed at. If a question carries 8 marks, then 8 - 12 to-the-point, progressive, sequential, descriptive statements should be adequate. Less than that, gains fewer marks.

DETAILED COMMENTS

UNIT 1 PAPER 01

Module 1

Question 1

This question tested the candidate's knowledge of the structure of the water molecule in relation to its biological roles. It also tested knowledge of the position and function of the cytoplasm/nuclear boundary.

In Part (a) (i), candidates clearly understood the concept of water molecules interacting with positively charged ions of the solute, but a common misconception was that hydrogen bonds were formed between water and the solutes. The fact that dispersion and interactions are enhanced was also given credit. In Part (a) (ii), the majority of candidates neglected to mention that as water cools its increases density (4 C), slows down kinetic movements and the molecules orientate themselves into 'crystals' or lattices. Although they mentioned that ice is less dense, and floats, they did not focus on the role of the molecular formation in reducing density, and strayed from the point of the question. In Part (a) (iii), most candidates failed to explain that heat energy is consumed in separating the previous adhesion or self-attraction between the water molecules. The term 'specific heat' was defined by several candidates but not taken further. The biological value obviously related to the general constancy of water temperature in the internal and external environment, despite fluctuations in environmental temperature.

Part (b) was quite well done, although some candidates failed to recognise that the electron micrograph only featured the nuclear area of the cell, and included other organelles in their labels.

In Part (c) (i), candidates who identified the nuclear pore correctly were also able to give its correct function, including the egress of long linear molecules. Some said it allowed 'things' to pass such as ions and gasses, but did not understand that the orientation of the polynucleotides at the portal was important. In Part (c) (ii), the nucleolus was identified accurately by about 50 per cent of the candidates, but many were not familiar with its function, stating that it was the site of DNA replication or that it controlled nuclear division. Production of ribosomal RNA was often omitted.

Question 2

Part (a) was fairly well done. Most candidates answered 1- ionic, 2 - hydrogen and 3 - sulphur bridges, but confused the rings in 4 with carbohydrates and used glycosidic bonding, instead of hydrophobic or Van de Vaals forces.

In Part (b), many candidates said the function of the prosthetic group was to combine with iron. Its function as an oxygen carrier should have been identified.

Part (c) was generally well done, but marks were lost due to imprecise answers, for example in B, the protein shape was an alpha helix, not just a helix, and in C, the protein structure was a beta pleated sheet, not just a pleated sheet. The abbreviation 1' and 2' for primary and secondary should be avoided.

In Part (d), though some answers were inexact, this question evoked a good response, citing hydrogen bonds or Van der Vaals forces.

In Part (e), for Test 1 butter, which is made from milk and milk proteins gives a positive purple test. Margarine, which is pure hydrogenated oil does not contain any protein, and so gives no purple result. Candidates seemed unfamiliar with the Biuret results.

Question 3

In Part (a), almost all the candidates were able to identify the molecule as glucose.

In Part (b) (i), mostly the alpha 1-4 linkage was correctly identified, but the 1-6 linkage was not.

Part (b) (ii) stressed that each building block is made of TWO units and that four blocks (of 2) were to be used in the diagram. This was to ensure an adequate number of bonds to reflect an intentional repetitive pattern in the bonding sequences when drawing starch (amylase) and cellulose. One of the four marks was reserved for compliance with this instruction.

In Part (c), enzymes in the human digestive tract could not digest cellulose to monomers such as glucose. Candidates failed to state that the lack of such absorbable monomers meant that no calories could be derived.

In Part (d), glycogen, a polymer of glucose, is traditionally referred to as 'animal starch' and produces a blue-black reaction with Iodine (in potassium iodide solution). A few candidates mentioned the reddish colour more typical of amylopectin.

Module 2

Question 4

In Part (a) (i), only a few candidates were able to demonstrate a knowledge of semi-conservative replication of DNA by actually drawing the appropriate DNA strands themselves. In Part (a) (ii), few could identify semi-conservative replication and the consequent labelling of the strands by radioactive thymine. Some candidates described meiosis, and the movements of chromatids.

Part (b) was well done, with many scoring full marks. Some candidates could not remember all the bases.

Very few candidates interpreted Part (c) correctly. Strain 1 was blocked at gene A, and strain 2 was blocked at gene B. However, even when the affected genes were identified, few candidates were able to explain their answers.

Question 5

In Part (a), candidates selected pro-, meta-, ana-, telo- and interphase, but some chose poor representative cells, rather than the clear and obvious ones.. They should have been sufficiently familiar with the material to have spotted five clear examples immediately.

Part (b) was a simple recall question which most candidates answered correctly.

In Part (c), mitosis preserves the genetic material of the cells, therefore cancer defects are passed on to the daughter cells. A common error was that the disease and not the genes were passed on during mitosis.

The correct answer in Part (d) (i) was 96 and Part (d) (ii) was 48. The most common error in Part (d) (ii) was 24.

In Part (e) (i), asexual reproduction was correctly answered by most candidates. In Part (e) (ii), since all the cells would possess the identical genome, they would be equally susceptible to the virus. The most common error was that the virus was passed on during mitosis and vegetative reproduction.

Question 6

Few candidates did Part (a) satisfactorily, and terms and descriptions were frequently mis-matched, for instance dioecious and monoecious. Protandry and protogyny were known, but correct outlines, as requested were confused and many obscure examples were put forward.

In Part (b), most candidates answered correctly that the pollen nucleus was haploid.

In Part (c), candidates reasoned well in Table 4, and most scored full marks.

In Part (d) (i), a plant with a rare allele will produce pollen (or stigma tissue) with the rare allele. Its rarity ensures that it is unlikely to

meet with another plant of the same genotype, and thus the pollen will germinate. Most candidates were able to reason this out.

In Part (d) (ii), similar alleles, for example, S1 in the pollen and S1 in the stigma, result in incompatibility. There is no fertilization and no zygote. Only dissimilar alleles are compatible and can form heterozygous embryos. Homozygous zygotes are not formed. This section was answered by about 30 per cent of the candidates.

Module 3

Question 7

In Part (a) (i) and (ii), two marks were available for each full definition. Brief or partial statements received one mark. Several candidates gave examples only. They needed to give a full, comprehensive definition of the terms.

In Part (b), the examiners expected the genotypes to be written: XGY, XgY or XGXG, XGXg. However, many candidates wrote simply GG or Gg. This led to some confusion with the genotype for the males, where many candidates used two alleles instead of one. The majority of candidates gained at least half marks for this answer.

Question 8

In Part (a) (i), most candidates correctly identified the light moth as the one with the disadvantage. In Part (a) (ii), the camouflage factor in the environment had changed from light to dark bark., due to industrial pollution, leaving the light moth more exposed to predators than the dark moth. In Part (a) (iii), most candidates read off the correct figures, 125 light and 60 dark. In Part (a) (iv), the larger population of birds in the country would result in more of the 1000 released moths being eaten.

In Part (b), candidates tended to describe the method of natural selection, rather than to define it.

In Part (c), 'Directional Selection' should have been answered for (i), and stabilizing and disruptive selection for (ii).

Question 9

Candidates still find difficulty with creating dichotomous keys. The last three Chief Examiner's Reports have stressed that this challenge is included regularly. Despite this advice there has been little improvement in performance. Candidates are advised to study their texts in relation to this Topic and prepare themselves.

In Part (b), candidates were unsure of the differences between viruses and bacteria. Living versus nonliving, size, organelles and metabolism were the most common and acceptable answers.

In Part (c), the well-known statement, **King Phillip Cried Oh For Goodness Sake** stimulates memory of: **Kingdom Phylum Class Order Family Genus Species**. (Use **King David** for **Division** in Plants). This should help candidates to distinguish between Family and Class, which only 50% could do. Answers for Gene and Allele, very basic information, were disappointing (see Syllabus, page 18 1.1). Few candidates were able to write one statement to distinguish between Allo- and Sympatric speciation.

UNIT 1 PAPER 02

Section A

Question 1

In Part (a), the majority of candidates were able to answer correctly. In the case of plant cells, determining the water potential of the bathing fluid posed greater difficulty. This suggests that the candidates had not actually viewed plant cells in osmotic experiments under the microscope. Many candidates failed to read that the question asked about the bathing solution, and not the state of the cells. Instead of writing iso-, hyper- or hypotonic they wrote 'turgid' or 'plasmolysed'.

In Part (b), the specific answer required related directly to the properties and components of animal cell membranes and plant cell walls. Most candidates cited the process of osmosis as the reason for the changes in cells sizes without reference to the red blood cell membrane properties and the cellulose walls. Definitions of the

terms iso-hyper- and hypotonic were also given as reasons for the change in sizes of the cells, although there were more references to the rigidity of the cell walls than the elasticity of the RBC membranes.

Part (c) was answered incorrectly by the majority of candidates. They were unfamiliar with calculations of magnification. This skill will be tested repeatedly, and needs to be prepared properly.

Parts (d) and (e) were answered fairly well.

Question 2

In Part (a), most candidates correctly identified A-E. For D, vascular bundle/tissue, phloem and xylem, were accepted. They had difficulty with F, the tapetum.

In Part (b), drawing skills were very fair. The compliance with a PLAN drawing was factored into the mark scheme. (compared with drawings of individual cells). Realism, correct proportions, and an illustration of the positions and sizes of all the features labelled in (a) were required. Much more practice is needed in drawing skills, and a question such as this, which tests drawing ability will be given in Section A each year.

Part (c) used the formula: 'drawn size' divided by 'actual size' = magnification, ($D/A=M$), rearranged to give $A=D/M$, and that is 0.67mm, which candidates should recognise as being about right, since an anther is about a mm. Candidates often have so much difficulty with this very simple calculation that repeated classroom and lab practice is suggested.

Part (d) was quite well done.

Question 3

Part (a) was generally well done but a number of candidates had difficulty with dihybrid inheritance, and used a single pair of alleles, as in monohybrid inheritance. Others used different symbols for each of the 4 traits, rather than two pairs, which would have communicated the dominant and recessive alleles. Much practice is needed with selecting appropriate symbols, and diagramming the crosses accurately.

In Part (b) (i), candidates were required to write the observed numbers directly from the information provided, and then call upon their knowledge, the 9, 3, 3, 1 expected ratio. Nine quick calculations were required and marks were awarded for the correct answers at each stage. In Part (b) (ii) the sum was 0.36.

In Part (c), candidates appeared not to know what to do with their result: select 3 degrees of freedom, and choose the 5 per cent (0.05) probability column. These intersect at 7.82, which implies that the difference between the expected and observed results is insignificant. Some candidates chose 0.5 instead of 0.05, and quoted 2.37.

Section B

Question 4

In Part (a), candidates were asked for a precise description of the structures of the cell membrane. Instead of describing or annotating a drawing of the structures, many described their functions. Those who did focus correctly only gave fair descriptions - few gave any dimensions.

In Part (b), candidates misfocussed their answers. Instead of describing the membrane systems of the Golgi apparatus and the RER, they dealt mainly with function.

Chloroplasts and mitochondria were described, but the question asked candidates to compare the membrane systems of the two. For chloroplasts: the outer membrane, inner membranes (grana and thyllakoids, pigments, electron carriers). For mitochondria: outer membrane, cristae, stalked particles etc. were required. These two organelles are basically 'modified bacteria', and their value to the Eukaryotic cells is their membrane systems, and there are interesting differences between their arrangement.

Question 5

In Part (a), many candidates performed satisfactorily with good descriptions of the effects of the three conditions on enzymes and enzyme activity. Substrate concentration was the least well known and the most poorly explained.

In Part (b), many candidates rewrote parts of the question, and did not discuss the reasons for the substrate or bond specificity. Some candidates misunderstood and used trypsin to exemplify substrate specificity, and sucrase for bond specificity.

In Part (c), the basic answer expected was feedback inhibition, but candidates needed to identify at least 4 points from the illustrated sequence, and explain them well to gain 4 marks.

Mean score, 11.55. Range, 0 - 20. Chosen by 68 per cent.

Question 6

In Part (a), most candidates demonstrated a satisfactory knowledge of the male reproductive system. Drawings were fair. In most cases, it would have been more efficient to have annotated labels. Most candidates set out the drawing with the labels, and then wrote another page explaining the structure in words, and added facts about function. Many descriptions were wordy and confusing, and candidates wasted time, thereby compromising their scores in the last question. Candidates should understand that timing, and adherence to a time plan is an essential exam technique, especially for essays. Going over time on any question always penalizes another.

In Part (b), many candidates were not clear about the differences between the two types of pills. They produced good descriptions of the roles of oestrogen and progesterone in the normal cycle, but could not relate or apply the information to the question asked.

Part (c) was generally well done, with good diagrams, particularly of the sperm. Some candidates did not compare the sperm with the ovum. They were unsure about digestion, forgetting the function of the acrosome is to release these enzymes to digest away the materials surrounding the egg. They dwelt on the fact that the sperm must digest food for itself, and some even mentioned a mouth. The presence of mitochondria and the tail details were required for energy use and movement.

Question 7

In Part (a), many candidates used four diagrams to show mitosis, whereas five were presumed to be essential to show the details of

crossing over in meiosis prophase I. The question did not ask for cells exclusively, and cross over details could have been provided with chromosomes alone. They must choose from their range of knowledge what visuals are best included when trying to show this intricate series of events. Some candidates explained crossing over and rearrangement of exchanged parts, but annotated drawings ONLY were requested.

Part (b) was fairly well done, and many candidates gave three ways in which variation was possible, but did not elaborate on the points. They often presented the three points in one sentence. They were asked to describe these ways, and two marks were allotted for good descriptions of each.

In Part (c), candidates correctly identified mitosis, but did not think of this question in terms of the values (advantages) of mitosis as a process, and its disadvantages in self perpetuation when giving their answers. Some advantages are that mitosis can effect a rapid increase of cells; it ensures the same genotype as the parent; all cells are identical in genome; favourable mutations are perpetuated; only one somatic cell with the full gene complement is necessary. Disadvantages: mitosis does not provide for the introduction of a new haploid set of chromosomes; there is no exchange of genetic material; there are no mechanisms to correct the set and number of chromosomes following, for instance polyploidy or nondisjunction; disadvantageous genes or mutations are perpetuated.

Question 8

In Part (a), candidates could not clearly distinguish between the terms *insitu* and *exsitu* and did not separate the two properly in the answer. For instance, after defining the terms, candidates dealt with examples, but did not clarify which type they were referring to. Several included egg and sperm banks. It may assist candidates if they can learn lists of examples, to provide them with breadth for such answers, and then learn how to expand the lists with descriptions of each item.

In Part (b), there was some confusion in the responses given. Genetic engineering, gene libraries and DNA preservation concepts were involved in maintaining genetic diversity, but macro-level ecological defense systems world wide were seldom referred to. The value of

wild types: their resistance to pathogens; the susceptibility of highly selected genotypes to viruses; the maintenance of breeding units; the preservation of a rich gene pool; the preservation of un-researched animals and plants for future uses; medical and industrial uses; the preservation of a wide microorganism gene pool for food technology or biological controls and the adaptation and survival of kingdom populations of relation to micro and global environmental challenges. Five of these, or similar points, with a brief explanation for each would have scored full marks.

In Part (c), natural and traditional home areas should be preserved including any seasonal migrators. The area should be large enough to support a breeding population. All necessary species in the food chain, including aquatic members should be present. Predator-prey relationships should be in balance in the reserve. Evaluation mechanisms, even culling and research should be in place - plus financing. These are some of the components to work into the answer. Many students gave very brief lists, e.g. size, predators, food plants, etc, without expanding to secure their five marks.

Question 9

In Part (a), candidates were not adept at writing about failure of chromosomes to separate. Those who were, wrote about whole sets of chromosomes failing to separate, due to spindle non-formation, and how it would affect the genetic content of cells, but the terms non-disjunction and polyploidy were not always used to describe it. They could have also referred to Down's syndrome (trisomy 23), or the failure of sex chromosomes to separate, with the consequent irregularities, (XXX, XXY and XYY types) following fertilization.

Concerning changes in chromosomal structure, candidates had access to eight marks, and should have provided four well-described examples. Those who did gave very poor drawings, although, of course, line-drawings were accepted provided they were correct, and the results following addition, duplication, deletion, inversion or translocation were shown.

In Part (b), candidates were asked to discuss the principles on which the Five Kingdom classification is based. They are Prokaryotic/Eukaryotic, unicellularity/multicellularity, autotrophs/heterotrophs, absorptive/ingestive feeding, degree of complexity, evolutionary

pathway. Once candidates knew some of these, they could express their view as to the applicability of these principles. The better candidates cited some of the principles, but many turned to the hierarchical divisions from Kingdom to species. They listed them and gave a brief description of each one. Scoring was low.

The Protocista was not well known at all. Many candidates wrote about viruses and bacteria. They did not know examples of protists. They did not understand that protozoans such as amoeba and paramecium which are unicells using heterotrophic nutrition were in the group as well as algae, which are multicellular and autotrophic. There is a wide range of organisms with few features in common, and it is not a natural group. The majority of candidates obviously lacked experience with the concepts.

Candidates scored lower marked in Module 3 than in Module 2 and Module 1 because:

1. They had used up too much time on earlier questions, and did not have enough for these questions. Answers were sparse and hurried.
2. This Module is not well covered; perhaps inadequate time is allotted to teaching it and the difficult concepts it contains are not understood by the students.

UNIT 2 PAPER 01

Module 1

Question 1

In Parts (a) (i), (ii) and (iii), most candidates knew that carbon dioxide was fixed in stage 1 of the Calvin Cycle, but a common error was water. Most knew that water must be present for ribulose biphosphate to complete the reaction, but a common error was minerals.

In Part (b), ATP was the energy source stated by most, but there were errors such as sunlight and ADP. Few candidates knew that reduced NADP was the electron donor referred to. Common errors were not using the phosphorylated form of NAD, or the reduced form of NADP.

In Part (c), two facts, the regeneration of RBP and the formation of carbohydrates were required for both marks. At least half stated both.

In Part (d) (i), granum was expected but thyllakoid was also accepted to compensate for any misunderstanding of the label. Common errors were lamella and chloroplast. In ii), few gained full marks for outlining the processes in the chloroplast. Some confused it with respiration, and some could not distinguish between sites A and B, and therefore could not link the processes.

Question 2

Part (a) was quite well done, but a few candidates did not assign the 1st level of the pyramid to the producers in Part (i). In Part (ii), the answer needed to show an obvious reference to Figure 4, which did not identify the primary producers. So to say simply that “they feed on primary producers”, without spatially identifying the producers is inadequate. Consumers always occupy the second trophic level and have the higher energy consumption.

In Part (b), several candidates failed to realize that the quantity of energy represented by level A, the producers, was the total quantity of energy entering the system, and then proceeded to total all the energy in the different levels to obtain a figure to calculate the amount of energy transferred from the producers. Furthermore, some candidates were unable to perform a simple percentage calculation. Most candidates recognized that heat is a major route for loss between trophic levels, but did not state that this loss was due to metabolic processes, such as respiration. Few mentioned loss from urine, faeces, the breath and sweat.

Part (d) was satisfactory.

In Part (e), marks were given for sequential stages of the calculation, and candidates were asked to show their working, so that the steps could be given credit.

In Part (f), most candidates failed to give the correct answer, that is, that the whales were tertiary consumers occupying the 4th trophic level.

Question 3

Although all candidates should have studied the electron transport chains which generate ATP, only the more capable candidates clearly understood the passing on of H⁺ along the chain and its ultimate combination with $\frac{1}{2}$ O₂ to form water. They identified substance 10 as ATP in Part (i), but were unable to put arrow heads in the correct directions to match up with 11. In (iii), only a few of the candidates were able to identify which numbers (between 1 and 8) represented the reduced state of the carriers. The enzyme at 11 was often identified as cytochrome.

In Part (b), most candidates did not know that hydrogen was accepted from four of the reactions in the Krebs Cycle, though the syllabus states “outline the Krebs Cycle and explain its significance in ATP formation”.

In Part (c), most were able to state that glycolysis is a source of hydrogen, but few were able to identify the pyruvate-acetyl co-A entry into the mitochondrion as being linked to hydrogen production. No one used the words ‘oxidative decarboxylation’, which enables students to link the fact that when CO₂ is produced in these reactions, hydrogen is also released. In Part (ii), instead of saying how ATP was generated directly from a ground phosphorylation in glycolysis by incorporation of inorganic phosphate (this is such an important reaction in creating subsequent survivable energy from glycolysis that it should not be overlooked in teaching), they stated how many ATP’s in general were formed.

In Part (d) (i), many of the candidates were able to say that when protons were moved into the inter-membrane space, the pH of this area decreased or became more acidic. In Part (ii), the correct response was that the protons diffused back to the matrix. Most candidates mentioned active transport, which would defeat the whole purpose of the energy -generating activity.

Module 2

Question 4

This was a question investigating how hormones and a neurotransmitter are admitted into cells through their membranes. There were two types of hormone: proteins and steroids.

Part (a), asked for one example of each type of hormone.

In Part (b), instead of realizing that hormones affect the nucleus, switching genes on or off, many candidates referred to mutations. Fewer than expected explained the nature of hormones in being effectors or repressors, and controlling protein production.

In Part (c), candidates should have been able to identify that the molecule which attaches to the receptor is acetyl choline, or they could have generalised with the word 'neurotransmitter substance'. In Part (ii), however, few understood that molecule B was a receptor for acetyl choline. This question tested application of knowledge of nerve cell membranes and neurotransmission at a synapse. In Part (iii), following stimulation of the membrane by attachment of acetyl choline, an action potential is initiated, and a depolarization of the membrane in which sodium ions move in and potassium ions move out.

In Part (d), cholinesterase is involved in breaking down the neurotransmitter (acetyl choline). Several candidates left this blank.

In Part (e), candidates were advised that Molecule A is a hormone. Hormonal action is controlled by feedback reactions. The inhibition of A by the product F is an example of negative feedback.

Question 5

In Part (a), the diagram of the artificial heart tested the candidate's understanding of its function as a fuel pump, with an intake and output flow. They were advised where blood entered and exited, both in the diagram and the text, and most were able to deduce the labels.

In Part (b), the majority of candidates correctly identified Z as the attachment for the pulmonary vein.

In Part (c), a large number of candidates disregarded the diagram, and explained how blood was circulated in the normal heart. They did not relate the artificial heart's pumping mechanism to the question asked, even though the question specifically referred to the artificial heart.

In Part (d), while the majority of the candidates were able to score one mark for the proximity of the lungs to the heart, many failed to cite the delicate nature of the lung tissue as a reason to require a lower blood pressure. The question asked why the right ventricle walls were thinner than the left. It did not ask why the left was thicker than the right, and many candidates dwelt on the need for thick muscle on the left. A number of misconceptions were identified, including different volumes of blood in the various chambers.

In Part (e), the majority of candidates were able to give suggestions on how to generate two different pressures. These were accepted if they were feasible - that is, if they took consideration of the fact that a person would have to LIVE with their modification, and that the heart had to be compact and portable. Addition of two extra pumps was therefore impractical, but varying the elasticity of the membrane was reasonable

Question 6

In Part (a), many candidates correctly choose sodium and protein respectively. A few confused the keys.

In Part (b), candidates did not perform well with the arithmetic required.

Some candidates confused ADH with ADP in Part (c). Others had misconceptions of ADH being released when urine is dilute or when blood pressure is high. The correct answer was that ADH is released when plasma osmolarity increases or when body dehydration occurs.

Most answers were satisfactory in Part (d) and involved dehydration and loss of solutes. Diabetes was cited correctly in Part (e).

Module 3

Question 7

In Part (a), about half of the candidates answered correctly in general, but few took any notice of Figure 10, and did not quantify their answers using the data from the chart. Answers were simplistic and

below the CAPE standard, and many candidates focused on the availability of medication and health care in developed countries, without understanding the significance of the word 'rising'.

In Part (b), half of the candidates could not distinguish between type I and type II, and could not describe type II. The syllabus defines "state" as to "provide factual information in concise terms, outlining explanations'. It describes "list" as to "itemize without detail". Those candidates who listed three points were not able to receive full marks. A "balanced" diet was mentioned, without reference to its constituents. Candidates suggested that no carbohydrates should be given to a diabetic. There were many such misconceptions.

In Part (d), less than 25 per cent knew why diabetics lose weight, eat more and produce more urine. They clearly did not understand the effect of insulin, or the fact that its lack results in reduced absorption of glucose into the body's cells, so that they need to metabolise fats and proteins to produce energy instead.

In Part (e), most candidates knew that glucagon was antagonistic to insulin, but few knew its action, merely saying that it increased blood sugar. A full two-line statement was expected, such as: "Glucagon, secreted when blood sugar is low, stimulates cells, particularly in the liver to convert glycogen to glucose to resupply the blood."

Question 8

In Part (a), for vaccination, candidates needed to say that the pathogen was inactive or attenuated, and that it is introduced purposefully to motivate the immune system. It is not correct to say that "a small amount of a pathogen is introduced". It must be treated to render it less dangerous. For Part (ii) the actual antibodies, made elsewhere in an organism, which can cope with the disease must be introduced, either artificially or from mother-to-baby.

In Part (b) (i), candidates should have been able to churn out the ready-learned sequence for the immune system response in a straight-forward manner. There was little challenge here. Those who knew their basic work could easily gain marks. Three well described points were needed. In (ii), the immune reaction is de-

creased as killer cells have invaded and reduced the pathogens, so that fewer antigens are being presented, and B cell stimulation is less. The Tc cells retard the number of B cells secreting antibodies. Some of this information should have been given.

In Part (b) (iii), the antigen has protein receptors which are already recognised. When the T helper cells present the protein pieces, memory cells are stimulated. Clonal expansion is very rapid as there is no requirement for clonal selection. B cells differentiate quickly into plasma cells, and antibody production occurs quickly. Those who knew their work did extremely well, but there were some spaces left by those who seem daunted by the immune system..

In Part (c), during phagocytosis antigens are engulfed, while Tc cells invade the organism, secrete perforins etc or destroy it internally by biochemical methods.

Question 9

In Part (a), this lovely question, presented at the end of the paper presented some difficulty to those who had not managed their time well. Most of them failed to use the tables properly, and did not use the information to support their points, so answers were generalised and unsubstantiated. One difference in age was needed, for example, that for protein, vitamin A or iron, or one difference for gender, for example, protein or iron - quoting the figures.

In Part (b), many candidates were able to accurately calculate the quantity to be 23.87g, but some did not spot the daily dosage at 350 g/day, and gave the amount per 100g. In (ii), since starving children have a lowered BMR, a sedentary habit, are dehydrated and have fewer enzymes etc, their nutritional requirements initially would be lower than normal, until a gradual re-adjustment was achieved.

In Part (c) (i), many candidates did this calculation well, but again did not allow for the dosage. On Part (ii), most candidates did very well.

In Part (d), candidates tended to use their limited general knowledge about milk instead of selecting precise information from the table to substantiate their points exactly.

Part (e) was very well done. Most scored full marks. Occasionally abdominal oedema was called an enlarged stomach. Biologists should be able to distinguish between stomach and abdomen.

UNIT 2 PAPER 2

Section A

Question 1

In Part (a), most candidates had the right idea, but many missed gaining two marks by giving shallow answers. The question asks about carbon gain. They needed to say that uniform light provides more light to the leaf surface than flecked light, and that light is essential for photosynthesis, which fixes carbon dioxide into carbon products.

In Part (b), the difference between carbon gain in Shorea grown in flecked and unflecked sunshine was:

- (i) at 350 units CO₂, 0.07, (range accepted, 0.06 - 0.08)
- (ii) at 700 units CO₂, 0.08, (range accepted, 0.07 - 0.09)

In Part (c), the average maximum photosynthetic rate of Shorea was:

- (i) at elevated CO₂ concentration (700 units), 53 - 57 units.
- (ii) at ambient CO₂ concentration 41 - 45 units.

In Part (d), the difference is 10 - 14 units.

In Part (e), candidates should know firstly that carbon dioxide is a limiting factor for photosynthesis, and that increasing the concentration increases the rate of the process. Secondly that CO₂ is fixed into trioses which are converted into all carbohydrates, thereby increasing the carbon gain. This answer is not dissimilar to that in (a) above.

In Part (f), if all the enzyme sites are operating at maximum capacity, increasing the substrate concentration cannot increase fixation and carbon gain beyond the enzymic capacity. Most candidates got this point but comments including acidity or lack of oxygen were preferred.

Question 2

Parts (a), (b) and (c) were straightforward questions, and well done by most candidates with the possible exception of Part (c), on the calculation of the diameter of the pores. A generous range of size, from 0.45 to 1.25 micrometers was accepted.

In Part (d) (i), a fully compliant answer needed to include the following: "Water uptake increases from 5 grams at 11.00am to 28 grams at 6.00pm and then declines to 2 grams at midnight." This is not difficult to answer, but candidates gave brief, inexact answers. If there are 4 lines allotted, all four should be used, as the examiners have planned that this amount is required.

In Part (d) (ii), candidates were asked to comment on the transpiration rate. Their answers to Part (d) (i) & (ii) were meant to help them to focus on and formulate the answer to Part (d) (iii). In Part (d) (iii), answers deduced from either the ascending or descending graph line at 22 units of water uptake were accepted. In Part (d) (iv), excess water is used to maintain turgidity, for photosynthesis, enzymic reactions, cytoplasmic streaming, the prevention of desiccation or growth. Most candidates managed one of these.

Question 3

In Part (a) (i), candidates knew their facts, and answered quite well. Examination technique is important here. When two marks are awarded, at least two points are required, and they should fill the space provided. In Part (a) (ii), sexual transmission involving the exchange of viral-laden secretions, contaminated blood in transfusions or on needles used for intravenous injections. A one word answer was not enough. A clear explanatory statement was expected.

Part (b) (i) and (ii) were well done. Allowances were made for slight deviations in estimating the co-ordinates in (b) (ii).

In Part (c) (i), the two statements could have included the following: that AIDS cases are highest in the late 20's age group; failure to use condoms can result in AIDS or that low condom sales correlate with the highest AIDS incidence. In Part (c) (ii), candidates needed to identify the problem of varying class intervals used by the two data

centres, and to suggest that communication on the research activities or the methods of standardisation of the two Caribbean organisations is necessary to make the data useful to all other agencies.

Section B

Question 4

In Part (a), two clear points with a good explanation of each point were required to gain the two marks available. This pathway evolved in bacteria millions of years ago, and has become successful and almost universal because it is efficient and effective. But candidates have become so used to recanting the series of steps that they fail to investigate what the steps accomplish.

In Part (a) (i), answers were limited to “making glucose more reactive”, and occasionally, “to make fructose diphosphate”. The need to increase activation energy, the critical manipulations of the phosphate groups to increase reactivity and create the symmetry of the Fructose 1-6 diphosphate to open the ring and create two smaller, reactive trioses were overlooked. In Part (a) (ii), candidates confused ATP and ADP, since they knew the function of ATP, but obviously did not consider that ADP *had* a function or was in any way useful. Its role as an essential phosphate acceptor was not understood. In Part (a) (iii), the ‘ground’ phosphorylation is extremely important because it takes inorganic phosphate into the pathway, and is a prelude to the generation of the two profitable ATP molecules (out of the four produced) in glycolysis. Candidates had little idea about this step, but if it did not occur, there would be absolutely no gain from glycolysis. In Part (a) (iv), the nicotinamide acceptor accepts hydrogen and facilitates the progress of trioses towards pyruvic acid. Without this removal of hydrogen, pyruvate could not be formed and no energy could be derived, either from glycolysis or from the electron transport chains. In Part (a) (v), errors included: that the splitting of fructose into two trioses generates energy, or that since trioses were necessary, this had to be done. There was no mention of the ‘opening’ of the stable ring structure, the lower molecular weight, the availability of bonding groups or the fact that pyruvate, the end product of glycolysis is a triose.

In Part (b), aerobic respiration in animals was better known and explained than in plants. In animals, most candidates knew that pyruvate was turned to lactic acid, but many were unable to state how or why. They knew the reaction was reversible when oxygen was available, but again were not clear on how the hydrogen was removed to recreate the pyruvate. As to how the potential for energy conservation was thereby accomplished, they were not clear, occasionally referring to the energy which had already been expended (for the oxygen debt), rather than the opportunity provided for pyruvate to proceed to the Krebs's Cycle, where ATP could be reaped.

In plants, the conversion of pyruvate to ethanol, then acetaldehyde and carbon dioxide reduces the 3-C triose to a 2-C compound. This irreversible reaction loses the energy built in to the triose during photosynthesis. It is a loss of potential energy. In this question, candidates needed to look to the fate/function of pyruvate in the Krebs Cycle, and understand the significance of the loss of pyruvate. Again, it was necessary for them to understand the importance of the sequential steps in a biochemical pathway.

Part (c) was fairly well done, however, responses were generally limited to alcoholic beverages, mainly beer. Wines and spirits which are of economic importance to various countries were seldom mentioned. Only a few mentioned gasohol. A significant number discussed the social value of alcohol consumption. This fact, and the production of carbon dioxide in baking did not gain marks.

Question 5

In Part (a), the description of the carbon cycle, which candidates could do purely from recall, and which earned 50 per cent (10/20) of the total marks available was quite well done, but in an essay-type descriptive answer, they should remember that marks are given for well explained points. In this case they should have been in sequence. The examiners looked for points for which they could give credit and it was up to the candidate to make enough clear and solid points. Aquatic components of the carbon cycle and carboniferous deposits were almost always overlooked.

In Part (b), definitions between food webs and food chains were not clear and many discussions failed to distinguish adequately between them. The higher level discussions as to which one best represented greater accuracy in the feeding relationships of an ecosystem were very generalized and were seldom illustrated by specific references. Mostly there were generalisations of birds and insects and grass. There were very few candidates who seemed to show a knowledge or delight in the flora and fauna of any specific ecosystem, or display any personal biological zeal or understanding of ecology.

In Part (c), very few candidates connected the flow of nutrients within the ecosystem with the processes involved in nutrient cycling. There were four main areas of comparison between energy and nutrients:

1. The source - the sun for energy, reservoirs e.g. soil, for minerals.
2. Fixation and absorption processes: photosynthesis for energy and active transport etc for minerals.
3. Flow: one way for solar and cycling for minerals.
4. Loss from the system for both: energy (as heat) and minerals by oxidation, putrefaction, decomposition etc. Some of these concepts were a challenge to the candidates.

Question 6

In Part (a) (i), many candidates wrote more than was necessary. They should be guided by the marks allotted. Two marks. This indicates that two points well explained, or four points in statement format would be adequate. Two pages of writing represented bad judgement.

Part (a) (ii) was poorly done. Many candidates did not clarify **how** red cells not only carry oxygen, but carry **large amounts** of oxygen. Surface area, membrane permeability, 250 million molecules of haemoglobin per cell, the details of the high affinity and the facilitation of speedy on-loading by structural re-conformation of the haemoglobin, etc. were needed for eight marks. Candidates were awarded one mark for each well-described point.

In Part (a) (iii), selection by macrophages or Kupffer cells in the liver, of damaged RBC's, lysis and recovery of components was required. Most knew what happened to the haemoglobin, but few

mentioned bile or the pool of amino acids resulting. Again, for two points, there should have been two well-explained points, or four pertinent statements.

In Part (a) (iv), several candidates wrote that haemoglobin was not filtered out because it was needed, showing not only a lack of comprehension of mass filtration and reabsorption, but a lack of understanding of the balancing forces of life. Some said that since the liver destroyed haemoglobin, there was no need to filter it out- oblivious of the time frame. Very few remembered that haemoglobin was **inside** the RBC and not free in the blood. Wherever it might be free, due to RBC damage, candidates should quote the molecular size. These questions, requiring precise answers, showed many flaws in the candidates' recalled knowledge.

In Part (b) (i), the candidates needed to utilize and apply their knowledge in this section, but many were unable to trace the higher levels of carbon dioxide from the air to the alveoli, blood and tissues. The effects of CO₂ on oxyhaemoglobin and on the pH of the blood was expected. In Part (b) (ii), candidates performed much better.

Question 7

In Part (a) (i), two marks were available for **distinguishing** between a motor and sensory neuron. Candidates tended to give a long description of each one separately and failed to identify their distinctions. In Part (a) (ii), candidates should have selected certain features and methodically described their structure and function, for example, cell body, myelin sheath, dendrons, dendrites, axons. Eight marks were available for straightforward recall answers giving eight clear, well presented answers.

Part (b), tested the application of the candidate's knowledge on synapse function. A diagram might have assisted candidates with reasoning out the answer.

In Part (c), candidates often forget that when they are taught about membrane transmission in neurons it pertains to unmyelinated neurons of annelids or molluscs. It should have been simple to describe, but few did it well. The information given on saltatory conduction in myelinated neurons with nodes was rather poor and brief. Four items of comparison were needed for the five marks.

Question 8

In Part (a) (i), candidates responded with long descriptions of pre-learned knowledge about the short and long term effects of alcohol on the brain, but they did not organise their information into the two categories of 'long term' and 'short term' effects. Many did not read 'on the brain', and wrote about the liver, social behaviour etc, thereby failing to conform to the mark scheme. In Part (a) (ii), two marks were available for this answer on tolerance, so two full points needed to be made. Those who wrote a page could not earn more than two marks, and should select material to match the reward available.

In Part (b), candidates needed to recognise the components of the question. They were: 1. the effects of cigarette smoking on the respiratory system, and 2. its effect on the cardiovascular system. The answers were recall-type: no reasoning nor deductions were required, just recitation of facts. Candidates should have been able to identify five ways in which cigarettes (nicotine, tars, carbon monoxide, toxins etc) affected the two systems. Few gave through answers tailored to the requirements of the question. Thoughts tumbled out with no management.

Question 9

In Part (a), transgenic organisms not only **possess** DNA/genes from another species incorporated into their genome, but they actually **express** the genes. That is why they were created - to produce the new phenotype. Few candidates understood this. In outlining the method by which these organisms could be produced, some candidates (as was expected), gave details on one method, while others gave an overview of several. Credit was given in both cases. Candidates were, however, expected to comply with one animal and one plant method, but many failed to describe both or generalised.

Part (b) was quite well done, but it was a complex question requiring two concepts, 1, environmental safety and 2, ethical implications, which then needed to be discussed in relation to genetically modified foods, **and**, human clones.

In Part (c), most candidates were able to define a 'restriction enzyme', but the majority were unable to describe the steps needed to remove a section of the genome. Candidates just need to learn this, step by step. A good definition, and three well described steps would gain the five marks.

PAPER 03: School Based Assessment, Units 1 and 2

Overview

The laboratory books were of a fair standard and the entire syllabus was covered in the majority of schools. A wide range of activities was used to reinforce the topics in the syllabus. The drawing skills of the majority of students were unacceptable. The ability of students to analyze and interpret data and to posit an explanation and draw a succinct conclusion was especially poor. The observation, recording and reporting was of a fair standard: A clear demonstration of an understanding of the appropriate use and effectiveness of different types of graphical representation was absent. In several instances it was not clear which practicals were used for the assessment of skills.

Mark Schemes

A high proportion of mark schemes submitted failed to place sufficient emphasis on the substantive elements of skills. In drawing, clarity and accuracy are the critical elements. Numerous mark schemes for drawing allotted 1/10 for titles, 4-5/10 for labels (labelling lines horizontal, lines not crossing, lines with no arrowheads, labels in script, labels correct, annotations), magnification 2/10 (calculation and/or stating), leaving a meager 3/10 for clarity and accuracy. For assessing drawing skills, 6-7 marks out of a total of ten should have been allotted to clarity and accuracy and three marks to labelling and magnification.

The Analysis and Interpretation (AI) mark schemes submitted showed deficiencies. In AI, the ability to relate the data collected to theory is critical, therefore, explanations and conclusions should have accounted for a minimum of 6 marks out of the total of 10. Four to Five marks for background information, which in a high proportion of cases was clearly taken directly from textbooks or given by the teacher, and a mere recording of results however presented.

The ORR mark schemes submitted were of a satisfactory standard and reflected the elements that were necessary for proper assessment of the skill.

It should be noted that all mark schemes, however configured, should be scaled to the appropriate mark and noted clearly in the laboratory books. For example mark totals out of 18 and 25 were received. In some cases the averages on the moderation sheets did not correspond to those noted in the lab books for the students. Some laboratory books were submitted without student names. In a few instances marks schemes were incomplete or not properly applied during assessment.

Drawing Skills

The drawing skills of many students were unacceptable. Poor drawings had thick, smudged, uneven lines; perfect circles and parallel lines created with a geometry aid; shading, cross hatching and stippling. In only a few cases, were the magnifications of specimen drawings calculated and inserted. Instead, students erroneously stated the power of the objective and eyepiece used to view the specimen.

Many, candidates were unable to determine the level of detail required in a plan drawing versus a high power drawing. Some drawings were copied from text books, showing free ribosomes, nuclear envelope, pores and plasmodesmata between plant cells which cannot be seen under a light microscope. In other cases, students in the same group had identical drawings. Good use was made of electronmicrographs to examine organelles and sub-cellular organization.

Analysis and Interpretation

The AI skills were weak. In a plethora of cases stimulus material, data, questions and methods from published literature or the internet was used in the development of laboratory practicals for AI and this information was not clearly presented in the students laboratorybooks or mark schemes to allow for a clear moderation of the exercise. Examples of these experiments included: the use of X-rays on mice, collecting the weights of babies, diagrams of apparatus with mercury in an open dish, human blood collection and examination. The

use of set questions to elicit explanations, discussions and conclusions by students is not acceptable. Students must apply theoretical knowledge to the analysis of results, discussing it concisely and formulating a conclusion.

Observation, Recording and Reporting

The ORR skills of students were of a satisfactory standard. Many books were well organized containing a Table of Contents, page numbers and appropriate titles for all the drawings, graphs and tables. The use of tables, graphs, pie-charts and histograms to illustrate trends in data was used effectively in number of cases and presentation was of a good standard.

Some of the methodologies presented for experiments contained insufficient detail. In a number of cases students neglected to give their tables, graphs and drawings (apparatus and specimen) appropriate titles. It should be noted that simple drawings do not lend themselves the proper assessment of ORR. Faulty grammar and spelling of biological terms were areas of concern.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2005**

BIOLOGY

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BIOLOGY**CARIBBEAN ADVANCED PROFICIENCY EXAMINATION****MAY/JUNE 2005****GENERAL COMMENTS**

The number of candidates continues to increase as more centres participate in the Advanced Proficiency Exams. In 2004, a total of 1416 Candidates took the exam, while in 2005, this rose to 1931. This increase comprised 1197 Unit 1 candidates in 2005, (compared with 1006 in 2004). The Unit 2 candidates increase from 410 in 2004, to 734 in 2005.

Both tutors and candidates should be familiar with the Glossary provided in the syllabus and be able to distinguish between skills requiring basic knowledge and comprehension, such as 'explain' and 'describe', and higher level skills such as 'discuss' and 'suggest', which search for understanding and comprehension of the subject matter. They should study the glossary and be clear as to what is required by descriptors such as 'list', 'outline' and 'state'.

As mentioned in previous years, candidates should note the value of each portion of the question. Marks are generally allotted on the basis of one mark for one good point with an explanation, expansion or statement to clarify it. If two marks are available, the mark scheme will obviously require two points of explanation. In Paper 01, (structured questions), candidates should be guided by the number of lines provided for the answer. This space has been planned to accommodate the expected length of their answer. If candidates do not utilise the available space, it is likely that their answer is too brief to gain the allotted marks. Where there is a single line, a statement is usually better than a one word answer.

In general, as users become more familiar with the requirements of CAPE Biology, candidates' answers are showing some improvement, and more of them are complying with criteria which enable them to reach a higher grade. In Unit 2, in 2004, 8.29 per cent gained Grade 1, while in 2005, 14.17 per cent achieved this top grade.

Structure of the Papers**Paper 01 of Unit 1 and Unit 2.**

Paper 01 for both Units was composed of nine compulsory questions each of which carries a 10-mark maximum. The questions typically present stimulus or challenge material such as graphs, micrographs and flow-charts which require interpretation and analysis. Questions were designed to give a 50:50 distribution of 'KC' (knowledge and comprehension), and 'UK' (utilization of knowledge), answering skills.

Paper 02 of Unit 1 and Unit 2.

Paper 02 of both Units 1 and Unit 2 was composed of nine questions, arranged into Sections A and B. Section A consisted of three structured questions, one from each

Module, based on practical/laboratory applications, particularly on those sections of the syllabus with a single underlining. Scale drawings, genetic crosses and calculations to determine significance are also included in question written for section A. Section B comprised three balanced pairs of questions, providing a choice between the pair. There was a pair of questions for Module 1, 2 and 3. They permitted much more freedom of expression, and choice of presentation style, and tested KC and UK skills.

UNIT 1

PAPER 01.

MODULE 1

Question 1.

Syllabus Objectives 1.3, 1.4.

Compulsory question. Maximum Marks =10
Highest mark 10, Mean mark 3.04, Lowest mark 0

Part (a). The question on bonding and the constituents of three polysaccharides was quite straightforward, but was not well done. Candidates should be aware of the importance of alpha and beta glucose monomers in the 1-6 bonding found in glycogen and starch as opposed to cellulose, and the 1-4 bonding of fructose and glucose to form sucrose. This is very basic biochemistry.

Part (b) (i) and (ii). Most candidates provided the correct position of the hydroxyl groups on the glycogen, but only 50 per cent or fewer could identify their location in the cellulose molecule.

In part (c) (i) most candidates circled both adjacent hydroxyl groups instead of a hydrogen from one chain with an adjacent hydroxyl from another chain, excluding oxygen.

(d) Reference must be made to the structure of glycogen, and how it relates to its function.; the coiling which serves for compact storage ; the side branches which allow simultaneous enzyme action at several sites to break down the molecule rapidly; the inclusion, in glycogen of up to 1000 glucose units as a ready source of hexose monomers and its property of solubility due to the exposed -OH groups. Most candidates scored only one of the two available points because they did not relate structure and function adequately.

Most candidates failed to compare the complex cellulose lattice with the linear (simply branched) shape of the glycogen, and the greater occupation by cellulose of its hydroxyl bonds, reducing their availability, and consequently, their solubility.

Question 2Syllabus objectives 1.10, 2.4, 2.5

Compulsory question. Maximum Marks =10
Highest mark 10, Mean mark 3.51, Lowest mark 0

Part (a). This part of the question was poorly done. Candidates were vague and failed to give relevant details. Sizes of cells were not given accurately, (0,5 - 10 um and 40 um or more). The words 'small' for Prokaryotes and 'large' for Eukaryotes were given. They failed to state that DNA in Prokaryotes is circular, and not membrane-bound, while in Eukaryotes it is linear, with histones, membrane-bound and surrounded by a double membrane. Mesosomes as energy generating structures were seldom cited, and ribosome differences occasionally made.

Part (b) (i) and (ii). Few candidates were able to correctly identify three features of animal cells not found in plant cells, but in contrast they could easily cite the reverse.

Part (c). Candidates were unsure of the procedural sequence, that is, whether hydrolysis or neutralisation came first. Lab experience should reinforce this. Several candidates were able to describe the effect of the acid on the bonds in the non-reducing sugar.

Question 3Syllabus objectives: 4.1, 4.2, 4.3, 4.4.

Compulsory question. Maximum Marks =10
Highest mark 10, Mean mark 6.9, Lowest mark 0

Part (a) was well answered. Additional points were (1) to control the sequence of reactions, and (2) to allow many reactions to occur simultaneously and (3) to permit reactions to occur at a speed which can maintain life.

For (b), most candidates agreed it would be effective in controlling tumour activity, even if it did not cure the tumour. They had difficulty in explaining their answer, and very often repeated the exact wording from the question.

In part (c), irreversible or non-competitive inhibition was correct.

In part (d), examiners were looking for the term reversible or competitive inhibition.

Part (e) (i), the catalysed reaction was B, the reason being that the activation energy is lower. Not many candidates used the term 'activation energy'. In (ii), the catalysed reaction was line A, the reason being that the enzyme speeds up the reaction, but when all the active sites are occupied, the rate levels out.

MODULE 2Question 4

Syllabus objectives: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6.

Compulsory question. Maximum Marks =10
Highest mark 10, Mean mark 4.76, Lowest mark 0

In part (a), only a few candidates were able to demonstrate knowledge of the coiling process by which chromatids condense to one tenth of their length. In most cases they merely stated that they ‘shortened and thickened’.

Part (b). Candidates scored well, however, too many mis-spelled the names of the bases, or substituted the names of amino acids for nitrogen bases, e.g. glutamine for guanine and alanine for adenine.

Part (c). Showed poor performance. Candidates seldom knew enough about the 3' to 5' linkage positions of the de-oxynucleoside groups of the sugar/phosphate backbone of DNA. They merely stated that both the 3' and the 2' hydroxyl groups were needed for replication.

In part (d) (i), most candidates were able to identify Stage A as transcription and B as translation, but with many spelling errors. In (d) (ii) for Stage A, candidates did not name the steps which were occurring in the process as ‘initiation’, ‘elongation’ and ‘termination’. Provided they described the sequential action from the unwinding of the double helix, the building of the mRNA strand, and the reformation of the DNA double helix and the release of the RNA molecule, they received their marks.

Question 5

Syllabus objectives: 3.4, 3.5, 3.6.

Compulsory question. Maximum Marks =10
Highest mark 10 Mean Mark 3.01 Lowest mark 0

Part (a). A surprising number of candidates failed to identify and correctly spell the labelled parts of the post-fertilization carpel, 5 - synergids, 6 - zygote, 7- endosperm nucleus, 8- antipodal cells, 9 - funicle.

Part (b) (i) and (ii). Many candidates misread the question, and failed to state the contributions with respect to the establishment of the next generation. Candidates from some centres used very out of date terms for floral parts. Label 3, the micropyle, allowed for the entry of water during germination/ the emergence of the radical during germination/ a weak spot in the testa which allows tearing for the hypocotyl to emerge.

Part (c) Many candidates were unfamiliar with this part of the syllabus, and did not

comprehend that it is the generative nucleus which divides to produce the two male nuclei. About 25per cent were able to state that one male nucleus fuses with the female nucleus, (usually the first to enter), and the other fuses with the diploid endosperm nucleus, thereby clearly identifying the four nuclei.

Part (d) (i) and (ii), The zygote differentiates into the embryo tissue of plumule, radical and cotyledons, (where food is stored), whereas the triploid endosperm differentiates into a mass of endosperm cells, such as in maize, which store food.

Question 6

Syllabus objectives: 4.9, 4.10, 4.11, 4.12.

Compulsory question. Maximum Marks =10
Highest mark 10, Mean mark 6.58, Lowest mark 0

In (a) (i), many candidates scored well, but a few gave responses such as amniotic fluid rather than amniotic cavity or sac. Functions should have included protection, room to move, etcetera but not constancy of temperature, because that is maintained by general homeostasis.

Part (a) (ii) was well done by most of the candidates except for a few who referred to the umbilical cord as the 'blood vessel', or 'fallopian tube'. The function included 'food', rather than nutrients, 'to breathe', rather than exchange of oxygen.

In part (a) (iii), candidates were able to cite the placenta, through the chorion and amnion were also selected.

Part (b). Candidates were aware that the use of alcohol by pregnant women was unhealthy for their unborn child. Foetal alcohol syndrome was frequently cited. Low birth weight, inhibited growth, mental retardation and organ defects were some of the effects expected.

Part (c). The foetal chorion separates the maternal and foetal blood supplies, but the diffusion of material of low molecular weight or size, for example, drugs, viruses is possible. Candidates brought out pore sizes and 'leakiness' of semi-permeable membranes. There were comparisons of molecules of glucose and alcohol for size, so most candidates were quite responsive, without necessarily using good biological expressions.

MODULE 3

Question 7

Syllabus objectives: 2.1, 2.2, 2.3.

Compulsory question. Maximum Marks =10
Highest mark 10, Mean Mark 4.55, Lowest mark 0

In part (a), candidates were able to identify crossing over between homologous chromosomes, and the formation of chiasmata, as the process which increases rearrangement of genetic material during meiosis. Few mentioned that the orientation of the chromosomes on the spindle and the random separation of the pairs at anaphase also increase variability.

Part (b) was fairly well done, but in (b) (i) very brief answers were given, such as 'trisomy', 'nondisjunction' or 'extra chromosome'. They did not specify trisomy of chromosome 21. However, examiners accepted all of the above, with two marks for a clear explanation, and one mark for a brief answer. In (b) (ii), a clear explanation of causation was required.

Part (c) evoked quite good responses. The points required were that when malaria is present, people with AA genotypes die from malaria whereas AS genotypes have better survival. In the presence of malaria, the AS genotype is therefore more prevalent. When malaria is reduced, the AS genotype loses its selective advantage, as AA genotypes survive and prosper. The incidence and distribution of sickle cell disease is reduced. Examiners expected at least four clear statements to earn the four marks.

In part (d), many candidates left the numbers at 199:678, instead of reducing them to the lowest ratios, i.e., 1:3.4 or 1:12. Some credit was given as it showed they knew where to find the information. However, many candidates did not complete their task by responding to the question "How do they compare"?

Question 8

Syllabus objectives: 3.1, 3.2, 3.3.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 5.86, Lowest mark 0

Part (a). Most candidates scored one mark for one point, failing to give two. They referred to the importance of classification to identification, research and in explaining relationships. Full answers can be found in the text books.

Part (b) (i). There was correct selection of the presence or absence of antennae or wings, but many candidates failed to give both. They often stated the presence of a feature as one point and the absence as another, e.g. wings present, wings absent. In part (ii), the original ancestors were recognised but the evolutionary order of descendants created problems. Candidates used a linear sequence without branching. No.5 is the obvious progenitor of 3 and 6, and forms one of the branches, and No 3 gives rise to 7 and 8, the second branch.

Part (c). Many candidates were unable to state such simple information as the names of the Kingdoms in the five Kingdom classification system, and most of the answers given suffered from inaccurate spelling. This is very basic knowledge, and it is

disappointing to find such a poor standard at advanced level. It confirms, as we have seen in past years, that any questions of the logic of the classification scheme are well beyond the knowledge of most of the candidates.

Part (d). Dichotomous keys are questioned each year and it is expected that candidates know what they are, (binary classification using pairs of distinguishing features), and how they are constructed. Teachers of CAPE can help their candidates by giving them practice to increase familiarity and competence.

Question 9

Syllabus objectives: 4.1, 4.3.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.03, Lowest mark 0.

Question 9, as is common, suffered from lack of time, probably due to using too much time on earlier questions. About 10 per cent of candidates were categorized as “NR” - no response. Others had sections without answers.

In Question (9) (a), Examiners agreed that information on Biomass was asking too much, and since few did well, it was disregarded. An adjustment was made to award one mark for a brief statement on Biome, with two marks for a good explanatory statement. In this way candidates were able to score quite well. Most candidates performed well in part (a) (ii).

Those who found time to tackle part (b) did well, but some confused embryo with egg. However, since some of the differences could apply equally well, e.g. surface area, volume, size, cellular inclusions, areas of differential density and dispersion of nuclear material in relation to the sperm, credit was given where applicable.

Part (c) (i). Candidates did quite well, even though the answers were rather generalised, using the term, ‘encroachment’, without exemplifying it. However, the loss of habitat or forest fires etc., have an equal effect on all animals in a given environment, and this type of answer only gained one point. The question required an answer more specific to the rarity of the white tiger. Low numbers are due to (1) the infrequency of the albino allele itself, and (2), the fact that it is recessive, and expressed only in the homozygous state. (3), premature death reduces the population, by being (4), less well camouflaged, (5), being hunted for unusual pelts, (6), being captured for exotic pets, for wealthy collectors or circuses. An answer of this nature gained the second point.

Part (c) (ii). Within the breeding program, with access to a network of sanctuaries, the following can be achieved: an increase in the numbers; maintenance of variation, prevention of inbreeding, breeding preferred qualities; use of invitro fertilization, mating preferences, litter size, monitoring, diet, care of cubs, etc. Candidates were expected to emphasise the insitu opportunities. The answer “to return them to the wild” was not accepted.

PAPER 02.**MODULE 1**Question 1

Syllabus objectives: 4.3, 4.5.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 8.21, Lowest mark 0.

Part (a) Good. Candidates had no problem in scoring the maximum marks on this section. Marks were awarded for correct axes, identification and appropriate class intervals. The points should have been plotted correctly and the lines drawn smoothly. Weaker candidates plotted the pH on the Y axis and the relative rates of reaction on the X-axis. Several candidates began graphs at values other than zero, but failed to indicate the break on the axes. Some extrapolated their curves to zero, but this was not required.

Part (b). The correct values for the optimal pH for the enzymes were given by most candidates, but many confused the axes and therefore read the Y axis instead of the X (pH) axis to determine the values.

Part (c). The pH range of 7.7 to 8.4 was correctly identified by the majority who has drawn their graphs correctly.

Part (d). This was a relatively simple question and most were able to identify two factors. Heat and temperature were occasionally given as two separate points.

MODULE 2Question 2

Syllabus objectives: 4.2, 4.6.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.67, Lowest mark 0.

Part (a). Candidates were not confident about the dates in the cycle at which the hormones reached their maximum, even though they were encouraged to draw in the graph lines if this would help them. If they knew the functions of the hormones and the events which they trigger, they would have been assisted by logic in getting them right. Probably candidates have previously been presented with textbook graphs and asked to describe or comment on them.

Part (b) (i). Most could identify Figure 2. as a section of the ovary, though a few chose a chloroplast. Several reverted to their textbook drawings and ignore the figure they were requested to draw. 75 per cent drew it as shown, 25 per cent used their own imagination of a memorised text drawing. Diagrams were drawn in circles or boxes, which was not necessary, as these shapes are artifacts. Instructions were ignored. Some tried to do a detailed drawing instead of a diagram to show the main areas.

These were difficulties at simply drawing it at half the size (x 0.5). Clearly much practice is needed with microscope work, and drawing to scale.

Part (b) (ii). Although the Mark Scheme provided for candidates to attain five or six correct answers to score three marks, Examiners soon adjusted this to “any three correct answers”: three marks, because the answers to this straightforward recall question were so very poor, and had offered too much challenge.

Part (c). To obtain the magnification of a drawing, divide the length of the drawing by the length of the actual specimen, that is, $8/3.5 = 2.3$. A range of 2 - 2.5 was accepted.

MODULE 3

Question 3

Syllabus objectives: 3.2, 3.3, 3.4.

Compulsory question. Maximum Marks =10

Highest mark 10, mean Mark 5.42, Lowest mark 0.

Part (a) presented the most difficulty. Few were able to construct an accurate set of dichotomous keys. At least four levels with contrasting pairs and “go to” were expected. This is an often repeated topic, and candidates need to receive practice until they are competent.

Part (b) was very straightforward, allowing for high scores, with only one distinguishing feature being required for each Kingdom.

In Part (c), Candidates did much better this year in their cognisance of the correct hierarchical taxa used in classification.

MODULE 1

Question 4

Syllabus objectives 3.1, 3.2, 3.3.

Optional essay question. % attempting: 49% Maximum Marks =20

Highest mark 20, Mean mark 11.52, Lowest mark 0.

Part (a). This section was well answered with the majority of candidates being able to draw and label the fluid mosaic membrane and list the function of four structures.

Part (b). Concerning the red blood cells, too many candidates failed to incorporate the effect of water potential on the direction of water movement during osmosis in their discussions. Generally they did not state that water moves from an area of high to low water potential, but gave CSEC level definitions instead. The term “plasmolysis” (which is applicable to plant cells with plasmodesmata) was used so frequently that it was accepted by the Examiners, as it was clear that all schools were using that term. Wrinkling or crenation was scarcely used. Some candidates in their

discussions did even mention the red cells.

Part (c). Many of the discussions on the operation of protein pumps were vague. The points are: (1) globular proteins fixed in the membrane which can, (2) move or rotate between the inner and outer surfaces, (3) have specific bonds for specific ions, for example, K^+ and Na^+ , (4) an ion on the outer side associates with the protein carrier, (5) causes isomeric changes which are (6) facilitated by ATP, which (7) releases energy as it is changed to ADP. (8) after temporary bonding the ion is released on the inner surface (9) another ion, from the inside is moved similarly to the outside. (10) These ATP supported actions are dependent on oxygen and respiration. A few good candidates referred to the hydrolysis of ATP to yield energy, and the conformational shape change of the intrinsic proteins, as well as the specificity of these receptor sites. Six good points earned six marks.

Question 5

Specific objectives: 2.2, 2.3, 2.4.

Optional Essay. % attempting 51% Maximum Marks =20

Highest mark 20, Mean mark 9.23, Lowest mark 0.

Part (a) Most candidates were able to give a very brief sketch of the structure and function of each of the organelles listed, but they were brief and often barely adequate, as many candidates were unfamiliar with the detailed structures of the organelles. Many answers were superficial, and simplistic statements were made, e.g. “Chloroplast - photosynthesis” or “ mitochondria - power house”. Time-wise, two minutes were available for each organelle, so two good sentences, and not just two words were expected.

Part (b). References to the electron microscope and light microscope were limited to what candidates would have been exposed to in the syllabus, Unit 1, Module 1, Cell Structure, objectives 2.1 NS 2.2, Page 9. They were not asked to compare the mechanisms of the two types, not compare their operation. The emphasis was on their use and importance in Biology. The answer should have included: (1) the greater magnification in the electron than the light; (2) the visualization of subcellular structures, such as the endoplasmic reticulum, golgi apparatus, mitochondria etc; (3) nuclear structure and details of sequential stages of mitosis and meiosis; (4), assisting in biological education by producing photomicrographs; (5), providing illustrations for student textbooks, CD's and videotapes; (6), determining the structure of viruses, such as HIV and flu; (7) research lab investigations; (8) histology and cytology in medicine, especially in pathology and cancer. Four marks were awarded for any four suitable points which illustrated the way in which these microscopes with their high resolving power could be put to use in important work in Biology.

MODULE 2Question 6

Syllabus objectives: 4.3, 4.5, 4.7, 4.8.

Optional Essay question % attempting 37%. Maximum Marks =20

Highest mark 20, Mean mark 12.30, Lowest mark 0.

Part (a). Many of the candidates who scored at least 2/3 of the marks available in this section demonstrated a commendable knowledge of the topic. However, there were many who could not name any of the hormones, nor their origin or effect.

Part (b). This section was poorly done by 30 per cent of the candidates, who had little knowledge of meiosis. Several confused meiosis with mitosis. Most did not keep to the question, which required the candidate to describe only the events only between prophase 1 and anaphase 1, and did not require the second part of meiosis. There was difficulty in distinguishing between pairs of chromatids and pairs of homologous chromosomes.

Part (c) (i). Candidates correctly mentioned the pH of the vagina, the cervical mucilage, the selection of the correct oviduct, and the need to swim for several hours against the cilia-generated current of the oviduct. For the most part candidates gained good marks.

Part (c) (ii). Eight marks were awarded for this section, and candidates were not only meant to mention a method of contraception, but indicate how this method was designed to utilize the structure of the physiology of the female reproductive system. Many candidates could list the methods, but not all candidates clarified how or why it worked in preventing fertilization, and the basis of its design.

Question 7

Specific objectives: 2.1, 2.4, 2.8.

Optional. Essay. % attempting question: 63%. Maximum Marks =20

Highest mark 20, Mean mark 12.30, Lowest mark 0.

Part (a). Reference could be made to the preparatory activities in interphase but the description of mitosis was expected to start at prophase. Many candidates missed out metaphase. Generally this part was quite well done. Candidates should decide on whether labelled drawings are really worth the time they invest in them, and if not, more detail could be given in writing.

(Part b) (i). This section was quite well done. Since nerve cells remain in interphase, they cannot undergo mitosis and if damaged cannot replace themselves. Similarly with cardiac muscle cells.

(b) (ii). Candidates understood the need for skin cells to be constantly regenerated

because of exfoliation and the need to repair damage.

Part (c). Perhaps candidates did not interpret the theme of the question which enquired about the extent of genetic variation in three methods of reproduction. They gave very superficial answers. Asexual reproduction depends on mitosis only, and there is no new introduction of genetic material. All the cells are clones, and chance mutations are the only cause of genetic change. In self-fertilization, meiosis and gamete production allows DNA to be recombined to form new allelic combinations from one genome. Bisexual reproduction offers three or four opportunities for increase in the mixing of two genomes.

MODULE 3

Question 8

Syllabus objectives: 1.1, 1.2, 1.3, 1.4.

Optional essay question.% who attempted: 28% Maximum Marks =20
Highest mark 20, Mean mark 7.89, Lowest mark 0.

Most candidates omitted part (a), and were unable to provide an accurate definition of epistasis, and a realistic example.

For part (b) (i), candidates' knowledge of chi square showed a fair level of understanding. The majority of the marks came from this part. Some candidates misinterpreted the question and only set out an empty table to show its structure without placing the information in it to demonstrate use of the format, as the question required. However, marks were available for setting out each step, so some marks were gained, even for an empty table. In previous years this objective has only been tested in a structured format where the table has been set out and the candidates were only required to fill in the sequential components with considerable guidance. When required to explain the procedure and set it out by themselves, the majority of candidates were lost, and left their answers blank.

For Part (b) (ii), the candidates seemed unsure at to how to interpret the significance of X^2 . In similar questions in previous years, candidates have simply been asked the question: 'is this significant or not?'. A simple yes/no answer was needed. The 2005 essay question was set to determine whether the candidates really understood their decisions and it was clear they were unable to explain the reasons.

Question 9

Syllabus objectives: 2.3, 2.4, 2.5, 2.9.

Optional essay question.% attempted: 72%. Maximum Marks =20
Highest mark 20, Mean mark 9.45, Lowest mark 0.

Part (a) (i). Most candidates were able to identify the three types of natural selection as directional, stabilizing and disruptive, though they experienced difficulty in providing accurate descriptions. Marks were also awarded where answers were expressed with labelled drawings/graphs which demonstrated the three types of selection adequately.

Part (ii). Candidates did not seem to perceive more than one point and there was too much repetition of the same information. Candidates should have explained abiotic factors - climate, sunshine, topography, soil types and nutrients, fresh or saline water, shelter etcetera, and biotic factors, the influence of plant communities, food webs, predators, etcetera. Organisms which are the fittest, survive and prosper under prevailing environmental conditions and contribute their genes to the next generation.

Part (b). Allopatric speciation was identified, but candidates made a poor job of describing the mechanisms which contributed to it, such as the physical separation of the gene pools by a geographical barrier, the canyon. With subsequent genetic changes in the population over time, reproductive incompatibility and isolation occurred when re-united.

Part (b) (ii) Sympatric speciation was identified, but only a few were able to identify the mechanisms. - genetic changes which occur within the population of tortoises. There are different preferential selections, (of food, seasons, habitat/niche, altitude, etc), re-enforcing divergence. These behaviours limit the free interchange of genotypes and form a barrier to genome compatibility over time, eventually leading to reproductive isolation.

UNIT 2

Paper 01

MODULE 1

Question 1

Syllabus objectives 4.1, 4.2, 4.3

Compulsory question. Maximum marks =10

Highest mark 10, Mean Mark 5.4, Lowest mark 0.

Part (a). When defining aerobic respiration, many candidates tend to re-use the word 'respiration' in their definition, thereby losing marks. Many limited the products of anaerobic respiration to carbon dioxide and water, and did not mention energy, which is its purpose. They should have emphasized the lack of oxygen in their definition.

Part (b). Some candidates included the industrial applications of fermentation in their answer. The answers should have included ethanol and lactic acid production.

Part (c) (i). This was quite well done.

Part (c) (ii). Candidates did not express their answers well, and many did not relate the panting to post-exercise oxygen debt.

Part (d). Mainly correct: Carbon dioxide.

Part (e). Anaerobic respiration produces inadequate ATP to support metabolism in organisms which normally produce ATP from their effective electron transport chains. Most candidates got this, but did not explain it properly. The products of anaerobic respiration are toxic as they accumulate.

Part (f). Despite the statement of 'all living cells' many candidates wrote about organisms. Different cells have different energy requirements. Examples are that (1) brain cells and nerve cells must maintain their resting potentials with a steady rate of respiration, based on glucose at a concentration of $90 \text{ mg}/100 \text{ cm}^3$, while in muscle cells, the rate of respiration can vary, depending on activity. Liver cells which carry out many metabolic functions have a higher rate of respiration. Any suitable example was accepted.

Question 2

Syllabus objectives: 3.1, 3.2, 3.4, 3.5, 3.6.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean Mark 6.39, Lowest mark 0.

Quite a good performance. For Part (a), 90 per cent of the candidates could indicate the respiratory chain with an arrow, but the weaker ones pointed at glycolysis in general.

Part (b), almost all were able to identify the Krebs's cycle (or use one of its other names).

For (c) the majority of candidates earned all three marks and correctly identified the pathways in Fig. 1 which do not function if O_2 is not available, (that is, pyruvate oxidation, Krebs's Cycle and the respiratory/electron transport chains). Oxidative phosphorylation was also acceptable but the term 'link reaction' was not acceptable by itself without a suitable and precise explanation.

For part (d), almost all candidates identified the mitochondrion.

In part (e), a popular and accurate response (60-70 per cent of the candidates), was of hydrogen ions. The most popular incorrect answers were phosphate ions, NADP instead of NAD.

For part (f), only half the candidates were able to provide an accurate definition of metabolism of a cell as: "the sum total of all the chemical reactions, both anabolic

and catabolic, taking place in a cell”.

For part (g), few candidate earned both marks. They did not always state that reactions using different compounds and enzymes produce end products which are used in other reactions, or that metabolic reactions are interdependent., that is, that exergonic reactions produce energy needed by endergonic reactions.

Question 3.

Syllabus objectives: 6.5, 6.6, 6.7.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 6.19, Lowest mark 0.

Part (a). The majority of candidates were able to identify these nitrite and nitrate bacteria, and a variety of suitable names was accepted.

Part (b). Nitrites (V), and nitrates, (U) were also fairly well identified.

Part (c). The simple terms denitrifying bacteria and nitrifying bacteria, were sometimes exemplified by (i) Pseudomonas, Thiobacillus, or (ii), Azotobacter, Rhizobium or Clostridium.

Part (d) Lightning was accepted, but not the Haber process, since this produces ammonia.

Part (e). No, energy is not recycled in the same concentration. Many candidates did not organise their answers well, and made only one comparison. At least three points of comparison between nutrient and energy recycling were required.

MODULE 2.

Question 4.

Syllabus objectives: 5.1, 5.4.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 6.00, Lowest mark 0.

Part (a) was well done. In (i), glomerulus, Bowman’s Capsule, renal capsule or other suitable names since textbooks vary were accepted, and for (ii), the answer recommended was that the glomerulus filters the plasma, but the filtration of blood was also accepted.

In part (b) (i) - (iii), any point within a wide range of 84 - 200 mmHg was accepted, but the term “mmHg” was compulsory. An amount between 134 - 149 cm³/minute was correct. In (iii) either of two points was accepted for renal failure: the fact that arterial pressure falls below 120 mmHg, or low/insufficient arterial pressure.

Part (c) (i). Active secretion and reabsorption was the expected answer, and most candidates were familiar with the role of the renal tubules. In (ii) an answer AND reason were required, and candidate must read the question carefully, and remember to give the reason as well. There are no half marks available, so failure to follow this instruction cause the loss of a whole mark, even for a partially correct answer. Inulin filtered into the glomerulus would remain in the tubule and would pass out in the urine. Inulin would not be retained in the animal's blood since the entire blood volume is filtered by the kidneys repeatedly. In (c) (iii), a suggestion of this nature: inulin of known amount/concentration should be introduced into the animal, the urine should be collected e.g. 1 cm³ per minute and the amount of inulin in the urine determined. Record the time when no more inulin is found in the urine, and calculate the clearance time. The candidates' ability to plan and design was tested, (a "utilization of knowledge" skill), and only 50 per cent made a satisfactory attempt.

Many candidates confused inulin with insulin, and there were references throughout the question to the islets in the pancreas, diabetes and heart failure.

Question 5.

Syllabus objectives: 6.1, 6.2, 6.3, 6.4, 6.5.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.09, Lowest mark 0.

In part (a) many candidates failed to gain full marks, as their accounts rarely mentioned both cations and anions, although both were specifically requested. Candidates did not always clarify that Na⁺ was pumped out and K⁺ in. Nor did they clarify that the potential difference was due to the rapid diffusion of K⁺ out compared to the slow diffusion of Na⁺ in, and that this left behind large immobile, indiffusible anions which caused the inside to be more negative than the outside. Some candidates wrote that the membrane was totally impermeable to Na⁺, rather than that it had limited permeability. Many candidates said that three Na⁺ were pumped out for every two K⁺ pumped in, without reference to the anions. A very common error was to mis-read the question completely, and discuss the movement of ions during an action potential. Calcium ions were often introduced, and confusion with synaptic transmission was also evident.

In part (b) (i) candidates clearly knew that Na⁺ ions diffused into the membrane in excess, during the first phase of the action potential, but did not describe the process adequately, or state why there was a change in polarity as shown on the graph.

In part (ii) almost all candidates thought that a lack of oxygen would affect the diffusion of Na⁺. Since no active transport is involved in the first phase of an action potential, and no ATP is used, a lack of O² would have no effect. A handful of candidates gave excellent and perceptive answers.

Part (c). Saltatory conduction involves local circuits and the "jumping" of the impulse or depolarisation across the Nodes of Ranvier, rather than traveling along the surface of the membrane. Some excellent answers included the actual comparative speeds. Other answers thought that saltatory referred to the conduction of salts.

Question 6.Syllabus objectives: 7.1, 7.2, 7.4, 7.5, 7.6.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.68, Lowest mark 0.

Part (a) (i). Most candidates were able to identify K as beta cells and Q as alpha cells, but occasionally they were inverted. In (ii), three effects were needed. Two were given by most candidates, and the vocabulary used was minimal. For (iii) answers were (1) glycogenolysis - conversion of glycogen to glucose, (2) Gluconeogenesis, production of glucose from non-carbohydrate sources, such as protein and fat. (3), increase of polysomes and enzyme production to increase glucose supply, (4) increase of glucose released into the blood.

In (iv), the concentration at P and T is the same, $90 \text{ mg}/100\text{cm}^3$. Most candidates got part P correct, but seemed to lack confidence to put the same value for T.

Most of the answers for part (b) were correct and candidates transferred their knowledge about bananas to mangos.

In part (c), Table 1 was completed mainly with one-word answers, despite the size of the squares.

MODULE 3.Question 7.Syllabus objectives: 2.14.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.79, Lowest mark 0.

For part (a), the majority of the candidates (70 - 80 per cent) were able to earn 2 of the 3 marks for correctly labelling the antibody in Figure 7. The preferred labels were: variable region of light chain: constant region of heavy chain, etcetera. However, examiners decided on a range of labels which were adequate as long as they showed that the candidate had a functional competence with the structure/activity of this molecule. The disulphide bond/bridge was well- answered.

In part (a) (ii) most candidates accurately circled the antigen binding sites.

Part (b) resulted in 2 out of 3 marks for most candidates. The most popular responses mentioned that the MHC complex of identical twins would be identical, since they arise from one zygote, or that the MHC for fraternal twins would be very similar. Candidates thought that children would have similar MHC to their parents, but often omitted the obvious explanation, that this would be due to a child being a genetic recombination of its parental genomes.

Section (c) proved to be the most difficult part of this question, and in (c) (i), candidates tended to guess, by placing “evenly dispersed” in all the boxes, (a) - (d). In (c) (ii), over half correctly answered Type O as the universal donor, and AB as the universal recipient. Some put type O for both answers.

Question 8.

Syllabus objectives 2.19, 2.21, 2.22, 2.23.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 5.66, Lowest mark 0.

For part (a), approximately 70 per cent of candidates were able to define socially acceptable drugs as legal drugs that are freely and traditionally used by a population. They named other examples besides alcohol and cigarettes, for example, aspirin, panadol. Almost all could define illicit drugs as illegal drugs used clandestinely, and provided good examples, marihuana, cocaine etcetera.

In part (b), only a few candidates were able to provide two causes for the appearance of the lungs in Fig 8. The most frequent were the deposition of tars in the lungs and the subsequent rupture of the alveoli. Answers were only accepted if they related to the photograph with its fibrosed and blackened areas.

Part (c). Almost all candidates provided accurate responses such as a reduced area for gaseous exchange, shortness of breath and persistent coughing. Weaker candidates gave the name of a disease, for example, emphysema, instead of stating a symptom.

In part (d), most candidates stated that the risk of road accidents increases as the blood alcohol concentration, (BAC), increases.

In part (e), less than 5 per cent of the candidates achieved the full three marks, as they were unable to give the key points. To answer, they needed to be aware of the effects of increasing levels of blood alcohol, and determine a level at which compatibility with safety was compromised. The points were: (1) to choose a reasonable concentration as a limit: (2), state what physical symptoms occur at that concentration and (3), use the graph to determine the accident rate at that concentration, and (4) whether/why it is acceptable. A few did it well, but the majority were only able to give the legal limit, and then they discussed the symptoms of alcohol abuse (not necessarily related to their chosen limit), and stated that narrow roads in various Caribbean islands were the main reason to limit alcohol when driving.

Question 9.

Syllabus objectives: 3.1, 3.2, 3.5, 3.6.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.12, Lowest mark 0.

Part (a). Candidates just did not read the question. The gene coding for human insulin had already been taken up by the plasmid, so the steps needed were to (1) allow the bacteria to take up the plasmids, (2), identify the bacteria which had taken up the insulin-containing plasmids, (by various methods), (3) to allow the bacteria to reproduce asexually to form large colonies, (4), to allow them to translate the gene for insulin, and to collect and refine the product. Most candidates insisted on lengthy explanations on how genes were spliced, and inserted into plasmids. None of this was necessary. As a result, the pertinent steps were squashed, with the utmost brevity, into the last two lines of the 8 lines available.

Part (b). The top splice of Hind II fits into No. 8, and the lower splice of Hind II fits with 2. Concerning ECORI, the top splice fits with 4, and the bottom splice fits with 6. However, so few candidates got all correct that allowances were made, and for Hind II, no. 5 and 7 were accepted as well as 2 and 8. For ECORI, no. 1 and 3 were accepted as well as 4 and 6.

In part (c) the correct answer for (i) was DNA ligase, and for (ii), was that it enabled the sticky ends of the DNA of the chromatids, after breakage and crossing over at the chiasmata, to rejoin correctly to the new sequence on the complementary strand.

There were some good answers for part (d), indicating that most candidates were aware of the effects of genetic engineering in wind pollinated plants. The question made it clear that the toxin killed insects, so candidates who said it would poison humans were incorrect. Those who stated that with all the insects extinct, the maize would overpopulate the earth strangling all other species, especially when it was windy, were also incorrect.. Correct answers were (1) that pollen blown on to the leaves of other plants used a food by insects would kill them and remove a vital link in a food chain. (2) that pollen accidentally gathered by bees and taken to the hive could kill the pollinating agent for wild plants and commercial crops. (3) that insecticide, present in the seed could kill a variety of non-problematic insects. (4) compatibility pollination extending the gene to related maize species. There were many more acceptable answers, but only one candidate cited the case of the monarch butterflies.

Unit 2

Paper 2

Module 01

Question 1.

Syllabus objectives: 3.2 - 3.7, 4.1.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.85, Lowest mark 0.

Part (a). Candidates should establish the controls, and start the experiment at zero

time, when the soda lime absorbs the CO_2 in the tube as it is formed by the seeds' respiration. Since the volume of oxygen taken up is not replaced by CO_2 , air from the tube is drawn in to take its place etcetera. Candidates should continue in a sensible sequential way to clarify four or more steps and gain the four marks allotted. In at least 50 per cent of the candidates' responses, the role of the soda lime was not mentioned.

In part (b), the function of the thermometer is to record the temperature of the beans, caused by respiration. Some candidates said it was to maintain the temperature.

For part (c), in Unit 2, candidates should be aware of the biochemistry of respiration. KCN inactivates the terminal oxidase of the electron transport chain, and so inhibits aerobic respiration in the seeds and CO_2 will not be released.

In part (d), the conclusion to be drawn is that ATP can be synthesised in mitochondria is an H^+ gradient is created. Any answer, expressed to convey the concept of the H^+ gradient gained the mark, and many candidates were able to deduce this based on their studies. In (e), an H^+ gradient is necessary for ATP synthetase to produce ATP, and the hydrogen pump creates the gradient. Some answers were poorly expressed, and did not say much about the gradient, or that the pump was responsible for it.

MODULE 2.

Question 2.

Syllabus objectives: 1.5, 1.6.

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.36, Lowest mark 0.

Part (a). In an effort to clarify the photograph, a graphic artist had drawn in the cell lines in Fig 3, leaving little for the candidates to do but copy. Of the four marks, one was given for each of: correct magnification, well drawn and proportionate guard cells, accessory cells, and pore shape and size. Candidates unfamiliar with the term 'accessory cell' should have had no difficulty, as it was explained and its position clarified. Examiners found that several candidates drew a transverse section of a leaf from memory. Lines were of poor quality, proportions were inaccurate, shading was often present, and drawings were unnecessarily boxed.

In part (b), candidates were asked to account for the differences in shape. Many candidates described the shape of the accessory cells in Fig A and B, but gave no reasons. About 40 per cent of the candidates used terms such as 'relaxing, contracting, expanded', but not the terms 'turgid' nor 'flaccid'. Very few mentioned that the pumping of ions caused the turgor changes, or that the accessory cells, in becoming turgid or flaccid, adjusted to the shape of the guard cells, and also enabled the epidermis to remain continuous, and not split, despite the change in shape of the guard cells.

In part (c) (i), most candidates drew the histogram/bar chart quite well, but there were errors which are repeated annually. The X and Y axes were sometimes confused, The variables were not written in, or they were written on the wrong axis. A graph line was used instead, and the lines, in general were untidy and irregular. In (c) (ii), candidates described the shape of the histogram, but did not try to account for its shape.

MODULE 3.

Question 3.

Syllabus objectives: 2.4, 2.5

Compulsory question. Maximum Marks =10

Highest mark 10, Mean mark 4.26, Lowest mark 0.

In part (a), the majority of candidates made an effort to describe a suitable procedure to find the VO₂ max of the person, and most gained at least 2 marks. Some accounts were very good. Fewer than 50 per cent of the candidates were able to suggest how the calculation shown on the question paper should be completed.

In part (b) (i), about half of the candidates experienced difficulty extracting and manipulating data from the graph, (it rose from 1.0 to 1.5, a 50 per cent increase), indicating that more emphasis needs to be given to developing this skill.

Part (B) (ii) was well done. The cells have reached their maximum size and cell diameter is a limiting factor in permitting efficient diffusion of O₂ in to the mitochondria and CO₂ out.

For part (b) (iii), answers were vague and simplistic, and should have included that more muscle cells are formed; that the capillary network needs to be extended to provide more oxygen; that aerobic enzyme production is increased.

In part (b) (iv), many candidates re-wrote the information given, and did not give adequate reasons for the differences in the declines: an abrupt decline for 's' and 'u', and a slow decrease for 't' and 'v'. Some candidates had difficulty with part (b) (v). The increase went from 1.0 to 1.5, so the 50% increase should be marked at 1.25 for 18, 20 and 22.

MODULE 1.

Question 4.

Syllabus objectives: 2.3, 2.4, 2.5

Optional question. Attempted by 65 per cent. Maximum marks =20

Highest mark 20, Mean mark 9.84, Lowest mark 0.

In Question 4 (a), examiners listed a number of points for consideration: (1) the mitochondria and chloroplasts were often confused in the descriptions of their

structure. (2), Glycolysis was confused with the Calvin Cycle. (3), NAD was used instead of NADP. (4), the Z-scheme was misrepresented or inaccurately drawn. (5), Candidates did not recognise the source of the electrons for NADP reduction as being the electron transporter in the cascade. Often they said it came directly from water. (6). They omitted information on the role of H⁺ ions in the synthesis of ATP.

Details for part (b) were sketchy, (outline three main processes of the Calvin Cycle and discuss why the processes stop in the dark). The processes include (1) carbon fixation, with outline, (2), reduction of PGA by NADPH, energised by ATP - outline the process, and (3), regeneration of RDP (RBP) with adequate information to constitute an outline. Reasons why it stops (gradually) in the dark are: light is needed for ATP production - give details: NADPH production is light-dependent; these products together are required to produce 1.6BP-ate, and the subsequent regeneration of the RDP acceptor.

For part (c), instead of dealing with Pot A and B separately, since they had different conditions, candidates lumped A and B together, and generalised their answers, making it more difficult for the examiners to identify points made in relation to the differing conditions to which the two sets of plants were separately exposed. The lizard was blamed for damaging/eating the leaves, and depriving the plants of water, instead of providing CO². In Pot A, the crowded plants were competing for CO² and light, and in Pot B the limiting factors were water, and light. Temperature differences were sometimes mentioned.

Question 5.

Syllabus objectives: 5.1, 6.1, 6.2, 6.3, 6.4.

Optional question. Attempted by 35 per cent. Maximum marks =20
Highest mark 19, Mean mark 7.62, Lowest mark 0.

The 35 per cent of candidates who attempted this alternative question scored modestly. In part (a) (i), many described the pyramid, rather than explaining how its was constructed, and provided one inconsistency only, instead of two. Better candidates included the examples of (1) a primary producer being a single large tree, or (2), where the tertiary consumer is a population of parasites and the apex is broader than the base. Part (a) (ii) received adequate responses.

In part (b) (ii) most candidates failed to grasp the concept of a forest, even though there are several Caribbean examples. Candidates mainly stated, and re-stated that large trees provide a variety of food. Candidates did not add that (1) the trees provide a variety of habitats and niches, including epiphytic and climbing requirements, and layered levels of vegetation: (2) trees determine the range of physical conditions - light, temperature, water vapour, air movements: (3) that seasonality ensures varied food throughout the year, and that (4) there is a variety of products for leaf litter consumers, soil dwellers and scavengers: (5) complexity of food webs increases security, and many more.

In part (b) (ii), many candidates gave a similar explanation as in (i), but were able to

collect at least two points for stating that the diverse and increased number of tropic levels contributed to stability. Candidates did not mention that some of these are very ancient, rich habitats, developed - over 60 million years, and that interdependency contributes to an equilibrium which is dynamic, and renewable or that finely tuned niche requirements are always available, and that, with a long-lived species as the dominant plant, the seasonality is predictable, and the biotic factors determined by the trees are relatively constant allowing for successful stable selection. All these points are in the texts, and good students should read their texts. Videos of these habitats should be used in teaching.

Question 6.

Syllabus objectives: 3.4, 3.5, 3.6, 3.7, 3.8.

Optimal question. Attempted by 83 per cent Maximum Marks =20

Highest mark 20, Mean mark 11.86. Lowest mark 0.

Part (a) was the most difficult part of the question, and very few achieved a perfect score of 6 marks, most candidates getting 2 - 4. Candidates did not think expansively to research in their minds all of the factors they knew of in logical sequence, but focused on the main CSEC points. Few discussed the role of the sino atrial node and its stimulation of the atrial wall muscle. Few candidates discussed the isostasy of the cardiac muscle and tissue in its ability to resume its shape (so it does not remain squashed after contraction), and the contribution of this to expanding the ventricular cavity, thereby reducing its internal pressure, and the fact that this 'expansion' pulls on the chorda tendinae, opening the valve slightly, even before the atrium contracts to force more blood in. The closure of the valve between the venae cavae at the entrance to the atrium should have been mentioned. The terms 'diastole' and 'systole' should have been used.

For part (a) (ii), many candidates explained that the pumping distance was shorter to the lungs, (right ventricle) than to the body (left ventricle). There were four marks allotted, so more was required. Overcoming resistance of the systemic circulation with its arch, branches and resilient walls opposing pulsation and gravity could have been compared with the low-resistance pulmonary supply. And the fact that the lungs are of delicate air-filled alveoli, with little fibrous tissue which could rupture at pressures higher than 4 Kpa, compared with the systemic toughness. In addition, the lungs constitute one capillary bed only, whereas the systemic circulation supports a portal system and several extensive capillary beds.

In part (b), candidates were asked how the blood vessels were adapted structurally and functionally to carry out their role. In (b) (i), a number of candidates included the names of all the arteries, stating their routes. Emphasis should have been on the diameters, the tunicas, their composition, thickness and adaptation to withstanding the velocity of pulsating blood. In (b) (ii), lumen diameter, wall composition (collagen, fibres etc), strength and valves were essential in relating to the low pressure, no pulsatility, nor resistance. For (b) (iii), the texts provide plentiful

information on the structural adaptation of capillaries to their function. The mark scheme listed eight features. Candidates needed to state just three.

Question 7. Syllabus objectives:

Optional question. Attempted by 17 per cent Maximum Marks =20

Highest mark 20, Mean mark 12.30, Lowest mark 01.

Part (a). For ten marks, candidates should have tried to describe six features of phloem structure at the electron micrograph level of clarity, and four aspects of the way in which these structures are related to its function. A clear annotated drawing could have been substituted for at least part of the description. Candidates are advised however, that when under time-pressure a written description, often in note-form is the safest way to secure marks. The candidates had a simple knowledge of phloem: not much was offered in dimensions, and candidates did not clearly relate the structures described to the functions performed.

Part (b) (i). The candidate who chose this question had a good idea of the pressure flow hypothesis. On-loading and off-loading was a bit weak, but they were able to distinguish between a source and a sink. In part (ii), four marks were available, but not for one-word answers. A justified statement was required to identify both the source and sink in the bean. Likewise with the vine. Marks must be earned.

Part (c). This straightforward question required an answer which would distinguish the advanced level candidate from the CSEC level candidate. Water movement was not outlined in a logical sequence. The root hair cells, their permeable walls and selectively permeable membranes, the pathways through the cortex and the endodermis were all sketchily done. Metaxylem, protoxylem, vessels and tracheids were all lumped together as 'xylem'. Bundle sheath cells, spongy mesophyll, intercellular spaces and stomata - even if mentioned, were treated superficially. A few marks were gained, despite the waffle, by candidates who knew their botany. Clear, crisp, accurate points were required.

MODULE 3.Question 8.Syllabus objectives: 2.1, 2.2, 2.3.

Optional question. Attempted by 47 per cent. Maximum Marks =20
Highest mark 20, Mean mark 10.93, Lowest mark 0.

Generally well-answered. In part (a), most candidates knew the symptoms of PEM better than those of anorexia.

In part (b), few candidates got the exact term, but their statements indicated general knowledge of Dietary Reference Values, so similar descriptors were accepted. The function of fibre in the colon was known.

In part (c), most candidates knew the terms atherosclerosis and coronary heart disease, but unfortunately treated them together instead of separately, as was expected. Therefore the precise and individual differences in causation and development which the mark scheme included (five marks each) were too generalised. A common misconception was that CDH was caused by fat deposits around the heart, and the involvement of the coronary arteries was not specified.

Question 9.Syllabus objectives: 2.13, 2.16, 2.17, 2.18.

Optional question. Attempted by 53 per cent. Maximum marks =20
Highest mark 20, Mean mark 9.55, Lowest mark 0.

Part (a). Candidates reflected a satisfactory understanding of humoral and cell mediated responses. Statements with at least two points for each of (i) and (ii) were required.

In part (b), there was familiarity with the term ‘monoclonal antibody’, and several candidates were knowledgeable about their use in diagnosis, mainly focusing on pregnancy testing. However, few candidates were able to describe their use in treatment. Rattle snake bites, rabies, targeting chemotherapeutic agents at tumour cells are amongst the uses listed in the ‘A’ level texts.

While many candidates scored well on part (c) (i), the weaker ones could not distinguish between the two types of artificial immunity and therefore could not discuss the advantages and disadvantages. Method 1 is active artificial immunity (immunization or vaccination), to cause the individual to create antibodies against the pathogen. Method 2 is passive artificial immunity: giving antibodies in serum to a person who does not have them but needs them quickly. Its major benefit is for protection in emergencies. The major disadvantage is that it is short-lived and temporary.

In part (c), (ii), four points were expected concerning the benefits of artificial immunity in children, such as (1), protection for newborns in correct dosage, (2), generating an artificial primary response, (3), causing production of memory cells, (4), specific protection against the diseases the child is likely to encounter, (5), creating immunity for the duration of childhood, (6), enabling travel to areas with a specific disease, (7), predicting the advent of a deadly disease (e.g. bird flu), (8), containing and preventing spread in a population or refugee camp. (9) herd immunity, (10). Providing the specific proteins which the child cannot make in time to guard against nursery and primary school diseases, etcetera.

School Based Assessment Unit 1 and Unit 2

Paper 3

Overview

The laboratory practicals submitted were of a moderate standard. The majority of schools covered the entire syllabus and several activities were performed to elucidate each of the topics. The level of Drawing skill of the majority of students was unacceptable. Across all schools, there was a dearth of students able to correctly calculate magnification of their drawings. The poorly developed drawing skill of CAPE Biology students continues to be an area of great concern. The analysis and interpretation of original data generated by the students themselves has improved. The ability to correctly link theoretical knowledge in order to offer explanations for results obtained, has improved in comparison to previous years. There was widespread misunderstanding of what constitutes the aim of an experiment and a lack of awareness of the difference between a discussion and a conclusion. The technique of drawing a succinct conclusion still needs to be acquired. The Observation, Recording and Reporting was of a fair standard. A clear, logical sequence (Title, Aim, Apparatus, Materials, Procedure/ Method, Results, Discussion, Conclusion, Limitations) was absent from many practicals examined. The inability to spell biological terms and flawed grammar was prevalent. It is necessary to underscore the point that under no circumstances are body fluids (saliva, urine, blood, cheek cells) to be used for experimentation.

Mark Schemes

Approximately half of the mark schemes submitted failed to place sufficient emphasis on the substantive elements of the skill to be assessed. For Drawing (DR), accuracy and clarity are the critical elements of the skill. Therefore, these two elements should garner 8/12 marks awarded. The calculation of magnification must be included for each drawing and this garners 2/12 marks. The ability to Analyze and Interpret (AI) scientific data is a vital skill, the key elements of which are explanation/ interpretation of results and arriving at conclusions based on data that are related to the original aim of the experiment. These two elements should garner 8/12 marks awarded. All marks submitted should be whole numbers. Lenient marking, inad

quate teachers' comments and failure to highlight mistakes made by students, leads to a situation where those students develop a false sense of competency in areas of Biology.

Underlying all scientific research is the hypothetico-deductive method. This methodology is used by scientists to ask questions and, to test answers. It involves: making observations, asking questions, formulating hypotheses, making predictions based on the hypotheses and conducting experiments. The skills of Observation/Recording/Reporting (ORR) and Planning and Designing (PD) are integral to conducting accurate and sound scientific investigations. It must be understood that science has a methodology and is not done haphazardly. The important elements of ORR are: good language and expression in a logical and grammatically correct format, appropriate use of graphical representation with titles and accurately recording and reporting observations. The principal elements of PD are: generation of an acceptable hypothesis that contains one variable, outlining a procedure that is feasible, recognizing the need for controls and repetition and the use a suitable sample size.

Drawing Skills

The Drawing skills of many students were unacceptable and those able to correctly calculate the magnification of their drawings were in the minority. Students erroneously stated the power of the objective lens and the eyepiece used to view the specimen as the magnification. Poor drawings had thick uneven lines, egg-shaped plant cells, shading, cross hatching, stippling, structures not in proportion or crowded inside a border and incorrect labels. The opportunities to practice drawings skill should be increased. Good use was made of electron micrographs to examine sub-cellular organization. The electron micrograph used for drawing should be included in practical books. In a few cases, drawings were presented that contained organelles such as mitochondria and were purported to be visualized under a light microscope.

Analysis and Interpretation

The Analysis and Interpretation skills have improved. Many excellent and varied experiments were devised and used in the assessment of AI. The use of commonly available materials, schoolyard paraphernalia and indigenous resources for teaching purposes is to be commended. Emphasis must be placed on graphical representation (line graphs, tables, histograms) of data with the correct use of x and y axes, best fit lines, titles, and clean clear organization. The use of set questions and textbook experiments was noted. These can be used effectively; however alterations to methodology must be stated. Where students simply answer preset questions, this does not encompass AI in its entirety since one is not sure if a student would have independently recognized the foci. In cases where students prepared their own experimental write-up numerous long, rambling methods/ procedures, discussions and conclusions had to be perused. The aim of an experiment should be designed so as to allow valid conclusions to be drawn. Experimental limitations and precautions were well understood. Applying theoretical knowledge to the analysis of results,

formulating a succinct discussion and conclusion is a skill that students must hone by practical exercise and constant repetition. Simple drawings and constructing models of mitosis/ meiosis ought not to be used for the assessment of AI since these tasks lack the level of complexity required to elicit higher-order thinking.

Observation, Recording and Reporting

The Observation, Recording and Reporting skills were of an acceptable standard. Tables of Contents, indexing, page numbering, diagrams and graphs were well utilized. This gave rise to laboratory books that were neat and well organized. Innumerable tables, graphs, drawings (apparatus and specimen) were presented without suitable titles. In some cases, the methodologies presented for experiments contained insufficient detail or referred to pages that were not included in the book. The translation of raw data into best-fit line graph with the appropriate x/y scales was beyond the capability of some students.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT OF THE CANDIDATES' WORK
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2006**

BIOLOGY

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BIOLOGY
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2006
GENERAL COMMENTS

Two thousand two hundred and nine candidates registered for the Unit 1 examination, compared with one thousand two hundred in 2005. For Unit 2, nine hundred and eight-eight candidates registered for the examination compared with seven hundred and fifty-eight in 2005.

The Examiners were satisfied with the standard of performance, especially in Unit 1, where there was an increase in both the maximum scores and the mean scores in Papers 1 and 2. In Paper 1, the maximum score increased from 79% (2004), to 87% (2005) to 91% (2006), and the mean scores also improved from 34.9% in 2004, to 52% in 2004, to 54% in 2006. Paper 2 showed a similar trend. In Unit 2, Paper 1 showed improvements in all modules, but the results in Paper 2 remained about the same, mainly due to the responses to Module 2 and 3 essay questions. Candidates need to read the questions and answer them precisely. Perhaps teachers could spend time analysing questions and planning the content of the responses. The mark allotment shown can be used as a guide to determine the amount of information/number of content points to be given to gain full marks.

Examiners took careful note of the areas where the School-based assessments needed to be improved, and these suggestions have been set out at the end of this report.

There were more candidates and more Grade A's in 2006 than in previous years. The keen participation of teachers from throughout the Caribbean in the marking exercise, and their continued determination to improve teaching and examining standards augurs well for future of CXC CAPE Biology.

Structure of the Papers

Paper 01 of Unit 1 and Unit 2

Paper 01 for both Units was composed of nine compulsory questions each of which carries a 10-mark maximum. The questions present stimulus or challenge material such as graphs, micrographs and flow charts, which require interpretation and analysis. Questions were designed to give a 50:50 distribution of 'KC', (knowledge and comprehension), and UK, (utilization of knowledge), answering skills.

Paper 02 of Unit 1 and Unit 2

Paper 02 of both Units 1 and Unit 2 was composed of nine questions, arranged into Sections A and B. Section A consisted of three structured questions, one from each Module, based on practical/laboratory applications, particularly on those sections of the syllabus with a single

underlining. Scale drawings, genetic crosses and calculations to determine significance were included in questions presented in Section A. Section B comprises three balanced pairs of questions, providing a choice between the pair. There was a pair of questions for Module 1, 2 and 3. They permitted freedom of expression and a choice of presentation style. They also tested KC and UK skills in equal proportion.

UNIT 1

PAPER 01

Question 1

Part (a)(i), (ii), (iii). The majority of candidates were able to achieve all three marks for stating gaseous (vapour), liquid, (but not water), solid. However, some candidates left this section blank, and others wrote solid, liquid and gas, in that order, probably through rote learning.

In Part (b), about 80 per cent of the candidates earned full marks by stating that in lakes or seas, a protective, insulating surface layer of ice allows survival of organisms underneath, where temperatures can remain constant.

In Part (c), most candidates stated two properties of water which supported the pondskater, but did not follow through with a correct explanation, e.g. 'surface tension', due to hydrogen bonding between water molecules at the surface and to molecules below, or 'cohesion' due to hydrogen bonding between water molecules continually breaking and reforming to make a strong dynamic structures. Weaker candidates gave the same description for both properties as being bonding between water molecules, without being exact.

For Part (d)(i)(ii), approximately 60 per cent of the candidates named Molecule A as sucrose and stated that it was a disaccharide. Many incorrectly identified it as glucose or cellulose. Others failed to gain a mark because they did not give both, the name and the type, as was asked. Many referred vaguely to sucrose as a source of short term energy. Very few said it was a means by which carbohydrate is transported in a plant.

For Part (e), approximately 60 per cent of candidates identified cellulose as the major structural polymer that is found in plants, but many cited starch.

For Part (f), even though a comparison of the structures of glucose and cellulose was not required, many candidates did so, and only 30 per cent of the candidates correctly answered this question. Most responses were very vague and did not properly state that cellulose has hydrogen bonds between its polymeric strands, and there are no free groups to form hydrogen bonds with water. Rarely did any student mention that water molecules surround individual water molecules and prevent them from re-associating.

Question 2

In Part (a)(i), this question tested the candidates' knowledge of movement of water into and out of cells and the role of hydrostatic pressure in the support of herbaceous plants. A surprising number of candidates were unable to express osmosis in terms of water potential, as required by the question, but many others referred to the movement of water from a region of high to low concentration (a CSEC concept rather than CAPE). Many definitions omitted mention or involvement of a selectively permeable membrane, and these therefore received no credit.

For (a). (ii), the term 'water potential' was again omitted, but some credit was given as long as it was clear that there was no net movement of water between the two solutions.

In (b), candidates correctly identified the 0.3 molar solution as the isotonic solution. since this matched the curved shape of the section when released from the stem. About 30% chose 0.4, presuming the section should be straight. Most students scored full marks for this section, though some did not respond to the word "precisely", and gave vague answers. Incorrect terminology was frequent: cells "crinkled or burst", despite being plant cells. Candidates stated that sucrose moved in or out, rather than water, highlighting their deficiencies in confidence with osmosis.

Part (d) was not well done. Only a few candidates recognised that the turgid cortical cells, when released from the constraining force of the epidermis, would be able to expand at their unconfined edges, resulting in the backward curving of the inelastic epidermis.

Very few candidates scored full marks in Part (e). Most answers restated the question, or referred to fibres and lignified cells. Excellent responses referred to the turgidity of the cortical cells, with their turgor pressure being opposed by that of the rigid, restraining epidermis, (small, tightly continuous cells covered with cutin). This creates an inflexible column.

Question 3

Candidates performed well in labelling the drawing of a plant cell from an electron micrograph. Most candidates could identify six labels, as required. The large nucleus with its many nucleoli proved challenging for some. The mark scheme allowed some leniency.

For Part (b)(i), most candidates correctly identified the Golgi apparatus. A minority stated it was the smooth ER, which caused them to lose marks in Part (ii). In Part (b)(ii), credit was given for any of the following functions: synthesis and secretion of material such as glycoproteins and glycolipids; chemical modification of proteins; packaging of materials to be used in the cell for export. e.g. in vesicles or lysosomes. A number of candidates incorrectly cited protein synthesis and intracellular transport as functions of the Golgi.

For Part (b)(iii), in spite of the error in the scale, the unit Km had no effect on the calculation, and the majority of candidates recognised this and used **um** or Km in their responses. They correctly calculated the width of the vesicle to be 0.375(**um** or Km). A range of 0.3 - 0.4 was accepted.

In Part (c), most candidates correctly identified the electron micrograph as a standard chloroplast, despite the introductory statement that it was found in both plant and animal cells. To compensate for the error, the examiners also allowed full marks to those candidates who identified the organelle as either a mitochondrion or a nucleus, provided the two functions cited were correct.

For Part (d), candidates were required to name two structures, selecting from: lysosomes, microvilli, centrioles, flagella, cilia, many small vacuoles, glycogen granules, centrosome or peroxisomes.

Question 4

In Part (a)(i) - (v), most candidates scored well: the stages of mitosis are well understood, and must have been well taught.

For Part (b)(i) and (ii), the intention of this question was to determine the relative increase in ploidy at prophase and anaphase. During replication the 24 pairs of chromosomes duplicate, forming 48 pairs of chromosomes, or 96 chromatids.

In Part (c), candidates scored low, and seemed unclear as to what to write, and there were some far-fetched answers. If spindle fibres cannot be formed, the chromosomes cannot be separated accurately, and would not be pulled to the poles of the cells before the medial cytokinesis occurs. Uneven numbers or extra chromosomes may result; nondisjunction may occur. Suitable answers were credited.

For Part (d), most candidates were not able to distinguish between the two terms, chromatin and chromatids. In this situation, a chromosome is a pair of replicated chromatids joined at the centromere, while chromatin is composed of the condensed/stained nucleic acid of the chromosomes combined with protein/histones. Some marks were given for a correct definition, but the question did ask candidates to make a distinction.

For Part (e), the responses to this question were balanced and mainly accurate.

Question 5

For Part (a), in general, the candidates' performance was very good, the majority, 70-80 per cent, were able to accurately label 3 out of 4 of the structures, with label no 1, the chorion being the most difficult. .

For Part (b), approximately 50 per cent of the candidates earned both marks for stating two functions of the amnion. A full clear explanatory sentence was needed, not a single word, nor a brief phrase. Thus, 'it protects the foetus' is inadequate, whereas, 'the amnion protects the foetus from mechanical shock or injury by enclosing it in a cavity containing fluid.' would be better.

In Part (c), at least 40 per cent of the candidates were able to correctly identify two of the three membranes. The most popular responses were the amnion and the chorion. Few responded with the allantois. One mark was given for any 2 correct answers.

In part (d), performance was poor. Candidates needed to focus how the membranes (the chorion-allantois), develop into functional structures. They grow into the villi which project into the uterine wall, which responds by enclosing them the relationship between the villi and the placenta although very close, always remains separate. The area becomes the placenta, an interface/barrier area for exchange by diffusion of substances between the mother and the foetus.

For part (e), candidates were unable to reach "A" level responses. Vague responses included "provides food, carries away carbon dioxide", etc, without naming the nutrients, the method of transfer or the state - i.e, bicarbonate ions in solution. The terms villi, lacunae or membranes were absent. Candidates, at 'A' level, should be fluent with the correct terminology for structures or processes.

(f). Fewer than half the candidates correctly identified this statement as false and wrote the amended statement. Some changed oxygenated to de-oxygenated, or artery to vein, but both should have matched correctly. Reference to the texts will enable students to review the answer they gave.

Question 6

In part (a), most candidates scored one mark, with the main error being the interchange of LH and FSH. Similarly many candidates interchanged the ovarian hormones, oestrogen and progesterone in C and D.

In Part (b), the events at E and F were recognised as menstruation/endometrial breakdown and proliferation/repair and thickening of the endometrium respectively. While candidates realised that G involved maintenance of the endometrium in preparation for fertilization, only the more competent candidates referred to increased vascularization. Weaker candidates did not focus on the endometrium as required.

Most were able to score on Part (c), and use their knowledge of progesterone to suggest a suitable explanation. Some candidates actually knew the mechanism by which RU486, operates and scored full marks. More careful attention needs to be paid to the difference between contraceptive methods, and birth control methods in general.

Part (d) was well done, and candidates gave answers as (i) four, (ii) one, and (iii) polar body respectively, gaining three marks.

Question 7

Answers in Part (a) were repetitive, and most candidates gained one mark. The Chi squared test is a statistical test using ratios (observed and expected), which allows one to determine if the observed data differ significantly from the expected data. There is a need for candidates to concentrate on the purpose of the Chi squared method, rather than just 'crunching numbers', and obtaining an answer. result.

Part (b)(i) was very well answered, (9:3:3:1), but in Part (ii), candidates should explain that the figure '3' represents one less than the number of classes of data. To state 'n-1' is insufficient.

Part (c) was also well done. In Part (ii), marks were awarded for 0.4, and in Part (iii), approximately 50 per cent of the candidates were able to use the probability tables, and read off 7.82 at 5 per cent probability. Again the examiners advise that candidates need to understand what they are doing, rather than just be instructed on what to do at each stage. This question endeavored to determine if candidates understood their manipulations.

Question 8

In Part (a), most candidates were able to explain the term 'mutation'.

In Part (b), this section was generally misinterpreted, as the word 'conditions' was not always observed. Most candidates gave correct responses, which included X-rays, UV light, colchicines, mustard gas, benzene, virus-effects and alternating hot and cold temperatures. Some candidates gave types of mutations and diseases rather than conditions, for example, changes in chromosome number or arrangement.

In Part (c) (i), candidates did not seem to grasp the concept of chiasma, and as a result spent very little time studying the diagram or reading the instructions. Some candidates did very well, and others, faced with unfamiliar material, scored poorly.

In Part (c)(ii), the centre of the sequence, E F G H was inverted, so the answer was 'inversion'. Many stated 'translocation'.

In Part (d)(i), most candidates were able to cite the cause of Down's Syndrome as being due to an additional chromosome, no 21. Those who did not know said there was an extra chromosome. Some related it to oogenesis. Few used the term 'non-disjunction' or 'trisomy 21'.

For Part (d)(ii), the relative incidence of Down's Syndrome increases with age. Using the data in Figure 13 as requested, candidates should have added that while at age 20, the relative incidence is only 1:2300 (one in two thousand three hundred), it increases at age 45 to one in every 46 births. However, candidates did not refer to the data, nor quote specific figures. They appeared to revert to their previous knowledge only and lost marks.

In Part (d)(iii), after reaching a peak at age 40, Down's Syndrome birth rates decline, because births in general decline, due to a decrease in maternal fertility.

For Part (e), in gene/point mutation the actual DNA molecule is affected, that is, one or more nucleotides are affected, but not the entire chromosome, as in Part (c)(ii) and (d). This was fairly well answered.

Question 9

For Part (a), more than 90 per cent of candidates gave a satisfactory definition of natural selection.

For Part (b), few candidates were able to produce three accurate points to describe how the widespread use of DDT could lead to the evolution of resistance in insects. Most candidates gained two, by stating that some insects which had a greater variation of resistance were able to survive and pass these resistant genes on to the next generation. In addition, greater ecological fitness would favour mating with other survivors, so DDT would gradually exert a selection pressure, resulting in the resistant genotype becoming more prevalent in the insect population. The most popular inaccurate response was when candidates linked DDT resistance to the development of immunity or antibodies in the insect, which was then passed on by memory cells (no reference made to genes) to offspring.

In Parts (c)(i) and (ii), approximately 70 per cent of the candidates correctly identified sympatric and allopatric speciation respectively. Too many spelling errors were encountered.

In Part (d), the majority (60 per cent), correctly responded that all races of humans can interbreed or mate with each other and create fertile offspring. Inaccurate responses were very vague or simply defined species in terms of similarity in genetic karyotype and matching chromosome numbers.

In Part (e), most candidates achieved at least one correct response, the popular answer being that organisms gradually adapt to the environment in which they live and they take time to grow and reach sexual maturity in order to pass down their genes. The infrequency of mutations; the need

for a beneficial gene to achieve penetrance of expression; appropriate environmental changes to permit natural selection; the fact that most mutations are unsuccessful, were other points which the examiners expected.

There were approximately 47 non-responses for Question 9. This indicates that candidates are not managing their time well and hence they are not able to complete the last question. The responses for Parts (b) and (e) were essay-like and perhaps candidates could not cope. However, 7.83 per cent of candidates scored full marks.

PAPER 02

Question 1

For Part (a), most candidates performed quite well, but others were unable to complete the table of food tests for the dessert correctly, and reach a conclusion as to a result. Candidates appear to require practice in applying the results of food tests rather than simply testing for a known single substance.

For Part (b) mostly, candidates who got the contents of the dessert were able to suggest the components.

For Parts (c) (i) & (ii), candidates lost marks because most of them used a model, diagram or simplified version of a phospholipid molecule, whereas the question asked for an accurate drawing. Two errors for each drawing were allowed, so most candidates gained some marks. For the cellulose molecule the most common error involved the location of the oxygen molecule on the ring, and the alternation of the 1-4 beta glucose bonds.

Question 2

For Parts (a)(i) & (ii), most candidates were able to illustrate crossing over in the correct way with chromatids by the homologous chromosomes. The most common error was confusing the labels of chromosomes and chromatids on their drawings. Frequently the centromere was omitted.

Part (b) was done fairly well, but about 20 per cent of the candidates were unable to utilize the columns and rows of the grid and identify the points of the chromosome being identified. They did not recognise that crossing over could only occur in rows 'c' to 'g', controlled by the shorter chromosome, and the chromatid in column 'B'. No crossing over was possible at the centromere.

Part (c) of the question was well done, and most candidates got the correct answer, by citing chiasma, which permit rearrangement of gene blocks between homologues, and orientation at the spindles, allowing maternal and paternal chromosomes to separate to opposite poles at random.

In Part (d), testing the utilization of knowledge of the cell cycle showed that some candidates were insufficiently confident with the material to complete Table 3. In interphase, DNA is replicated and the diploid chromosome number doubles (200 per cent). After cytokinesis it would be halved (100 per cent). Coming out of the cell cycle of interphase where DNA is replicated and chromosome is doubled. Following cytokinesis II, it would be 50 per cent or one quarter of 200 per cent. However, the mark scheme was liberal, and allowed for two errors, so approximately 40 per cent of candidates gained full marks.

Question 3

For Part (a), many candidates had a good knowledge of classification. While the majority produced the standard dichotomous key - which is what was expected, about 20 per cent used other designs, such as dendrograms and flow diagrams. Some allowance was made if they communicated what was expected accurately, but again for the fifth year, this report endeavours to persuade teachers to review this topic, which is relatively simple, and which annually gifts 4 marks.

Many candidates were not focused, and gave descriptions of faces, (skulls), flaps, boulders, shells, (dorsal scales) and arms, (forelimbs). Appropriate expression and terminology is expected at this level. Horney skins were referred to, but the diagrams were of skeletons. However, marks were available for a set of viable keys.

For Part (b), the prose in this unusual question was clearly understood by the candidates, but they were uncertain of the names of the three types of selection. They chose appropriate phrases from the passage, but could not apply the terms stabilizing, directional or disruptive selection. One mark was offered for the general term 'natural' for any one of the selected sentences.

Question 4

Part (a)., was generally well done but many candidates failed to describe the features of a typical plant cell, and just listed them. Others used diagrams of plant cells, but failed to annotate them. A simple labelled diagram does not communicate specific information, and needs to have a method of drawing appropriate attention to its characteristics. Otherwise full credit is not realised. Candidates were able to point out at least 3 features of contrast between plant and animal cells, and scored full marks.

For Part (b), in elaborating on the differences between Prokaryotic and Eukaryotic cells, too many candidates were not comparative in their answers, and stated what applied in one group, but not in the other - there were incomplete comparisons. The average candidate identified half of the required number of six differences. Too many candidates were not comparative in their answers, and thus only stated what happened in one case but not in the other.

Part (c) was not well done by the majority. Some candidates seemed unfamiliar with the term 'endosymbiont theory' and proceeded to discuss symbiosis and parasitism. For those who knew the work required in the syllabus, specific objective 2.5, there were some excellent answers.

Question 5

In Part (a) the majority of candidates gained full marks for distinguishing between competitive and non-competitive enzyme inhibition.

Part (b) was generally well done but there were misconceptions about enzymes and substrates, and too much time was wasted by giving a pre-ambule about enzymes in general. The mark scheme identified ten relevant points, of which six points with adequate elaboration were required for full marks. The Question (b) had six clues in it, as a guide to achieving a full answer.

In Part (c)(i), some candidates made reference to the enzyme's being killed, as opposed to denatured and thereby inactivated.

In Part (c)(ii), candidates gave generalized statements rather than focus on specific note of reference which was made to the neutralizing effect of the bicarbonate on the acid contents from the stomach. They should have clarified the link between high pH and pepsin structural denaturation, resulting in cessation of activity.

In Part (c)(iii), there was some difficulty by candidates in expressing rate of reaction as the amount of time taken for clarification. The enzyme concentration, now increased, will cause the clarification of apple juice in a shorter time.

In Part (c)(iv), examiners felt that candidates were not reading the instructions and using the information properly. With the reduction of concentration of the enzyme, a longer time is taken to clarify the juice.

For Part (c)(v), the majority of candidates had difficulty in interpreting the question. Many of the candidates' responses reflected a lack of understanding of the topic and points were often not represented in a sequential order. There were a few centres where mature responses gained full scores. Generally, if xylulose digests the glucose backbone and releases the xylans, then this causes clarification, and the cane juice should become clear.

Question 6

For Part (a)(i) concerning the sequence of nucleotides in the RNA molecule, a majority of candidates gained at least 3 of the 6 marks, but more details of the sequence were required and several points expected were not mentioned. A majority of candidates gained at least 3 points, getting 3 marks. Several points expected were not mentioned. Candidates should note that the RNA strand which is formed is complementary/reciprocal and NOT identical to the DNA template.

For Part (a)(ii), the roles of rRNA, mRNA and tRNA need to be well known to the candidates in order to use them with ease. Credit was given if candidates included mRNA's leaving the nucleus or being enclosed by the ribosome to facilitate the reading of the code as well as the role of tRNA in recognition of a complementary codon and bringing the appropriate amino acid into its relevant position for polypeptide synthesis. The majority of candidates used the term 'anticodon' out of context.

Part (b)(i) was the most difficult part for the candidates, and the majority of candidates generally scored low. Candidates were unable to link the organisms DNA to the precision of folding of globular proteins. Such proteins: biochemically active proteins such as enzymes and hormones, and structural proteins such as collagen etc must be precise in their structure, (folding), to be effective in their role. Reference to secondary structure, type of amino acid affecting the pattern of folding, and types of bond stabilizing the tertiary structure, were expected.

For Part (b)(ii), the majority of candidates knew that sickle cell anaemia was due to a gene/point mutation caused by substitution of a DNA base, and the consequent change in mRNA. However, further details were lacking, reducing their scores. Candidates should have mentioned the change in the codon, and the resultant mis-transcription with the wrong anticodon. Naming the specific amino acids, valine substituting for glutamic acid and the reason for the subsequent change in the haemoglobin molecular configuration also gained marks.

Question 7

For Part (a), candidates knew the structure of the anther to CSEC level very well, and some candidates used too much time with drawings and explanations. Some good diagrams were done, but not always well labelled. Annotated drawings would have been more precise and have saved time. Over 50 per cent gained 2 of the 4 marks, but few were able to give the required details for pollen formation. There was confusion concerning mitosis and meiosis and the term 'pollen mother cells'. The role of the tapetum and vascular bundle was often left out.

For Part (b), all candidates responded by using the word 'pollination' despite the inaccurate use of the word fertilization in the stem of the question. These pollination methods are listed in the syllabus, (Module 2, page 15, objective 3.4), and it was expected that candidates should know and use these terms. Many candidates re-described the facts given in the question as a method of gaining marks for describing the mechanism used.

For Part (c), the majority of candidates scored full marks in this question by describing at least two advantages and two disadvantages. Obvious familiarity with CSEC descriptions surfaced, and candidates wrote much more than required. Very few candidates referred to the 'these plants' that is, the bananas, sweet potatoes or tomatoes and peppers, (which were used as Caribbean examples).

Question 8

In Parts (a)(i). & (ii), most candidates could recall and repeat the meanings of 'gene' and 'allele'. The question did not request a definition, so there was no need to condense the meaning into one concise sentence. Elaboration in order to nail the marks would have been wise.

Part (b) was understood by most. Many candidates spent time on the explanation of multiple allele operation and scored well. Four of the marks were derived from the genetic diagrams, and four from the dialogue. Well-laid out (non-squashed) diagrams were commendable.

In Part (c)(i), approximately 95 per cent of those who attempted this question provided much information and did well. Candidates needed to describe the structure of the sex chromosomes, distinguish them from autosomes, outline their functions, and then, preferably by means of a diagram, chart, or small Punnett square, demonstrate how they control the inheritance of sex.

Part (c)(ii) was mostly explained satisfactorily. Some candidates described inheritance of blood groups rather than colour blindness, which was requested. For candidates who knew their work and who wrote a clear sequential, appropriately illustrated account, good scores resulted.

Question 9

Part (a) of this essay question, worth 10 marks had three components. Firstly candidates had to describe the five kingdom classification system. Then they had to discuss the principles on which it was based, and finally to discuss the importance, (that is, use), of modern classification systems. Candidates, who read the question, broke it down into these components and timed themselves, did well. Disorganised answers ran out of information quickly, or were confused and difficult to evaluate. Unfortunately, many candidates were not comfortable with classification. They could not remember the names of the phyla, nor the critical features on which the divisions

are based. Long descriptions of phyla were not needed, and those who did this left little time for the principles and importance.

For Part (b), most candidates spent little attention to the methodology of classifying organisms but instead focused on the procedure of identification. The key word was 'classify' not 'identify', since if it was not known, there would be no identity to find. The features which permit categorization and separation include physical characteristics, e.g. morphology and anatomy; monocot/dicot: herbaceous/woody: floral characteristics; seed/fruit type and dispersal. Further, DNA profile, habitat and adaptation, comparison with herbarium specimens, and examination of diagrams/photographs in Flora.

UNIT 2

PAPER 01

Question 1

For Part (a), although strictly speaking, chlorophyll a is the major pigment in photosynthesis, the examiners decided to accept just 'chlorophyll' as so few candidates made the distinction between chlorophyll a and b. The accessory pigments were more precisely identified, being carotenoids, xanthophylls and for some, chlorophyll b. Approximately 80 per cent provided these straightforward memorised answers.

For Parts (b)(i) & (ii), Photosystem I, as P 700, and II, as P 680 - 690 were identified by 75 per cent of the candidates.

For Part (c)(i), most candidates correctly identified Box 1 as Photosystem II and Box 2 as Photosystem I. All the above were simple recall answers.

For Part (c)(ii)(a), only 30 per cent correctly explained that incident light at reaction Centre 1 caused the accessory pigments to become stimulated and pass electrons to chlorophyll a which was also stimulated to release electrons.

For Part (c)(ii)(b), candidates needed to give more comprehensive responses such as - 'When an electron is ejected it leaves a "hole" and another electron moves in to fill it', or, 'losing an electron is equivalent to oxidation and leaves a charge on the molecule which attracts an electron'. Candidates' responses were too simplistic, for example, 'losing an electron attracts another electron' or, 'to replace the electrons lost in Box 1'.

For Part (c)(iii), forty percent achieved 1 of the 2 marks: 'the electron is accepted by an acceptor and is passed along a series of carriers, (cytochromes),' or 'as the electron is exchanged energy is given off and is used to make ADP and P combine to make ATP.'

For Part (c)(iv), the question asked for two events which occurred between Boxes 4 and 5. The most obvious event was the boosting of an electron in the chlorophyll of photosystem 2 to a higher energy level. Additionally, the electron is trapped by an acceptor, then passed down an electron cascade. Several candidates chose, unnecessarily, to go beyond Box 5 and identified NADP+ as the final electron acceptor. Approximately 20-30 per cent of candidates earned a mark for (iv).

For Part (c)(v), almost 60 per cent of candidates identified the substances as follows; Box 6, hydrogen ions, hydrogen, protons; Box 7, NADPH (reduced NADP); Box 8, ATP. The competency to get two correct gained one mark.

In Part (d), most candidates correctly stated that it was hydrogen that was stored in the thylakoid space.

Question 2

In Part (a), the maximum respiratory rate is **550 - 590 $\mu\text{m}^3 \text{O}_2/\text{g}\cdot\text{h}$** . While the value given was often correct the units were often incorrect or in a few cases not stated at all. The different quantities represented on the same set of Y axes gave candidates difficulty in deciding which values to use. More practice is needed with challenging graphs, which reach a standard above CSEC.

In Part (b), the concentration of oxygen is 3.4 - 3.8 mg/L O_2 . Again, candidates made errors with the units.

In Part (c), most candidates correctly identified aerobic respiration on day 3 and anaerobic on day 28. However, reasons for these answers were not well articulated. Candidates need to be more precise and convey adequate information in limited time and space.

In Part (d), few scored full marks here because many suggestions incorrectly referred to lactic acid in spite of the cell suspension being derived from plants. Most candidates were able to gain one mark for stating that CO_2 was produced, and when dissolved in water, hydrogen ions are produced which decrease the pH. Ethanol which is also produced is weakly acidic.

In Part (e), several candidates failed to score on this section because they attempted to determine the values without using a ruler and thus obtained an incorrect answer. The correct answer was 118 - 130 $\mu\text{g cm}^3$

In Part (f), most candidates focused on the fact that the lack of oxygen was responsible for the number of cells. It seemed as though they did not remember that respiration can occur without oxygen, but if nutrients are lacking, there can be no further growth.

In Part (g), too many candidates were unable to give a balanced equation. Those who did rarely gave the correct formula for ethanol. Most neglected to refer to energy/ATP in their equations. But the majority of candidates gave the correct response (the medium becomes too acidic and growth is inhibited). The use of the process included industrial, medicinal and fuel related ethanol, (gasohol), wine and spirit production, soy sauce, etcetera.

Question 3

In Part (a)(i), few candidates scored really well here, even though the mark scheme accepted the stage or the organism. Identifying items 5 and 6 presented most difficulty. Credit was given in 5 for amino acids in animals/assimilation in animals, and in (6) for excretion/defecation/loss of hair, skin, horns etcetera.

For Part (a)(ii), the majority of candidates were able to define the term mutualism. A few candidates referred to it as a feeding relationship or a parasite/host relationship. No credit was given for those responses.

For Part (a)(iii), a range of responses was accepted here so that the majority were able to obtain 2 marks. In some instance the answers were too brief or vague. The removal of trees causes loss of nitrogen, minerals and humus; removal of roots results in erosion; there is loss of edible material, shelter and niches for animals. Increased water loss from the soil due to direct evaporation and run-off affects the water cycle and weather; oxidation of minerals and less removal of CO₂ from the air, results in global warming. Any two of these, well expressed, would gain the two marks.

For Part (b), the mark scheme listed five benefits, all available from the texts. A well-expressed, substantial sentence was required for the answer; nothing vague, weak or minimalistic. The most common error was in referring to the role bacteria play, rather than the benefits derived by the bacteria.

For Part (c), candidates did not relate their answers to effect on the nitrogen cycle. They were able to state the effect of flooding on the soil, (drives oxygen out of the soil; reduces plant uptake of minerals; drowns soil organisms, leaches mineral, etcetera.), but the effects of these on the bacteria and processes of the cycle were omitted, (death of bacteria, non-functioning of aerobic bacteria, denitrifying bacteria, nitrogen fixing bacteria). The actual interference to the cycle should be cited.

For Part (d), the largest reserve of nitrogen is as atmospheric gas, but many candidates did not give the 'support', as requested in the question. Credit was given if they stated any percentages between 70-80 per cent.

Question 4

For Part (a), many candidates were unable to differentiate between the TS of a stem and TS of a root. In place of the named plant organs, candidates filled in names such as sclerenchyma, collenchyma, parenchyma, vascular bundles. Many candidates could not recognise nor label the phloem.

For Part (b)(i), candidates broadly identified the dark cells as phloem rather than identifying the sieve tube elements (b)(ii). The majority of the candidates were able to explain that the radioactive carbon was incorporated into the sugar molecules, and that these were transported in the phloem. Since they are the only cells that transport carbon containing compounds, (other than minute traces occasionally in the xylem), this confirmed their identity as sieve tube cells. Some candidates stated that the dark regions were chlorophyll.

For Part (b)(iii), a range from 22 - 30 micrometres was accepted. Several candidates failed to read the question carefully. It requested the WIDTH in the LONGITUDINAL section: not the length of cell A.

For Part (c), in stating the pressure flow hypothesis, many candidates confused translocation with the transpiration pull, and its associated root pressure, cohesion and adhesion. Many candidates wrote of the movement of substances from high to low pressure.

Question 5

In Part (a)(i), approximately 70 per cent of the candidates scored the two marks by correctly identifying 3 of any 4 substances present in the tubule lumen. Popular responses included glucose, amino acids and urea.

In Part (a)(ii), candidates surprisingly had difficulty defining processes such as osmosis, diffusion and active transport, but at least they were able to name the substances being 'transported', for example, water in osmosis.

In Part (a)(iii), virtually no candidates were able to provide even one well-explained reason why substances which accumulate at the intercellular space, between the tubule and the capillary, moved into the capillaries and did not return to the tubule. If they mentioned it was due to the presence of a diffusion gradient, they failed to express that this gradient was created when blood moving through the capillary carried away the diffused substance. Reasons were only partially or incorrectly expressed.

In Part (b)(i), about one third of the candidates did not attempt to draw the transverse sections of the loop of Henle at T1 and T2. Half of the remaining 60 per cent drew longitudinal sections instead of transverse. The remaining 30 per cent failed to meet at least the requirement of a magnification of X5, and accurate drawings as requested. For T1, there should be a wall of thin cells adapted for diffusion, and for T2, a wall of thicker, cubical cells adapted for active transport. In both T1 and T2, the lumen should be of similar diameter.

In Part (b)(ii), almost all candidates failed to provide a proper functional reason for the differences in structure between T1 and T2. They did not relate the thinness of T1 to the function by its cells of diffusion only, nor did they state that the difference with T2, (having the same diameter lumen, but cubical cells in the wall) was related to active transport and more control being applied by the cells to modify the contents of the lumen.

Question 6

Part (a)(i) was well done. Almost every candidate got this correct, but they made reference to the atrium, instead of the atria, (left & right).

In Part (a)(ii), there were generally good responses on the AVN. Several candidates said the AVN distributed the excitation throughout the muscles of both ventricles, thereby confusing its role with the Purkinje tissue.

In Part (a)(iii), most candidates knew that the Purkinje tissue distributed the excitation, but omitted to include both the right and left ventricles.

In Part (b)(i), any one of the following points: to allow time for the atrial entrance to seal off; to allow time for the atrial muscles to complete their systole; to allow time for the ventricles to fill completely; to prevent premature contraction of the ventricles. The candidates referred to the closing of the valves, and some answered quite well.

There were some satisfactory answers in Part (b)(ii). Candidates should have emphasised that the blood must be squeezed from the base to the apex, to propel it out of the aorta/pulmonary artery.

In Parts (c)(i) - (vi), there were vague imprecise answers in many of the boxes. A brief statement, rather than one word, would have helped the examiners to give the benefit of the doubt and award marks. All these answers are available from the texts.

In Part (d)(i), even though this section was well within their competence, candidates misinterpreted it and for a low pH made mention of a decrease in heart rate rather than an increase. In Part (ii), where the body temperature is low, the candidates incorrectly made

reference to an increase in heart rate. The relationship between a drop in temperature and a slower rate of metabolism was not made.

Question 7

Part (a)(i)(a) was generally well answered. The question related to the drinkers in relation to their age, not their gender, but many candidates based their comparison on the males/females, and strangers versus acquaintances rather than focus on age. Most candidates actually referred to the data, and the mark scheme required that the figures they selected supported, for the age range, the point they were making. Some candidates were confused, and read the table as if it were a grid. They explained that the strangers and acquaintances attacked the males and females, with little reference to age.

In Part (a)(i)(b), the answer should contain the fact that males attack strangers more so than females, (one mark), and this should be justified by selecting relevant data (1 mark). Next; the females attack acquaintances more so than males, (one mark), and this should be justified with supportive data (1 mark). Total: 4 marks. Some candidates did this quite well, but many failed to support the observations they had made.

In Part (a)(ii), candidates were requested to provide a sociological reason as to why males typically commit violence against strangers, and females respond to situations by preferentially attacking females. This open ended question was attempted by 70 per cent of the candidates who gained a mark for a logical answer. Mainly, answers referred to the fact that males drink in public, alone or with a supportive group, while females drink in public less frequently; they often know the person with whom they have contention, either as a domestic or inter-relationship quarrel.

In Part (b)(i), candidates were asked to write the totals on the bar charts. Over half of them did not comply.

In Part (b)(ii), candidates were asked to refer to the data in Figure 6 and comment on the relationship between alcohol consumption in units per day and the total assault rate. Four lines were allotted for the answer, which should have included the following: 'as units of alcohol per day increase, (from 1 - 10 units), the incidence rate of assaults also increases, (from 104 to 868 per 10,000).

(Two to four units of alcohol per day is the accepted safe limit for the average person. Also accepted was 20-40 mls, 1 pint of beer, 1 glass of wine or 1 measure of spirits).

Question 8

In Part (a)(i), the majority of candidates, about 90 per cent, were able to name the disease as CHD or atherosclerosis. Few candidates were able to spell atherosclerosis correctly. The most common error was to use the term arteriosclerosis.

In Part (a)(ii), candidates were required to show their competency in the knowledge of coronary artery disease by citing four symptoms, (without descriptions). Two marks were awarded. Most candidates were able to give three or four symptoms, and gain two marks, but many gave one or two symptoms and gained one mark.

In Part (a)(iii), most of the candidates estimated a 65-85 per cent obstruction of the lumen of the coronary artery.

In Part (b), the majority of the candidates were able to identify 2 components of cigarette smoke, but the effect on the body was not well done. The major misconception was that nicotine was a carcinogen rather than the tar. Browning of teeth and smelly breath were not the biological factors most suited for this answer.

Part (c) was generally well answered, by reading the information from the Figure. The incorrect placing of the information in the squares was the most common error.

In Part (d), one comparative fact, for each country was required to gain the two marks. Even though the candidates were able to identify the factors that contributed to CHD levels the comments were too general, and the two countries for which the comparative information was given, Japan and the USA, were not mentioned. A high fat diet contributes to plaque and occlusion of the coronary arteries. In the USA the diet is high in saturated fats, including cholesterol, low in fibre (which absorbs fat in the colon) and high in sugar and alcohol content, both of which, in excess, are converted to fat, while in Japan, the diet is low in saturated fats, high in fibre, vitamins and minerals and low in sugar content. The candidates did not correlate how the dietary contents related to CHD in the two countries.

Question 9

For Part (a), most candidates showed competency, and gave sufficient reason to gain one or two marks. These methods can be found in the texts, and should have been basic knowledge.

For Part (b), candidates understood the requirement for water in the life-cycle, and the mark scheme listed five suggestions for this answer, where the candidates needed to provide only two.

For Part (c), only 40 per cent of the candidates were able to reason that *A. bellator* bred in bromeliads, between the overlapping branches where water accumulated, and these were not affected by spraying the swamps. The majority of the candidates did not factor in this alternative habitat, but stated that the *A. albimanus* mosquitoes developed resistance or immunity to the insecticide sprayed in the swamps, and were able to survive and spread the disease.

For Part (d)(i), eighty per cent of the candidates could identify Plasmodium, (or a protozoan) as the malarial parasite. Of those candidates who chose dengue, very few could cite a virus, (Flavivirus), as the causal factor.

For Part (d)(ii), about half of the candidates were unable to score full marks by listing four symptoms of malaria or dengue fever. The examiners did not accept a mixture of symptoms from the two diseases.

In Part (d)(iii), for both dengue and malaria, most candidates were able to identify the part of the day when an individual would be most likely to receive a 'bite'. For dengue this is daylight hours and for malaria, dusk to dawn.

In Part (e), the appropriate precautions for the time of day were given, for example, sleeping under a net at night, or wearing clothing to cover the body during the day. Some candidates gave the same reasons as they did for (a), but in this question, personal and individual protection was being examined. There was a variety of answers, and these were assessed by the Examiners.

PAPER 02

Question 1

In Part (a), the highest yield is with 87 kilograms per hectare urea. Most candidates gained full marks in this section as they were simply required to take the value from the graph. Those who gave their answer as 'urea' gained no marks, for failing to recognise that more than one treatment contained urea.

In Part (b), the majority of candidates also gained full marks here, but some actually tried to calculate the percentage increase. They failed to recognise that the values were already given in percentages, hence a simple subtraction to obtain 5 per cent was all that was required.

In Part (c), most candidates were able to subtract the two values to obtain the difference of 212 kg/ha-1.

For Part (d), in order to test the candidates' knowledge of the factors affecting photosynthesis, two factors other than the availability of nutrients from fertilizer were required. They included light intensity, carbon dioxide availability, moisture/water in soil and temperature. The question was fairly well answered.

In Part (e), the plant compound could be protein, amino acids, nucleic acids, nitrogen bases, NADP etcetera, and most candidates gained the mark. Those who did not appeared not to understand the meaning of the term 'compound'.

For Part (f), most candidates could only give one good reason, not two. The texts explain why it is better to use manure rather than chemical fertilizers, and students should refer to them.

For Part (g), in assessing the drawing of a TS of a leaf, marks were awarded for correct proportion, (1 mark); clean, clear lines, (1 mark); accuracy, (1 mark) and at least four labels, (1 mark). Drawings were very fair, and drawing skills need to be further developed to accurately represent what is actually seen. Some candidates drew a few individual cells within the rectangle, rather than showing the packing and arrangement of cells relative to each other.

Question 2

For Part (a)(i), the majority of candidates did well, and drew the graph required. Four marks were given for having the X and Y axis values and identification correct, and Graph A and B drawn correctly. The difficulty encountered by some candidates lay in their uncertainty about the zero line.

For Part (a)(ii), two differences were required between the peaks in A and B. In A the peak reaches +50 millivolts and in B, it reaches +15 millivolts. In A the peak occurs at 0.45 milliseconds, and in B it occurs later, at 0.8 milliseconds. Most candidates said 'A is earlier', or 'B is lower'. This was inadequate. Candidates could do much better with guidance on how to cite data from tables to substantiate their observations. A comparison between two items must refer to both items, not just one. One mark was the usual score.

For Part (a)(iii), the strength of the response is determined by the availability of sodium ions. There are more sodium ions in normal seawater than in 50:50 sea and distilled water mixed.

(Therefore the action potential of the neuron in a higher sodium ion concentration was greater and faster). Candidates did quite well with this question.

For Part (b), in this relatively simple recall question, candidates were presented with four items to label on the motor neuron. Competency in correctly labelling three of these gained one mark. Examiners were understanding and always gave the benefit of the doubt -- especially with the minutely misplaced 'Node of Ranvier' label, and any appropriate alternatives.

Question 3

For Part (a), gene therapy, genetic engineering and recombinant DNA technology were all accepted. Most candidates gained the mark.

For part (b), the types of enzymes used to remove the normal gene are restriction enzymes or restriction endonucleotidases. Those candidates who knew about this topic got this answer correct.

For Part (c), most candidates could identify one benefit, (cure patient, relieve symptoms, improve quality of life). However, it must be noted that the faulty gene is not replaced. It remains, but the newly implanted gene is transcribed preferentially and is expressed. A hazard would be unintended effects, when the treatment does not work as intended. About 50 per cent of candidates made an effort to suggest a hazard.

For Part (d), candidates who attempted this question gained one mark for stating that the change in genome is not passed on to the individual's offspring. They gained the additional mark for stating that the gene remains in the body (somatic) cells and is not present in the sex cells or gametes.

Part (e). Candidates must read carefully and distinguish between the terms 'detection', which refers to the method of investigation and 'observation' which relates to the result obtained. Examiners were looking for these concepts in the answers. Approximately half the candidates attempted this section and in most instances the responses lacked clarity. In (i), detection would involve tetracycline and kanamycin sensitivity/resistance, or the production of corn protein. The observation would be that if no DNA was taken up, then Ecoli would be sensitive to both antibiotics, or that no corn protein would be produced. In (ii), detection would be to use antibiotics tetracycline and kanamycin sensitivity/resistance or the production of corn protein by bacteria, and the observation would be that if DNA was taken up, the bacteria would be sensitive to tetracycline and resistant to kanamycin and produce corn protein. Examiners were asked to tweak correct points, even if the answer was not so well expressed.

Question 4

The majority of candidates did not select this question. The quality of responses showed that only the better and more prepared candidates were able to answer fully.

For Part (a)(i), candidates stated that CO₂ was removed from pyruvate by decarboxylation for the purpose of reducing it from a 3-carbon compound to a 2-carbon compound. They could have added that the 2-carbon compound is acetyl co-A, which is an entry point for carbon into the Krebs's cycle. Hydrogen is also removed from pyruvate and is accepted by NAD in order to be passed to the electron transport chains to form ATP. Any two actions and two purposes gained four marks.

For Part (a)(ii), candidates gained three marks if they drew an accurate diagram of the Krebs cycle which explained its actions. Otherwise they needed to describe them individually. Also in their account, they needed to clarify the purposes of the three actions they chose from the Krebs cycle to gain three marks, six in all.

In Part (b), for ten marks, candidates had to accumulate ten good points, four from the diagram which they were asked to provide, and six from their account in which they showed the roles of: (i) hydrogen, (ii), electron carriers, (iii), phosphates, (iv) the production of ATP and (v) the role of oxygen. Provided they analysed the question properly and wrote clearly about each of these stages they should have done well. Although in general responses were good, marks were lost when candidates failed to link the actions to the appropriate purposes.

Question 5

For Part (a), the definitions were correctly answered by approximately 75 per cent of the candidates. Weaker definitions were vague or overly simplistic, e.g. 'Habitat' was defined as the home of the animal, while 'niche' was its occupation/job - with no further comprehensive insight. When defining 'ecosystem' candidates tended to omit the interaction of the living organisms with their physical environment, or between organisms, Habitat was defined poorly, and many candidates could not adequately define a food chain. This problem may be due to the fact that candidates have little real understanding of these environmental factors, and they are not supported by actual field work. Many also have the concept of 'one fact, one mark', whereas, in fact, definitions need to be a synthesis of a number of points, to gain the single mark.

Part (b). This section was only fair, and about 25 per cent of candidates demonstrated a comprehensive understanding of the question's requirements. Candidates must be aware that many of the aspects of the ecosystem are constantly changing, as well as how closely they interact and contribute to returning the ecosystem to normal equilibrium. Their responses included comments such as 'too much competition is bad' or 'factors which move the ecosystem away from equilibrium should be eliminated'. Candidates needed to identify four components of an ecosystem and state how they maintained ecological balance, for example, a food chain is a component of an ecosystem where a food net develops between primary producers and three or so levels of consumers. It ensures varied, food sources and a balanced diet, and if some members are depleted in number from time to time, the group of interdependent species still survives.

For Part (c)(i), the flow of energy through ecosystems is linear, not cyclical because it begins with a single extra-terrestrial source - solar energy, which cannot be recycled back to the sun. It is captured in photosynthesis to make carbohydrates, then used for respiration or by decomposers. Small amounts of energy are lost sequentially as heat, or are incorporated into chemical bonds some of which may be fossilized and not available for recycling. Three good points gave three marks.

For Part (c)(ii), three marks were available for citing three points to show why food chains are limited to three or four links. These answers are available from the text.

For Part (d), very few candidates earned all 6 marks, the majority earning 2 or 3 for this question. Rather than using their knowledge of the three types of pyramids and relating them to the ecosystem of the tree, they simply stated the advantages/reliability and disadvantages of each type of pyramid. Some candidates used only diagrams with no commentary, and several did not identify the tree as a single organism - referring to it in terms of the 'many leaves'. Most

pyramids were inaccurately drawn because candidates did not recognise that snails and caterpillars were both herbivores, and together they represented the primary consumers level. Snails were frequently cited as consumers (that is, carnivores), of caterpillars.

Question 6

For Part (a), most candidates demonstrated a good knowledge of homeostasis and set point. However, the concepts of detectors and regulators were not well understood, (See syllabus p 29, U2 M2 4.1). Some candidates were unable to define the terms but instead focused only on explaining the events involving glucose. Some accounts made no mention of either the liver or the pancreas, so these candidates did not really read the question, nor attempt to create an answer which responded to the requirements of the question.

For Part (b), most candidates were familiar with the reactions performed by the liver on proteins, but many accounts lacked detail. The liver converts protein to amino acids by enzymes in the hepatocytes; de-aminates them by the removal of the NH₂ groups; utilizes the amino group to synthesise needed amino acids; utilises the NH groups to synthesise nitrogenous bases for nucleotides; converts the ammonia to urea, transaminates amino acids; creates a pool of amino acids to make plasma proteins, albumins and globulins for carrying minerals, hormones & lipids; destroys bacteria in capillaries (Kupffer cells), and deaminates them. Any five of these points well explained, would gain ten marks.

Question 7

In Part (a), the design of the question and half of the answer was provided for the candidates. They had to describe the ascent of water (and were reminded to start outside the root, and continue to the intercellular spaces of the leaf), and include five given components in their answer. It was almost impossible to go wrong. The Examiners note that many candidates do not understand and can not explain the cause of root pressure. Too much information was given on the apoplast pathway to the detriment of the mechanisms of ascent to the leaves. Candidates need practice in this area.

In Part (b), candidates did quite well at relating the xylem vessels to their function.

In Part (c), plant 1 was placed in potassium cyanide, but most candidates did not recognise this as a metabolic/respiratory inhibitor, and assumed it was a fertilizer and a source of potassium. It prevents ATP formation, and active uptake of minerals is inhibited. and membranes cannot pump ions against a concentration gradient to accumulate in the cells, where they would reduce the water potential and encourage osmosis. Briefly, transpiration would continue, flaccidity and dehydration would occur, and the plant would become water-stressed. Plant 2, in 100 per cent humidity would experience slowed transpiration, and a reduced supply of mineral and fresh water due to a sluggish transpiration pull. Candidates understood the effects on Plant 2 better than Plant 1, but the answers did not utilize the depth of botanical knowledge and expression expected.

Question 8

For Parts (a)(i) & (ii), candidates must read the question carefully. It asked about the mode of action. The role of phagocytes was well known, but candidates were not as familiar with plasma cells, and often confused them with platelets.

For Part (b), the question asked candidates to distinguish between the origin and maturation of B and T lymphocytes. It did not require information how the cells operate, which many candidates describe at length. Candidates were not certain whether the T cells matured in the lymph nodes or the spleen.

For Part (c), those who knew about and understood monoclonal antibodies and were familiar with the operation of the test answered this question very well and were able to give four convincing facts. Others struggled to remember a text book description. Since these mini-kit monoclonal tests are increasing in diversity, schools could purchase and demonstrate a few.

Part (d) was disappointing in general. This section offered a relatively easy way of scoring 6 marks. Candidates appeared to be confused about active and passive artificial immunity. Active artificial immunity includes Polio, MMR, Small Pox, etcetera. It uses attenuated antigens which these simulate epitopes; the immune system responds and produces antibodies, etcetera. Passive artificial immunity involves snake and spider bites. Because the patient is so ill, and does not have time or strength to make the antibodies, stored antibodies for the specific disease, which have been taken from the blood of a person who has already been exposed to the disease, are used. These antibodies counteract the antigen and control its effect. The effect is short in duration, and a booster of antibodies may be needed. (Some candidates should be reminded that there is still no effective malaria vaccine available for active artificial immunity). Three marks were allotted to each type of immunity, and there were some very good answers, indicating that some centres have successfully dealt with this area of the syllabus.

Question 9

In Parts (a)(i), (ii)& (iii), for each example, candidates needed not simply to state the necessity for specific nutrients, since these are the basic components of a generic diet, but to identify the relative amounts of such nutrients, and to indicate why each category had such a requirement. The individually tailored difference particular to the condition should have been discussed. There was no requirement in the question to plan a menu. A common misconception was that lactation is the result of accumulation of lactic acid by athlete.

In Part (b)(i), for each disease, at least two categories were required to gain full marks. There were several possible alternatives for each disease: for AIDS, chronic, mental, infectious, and for diabetes, inherited (genetic predisposition), chronic and self-inflicted. Although diabetes has a very strong genetic predisposition, it is not strictly categorised as a genetic disease, in the same way a sickle cell anaemia - this was one of the most common errors.

In Part (b)(ii), there was much overlap in this area. Candidates also gave both reasons for the global distribution of AIDS and diabetes together, rather than dealing with each disease. Quite a few candidates read the term 'global distribution' and linked it to global travel with points that were not relevant to the answers. Diabetes is largely due to high carbohydrate in the diet, and a shift from the traditional staple diet of root crops to the more fashionable fatty fast food diet. With an increased workforce, there is less time to prepare foods, and more processed packaged food are successfully marketed. Increasingly sedentary lifestyles limit exercise and cause obesity. Similarly, for AIDS, candidates needed to highlight the factors which contribute to world-wide spread.

In Part (e), while most candidates gave an acceptable definition of 'healthy' there was much more difficulty with the term malnutrition. This results from a deficiency or imbalance in the necessary molecules/nutrients required for metabolism and maintenance of proper body function.

Candidates should have reviewed the components of Betty's diet, and commented on the over-representation, or under-representation of required nutrients, and the effects that such discrepancies would have created in the long-term. Five well-described points would have gained five marks.

School Based Assessment. Unit 1 and Unit 2

The Examiners made the following assessment of the School-based submissions.

DRAWINGS.

Candidates have shown an overall improvement, but there are issues which need to be considered:

CXC suggests the use of pencil in labelling, but candidates still use ink. Label lines are not parallel to each other, and are often seen above and below the drawing. Clarity has improved even though very few candidates are managing to score the full 3/3 marks available. Most drawings were of reasonable proportions with structures typical of the specimen, but reality/faithfulness of reproduction was poorly represented. Drawings from textbooks are not acceptable for assessment: the slide or specimen should be used.

There has been an increased incidence of 3-dimensional drawings being submitted, whereas the standard 2-D drawings are accepted by CXC CAPE. The standard of drawings was fair with a few schools showing more proficiency. There are still too many candidates using sketch lines and unwelcome shading. There should be clear distinction in the titles between plan drawings and high power renditions, and obviously the degree of detail must be appropriate. Plan drawings should not contain individual cells - just areas of tissues or particular structures.

Magnification is a requirement. Candidates unable to perform this skill lose marks. The magnification of the specimen in relation to its actual proportions is required. Simply reading off the figures etched on the objective lens is not acceptable.

ANALYSIS AND INTERPRETATION

Generally, these skills have been quite good, and teachers are definitely using the labs that are applicable to this area. However, there is still a small percentage of schools using models of mitosis and meiosis to assess A & I. Candidates do not always provide sufficiently detailed explanations of their results, based on correct Biological principles. Candidates should be encouraged to include a 'background to the activity' to orientate the reader to their topic.

The 'conclusion' should be separate from the general discussion, and must relate to the experiment. In too many cases the conclusion is included in the discussion, and therefore difficult to separate and assess properly. Therefore it was not credited. Candidates deserve proper instruction on this matter.

The standard of presentation and arrangement of content of tables and graphs is still poor at some centres, and in most cases, they were not properly titled, and no reference was made to them in the results or discussion. Limitations of the method must also be included, and sources of error, or the need for precautions should be clarified.

PLANNING & DESIGN.

In most cases the exercises chosen to assess this skill were inappropriate. Frequently, exercises in the texts were simply re-written in the P & D format. Examiners are familiar as a Group with all the texts. In several cases, it was noticed that the candidates also appeared to have tried to modify existing text book procedures, but not always to the extent that they were appropriate.

GENERAL COMMENTS.

Teachers need to assess a minimum of two Labs per skill. These labs need to be clearly indicated in the candidate's report, that is, they must provide sufficient information to identify exactly what the report is, so that the examiners can understand how to accept it as either a Drawing or an Analysis skill, and assess it appropriately. Planning and Design Labs are not to be taken from the text. Original topics or problem situations need to be used. It is suggested that body fluids such as blood, saliva or urine are not used in experiments.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2007**

BIOLOGY

UNIT 1**PAPER 02****SECTION A**Module 1Question 1

Syllabus Objectives: 1.1

Compulsory Question: Maximum Marks = 10

Highest mark 10. Mean mark 4.72. Lowest mark 0.

In part (a) (i) approximately 75 percent of the candidates were able to achieve two marks out of the three for this question. The expected responses were: X, reducing sugar/glucose; and Y, protein and starch. For X, candidates frequently added 'or sugar', for which no marks were awarded. Option Y was omitted from the question paper. Three marks were therefore awarded for answering X and Y alone.

In part (a) (ii) concerned the colour change in the Benedict's solution, the majority of the candidates referred only to the sequential change, blue to green, to yellow, to orange to brick red. They failed to comply with the question which required them to explain the colour change. Benedict's solution is blue, due to the presence of CuSO_4 (Cu^{++} ions). Fewer than 50 percent of the candidates were able to explain the reduction of blue Cu^{++} to Cu^+ ions by the reducing sugar, and relate it to the change in colour, due to the presence of brick red copper oxide.

In part (a) (iii) candidates found difficulty in devising a method to determine the concentration of the substance in Solution X. Responses were vague and poorly thought through, and candidates appeared unable to write in a logical sequence, even though there was evidence that they had some idea of the method. There were very few responses which gained all four marks. The expected response was to state that; 1) from the samples, one should perform progressive dilutions to form a range of solutions of gradually decreasing concentration; 2) identical amounts of known quantities of the each strength of the reducing sugar should be used; 3) standard volumes of Benedict's solution should be added; and 4) colour changes should be recorded to produce a colour chart, and the colour change of Solution X should then be compared with the colour chart of known concentrations to determine the concentration of Solution X.

In part (c) only 70 percent of candidates were able to describe the test for a lipid adequately. Many stated 'perform the emulsion test'. Marks were allotted for adding distilled water to the lipid, followed by alcohol. Vigorous shaking would create a lipid-alcohol emulsion which floats on the surface of the water.

Module 2Question 2

Syllabus Objectives. 2.1, 2.2.

Compulsory Question. Maximum Marks = 10

Highest Mark 10 Mean mark 5.92. Lowest mark 0

In general this question proved to be challenging to most candidates.

In part (a), most candidates were able to identify Figure 1(a) as metaphase, but had difficulty in identifying B as prophase. Incorrect responses for B included pre-prophase, interphase and telophase

Those candidates who followed the instructions given in the question were able to draw cells accurately and realistically and obtain the allotted marks. Diagrammatic representations direct from the textbook which had no realistic depiction of A and B received no marks. It appears that candidates require more practice in the interpretation of photomicrographs. Also they need re-enforcement in observing the required criteria for drawing that is 'reasonable proportions, clean continuous lines and neatness. Easy marks were given for correct x2 magnification - just measure the cell's length and width, then double them.

In part (b), the majority of candidates were not familiar with the procedure required to prepare a slide of the onion root tip. Many incorrectly described the mounting of onion scale leaf base epidermis. They needed to emphasize the point that the tissue must be sliced extremely thin, and that staining is required to provide contrast and show up the chromosome structures. Acetic orcein is the best stain for DNA. If unaware of the name of the stain, they should communicate that chromosomes must be stained in order to create contrast and visibility. A water mount and a coverslip could be mentioned. Where prepared slides were used, candidates should be familiar with the same facts, thin slices, contrast staining, mounting. In some cases candidates described the preparation of squashes. Provided they clarified the necessary conditions, these were accepted.

Part (c) was poorly done. Responses were generally vague and included areas such as the stem, bark and leaves. More precise locations were required: the cambium, (vascular cambium) cork cambium, apical meristems of shoots and buds, damaged areas for regeneration, pollen sacs prior to sporogenesis, and in the ovule to form the nuclei of the embryo sac. Also, in the formation of the embryo itself.

Module 3

Question 3

Syllabus Objectives. 3.2, 3.4.

Compulsory Question Maximum Marks = 10

Highest Mark 10 Mean mark 5.42. Lowest mark 0

In part (a), candidates were required to identify the five kingdoms of Margulis and Schwartz, represented in Figure 2. Clearly number 1 represented Prokaryotes (v), and number 2 represented the Protoctists, (iii). Numbers 3, 4 and 5 on the diagram could be matched to (i), (ii) and (iv) in any order. Candidates performed so poorly that the mark scheme was adjusted to require them to identify only four kingdoms, and marks were transferred to other sections of the question where they had given much better, fuller answers.

The term 'discriminate' refers to the identification of significant differences between the kingdoms, by which a clear separation can be made. These can be based on phenotypic features or of metabolic/physiological differences, which characterise one kingdom as opposed to another. Such a difference must be expressed as a pair of alternatives. For instance in part (b) (i), almost any prokaryotic feature could be used, 'Prokaryotes have 70S ribosomes in their cells while all the other kingdoms have 80S ribosomes in their cells'. To state a feature of one, without stating the distinguishing alternative of the other is to leave the distinction incomplete. No marks were awarded for incomplete distinctions. A pair is essential. One factor is to be compared with the other factor. A pair represents ONE answer, not two answers.

Concerning animals and plants in part (b) (ii), an acceptable distinguishing factor would be that plants are typically autotrophic, while animals are heterotrophic. Two answers were required, so another pair of distinguishing features was needed. Too many candidates gave very elementary answers. For animals, 'have two legs' was an example, or 'nurse their young'. No comparisons were given with plants, so these two responses did not score any marks.

Part (iii) also drew poor answers. That fungi ‘release spores’ did not distinguish them from plants. Almost no candidates mentioned mycelia, hyphae, septate, multinucleate, etc.

In part (b) (iv) few candidates were aware of the wide range of form in Protoctists, and this impaired their ability to identify precise distinguishing features.

Originally three marks were awarded for six paired distinctions, which were presumed to be easy responses. However, these expectations were lessened, and obvious unfamiliarity with this section of the syllabus required an adjustment.

In part (c), most candidates showed increased competence with the format of dichotomous keys this year and were able to recognise and select distinguishing features between the cells of the immune system. Unfortunately, the dark printing reduced the clarity of the photographs so that nuclear shape and cytoplasmic granules were difficult to distinguish, especially in lymphocytes numbers 1 and 3. In numbers 1, 2 and 5, nuclei were misinterpreted as vacuoles. The mark scheme was again adjusted to require three complete keys and four identifications instead of four keys and five identifications, as the photographs were difficult to decipher. This adjustment was appropriate. The innovative use of dendrograms and charts, which were functionally adequate, was accepted. Several candidates omitted the question - as they have done in previous years.

SECTION B

Module 1

Question 4

Syllabus Objectives. 1.8, 1.9, 4.5

Optional Question. Maximum Marks = 20

Highest Mark 20 Mean mark 9.61. Lowest mark 0

Candidates selecting this option, 48 percent

Part (a) concerned the meaning of the term, tertiary protein, candidates’ responses were very poor, which was surprising, as in previous years they have written well about protein structure. Perhaps isolating tertiary proteins, instead of allowing candidates to present the whole scenario of protein configuration, made it difficult for them to focus on a specific level. Candidates mentioned the folding of the polypeptide chain into a globular shape, and listed some of the bonds found in the configuration. Only 5 – 10 percent of the candidates clarified the way in which the bonds and cross linkages actually secured the specific shape. Such answers were very brief without an attempt to give the quality that would earn both marks. Candidates need to understand that in essay questions two marks requires two full, generous sentences.

In part (b) (i), candidates were required to draw the haemoglobin molecule composed of four folded and coiled polypeptide chains, two alpha and two beta. Then they needed to add labels to identify these component structures. Again candidates gave poor performances with only five percent of the candidates producing diagrams of the required standard of accuracy. The majority of the candidates represented only one of the polypeptide chains, with one haem. Another common mistake was to depict four subunits with only one haemoglobin, shared by the four. As a result of the poor diagrams, the candidates were limited in scoring marks from the labels. Approximately 20 percent of the candidates earned the three marks available for accurate labels.

Part (b) (ii) concerned the function of the haemoglobin molecule, approximately 60 – 70 percent of the candidates gained one mark for stating that it carried oxygen or that it had a high affinity for oxygen. Only 30 – 40 percent of the candidates identified another function related to its structure, for example, that there are four haemoglobins in each molecule, which increases oxygen attraction fourfold, and only two percent of the candidates knew of the molecule’s distortion which occurs when the first oxygen molecule bonds, facilitating the faster uptake of the second, third and fourth oxygen.

In part (c) candidates performed well with this section on enzyme activity. The most popular factors identified and accurately discussed were pH, range of temperature and enzyme concentration. Others were substrate concentration, inhibitors and allosteric effects. Four marks were awarded for four distinct factors, and a further six marks were available for any additional factors, or for elaboration and discussion. Candidates who cited competitive and non-competitive inhibitors demonstrated a clear understanding about their roles.

Question 5

Syllabus Objectives. 2.3, 3.2, 3.3.

Optional Question. Maximum Marks = 20

Highest Mark 20 Mean mark 11.11. Lowest mark 0

Candidates selecting this option 52 percent.

In part (a), approximately 75 percent of the candidates answered well on the topic of the cell membrane and earned six marks. Two marks were awarded for the cell membrane's structure and the additional four, for identifying component molecules and their biochemical nature. Very few gave the required answer, that the membrane is a continuous layer enveloping the entire cell, protecting it and forming a barrier layer controlling entry into the cell. Candidates added that the membrane is a phospholipid bilayer which has a flexible, fluid consistency. Weak candidates described only the phospholipids as having a hydrophilic head and hydrophobic fatty acid tail, while more advanced candidates added that the head faced the exterior and interior aqueous environments, and the fatty acid tails faced and interacted with each other, securing the membrane interior.

Other functional molecules included the membrane were various proteins, glycoproteins and glycolipids, whose functions as receptors or in cell-to-cell recognition were described. Cholesterol and its contribution to membrane flexibility and fluidity were included. A drawing was not requested, but when candidates provided a drawing, it was considered, along with adequate annotated labels, in areas where the candidate did not write an adequate description.

In part (b) (i), at least 40 percent of the candidates earned one of the two assigned marks. Most popular were the use of carrier proteins which utilized energy from ATP, (active transport) and the Na⁺/K⁺ pump. Only 10 percent mentioned that the potassium could enter via channel proteins by facilitated diffusion.

In part (b) (ii), approximately 30 percent of the candidates adequately described the process of endocytosis. Weaker candidates merely stated that the cell membrane engulfed the large molecules, without any further elaboration. This gained only one mark.

Part (b) (iii), two marks were awarded for the correct answer. This question was probed further into candidates' knowledge of the movement of non-ionic molecules into the cell. About 10 percent earned one mark by stating that the non-ionic sucrose entered the cell via carrier proteins by active transport. However, less than one percent indicated that sucrose needed to be carried by a protein or ion to use the ion pumps.

In part (b) (iv), candidates found it difficult to answer this higher level question. About 70 percent of candidates used their initiative and indicated that the membrane resisted the toxic ions by reducing its permeability in some way, or said that the protein receptors did not recognise the toxic molecules, thereby preventing their entry. Actual prevention of entry is due to the reduced transcription and translation of the membrane proteins or portals which enable these ions to enter, so that their uptake is limited. Such selective impermeability allows, for example, plants to tolerate soils containing mercury or copper, without ion penetration into the root hair cells.

Part (c) tested osmosis and the candidates' ability to understand its physiology and utilize the vocabulary appropriately. About 70 percent of the candidates gave a good definition of osmosis but only rarely did candidates mention that water AND solutes in the cell caused the increase in volume.

None of the candidates mentioned that the membrane resists egress of solute molecules from the potato, causing the solutes to be retained inside the cell. Too many candidates are still using the elementary term 'semipermeable' to describe the selectively permeable membrane. The correct use of this term might assist them in understanding the membrane's discriminatory function.

Module 2

Question 6

Syllabus Objectives. 1.1, 1.2, 1.6.

Optional Question. Maximum Marks = 20

Highest Mark 20. Mean mark 10.19. Lowest mark 0.

Candidates selecting this option 67 percent.

Part (a) (i) was fairly well done, and the majority of candidates were able to describe or draw and annotate the structure of the molecule of DNA. Many candidates misspelled the names of the four bases, or confused thymine and thiamine, cytosine and cysteine.

In part (a) (ii) candidates did not score as well as expected, possibly due to their assumption that the 10 marks were allocated equally between parts (i) DNA, and (ii) RNA, as five marks each, and they wrote to the value of five marks for both types of nucleic acid. The examiners had in fact awarded eight marks for the DNA description and two marks for the RNA differences.

Part (a) (iii) was very well done, as candidates probably assumed they would receive five marks, and gave detail to that value. This was not so however. The section was worth only two marks.

A common misconception was the use of the term 'single helix' rather than 'single stranded', to describe the structure of RNA. It is only in transfer RNA that the single strand is folded back on itself, (in a clover leaf shape), to give the appearance of a double helix for short sections.

In part (b), the majority of candidates recognised that the question was dealing with the point/gene mutation that causes sickle cell anaemia. They linked the change in the DNA to a change in the quaternary structure of the haemoglobin molecule. This results in the red blood cells' assuming a sickle shape, with a reduced efficiency of oxygen carriage. The distorted shape reduces the ability of the red cells to pass through the narrow capillaries. They then occlude the capillary, preventing blood flow, and causing pain and cramping in the tissues.

A few of candidates failed to score well. After recognising that a mutation was involved, they went on to elaborate on the different kinds of mutation, or to describe the entire process of protein synthesis. They neglected to describe the effect of sickling on the function of the erythrocytes.

Question 7

Syllabus Objectives 4.9, 4.10, 4.12..

Optional Question. Maximum Marks = 20

Highest Mark 20 Mean mark 10.88. Lowest mark 1

Candidates selecting this option 33 percent.

Part (a) (i) - In assessing the labelled diagram of the placenta, marks were awarded for accuracy of representation, clean clear lines and the required labels, correctly assigned. The majority of the candidates managed the labels, but found the drawing of the placenta challenging, and as a result, failed to score well. A plan diagram of the type used in the text, and illustrated by teacher on the blackboard would have been an adequate response for gaining an average mark. Candidates should try to fulfill requirements, rather than to leave a gap. Annotated labels could have been useful even with a very basic diagram.

In part (a) (ii), most of the candidates indicated the oxygenated blood in the umbilical vein flowing towards the foetus and the deoxygenated blood in the umbilical artery flowing towards the placenta. Candidates were asked to label these by means of arrows on a diagram, and should have followed these instructions, rather than writing about them.

Part (b) was generally well done, with the majority of candidates gaining full marks for parts (i) and (ii), (amion function and the effects of the foetus on the mother). Several candidates failed to score full marks for part (ii) because the responses were either too generalised or focussed on changes in maternal behaviour rather than on the specific physiological effects of the foetus on the mother. Expected responses to this section included: hormonal changes leading to the cessation of the menstrual cycle; development of mammary glands; increased activity of the liver and kidneys in their functions; increase appetite and skeletal; posture and balance adjustments etc.

Part (b) (iii) was well answered, often too colloquially and rambling for an advanced Biology examination, since specifics such as essential vitamins, minerals, a well balanced diet, regular exercise which encourages blood flow, cessation of smoking and alcohol consumption, adequate rest, regular medical monitoring for blood pressure, oedema or other more serious symptoms, were required.

Module 3

Question 8

Syllabus Objectives. 1.2, 1.3.

Optional Question. Maximum Marks = 20

Highest Mark 20 Mean mark 9.2. Lowest mark 0

Candidates selecting this option, 54 percent.

Part (a) (i) had good responses from most centres. Two marks were available and candidates were given credit for any two of the following: explaining the sex-linked location of the allele; clarifying the female and male allelic combinations and incorporating the terms heterozygous, homozygous, carrier, dominant and recessive or carrier into the sentence.

In part (a) (ii) most candidates correctly answered that Prince Albert was a normal, (non-haemophilic) male, so his daughters were either heterozygous carriers or normal. In most cases the genotypes were given and the candidate scored the two marks.

In part (a) (iii) many candidates spent too long depicting diagrams or charts of inheritance of the haemophilia allele to arrive at their conclusion.

In part (a) (iv) six marks were given for stating and presenting the correct genotypes in the diagram. Candidates cited the six genotypes either as AA, AO, BB, BO, AB and OO directly, or they drew the chromosomes carrying the labelled alleles. To gain marks, candidates needed to be systematic in explaining the ABO system, referring to multiple alleles and matching the phenotypes to the genotypes.

In part (b), the candidates were required to outline the steps in applying the Chi squared test, but many unnecessarily undertook to do the series of calculations. Marks were allotted firstly for recognising the 1:1:1:1 ratio of a dihybrid back cross with the double recessive. Many candidates were only familiar with a 9:3:3:1 ratio, and laboured to make the figures fit this ratio. The expected ratio would be 1:1:1:1, and the observed results of 108, 102, 105, 101 totalled 116, giving an expected result of 104 each. Candidates needed to explain how the differences between the observed and expected results would be obtained, (O-E), and then progress to the square of the difference, (O-E)². Marks were allotted for describing each stage or for demonstrating each step in tabular form up to the Chi-squared formula. Reference to the table of values, degrees of freedom and selection of the probability should have been outlined on a “how to do it step by step” basis.

Determining acceptance or rejection of the null hypothesis, and significance or insignificance should have been explained. Candidates were awarded up to six points for describing at least six steps adequately.

Question 9

Syllabus Objectives.2.7, 2.8, 2.9, 4.2.

Optional Question. Maximum Marks = 20

Highest Mark 20 Mean mark 9.01. Lowest mark 0

Candidates selecting this option, 46 percent.

In part (a) (i), the definition of the term environment posed difficulty for many candidates and there was a wide range of answers. There should have been reference to the sum total of all conditions under which an organism lives - which affect lifestyle, adaptations and survival. Many candidates gave very brief answers and gained one of the two marks. Approximately 70 percent of the candidates were able to give a biotic factor, (tree cover, human influence, disease etc). Fewer candidates could explain a physical factor (climate, altitude, edaphic, etc). They may have been more familiar with the term 'abiotic' than 'physical'.

In part (a) (ii), examiners were looking for key words in the definition of 'evolution' such as a slow (in time), gradual change through successive generations, genotypes, survival and natural selection. Many candidates confused the terms allopatric and sympatric but furnished adequate descriptions of the two, indicating that they knew the difference between the two types of speciation. Some credit was given for displaying an understanding of the differences despite superficial forgetfulness.

In part (b) candidates were required to give generous reasons for the importance of maintaining biodiversity, not just lists or single words. At this level, candidates are expected to show competence in putting forward four coherent points.

In part (c), four marks were given for each of stabilizing and directional selection, eight in all, including two examples. Many candidates confused them with each other or with disruptive or natural selection in general. Approximately 70 percent of candidates gained three descriptive points but not all were able to give adequate details. The most common examples were industrial melanism in moths or neck length in giraffes for directional selection, and mean birth-weight for stabilizing selection.

In part (d) candidates should have clarified the meaning of both speciation and disruptive selection briefly. Since disruptive selection creates barriers to interbreeding, it promotes the separation of the gene pool into subspecies whose reproductive compatibility eventually becomes unsuccessful. Good candidates logically defined both terms and gave one supporting statement.

UNIT 2

PAPER 2

SECTION A

Module 1

Question 1

Syllabus Objectives 2.6.

Compulsory Question. Maximum Marks = 10

Highest Mark 10 Mean mark 5.66. Lowest mark 0

Part (a) - In explaining the usage of the apparatus in Figure 1, candidates stood to gain five points. The collection and measurement of oxygen is achieved in the school laboratory by using variants of the apparatus in Figure 1. As expected, 75 percent of the candidates showed familiarity with the principle of a photosynthometer, but many were unpracticed in its operation. They mentioned the movement of an air bubble along the capillary tube, the use of coloured water or the counting of air bubbles leaving the plant in a given period of time. The required response was to allow oxygen to accumulate in the flange of the tube, and then, using the syringe, pull the air bubble into the capillary tube alongside the scale, to measure its entire length. Candidates should state that the length of the bubble and the bore of the capillary tube could be used to calculate the volume of oxygen produced in a given time.

Many misconceptions were evident, including the idea that the oxygen pushed its way into the tube, forcing the meniscus along, and pushing the plunger out of the syringe - this is obviously confused with a respirometer, using sodium hydroxide to absorb CO_2 , which creates a pressure deficit, drawing in a gas bubble.

In part (b) (i), the majority of candidates were able to interpret Curve A and state that the rate of photosynthesis increased as light intensity increased, and then levelled off.

In part (b) (ii) candidates needed to state that in both curves, as light intensity increased, the photosynthetic rate increased too, but that in Curve A, the low level of CO_2 , (0.03 percent) is a limiting factor causing the levelling off in rate earlier than in Curve B. In Curve B, the 0.13 percent CO_2 allows the rate of photosynthesis to increase to almost double that in Curve A before levelling off due limitation. The question required candidates to compare the curves, but only 50 percent genuinely accounted for the difference in the shapes.

In part (b) (iii), there was about 90 percent accuracy, with candidates providing a satisfactory hypothesis - for which their teachers are to be commended.

Module 2

Question 2

Syllabus Objectives 3.2, 3.4..

Compulsory Question. Maximum Marks = 10

Highest Mark 10 . Mean mark 4.80. Lowest mark 0 .

Part (a) (i) tested the candidates' experimental skills by requiring them to make a plan diagram from a photomicrograph of right wall of the heart in longitudinal section. This section of the heart wall represented familiar material - it is part of the shape which the candidates produce every time they draw or diagram an LS of the heart. Almost all candidates drew the outline and valve flap correctly, for which they gained part of the marks. The better candidates recorded the outline of the thick muscle block in the ventricle wall, the thinner block in the atrial wall and the small blood vessels in the atrio-ventricular region. Some candidates drew cellular detail, even though a plan diagram was requested. Unfortunately the reproduction of the photograph was rather dark, and not nearly as clear as expected.

In part (a) (ii) candidates were asked to draw a rectangle on Figure 3(b), to indicate the location from which the photograph was taken. The majority of candidates enclosed the area around the bicuspid valve. Several candidates overlooked this part of the question, perhaps because it was typeset at the top of the opposite page, and may not have attracted their attention adequately. It was an easy mark lost for these candidates.

In part (b) (i), the labels proved challenging for many candidates. Since they were not expected to have seen the specimen, their ability to identify the structures depended on their application of biological knowledge. Those who drew the diagram well were better able to gain marks. However, the mark scheme was adjusted so that candidates needed only to identify two of the four structures.

In part (b) (ii), the left atrium (E), and left ventricle (F) were upgraded to one mark each, instead of one mark for both, so candidates gained more marks here.

In part (c), the proportions of the walls at G:H were 1:3, or one third, or 33.3 percent. Figures close to these gained marks. Most candidates scored well by following instructions.

In part (d) candidates were asked to give one reason for the difference in wall thickness between G and H. Examiners gave credit for any one of four reasons, including that wall G pumps blood to the atrium, while wall H pumps it to the body. Many candidates forgot to refer to both G and H in their comparison and lost marks. Teachers are requested to emphasise the use of a pair of statements when citing either comparisons or differences.

Module 3

Question 3

Syllabus Objectives. 2.4, 2.23.

Compulsory Question. Maximum Marks = 10

Highest Mark 10. Mean mark 7.07. Lowest mark 0.

In part (a) (i), the majority of candidates referred to Figure 4 and answered it correctly. Some paid little attention to the data provided, and provided vague answers from extraneous knowledge. When candidates are instructed to refer to the data provided in a figure or a graph, they must do so. The examiners have very specific answers which the candidates can only deduce by reading off values from the graph provided.

In part (a) (ii), the answer was straightforward. At age 45, all the graph lines were at zero.

In part (a) (iii), most candidates were able to use the data provided, and gave the correct answer: 2.28 percent.

In part (a) (iv) candidates were asked to predict an outcome based on data provided in Figure 4. They should have read off the percentage cumulative risk of 50 year old men who never smoked (0.00 percent), and 70 year old men (that is, 20 years later, 2007 - 2027), who continued to smoke. The difference was approximately 10 percent. Two marks were awarded, one for observing that the risk would increase, and one for using the data to suggest a percentage increase in risk. About 20 percent of candidates described the factors which cause lung cancer without any reference at all to Figure 4.

Part (b) - In this planning and design exercise candidates should have recognised two separate groups, A and B. Many candidates ignored the groups and failed to consider a hypothesis that there might be measurable differences between them. Procedurally, methods of measuring the pre-exercise values for blood pressure, pulse and respiration rates under controlled, timed conditions should be established, and the mean values for each group determined. Post exercise data was needed, and their mean values compared with the pre-exercise values for both A and B. Marks were available for a point by point outline. The presumed/expected results should be related back to the smoking habits of the two behavioural groups. Candidates omitted many of the details, forgetting to record pre- or post-exercise values. Many candidates did not refer to the apparatus, the use of the stairs or the blood pressure equipment. In general at least 50 percent gained two of the four marks.

SECTION BQuestion 4

Syllabus Objectives. 1.1, 3.1, 3.2, 4.1, 4.2.

Optional Question. Maximum Marks = 20

Highest Mark 20 Mean mark 11.85. Lowest mark 1

Candidates selecting this option 58 percent.

In part (a), approximately 65 percent of the candidates identified and explained specific cellular processes. Popular responses included the active transport of Na^+ and K^+ across the cell membrane via the Na^+/K^+ pump, anabolic reactions such as protein synthesis, and examples from photosynthesis and glycolysis.

In part (b) (i), approximately 80 percent of the candidates gained two marks by defining glycolysis as the splitting of a glucose molecule in a series of low energy, enzyme-controlled reactions to form two molecules of pyruvate.

In part (b) (ii), 50 percent of candidates identified six major sequential steps of glycolysis. Very few stated how glucose was phosphorylated and when. They merely wrote that it was phosphorylated to make it more reactive. They identified the cleavage of the phosphorylated hexose into two 3-carbon molecules, but most omitted the fact that one needed to be converted to the other isomer in order to continue along the glycolytic pathway. About 10 percent said the dehydrogenation of each GALP produced a reduced NAD molecule with two ATP molecules. Most candidates said that the end result of glycolysis was two reduced NAD, two molecules of pyruvate and a net gain of two ATP.

In part (c) (i), approximately 80 percent of the candidates stated that anaerobic respiration resulted in energy production in the absence of oxygen. However fewer than five percent acknowledged that the electron transport chains (and therefore the Krebs Cycle), cannot function in anaerobic conditions because there is no oxygen to finally accept the H atoms. About half of the candidates said that anaerobic respiration was inefficient since it resulted in a net gain of only two ATP molecules, while aerobic respiration produced as many as 36 ATP molecules.

In part (c) (ii), approximately 10 percent of the candidates were able to earn all four marks. Most included the production of lactic acid under anaerobic conditions, by the muscles, and recognised that insufficient oxygen was being supplied during strenuous exercise, as opposed to insufficient ATP. Hence an oxygen debt was created. About 90 percent stated that an accumulation of lactic acid in the muscles was toxic and produced cramps or pain until the oxygen debt was repaid. Some mentioned that lactic acid in the blood increased breathing rate.

Question 5

Syllabus Objectives 6.5, 6.6, 6.7.

Optional Question. Maximum Marks = 20

Highest Mark 20. Mean mark 10.23. Lowest mark 0.

Candidates selecting this option: 42 percent.

In part (a), the majority of candidates (90 percent) were able to identify the sun as the energy source for producers, but most failed to identify the nutrient source of the producers. Those that did stated simply the soil. Most candidates, (90 percent) were able to identify that the source of energy and nutrients for consumers were the primary producers and other consumers, but focused on either energy or nutrients, not both.

Most candidates (80 percent) were aware of how decomposers feed, but were not specific as to what exactly the decomposers were obtaining in the process - as to whether it was nutrients or energy. The majority of candidates identified at least one difference between nutrient cycling and energy flow, including the cyclic nature of nutrient transfer and the unidirectional, linear flow of energy, with a diminishing value of energy, (by 10 percent), at each successive level. Only 10 percent stated that nutrient transfer remained relatively constant.

In part (b) candidates were unable to give clear distinctions between food webs and food chains, and in most cases gave only one clear point of comparison. Most correct answers referred to the varied diet in food webs versus single sources in a food chain. The loss or death of members of a food web would be less disruptive than in food chains. Almost no examples were given, referring to the names of plants or animals in a food chain, let alone, Caribbean examples.

Concerning the interference of the slash and burn method of deforestation on the nitrogen cycle, the majority of candidates, (80 percent), were able to identify more than four clear points where the cycle was affected. It was expected that candidates would write these point in prose. Diagrams of the nitrogen cycle were not accepted unless relevant points were annotated and incorporated exactly.

Overall the stronger candidates (58 percent), who were more competent with biochemistry, chose Question 4, and those who opted for Question 5, (42 percent), tended to be weaker, imprecise and rambling. Almost none referred to the tropical rain forests, fruits and branches referred to in the question, or displayed any familiarity with the organisms in a tropical environment. They were very theoretical. Candidates tend to avoid, or be uncomfortable with questions on ecology, as it is too broad a topic for them, and they appear to have little practical experience. In this section they failed to state specifically how the cycles would be affected by deforestation or slash and burn and were unable to visualise and demonstrate the link between these deaths and the disruption of the cycle.

Question 6

Syllabus Objectives 5.2, 5.4, 5.6.

Optional Question. Maximum Marks = 20

Highest Mark 20. Mean mark 8.90. Lowest mark 0.

Candidates selecting this option: 64 percent

In part (a) (i), the drawing of the nephron was generally poorly done. Many candidates failed to differentiate between the Bowman's capsule and the glomerulus, while others drew the distal and proximal tubules as straight tubes. Many drawings were not proportionate, and lines were ill-defined. They were expected to have been more familiar with the structure of the nephron from their pre-requisite of CSEC Biology.

In Part (a) (ii) candidates were asked to outline the role of the loop of Henle in water conservation. They found this difficult and few scored the five marks available. The hairpin loop, the countercurrent exchange and the vasa recta should be mentioned. Good candidates clarified the active removal of salt from the ascending limb and its deposition in the medullary tissue, decreasing its water potential. This causes water to diffuse out of the descending limb, where its potential is high, and into the vasa recta for retention and conservation. These points are explained fully in the text books. The question referred primarily to the Loop of Henle rather than the proximal and distal convoluted tubules or the collecting ducts. Some candidates misinterpreted the question and wrote extensive accounts of the role of ADH in water conservation in the collecting ducts, and therefore failed to score.

In part (b) (i), the metabolism of both the mother and foetus in terms of water and salt regulation, as well as, the filtration of waste is managed by the mother's kidneys during pregnancy. Candidates identified the increase in removal of nitrogenous waste and other typical components of the urine, as well as the regulation of salt and an increase in the filterable volume of fluid, resulting in an increased frequency of urination. There is also an increase in the removal of hormones such as HCG.

The high glucose level in the urine indicates that the concentration in the blood plasma is being exceeded. This is typical of late onset, Type II diabetes, which suggests inadequate production of insulin by pancreatic cells, or failure of target cells to respond by taking up glucose as instructed. The high protein level indicates the loss of ability to restrain the passage of protein molecules in the plasma. The filtrate mechanism of the pores in the basement membrane which usually retains plasma proteins may be damaged or failing, due to impairment, hypertension, etc. The patient would need to regulate glucose levels by either diet, exercise or insulin replacement, and have further tests on kidney competency.

Candidates did quite well and were able to link metabolic, physiological and structural faults to the high glucose and protein level in the urine. Many candidates attained the eight marks available.

Part (c) was well done. Candidates linked the high glucose level in the urine to diabetes Type II or late onset, and went on to discuss the physiological changes such as inadequate insulin production taking place in the 60-year old patient. Similarly, high urinary protein levels were associated with kidney failure due to either disease or hypertension.

Question 7

Syllabus Objectives 6.4, 6.5, 6.6.

Optional Question. Maximum Marks = 20

Highest Mark 20. Mean mark 12.65. Lowest mark 0.

Candidates selecting this option: 36 percent

Although this was not the more popular of the two questions from this module (36 percent), it proved to be the more high-scoring (12.6 versus 8.90).

In parts (a) (i) and (ii), most candidates gave large clear well-labelled drawings of the synapse and earned full marks. Some candidates failed to label the pre- and post-synaptic membrane exactly. They labelled the knobs or the axons, possibly confusing the sites with the pre- and post-synaptic neuron.

In part (a) (iii), most candidates knew about the method of transmission of an impulse across a synapse, gave excellent responses and scored full marks.

Part (b) (i) alluded to synaptic summation, and required candidates to relate an incoming impulse, (the gradually increasing sound of the cries of a waking baby), to the increase in number and frequency of impulses arriving at the sensory neuron's receptor membrane. When the stimulation reached the threshold level an action potential was generated, resulting in an awareness of, and response to the cries. Many candidates gained the three marks.

In part (b) (ii), the normal reflex to drop the hot dish is inhibited, increasing the difficulty for excitatory impulses to pass the synapse. The transmitter may be blocked or may cause the post-synaptic membrane to become more negative than usual, so that it does not become depolarised and an action potential is not generated, resulting in a muscle response to hold the dish. The mark allotment for this section was reduced, from three to two, to compensate for the challenge of the question and the marks were redistributed.

Part (c) centred on the differences between endocrine and neural systems and was well answered. It is familiar material from CSEC and most answers were set out clearly. However, candidates must remember that 'differences between' requires a pair of responses.

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Question 7

Syllabus Objectives 6.4, 6.5, 6.6.

Optional Question. Maximum Marks = 20

Highest Mark 20. Mean mark 12.65. Lowest mark 0.

Candidates selecting this option: 36 percent

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Question 8

Syllabus Objectives 2.6, 2.7, 2.8.

Optional Question. Maximum Marks = 20

Highest Mark 20. Mean mark 11.66. Lowest mark 0.

Candidates selecting this option: 84 percent

In part (a) (i) candidates knew that 1) HIV is a virus, (retrovirus), which affects T helper lymphocytes (CD4 cells) and that 2) The viral RNA is translated into DNA and incorporated into the DNA of the host nucleus, thus 3) Destroying/inactivating, the CD4 cells and 4) Preventing them from carrying out their normal immunological function. AIDS is a syndrome which describes a variety of opportunistic infections which would normally be controlled by the CD4 cells. Thus in AIDS, simple infections become lethal. 59 percent of the candidates achieved all three marks. Some, instead of describing how the infection eventually causes AIDS, described the methods of transmission of HIV.

In part (a) (ii), excellent answers were given to this question by the majority of the candidates.

In part (a) (iii), the mark scheme identified least 12 areas of impact of AIDS in the Caribbean and candidates were required to discuss four. They were quite knowledgeable and expressed strong opinions on the most popular topics: 1) AIDS is a major cause of death in the region, especially among the 15 - 45 age group; 2) The Caribbean ranks second in the world for infection rates and therefore continued infection is increasing; 3) The cost of AIDS treatment and prevention is a significant drain on the limited resources; 4) Funds allotted to AIDS medication are being taken from other essential budgets education, infrastructural development etc. and 5) The quality of family life, including the deprivation of parental care, income generation etc. are negatively impacted by AIDS morbidity and deaths.

In part (b), two marks were allotted for Malaria transmission, but the responses were too detailed and candidates wasted their time. Unfortunately candidates were unaware of the fact that part (b) (i) carried only two marks, and part (b) (ii) carried eight. Candidates answered part (b) (ii) as if it had a value of five marks, instead of eight, (which they did not know), and so they provided too few details, and lost marks. Many candidates said the causative agent was a bacterium or virus, instead of a protozoan. The text contain excellent accounts of preventative methods, taken from the following categories: life cycle and stage-related environmental factors, host blood management, vaccination, pro-active drug-taking, factors in the home (sprays, light paint, fans air conditioning, nets, clothing, etc), based on nocturnal activity. The text books also included the benefit of sleeping with pigs, in-so-far as mosquitoes may preferentially 'bite' domestic animals thereby sparing humans. Although not a Caribbean habit, many candidates quoted it.

Question 9

Syllabus Objectives.

Optional Question. Maximum Marks = 20

Highest Mark 20. Mean mark 12.36. Lowest mark 0

Candidates selecting this option: 16 percent.

In part (a) (i), this rubric was fairly well done. Many candidates knew what restriction enzymes were and gained both marks. About 60 percent could state the normal function of restriction. Endonucleotidases in life, for example, used by bacteria to sever and fragment DNA strands of infectious agents such as viruses or bacteriophages.

Part (a) (ii) - In previous years there have been some good answers on this topic. A straightforward knowledge and comprehension-based answer describing the process of genetic engineering was required. Guidelines were given to ensure that the candidates clarified the relevant points: plasmids, bacteria and gene probes. Only about 55 percent of the candidates scored well, giving eight generous and clear points. The remaining 45 percent did not furnish adequate details, and confused the sequence.

Part (b) (i), this higher level question, required candidates to describe the procedures of gene therapy and add factors affecting its use, for instance, that the debility must be one that can be remedied by a single known gene; that the gene can be preferentially transcribed - that is dominant; that it can be cloned and incorporated into a plasmid, lysosome or other vector, packaged into a 'dosage' and introduced to the host's specific target cells by an appropriate method., for example, nasal sprays, inhalation, and "shooting". The therapeutic effect may be temporary, and require repeated therapy, for example, where epithelial cells are shed. Many candidates were knowledgeable in describing the theory of gene therapy, but were not au fait with or aware of how it could be implemented, practically.

Part (b) (ii) was also well done. Candidates were able to express their views freely, but needed to make distinctly awardable points. Stem cells and ethical issues were discussed, but candidates failed to give specific reasons or support for them.

School Based Assessment

General comments

Overall the quality has improved since 2006. Some of the teachers at some Centres are doing excellent work, especially with coverage of the syllabus, using a range of activities and innovative approaches. There has been a good emphasis on drawing in general.

However, in several cases the practical/laboratory exercises which were chosen to teach skills to the candidates, and to make assessments, were sometimes inadequate and the criteria used to evaluate performance were below the appropriate descriptors. This resulted in the candidate being poorly prepared for Paper 02 Section A, or at a disadvantage when being marked against the Examiners' standardised marking scheme, which expects more than is being required by the school, during internal assessment.

Territory-based workshops which communicate the Council's expectations for CAPE SBA would make it easier for teachers to comply, and for Examiners to mark expeditiously. Where there are two teachers responsible for SBA at one centre, their mark schemes should be standardised across any exercise-in-common. In some cases, coverage of the syllabus seemed incomplete. It is useful to provide the students with handouts with practice questions to help explain the laboratory, and to provide sample mark schemes to show students how they will be evaluated.

Drawings

There are still major problems overall, and some Centres are giving marks too easily. A marking plan should include the following: 1) clarity of the drawing; 2) appropriate selection of the cells or tissue, so that it is typical of the cells being represented; 3) faithfulness and accuracy in recording the drawing; 4) correct proportions in all dimensions; 5) correct title, preferably at the top of the page to introduce the drawing. This needs some descriptors - the name, the view, the type (high power, low power - etc.); 6) the placement of the drawing on the page, for example, slightly left to allow room for labels; 6) labels and annotations - neatly set out, with planning to ensure the finished presentation is the best it can be; and 7) recording the correct magnification. Insistence on these seven factors, which the examiners must match to their mark scheme, is essential if candidates are to gain good scores.

Analysis and Interpretation

The following areas were selected by the examiners for improvement by 2008: 1) Adequate inclusion of background information to identify and explain relationships and patterns; 2) The ability to draw logical conclusions and make predictions from observations and data; 3) Understanding of the limitations of the observations and data; and 4) Understanding the relationship between the results obtained and the original hypothesis

Planning and Design

The major challenges were that Planning and Design exercises did not always following prescribed format guidelines, and that, in many instances the Planning and Design topics were found to be inappropriate. In addition, the examiners had some difficulty in evaluating activities that were clearly taken directly from a text book with few or no amendments, and were contrived to produce a specific result, which had been pretested, with well-known results. Candidates are required to show their capacity to confront an investigation, and to work out a managerial approach to cope with it. This involves teaching and re-enforcing: 1) A better understanding of how to formulate a hypothesis based on an observation and express it clearly, so that candidates can keep it in mind throughout, and return to it at the end of the exercise to indicate the extent to which it has been supported. This hypothesis should be logical and testable; 2) State a clear aim; 3) List or describe the appropriate material and apparatus. Candidates should review this to ensure that nothing is omitted. If it is, the investigation cannot be completed, and marks will be lost; and 4) A well thought out method, expressed clearly with a reasonable attempt to control other conditions or variables.

Furthermore, the procedure should be accurate and repeatable, the site for sampling and the size and cover of the samples should be reasonable. An understanding of the limitations which affect the design of the experiment and the extent to which limitations modify the outcome and results with limitations should be included. The method of collecting results, summarized and expressed using graphs, tables or pie charts should be visualized, and finally, the overall format should be suitable for a planning and design activity. As stated previously, it is expected that teachers will test the candidates' original approach and concept, because the examiners are not impressed by activities obviously and openly copied from the text book and presented as the student's own original plan and design.

In 2007, a decision was taken by the examiners to request the Council to hold workshops in the territories to provide teachers with more information on the criteria required, an understanding of the moderation process, and the communications intended in the feedback process.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2008**

**BIOLOGY
(TRINIDAD AND TOBAGO)**

**BIOLOGY
(TRINIDAD AND TOBAGO)**

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2008

GENERAL COMMENTS

This year, the examination has a new format following a review of the syllabus. The examination now comprises Paper 01, a Multiple Choice paper consisting of 45 items, 15 from each of the three modules; and Paper 02, consisting of six questions. Paper 02 is divided into two sections – Section A and Section B. There are three compulsory structured questions in Section A, one testing each module and three essay questions in Section B, one testing each module. Each question on Paper 02 is worth 15 marks. The paper has the same structure for Unit 1 and Unit 2.

The modules in each Unit are:

Unit 1

- Module 1 - Cell and Molecular Biology
- Module 2 - Genetics, Variation and Natural Selection
- Module 3 - Reproductive Biology

Unit 2

- Bioenergetics
- Biosystems Maintenance
- Applications of Biology

This year, 1 175 candidates registered for the Unit I examination. The overall mean was 58.5 per cent and 92.1 per cent of the candidates achieved Grades I – V. There were 836 candidates registered for Unit II. The overall mean was 65.5 per cent and 97.1 per cent of the candidates achieved Grades I - V.

DETAILED COMMENTS

UNIT 1

PAPER 02

SECTION A

Question 1

In Part (a) (i) the attachment of the third glucose molecule in structural form to show an alpha 1-6 linkage proved to be extremely challenging as candidates had problems identifying the alpha position. Many candidates re-drew the entire molecule to get a better placement for the molecule layout with which they were more familiar. All candidates should be able to number the carbon atoms as it is part of identifying the linkage positions for 1-4 and 1-6 bonds. Also in a glycosidic bond, water is produced by hydrolysis, hence two –OH groups only can be involved, while an –H group cannot be part of it.

Generally, Part (a) (ii) was adequately answered. Glycogen and amylopectin were the correct responses, but many candidates erroneously offered 'starch'.

In Part (a) (iii), most candidates had the required knowledge of alpha and beta linkages but the concept of distinguishing between them proved challenging. The candidates provided information on either the alpha linkages or the beta linkages, but not both. Poor responses included that 'beta linkages are found between beta glucoses', and 'alpha linkages occur between alpha glucoses. As mentioned previously, identifying carbon numbers 1 and 4 proved to be a challenge.

In Part (a) (iv), candidates should have been able to state that the alpha linkages are associated with molecules used in metabolism, energy production or for storage, such as starch; while a beta linkage, which enables each successive moiety to rotate, is involved in structural molecule-building such as cellulose. Many candidates did not pay attention to the fact that the difference in *function* was requested.

In Part (b) (i), the candidates were expected to state that the linkage occurred between the NH⁺ group of one amino acid and the CO⁻ groups of another amino acid further along the same polypeptide chain. This repeated sequential bonding holds the spiral form in place.

In Part (b) (ii), most candidates were able to use the table provided to distinguish between the physical properties associated with the alpha helices and the beta pleated sheets. They primarily referred to the tensile strength and elasticity.

In Part (b) (iii), several candidates obtained the full score. For the structured bond A, 'hydrogen bond' was accepted, while the structured bond B was identified as a disulphide bond or bridge. In some cases, hydrogen bonding was opted for rather than ionic bonding.

In Part (c) several candidates used the Biuret protein test for the confirmation of catalase, possibly because it is chemically a protein. However, the question required candidates to design an experiment to demonstrate its activity. Many candidates were not able to describe the sequential steps in the procedure. Three required steps were - soaking and crushing peas, adding catalase and observing effervescence from the H₂O₂ in the tissues, presuming the gas to be oxygen and testing with a glowing splint to confirm. In addition, a control should have been included to confirm that the action was due to catalase alone. Candidates are reminded that Section A of Paper 2 endeavours to test practical-based topics and candidates must be able to relate the theory and practical.

Module 2

Question 2

In Part (a) (i), candidates were required to give a brief outline of the role of DNA in genetic inheritance. Acceptable responses included: 'DNA is a polynucleotide which codes for genetic information and controls cellular activity through protein synthesis. It forms the chromosomes which, by mitosis or meiosis, pass the code on to offspring.' Many of the candidates focussed on the structure of the molecule, the method of storage of information, or the transcription to RNA and omitted mention of chromosome behaviour.

In Part (a) (ii), many candidates were able to provide good explanations for chromatin: 'a diffuse, loose network of DNA and histones evident at interphase'. For the term 'chromosome', the answer, 'structured, condensed coils or threads of DNA and histones visible during nuclear division', was required. Candidates were expected to distinguish between the two terms by stating the distinctions between them and not by using two separate descriptions. The following statement, for example only

gained partial credit: ‘the chromosomes are not identifiable in chromatin’, or ‘chromosomes are composed of two chromatids’.

Part (b) required candidates to state three reasons why mitosis is important in the life-cycle of a eukaryotic organism. Candidates were expected to write a descriptive sentence on any three of genetic stability, growth, repair and replacement, regeneration or asexual reproduction.

In Part (c) candidates were asked to draw three consecutive stages between the two un-named drawings provided. Candidates should have understood that these represented prophase and early anaphase. The required drawings were, synapsis in prophase, where homologous chromosomes come together in pairs, with each pair composed of two chromatids; crossing over between the four chromatids, showing chiasmata; lining-up of the homologous pairs at the equator of the spindle, attached by centromeres.

This question was very challenging for most candidates, and drawings were either incomplete, of poor quality or incorrect. It is recommended that students be given repeated practice with illustrating these stages.

Module 3

Question 3

In Part (a) (i), candidates were required to add the ovule and the path taken by a germinating pollen grain to a diagram showing the longitudinal section through a carpel. Few candidates provided good drawings. They were unable to draw the ovule, the integuments and the micropyle accurately, and had difficulty with the pathway of the pollen tube. The pollen tube grows along the locule wall but does not float through the locule space. It absorbs nutrients from the surface. It does not bore through the ovary wall, as the tissue is too dense. Part (a) (ii) requiring candidates to label features of the embryo sac was adequately done.

In Part (b), the term ‘dioecious’ was often spelled incorrectly. However, most of the candidates scored full marks. The disadvantages to having this feature included reduced pollination, wastage of pollen, reduced number of fruits produced, dependence on a pollinating agent to bring the pollen, (wind or insects) and reduction in the number of plants in the population producing pollen.

In Part (c) (i), bulbs, rhizomes, corms and so on were accepted with an explanation of the mechanism of non-sexual propagation. Responses in Part (c) (ii) should have included that only one parent was required, energy and resources used in the production of gametes and sexual structures were saved, genetically identical offspring were produced, genetic stability was maintained and rapid spread/colonisation can occur.

In Part (d), almost all the candidates were able to interpret the description of ‘artificial propagation of small amounts of plant material’ to refer to methods such as tissue culture, stem tip cuttings, bud grafting and so on. In general, the advantages included disease-free propagation, rapid production of hundreds of plantlets, laboratory operations are unaffected by seasonal changes and compact propagation areas, such a labs or sheds are adequate. Many candidates scored full marks, but several answers indicated practical unfamiliarity with vegetative propagation techniques.

SECTION B**Module 1**Question 4

In Part (a) (i), the majority of candidates scored marks for describing features of mitochondria and chloroplasts which support the theory that they have arisen from prokaryotic cells, engulfed and existing symbiotically in eukaryotic host cells. The most popular answers included the presence of organelles of such prokaryotic features as the presence of circular DNA, 70s ribosomes and the existence of a double membrane, the inner representing the surface layer of the prokaryote, and the outer representing the membrane of the host cell. Some candidates misinterpreted the question and supplied features and characteristics of the organelles without applying these to the endosymbiont theory. Candidates who stated 'no nucleus' should have clarified that DNA lay freely in the cytoplasm without a nuclear membrane. The size of prokaryotes and the organelles could have been used to show their similarity in comparison with the much larger size of the 'host' eukaryotic cell.

The responses to Part (a) (ii) were below the expected standard. The expected response was that 'symbiosis is a close association/relationship between two organisms of different species'. Further, the candidates should have elaborated by mentioning mutualism and commensalism.

In Part (a) (iii), approximately half of the candidates scored 3 of the 4 marks available, by stating the functions of chloroplasts and mitochondria. Candidates expressed the mutualistic relationship and indicated the benefits to the eukaryote (energy from the mitochondrion, food and oxygen from the chloroplast), but failed to explain the benefit the prokaryote gained (shelter, protection, food source and oxygen acquisition). Candidates often dwelt too much on describing the structure of the organelles instead of providing a link to the symbiotic relationship, as requested.

In Part (b) (i), the terms 'tissue' and 'organ' were well defined by most candidates, but many failed to mention that cells/tissues work together for a particular function. Comments such as 'bundles of cells' showed limited use of good biological expression.

In Part (b) (ii), very few candidates described the tissues found in the roots. Many simply listed them without reference to their structure or function. Areas of difficulty appear to be distinguishing the function of phloem from that of the xylem and misspelling scientific terms associated with the root. (pholem for phloem, endometrium for endodermis and epididymus for epidermis, and so on). When asked to use the root as an example to distinguish between a tissue and an organ, few candidates gave clear, exemplified answers. Many referred to the xylem and phloem as organs and rarely mentioned the root in its entirety. The answers revealed that candidates have a very poor comprehension of plant tissues and organs. They rarely discussed the tissues in a systematic way or their cohesive role in the levels of organization and functions of the root.

Module 2Question 5

In Part (a) (i), candidates were unable to adequately define the term 'species'. Candidates were expected to emphasize the terms similar or closely-related organisms, capable of interbreeding and production of fertile offspring.

In Part (a) (ii), the discussion of limitations was poorly done. It is evident that candidates have difficulty understanding the 'biological species' concept. As such, they found it impossible to discuss the limitations in terms of breeding.

In Part (b) (i), the expected responses should have included disruptive selection, gene mutation, allopatric and sympatric speciation. When gene flow is interrupted in a species, by various methods,

two subpopulations may become genetically isolated, resulting in speciation. With this example in mind, candidates could have reduced the confusion they had with natural selection.

Part (b) (ii) tested Darwin and Wallace's theories and was done fairly well. Candidates listed the mechanisms for the basis of speciation, and many used the example of the Peppered Moth. The expected response was that individuals produce more offspring than required, the offspring have a range of variation, some of which are better suited to the environmental challenges than others, the fittest survive, those individuals produce more offspring than the less-well adapted individuals, and this results in the better-adapted individuals having a greater share of the on-going gene pool than the less-well adapted types.

Module 3

Question 6

This question tested the candidates' knowledge of the role of hormones in gametogenesis and how this knowledge is taken into consideration when developing contraceptives.

In Part (a) (i) a), Gonadotrophin-releasing hormone stimulates the anterior pituitary to secrete Follicle Stimulating Hormone (FSH) and Luteinising Hormone, (LH). Most candidates provided the correct information about their influence in oogenesis. In Part (a) (i) b), candidates gained credit for stating either that LH causes ovulation, or that LH stimulates the remaining part of the Graafian follicle to become the corpus luteum, which secretes oestrogen and progesterone. In Part (a) (i) c) any of the four functions of FSH was accepted.

In Part (a) (ii), candidates were asked to explain how these hormones functioned in males as compared with females. Approximately one-third of the candidates stated that these hormones are not produced in males. The remainder received partial credit for stating that FSH stimulates the Sertoli cells to complete sperm maturation, LH stimulates the synthesis of androgens by the Leydig cells of the testes and also stimulates the production of male hormones.

In Part (b), a large percentage of the candidates misinterpreted the question and instead of stating why the inhibition of production of LH and FSH in males cannot be the basis of the development of a male contraceptive, many stated that it was totally impossible to develop a male contraceptive. Candidates were expected to state that GnRH stimulates the anterior pituitary to secrete LH and FSH and to refer to the functions of LH and FSH in males, explaining the impact of the inhibitions of the hormones. Further, interfering with these hormones affects too many physical factors in males. LH stimulates male hormone production and muscle mass and maintains secondary sexual characteristics, testosterone also maintains muscle mass and facial hair. If absent these features do not develop and potency and libido would be affected. The impairment of the hormone action would need to be continuous since, unlike the female cycle, there is no critical timing for the male contraceptive.

In Part (c), candidates were required to discuss two differences with respect to the timing of oogenesis and spermatogenesis. Many candidates failed to focus specifically on timing and instead wrote about the process and differences in general, thereby losing marks. The points required centred on females having the full complement of a fixed number of primary oocytes from birth and produce ova from them between menarche and menopause, while in males, primary spermatocytes develop from the germinal epithelium after puberty, and continue throughout life. Further, whereas the development of mature sperm takes approximately 70 days, oogenesis can take as long as 48-50 years. The formation of the mature sperm from spermatocytes is smoothly sequential, whereas in oogenesis, the final meiotic division does not take place for many years and then only after the certainty that a sperm has entered the secondary oocyte and is available for zygote formation.

PAPER 02**SECTION A****Module 1**Question 1

In Part (a) (i), the majority of the candidates scored the marks allocated for (I) cristae and (II) matrix, although some confused the two organelles, as well as the matrix and stroma.

The responses to Part (a) (ii) were fairly good. However, some candidates did not relate the structures I and II in this section to those given in Part (a) (i), and wrote about the matrix before the cristae. The cristae contain the respiratory chains and the matrix is the site of the Krebs's cycle and fatty acid oxidation.

In Part (a) (iii), a large percentage of the candidates performed creditably showing both the calculation and the solution. However, many candidates did not know how to complete the calculation and many did not use their rulers accurately to give concise readings. There were a few candidates who changed nanometres (as shown on the scale) to micrometres. Candidates need to practise calculations relating to size and magnification, and must learn to recognize and apply the scale of the drawing/graphic in such calculations.

Part (b) was fairly well done. For similarities, candidates referred to the double membrane, free DNA, 70s ribosomes and the extensive internal membrane system. For differences they were able to cite many of the features listed in the texts.

In Part (c), more than half of the candidates ignored the instruction to use an annotated diagram. They either did not include annotations or wrote an essay accompanying the diagram. Teachers need to help candidates to practise annotations of diagrams. In the diagrams, many candidates included arrows representing the reactions, but the arrow directions were haphazardly done and candidates confused the redox states. It is critical that candidates understand redox states to get a rational idea of the processes occurring in sequence. Too many candidates seem to be memorizing the pattern of the arrows without comprehending the reactions which involve the on-loading of hydrogen (reduction), and off-loading of hydrogen (oxidation).

A few candidates drew diagrams for all the entire metabolic reactions, including the Krebs cycle and did not confine their answers to the respiratory chain reaction. No marks were awarded for glycolysis or the Krebs cycle. Many candidates drew the anatomical structure of the membrane including the protein carriers and internal and external spaces. In these models, the generation of energy which involve redox reactions was not suitably explained.

The candidates' responses were interpreted in relation to their performance in drawing of the model, naming of the carriers and the state of oxidations and reductions, with the generation of energy, but all arrow heads had to logically agree with the reaction from the substrate to the product.

Module 2Question 2

Part (a) (ii) tested the candidates' knowledge of the concept of mass flow hypothesis, requesting six main features of the hypothesis. Overall, there were some good responses. The following illustrations

of the mass flow hypothesis were credited: sucrose is actively loaded into the sieve tube cell from the source; water enters the sieve tube cell by osmosis; hydrostatic pressure builds up at the source; translocation occurs along the tube, following a pressure gradient, forcing the contents to the sink; the sucrose contents are offloaded at the sink, and water flows by osmosis. Some candidates dwelt too long on the process of osmosis, or explained sections of photosynthesis and the production of sucrose.

In Part (a) (ii), the majority of the candidates were able to describe one major difference between the transport mechanisms in xylem and phloem. These included the fact that ascent in the xylem is driven by a negative pressure (tension) while movement through the phloem is driven by a positive hydrostatic pressure. In addition, some candidates mentioned the active and passive processes in both tissues. The weaker candidates spent too much time on describing the transport of water in the xylem and food in the phloem, or that one tissue was living and one dead and lignified. Candidates must remember that the term “difference between” requires a pair of responses on the same theme.

In Parts (b) (i) and (ii), most candidates were able to identify the four chambers of the heart and the flow of blood correctly. While most of the diagrams of the heart were acceptable, a small percentage was disproportionate, especially in relation to small atria and extra large ventricles.

In Part (b) (ii), where candidates were required to identify the chamber of the heart which plays the most important role in pumping, a few candidates stated that the most important chamber was the right atrium, since it contained the sino atrial node. This was given credit.

Module 3

Question 3

In Part (i), most candidates struggled to come up with the true meaning of ‘health’. It should have referred to the ‘state of complete physical, mental and social well-being’ and also ‘the absence of disease or infirmity’.

Part (a) (ii) was poorly done overall. It appeared that candidates did not understand that they were to use two examples of a disease which fits more than one category. Such categories include degenerative, self-inflicted, deficiency and genetic/inherited diseases. Cancer, for example, may be classified as a degenerative, self-inflicted or inherited disease and cannot be placed in a single category. A self-inflicted illness may be due to a pre-existing mental illness.

Part (b) (i) was also poorly done and it seems that while the candidates have theoretical knowledge of what BMI is, they have little knowledge of how it is calculated or what measurements are relevant to its calculation, and the implications of its being high or low. Approximately one-third of the candidates scored full marks in this section. Partial credit was given for evidence that there is a relationship between body mass and height in determining the BMI.

Part (b) (ii) was very well done. Even those with a previous incorrect answer were able to deduce the correct answer.

In Part (b) (iii), the majority of the candidates offered two of the three possible answers. These were that high BMI or obesity could lead to diabetes, the individual could develop cardiovascular disease or both high cholesterol and high BMI could lead to hypertension. Several answers included death from a heart attack.

In Part (c) (i), most of the candidates drew the graphs competently but common mistakes included inadequate labelling of the axes and accurate plotting of the points. Most of the candidates drew bar charts or histograms.

In Part (c) (ii), candidates were asked to suggest one reason for the changes in the Mortality Rate after 1994. Many candidates were unfamiliar with the term ‘mortality rate’, but noted that the graph line

was descending. The typical answers included a decrease in having large families, improved medical services, improved diet, cleanliness, health education and diagnostics.

SECTION B

Module 1

Question 4

Part (a) (i) required the candidates to discuss the concept of 'biodiversity' in terms of genetic, species and ecosystem diversity. The majority of the candidates scored at least 50 per cent of the marks. Common errors included brief statements of relatively simple ideas without any discussion. There was little attempt to describe the three terms given, and almost no expansion on the definitions.

In Part (a) (ii), the reasons for conserving biodiversity were fairly well known, but candidates expressed them very briefly with almost no elaborations. They should have been able to explain the benefits on the basis of ethical, aesthetic, economic, medical, scientific, resource, preservation and environmental reasons.

In Part (b) (i), candidates tended to define a habitat rather than an ecosystem and limited their definition to abiotic and biotic factors only. Frequently the term 'self-contained' was used instead of 'self-sustaining'. Few candidates mentioned nutrient cycling or energy transfer, and they referred to animals and plants only, rather than 'all living things'. Three descriptive points were required to gain full credit.

Part (b) (ii) proved challenging to a number of candidates. Possible responses should have included biotic interactions such as predation, parasitism or mutualism, food webs and chains, the effect of regular, seasonal and climatic changes, abiotic influences of the environment on the ecosystem, such as topography, soil conditions, light, temperature and water availability. There was little or no discussion as to what the changes were or how they affected the ecosystem.

Module 2

Question 5

In Part (a), candidates were asked to describe the basic structure of a myelinated motor neurone. The majority of the candidates responded competently. A few candidates confused motor and sensory neurones and thus lost a considerable proportion of their marks. Candidates were expected to systematically identify at least six major structural features of the motor neuron and support them with brief descriptions.

In Part (b), candidates found difficulty in explaining the electrical nature of a nerve impulse in relation to the structure of a neurone. The responses expected included that the membrane is polarized, the potential difference is negative on the inside of the membrane with respect to the outside, at rest the potential difference is about -70mv, the cytoplasm of the axon has a high concentration of potassium ions and low sodium ions in contrast to the outside of the membrane, the resting potential is maintained by active transport of ions against their electrochemical gradients, (by K and Na pumps), and by passive diffusion. This part of the question was poorly done. Instead of explaining the basis of maintenance of the resting potential across the neurone membrane, as was required, many candidates

interpreted the 'electrical nature of the nerve impulse' as an 'action potential', and gave descriptions of the conduction of the impulse.

In Part (c), candidates were asked to cite three main phases of activity to discuss how a neurone functions to transmit an impulse upon receiving a stimulus. The majority of candidates did quite well, but answers were compromised because of the difficulty they had interpreting Part (b). The three phases of activity were depolarisation, action potential and propagation of the action potential.

Module 3

Question 6

Part (a) was well done and candidates scored well as they had an excellent knowledge of the mode of transmission of HIV and Dengue and the prevention of their spread. The responses were not as good concerning the onset of symptoms, as they did not distinguish between the onset of HIV (5 – 10 years), and Dengue (5 – 15 days). Some candidates thought that Dengue was caused by a protozoan, confusing it with Malaria, rather than a virus.

In Part (b) (i), when asked to explain how HIV becomes a permanent part of the cell of an infected person, most of the candidates appeared to have a very good understanding of the process. They cited attachment by the virus to receptor proteins on the lymphocyte cell membrane, followed by entry into the cytoplasm. The RNA, reverse transcriptase and copying process were described by most of the candidates as well as the integration of viral codes into the host DNA. The compromising of the normal function of the lymphocytes due to synthesis of HIV components and the conveyance of viral DNA to other lymphocytes was well known.

In Part (b) (ii), the viral DNA of Dengue does not become a permanent part of the host because the nuclear material does not enter the host cell nucleus, nor does it attack the immune system. Candidates lacked some precision in stating these facts, but the majority of candidates scored the single available mark.

The responses to Part (c) were below the required standard and tended to be vague. Candidates discussed the general views of cancer and why it develops, rather than relating the association with changes in DNA structure. Required answers included ionising radiation, which damages ions and bonds in cells, breaking DNA strands and causing mutations, UV light, the energy from which increases reactivity of DNA, causing bases to isomerise to more active forms, compromising accurate transcription and translation, DNA viruses which stimulate uncontrolled division of cells and chemicals such as tar in tobacco smoke which irritate cells in the bronchioles. Candidates needed to identify two causes and explain them both at the DNA level, in order to gain maximum credit.

Internal Assessment

General Comments

The overall quality of the Internal Assessment continues to improve, an indication that some of the teachers are doing excellent work, especially with coverage of the syllabus, using a range of activities and innovative approaches.

However, in a number of cases the practical/laboratory activities selected to teach the requisite skills to the candidates, and to make assessments, were sometimes inadequate. Further, the criteria used to evaluate performance were below the appropriate and recommended descriptors. This resulted in candidates being poorly prepared for the questions in the written papers which were based on practical experiences. .

In some cases, the coverage of the syllabus seemed incomplete. Teachers should continue to provide the students with handouts including practice questions to assist in completing the laboratory tasks as well as to explain the procedures. Further it is recommended that students be provided with sample mark schemes and rubrics to inform them of the expected quality of work.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2008**

**BIOLOGY
(REGION EXCLUDING TRINIDAD AND TOBAGO)**

BIOLOGY
(REGION EXCLUDING TRINIDAD AND TOBAGO)
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2008

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The modules in each Unit are:

Unit 1

- Module 1 - Cell and Molecular Biology
- Module 2 - Genetics, Variation and Natural Selection
- Module 3 - Reproductive Biology

Unit 2

- Bioenergetics
- Biosystems Maintenance
- Applications of Biology

This year, 1 725 candidates registered for the Unit I examination. The overall mean was 58.3 per cent and 93 per cent of the candidates achieved Grades I – V. There were 1 242 candidates registered for Unit II. The overall mean was 58.2 per cent and 95.3 per cent of the candidates achieved Grades I - V.

DETAILED COMMENTS

UNIT 1

PAPER 02

SECTION A

Module 1

Question 1

In Part (a), candidates were tested on a drawing of a dicotyledonous root, and required to identify the eight structures labelled. This was an easy introductory question, testing a practical skill, but candidates did not perform as well as expected.

In Part (b), many candidates did not distinguish between drawings of cells and plan diagrams of tissues. They were required to draw an outline of the areas of the tissues without giving details of the individual cell structure. Credit was given for (i) giving a plan diagram of the distribution of tissues, (ii) placing the diagram in the correct location in the rectangle, and in the correct proportions and (iii) giving the correct location and proportions of the xylem and phloem in the stele. Strong candidates read the question carefully and displayed the required skills, while others drew cell details, text book drawings or stem-like memorized sketches.

Part (c) tested calculation skills on magnification and candidates were asked for the actual width of the specimen from X1 - X2, given that the photograph had been magnified 100 times. Candidates should have measured X1 - X2, (11 cm or 111 mm), and divided it by the magnification (100), resulting in an actual size of 1.1 mm. Acceptable ranges in micrometres, millimetres or centimetres were credited.

In Part (d) (i), the electron microscope has a higher resolution than the light microscope and can distinguish between two points at higher magnification, producing a sharp image. With the light microscope the resolution does not increase as the magnification increases, so the image becomes bigger but blurred. Fifty per cent of candidates were unable to explain 'resolution' or 'resolving power' and it was often confused with magnification. The reason for a better resolution lies in the wavelength of light rays and electron wavelengths so that the separation capacity of the electron wavelengths between cell structures is much finer, narrower and more acute.

Part (d) (ii) which dealt with the advantages and limitations of the light microscope compared with an electron microscope, was well answered. Examples given with respect to the light microscope were: the specimens were quicker and easier to prepare; living cells and small animals can be observed without damage; stained specimens provide for colourful distinctions between tissues, and users need minimum skills. The limitations included the light microscope's resolution and its power of magnification. At least one advantage and one limitation were required, and the three points should have been clearly explained. A variety of minor issues was given for the advantages, and some were accepted, but technical and operational differences were expected, so that 'convenient carrying cases' and 'fitting on trolleys' showed failure to grasp the point.

Module 2

Question 2

In Parts (a) (i) and (ii), the genotype of the F1 plant is RrCc. The phenotype is pink because, as stated, R (red) and r (white) are co-dominant and the dominant allele for enzyme production 'C' is present, so that genotype colour can be expressed. Red, white and pink flower colour is a commonly used example to demonstrate co-dominance. In Part (c) (i) of the question, the fact that red, pink and white flower colour is a component of this question is made obvious. Approximately 25 per cent of the candidates were able to score full marks for correctly answering both the genotype and the colour.

In Parts (b) (i) to (iv), candidates were asked to consider the dihybrid genotype, RrCc in (a) (i) above and state the four allelic combinations in the gametes. They were RC, Rc, rC and rc. A satisfactory number of candidates gave the accurate answer, but many gave erroneous combinations such as RR CC rr or cc. This question was considered to be a very straightforward enquiry into the candidates' familiarity with basic genetics. It was assumed that all candidates would have been competent with this material.

In Part (c) (i), those candidates who were able to give the correct allelic combinations in the gametes in (b) above were able to score full marks in the Punnett square. In marking this part of the questions, a

maximum of two errors was allowed in completing the grid. However, there were several candidates who appeared not to understand the concept of the Punnett Square.

In Part (c) (ii), most of the candidates who got the correct genotypes, earlier, were able to determine the correct phenotypic ratios. Application of knowledge on co-dominance and epistasis was required and candidates needed to have read the introduction carefully. Whenever the alleles CC or Cc were present in the genotype, the enzymes were able to produce the pigment, be it RR (red), Rr (pink) or rr (no pigment, and therefore, white). Wherever the double recessive allelic combination for colour, 'cc' is present, the enzyme systems cannot be interpreted, a coloured pigment is not produced and the petals remain white.

In Part (d), the majority of candidates scored full or almost full marks. Occasional errors in calculation indicated that candidates either did not have the use of a calculator or were unaware that the square of a negative number gives a positive answer.

In Part (e) (i), almost all candidates scored the mark for stating that the degrees of freedom is 'the number of classes minus one'. However, in Part (e) (ii), it appeared that some candidates did not know how to interpret the Chi-Squared table. The 5 per cent probability should be read as 0.05 (bottom row of the table). They should follow that column vertically to its interception with the row labelled '1 Degree of Freedom'. The value is 3.84. The result obtained from the calculation, 0.25, is less than 3.84 and is therefore insignificant. Some candidates stated that 0.25 is less than 0.5 and erroneously gave this as the reason for insignificance.

In Part (e) (iii) the majority of candidates were able to explain that a large Chi-squared value of 7 would have been significant because it is greater than 3.84 and decreases the probability below 0.05, (5 per cent) to less than 1 per cent. The result would have been due to some other factors or bias and not to chance alone.

Module 3

Question 3

In Part (a) (i) candidates were asked to study Fig 3, showing the structure of the mammalian ovum and sperm, and to state four structural differences between them. Well-constructed sentence was required for each difference and not just a few words. The obvious answers included size, where candidates should have referred to the actual sizes given, or calculated the proportions, instead of just stating 'bigger' or 'smaller'. Such an answer fails to lift off information from the graphic and demonstrates limited initiative by the candidate. Other responses referred to the acrosome, the corona and zona, and the mitochondrion-filled middle piece and flagellate tail. The drawing of the sperm did not include the nucleolus nor cytoplasm.

In Part (a) (ii), concerning the ways in which the ovum and the sperm were suited to their respective functions, the streamlined shape of the sperm and the nutrient-filled cytoplasm of the ovum, the functions of the corona and zona in the egg and the acrosome and mitochondria in the sperm, were all cited. At least one point was required for each of the ovum and sperm. The majority of the candidates scored three of the four available marks.

In Part (b) the correct answer was that meiosis I has been completed with the production of the first polar body, and that meiosis II, which produces the second polar body and the actual ovum does not occur until after the sperm has entered the structure shown. Several candidates explained this meiotic sequence clearly and gained two marks. Credit was given for a reasonable effort, for example that the structure is

haploid; that it is presently unfertilized; that entry of the sperm leads to diploid zygote formation and sealing of the zona, and gained partial credit.

In Part (c) (i), when required to produce a graph, candidates must always provide the following: an appropriate title, the horizontal X axis with class intervals and identity, the vertical, variable Y axis, labelled similarly and the points plotted correctly. Four accessible marks were available for this routine question. Many candidates omitted the title and confused the X and Y axes and the labelling of axes was often incomplete. Since graphs are frequently tested in Paper 2, Section A, candidates need to prepare themselves well to enhance their scoring capacity.

In Part (c) (ii), the answer could be deduced from either the graph or Table 4. At the highest sperm velocity, 0.28 mm per sec, fewer sperm, 2.0 per cm^3 were needed to fertilize the ovum. Good candidates generally scored well on this section, while others found difficulty in observing the overall trend and instead stated that it fluctuated.

SECTION B

Module 1

Question 4

In Part (a), candidates needed to show the glucose and fructose molecules joined by a glycosidic bond. Very few candidates gained full marks, with the fructose molecule being the stumbling block.

In Part (b) (i), the answers to this section were vague. While the majority were able to identify water as being a polar molecule, there were inadequate references to the positively charged H^+ ions and the negatively charged OH^- ions. These charges interact with ionized solutes, salts and so on, and surround, separate and dissolve them.

In Part (b) (ii), the charges on the water molecule attract other water molecules and bond cohesively with them forming a surface layer under high tension which resists perforation or separation. The cohesion also permits capillarity in the narrow xylem tubes. Most candidates gained one mark for describing the surface film, but were unable to relate the charges to the cohesive property.

In Part (c) (i), the majority of the candidates gained full marks, indicating that this topic is well taught and understood. However, several candidates did not explain that the enzyme is the larger globular protein, (the lock), and the substrate is a smaller molecule, (the key). The small key should be visualized as entering the large (enzyme) lock at the keyhole, 'active site'.

Part (c) (ii), which tested competitive and non-competitive inhibition was also well done by the majority of the candidates. They gained marks for comparing their definition, sites of impact, differing effects on the active site, and the consequent effects on the operation of the enzyme, especially in relation to increasing substrate and the extent of reversibility.

Module 2

Question 5

The question tested the candidates' understanding of variation, directional and stabilising selection as well as genetic engineering.

In Part (a), two causes of variation in sexually produced organisms were required. Approximately 50 per cent of the candidates were able to identify as least one cause. Meiotic crossing over, random assortment of homologous chromosomes, gene or chromosome mutations and random fertilization were most common.

Part (a) (i) and (ii) which tested directional selection and stabilizing selection, required well-drawn graphs, good examples and clear explanations. However, graphs often lacked details or labels to point out the shift for directional selection, or the extremities which showed the phenotypes at a disadvantage, as seen in stabilising selection. Several directional examples: neck length in giraffes, industrial melanism in the Peppered Moth and antibiotic resistance in bacteria were acceptable. For stabilising selection, birth-weight in babies was useful. There were many unacceptable examples. Candidates should be familiar with the standard examples and not fabricate unlikely situations.

In Part (b), it must be emphasized that the details of the four key steps involved in producing a piece of recombinant gene are expected from all candidates at this level. The more able candidates gave details on the required steps, including the isolation, fragmentation, insertion and multiplication processes involved in producing the recombinant DNA section. Facts on the action of restriction enzymes that cut the DNA into fragments and the enzyme ligase which joins the ends of the two pieces of DNA were needed.

In Part (c), most candidates failed to discuss the major issues concerning the application of genetic engineering. Single words such as 'moral', 'social', 'ethical' and 'religious' were frequently listed with little or no explanation or development of the point. Issues relating to human and environmental safety, animal ethics, human cloning and cost of treatment issues were most commonly cited.

Module 3

Question 6

In Part (a), many candidates focused on the structural aspect of the female reproductive system rather than discussing the biological basis for the two methods of contraception: rhythm and contraceptive pill. They did not apply their knowledge to answer the specific question, but instead presented what they knew about the structure of the organs in the hope of gaining marks.

In Part (a) (i), for the rhythm method, candidates should have referred to the 28 day menstrual cycle and pointed out that ovulation occurs at mid-cycle, (approximately the 14th day). By monitoring the cycles over several months, the date of ovulation can be predicted. Since the ovum will be in the Fallopian tube at Day 14, intercourse at that time can be avoided. Such avoidance should occur three days before ovulation (to prevent active sperms being present in the oviduct prior to ovulation, or to counteract early ovulation), and three days after ovulation, since the ovum is viable for three days, and could be fertilized by sperm deposited on Day 17. Most candidates suggested avoidance between Days 12 to 16 of the cycle, but did not give adequate reasons. A number confused the rhythm method with withdrawal. However, the question was answered quite well by the majority of the candidates.

In Part (a) (ii) for the contraceptive pill, candidates were expected to state any of the following options: the contraceptive pill contains oestrogen and/or progesterone, that FSH action is modified, that Graafian follicle development is arrested, ovulation does not occur or that the ovule is not available for ovulation. A few candidates mentioned the progesterone pill ('pop'), and described its biological basis accurately. Almost all of the candidates stated that without the ovum, effective contraception due to non-fertilization, occurred.

In Part (b), most candidates responded well and met the expected requirements. The expected response was an explanation of the role of the placenta as a guardian for the developing foetus by describing it as firstly a physical barrier, preventing direct maternal/foetal blood exchange, and as a blood pressure reducer. As a chemical barrier, controlled trans-placental transport should have been mentioned, for example, restriction of larger protein molecules, hormones and most harmful pathogens. Selective absorption by active transport or facilitated diffusion by placental membranes also exert control against harmful substances passing to the foetus. The removal of waste and provision of oxygen and food also qualify its role as a guardian.

Several candidates referred to the amnion instead of the placenta. Where the term, 'protection of the foetus by the placenta' was given, it was accepted, provided such protection related to the physiological and chemical barrier functions against toxins and pressure and not physical protection, which is the role of the amniotic cavity and its fluid.

Part (d) tested the candidates' knowledge of how cross fertilization is promoted. Several candidates dwelt on cross and self pollination, which is mentioned in the explanatory notes to this objective. A small percentage of the candidates mentioned that genetic variation and an enriched gene pool result from cross fertilization, and that reduced variation or inbreeding result from self-fertilization. The retention of a valuable genotype through self-fertilization and the chance of receiving unfavourable alleles through cross fertilization was mentioned. The reliability of self pollination and the wastefulness of cross pollination were also good answers. However, this section did not produce good scores because most candidates failed to relate plant sexual reproduction to genetics and variation.

UNIT 2

PAPER 02

SECTION A

Module 1

Question 1

In Part (a) responses to this question did not reflect the expected standard. However, the majority of candidates were able to achieve more than half of the available marks. A small percentage of candidates scored full marks. Candidates should apply their knowledge of the principles of operation of a simple respirometer to the apparatus shown. Good responses should have clarified that the apparatus must be airtight, the initial and final levels must be noted, the use of the calibrated scale is essential, organisms should respire for a set period of time, Tube B is a control and that the filter paper soaked with potassium hydroxide absorbs carbon dioxide more efficiently.

Part (b) (i) was poorly answered. The expected response was to use glass beads, boiled peas or other non-living material as a control. Some candidates had difficulty differentiating a controlled variable from a control for the experiment.

In Part (b) (ii) about 60 per cent of the candidates were able to score at least 3 of the 4 marks. Most were able to get the X and Y axes correct, the independent and dependant variables respectively. Appropriate class intervals and a good, descriptive title were needed. Definite marks, small circles or x's should be used to plot the points.

Part (b) (iii) was quite well done but some candidates did not identify the units and lost a mark. The expected answer was at 10°C – 0.33cm³/min and at 25°C – 0.72cm³/min.

In Part (b) (iv) (a) for one mark the answer was 1- + 25°. The majority did well with the following response: the rate of oxygen uptake increases with an increase in temperature.

In Part (b) (iv) (b) for one mark the expected response was ‘germinating seeds have a higher rate of respiration than non-germinating seeds’. The majority of candidates did well.

Module 2

Question 2

In Part (a) (i), almost all candidates were able to read the bar graph and record the figures in the table to attain the two marks. Consistency was necessary when selecting the length to measure, that is candidates should have measured from the base to the top of the column for each column. Although the cells of the table were filled in correctly, candidates had difficulty with the calculation of the percentages.

In Part (a) (ii), the candidates were asked to determine the difference between the diameter of the trunk of the tree and the shallow roots and to account for the difference. Few candidates gave a good response, that is, that the shallow roots were surrounded by soil water at a higher water potential, causing water influx, and that the large volume of water available to be conducted upwards was associated with the wide lumen of the vessels. Concerning the trunk xylem, candidates failed to explain that there was less water volume and a greater transpiration pull, causing a deficit or ‘suction’ on the water column resulting in narrower vessels being produced by the plant in order to overcome cavitation. Many of the answers indicated misconceptions concerning pressure relationships in these areas, with ‘pressure’ being applied to the trunk, instead of ‘tension’.

In Part (a) (iii), two factors other than transpiration pull were required to account for water movement up the xylem. Popular answers were capillarity, cohesion-tension theory or root pressure. Some candidates erroneously quoted factors which affect the transpiration pull, such as humidity and light.

In Part (b) (i), candidates performed only moderately at identifying the three main types of tissues shown as xylem, cambium and phloem.

In Part (b) (ii), candidates were given instructions to draw the four cells with an ‘X’ in them, and all the cells between them at a magnification of x2. The answers showed that candidates require much more instruction in drawing plant cells. Many candidates drew the cells floating apart from each other, or in a line. Only a few candidates produced adequate drawings.

Part (c) (i), which required the identification of all three structures - the sieve plate, the companion cell and the sieve tube, (or vacuole, lumen, phloem tube) proved challenging for the majority of candidates.

In Part (c) (ii), a number of candidates gained two out of the three allotted marks for accurately relating each structure to its function. Responses included the existence of the plate, as a modified end wall is to support the living tube, the sieve plate facilitates transport of food, bypassing active transport, and reducing ATP expenditure and membrane pumps, permitting ‘mass flow’. Candidates should be thoroughly familiar with the extensive functions of the companion cells, and use them to their advantage to gain maximum marks. These features should not just be listed, but their functions carefully described, as requested.

Module 3Question 3

Part (a) was well done with most candidates earning at least two of the six marks for their graph. Almost all of the candidates had the points correctly plotted.

In Part (b), more than 90 per cent of the candidates performed satisfactorily, but many focused their attention on previous knowledge of obesity and fast food outlets instead of using the data that were presented to them in the Table and the completed graph. Some candidates indicated a percentage overall increase whereas they should have noted the increase over the time specified in the question. Other candidates did not refer to the data in thousands or millions as specified and many candidates did not give the year of the data they were referring to. Candidates need to know how to use facts, get the descriptors correct and produce sentences comparing two descriptors, two or three magnitudes and a sequence of times, to prove a point.

In Part (c), while many candidates performed below the required standard, there were some with perfect responses. Following the existing points of their plot, they were able to show that the increase in prevalence of obesity exceeds the comparative increase in fast food outlets. This indicates that fast food outlets are not the sole cause of obesity, since obesity is outpacing them. The better candidates furnished excellent responses.

In Part (d), the candidates were required to explain the factors which caused obesity, other than the availability of new fast food outlets. Some of the most popular answers were: lack of exercise, modern convenient transport, overeating and gluttony, stress and genetic predisposition. Lists were not accepted since discussion and explanations were required. There were some inaccuracies about diabetes causing obesity, but in general candidates wrote well.

SECTION B**Module 1**Question 4

In Part (a), candidates were expected to provide at least two structural points and explain how these structures enabled the thylakoids to carry out their function. Structural points included the thylakoids are fluid-filled, disc-like structures with a very large surface area offered by there being thousands of thylakoids (arranged in grana) in each chloroplast, and the fluid inside the discs is separated from the external stroma by the membranes; the membrane contains phospholipids and proteins which hold ATP-ase enzymes, NADP carriers, pigments (chlorophyll) and photosystems. Other relevant structural features were also accepted.

Two functional marks would include that the pigments are held in place to facilitate efficient interaction and electron flows; the separation of the fluid inside the thylakoids from that of the stroma creates a system of H⁺ gradients involving NADP and ATP.

The weaker candidates failed to relate structure to function. Many candidates stated that the thylakoids were located in the mitochondria. Quite a few of the candidates who provided a function, stated involvement in light-dependent reactions.

In Part (b), candidates were required to identify and explain the pathway of an electron within Photosystem I to show how an electron is incorporated into NADP. Approximately half of the candidates showed reasonable competence by referring to the electron acceptor ferredoxin and the existence of the hydrogen ions from the photolysis of water. To gain maximum marks, candidates needed

to make clear, sequential points, such as incident light at 700 nm excites electrons in PS I and an electron is accepted by ferredoxin, which it reduces, on oxidation ferredoxin transfers the electron to NADP, hydrogen ions (protons) from the photolysis of water combine with the electron to form a hydrogen atom which reduces NADP to NADPH.

The weaker candidates failed to show how the H^+ is incorporated into the NADP, and neglected to explain that the incident light at 700 nm excited the PS I electron. Several candidates wrote about the Calvin Cycle, again confusing chloroplasts and mitochondria.

Part (c), which tested ecological pyramids posed problems for most candidates who were unable to provide an adequate description, that is, a diagrammatic or quantitative depiction to summarize the path of energy flow and nutrient cycling within a community or feeding chain, to represent feeding relationships or trophic levels. Any appropriate explanation was evaluated for mark-worthiness, but only a moderate number of candidates gained marks. A common misconception was reference to food webs. However, most candidates were able to identify pyramids of numbers, biomass and energy.

Part (d) was well done by all candidates and posed few challenges. Some responses were excellent and referred to solar energy entrapment by autotrophs/primary producers and its conversion by herbivores, (primary consumers), and secondary consumers. The decrease in the transfer of energy at each level was well described.

Module 2

Question 5

In Part (a), most candidates were able to obtain at least half of the marks. However, too many candidates listed the structural features of red blood cells without accurately describing how they enhanced the uptake of oxygen. For instance, the absence of a nucleus creates an opportunity for more space to carry 250 million molecules of haemoglobin. At this level, candidates should be able to give an appropriate description of the biconcave shape of the RBC and desist from using the term 'donut-shaped'. Most texts clearly explain the many ways in which the red cells are adapted to carry out their oxygen-carrying function efficiently. A number of candidates were unable to relate haemoglobin's structure to its function. Candidates were confused between the number of molecules that can be carried by one haem group and one molecule of haemoglobin.

In Part (b), the majority of the candidates were unable to gain more than half of the allotted marks. Instead of explaining the Bohr effect, several described the dissociation curve of oxyhaemoglobin, while others displayed a lack of understanding of the concept of the Bohr effect, stating that the dissociation curve shifted to the left during high partial pressure of carbon dioxide. Only a few candidates gave a thorough explanation by mentioning that carbon dioxide combines with water to form carbonic acid. This, on dissociation produces H^+ ions which combine with haemoglobin, displacing the oxygen, which is then released to the tissues. However, most of the candidates were able to state that during high partial pressures of carbon dioxide, oxygen was more readily released to the cells.

In Part (c), candidates had a good understanding of the concept of blood glucose regulation and many scored well in this section. There were some who lost marks for the following reasons: (i) explaining the increasing blood glucose levels but not the decreasing levels; (ii) failure to mention the feedback inhibition (check) of insulin and glucagon once a steady state was reached; (iii) confusion between glucagon and glycogen and (iv) erroneously stating that the hormones are released from the liver and are controlled by antidiuretic hormone. Candidates should understand and use correct terms for anabolic and catabolic reactions. Too many made mention of the 'breakdown' of glycogen to glucose.

Module 3

Question 6

This question was, in general, poorly done. Few candidates attempted to provide detail in their answers and Parts (c) and (d) were answered mainly in point format.

In Part (a), the more competent candidates scored full marks for a labelled diagram of an antibody molecule. However, many drawings were below the required standard, with incomplete labels and few annotations. Several candidates gave sketches without labels or failed to respond to this section.

In Part (b), many candidates wrote all they knew about B and T cells without really interpreting the question, which referred to 'mature' cells. The maturation processes were not required. Few candidates gave clear distinctions between the roles of B or T cells in humoral or cell-mediated responses to antigen exposure, which was the focus of the question. Frequently the roles were confused and typically candidates linked the T cells to phagocytosis.

In Part (c), the candidates showed that they were not familiar with the critical differences between physical and psychological drug dependence. They needed to address the fact that drug dependence refers to an uncontrollable addiction to a chemical substance, despite the potential for bodily harm; physical dependence is characterized by withdrawal symptoms of a physical nature, nausea, sweating, headaches or loss of balance when the drug is suddenly discontinued; psychological dependence affects behaviour, the yearning for the comfort of a habit, expectation of euphoria, especially following deprivation, with compulsive strategies towards acquisition which may involve lack of reason, confusion or delusion.

In Part (d), liver damage from long-term excessive alcohol consumption includes fatty liver due to deposits of fat in the liver tissue; alcoholic hepatitis, involving inflammation and destruction of tissues; alcoholic cirrhosis, characterized by the replacement of normal hepatocytes and fibrosis, which distorts the internal structure and impedes blood and bile flow. Many candidates, instead of focusing on the liver, substituted information on the effect of alcohol on the heart and blood vessels.

Internal Assessment

General Comments

The overall quality of the Internal Assessment continues to improve, an indication that some of the teachers are doing excellent work, especially with coverage of the syllabus, using a range of activities and innovative approaches.

However, in a number of cases the practical/laboratory activities selected to teach the requisite skills to the candidates, and to make assessments, were sometimes inadequate. Further, the criteria used to evaluate performance were below the appropriate and recommended descriptors. This resulted in candidates being poorly prepared for the questions in the written papers which were based on practical experiences.

In some cases, the coverage of the syllabus seemed incomplete. Teachers should continue to provide the students with handouts including practice questions to assist in completing the laboratory tasks as well as to explain the procedures. Further it is recommended that students be provided with sample mark schemes and rubrics to inform them of the expected quality of work.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2009**

BIOLOGY

BIOLOGY**CARIBBEAN ADVANCED PROFICIENCY EXAMINATION****MAY/JUNE 2009****GENERAL COMMENTS**

The CAPE Biology examination comprises Paper 01, a multiple choice paper consisting of 45 items, 15 from each of the three modules; Paper 02, consisting of six questions and Paper 032, the alternative paper for candidates who do not register for the Internal Assessment. Paper 02 is divided into two sections – Section A and Section B. There are three compulsory structured questions in Section A, one testing each module and three essay questions in Section B, one testing each module. Each question on Paper 02 is worth 15 marks. Paper 032 was offered for the first time this year, to the out-of-school candidate population.

The modules in each Unit are:

Unit 1

- Module 1 - Cell and Molecular Biology
- Module 2 - Genetics, Variation and Natural Selection
- Module 3 - Reproductive Biology

Unit 2

- Module 1 - Bioenergetics
- Module 2 - Biosystems Maintenance
- Module 3 - Applications of Biology

UNIT 1**Paper 02****Section A****Module 1 - Structured Items**Question 1

Part (a) (i) was challenging. However, most candidates were able to identify structures (A) and (D) as the cell membrane and nucleus/nucleolus respectively. Candidates were also credited for identifying (B) as either centrioles or glycogen granules and (C) as mitochondria.

For Part (a) (ii), candidates were required to name a structure that is present in an animal cell and not in a plant cell. Correct responses were centrioles and glycogen granules.

For Part (a) (iii) of the question, in order to gain full marks, candidates were expected to give responses of the smooth endoplasmic reticulum and Golgi apparatus as the two structures that work together to make lipids available to the cell. Some candidates lost marks for failing to correctly identify both of the structures.

In Part (a) (iv), very few candidates gained full marks. Most of the candidates knew that smooth endoplasmic reticulum was responsible for lipid synthesis followed by processing and packaging in the

Golgi body. However, candidates did not clearly state that the lipoproteins finally bud off as Golgi vesicles to complete the delivery process.

In Part (b) (i), most candidates were able to gain full marks. Candidates need to be reminded that basic mathematical skills are required for plotting graphs. Some candidates did not know which variable should be the x-axis and which the y-axis.

In Part (b) (ii), candidates were required to explain the shape of the curve. A few candidates failed to answer the question since they limited their responses to describing the shape of the curve. The correct response was the link between the effect of kinetic energy on molecules and temperature. Many candidates failed to mention that denaturation occurs only above the optimum temperature for activity of the enzyme.

In Part (b) (iii), approximately 80 per cent of the candidates scored full marks for stating factors that affect enzyme activity such as enzyme or substrate concentration.

Module 2

Question 2

In Part (a) (i), more than 50 per cent of the candidates obtained one mark for stating the term ‘epistasis’; however, it was often incorrectly spelt. Many did not obtain full marks for the explanation. A simple statement about one gene at one locus inhibiting a gene at another locus would have been awarded the marks.

Part (a) (ii) was fairly well done with most candidates gaining full marks for the ratio 9:3:4 for black to brown to white. Many candidates correctly matched the genotypes with the colours. To obtain full marks, candidates also needed to match ratios to colours.

In Part (b) (i), approximately 75 per cent of the candidates gained full marks. They correctly identified the stages of Meiosis 1 as Prophase, Metaphase and Anaphase.

In Part (b) (ii), most candidates obtained full marks by describing the changes that occur at Telophase 1.

In Part (b) (iii), at least 60 per cent of the candidates earned one of the two marks allotted. The most popular answers were chiasmata formation and crossing over between homologous chromosomes involving exchange of genetic material that contributed to heritable variation.

Module 3

Question 3

For Part (a) (i) of the question, candidates were required to define the terms ‘sexual reproduction’ and ‘vegetative propagation’. At least 60 per cent of the candidates scored full marks. Some good responses included ‘one organism only, one parent only, no gametes used and no fusion of gametes’. It was necessary to state that vegetative propagation referred to plants only.

In Part (a) (ii) of the question, candidates were required to state one characteristic of the tissue of structures, such as corms, that facilitate the function of vegetative propagation. The majority of the candidates provided good responses, such as, ‘the structure contained meristematic tissue, or undifferentiated tissue, were totipotent or were mitotic’.

In Part (a) (iii), most candidates answered the question correctly. Other functions carried out by bulbs, tubers and corms include (food) storage and perennation. Tissue culture and genetic engineering were not accepted as answers.

Part (b) (i) of the question required the candidates to describe the four main features of the unlabelled pollen grain shown in the diagram. Candidates were expected to choose from exine, intine, pits, (large) generative nucleus and (smaller) tube nucleus. This proved to be challenging, as many candidates identified structural features of somatic cells.

For Part (b) (ii), candidates were required to draw and label the pollen grain at the end of germination. Only about 40 per cent of the candidates produced a labelled diagram of the required standard to earn the maximum three marks. It was expected that the drawings would show a long pollen tube with three nuclei near its tip; these structures would be labelled. Some candidates redrew the mature pollen grain provided in (b) (i) and labelled it.

For Part (b) (iii) of the question, candidates were asked to state one major change that occurs when a pollen grain germinates and to state its significance. Only about 30 per cent of the candidates answered correctly. Responses expected included that the pollen tube grew out to allow the nuclei to enter the ovule; the generative nucleus divides into two nuclei that will contribute to the zygote and endosperm formation. Some candidates explained the process of germination of seeds.

Part (c) of the question posed a great deal of difficulty for the candidates. The majority failed to clearly outline the role of the stigma in fertilization. Candidates were expected to state that the stigma produces sucrose which leads to the germination of the pollen grain and the production of the pollen tube. The sucrose also prevents the bursting of the pollen tube. The release of factors that prevent germination of incompatible pollen grains could also have been mentioned. Instead, many candidates wrote detailed accounts of pollination and germination.

Section B - Essays

Module 1

Question 4

For Part (a) (i), although candidates were required to use a simple diagram to describe the structure of phospholipids, and a detailed chemical formula was not required, many candidates still drew the detailed structure. However, they were not penalized for so doing. A simple diagram with a single polar (hydrophilic) head and two non-polar (hydrophobic) fatty acid tails, or even a polar head with a phosphate group attached to the glycerol was appropriate.

In Part (a) (ii), candidates did not emphasise the properties of the phospholipid (hydrophilic and hydrophobic) portions to explain why lipids are arranged as a bi-layer in the plasma membrane. Instead, they concentrated on the membrane and the movement of substances across it. A few candidates mentioned the hydrophobic interactions between the tails of the phospholipid molecules which hid in the interior of the membrane.

In Part (b) (i), most of the candidates scored at least 50 per cent of the marks. Many candidates did not contrast osmosis with endocytosis. Instead they gave definitions or descriptive statements of each. When explaining osmosis, candidates used terms such as molecules, particles and solvents instead of water and frequently mentioned the obsolete term 'semi-permeable' rather than 'selectively permeable' membrane. Good responses included that during osmosis only the movement of water occurs, while endocytosis involves the movement of larger particles. Osmosis requires a concentration gradient for movement of water to take place while endocytosis does not require such a gradient. Finally, osmosis, unlike endocytosis, can take place in both directions across a membrane and is passive, not active.

In Part (b) (ii), few candidates provided two examples of the use of endocytosis for the uptake of nutrients in animal systems. Acceptable answers include feeding in *Amoeba*, phagocytosis by white blood cells and the uptake of nutrients by human egg cells from the follicle cells. A large number of candidates appeared to misunderstand the use of the phrase 'in animal systems.' They seem to have

interpreted this to mean ‘in humans’ and consequently neglected to mention organisms like *Amoeba* and other protists.

Module 2

Question 5

Part (a) (i) was relatively well done by the candidates. However, many of them did not identify the ‘vector’ as the carrier of the DNA and the ‘recipient’ as the cell accepting the DNA of the donor during genetic engineering. A common error was to describe the vector and recipient in relation to diseases such as malaria.

In Part (a) (ii) of the question, candidates were asked to discuss the role of *E. coli* as a vector and recipient in the production of insulin, utilizing genetic engineering; this part of the question was not well done. Responses should have included that as a vector, *E. coli* cells are broken, the plasmid DNA is extracted by centrifugation and the gene/cDNA for insulin is then inserted. As a recipient, *E. coli* picks up the plasmid from a solution containing calcium ions and is then cloned to make several copies of the gene.

In Part (b) (i), candidates’ scores were better, as they described the structure of RNA as being made up of a polynucleotide strand with pentose sugars, phosphoric acid and organic bases. Some confused the term polynucleotide with polypeptide. Differences in the structure of DNA and RNA were well known; however, candidates were not given full marks for a comparison when the structural feature was provided for one nucleic acid without the corresponding feature for the other nucleic acid, for example, ribose but not deoxyribose.

In Part (b) (ii), more than 80 per cent of the candidates gained full marks. Candidates had knowledge about protein synthesis but were not always clear about the different roles played by DNA, mRNA, tRNA and rRNA. Mention of the role of all four of these molecules was necessary for the award of full marks. Some candidates also confused the terms, DNA replication, transcription and translation.

Module 3

Question 6

Part (a) of the question was poorly done. The majority of candidates explained the functions of the five main regions which make up the human female reproductive system; they were expected to describe their structure. Good responses from some candidates included that the fallopian tube is a narrow tube-like structure with cilia; the uterus is a pear-shaped muscular organ; and the cervix is a narrow tube with a ring of muscles.

In Part (b), candidates were required to demonstrate that they understood that despite some similarities between the male and female reproductive systems, there are ways in which the female system is unique. About 75 per cent of the candidates obtained at least three of the four marks that were allotted to this section. An example of a good response was that the uterus facilitates internal fertilization and houses the developing embryo.

Part (c) of the question was well done, as approximately 75 per cent of the candidates scored at least five of the six marks allotted. Some responses were exceptionally good. However, about 10 per cent could not apply their understanding of negative feedback mechanisms to explain the role of hormones in the menstrual cycle. Full marks were also awarded for detailed diagrammatic representations. Good responses included that FSH stimulates growth of follicles in the ovary; LH results in follicle maturation, and release and development of the corpus luteum.

UNIT 2**Paper 02****Section A****Module 1 - Structured Items**Question 1

Part (a), which tested understanding of some aspects of practical work, was most challenging for the candidates and few scored full marks. Many candidates were unable to make the distinction between photosynthesis and respiration and incorrectly stated that CO₂ was used as opposed to being produced by the seeds. Candidates should be reminded that a control is for comparison and the tube with the beads was used for compensation for any atmospheric changes. A common misconception was that KOH gives off CO₂.

In Part (b), a few candidates inaccurately stated that the apparatus could be modified to determine the effect of temperature on oxygen uptake by removing the syringe or the capillary tube and replacing it with a thermometer, since the apparatus for this investigation had to be a closed system. Answers such as refrigerators, air conditioners and light/ bulbs were not accepted. Approximately 80 per cent of the candidates provided good responses, such as, placing the apparatus in a water-bath or conducting the experiment at different temperatures.

Part (c) (i) of the question tested candidates' knowledge of the Krebs's Cycle; it was well done. About 80 per cent of the candidates scored at least three of the five marks for correctly indicating where decarboxylation and dehydrogenation reactions occur in the cycle and preceding reactions. Some candidates lost the marks for not placing the letters on/near the lines connecting the two compounds but beside the compounds in the boxes.

Part (c) (ii) was well done and good candidates correctly identified the matrix of the mitochondria as a site of Krebs's Cycle.

In Part (c) (iii), most candidates were awarded the two marks for explaining the role of NAD in the Krebs's Cycle in relation to energy production. Candidates knew that NAD is a carrier/acceptor of hydrogen ions/electrons; it is reduced to form NADH₂ that will eventually generate ATP/energy.

Module 2Question 2

Part (a) of this question tested candidates' knowledge of the structural features of the xylem vessel. The majority of the candidates were able to provide excellent responses such as narrow, hollow or elongated tubes with pits, lignified walls or cells fused end to end with perforated end walls.

In Part (b) of the question, candidates were required to explain three functions associated with the features identified in (a) above. Candidates provided a wide range of good responses, such as, the pits aid in lateral flow of water, lignified walls provide mechanical support, and narrow tubes aid in capillary action. However, weaker candidates incorrectly wrote detailed accounts of the sieve tube and the apoplast, and symplast pathway, consequently losing the marks.

Part (c) (i) of this question was challenging; many candidates failed to identify four tissues from the cross-section of a mammalian artery. Stronger candidates provided appropriate responses which included: (A) Blood, (B) Tunica media/adventitia, smooth muscles or elastic muscle, (C) Tunica intima/elastic tissue/middle coat, (D) Tunica externa/ collagen fibres/ outer coat.

Part (c) (ii) of this question required candidates to make a plan diagram and to show the distribution of the tissues of the artery; it was well done by a majority of the candidates. They were awarded marks for accurate magnification, both (width and length), correct proportions, major tissues identified and an appropriate title. *Titles must include the view (T.S, L.S), what is drawn and the magnification. It should be written in capital letters, underlined and placed at the base of the diagram.*

Module 3

Question 3

For Part (a) (i) of the question, candidates were provided with data on the use of psychoactive substances by males and females and asked to per cent it as a bar chart. About 95 per cent of the candidates scored the three marks for this section. Candidates accurately placed the bars for females next to the bars for males (that is, touching) and also used the key to identify these bars.

Part (a) (ii) was very well done. Candidates were able to describe three trends seen in the data. Competent candidates gave accurate responses such as:

- More males than females use these substances.
- The greatest use by both males and females is of alcohol followed by tobacco.
- Many persons used more than one substance.
- The only psychoactive substance that is used more by females than males is tranquilizers.

For Part (b) (i), many candidates scored two of the four marks awarded for the question, which solicited information on the effects of consistent use of alcohol on the liver. A brief mention of fatty liver, hepatitis, cirrhosis and cancer impaired function of the liver was awarded marks. Good candidates gained the full four marks by explaining two of these stages of liver deterioration. The link between alcohol consumption and the progressive harmful effects of the resulting diseases was rarely mentioned.

Part (b) (ii), which focused on the effects of consistent use of alcohol during pregnancy on the foetus, was very well done, as was reflected by approximately 90 per cent of the candidates getting the mark. Popular answers included foetal alcohol syndrome, mental retardation/mental disorder, small brain, deformed foetus and foetal abnormalities.

Part (c) of the question sought to ascertain whether candidates understood what additional data needed to be collected before it could be stated that the use of a particular psychoactive substance presented a health or social risk. Many candidates scored four marks in this section. Candidates were able to mention quantity/ frequency of the drug used and correlated this with the drug users' medical records to gain marks. Collection and correlation with data on relevant social problems, such as, abuse and unemployment was a popular answer.

Section B - Essays

Module 1

Question 4

Overall this question was well done. For Part (a), an appropriate definition illustrated by an example was sufficient to gain full marks. Good responses described the ecosystem as a biotic community and its abiotic environment, for example, the frogs, fishes and plants and the pond water in which they live. The ecological niche is simply the role played by each biotic component in the ecosystem, for instance, what it feeds on.

Part (b) was fairly well done. Good candidates were able to explain why energy is said to flow through the ecosystem rather than cycle. The answers were variations of ‘the energy constantly enters the ecosystem as solar radiation which plants absorb to make food that animal eat, and then drains away as respiratory losses. The movement is linear and less and less energy is available at each trophic level as energy is continuously lost’.

Part (c) (i) was very well done by most candidates. They were able to explain the term ‘in situ’ as the natural environment, for example, natural parks and protected areas and ‘ex-situ’ as specially prepared environments, such as, zoos, botanical gardens and seed banks. A few candidates gave incorrect examples for the two terms.

Part (c) (ii), was answered very well and most candidates were able to score full marks. However, some misunderstood the word “challenges” and gave reasons for maintaining biodiversity. Some good examples included the need to avoid inbreeding, transport of stock for breeding would be expensive, overcrowding due to long life or that lessons learnt in the wild cannot be learnt in captivity. Some candidates clearly did not understand the concept of maintaining biodiversity and confused it with variation.

Module 2

Question 5

Part (a) (i) of the question, which tested candidates’ knowledge of how hormones contribute to the maintenance of a fairly constant internal environment, was fairly well done. Approximately 70 per cent of the candidates were able to score three or four marks out of the five marks allocated. Good responses clearly explained terms like detector/receptor and effectors and included, in a logical sequence, the role of hormones in regulating the negative feedback mechanism. Most candidates who performed well in this question used the regulation of glucose concentration in the blood to illustrate their points. However, some candidates were more focused on explaining the term homeostasis than explaining the role of hormones in maintaining homeostasis and so lost marks.

Part (a) (ii) of the question inadvertently tested candidates’ knowledge outside the syllabus and so posed a problem to most of them. They were asked to suggest two ways, other than speeding up of the ripening of fruits, in which ethane plays a regulatory role in plants. A number of extra points were added to the mark scheme, so that the majority of the candidates obtained at least one out of the two marks allotted for this section. However, some candidates were able to produce the expected responses, like promotes growth, respiration, and abscission of fruits and leaves.

Part (b) (i) of the question was not well done, as candidates failed to define the terms ‘ultrafiltration’ and ‘selective reabsorption’ using the key words. Expected definitions were “ultrafiltration is the movement of substances out of the capillaries (glomerulus) into the Bowman’s capsule under high pressure; selective reabsorption is the movement of useful materials from the glomerular filtrate back into the blood”.

Part (ii) was the best done part of the question. Candidates were required to discuss, with reference to three structural features, how the proximal convoluted tubule is ideally suited to carrying out selective reabsorption. About 70 per cent of the candidates were able to gain four to five marks. Good responses included microvilli to increase surface area; rich supply of blood capillaries to provide quick reabsorption/diffusion of useful materials from the glomerular filtrate; and thin, partially permeable membrane to facilitate easy diffusion. However, the use of semi-permeable membrane instead of selectively/partially permeable was not accepted.

Module 3

Question 6

Part (a) (i) was well done except that a few candidates only outlined the symptoms of diabetes rather than discuss the key features of the disease. Some expected responses included a chronic, metabolic disease, characterized by high blood glucose levels (hyperglycemia), resulting from defects in insulin secretion by the pancreas, or that the body could not use the insulin produced efficiently.

Part (a) (ii) was also well done. Candidates were able to list the factors that contribute to the increase in diabetes in the Caribbean. However, they were unable to clearly explain how these factors contributed to the disease and hence could not gain the full four marks.

Part (b) was also well done. Some candidates stated that natural (even in relation to immunity) meant something with which you are born instead of stating that it was acquired naturally, for example, by exposure to infectious agents or from colostrum in mother's milk. Most of the candidates were able to accurately explain artificial immunity as being achieved by vaccination/injection of attenuated antigens or antibodies.

In Part (c), approximately 90 per cent of the responses were excellent. Many candidates stated that monoclonal antibodies are produced by a single clone of B-cells. Sometimes the definition was not concise but very descriptive and often the key term, B-cell, was omitted. The benefits of monoclonal antibodies include rapid, specific or accurate diagnosis, early detection of cancers and the ability to distinguish closely related pathogens. Occasionally candidates described the treatment rather than the diagnosis of the disease and mentioned organ transplant and early pregnancy testing which are not considered diseases.

Internal Assessment

Overall the quality of the candidates' practical/ laboratory assignments has improved noticeably since 2008. Several of the teachers at the centers are ensuring that a high standard is maintained by their students as it relates to their Internal Assessments. The improvements seen were in the generally weaker areas of *drawing* and *planning and design*.

However, despite this pleasing trend, there were still some cases where the laboratory exercises used were inappropriate for the skill(s) being assessed.

It is suggested that workshops be held in the territories and internal standardization of teachers responsible for practical activities at a given center, be implemented, as this is pivotal in ensuring that candidates are provided with all the necessary tools to produce work of a high quality.

A reminder to teachers is that each experiment should be assessed for only two skills at any given time. A pair of laboratory practical exercises can be used to provide the average score for each skill. Despite this, teachers still have to reinforce the standards expected by practising and presenting several other experiments in each area (AI, DR, P&D, ORR and MM).

Finally, the mark awarded for the assignment must be clearly shown and presented out of a score of 16.

Drawing

There is still great concern in this area of assessment. Some teachers have allowed students to submit textbook drawings as theirs. It is important that students provide true representations of specimen/ slides with which they are provided. Reproductions of drawings in textbooks are not appropriate for assessment of drawing skills.

An assessment of the drawing needs to include:

- Clarity of drawing.
- A selection of cells that is truly representative of the section being viewed.
- A low power plan of the tissues and high power details of a FEW representative cells should be done for each specimen. There is no need to attempt to draw all the cells seen.
- Faithfulness and accuracy in recording the drawing.
- Correct proportions of all components of the specimen is pivotal.
- Title must be placed at the base of the drawing, in uppercase and underlined.
- The view must be stated in the title, where applicable, for example L.S (Longitudinal Section) / Whole Mount.
- Neat placement of labels and annotations.
- Justification of labels to the left, right or evenly distributed on either side of the drawing is expected.
- Magnifications must be calculated and all working shown. The correct size of the specimen needs to be used in the calculation.

Insistence on these areas will afford candidates the opportunity to score highly in this area of internal assessment.

Analysis and Interpretation

Areas for immediate improvement highlighted by Examiners for 2010:

1. Adequate inclusion of background information.
2. Deducing trends and relationships from data collected.
3. Presenting concise explanations of the observed trends and relationships.
4. Understanding the relationship between data obtained and the original aim/ hypothesis of the experiment.
5. Formulation of a conclusion that summarizes the findings from observations and data [with reference to the link between data collected and the aim] is essential. Generally, conclusions were of poor quality because the aim of the experiment was poorly crafted to begin with.

Planning and Design

The major challenge still remains where teachers are not encouraging their students to refrain from the use of textbook laboratory activities. Students need to be encouraged to use original approaches and concepts, as they seek to formulate their hypotheses and plan their procedures.

Over the years, students have found this skill to be somewhat challenging. However, with continuous reinforcement of criteria, students will be able to grasp these concepts:

- Hypotheses need to be logical and testable.
- Aims must be concise and clearly stated, and relate to the hypothesis.
- A complete list of all materials and apparatus to be used must be stated. Items critical to the execution of the proposed method should not be omitted.
- Methods/ Procedures need to be in instructional/ point form.
- A control is essential and should be evident in the method proposed. simply identifying the controlled variable is not enough.

- Repetition of the procedure under identical conditions is needed to ensure validity.

Paper 032 - Alternative To Internal Assessment

CAPE Biology has attracted a number of candidates who are not registered as full-time students at any educational institution and therefore have difficulty assembling the Internal Assessment journal. The alternative to IA (Paper 032) was developed for these candidates. This paper was offered/piloted for the first time in 2009 to a small number of candidates in a few territories. Paper 032 comprised the following activities which were conducted in a laboratory under appropriate supervision.

Activity	Unit 1	Unit 2
Investigation to be conducted during examination	*	
Drawings	*	*
Analysis and Interpretation	*	*
Planning and Design		*

Teachers and candidates need to be reminded that this is an alternative to the IA and **NOT** an alternative to practical work. As such, candidates should have availed themselves of every opportunity to develop their practical skills, particularly in manipulation and in drawing, since these practical activities are carried out under examination conditions for Paper 032. This misunderstanding is reflected in the reports on the questions that are provided below.

UNIT 1

Module 1

Question 1

- (a)-(d) Candidates were required to carry out a simple investigation of the effect of substrate concentration on the rate of reaction of the enzyme amylase, and to complete a table to show the colour changes with Benedict's solution. This question was generally poorly done.
- (e) The expected results (since the Benedict's solution was not heated) were a pale blue colour for all test tubes; no colour change was expected. However, some candidates recorded the expected colour changes rather than what they actually observed. The starch concentration column was incorrectly completed; some candidates wrote the volumes instead of concentrations and percentages.
- (f) Writing an appropriate title for Table 1 was poorly done. Most candidates did not mention the effect of amylase on varying concentrations of starch.
- (g) Based on the observations from the investigation, no apparent relationship should exist. However, candidates described the expected relationship between substrate concentration and enzyme activity.
- (h) This part was well done as many candidates recognized that test tubes A1 to D1 were the controls for their respective mixtures.

- (i) Many candidates explained the expected colour changes; however, no changes were actually seen.
- (j) Very few candidates were able to outline the procedure that can be used to produce quantitative colour standards for reaction mixtures using Benedict's solution. In a simple procedure, a series of solutions of known concentrations should be made and Benedict's solution added to each. Each should be heated and the colour changes graded according to the specific concentrations of reducing sugars.

Module 2

Question 2

- (a) (i) Several candidates found it difficult to calculate the mitotic index even though information was given on what the term meant, that is, per cent cells examined in mitosis and an example was provided.
- (a) (ii) Many candidates were able to gain at least one mark for deducing that the steroidal plant hormone, BL, promotes cell division in onion root tip. Candidates need to practise analyzing data and determining trends.
- (b) (i) Most candidates did not deduce that the cross was sex-linked or that independent assortment was involved.
- (b) (ii) This part of the question was very poorly done. Drawing genetic diagrams proved to be very challenging for candidates. The simple lay out of a cross involving parents, phenotypes, genotypes, meiosis, gametes, random fertilization and the F₁ progeny was not done.
- (b) (iii) More than 50 per cent of the candidates were able to use the data from the table to calculate the percentage of offspring exhibiting non-parental phenotypes.
- (b) (iv) Candidates found it difficult to explain the significance of finding the offspring from the second cross (F₂) exhibiting non-parental conditions. Responses such as independent assortment of alleles and recombination between alleles on the X chromosome were expected.

Module 3

Question 3

- (a) (i) The drawings of the stained transverse sections of the ovary of a mammal were poorly done. Candidates had difficulty in accurately labelling an ovary and some drew a mature Graafian follicle instead. Most drawings lacked the title, labels and magnification.
- (a) (ii) Several candidates omitted this section of the question. They had difficulty calculating the diameter of the mature oocyte.
- (b) (i) Many candidates drew the entire anther rather than locating and making a detailed labelled drawing of one pollen sac. The quality of the drawings was poor. The title, labels, and magnification were again omitted.
- (b) (ii) Very few candidates were able to describe two key differences between the pollen sac observed and a section of a completely mature anther. Differences included splitting of the pollen sac in the mature specimen and separate pollen grains with sculptured walls.

UNIT 2**Module 1**Question 1

- (a) (i) Candidates were required to make a labelled *plan* drawing of the slide of the artery that was provided. Many produced well-labelled plan drawings with clean continuous lines. However, the title and magnification (which should accompany all drawings) were sometimes omitted, and the features not drawn in correct proportion.
- (a) (ii) More than 50 per cent of the candidates commented on two features of a vein rather than an artery, as was requested.
- (a) (iii) Again, candidates made deductions about the nature of blood flow of a vein and missed the point that blood flow is under high pressure in an artery.
- (b) (i) Candidates were asked to draw a palisade cell from a transverse section of a dicotyledonous leaf. About 90 per cent of the candidates omitted the vacuole in this simple drawing of a typical plant cell. Many could not label four parts of a plant cell accurately.
- (b) (ii) The majority of the candidates were able to give one difference between palisade and mesophyll cells, for example, a rectangular shape compared to an oval shape. Very few candidates mentioned that chloroplasts were more numerous in palisade cells.

Module 2Question 2

Candidates were provided with apparatus and materials to design an experiment to test the effect of an environmental factor on transpiration in plants.

- (a) More than 90 per cent of the candidates were able to formulate a suitable hypothesis for the factor being tested.
- (b) Many candidates could write a suitable aim based on the hypothesis written in response to (a).
- (c) Candidates were asked to design an experimental procedure to test the aim stated in (b), that is, the effect of light on the rate of transpiration in plants. A description with a suitable and logical sequence of the set-up was not done. The controls and repeat trials to ensure reproducibility of the experiment were not included. The candidates correctly wrote the experiment in the present tense and also included the duration of investigation.
- (d) Two precautions when setting up the experiment were required. Many candidates explained why the fittings must be airtight but omitted the point that the plant stem must be cut under water.
- (e) This was poorly done. Candidates made an inference rather than writing about the results that might be expected from the investigation, for example, the amount of water (changes in volume) taken up by the plant will increase when the cutting is exposed to increased light intensity.
- (f) Candidates were required to design an appropriate table to show how the results could be represented. This was poorly done. The title and the units of measurement were often omitted. Many candidates inaccurately designed a table for the movement of a bubble.

- (g) Candidates were asked to suggest two factors that may affect the accuracy of the experiment. Many listed two factors but did not give the required explanation. Many correctly mentioned that the heat from the lamp would also increase the temperature of the leaves.

Module 3

Question 3

- (a) (i) Candidates were required to construct a graph from a table that showed the effect of exercise on blood pressure in 12 human subjects. Most candidates plotted the points accurately and labelled the lines for the systolic and diastolic pressure. However, many candidates lost marks for omitting the base lines and the title of the graph. Students should be encouraged to learn when to represent two sets of data on one graph instead of drawing two separate graphs.
- (a) (ii) Candidates did not demonstrate much ability to comment on the effects of exercise on blood pressure using quantitative data from the graph. A few mentioned that the immediate effect of exercise was a dramatic increase in systolic blood pressure and a decrease in diastolic blood pressure followed by decrease in systolic pressure when exercise stops.
- (a) (iii) Candidates had difficulty explaining the physiological significance of the change in systolic pressure that was recorded after exercise. Only a few suggested that there is a dramatic increase in blood flow to supply muscles with oxygen and glucose.
- (b) (i) Candidates were asked to construct a histogram to display the data provided in a table showing the yearly incidence of cancer. This was well done; the bars were well drawn. However, some candidates lost a mark for either writing a poorly worded title or for omitting the title entirely.
- (c) (ii) This part required that the candidates comment on the change in incidence of cancer over the five-year period. Values from the histogram were not used to answer the question but general trends were noted.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2010**

BIOLOGY

GENERAL COMMENTS

The CAPE Biology examination comprises three papers based on each unit covered in the syllabus. Paper 01, a Multiple Choice paper, consists of 45 compulsory items (15 from each of the three modules). Paper 02 consists of six compulsory questions (two from each of the three modules) and Paper 03/2, an alternative to the Internal Assessment, is taken by candidates who do not register for the Internal Assessment. Paper 02 is divided into two sections: Section A with three structured questions, one from each module, and Section B with three essay questions, one from each module. Each question on Paper 02 was worth a total of 15 marks. Each question on Paper 03/2 was worth 16 marks.

The modules in each unit are:

Unit 1

- Module 1 Cell and Molecular Biology
- Module 2 Genetics, Variation and Natural Selection
- Module 3 Reproductive Biology

Unit 2

- Module 1 Bioenergetics
- Module 2 Biosystems Maintenance
- Module 3 Applications of Biology

DETAILED COMMENTS

Paper 01 – Multiple Choice

Overall performance on Paper 01 was generally good for both units. While performance was fairly even across the modules, candidates continued to be challenged by items based on genetic variation and natural selection (Unit 1) and to a lesser extent, with items testing knowledge and understanding of water potential. An unexpected finding was the fact that candidates seemed to have some difficulty in distinguishing between pulse (rate) and blood pressure. Since the concepts related to those topics are fundamental to Biology, it is essential that greater emphasis be placed on ensuring that all candidates have a sound understanding of these topics.

UNIT 1

Paper 02 – Structured/Essay Items

Section A – Structured Items

Module 1

Question 1

Syllabus Objectives: 1.8, 4.1, 4.2, 4.4

Highest Mark: 15 Mean Mark: 5.62 Std. Dev: 2.88

This question was designed to test candidates' knowledge of the basic structure and functions of proteins as well as their understanding of the properties and functioning of enzymes. Despite the straightforward nature of the question, the majority of candidates failed to score high marks; only two were able to gain full marks. Many candidates lost marks because of an inability to provide clear explanations for expected points.

Part (a) (i) required candidates to list four functions of proteins in living organisms. Most candidates were able to list at least one or two functions. However, many gave responses such as enzymes or hormones without indicating the functions, for example, enzymes – accelerating biological reactions. Other acceptable functions include structural support and transport. For Part (a) (ii), candidates were asked to circle the peptide bond in a diagram of a dipetide molecule. Many candidates incorrectly circled the region of the C=O and/or the N-H bonds in addition to the C-N peptide bond and were therefore unable to score the one mark. A small percentage of candidates were unable to identify the peptide bond. Part (a) (iii) proved more challenging than expected, as many candidates were unable to correctly illustrate the amino and/or carboxyl groups; in some cases, bonds were omitted.

Part (b) (i) asked candidates to state one property of enzymes that relates to their structure and one that relates to their main function in the cell. While candidates appeared to be familiar with properties of enzymes, many were unable to distinguish between a structural property versus one which is functional. The sketching of the curves for Part (b) (ii) was poorly and untidily done despite the guides provided in the given figure. Another error noted was a misconception as to whether the presence of an enzyme increased or decreased the amount of energy needed for the reaction to progress.

Part (c) (i) proved difficult and was also poorly done. Candidates were unable to accurately describe the trend observed for each graph. For Part (c) (ii), some candidates incorrectly identified the types of inhibitions shown in the graphs or used inappropriate terms, for example, continuous. An appropriate response should read:

Graph A shows competitive inhibition because with increasing concentration of the substrate, the rate of reaction was slower in the presence of an inhibitor but the same maximum rate of reaction was attained.

Module 2

Question 2

Syllabus Objectives: 2.1, 2.2, 2.6, 2.5, 2.6

Highest Mark: 15 Mean Mark: 8.67 Std. Dev: 3.32

This question examined candidates' knowledge and understanding of mitosis and meiosis. Part (a) examined candidates' ability to recognize three key stages in mitosis, as illustrated in the figure and to evaluate whether, based on observation of features shown, a candidate could describe a characteristic feature for each stage. Most candidates obtained at least three out of a maximum of six marks for identifying the stages. The expected responses were: A – Prophase; B – Anaphase; and C – Telophase. Many candidates were able to correctly state a characteristic feature for each stage. Despite the good performance, it was noted that terms were incorrectly used, for example, for Anaphase chromosomes instead of chromatids. Teachers should ensure that misconceptions are addressed.

In Part (b), candidates were expected to draw the arrangement of chromosomes during Metaphase I of meiosis. Generally, this was not well done as drawings were either unclear or incorrect as to the number of chromosomes that should be drawn. The majority of candidates obtained at least one of the three allocated marks based on the fact that they were able to show the position of the chromosomes at the metaphase plate. A common misinterpretation was to represent mitosis instead of meiosis, hence many candidates did not show two homologous pairs of chromosomes, show the sister chromatids in the form of tetrads or distinguish between a homologous pair (maternal and paternal) by the shading or stripping of one member of the pair.

Part (c) was fairly well done with a majority of responses obtaining two out of a possible three marks. Some candidates did not seem to understand the term 'ploidy'. The last feature listed in the table proved difficult for candidates to obtain full marks. A precise phrase was required, so for mitosis this was 'genetically identical' to parents and each other. Candidates incorrectly wrote 'similar' which does not imply having the same genetic composition.

Part (d) proved the most challenging. Many candidates did not attempt this part of the question. It was expected that for (d) (i), they would have been able to name the process which chromosomes undergo prior to nuclear division, that is, replication/duplication of DNA. Similarly, the stage should have been easily identified as Interphase. Part (d) (ii) asked candidates to state one reason why the process named in (d) (i) was necessary. Providing a correct response — maintaining genetic stability — proved difficult for many. Other acceptable responses included *condensation allows for pairing, alignment or separation of chromosomes*.

Module 3Question 3

Syllabus Objectives: 3.4, 3.5

Highest Mark: 15 Mean Mark: 7.0 Std. Dev: 3.03

A good knowledge of the structure of human sperm and ovum was key to answering question three.

For Part (a) (i), candidates were asked to identify four structural regions of the sperm, highlighted in the figure, to attain two marks. Many were able to accurately identify all four regions, that is, tail, middle piece, neck and head. Some candidates confused the sequence of the regions and thus gave incorrect identifications; others gave inappropriate names, for example, mid-rib, lamella.

Part (a) (ii) was generally well done by the majority of candidates. Again, some candidates did not seem to understand the term 'ploidy' and gave answers such as 'n' instead of stating the term 'haploid'. Clearly, the teaching of this concept needs some attention. The majority of candidates were unable to give two reasons to account for the presence of a large number of mitochondria in the sperm. While many were able to relate this to the supply of energy for the sperm to swim, few, if any, related this to the long distance which the sperm must travel in order to fertilize the ovum.

Part (a) (iv) was not well done as some candidates failed to recognize the acrosome as being a lysosome and to correctly describe its function as releasing hydrolytic enzymes to digest the outer layers of the ovum.

Part (a) (v) was well done with many candidates giving secondary oocyte as the correct response. However, drawing of the secondary oocyte, as required for Part (a) (vi), was poorly done. Approximately 40 per cent of the candidates failed to present an appropriate drawing with appropriate annotations. A major failing was providing functional annotations and not annotations giving structural details of the ovum as stipulated. Teachers are reminded that annotations are notes that accompany a label and are not restricted to functional details.

Part (b) examined key differences between ovum and sperm. This was well done and many candidates were able to gain full marks. Similarly, Part (c) was well done.

Section B – Essay Items

Module 1

Question 4

Syllabus Objectives: 2.3, 2.6, 3.2

Highest Mark: 15 Mean Mark: 6.28 Std. Dev: 3.94

This question focused on two aspects of cell organization, one being the chemical composition of cell membranes and the other a comparison between prokaryotic and eukaryotic cells.

For Part (a) (i), candidates were required to name five chemical components of the cell membrane and state a function for each. Approximately 70 per cent of candidates gave satisfactory responses. Several, however, seemed unclear about what was meant by ‘chemical components’ and wrote about chemicals such as oxygen, carbon and water. Average responses listed four to five components but were unable to provide a complete list of functions. A common error was a description of the nature of the components, for example, hydrophilic phosphate head of a phospholipid, rather than functions.

Part (a) (ii) was generally well done, and many candidates who performed well on Part (a) (i) also did well on this part of the question. Weaker candidates wrote on transmembrane protein or simply protein and did not make the distinction between a carrier and a channel protein. In some instances, candidates confused the functioning of a channel protein with that of a carrier protein. An acceptable response was *the carrier protein shape can change (ping state to pong state) to allow for movement of materials* or *the channel protein has a fixed shape with a hydrophilic pore which allows passage of specific ions (polar molecule)*.

For Part (b) (i), about 25 per cent of the candidates did not seem to understand that the question, as stated, required them to only distinguish between the terms ‘prokaryotic and eukaryotic’. Many of them stated differences which did not relate to the meaning of the terms. Hence, responses to this part of the question overlapped with what was expected for Part (b) (ii). Simply stating that ‘prokaryotes do not have a true nucleus while eukaryotes do have a true nucleus’ would have gained two marks. A small percentage of the candidates (15%) gave one of the expected answers for Part (b) (ii) in Part (b) (i) and therefore were unable to score any marks for that particular point. Nonetheless, at least 20 per cent of the responses received five of the six allocated marks and approximately five per cent achieved the full score. Some candidates seemed not to know that photosynthesis in prokaryotes occurred on special membranes called lamellae and simply stated that prokaryotes did not have chloroplasts.

Question 5

Syllabus Objectives: 4.1, 4.2, 5.3, 2.4

Highest Mark: 15 Mean Mark: 4.76 Std. Dev: 3.53

The overall performance on this question was less than satisfactory as topics such as genetic variation and mutation continued to be challenging for candidates.

Part (a) (i) was generally well done. Candidates were awarded one mark for stating ‘a variety of genotypes in a population’. Candidates were knowledgeable about the sources of variations and gave good explanations of ‘crossing over’ but were weaker in attempting to explain ‘independent assortment’.

For Part (a) (ii), many candidates were able to clearly define mutation as ‘*a change in the DNA of a cell*’ but several failed to state that both gametes and somatic cells were the cells in which mutations occur.

Good responses were noted for Part (a) (iii) and candidates gained two marks for simple explanations of deletion and substitution, for example, deletion ‘*involves loss of a nucleotide in a triplet*’ while substitution ‘*involves the replacement of a nucleotide in a triplet*’. Discussion of the statement was not well done and the connection between the mutation and consequences of potential changes in amino acid sequences was not addressed. Teachers are encouraged to place greater emphasis on covering the concepts related to this topic.

Given the nature of the poor responses for Part (b), it is clear that candidates did not have a sound knowledge of genetic engineering, in particular the role of restriction enzymes in bacterial cells. Many candidates were of the opinion that restriction enzymes cut bacterial cells. However, a few candidates did seem to understand that the role of restriction enzymes in bacterial cells was to protect the cells, ‘restricting’ foreign DNA, for example, viral DNA that enters the cell, by destroying it. At least one mark was awarded if a candidate indicated that restriction enzymes ‘recognize and cut specific sequences in double-stranded DNA’. Despite the apparent lack of understanding that biologists can use restriction enzymes to cut a stretch of DNA from the genome of one organism and paste it into the genome of another, some candidates were able to obtain some marks for Part (b) (ii). Again, teachers must ensure that basic principles are well explained as outlined in Objective 4.1.

Module 3

Question 6

Syllabus Objectives: 2.6, 2.7, 2.8

Highest Mark: 15 Mean Mark: 5.08 Std. Dev: 4.44

This question tested candidates’ knowledge and understanding of plant reproduction.

Part (a) was reasonably well done and the majority of candidates were able to score at least three or four out of a possible six marks. In some instances, definition of pollination was incomplete or not at the expected level. Some misconceptions were: pollen falling from the male part of a plant onto the female part or pollen being transferred to the style or pistil. An acceptable answer is: ‘*Pollination is the transfer of pollen grains from the anther to the stigma*’. Most candidates seemed to have a sound understanding of the events which lead from pollination to fertilization. However, some lost marks for not presenting the information in the correct sequence.

About 60 per cent of the candidates were able to score at least two marks for Part (b). Marks were lost for not mentioning the fusion of two polar nuclei (secondary nucleus) with one of the male gametes to form the endosperm, as well as the more obvious point of fusion of one male gamete with the female gamete to form a zygote. Candidates were awarded one mark for any one significance

stated. A few candidates gave clear definitions of double fertilization in Part (a) but failed to repeat the information in (b) where it was required.

The performance for Part (c) was noticeably better as approximately 80 per cent of the candidates demonstrated a clear understanding of the question and scored from four to six marks. A few candidates misinterpreted the question and gave explanations of the ovary and zygote for humans.

Paper 03/2 - Alternative to Internal Assessment

Module 1

Question 1

Highest Mark: 13 Mean Mark: 8.27 Std. Dev: 3.43

Generally this question was reasonably well done, with approximately 30 per cent of the candidates attaining scores ranging from 11 to 13 marks.

For Part (a), most candidates were able to score at least 50 per cent of the marks for constructing the table to show the results of an investigation of the effects of potato extract on varying concentrations of catechol. However, some omitted to include the title of the table. The table lines were well drawn and columns were named accurately in 70 per cent of the cases. A gradual intensity of colour as the substrate concentration increased was rarely stated.

In Part (b), many candidates did not gain full marks for suggesting a specific aim for the experiment, as they neglected to mention that it was an investigation of 'varying' substrate concentration on the rate of the reaction or product formed.

For Part (c), the relationship between substrate concentration and enzyme activity was accurately stated by most candidates, but there was *no reference to the intensifying colour changes* that determined the relationship.

Commentary on the purpose of Tubes 4 and 5, Part (d), was poorly answered as candidates did not determine that there was no substrate present in Tube 4 and no enzyme present in Tube 5 and that these tubes acted as controls for the experiment.

Part (e) asked candidates to identify one limitation. This was not well done as only ten per cent of the responses identified a limitation. The fact that the experiment required a qualitative assessment of colour which was subjective to visual observation and determination seemed to elude candidates.

In responses for Part (f), candidates suggested that the colours needed to be accurately determined, only a few mentioned the use of the colorimeter which could be used to convert the colour absorbance values into quantitative data.

Part (g) was generally well done as most candidates stated factors such as temperature, pH and presence of inhibitors or enzyme concentration as those that can affect the state of an enzyme catalysed reaction.

Module 2

Question 2

Highest Mark: 15 Mean Mark: 6.53 Std. Dev: 3.96

Responses to this question were generally fair with about 50 per cent of the candidates gaining scores ranging from seven to ten marks.

For Part (a) (i), most candidates accurately stated the ratio of 1:1:1:1 for the test cross of the red-flowered, short stemmed F_1 generation phenotypes from red-flowered, short stemmed and yellow-flowered, long stemmed parents. However, very few gave adequate reasons to explain why the F_1 progeny were phenotypically alike as required for Part (a) (ii). Some accurately suggested that red colour and short stem were dominant to yellow colour and long stem, but omitted the point that the parents are pure-breeding or homozygous for the trait.

In Part (a) (iii), candidates were asked to explain the ratio obtained from the cross of the F_1 generation plants. Very few stated that the four alleles were situated on different pairs of chromosomes or that the two genes were not linked. An accurate and complete diagram of the test cross ($RrSs \times rrss$) would have been awarded full marks but was rarely seen.

Part (b) was based on two histograms showing the effect of ozone and ultraviolet radiation on the growth of pollen tubes in two plant species. In Part (i), candidates were asked to describe and explain the common trends in the data. Many candidates recognized that ultra violet (UV) and ozone reduced the growth of the pollen tube for both species of plants but failed to mention that the nature of the retardation was different for each inhibitor and each species of plant. For Part (ii), candidates were expected to compare the effects of each treatment on *N. tabacum* and *P. hybrida*. Expected answers were:

- Ozone reduced pollen tube growth and the effect was greater in *N. tabacum* than in *P. hybrida*.
- UV radiation inhibited pollen tube growth approximately the same for both plants, but with a slightly greater effect in *P. hybrida*.
- The combination of ozone and UV radiation was greater than any single factor for both plants, but with a slightly greater effect on *N. tabacum*.

In Part (ii), candidates were required to suggest two sources of error when interpreting the results of the experiment. Many accurately stated the discrepancies in accuracy of pollen tube length due to small size and also the inability to deliver ozone and UV radiation consistently and accurately.

In Part (iv), most candidates accurately explained that ozone and UV radiation could impact negatively on a plant by reducing the chances of fertilization. This would also impact on the seed/fruit development and eventually limit the continuation of the species.

Module 3Question 3

Highest Mark: 16 Mean Mark: 5.71 Std. Dev: 4.48

Overall this was not a high scoring question, with only one candidate gaining full marks.

Part (a) was based on a slide of a transverse section of an anther prior to dehiscence. In Part (i), candidates were required to make a detailed annotated diagram of one of the pollen sacs seen in the specimen. Most drew the entire anther with the four pollen sacs but few gave a good diagram of the correct region. A drawing with clean continuous lines and of reasonable proportions and size was seen in many cases. Few candidates gave appropriate annotations. Calculation of the magnification, Part (a) (ii), was poorly done as few candidates were able to accurately calculate the magnification of the drawing given. Teachers are reminded of the importance of teaching this skill. Many candidates correctly described the appearance of the specimen after dehiscence, that is, the pollen sac would not be continuous, the pollen grains would be scattered or the fibrous wall would be ruptured after dehiscence.

In Part (b) (i), candidates were required to make a plan drawing of a section of the human ovary to show four key stages in the development of the Graafian follicle up to ovulation. Many produced drawings of clear continuous lines with no shading or unnecessary detail, and of reasonable proportion. However, very few were able to show any of the stages, which included the germinal epithelial, primordial follicle, primary follicle, secondary follicle, Graafian follicle (mature) and Graafian follicle (ruptured). Perhaps having a question only testing drawing skills and doing so twice proved to be too demanding.

Again, very few candidates were able to calculate the diameter of the mature Graafian follicle observed; a value approximately 1–2 μm depending on material would have been an acceptable answer for Part (b) (ii). For Part (b) (iii), few candidates were able to state the presence of the antrum or oocyte attached to the follicle wall by stalk as an observable distinguishing feature of a mature Graafian follicle.

UNIT 2**Paper 02 – Structured/Essay Items****Section A – Structured Items****Module 1**Question 1

Syllabus Objectives: 1.1, 3.5

Highest Mark: 15 Mean Mark: 8.78 Std. Dev: 3.68

This question tested candidates' knowledge of chloroplast structure in relation to photosynthesis.

For Part (a) (i), the majority of candidates were able to score at least three of the four allocated marks despite the fact that many drawings were below the expected standard. Less than 25 per cent of the responses showed good drawings. Many omitted the double membrane or did not annotate the drawing as instructed.

Part (b) (ii) was generally well done. Approximately 80 per cent of the candidates were able to gain three of the four allocated marks. Marks were lost for inadequate descriptions of the structure of the thylakoid and/or granum as they relate to photosynthesis.

Part (b) was fairly well done. Candidates were required to identify various processes in the nitrogen cycle. However, in some instances, candidates seemed not to understand the difference between assimilation and absorption and used the terms interchangeably. Some gave descriptions of the processes when they were asked to only identify the processes.

Parts (b) (i) and (ii) proved to be challenging as most candidates were unable to describe two ways by which nitrogen is lost from soil ecosystems. Many gave only one way. Similarly, many were unable to describe two human activities which impact on the nitrogen cycle for Part (b) (iii).

Module 2Question 2

Syllabus Objectives: 1.5, 2.1

Highest Mark: 15 Mean Mark: 6.73 Std. Dev: 2.88

Overall, performance was fair. Good answers were noted for Part (a) (i), despite the fact that many candidates were unable to explain all four precautions.

For Part (a) (ii), some candidates were unable to correctly state that the lower surface was the region where water loss will be greater. Identifying the factors — light, wind, temperature, humidity — that affect the closing and opening of stomata was well done but providing an explanation of how these factors caused stomata to open or close was not as well done which resulted in a loss of marks for Part (b).

Despite the clarity of the photomicrograph of a companion cell and sieve tube, several candidates were unable to correctly identify these structures for Part (c) (i). For Part (c) (ii), candidates were asked to discuss two structural differences between these two cells and to describe how or why despite these differences they function as a unit. This was generally not well done and there was some indication that candidates were unclear about what was required. A good answer should have included: *'A single tube (Y) has no nucleus, ribosomes, cytoskeleton but a companion cell (X) does. Y is dependent on X for support, energy for movement of sugars and amino acids.'*

Naming a route by which substances move from chloroplast in leaves to the phloem, such as symplast or apoplast should have been easily answered but some incorrect answers were found for Part (c) (iii).

Module 3

Question 3

Syllabus Objectives: 1.1, 1.2, 1.3, 4.5

Highest Mark: 15 Mean Mark: 7.82 Std. Dev: 2.47

Overall, performance was fair. In order to gain full marks for various sections, detailed information was needed and this proved to be quite challenging especially for candidates with poor writing skills.

Those candidates who could give a basic definition of health (Part (a) (i)) and distinguish between pairs of diseases (Part (a) (ii)) gained full marks. Candidates lost marks for failing to state that, for infectious diseases, organisms were transferred from one host to another. Part (a) (iii) was not well done and very few candidates gained full marks. Many candidates clearly did not understand that protein–energy malnutrition could be classified in more than one category and gave vague answers.

Part (b) proved to be even more challenging and many candidates either confused the graph lines or did not understand how to discuss the curves. For Part (b) (i), some marks were awarded for correctly describing trends, supported by data from the graphs, as part of the discussion. Greater attention and emphasis should be given to teaching the skill of interpreting graphs, especially with respect to describing observable trends. This is perhaps best done in practical exercises. Candidates were able to suggest two fairly good reasons for the difference in the shape of the curves but some lost marks for simply stating differences, some of which were covered in Part (b) (i), rather than suggesting reasons.

Part (b) (iii) was perhaps the most well done section of the entire question as any reasonable and well explained challenge was acceptable, such as addictive nature of smoking, absence of legislation to ban cigarette smoking or lack of funding for education programmes, detection or treatment.

Section B – Essay Items**Module 1**Question 4

Syllabus Objectives: 1.4, 2.2, 2.6

Highest Mark: 15 Mean Mark: 8.01 Std. Dev: 3.27

Two topics, glycolysis and photosynthesis, were examined in this question. Part (a) (i) tested candidates' understanding of the term 'glycolysis' and knowledge of where in the cell glycolysis occurs. Good responses were able to secure full marks for including in the explanation that '*the glucose molecule is split and converted into two molecules of pyruvate*' and that it occurred in the cytoplasm of the cell. Marks were lost for omitting key aspects of the process, such as not indicating that the glucose molecule is split or converted into two molecules of pyruvate.

Part (ii) was generally well done with many candidates being able to attain the full score of four marks. The majority of candidates cited as one reason the fact that the equation did not represent '*the several steps involved in cellular respiration, such as glycolysis, Kreb's cycle, link reaction, electron transport chain*' or the total amount of energy used and released. Other acceptable reasons included '*no indication of electron transfer aspects*' or the fact that '*enzymes and other molecules such as FAD and NAD*' are involved in the process. Some candidates discussed anaerobic respiration as opposed to aerobic respiration as required.

Parts (b) and (c) were generally well done. Many candidates were able to explain the role of photosynthesis as being 'to trap or absorb light energy' and even specified the wavelengths. Some further explained that when an electron gains energy it is 'excited'. The excited electron is then transferred to another molecule (called a primary electron acceptor). In commenting on the significance of ATP and NADPH₂ in photosynthesis, candidates gave an excellent range of responses, for instance, ATP as a source of energy and the reducing power of NADPH₂ — both supported by examples. It was reassuring to see that candidates did have a sound understanding of this aspect of photosynthesis.

Module 2Question 5

Syllabus Objectives: 4.4, 6.1, 6.4

Highest Mark: 15 Mean Mark: 6.07 Std. Dev: 3.19

Part (a) of this question tested the structure of a motor neurone and synaptic transmission. For Part (i), candidates were required to demonstrate their knowledge of the structure of a motor neurone by doing an annotated diagram. Overall, candidates were able to do a fairly good diagram but did not do as well with respect to the annotations. Many gave functional notes rather than notes about the structure of the neurone. This meant that only a small percentage of responses were able to gain full marks; some credit was given if structures were correctly named. A few candidates incorrectly gave diagrams of a sensory neurone or a synapse.

Part (a) (ii) was not as well done because most candidates were unable to apply their knowledge of synaptic transmission to answer the question as asked. While some marks were awarded for explaining how acetylcholine functioned at the synapse, failure to mention that a build-up of acetylcholine in the synapse resulted in continuous generation of nerve impulses, and thus muscle stimulation, contributed to a loss of marks.

Part (b) (i) dealt with a comparison of nervous and hormonal control. Many candidates were unable to clearly outline two differences and gave partially correct responses. Of particular concern is the fact that the majority of candidates failed to recognize that nervous control involved both electrical and chemical transmission.

For Part (b) (ii), many candidates gave detailed explanations of the functioning of insulin rather than focusing on the ways in which a malfunction in insulin activity could lead to disease.

Module 3

Question 6

Syllabus Objectives: 2.2, 2.4, 2.7

Highest Mark: 15 Mean Mark: 7.87 Std. Dev: 4.13

This question tested candidates' knowledge and understanding of immune response and immunity. Part (a) was well done with most responses giving an appropriate definition such as '*defence reactions to invading organisms or foreign material*'. In distinguishing between cell-mediated and humoral responses, many candidates correctly stated that '*cell-mediated responses involved T cells which are directly involved in the elimination of antigens compared to humoral responses which are due mainly to the activities of B cells producing antibodies*'.

Discussion of the maturation of B and T cells was fairly well done in Part (b). The majority of candidates were able to state that B cells mature in the bone marrow or spleen compared to T cells which mature in the thymus. However, not all were able to fully discuss the maturation in relation to their specific roles, for instance, B cells circulating in the blood and lymph and transforming into plasma cells on exposure to antigens, or T cells transforming into cytotoxic cells or producing cytokines to destroy antigens.

Part (c) was also well done with many candidates being awarded full marks for stating that

' a sample of a woman's urine is tested for the presence of human chorionic gonadotropin (HCG) hormone which is produced by the placenta and is usually only present in a woman's body when she is pregnant. Anti HCG monoclonal antibodies, produced commercially from a single cell line, are used in the test kit and these will bind to HCG if present in the urine sample. A positive reaction is indicated by a colour change in the test strip'.

Part (d) proved to be the most challenging for some candidates despite the simplicity of the topic. Most candidates were able to explain that active artificial immunity was due to '*the administration of weakened or attenuated antigenic material (vaccines), therefore artificial, which stimulated the recipient's immune response to produce antibodies, hence active*'. However, explanations of passive artificial were not as clear, as many candidates failed to either include the fact that antibodies were

harvested from other individuals and injected into the recipient or did not mention that there was no stimulation of an immune response. In differentiating between the two types of immunity, some candidates did mention that 'one could result in long-term immunity whereas the other did not'.

Paper 03/2 - Alternative to Internal Assessment

Question 1

Highest Mark: 14 Mean Mark: 7.00 Std. Dev: 4.42

For Part (a), most candidates were able to formulate a suitable hypothesis for the designed experiment. '*An increase in temperature will cause an increase in oxygen uptake*', was the most popular response. Candidates accurately wrote a suitable aim to match the hypothesis such as: 'To investigate the temperature on the rate of oxygen uptake in germinating pea' for Part (b).

For (c) (i), few candidates were able to make a good drawing of the experiment set-up. Each boiling tube (one with dead peas and the other with respiring peas) should have been attached to a manometer with a calibrated scale. Also, the tube with the respiring peas needed to be heated using a Bunsen burner.

Very few candidates were able to outline exactly how the experiment would be conducted in (c) (ii). Equal quantities of dead and respiring peas should be used and manometers set to the same level by using spring clips. At each experimental temperature, the respiring peas were left for five minutes to equilibrate before reading and recording from the manometer. The procedure should be repeated for at least three different temperatures within the 10° C and the 35°C range. The procedure should be written in present tense and a control using dead peas included in the design.

For (d), very few candidates suggested that precaution must be taken when setting up the experiment so as not to touch the soda lime with bare hands or that the water bath temperature should be monitored. The prediction (e) that an increase in temperature will result in an increase in oxygen consumption was almost always written by the candidates.

Lastly, few candidates were able to design an appropriate table to show how the results could be presented. The title was often omitted and the units of measurement were seldom seen.

Question 2

Highest Mark: 14 Mean Mark: 8.22 Std. Dev: 4.74

For Part (a), candidates were required to make a labelled plan drawing to show accurately the shape of the section of a mammalian kidney (L.S). Most candidates scored the marks for the shape of the kidney, continuous lines of even thickness and the tissue regions drawn proportionately. However, the title and magnification were rarely given. The label lines should be straight, parallel and drawn with a ruler. The fibrous capsule, cortex, medulla and pelvis were at most times labelled accurately.

For (b), the structures of A (sieve plate), B (sieve tube element), C (companion cell) and D (phloem parenchyma cell) were identified accurately by most candidates (the parenchyma cells to a lesser extent). For each structure, its main function was correctly stated.

Question 3

Highest Mark: 16 Mean Mark: 11.11 Std. Dev: 3.26

Candidates were required to summarize data on mortality rates for breast cancer in women. Most candidates accurately identified Uruguay as the country with the *highest* mortality rate, quoting data from the table (44.6%), for Part (a) (i). In (ii), most candidates accurately commented on the overall trend for the Caribbean in comparison to the North American countries. The data showed that Caribbean countries had a lower mortality rate for breast cancer and that, except for Cuba, there were increasing rates over the study period. Many candidates accurately suggested improved treatment and early detection as possible explanations for the decrease noted for Canada and the USA.

For (b) (i), many candidates were able to score full marks for the construction of a bar chart to display data given in a table. However, the title was omitted very often and the graph space given was not put to good use. The axes were labelled correctly and the bars accurately drawn.

The incidence for the period 2000–2005 was calculated accurately by almost all the candidates (Part (ii)).

Incidence rate = no. of new candidates/no. reported for the period = 20,000/40,000

Ans. 0.05

Candidates were required to suggest two possible reasons for the increase in the number of Dengue cases reported for the period in Part (iii). Many accurately stated that there was an increase in population size, travel, rainfall, urbanization and vector population. Also noted was the fact that there was deterioration in public health services.

General and Specific Recommendations for Teachers

In covering the syllabus, teachers must ensure that basic concepts are emphasized. While factual knowledge is important, such knowledge cannot be readily applied if there is little or no understanding of the basic principles. The absence of such understanding is evident in the poor responses to questions requiring some critical thinking. Greater emphasis must be placed on linking practical skills and exercises to the theory covered. Too often, candidates score poorly because of a weakness with respect to certain practical skills, for instance, being able to draw a graph or describe an observable trend.

General issues for Paper 03/2

- Concerns were expressed about inadequate preparation at centres for the practical examinations with respect to the availability of appropriate materials and equipment, for example, slide specimens, solution for experiments, functional microscopes.
- Provisions should be made to ensure that private candidates have access to facilities which would allow some training for practical exercises.

General Comments on the Internal Assessment

Overall, the quality of candidates' practical/laboratory assignments has improved tremendously since 2009. Several of the teachers at the centres are ensuring that a high standard is maintained by their students as it relates to their Internal Assessments. The improvements seen were in the generally weaker areas of Drawing and Planning and Design. It must be noted that authentic and novel Planning and Design (P and D) exercises were being used more often than textbook replicates.

However, despite this pleasing trend, there are still areas of concern. These include the poor formulation of hypotheses and related aims. In several cases, too many variables are being tested at once, thus creating difficulty in producing a relevant and appropriate aim. Finally, there were still some cases where the laboratory exercises used were inappropriate for the skill(s) being assessed. Research projects if used for P and D assessment need to adhere to the CXC/CAPE P and D guidelines when constructing the mark schemes.

It is suggested that territory workshops, focusing on local standardization of teachers responsible for Internal Assessment, be implemented. This is regarded as key to ensuring that candidates are provided with all the necessary tools to produce work of a high quality. Teachers are reminded that each laboratory exercise/ experiment should be used to assess only two skills at any given time. A pair of laboratory exercises can be used to provide the average score for each skill. Despite this, teachers must reinforce the standards expected by including several other experiments for each skill area, that is, A and I, DR, P and D, ORR and M and M.

Teachers are reminded that the awarded score along with constructive feedback must accompany each assignment/laboratory exercise marked. Feedback affords students the opportunity to improve further assignments.

Finally, the mark awarded for the assignment must be clearly shown and presented out of a score of 12. This facilitates more efficient moderation.

Drawings

There is still great concern in this area of assessment. Some teachers have allowed students to submit textbook drawings as their own original work. It is important that students produce true representations of specimens/slides with which they are provided. Reproduction of drawings in textbooks is not appropriate for assessment of drawing skills.

The following should be borne in mind regarding the assessment of drawing.

- Clarity of drawing.
- A selection of cells that is truly representative of the section being viewed.
- A low power plan of the tissues and high power details of a **few** representative cells should be done for each specimen. There is no need to attempt to draw all the cells seen.
- Faithfulness and accuracy in recording the drawing.
- Correct proportions of all components of the specimen are pivotal.
- Title must be placed at the base of the drawing, in uppercase and underlined.

- The view must be stated in the title, where applicable, for example, L.S (Longitudinal Section)/Whole Mount.
- Neat placement of labels and annotations.
- Justification of labels to the left, right, or evenly distributed on either side of the drawing is expected.
- Magnifications **must** be calculated and all working shown. The correct size of the specimen needs to be used in the calculation.

Insistence on these areas will afford candidates the opportunity to score highly in this area of Internal Assessment.

Analysis and Interpretation

Areas for immediate improvement highlighted by Examiners for 2010 are as follows:

1. Including adequate background information.
2. Deducing trends and relationships from data collected.
3. Presenting concise explanations of the observed trends and relationships.
4. Understanding the relationship between data obtained and the original aim/hypothesis of the experiment.
5. Formulating a conclusion that summarizes the findings from observations and data (with reference to the link between data collected and the aim) is essential. Generally, conclusions were of poor quality because the aim of the experiment was poorly designed.

Planning and Design

This year, the major challenge was in the area of conceptualising and formulating testable hypotheses from a stated problem.

Over the years, students have found the evaluation of this skill to be somewhat challenging. However, with continuous reinforcement of criteria, candidates should be able to grasp these concepts:

- Hypotheses need to be logical and testable.
- Aims must be concise and clearly stated.
- A complete list of all materials and apparatus to be used must be stated. Items critical to the execution of the proposed method should not be omitted.
- Methods/Procedures need to be in instructional/point form.
 - A control is essential and should be evident in the method proposed; simply identifying the controlled variable is not enough.
 - Repetition of the procedure under identical conditions is needed to ensure accuracy.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
ADVANCED PROFICIENCY EXAMINATION**

MAY/JUNE 2011

BIOLOGY

GENERAL COMMENTS

The CAPE Biology examination is based on three papers for each unit covered in the syllabus: Paper 01, a multiple choice paper consisting of 45 compulsory items, 15 from each of the three modules; Paper 02 consisting of six compulsory questions, two from each of the three modules and Paper 032, an alternative practical paper for candidates who do not register for the School-Based Assessment. Paper 02 is divided into two sections: Section A with three structured questions, one from each module, and Section B with three essay questions, one from each module. Each question on Paper 02 is worth a total of 15 marks.

The modules in each unit are:

Unit 1

- Module 1 Cell and Molecular Biology
- Module 2 Genetics, Variation and Natural Selection
- Module 3 Reproductive Biology

Unit 2

- Module 1 Bioenergetics
- Module 2 Biosystems Maintenance
- Module 3 Applications of Biology

DETAILED COMMENTS

Paper 01 – Multiple Choice

Overall, there was some improvement in performance for both units. More than 50 per cent of the candidates gained above average scores for Unit 1 and about 65 per cent for Unit 2. Less than 15 per cent of the candidates were awarded low scores for Unit 1 compared to 10 per cent for Unit 2. For Unit 1, there was a decrease in performance in the highest grade band; however, there was an increase in performance for most of the other grade bands.

A difference in performance in the modules was observed with the highest mean score recorded for Module 1, followed by Module 2, with a further decrease for Module 3. With respect to Unit 2, a marked increase in the performance in the highest grade band was noted, including a few candidates attaining full scores. The best performance was seen for Module 3 which had the highest mean score, followed by Module 1 and then Module 2 which had the lowest mean score.

Items based on genetics continue to challenge candidates. This is so even for basic concepts. For example, a clear understanding of ‘test cross’ ratios for dihybrid inheritance was not evident even among the more competent candidates.

UNIT 1**Paper 02 – Structured/Essay Items****Section A – Structured Items****Module 1**Question 1

Syllabus Objectives: 2.4, 2.5, 2.6, 3.3

Highest Mark: 15 Mean mark: 6.86 Lowest mark: 0

Parts (a) and (b) tested candidates' knowledge of the basic structure of prokaryotes and eukaryotes, as well as similarities and differences between animal and plant cells. Part (c) examined candidates' understanding of water potential for which candidates were required to outline an experimental design using potato.

Overall, the question was generally well done with a few candidates attaining almost full marks. However, performance was found to be average for the majority of candidates. The fact that the question was subdivided into several sections, each carrying a few marks, may have allowed candidates who were less familiar with the subject material to access some marks.

In Part (a) (i), some candidates did not recognize the diagram as being that of a prokaryote and mistakenly identified structures belonging to a human male gamete. The presence of a prominent flagellum on the figure may have contributed to this mis-identification as a few candidates referred to the flagellum as a tail. Despite these errors some candidates gave fully correct answers for the designated labels.

Despite the simplicity of Parts (a) (ii) to (a) (iv), not all candidates were able to give correct answers especially for Part (a) (ii) where simple differences were expected, for example, *cell walls contain murein in prokaryotes compared to cellulose in eukaryotes*. Parts (a) (iii) and (iv) were fairly well done, with many candidates giving the correct answer as *animal cells* for (a) (iii) and *mitochondria* for (a) (iv). Incorrect answers for Part (a) (iv) included lysosomes, golgi apparatus, chloroplasts and other organelles. Part (a) (v) seemed to be more challenging as several candidates did not attain full marks. Candidates seem not to understand that in stating a difference a clear comparison, giving differences for *both* cell types, is needed. When reviewing question rubrics with students, teachers must emphasize this point.

Overall, Part (b) was reasonably well done, with at least 70 per cent of candidates giving a correct answer for the first feature. However, for the second and third features many candidates did not seem to know that in plant cells the *central vacuole* is important in removing foreign matter and that *plasmodesmata* allow for communication between adjoining cells. Despite the straightforward nature of Part (c) (i), many candidates were

unable to clearly outline a simple investigation and hence few attained full marks. This weakness was also noted in the Planning and Design exercises for the School-Based Assessment. Candidates did not gain full marks because they failed to mention the use of more than one strip per solution, the need for a standardized time, that strips should be of equal size, the need for a control, among other things. It is obvious that the importance of reproducibility and reliability in an experimental design is not clearly understood.

The concept of water potential continues to be a challenge as several candidates were unable to correctly describe the expected observation as being ‘*no change in size of the potato strip*’ for (c) (ii), and some mistakenly referred to the volume of the solutions instead of the size of the potato strip. Greater effort must be devoted to teaching this concept especially through the use of practical tools.

Module 2

Question 2

Syllabus Objectives: 3.1, 3.2, 3.3, 3.4

Highest Mark: 15 Mean mark: 4.85 Lowest mark: 0

Topics in genetics continue to be problematic for candidates. Part (a) of this question focused on knowledge of fundamental aspects of genetics, with candidates being asked to define two key terms, and to represent a dihybrid cross in the form of a genetic diagram. Part (b) tested candidates’ understanding of the null hypothesis and the Chi-square test.

In Part (a) (i), many candidates were able to identify the interaction as *epistasis*. Incorrect responses included codominance, sex linkage, and independent assortment among others. In contrast, for Part (a) (ii), several candidates were unable to give simple or concise definitions of an allele as being *an alternative form of a gene* and that dominant refers to the *allele which influences the appearance of the phenotype in the presence of a recessive allele*. Responses to (a) (iii) clearly showed that candidates did not know what constituted a genetic diagram. Some consideration was given to the use of a Punnett square as part of the diagram. However, use of a punnet square alone was considered unacceptable. Other errors included genotypes not being clearly identified, incorrect representation of gametes, despite the fact that symbols were given in the question, and failure to show steps in sequence.

For Part (b) (i), most candidates gave the correct response of $9:3:3:1$, an indication that some aspects of dihybrid inheritance are fairly well understood. A few candidates attempted to derive the ratios by calculating from figures given and incorrectly gave $7:3:3:1$ as the answer. Only a small percentage of candidates were able to correctly state a null hypothesis for a Chi-square test for Part (b) (ii). Those who stated the hypothesis as being *one of no difference between observed and expected results* neglected to qualify the difference as being ‘*significant*’, a term that is regarded as critical to the statement.

In Part (b) (iii), while the majority of candidates understood the concept of degrees of freedom and were able to correctly state the formula and do the simple calculation, a few mistakenly gave the Chi-square formula while others neglected to explain what 'n' represents.

For Part (b) (iv), most candidates were able to use the table provided to determine the given probability as being between 1 and 2 per cent. However, interpretation of the result, as required in Part (b) (v), proved to be more difficult as only the very competent candidates were able to give a correct conclusion for results obtained, for example *that chance alone could account for the deviation*.

Module 3

Question 3

Syllabus Objectives: 3.1, 3.8, 3.4

Highest Mark: 15 Mean mark: 4.44 Lowest mark: 0

This question tested candidates' knowledge of certain selected topics on human reproduction and their ability to do a plan drawing.

Overall, performance on this question was below the expected standard. For Part (a) (i), candidates were asked to identify three structural regions from a schematic diagram of the human male reproductive system. Interpretation of this schematic diagram seemed to present some difficulty, possibly because students are not routinely exposed to such diagrams. Teachers should ensure that students understand what is meant by a schematic diagram and how it should be interpreted.

Overall, only the structure representing the testes was correctly identified by the majority of candidates. Incorrect answers included the scrotal sac or testicles. Structure B was incorrectly identified by many candidates as being *vas deferens* instead of the *epididymis*. With respect to structure C, many candidates interchanged the terms uterus, ureter and urethra. Of particular concern is the degree of errors in the spelling of the correct answer, *urethra*, and technical terms in general. Teachers should advise students of the importance of spelling technical terms correctly. Stating functions of structures, as required for Part (a) (ii), was fairly well done although there were many instances where the specific functions of Structures X and Y were interchanged or where many candidates were unable to relate the particular structure to its specific function.

An inability to interpret a scale, measure the length of an item (using the given scale) from a given figure and clearly state values were evident in responses for Part (b) (i). Many candidates simply used the given measurement for the width of the head (2.5µm) and calculated how many times this value fitted into the entire length of the drawing of the mature human spermatozoon shown in the diagram. Conversion of the units was also problematic for many candidates. Of those who were successful in calculating the length of the spermatozoon, some converted the calculations into centimetres and metres. Again, this is indicative of weak practical skills with respect to drawings.

For Part (b) (ii), candidates failed to give an adequate comparison between the spermatozoon and the ovum based on features observed in the diagram. Again, it must be emphasized that when differences

are required, reference must be made to both items under comparison. For example, many candidates referred to characteristics of the spermatozoon but failed to state the comparative characteristics of the ovum or simply mentioned features of the ovum without reference to what was noted in the diagram given. Popular responses included ‘the sperm is divided into distinct regions’, ‘the sperm is smaller’ or ‘the sperm has a tail’ with no specific mention of the comparative difference in the ovum. Also, some candidates gave functional differences, not seen in the diagram, and hence, ignored the stipulation of the question ‘with reference to the figure’ which implied observable features.

Part (c) (i) was not well done as drawing skills continued to be below the expected standard. Despite the fact that a colour photomicrograph was used to ensure clarity, the majority of candidates were unable to follow the instructions given to do a plan diagram of the highlighted region; inability to apply knowledge and skills was very evident. Several candidates simply reproduced the entire figure of the mature Graafian follicle in a plan diagram, or those who attempted the plan diagram gave unwanted details; also, the labelling of the specific tissue layers was incorrectly done. These errors, routinely noted in the drawings for the School-Based Assessment, indicate that students continue to be unclear as to what constitutes a *plan diagram* versus a *detailed drawing*. Teachers are advised to pay close attention to the comments on the feedback forms concerning drawing skills for the School-Based Assessment.

Section B – Essay Items

Module 1

Question 4

Syllabus Objectives: 1.8, 4.2, 4.4

Highest Mark: 14 Mean mark: 4.33 Lowest mark: 0

This essay question examined candidates’ knowledge of the levels of structural organization of proteins and tested their ability to apply this knowledge to describe the structure of collagen. Understanding enzyme activity and how enzyme activity is affected by insecticides were also tested.

Candidates experienced difficulty in correctly answering Part (a) (i). While most candidates knew the general levels of structural organization of a protein, they were unable to apply this knowledge to describe collagen. Some either stated the levels of organization of proteins in general or described the structure of collagen without reference to the levels of organization. In addition, there were many incorrect statements about either the levels of structural organization of proteins or about the collagen structure, both hinting at some degree of misconception. Errors included polysaccharides for polypeptides, the structure of cellulose for collagen, α and β glucose for α helix and β pleated sheet and DNA structure with protein structure. However, a few candidates understood what was expected and gained full marks. Candidates were expected to state that, for example, *the primary structure of collagen is the linear sequence of about 1000 amino acids which are joined by peptide bonds*. A good response for the secondary and quaternary structure of the protein was *in the secondary structure of collagen, each polypeptide chain is a loosely coiled helix (but not an alpha helix) with –CO and –NH groups projecting outwards and held by hydrogen bonds. In the quaternary structure of the protein, tropocollagen, helices lie parallel to each other and form a stable covalent bond with neighbouring helices forming microfibrils*. The tertiary structure of collagen was the least understood.

It was expected that candidates should have been able to give the correct response of *fibrous protein* with a supporting description for collagen.

In Part (a) (ii), many candidates accurately identified a functional property of collagen but were unable to give an explanation for the property. Several described collagen as being ‘elastic’ or ‘stretchy’. Candidates need to distinguish between ‘flexibility’ and ‘elasticity’. Others stated that collagen was ‘strong’ and ‘hard’ instead of *possessing high tensile strength or resistance to stretching because of the overlapping of the staggered ends of the collagen fibrils*. Candidates were also expected to identify that collagen was *rigid because of the hydrogen bonding within the chains and within the triple helices* as another functional property.

Part (b) (i) was well done. Most candidates were able to gain at least one of the two allocated marks. There was some confusion between ‘mode of enzyme’ action and factors affecting enzyme activity. Candidates were able to recognize that the substrate interacted with the active site of the enzyme to form an E-S complex which then formed products. However, some candidates thought that the active site was located on the substrate.

Part (b) (ii) focused on the effect of insecticides on enzyme activity using a specific example. Candidates were expected to give an example of an insecticide, for instance, an organophosphate or a carbamate (it should be noted that pyrethroids are not the best example for this question). However, many candidates gave names of herbicides or general names of insecticides like Baygon. A number of candidates did not understand the term ‘insecticide’ and mistakenly wrote about the plant being sprayed with insecticide and then humans consuming this plant and the consequent effect on the digestive system. Candidates were expected to know that insecticides inhibit enzyme activity. They were also expected to discuss how the insecticides acted as competitive inhibitors or non-competitive inhibitors with the end result being that catalytic activity of the enzyme would be prevented and the enzyme activity would be decreased.

Module 2

Question 5

Syllabus Objectives: 2.1, 2.6, 5.6, 5.7, 5.8

Highest Mark: 15 Mean mark: 5.68 Lowest mark: 0

Knowledge of meiosis and understanding of the types of natural selection were examined in this question.

For Part (a) (i), candidates were asked to outline the stage of meiosis I and to comment on the importance of this phase of meiosis. The majority of candidates failed to answer the question as required. Many did not give the correct sequence of events for meiosis I and/or used incorrect terminology, for example, ‘chromatids’ instead of *chromosomes*. Stronger candidates were able to provide what was required, even giving details of chiasmata formation and crossing-over. Of particular concern was the observation that some candidates opted to answer this part of the question using diagrams with little or no explanatory text or notations. While, for an essay, diagrams may be used to support descriptions, it is unacceptable to use only diagrams unless specifically stipulated in the question rubrics. Excellent responses made mention of the chromosome number being reduced from diploid to haploid and crossing-over resulting in genetic variation of the offspring. Part (a) (ii)

of the question was generally well done by the candidates who gave good responses such as the *daughter cells are genetically identical in the case of mitosis versus different for meiosis, or that daughter cells are diploid in mitosis and haploid in meiosis*. Weaker responses exhibited a lack of clarity and therefore failed to gain a mark in this area.

Part (b) of the question was designed to test candidates' ability to identify the type of selection based on information given, that is, *disruptive selection*. The majority of candidates were able to give the correct response and an appropriate justification, for example, reference to *only the two size categories present with no intermediates forms of bills*. Weaker responses stated allopatric speciation, Darwin's theory of evolution or co-dominance, hence suggesting a lack of in-depth understanding of the topic. Teachers must ensure that this topic is adequately covered in classes.

Module 3

Question 6

Syllabus Objectives: 1.1, 1.3, 2.4, 2.5

Highest Mark: 15 Mean mark: 5.47 Lowest mark: 0

The aim of this question was to examine candidates' knowledge of vegetative propagation and their understanding of the advantages and disadvantages of tissue culture as a tool for plant production. Knowledge of the strategies for promoting self-fertilization was also tested in Part (b).

Overall, performance on this question was not as good as expected. Part (a) (i) was generally well done. The weaker candidates failed to give a precise definition such as the *ability of plants to produce new plants from existing vegetative structures by asexual means*. In some responses instead of giving a definition, several examples of vegetative reproduction, such as cuttings and buddings, were stated. Some candidates did not mention that the process occurs in plants.

Part (a) (ii) posed a great deal of difficulty as candidates failed to discuss the advantages and disadvantages of tissue culture and simply stated relevant points. This resulted in either incomplete or superficial responses where candidates failed to discuss implications. Teachers must provide guidance as to what is expected when a question requires a discussion of information. A common misconception was that candidates referred to genetic engineering as an example of tissue culture.

Part (b) (i) required a simple distinction between pollination and fertilization. Less than 50 per cent of the candidates were able to gain full marks for stating that the *pollen grain was transferred from the anther to the stigma* and many more did not mention that *a zygote was produced after fusion of male and female gametes*. A common misconception was that fertilization only occurred in humans/animals and many replaced the term zygote with embryo. About 50 per cent of the candidates who attempted Part (b) (ii) scored full marks. Weaker responses described how a flower is adapted for insect and wind pollination instead of describing strategies to promote cross-fertilization. Candidates were expected to describe any two strategies such as *being dioecious, protandry/protogyny, self-incompatibility and shape or arrangement of flowers*. In some responses, the strategies were simply stated with no attempt to describe them.

UNIT 1**Paper 032 – Alternative to the School-Based Assessment (SBA)****Unit 1****Module 1**Question 1

Syllabus Objectives: 1.10

Highest Mark: 13 Mean mark: 8.96 Lowest mark: 4.0

This question examined candidates' ability to conduct an experiment based on given instructions.

Part (a) (i) assessed candidates' ability to conduct two food tests and record observations. A variety of colours were recorded as the end result for both the Biuret and the Benedict's tests. This suggests that the reagents available in many centres were either contaminated or past their expiration dates. It is recommended that centres selected for the conduct of Paper 032 examinations should ensure that they have access to adequate fresh supplies of reagents prior to an examination. A few candidates were able to score full marks for this part of the question.

For Part (a) (ii), there was some minor confusion in identifying the correct test being done in Procedure 1. Candidates commonly named the test for protein as the reducing or non-reducing sugar test. It is suggested that candidates pay more attention to learning the correct names for each food test.

In Part (a) (iii), most candidates accurately deduced that the first two tubes contained the nutrient but many could not identify the nutrient as protein, as well as the fact that tubes presenting no colour change/blue colour had no proteins.

As was the case in Part a (i), for Part (b) (i), candidates obtained a vast range of colours for the Benedict's test. Every colour in the spectrum was offered as an observation including purple and pink. The concept of the reducing and non-reducing sugar tests is one that needs to be more thoroughly reviewed as there were many incorrect responses for Part (b) (ii). Most candidates were able to deduce that D contained distilled water but did not pay attention to the fact that the question asked specifically about the test tubes used in Procedure 2. The correct answer, D2, was not offered in most cases.

In the majority of responses for Part (c) (i), candidates did state two of the three expected tasks needed before testing whole beans for a nutrient. Crushing and dissolving in water were commonly cited but very few mentioned filtering to get an extract. Stating a source of error was not well done but a few candidates managed to give a correct response.

Module 2Question 2

Syllabus Objectives: 2.1, 2.2, 2.3

Highest Mark: 12 Mean mark: 6.0 Lowest mark: 0

Observing a specimen using a microscope, making representative drawings and solving a genetic problem on dihybrid inheritance were the skills examined in this question.

Overall, Part (a) was very badly done. For Part (a) (i), very few candidates produced drawings of the stages of mitosis, in onion root tip, that were consistent with what should have been observed from a root tip slide. Most representations were evidently textbook interpretations of what candidates should have observed. Few were able to correctly identify the stages drawn but many were able to correctly sequence the named stages for Part (a) (ii), again suggestive of memory/recall rather than analysis of given material. The correct response for Part (a) (iii) is *cell plate* but all responses indicated cell wall.

Those candidates who attempted Part (b) gave adequate responses with many correctly stating *RRSS* as the genotype for the homozygous purple-coloured flower for (b) (i). Not many candidates attempted to complete the Punnett square but those who did were able to gain full marks. Very few attempted Parts (b) (iii) and (iv) and of those who did, even less were able to correctly deduce that phenotype of crossing a heterozygote with a homozygote was a purple flower and to suggest how the cross would have been different if both parents were heterozygous.

The overall impression, based on the responses to Question 2, is that the candidates were under-prepared for microscopy and genetics. Greater efforts should be made to adequately prepare candidates for this practical examination.

Module 3Question 3

Syllabus Objectives: 4.5

Highest Mark: 16 Mean mark: 12.26 Lowest mark: 6.0

Data management and analysis were the skills being tested in this question.

In Part (a) (i), the bar charts were very well done with one exception. Many of the responses failed to give a suitable title. More stringent adherence to guidelines for doing graphical representations may prove beneficial. Identifying and describing trends from a graph continues to be a challenge for candidates. However, most candidates were able to identify at least two of the three expected trends. Transcribing data from a graph into a table format and interpreting data, as expected for Parts (b) (i), (ii) and (iii), were both well done. However, most candidates scored zero for Part (b) (iv), signalling that development of critical thinking skills is needed.

UNIT 2**Paper 02 – Structured/Essay Items****Section A – Structured Items****Module 1**Question 1

Syllabus Objectives: 1.1, 2.4, 2.9, 3.4

Highest Mark: 15 Mean mark: 8.25 Lowest mark: 0

This question tested candidates' knowledge of the structure of the dicot leaf and the practical skill of doing a detailed drawing. Knowledge and understanding of biological pyramids were tested in the second part of the question.

The question was generally well done. For Part (a) (i), the majority of responses correctly identified the labelled structures as *epidermal cells*, *palisade cells*, *veins/vascular bundle* and the *stoma/guard cell*. Common errors were epithelial cells for A and stroma for D. Many candidates gained at least three marks for the detailed drawing of the highlighted section of the photomicrograph in Part (a) (ii). Several candidates were unable to produce drawings with accurate magnifications and proportions, and omitted key cellular details. Most candidates were unable to calculate the actual width of the specimen and some did not state the appropriate unit of measurement.

For Part (b) (i), many candidates were unable to score the full two marks for the definition because they failed to give a comprehensive definition of the term 'biological pyramid', for example, *a diagrammatic representation of the feeding relationships between organisms in an ecosystem*. A misconception was the use of the term 'food chain' instead of 'ecosystem' in the definition. Not many candidates were able to identify the pyramid as a pyramid of energy or to explain the significance of a pyramid of energy. Many replicated the details shown on the pyramid instead of highlighting *energy loss as it is transferred from one trophic level to the next*.

Module 2Question 2

Syllabus Objectives: 1.6, 5.2, 5.5

Highest Mark: 15 Mean mark: 8.61 Lowest mark: 0

This question tested candidates' knowledge of the apparatus used to investigate the effect of environmental factors on the rate of transpiration. The second part of the question focused on the mammalian nephron and examined candidates' understanding of water conservation and the role of the loop of Henlé.

For Part (a) (i), most candidates seemed to know that the syringe was used to reset the reading or to replace the water removed. However, there appeared to be some misconception concerning the role of the syringe as several responses indicated that the syringe was used to remove the bubbles from the apparatus or to move the bubbles along the capillary tube. For Part (a) (ii), some students had

difficulty stating two precautions. Teachers should highlight this aspect when discussing experiments. Popular answers included *cutting the shoot under water* or *setting up the apparatus under water* among others.

Part (a) (iii) was not done very well as several responses failed to state both distance and time, giving instead an incomplete answer. A few candidates gave volume and diameter of the bore of the capillary tube as their response. It should be noted that volume is not a visible measurement in the capillary tube but must be calculated. Part (a) (iv) was well done with the majority of candidates gaining the full marks for stating that the experiment must be repeated to ensure reliability.

Part (a) (v) proved challenging for most candidates with a few candidates attaining the full two marks awarded for this section. Candidates were expected to state that the plant would be exposed to the sunlight and the control of the investigation would be under dark conditions. Also, candidates had difficulty in understanding the term ‘control’, a feature noted in the reports of the School-Based Assessments.

Less than half of the candidates were able to gain the full marks for Part (b) (i). Some candidates lacked a sound understanding of functions of the regions of the Loop of Henlé. Most of the candidates scored the one mark for Part (b) (ii) for stating *that energy was required for active transport*. A few candidates simply stated that the numerous mitochondria were required for active transport which was already given in the rubric. For Part (b) (iii), approximately half of the candidates attained full marks for giving a clear statement that the urine would be more concentrated in small desert mammals and that the loop of Henlé would be longer. Some gave juxtamedullary nephron as a response and neglected to focus on the Loop of Henlé as required. Part (b) (iv) was generally well done as candidates were able to identify the two regions as being Bowman’s capsule/glomerulus/ basement membrane/renal corpuscle and the proximal convoluted tubule.

Module 3

Question 3

Syllabus Objectives: 1.3, 1.4, 3.5, 3.6

Highest Mark: 15 Mean mark: 9.14 Lowest mark: 0

This question was designed to test candidates’ understanding of incidence rate and ability to analyse data and reproduce a bar graph of given data. The second part of the question focused on knowledge of the HIV life cycle and routes of transmission.

Overall, this question was well done with many candidates giving satisfactory answers. In some instances, almost full scores were awarded. It is clear that candidates had a good understanding of the relevant topics.

Part (a) (i), worth two marks, posed some difficulty as candidates failed to explain that incidence rate was *the number of new cases of diseases occurring during a given period in a given population*. Most candidates scored one mark for recognizing that it was the occurrence of a disease during a given time in a given population but neglected to mention new cases. Part (a) (ii) was designed to test candidates’ ability to draw a bar graph to represent the data for two countries. Common errors

included drawing of a histogram instead of a bar graph, the drawing of two separate bar graphs and the omission of a key. Most candidates were able to plot the points accurately and use bars of the same width. The axes were, for the most part, accurately labelled and candidates easily scored three marks or more out of the five. Very few candidates scored full marks in Part (a) (iii) because of inadequate comparisons of the trends shown. Candidates easily determined that the rates were higher for one country compared to the other but only some of them were able to score the second mark for observing that the rates of one country fluctuated more than the other.

About 30 per cent of the candidates answering Part (b) (i) were able to concisely describe the stages highlighted in the diagram of the replication cycle of the Human Immunodeficiency Virus. Candidates who attained high scores accurately stated that

- *the virus injected its RNA into the host cell*
- *reverse transcriptase was used to make viral DNA from viral RNA*
- *viral DNA was incorporated into the host DNA*
- *virus breaks free from host cell*

Common misconceptions were that the entire virus entered the host cell, virus RNA entered the host nucleus and that the virus cloned itself as it left the host cell.

The two distinct routes required in Part (b) (ii), by which HIV can be transmitted to humans, were almost always given. Candidates performed well as over 95 per cent accurately stated any two of the following: *blood transfusion, across placenta, during breast feeding or sharing needles.*

Section B – Essay Items

Module 1

Question 4

Syllabus Objectives: 1.3, 2.7

Highest Mark: 15 Mean mark: 7.02 Lowest mark: 0

The main topics examined in this question were phosphorylation and the nitrogen cycle.

Generally, Part (a) was well answered by the majority of candidates who gave expected responses indicating a sound knowledge of phosphorylation. Some candidates simply responded by stating that ‘phosphorylation involved the addition of a phosphate molecule’ without identifying the recipient of the molecule. Other candidates stated either a ‘substance’, or a ‘compound’, and a few gave the initial steps of glycolysis as the only means of describing the process.

In distinguishing between photophosphorylation and oxidative phosphorylation, many candidates stated that photophosphorylation involved the use of light from the sun to manufacture ATP but many were unable to accurately distinguish this description from oxidative phosphorylation by outlining, for example, that the latter is the *process in which most ATP molecules are made by ATP synthase enzymes in the respiratory chain and that the process requires oxygen.* A clear understanding of the concept, that, in photophosphorylation the source of high energy electrons is water compared to organic molecules, as occurs in oxidative phosphorylation, was not evident in responses.

Part (b) of the question was generally well done with the majority of candidates giving an acceptable discussion of similarities and differences between the two processes mentioned before.

Part (c) (i) was the most comprehensively done section of the question. Many candidates were able to gain most of the marks by detailing the particular steps involved in the three processes, *nitrification*, *denitrification* and *nitrogen fixation* as expected. Using nitrogen fixation as an example, a typical response was ‘this involves the fixing of atmospheric nitrogen to be used by plants’ with no mention of steps, the organisms or environmental factors involved; similar responses were given for the other two aforementioned processes.

Part (c) (ii) was reasonably done, many candidates achieved more than half of the allocated marks. Despite this, many candidates did not link the statement outlining the problem to the nitrogen cycle, to which the question related.

Module 2

Question 5

Syllabus Objectives: 2.5, 3.10, 3.11, 3.12

Highest Mark: 15 Mean mark: 4.96 Lowest mark: 0

This question examined candidates’ understanding of haemoglobin as an efficient carrier of oxygen and knowledge of the oxygen dissociation curve. The second part of the question dealt with translocation and understanding of the mass flow principle.

For Part (a) (i), many candidates were able to gain at least two of the allocated four marks awarded for explaining why haemoglobin is an efficient carrier of oxygen. Candidates were expected to state that *the haem group binds to the oxygen molecule and up to four molecules of oxygen can be transported*. Candidates with a clear understanding of the process mentioned *co-operative binding of oxygen molecules* to the haem group. Additionally, many candidates were able to state that *haemoglobin binds reversibly to oxygen*. Several candidates incorrectly wrote about the adaptations of the red blood cell for transporting oxygen instead of haemoglobin. Part (a) (ii) was the most challenging part of the question for many candidates who explained rather than described the shape of the graph. When describing a graph, reference to information from the x-axis should be related to information from the y-axis. One obvious feature is the fact that *the curve is ‘S’ shaped (sigmoid)*. Other features include the fact that *the initial part of the curve is steep*, that *the curve plateau (flattens)* or that *beyond a certain point, increasing the partial pressure of oxygen does not alter the shape of the curve*. Common misconceptions were: (1) that the sigmoid curve is drawn as the letter ‘S’ and (2) a discussion on the Bohr effect was required rather than a description of the oxygen dissociation curve.

Part (b) (i) was generally well done by candidates. Teachers should ensure that required definitions are thoroughly covered. In Part (b) (ii), many candidates were able to gain the one mark awarded for this part of the question, outlining the mass flow principle, by stating that mass flow is the *bulk transport of materials from one point to another as a result of pressure differences between the two points*. In teaching this topic, the distinction between a process (translocation) and mechanism of the process (mass flow) must be highlighted. Correct experimental evidence included the *use of aphids and the ringing of the bark of trees*. These two pieces of experimental evidence were most frequently

quoted. Other acceptable answers included a *description of the movement of viruses when exposed to light in the phloem and the observation of mass flow in microscopic sections of living sieve tube elements*. In discussing the evidence, candidates were expected to mention that a pressure difference was observed, hence the link to mass flow principle.

Module 3

Question 6

Syllabus Objectives: 2.4, 2.5, 4.2, 4.3

Highest Mark: 15 Mean mark: 5.70 Lowest mark: 0

Knowledge of the differences between cell-mediated and immune responses, and understanding of physical and psychological drug dependency were examined in this question.

The section dealing with the immune responses was poorly done by the majority of candidates who experienced difficulty in giving clear distinctions for cell-mediated and humoral. For Part (a) (ii), while many candidates seemed to understand what was required, several had difficulties in using their knowledge to explain the immunological process and simply stated information. A good understanding of primary and secondary responses was evident but explanations were vague or not logically presented.

Distinguishing between physical and psychological dependence on drugs was reasonably done by candidates. Once again, knowledge was evident but points were not well written. In attempting to explain the possible effects of long-term consumption of alcohol, candidates did not clearly distinguish between physical manifestations and possible outcomes, for example, *brain damage leading to loss of short-term memory*. Some candidates failed to note that the question focused on the nervous system and therefore answers dealing with the liver were unacceptable.

UNIT 2

Paper 032 – Alternative to the SBA

Question 1

Syllabus Objectives: 2.8

Highest Mark: 13 Mean mark: 8.73 Lowest mark: 5.0

In this question, candidates were required to design an experiment to determine the rate of respiration in seedlings.

For Part (a) (i), candidates displayed a good working knowledge of the procedure and the majority of them managed to list at least six steps. However, there were common errors as follows:

- Many candidates could not identify a suitable control in the method described.

- Many candidates could give only vague details on how to measure the rate of oxygen uptake.
- Most methods described did not include 'enough time for equilibrating'.

In Part (a) (ii), limitations of the procedure were also not well described, a shortcoming often encountered in practical exercises. Candidates seemed unable to distinguish between a precaution, a source of error or a limitation. For Part (a) (iii), about half of the candidates correctly stated the purpose of the soda lime granules (to absorb carbon dioxide) and the glass beads (to control) used in the investigation.

In Part (b) (i), though candidates elected to show working, many did not generate the correct answer. In teaching experimental procedures, greater attention needs to be given to the calculation of rates. The difference between the rate of oxygen consumption at 25°C and 35 °C was clearly identified but the explanations for the faster rate at the higher temperature was not obvious to many of the candidates.

Question 2

Syllabus Objectives: 3.1, 3.2, 3.9

Highest Mark: 11 Mean mark: 5.09 Lowest mark: 1.0

This question was designed to test drawing skills using a mammalian blood smear and section of a blood vessel. Overall performance for this question was poor as microscopy and ability to produce a reasonable quality drawing continue to be weak areas for candidates.

Part (a) (i) was the weakest section in the question. Candidates were rarely able to correctly identify the white blood cells on the slide. The drawings suggest that candidates, at some centres, observed what was intended but failed to correctly identify the cells. Despite the poor performance, it should be noted that the clarity of the drawings was generally good. The calculations of the magnification were incorrect and it would seem that candidates were unable to convert μm to mm/cm.

The plan drawing done for Part (b) (i) had several common errors as follows:

- Most candidates labelled the layers incorrectly.
- In most cases the tunica intima was not shown as being wrinkled.
- Most candidates had too many layers or included details for the required plan drawing.

However, even though not appended to the labels, the quality of the annotating notes was good.

Question 3

Syllabus Objectives: 4.5

Compulsory question: Maximum Marks = 16

Highest Mark: 16 Mean mark: 10.82 Lowest mark: 9.0

Data management and analytical skills were examined in this question.

In Part (a) (i), the graph was well done but with one common flaw — few candidates recognized the need to show the y-intercept of the graph, perhaps because no zero value was provided in the data table. For Part (a) (ii), most candidates could clearly identify at least one limitation that would affect the interpretation of the collected data on smoking and the incidence of cancer.

For Part (b) (i), the description of the findings of the survey was also fairly done with most candidates correctly identifying the trend. Part (b) (ii) was badly handled. Most candidates recognized the correlation between smoking and cancer but few of them were able to account for the correlation. Where candidates managed to identify the carcinogen in the cigarette, they failed to show how it led to cancer. There was very little mention of tobacco's carcinogens switching on oncogenes or altering genes so that uncontrolled mitosis occurs. In Part (b) (iv), most candidates correctly concluded that *smoking promotes cancer*.

General and Specific Recommendations for Teachers

The importance of focusing on concepts and ensuring that these are adequately taught is once again emphasized. While factual knowledge is important, such knowledge cannot be readily applied if there is little or no understanding of the basic principles. The absence of such understanding is evident in the poor responses to questions requiring some critical thinking or synthesis of information. Also, greater attention must be placed on ensuring that students are able to correctly spell technical terms and understand the rubrics of a question, in particular, 'discuss' and 'distinguish'. Finally, the importance of mastering practical skills must be conveyed to students as these skills will be examined in the final examination papers.

General Issues Concerning Paper 032

Again, concerns were expressed about inadequate preparation at centres for the practical examinations, especially with respect to the availability of appropriate materials and equipment, for example, slide specimens, solutions for experiments and functional microscopes.

General Comments on the SBA

Overall, a marginal improvement was observed with respect to the quality of the SBAs and the skills assessed. For Unit 1, Drawing Skills (DR) continue to be below the expected standard and, therefore, the weakest of the skills assessed for this unit. This weakness is clearly reflected in the poor performance of candidates on questions testing drawing skills (for example, Question 3 in Unit 1). In Unit 2, the skills, Planning and Design (PD) and Analysis and Interpretation (AI) still pose a

challenge for several teachers and students. Teachers are reminded that each laboratory activity/experiment should only be assessed for two skills at any given time. A minimum of a pair of practical exercises must be used to provide the average score for each skill. Despite this, teachers still have to reinforce the standards expected by practising and presenting additional experiments apart from those being moderated in the skill area (AI, DR, P&D, ORR and MM). Finally, it should be noted that these skills are assessed in Section A questions for both units.

Scores which are recorded on the moderation sheet need to be expressed as an average and also as a whole number and not as a fraction. Finally, the mark awarded for the assignment must be clearly shown and presented out of a score of 12. Teachers are reminded that the gained score along with constructive feedback must accompany each assignment/laboratory activity marked. Feedback affords students the opportunity to improve future assignments.

Planning and Design (PD)

- Hypotheses need to be logical and testable and ideally test for ONE variable.
- Aims must be concise and clearly stated.
- A complete list of all materials and apparatus to be used must be stated. Items critical to the execution of the proposed method should not be omitted.
- Methods/ Procedures need to be in instructional/point form.
 - A control is essential and should be evident in the method proposed; simply identifying the controlled variable is not enough.
 - Repetition of the procedure under identical conditions is needed to ensure accuracy.

Wholesale replication of textbook laboratory exercises was still seen, and, far too often. This practice continues to limit students in attaining high scores for this skill. Teachers must guide their students in the formulation of authentic Planning and Design exercises. Other areas of concern include the poor formulation of hypotheses and related aims. Also, the reliability of any experiment hinges on the repetition of findings. The use of a control experiment is also essential in such experiments and need not be confused with a control variable. In several cases, too many variables were being tested at once, thus creating difficulty in producing an applicable Aim. Finally, there were still some cases where the laboratory exercises used were inappropriate for the skill(s) being assessed. Research projects, if used for PD assessment, need to follow the CAPE PD mark scheme.

Analysis and Interpretation (AI)

One of the AI criteria requires that background information accompany the analysis of results. Data collected must be used to highlight trends/comparisons. Linking these trends with/to supporting literature/background information as a basis for reinforcing findings is important and critical. The use of drawings and electron micrographs for assessment of AI skill is inappropriate. Formulation of a conclusion that summarizes the findings from observations and data (with reference to the link between data collected and the aim) is essential. Generally, conclusions were of poor quality because the aim of the experiment was poorly conceived.

These areas for immediate improvement were highlighted by moderators:

- Adequate inclusion of background information
- Deducing trends and relationships from data collected
- Presenting concise explanations of the observed trends and relationships
- Understanding the relationship between data obtained and the original aim/hypothesis of the experiment

Limitations are uncontrolled occurrences that have to be worked around and their impact must be considered when analysing the raw data. A source of error may also be a limitation. However, a precaution is what is done, to the apparatus or materials, as a preventative measure. It ensures that execution of the method occurs flawlessly.

It is suggested that territorial workshops and internal standardization of teachers responsible for SBA's at a given centre, be implemented. This will provide candidates with all the necessary tools to produce work of the highest quality. Perhaps this could be done using the technology and by distance learning.

Drawings

There is still great concern in this area of assessment. Some teachers have allowed students to submit textbook drawings as their own. It is important that students provide true representations of specimens/slides provided and examined. Reproductions of drawings in textbooks are not appropriate for assessment of drawing skills.

An assessment of drawings is based on the following criteria:

- Clarity of drawing
- A selection of cells that is truly representative of the section being viewed.
- A low power plan of the tissues and high power details of a *few* representative cells should be done for each specimen. There is no need to attempt to draw all the cells seen.
- Faithfulness and accuracy in recording the drawing
- Having correct proportions of all components of the specimen is essential.
- Title must be placed at the bottom of the drawing, in uppercase and underlined.
- The view must be stated in the title, where applicable, for example, L.S (Longitudinal Section)/Whole Mount etc.
- Neat placement of labels and annotations.
- Justification of labels to the left, right or evenly distributed on either side of the drawing is expected.
- Magnifications **must** be calculated and all working shown. The correct size of the specimen needs to be used in the calculation.

Adherence to these guidelines will afford candidates the opportunity to attain high or even full scores for this skill.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®**

MAY/JUNE 2012

BIOLOGY

GENERAL COMMENTS

The CAPE Biology examination is based on three papers for each unit covered in the syllabus: Paper 01, a multiple-choice paper consisting of 45 compulsory items, 15 from each of the three modules; Paper 02 consisting of six compulsory questions, two from each of the three modules and Paper 032, an alternative practical paper for candidates who do not register for the School-Based Assessment. Paper 02 is divided into two sections: Section A with three structured questions, one from each module, and Section B with three essay questions, one from each module. Each question on Paper 02 is worth a total of 15 marks.

The modules in each unit are:

Unit 1

- Module 1 Cell and Molecular Biology
- Module 2 Genetics, Variation and Natural Selection
- Module 3 Reproductive Biology

Unit 2

- Module 1 Bioenergetics
- Module 2 Biosystems Maintenance
- Module 3 Applications of Biology

DETAILED COMMENTS

Paper 01 – Multiple Choice

The performance of candidates on Paper 01 improved significantly for both units. This was particularly striking for Unit 1 where the percentage of candidates in the Grade I category doubled (60 per cent) compared with 2011. Also for both units, the percentage of failures showed a marked decline to about 3 per cent. For both units, performance across the modules was consistent and no questions proved especially challenging for candidates.

UNIT 1

Paper 02 – Structured/Essay Questions

Section A – Structured Questions

Module 1

Question 1

Syllabus Objectives: 1.1, 1.5, 3.3

Highest Mark: 15 Mean Mark: 8.19 Lowest Mark: 0

Part (a) tested candidates' knowledge of the properties of water as well as an understanding of the importance of one of these properties to life. Part (b) was designed to evaluate the skill of plotting a line graph using water potential data, as well as the ability to describe and interpret the given data. Part (c) examined candidates' knowledge of the structure of a triglyceride.

Generally, the question was fairly well done with a small percentage of candidates attaining full marks. However, performance was found to be average for the majority of candidates; approximately 60 per cent of the responses were awarded scores ranging from six to ten marks.

In Part (a), some candidates were able to score all three marks by identifying the appropriate properties — *cohesion/adhesion and high specific heat capacity* — as well as correctly stating the importance of solubility to life. Most candidates scored only two marks because they were unable to state that water allows for solubility of compounds in order for these *to be transported or moved into and out of cells* or that *biochemical reactions occur in solution*. Teachers should ensure students understand fully the difference between how water acts as an excellent solvent of many substances and its importance to living organisms as a consequence of being a very effective solvent; the same approach should be applied for other properties of water. It should be noted that all substances have a specific heat capacity but water has a particularly **high** specific heat capacity and this contributes to its importance to life.

Overall, Part (b) (i) was reasonably well done with almost every candidate attempting to draw the graph. Most candidates scored at least two marks in this section with a number of candidates scoring full marks. Candidates were able to plot *at least six points accurately and produce a smooth curve*. However, marks were lost for *not stating the scale at the axis, not naming the x-axis or not including a title for the graph*. Many candidates who stated a correct scale for the graph failed to implement the scale at the x-axis. Instead, they plotted the values given for time of day equidistant along the x-axis and consequently the mark could not be awarded; some candidates did not know which was the x- or y-axis. Despite a noticeable improvement in the quality of graphs over the past few years, teachers should

continue to place emphasis on how various graphs are drawn in both practical and theoretical coverage of topics in the CAPE Biology syllabus.

Part (b) (ii) proved to be the most difficult section for candidates as the concept of water potential continues to be a challenge. In their description, candidates were expected to identify the three major changes in water potential in relation to time of day to gain a mark and then account for those changes in terms of *absence of sunlight, no water loss at night as stomata are closed or due to cooler temperatures at nights* and the *reverse during the day* to gain the remaining two marks. Candidates focused mainly on the description of the graph rather than accounting for its shape as required by the question. In their descriptions, candidates described the line as ‘zig-zag’, ‘U’ or ‘W’ shaped rather than describing the graph in relation to the values given in the x-axis and in the y-axis. Teachers should encourage students to highlight the critical features on the graph or table by using arrows or some other distinguishing label. This would help them to refer to these aspects of the data in their description. Teachers should also ensure that students fully understand the difference(s) between the terms *account* and *describe*. It should be noted that the general description of a graph and its interpretation are skills required for the analysis and interpretation activity in the School-Based Assessment component of the examination.

Part (c) (i), which was based on a diagram of a generalized triglyceride, was well done. Most candidates were able to identify *the glycerol and fatty acid chain/long hydrocarbon chain* parts of the structure. Also, Part (c) (ii) was well done with candidates clearly identifying the ester bond. However, some candidates in identifying the bond correctly included a label other than ester bond, for example, glycosidic bond. Part (c) (iii) proved problematic for some candidates. The question asked for a feature of the triglyceride which makes it a good energy molecule. Candidates were supposed to focus on the *higher proportion of hydrogen atom, long hydrocarbon chain, more C–H bonds or carbon atoms and much less oxygen compared to carbohydrates*. Instead, some candidates cited the insolubility of the molecule.

Generally, in answering a question, students should be encouraged to highlight a few key words in the stem, especially the command word so that the focus of the question is indicated. Also, they should know the differences between the command words. (This is given in the CAPE Biology syllabus.) This skill as well as others, for example, analysing data given in graphs and tables, can be practised in class and internal school examinations.

Module 2

Question 2

Syllabus Objectives: 1.2, 5.7

Highest Mark: 15 Mean Mark: 6.08 Lowest mark: 0

Part (a) focused on knowledge of some of the main steps in DNA replication and understanding of the significance of the term *semi-conservative*. Data on directional

selection was used for Part (b) to determine/test candidates' ability to interpret data on natural selection, presented graphically, and recognition of the type of selection.

Performance on this question was found to be satisfactory; Part (a) was widely known while Part (b) proved difficult for candidates. About 50 per cent of the responses attained scores of between six and ten marks while a small percentage of candidates were unable to gain any marks at all.

Overall, Part (a) (i) was well done. Candidates were required to give concise descriptions of the events, indicated at steps labelled 1, 2 and 3, of a DNA molecule during replication. Answers for Steps 1 (initiation) and 2 (elongation) were generally of a higher standard than those for Step 3 (termination). Some candidates could not be awarded the marks as their responses did not correctly match the highlighted steps even though the information given was accurate for DNA replication. Many candidates wrote about transcription and translation of protein synthesis instead of DNA replication. More than 50 per cent of the candidates scored at least two of the allotted six marks, with many scoring full marks. For Part (a) (ii), candidates were required to comment on the significance of the fact that DNA replication is semi-conservative. Many were able to score at least one of the two marks for stating either that *one half of the original strand is always saved* or that *this allows for exact copying of genetic material*.

Part (b) (i) explored candidates' ability to interpret data given in two graphs showing the effect of drought on a population of ground finches. Most candidates focused on the given information of population numbers and many did not refer to the frequency distribution. Many candidates scored one mark for stating that *the average beak depth increased after the drought* and then scored the second mark for quoting the values (*from 9.4 to 10.1 mm*) as instructed. Very few candidates stated that *drought favoured the survival of finches with the greater beak depths* or that *there was a decline of the number of finches with smaller beak depths (from 6 to 8 mm)*. Nonetheless, most candidates scored two of the allotted four marks.

In Part (b) (ii), candidates were required to use a simple diagram to illustrate *directional selection*, which was the type of selection illustrated by the data in Figure 3, for one mark and then make a comment for a further two marks. This section presented difficulty to candidates as few were able to draw a good diagram to illustrate directional selection. There were many 'sketchy' drawings of one curve that attempted to show directional selection and many interpreted the data graphs as showing stabilizing or even disruptive selection. Also, there were drawings of birds with increasing beak depths but with no descriptive annotations.

The comment for two marks required candidates to state '*directional selection*' and then to comment that *birds with short beak depth were selected against or died or, that birds with long beak depths were selected for or survived, and this caused a shift in the distribution to the right*. Many candidates described natural selection in general and not directional selection. However, some candidates were able to score the full three marks.

Module 3

Question 3

Syllabus Objectives: 2.2, 3.10

Highest Mark: 15 Mean Mark: 3.49 Lowest Mark: 0

For Part (a), candidates were provided with an incomplete diagram showing stages in the development of an embryo sac and were expected to complete the diagram for two missing stages. In addition, they were required to identify the point at which meiosis occurred and location of the female gamete. In Part (b), candidates were asked to identify five structures in a schematic diagram of the human placenta, and to comment on the function of one of the structures.

Generally, this question was not well done as only a small percentage of candidates were able to score more than 10 of the 15 allotted marks. Part (a) (i) proved to be quite challenging for some as in many of the responses diagrams were poorly done, incomplete or simply incorrect. Common errors included lack of correct orientation of the cells in the embryo sac for Stage A and, for Stage B, improper representation of the female gamete, antipodals and synergids as cells, and the polar nuclei as nuclear structures. While the majority was able to correctly indicate where meiosis occurs (C), not all were able to identify the female gamete (D). Too many candidates labelled the gamete based on recall of textbook material rather than in relation to the diagram drawn for Stage B. Part (a) (iv) was generally not well done as the majority of candidates were unable to score full marks. Some repeated information given in the stem while others gave incorrect or incomplete comparisons. Also, candidates seemed to be confused by the use of the term *angiosperm*.

In Part (b) (i), despite the use of a common textbook diagram of a section of the placenta of a mammal and inclusion of guiding labels, many candidates incorrectly identified the foetal artery and vein as being renal artery or pulmonary artery and vein. However, some responses correctly identified all the stipulated structures. Part (b) (ii) proved to be the most challenging section as in more than 70 per cent of the responses structure E, the *lacuna*, was identified as the amnion and as such the incorrect function was given, that is, shock absorption instead of *exchange of substances between mother and foetus or to prevent mixing of maternal and foetal blood*.

Section B – Essay Items

Module 1

Question 4

Syllabus Objectives: 2.2, 2.3, 2.7

Highest Mark: 15 Mean Mark: 5.08 Lowest Mark: 0

This question examined candidates' knowledge of the structure of two organelles, chloroplast and mitochondrion, and understanding of the difference in their main functions. Knowledge of the difference between a tissue and an organ was examined in Part (b).

This question was reasonably well done with about 20 per cent of the candidates gaining above average marks. In Part (a) (i), candidates were unable to gain full marks as clear descriptions of three structures were not given. Many mistakenly referred to both the mitochondria and the chloroplast as cells instead of *organelles*, or stated structures common to both without giving relevant details. For example, the majority of candidates simply identified *membranes* but failed to add *double*, or simply neglected to describe characteristics of the double membrane, that is, *outer layer is smooth while the inner is folded (branched)*. Also, some correctly identified *ribosomes* as a structure common to both organelles without giving a description, for example, *70s* or *small* or *unbound*. Similarly, *DNA* was listed but no mention was made of the fact that it is *circular*. For Part (a) (ii), many candidates were unable to identify the main function of both organelles and instead gave details of photosynthesis and respiration. Others focused on a difference in structure rather than function.

In Part (b), a high percentage of candidates gave incomplete answers by simply stating that '*tissues are grouping of cells*', while '*organs are groupings of tissues*', omitting to qualify the explanations by stating that a *tissue has a specific purpose* compared to an organ where *tissues work together for a common major role/purpose*. Many were able to give examples of both tissues and organs but were unable to use the dicotyledonous root to clearly illustrate the difference between the tissue and organ as specified in the question.

Module 2

Question 5

Syllabus Objectives: 4.2, 5.2, 5.3

Highest Mark: 15 Mean Mark: 4.39 Lowest Mark: 0

The ability to distinguish between gene mutation and chromosome mutation was examined in Part (a) (i). In Part (a) (ii), emphasis was placed on testing knowledge of sequence of changes leading to sickle-cell formation, while in Part (b), knowledge of gene therapy and understanding of application of gene therapy for cystic fibrosis was emphasized.

Overall performance for this question was average with only about 10 per cent of responses being awarded more than 10 of the 15 marks. In Part (a) (i), many candidates were able to correctly distinguish between gene mutation and chromosome mutation. Good responses stated that a gene mutation involved a *change in nucleotide sequence in a particular locus* and that this could *occur by substitution or deletion during DNA replication*. While many were able to describe chromosome mutation, not all made the link to the fact that *it is as a result of an error occurring during mitosis or meiosis*. Part (a) (ii) was generally not well done. Candidates were required to describe the sequence of changes triggered by gene mutation in sickle-cell anaemia. Few candidates scored full marks. While the majority stated that the *amino acid glutamine* (hydrophilic) *was replaced by valine* (hydrophobic), only a small percentage identified the *single-base change as being from CTC to CAC*. It was evident that many candidates did understand that the change in amino sequence resulted in a *change in the secondary, tertiary and quaternary structure* of the haemoglobin beta chain molecule but they neglected to mention that this lead to a *reduction in the solubility of the molecule which in turn caused polymerization of Hb S molecules into rigid fibres accounting for the 'sickling' of red blood cells*. Also, in order to gain full marks, the points had to be listed in correct sequence, as required by the question.

Part (b) (i) was fairly well done. Approximately 40 per cent of the responses gained full marks for outlining four key steps as follows: *a copy of the normal gene must be isolated, inserted into a vector, then introduced into the transgenic virus/bacterium, cloned and re-introduced into a patient*. A common misconception was 'cutting out the defective gene and replacing it with a healthy one'. Very few candidates were awarded the full two marks for Part (b) (ii), as many were unable to accurately comment on one difficulty in using gene therapy to treat cystic fibrosis, for example, *problems in method of delivery, treatment being temporary, possibility of patients eliciting an immune response to the viral vector or need for the therapy to target specific cells*. Several candidates mistakenly dealt with the disease and not the gene therapy.

Module 3

Question 6

Syllabus Objectives: 1.1, 1.2, 2.6, 2.7

Highest Mark: 15 Mean Mark: 6.87 Lowest Mark: 0

In Part (a), the aim was to examine candidates' ability to distinguish between binary fission and budding, as methods of asexual reproduction. Part (b) tested candidates' knowledge of stages leading to fertilization after germination, and understanding of the significance of double fertilization.

Overall, the question was generally well done, even though only a small percentage of candidates gained full marks. However, despite the simplicity of the question, some parts posed difficulties for candidates. For example, Part (a) (i) proved to be challenging for a large number of candidates. While the majority of candidates correctly identified binary fission as a *process by which the original organism divides by mitosis to produce two identical cells*, there were many misconceptions surrounding budding. Many candidates did not deal with budding as a form of asexual reproduction and incorrectly referred to budding as the process by which a bud fell off a plant and gave rise to a new plant. However, a few candidates correctly described budding as a *process, not involving mitosis, by which a small part of the parent is pushed out from the parent, becomes detached and then exists either separately or in a colony*.

Part (a) (ii) was fairly well done, with at least 80 per cent of the candidates demonstrating a sound knowledge of the advantages and disadvantages of asexual reproduction. Though many candidates were able to correctly state an advantage and/or a disadvantage, many did not fully discuss these points as expected, for example, *easier as only one parent needed or the fact that lack of genetic variation could be detrimental*. Nonetheless, several candidates gained at least three of the four allotted marks.

Part (b) (i) yielded a range of scores based on the given number of sequential steps leading from germination to fertilization; in some cases responses were below the expected standard. Although fairly well done, there were many candidates who appeared to have misread the question and dealt with pollination rather than germination or who incorrectly focused on pollen grain formation. Good responses gave a clear description of the sequence of events starting with the *formation of the pollen tube, its subsequent growth down the style to the ovary and entry into the embryo sac to end with fertilization*. Included in these responses was the *splitting of the generative nucleus to form two male nuclei which were discharged into the embryo sac via the micropyle upon degeneration of the tube nucleus/bursting of the pollen tube*. Excellent responses mentioned that *both male nuclei were fused with nuclei from the embryo sac or more specifically, with the ovum and polar nuclei respectively* and hence were able to gain full scores.

In Part (b) (ii), the majority of candidates seemed to recognize that double fertilization led to the formation of the embryo and the triploid endosperm. However, many candidates failed to comment on the significance of the event, that is, the *role of the endosperm in providing nourishment for the developing embryo*. This failing contributed to a lower standard of performance. Based on the responses given, it is clear that candidates did not understand what was meant by *significance* and focused more on giving a description.

Paper 032 – Alternative to School-Based Assessment (SBA)

Module 1

Syllabus Objectives: 4.5

Highest Mark: 16 Mean Mark: 13.71 Lowest Mark: 8

Question 1

This question was very well done. Most candidates gained at least 13 of the allotted 16 marks. Candidates were given a list of apparatus and material to investigate the effect of substrate concentration on the rate of reaction of catalase.

Part (a) was successfully done as most candidates recorded the height of bubbles formed; a few candidates gave unrealistic values. For Part (b), most candidates wrote an appropriate title for the table, for example, *Effect of substrate concentration on the activity of the enzyme catalase*. Part (c) was accurately calculated using results obtained. For Part (d), the relationship between substrate concentration and enzyme activity was accurately stated by most candidates. They were able to clearly identify the purpose of distilled water in tubes D and D1 as being the *controls for the experiment* (Part (e)). Part (f) proved to be the most difficult section for candidates. Few were able to include a design which gave the hydrogen peroxide concentration as the controlled variable and the temperature as the manipulated variable in the procedure.

Module 2

Syllabus Objectives: 2.6, 2.7, 3.2

Highest Mark: 16 Mean Mark: 6.84 Lowest mark: 0

Question 2

This question was difficult for most candidates as approximately 50 per cent scored between zero and six marks. In Part (a) (i), candidates were given plastic ties of three different colours and three different lengths. They were required to use this material to construct a model of the structure of a bivalent for two chromosomes at the end of prophase I. In constructing the

model, bivalents, for any one chromosome, should all be the same length, comprising of two pairs of ties with each pair consisting of a different colour and with centromeres correctly positioned. Most candidates failed to construct acceptable models. Areas of weakness included omission of a chiasma in the model, not correctly arranging the bivalents as they appear at the end of prophase of meiosis I, and neglecting to show the cylindrical shape of the centrioles and the radiating spindle fibres or representing them incorrectly.

Part (b) was generally well done with most candidates gaining full marks. Candidates correctly identified the parental genotype for colour blindness as *Male: X^aY and Female: $X^A X^a$ or $X^a X$* and used the Punnett square to accurately demonstrate the cross. However, some failed to correctly represent the gametes even when they gained full marks for Part (b) (i). For Part (b) (iii), many candidates failed to identify the heterozygote as a carrier female; many stated *not colour blind*. A few candidates referred to the colour-blind male as a carrier.

Module 3

Question 3

Syllabus Objectives: 3.1, 3.2

Highest Mark: 14 Mean Mark: 9.44 Lowest Mark: 4

This question evaluated candidates' knowledge of reproductive structures and their functions. Most candidates gained 50 per cent or more of the available marks. Part (a) (i) required candidates to make a labelled plan drawing to show the distribution of tissues in the testis. Many candidates produced high power drawings instead of plan drawings. Of the few who produced plan drawings, some included cells and failed to represent the tissues in correct proportions. Many omitted magnifications and a title. However, most were able to accurately label the drawings.

In Part (a) (ii), most candidates were able to annotate the labels indicating where sperm and testosterone are produced. Few of them identified the role of the tunica albuginea in maintaining the integrity of the testis.

Candidates had their best score for Part (b). Almost all candidates correctly identified labels A to E as the *fallopian tube, ovary, uterus, cervix and vagina* respectively. Most gave correct annotations to indicate fertilization of the ovum occurring in the *fallopian tube* and implantation of the zygote occurring in the *uterus*.

UNIT 2**Paper 02 – Structured/Essay Items****Section A – Structured Items****Module 1**Question 1

Syllabus Objectives: 1.4, 2.5, 2.9

Highest Mark: 15 Mean Mark: 6.2 Lowest Mark: 0

The first part of this question tested candidates' knowledge of the Calvin cycle, understanding of the purpose of the main phases and the difference between this cycle and the Krebs cycle. The second part of the question focused on aerobic/anaerobic respiration and in particular the relationship between oxygen debt and build-up of lactic acid.

Overall, the question was fairly well done with about 15 per cent of the responses being awarded more than ten marks. Part (a) (i) was not well done as many candidates were unable to correctly indicate the stages at which ATP or NADPH is used and, for those who did, several neglected to include the number of molecules. Fairly good responses were given for Part (a) (ii) with at least 70 per cent of the candidates being able to correctly outline the main purpose of the stages, that is, *carbon fixation*, *reduction* and *regeneration*, highlighted in the figure. Some misconceptions included suggesting phosphorylation or focusing on RuBP. Part (a) (iii) seemed to have presented little difficulty as at least 85 per cent of the responses stated a correct difference between the Calvin cycle and Krebs cycle. Some candidates were unable to give a comparative difference, thus suggesting that an understanding of what is required continues to pose problems for candidates. Answers to Part (b) (i) were of a higher standard, with candidates being able to adequately describe changes in blood lactate and glucose levels to gain at least three or even full marks. Poor performance was due to either incorrect comparisons or inaccurate interpretations of the graphs. Part (b) (ii) was fairly well done with some candidates giving excellent responses stating that *blood lactate levels increase because of an accumulation of lactic in the muscles creating an oxygen debt*. A common error was failure to link lactate with the demand for oxygen. Part (b) (iii) was poorly done. Many candidates described the outcome, that is, an increase in the cyclists' performance but did not comment on the significance of this with respect to aerobic performance.

Module 2

Question 2

Syllabus Objectives: 1.1, 1.5, 3.4

Highest Mark: 15 Mean Mark: 4.71 Lowest mark: 0

This question tested candidates' knowledge of certain structures of the mammalian heart and their respective functions. Transport of water and ions in root cells was the main topic being tested in the second part of the question.

Overall performance for this question was below average with about 70 per cent of the candidates scoring less than eight marks. For Part (a) (i), many candidates did not give annotations describing the structures highlighted in the diagram but instead focused on functions; less than 50 per cent of the responses gained full marks. Expected answers included *node (small or compact area) of specialized muscle (myogenic)/nerve cells* for A and C, *thin-walled chamber for B*, *modified cardiac fibres (Purkyne) for D* and *thick-walled chamber* for E. Part (a) (ii) was also not well done as many candidates failed to clearly state the roles for structures A, C and D as being *pacemaker* for A, *delaying or slowing of electrical signal passing down to ventricle* for C and *conducting electrical signal to ventricle* for D. Part (b) proved to be challenging, as either incorrect locations were indicated or arrows were not used, and poor or inaccurate outlines were given for the movement of ions at the locations. Weak or incomplete explanations of the relationship between the movement of ions and water were given for Part (b) (iii) that is, *a high concentration of ions created a more negative water potential causing water to move in the root cells by osmosis*.

Module 3

Question 3

Syllabus Objectives: 1.4, 3.1, 3.3

Highest Mark: 15 Mean Mark: 10.8 Lowest Mark: 1

This question was designed to test candidates' understanding of mortality rate and their ability to plot and analyse data on mortality rates in the form of a bar chart. The second part of the question focused on a balanced diet and analysis of information presented in the form of a pie chart.

Overall, this question was quite well done with approximately 70 per cent of the candidates gaining ten or more marks; full scores were attained by more than one per cent of the candidates. It is clear that candidates have mastered the skill of plotting a bar graph and had a good understanding of the relevant topics. For Part (a) (i), a few candidates mistakenly drew a line graph or a histogram instead of a bar graph as expected. Failure to include a key, to use distinct bars and errors in plotting values accounted for loss of marks. Part (a) (ii) was well

done with the majority of candidates being able to accurately comment on the trends shown for cancer and diabetes. Almost all of the responses correctly identified *heart disease* as the leading cause of death. Part (b) was not as well done. This was in part due to the fact that many candidates were unable to give a complete explanation of the term *balanced diet*, which is the *right types of foods, in correct proportions to supply adequate nutrients or maintain health*. For Part (b) (ii), many candidates did not make reference to information given in the pie chart but instead used their general knowledge of the topic to answer the question. Part (b) (iii) was quite well done as most candidates were able to comment on one health consequence of consuming fats in excess — *obesity, diabetes and heart disease* were popular answers.

Section B – Essay Items

Module 1

Question 4

Syllabus Objectives: 3.2, 4.4

Highest Mark: 15 Mean Mark: 5.82 Lowest Mark: 0

This question tested candidates' ability to explain the terms *species diversity* and *stability* of a community. Additionally, an understanding of why there may be a positive correlation between species diversity and ecosystem stability was examined. The second part of the question focused on candidates' ability to define the term *food chain* in terms of energy flow and to evaluate whether there is an understanding of why a food web better describes energy flow in an ecosystem than does a food chain.

Performance on this question was slightly above average with only about ten per cent of the candidates being awarded ten or more marks. Part (a) (i) was generally lowscoring. Very few candidates were able to fully explain species diversity to incorporate both the *variety of species* present in a community and *their relative abundance*. In teaching the concept of species diversity, it is recommended that teachers distinguish between species diversity and the variation that exists between organisms of the same species, as this was an area in which there were misconceptions. Even fewer candidates were able to give a comprehensive explanation of the *stability* of a community. Many candidates incorrectly referred to stability simply as a *well-balanced ecosystem*. However, the more capable candidates were able to gain full credit by stating that stability was a *measure of the community's ability to withstand change and to recover from change to former levels of species richness after a disturbance*. Part (a) (ii) was fairly well done. Even though most candidates recognized that communities with high species diversity were more resilient and resistant and thus more stable, the responses revealed that the concepts of resilience and resistance were not well understood.

Part (b) (i) was also generally well done. The majority of candidates were able to define a food chain *as the sequence of steps through which the energy stored in autotrophs (primary producers/plants/other photosynthetic organisms) passes to higher trophic levels*. In Part (b) (ii), the majority of candidates explained several ways in which the food web was better at describing energy flow in an ecosystem than the food chain. Candidates typically made reference to the fact that the *food web was more complex than the food chain* as it included a larger variety of organisms. Another common correct response was that the *food web was better able to show the relationships between organisms, as it was a network of interrelated food chains*. Credit was also given for responses which indicated that the food web was *better able to show how one organism could occupy more than one trophic level or may have more than one source of food*.

Module 2

Question 5

Syllabus Objectives: 5.6, 5.4

Highest Mark: 15 Mean Mark: 6.6 Lowest Mark: 0

Synaptic transmission and functions of the human kidney were the main topics examined.

This question was fairly well done with approximately 25 per cent of the candidates gaining ten or more marks. For the first section of Part (a), the majority of candidates gained at least one of the two allotted marks. Unfortunately, some candidates confused *synaptic transmission* with propagation of action potential. In Part (a) (ii), the majority gained some marks and of these many were awarded full marks as they were able to state all of the steps in the *chemical transmission of an action potential across a synapse*. However, some candidates omitted key steps especially, for example, *the neurotransmitter diffuses across the cleft* and *the inflow of sodium ions causes depolarization of post synaptic membrane*. Also, a few candidates did not list the steps in the correct sequence.

Part (b) (i) was reasonably well done with many candidates gaining at least one of the two allocated marks for outlining at least one main function of the kidney, that is, either *excretion* or *osmo-regulation*. Candidates who simply stated two functions but gave no outlines were awarded one mark. Part (b) (ii) proved to be the most challenging for the majority of candidates, in particular the section which required them to explain how the *kidney accomplishes its functions by the process of 'secretion'*. Generally, for all three processes, candidates were unable to link the significance of the process with the main functions. In explaining *ultra-filtration* most candidates referred to *hydrostatic pressure, under pressure, pressure* or *create pressure* without actually stating *high pressure* as expected. The section on how *the kidney accomplishes its function by selective re-absorption* was quite well done, with many candidates gaining the maximum two marks.

Module 3

Question 6

Syllabus Objectives: 2.1, 4.5

Highest Mark: 15 Mean Mark: 4.45 Lowest Mark: 0

In Part (a) (i), candidates were required to explain the term *complement* and outline its role in the body's response to invasion by foreign organisms. Part (b) focused on an understanding of ways in which cigarette smoke may result in breathlessness and difficulty in breathing.

Generally, candidate performance for this question was found to be satisfactory. There was some discrimination between candidates who did very well and those who knew little on the topics of immunity and the effects of substance abuse, and thus gave poor responses. Part (a) (i) presented some difficulty for candidates. While many were familiar with the elements of an immune response, few were able to effectively relate this knowledge to the function of complement proteins in the process. Also, most candidates did not adequately explain the term *complement* as required in the question and therefore gained only one mark for simply stating that complement *consisted of proteins*. A few did mention that the *proteins were inactive* and even less referred to the *cascade of reactions*. Most candidates, who gained additional marks, were able to do so by outlining aspects of an immune response that involved complement such as *phagocytosis* and *opsonisation* of bacteria which dealt with the role of complement.

Part (a) (ii) was fairly well done and many candidates were able to obtain at least two of the three assigned marks. Some candidates were too general in their responses and did not link each aspect to how it occurred. Most of those who gained the marks were able to explain the inflammatory response and could state specifically how each aspect arose, such as the *increase in blood flow (vasodilation) at the infection site for redness, increase in production of phagocytes and their subsequent activities which increased metabolic heat for warmth and the 'leakiness' of blood capillaries at the site resulting in swelling*. Candidates are reminded to take note when terms are highlighted in bold or capitalized in the stem of a question as this is intended to guide them on how to approach the question to arrive at the expected correct response.

In Part (b), candidates appeared familiar with the general content on the effects of cigarette smoke on the body, though some were unable to make the direct connection of these effects to the appropriate disease. Also, some candidates were unable to focus on only those effects of smoking that would affect breathing, and thus dealt with addiction of nicotine or the formation of cancer due to tars. Good responses first referred to the cause of Emphysema as the *breakdown of the alveoli wall by elastase due to the presence of tars/particles, which leads to the reduction in surface area for gaseous exchange and the inability of the alveoli to efficiently recoil and stretch to accommodate fresh air, thus labouring breathing*; Bronchitis

being caused by *build up of particles along the respiratory tract that increases mucus production, narrowing the airways and damaging cilia and lungs leading to breathlessness.*

Paper 032 – Alternative to School-Based Assessment (SBA)

Question 1

Syllabus Objectives: 2.8

Highest Mark: 12 Mean Mark: 4.15 Lowest mark: 0

Overall, this question was not well done as most candidates scored less than 50 per cent of the allotted marks. For Part (a) (i), very few candidates were able to draw a diagram showing how the given apparatus and material could be assembled to determine the rate of oxygen uptake. Even when they successfully drew the diagram, they failed to annotate the labels. Part (a) (ii) was fairly well done as most candidates indicated that the rubber and glass connections must be airtight as a precaution. Many candidates restated precautions when asked to suggest one step that should be taken to ensure the reliability of the results of the investigation (Part (a) (iii)). Expected answers included *taking multiple readings under the same conditions for the same time* or *resetting the apparatus to ensure that the levels of the water in both manometers are the same before the start of the investigation*. For Part (a) (iv), the experiment required candidates to collect and use data to determine the amount of oxygen used by the germinating beans. Only ten per cent of the candidates were able to give an appropriate answer such as *use graph paper to record the initial and final manometer fluid levels* and to *calculate the difference to determine oxygen utilized*. Many candidates knew that the *small plant would carry out photosynthesis in addition to respiration*. However, they struggled to explain that the gases, carbon dioxide (needed for photosynthesis) and oxygen (produced by photosynthesis), would impact on the readings for Part (a) (v).

Question 2

Syllabus Objectives: 1.5, 3.2

Highest Mark: 15 Mean Mark: 9.95 Lowest mark: 5

This question tested candidates' knowledge of the structure and function of vascular tissue in plants and animals. Candidates performed well on this question with more than 70 per cent gaining at least half of the allotted marks. For Part (a) (i), some candidates were able to identify and adequately represent the vein, while others could not distinguish between the artery and the vein or represent the tissue using neat, clean lines in correct proportions. For Part (a) (ii), most candidates were able to get maximum marks for stating two observable differences between the artery and the vein.

Part (b) (i) required candidates to plot given data as a line graph. This part of the question was successfully done by most candidates. However, a few did not label both axes and failed

to use and/or state an appropriate scale. Part (b) (ii) proved to be the most challenging as only a few candidates gained full marks. Many were able to describe the trends but did not suggest a reason for the shape of the graph.

Question 3

Syllabus Objectives: 3.1

Highest Mark: 16 Mean Mark: 12.75 Lowest Mark: 8

This question presented candidates with data on the prevalence of obesity in children of some Caribbean territories and tested their ability to use and analyse that data. Almost all candidates successfully answered Parts (a) (i), (ii) and (iii). In Part (a) (iv), candidates were able to identify that *prevalence of obesity increased in each country and that the percentage increase in each country was different*, along with other trends. For Part (b) (i), candidates were able to identify that *St Vincent had the second highest prevalence of obesity in 1990* and that the increase in prevalence was the *least by 1999*. Many candidates were able to score full marks for discussing four reasons for the increase in childhood obesity in the Caribbean in Part (b) (ii). Few mentioned *inadequate breast feeding* or *early introduction of formula* or *solid foods* as a reason for childhood obesity.

General and Specific Recommendations for Teachers

Understanding of basic concepts is essential at this level and teachers must ensure that these are clearly identified and adequately taught. This is especially critical for certain topics, for example, ecology and evolution. While factual knowledge is important, such knowledge cannot be readily applied if there is little or no understanding of the basic concepts. Also, there is need to ensure that students are competent in the use of technical terms and can interpret information presented in a diagram or in graphical form. In addition, an understanding of rubric terms, for example, *comment* versus *discuss* or *outline* versus *explain* is critical to the quality of a response. Finally, the importance of mastering practical skills must be conveyed to students, as these skills will be examined in the final examination papers.

General Issues Concerning Paper 032

Inadequate preparation of candidates for this paper continues to be of concern.

General Comments on the SBA

Practical activities in the SBA laboratory books indicated a true practical approach with wide syllabus coverage. However, each skill should be assessed from more than one syllabus topic. There are still instances where schools are using outdated syllabuses and consequently the laboratory exercises selected for assessment, in some cases, were inappropriate. Teachers are still not completing the moderation sheets. Teachers are reminded to review the accuracy of

marks entered on the moderation form. Teachers should ensure that all moderation forms are completed accurately and that the scores entered for each skill coincide with those recorded in the students' reports. The two best laboratory exercises should be selected and the average grade entered for each skill. The exercise chosen for SBA moderation should be clearly identified, either in the mark scheme or in the table of contents. Teachers should be careful not to use decimals or fractions in the completion of the moderation forms.

Planning and Design (P/D)

Students are still presenting inappropriate laboratory exercises for P/D assessment. Selection of CSEC level and textbook laboratory exercises should be discouraged. Students did not write the procedure for P/D in an instructional format, but rather used continuous prose and reported in the past tense. Students should be encouraged to submit original work for the P/D activity. P/D experiments should not be copied from the textbook. All students in a given centre should not have the same hypothesis, aim, material apparatus and method.

Teachers are reminded to provide problem statements, questions or observations which allow students to design original laboratory exercises for P/D. Students should be instructed to investigate one variable at a time. The aim of the experiment should be very specific. Students should be given an observation which should be used to generate the hypothesis, aim and method.

A significant portion of students demonstrated that they did not have a clear understanding of what constitutes a proper hypothesis. The hypotheses stated were sometimes too lengthy. A control should be included as well as the specific quantities of substances to be used. Biological principles should be used in explaining predicted results.

P/D activities should reflect original and creative thoughts. While many laboratory exercises used adequate sample sizes, very few included repetition of the activity in the design of their method. Although some laboratory reports were well presented and organized, too many were of a low standard. Laboratory reports should be securely bound and properly labelled with a useful table of contents. Students should be encouraged to number the pages of the reports, and to use these in the preparation of the table of contents. Teachers are not totalling marks out of 12. While the quality of assessment by teachers has improved for some schools, overall the standard of marking was found to be lenient.

Analysis and Interpretation (A/I)

In general, students displayed weakness in their ability to analyse the data obtained in a practical exercise. Students need to link a biological concept to the observed results and should justify each trend observed. A concise conclusion relevant to the aim should be stated. Background theory must be included, and should not be too lengthy. Teachers are reminded that the use of drawings and electron micrographs for assessment of A/I skill is inappropriate.

Water potential, enzymes and osmosis or other physiology related topics can be considered as alternatives. Candidates failed to connect the biological principles with the results obtained. Also, they listed sources of errors as limitations; the difference was not clear as they were unable to distinguish between the two. Simple food tests confirming the presence of a nutrient are not recommended for the assessment of A/I. The background information should be directly related to the results from the experiments, and should be used in the interpretation and explanation of the results. It was evident that teachers made an effort to address the proper construction of a discussion, but there were weaknesses in the interpretation of the data and in addressing limitations and sources of error in the experiments.

Drawings

The quality of drawings, although improved, was still not at the expected standard. The magnifications were not calculated and recorded; titles did not display the view and name of the specimen being drawn; annotations were inadequate. Copies of textbook drawings continued to be included for assessment. Students should use the term *drawing of...* instead of *diagram of...* in their titles. Where magnifications were stated, many students neglected to include the formula and/or show calculations for magnifications. The misconception persists in assuming magnification refers to the power of the microscope used to observe the specimen. Magnifications should be calculated using the formula: *size of drawing divided by actual size of specimen*. Very few students produced drawings that gained full marks for clarity.

Plan drawings included cellular details. Students must be advised against including an excessive number of cells when recording cellular detail in a high power drawing. Three to four well drawn cells, in breadth and depth, will suffice. An improvement was seen in the faithfulness of reproduction and in the use of reasonable sized drawings. Approximately 50 per cent of the SBA samples presented drawings with label lines that were not justified. Some students have not been correctly instructed in the construction of label lines. Every effort should be made to ensure that label lines are parallel and neatly drawn with a ruler. Labelling in cursive should be discouraged. Labels should be in script only and in upper or lower case. One format should be selected and maintained for all labels and annotations, and for all drawings. Teachers and students are reminded that annotations are short descriptive notes about form or function of the labelled structure.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®**

MAY/JUNE 2013

BIOLOGY

GENERAL COMMENTS

The CAPE Biology examination is based on three papers for each unit covered in the syllabus: Paper 01 – a multiple-choice paper consisting of 45 compulsory items, 15 from each of the three modules; Paper 02 consisting of six compulsory questions, two from each of the three modules; and Paper 032, an alternative practical paper for candidates who do not register for the School-Based Assessment. Paper 02 is divided into two sections: Section A has three structured questions, one from each module, and Section B has three essay questions, one from each module. Each question on Paper 02 is worth a total of 15 marks.

The modules in each unit are:

Unit 1

Module 1	Cell and Molecular Biology
Module 2	Genetics, Variation and Natural Selection
Module 3	Reproductive Biology

Unit 2

Module 1	Bioenergetics
Module 2	Biosystems Maintenance
Module 3	Applications of Biology

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

There was a decline in the overall performance of candidates on this paper as a result of the decline in the percentage of candidates achieving Grades I (ten per cent for this unit). With respect to the percentage of failures, there was a minimal increase for this unit.

Paper 02 – Structured/Essay Items

Section A – Structured Items

Module 1

Question 1

Syllabus Objectives: 1.2, 1.4, 1.10

Highest Mark: 15 Mean Mark: 9.78 Lowest Mark: 0

The first part of this question focused on candidates' knowledge of food tests and their ability to apply this knowledge to analyse and interpret data. The second part examined candidates' understanding of the concept that macromolecules are polymers formed from monomers, for example, glycogen.

Overall, knowledge of the topics being examined and understanding of key concepts and terms were found to be adequate; the level of difficulty of the question was appropriate. Also, candidates correctly interpreted the use of rubrics such as *explain* or *state*. Overall performance was quite good with more than 50 per cent of candidates gaining ten or more marks; of these, three per cent attained full scores.

In Part (a), candidates were given a table of data showing the qualitative results of an investigation of the nutritional composition of various food items. For Part (a) (i), candidates were required to identify the nutrient being tested for the given reagents, and in Part (a) (ii), they were asked to identify foods which contained all four major nutrient components. Both sections were generally well done, with the majority of candidates demonstrating a good knowledge of the food tests and correctly interpreting the qualitative results. However, it was evident that candidates were less knowledgeable with respect to the range of expected colour changes in relation to the quantity of any one nutrient present in food items. For example, some candidates did not recognize that a change in colour from pale blue to pink, in the Biuret test, was indicative of a small amount of protein (short-chain peptides are present). In practical sessions, some attention should be paid to guiding students as to expected colour changes and interpretation of such qualitative results.

For Part (a) (iii), some candidates seemed unclear as to the number of food items which should have been listed. These included *eggs*, *hamburger patty* and *pepperoni pizza* as good sources of protein and *donut* as a good source of lipids; both nutrients being important for supporting cell growth and structure. With respect to a key nutrient for providing energy, all food items with good starch (glucose) content could have been listed. Also, mention of a *strong positive colour change* as justification for selection of food items was accepted.

Part (b) (i) presented no difficulty, with most candidates being able to correctly indicate the location of the two stipulated linkages. Candidates found Parts (b) (ii) and (iii) the most challenging. Sketches were often poorly done or were incomplete and therefore did not clearly show the two expected features, that is a linear series of interconnected glucose units with side branches. In a few cases, candidates incorrectly sketched the structure of a glycoprotein or a triglyceride molecule. Teachers should ensure that students clearly understand what is required when asked to do a sketch. For Part (b) (iii), many candidates were unable to distinguish the structural and functional differences between amylose and cellulose. For example, *glucose units in amylose are bonded together by alpha linkages compared to cellulose which is composed of beta linkages* or *amylose is a compact molecule which therefore makes it a good energy store compared to the cellulose which forms microfibrils and hence is of structural importance.*

Some candidates incorrectly referred to amylopectin instead of amylose.

Module 2

Question 2

Syllabus Objectives: 1.3, 1.4, 3.3, 3.4

Highest Mark: 15 Mean Mark: 7.96 Lowest Mark: 0

This was a very straightforward question testing candidates' understanding of a monohybrid test cross, ability to apply a Chi-square test to given data, with emphasis on formulation of a null hypothesis, and understanding of the concept of probability. In addition, candidates' understanding of the concept that translation is an RNA-directed process using codons which translate into amino acids, and ability to decipher codons using given information were assessed.

Overall, this question was fairly well done with four per cent of candidates attaining full marks and about 35 per cent attaining more than ten marks. However, genetics continues to be challenging for some candidates as at least five per cent of them gave no responses and approximately ten per cent gave incorrect answers.

Several candidates were unable to state the correct phenotypic ratio (3:1) for Part (a) (i). Some candidates stated the genotypic ratio (1:2:1) despite the inclusion of phenotypic information in the stem. Others stated the ratio as 1:3 without specifying the phenotypic categories. Part (a) (ii) was fairly well done with approximately 65 per cent of the responses demonstrating an understanding of the null hypothesis as being one of *no difference between observed and expected ratios* and by extension an alternative hypothesis where there is a *difference between observed and expected ratios*. Parts (a) (iii) and (a) (iv) were quite well done with about 85 per cent of candidates gaining full marks. Part (a) (v) seemed to be the

most challenging as several candidates were unable to apply the calculated Chi-square value from Part (a) (iii) to interpret the null hypothesis stated in Part (a) (ii).

All sections of Part (b) were well done with only a few candidates giving incorrect responses to parts of the question. Incorrect responses for Part (b) (i) included transcription, translation codes, bases, instead of the expected answer of *codon and anticodon*. Errors in deciphering the corresponding triplet bases for both tRNA and on the DNA strand accounted for candidates not gaining full marks for Parts (b) (ii) and (iii).

Module 3

Question 3

Syllabus Objectives: 2.8, 3.2, 3.3, 3.6

Highest Mark: 15 Mean Mark: 5.18 Lowest Mark: 0

This question focused on a comparison of various aspects of spermatogenesis and oogenesis. In addition, the ability to make a plan drawing of a section of the ovary was tested as was knowledge of the carpel.

Overall, performance on this question was lower than expected with only 12 per cent of candidates gaining ten or more marks.

Parts (a) and (b) (particularly the plan drawing) proved to be a challenge for candidates. In Part (a) (i), many candidates were unable to score full marks as they failed to adequately compare the ‘duration of the process’ of spermatogenesis with that of oogenesis despite the fact that an explanatory notation was included. Expected correct responses included that

for spermatogenesis mitosis and gamete maturation start at puberty and continue through to the rest of the life span compared to oogenesis where mitotic division was completed before birth and gamete maturation occurs from adolescence to menopause.

For Part (a) (ii), candidates’ knowledge of the roles of follicle stimulation (FSH) and luteinizing hormones (LH) in spermatogenesis was not as good as expected and they appeared to be more knowledgeable of the roles of these hormones in oogenesis. While many stated that *FSH promoted the activity of Sertoli cells*, not as many made the link to *nourishment of developing spermatozoa* or *making the Sertoli cells more receptive to testosterone*. Similarly luteinizing hormone *binds to the Leydig cells thus stimulating production of testosterone and hence production of spermatozoa*.

For Part (b), candidates were required to do a plan drawing based on a photomicrograph showing details of a section through an ovary. Drawing skills were generally below the

expected standard. In many responses, candidates did not give a plan drawing, omitted stages, or neglected to state a title and/or magnification. Also, the instruction which directed candidates to *include the stage of the developing ovum just prior to release* appeared to have been misinterpreted as several candidates included an additional stage not seen in the given material. In a few cases, a detailed textbook drawing of only the stage of the ovum just prior was given. Others omitted some stages, especially those post-release of the ovum, or labelled the stages and other features even though this was not required. Teachers must ensure that clear guidelines are given to students as to what constitutes a plan drawing versus a detailed drawing (see comments for SBA). As a result of these errors, only a small percentage of the responses were awarded the full six marks.

Part (c) was generally well done with the majority of candidates gaining at least two of the allotted three marks for recognizing that *X (the ovary wall) develops into the fruit* and that *Y (the ovule wall) becomes the testa/the ovule becomes the seed/the fertilized egg becomes the embryo/polar nuclei when fused with the male nucleus forms the endosperm*.

Module 1

Question 4

Syllabus Objectives: 3.1, 3.2,

Highest Mark: 15 Mean Mark: 5.32 Lowest Mark: 0

This question tested candidates' understanding of the concept of diffusion as a mechanism for movement of substances, and candidates' ability to use this understanding to define diffusion and to distinguish between facilitated diffusion and active transport. Also, knowledge of the concept that cellular membranes are fluid mosaics of lipids and proteins, and understanding of the role of proteins in the movement of substances in relation to the model were examined.

Overall, performance was less than satisfactory as only nine per cent of candidates gained ten or more marks.

Part (a) (i) proved to be challenging for a large number of candidates. While the majority were able to score at least one mark for stating that diffusion involved the movement of molecules from *an area of high concentration to an area of low concentration*, few were able to access the full two marks because they neglected to mention *net movement* or that movement took place *until an equilibrium was reached*. Of note was a common misconception that diffusion was limited to movement of water molecules and that this required the presence of a selectively permeable membrane. Several candidates were unable to give a clear distinction between active transport and facilitated diffusion, and opted to focus on descriptions of the processes rather than highlighting the differences. For example, *active transport requires energy while facilitated diffusion does not*.

Part (b) (i) was fairly well done with the majority of candidates being able to describe several aspects of the fluid mosaic model of membrane structure. However, the diagrams were not as well done. Errors included incorrect orientation of the phospholipid molecules, incorrect representation of the glycoprotein/glycolipid and omission of the range of protein molecules. Many neglected to highlight what components of the model contributed to the ‘fluid’ or ‘mosaic’ nature of the membrane. A common misconception was that cholesterol was directly responsible for the fluid nature rather than having a regulatory role in maintaining fluidity in animal cells. Rarely did candidates correctly relate ‘fluidity’ to *ability of the phospholipids to move laterally within their own bilayer*. Even fewer made reference to the fact that *integral membrane proteins, when viewed from above one surface or the other, contribute a mosaic pattern to a membrane or that these proteins are capable of lateral movement and hence are linked to the fluid nature*. A small percentage of responses were awarded full marks for Part (b) (ii). The majority of candidates gained at least one mark for stating that *proteins were important in the transport of polar molecules and ions*. Not all, however, correctly discussed other aspects such as the specific roles of channel and carrier proteins and hence many did not score full marks.

Module 2

Question 5

Syllabus Objectives: 5.6, 5.7, 5.8, 5.10

Highest Mark: 15 Mean Mark: 4.56 Lowest Mark: 0

This question tested candidates’ knowledge and understanding of natural selection using the example of antibiotic resistance in the bacterium that causes tuberculosis. In addition, understanding of the relationship of mutation to evolution, as well as knowledge and understanding of a process leading to speciation, was examined.

Overall, performance on this question was less than expected with only nine per cent of responses being awarded ten or more marks.

In Part (a) (i), most candidates scored at least one mark for explaining that natural selection involved *survival of the fittest* but many neglected to mention that those *best suited produce more offspring*. Only a small percentage of the responses gave a clear discussion of antibiotic resistance in relation to Darwin’s theory. Expected key points included *existence of variation to susceptibility in the bacteria population*, that those that are *resistant to antibiotics are more likely to survive and reproduce* and that as a result the *frequency of resistance will thus increase from generation to generation*. For Part (a) (ii), most candidates were able to score one mark for explaining that *mutation, a driving force, involves a change in DNA or chromosomes*. However, many failed to state that *the change is random* or to link mutation to variation in the gene pool of a population.

For Part (b) (i), most candidates were able to define *speciation* as being the *process which leads to the formation of a new species* but some failed to include *reproductive isolation* as part of the definition. About 60 per cent of the responses gave an accurate explanation of how geographical isolation leads to speciation where a *population of a species becomes separated by a physical barrier (lake, ocean, mountains), allowing each group to diverge along separate evolutionary paths*. However, many included explanations of sympatric, disruptive and directional selection. Most candidates gained two marks for providing relevant examples such as *mountains* or *lakes* as isolation barriers and reference to speciation in Darwin's finches.

Module 3

Question 6

Syllabus Objectives: 3.8, 3.10, 3.12

Highest Mark: 15 Mean Mark: 8.10 Lowest Mark: 0

Knowledge of the process of fertilization, a complex of events designed to ensure a spermatozoon meets an egg, and understanding of its significance, were the focus of one part of this question. Additional parts examined knowledge of the functions of the placenta and understanding of how maternal behaviour can affect foetal development.

Overall, this question was fairly well done with approximately 35 per cent of candidates being awarded ten or more marks.

Part (a) (i) was generally well done with at least 85 per cent of the responses giving good descriptions of the key stages and scoring between three and four of the allotted five marks. Expected stages included

acrosome reaction which results in the release of hydrolytic enzymes which digest a path through the layer of follicle cells (corona radiata) that surround the oocyte, the sperm 'swimming' to reach the outer surface of zona pellucida, the sperm head fusing with microvilli surrounding secondary oocyte and penetrating into the cytoplasm, the fusion of the male nucleus with that of the oocyte to form a zygote.

A common error was that candidates commented on mitosis and meiosis. Part (a) (ii) posed little difficulty as about 75 per cent of candidates gained at least one of the two allotted marks with more than 15 per cent gaining full marks for stating *genetic variation emerged, determines the sex of the embryo* or *restoration of the normal diploid condition*. However, a few candidates mistakenly commented on the significance of reproduction rather than fertilization.

For Part (b) (i), at least 70 per cent of candidates were able to give good descriptions of two functions of the placenta to gain the full four marks. Excellent responses included *production of hormones, exchange of gases, acting as a selective barrier and removal of excretory products*. Part (b) (ii) was quite well done with about 90 per cent of the responses attaining full marks for discussing any two of the following: nutrition, smoking, alcohol and drugs or maternal self-care.

Paper 032 – Alternative to School-Based Assessment (SBA)

Despite an obvious improvement in general performance especially for Unit 1, the quality of preparation of candidates for this paper continues to be of concern.

Module 1

Question 1

Syllabus Objectives: 2.2, 3.3

Highest Mark: 16 Mean Mark: 6 Lowest Mark: 4

This question tested candidates' knowledge of the ultrastructure of a cell by focusing on their ability to interpret an electron micrograph. Manipulative and measurement skills, as well as the ability to record and interpret results, was assessed in the second part of the question.

This question was fairly well done with approximately 59 per cent of candidates gaining above average scores.

For Part (a), experimental values were not accurately recorded in the tables provided. Candidates had difficulty stating a relevant aim for the experiment. Similarly, stating an appropriate title proved challenging. Based on the results obtained, some candidates deduced that they were given an isotonic solution. The expected results for changes in length in the hypotonic and hypertonic solutions were not always evident. Hence, the explanation accounting for movement of water was poor. It was evident that candidates did not understand what was required for Part (a) (iv) as few were able to provide a correct explanation of the results.

Part (b) also proved challenging for some candidates who identified the endoplasmic reticulum as Golgi.

Module 2

Question 2

Syllabus Objectives: 3.2, 12.1

Highest Mark: 12 Mean Mark: 4.46 Lowest mark: 0

Candidates' knowledge of dihybrid inheritance, ability to represent a genetic cross using a Punnett square, and ability to identify and draw a stage in mitosis were examined in this question.

The question proved difficult for most candidates as approximately 65 per cent of them scored between zero and six marks; no candidate was able to gain full marks.

For Part (a) (i), candidates were asked to complete the table of data which consisted of filling in six values for a total of three marks. Unfortunately, very few candidates were able to do this successfully. They were not aware that the selfing of such parental genotypes led to a typical 9:3:3:1 ratio and that simple mathematical calculations were required to complete the table of data; not many scored the full quota of three marks allocated to this question. Candidates seemed unclear as to whether 9:3:3:1 was the required answer to the ratio requested versus the calculated values 639, 213, 213, 71 (the calculated expected ratios). For Part (a) (ii), few candidates were able to state the expected answers *pure breeding* and *dominance* to gain two marks. Very few understood the concept of pure breeding and as such, references to the parents being 'homozygous' were also accepted. For Part (a) (iii), few candidates were able to identify all four symbols correctly, in order to state the phenotypes. Unfortunately, some candidates did not know how to construct a grid/table for the Punnett square data and even fewer understood that the backcross or testcross meant that the homozygous recessive condition was being crossed with a heterozygote. Few candidates were able to gain more than four of the five marks for the drawing of metaphase in the onion root tip for Part (b). A proper title, a reasonably correct magnification, clean, clear lines without shading, cell wall, and chromosomes aligned along the equator were key points for which marks were awarded. It was encouraging to note that some candidates were able to show calculations for the magnification value.

Module 3Question 3

Syllabus Objectives: 3.4, 3.9

Highest Mark: 16 Mean Mark: 10.9 Lowest Mark: 3

This question tested candidates' ability to identify a spermatozoon and relevant structures from photomicrograph. Other skills tested included candidates' ability to plot data in the form of a histogram and to analyse the given data.

This question was quite well done, with 60 per cent of candidates gaining ten or more marks. Most candidates were able to score two of the three allotted marks for Part (a) (ii). Many lost marks for Part (a) (iii) as they failed to give a complete comment on the function of the middle region as: *containing many mitochondria to produce large amounts of ATP needed for rapid movement*. Parts (b) (i) and (ii) were fairly well done with many candidates gaining at least two marks for both parts. Part (b) (iii) posed no difficulty as almost all candidates were able to identify the *female condom as an alternative barrier method*.

UNIT 2**Paper 01 – Multiple Choice**

There was a decline in the overall performance of candidates on this paper as a result of the decline in the percentage of candidates achieving Grade I.

Paper 02 – Structured/Essay Items**Section A – Structured Items****Module 1**Question 1

Syllabus Objectives: 1.6, 2.2, 3.6

Highest Mark: 15 Mean Mark: 8.49 Lowest Mark: 0

The first part of this question tested candidates' knowledge of the energy investment phase of glycolysis. In the second part, candidates were given a general model of nutrient cycling and were required to use critical thinking skills to make deductions about elements and processes. A third part focused on the effect of increasing light intensity on the rate of photosynthesis.

Overall, the question was fairly well done with about 40 per cent of the responses being awarded ten or more marks.

Part (a) (i) was quite well done with the majority of candidates stating *cytoplasm* as the part of the cell where glycolysis occurs; a few candidates incorrectly stated mitochondria. For Part (a) (ii), most candidates were able to correctly state the events occurring at the highlighted stages as being *phosphorylation of glucose, isomerization, transfer of another phosphate molecule to the sugar molecule and splitting of the 6C sugar molecule into two 3C sugar molecules*. Similarly, Part (a) (iii) was quite well done with many candidates being able to score full marks for suggesting that *glycolysis was significant because glucose was made reactive or ready for use in the Krebs's cycle*.

In comparison, Part (b) was not as well done. Several candidates were unable to correctly identify the reservoirs as being *A* and *D*. In Part (b) (ii), many mistakenly referred to the nitrogen cycle in attempting to name the processes. For Part (c) (i), many candidates were able to correctly identify the regions on the graph where light and other factors were limiting photosynthesis. Errors included using arrows that were too small, incorrect labelling, or neglecting to label the arrows. Part (c) (ii) proved to be the most challenging as the majority of candidates was unable to explain that *point D represents the optimum light intensity with light no longer being a limiting factor* and that *point E represents the maximum rate of photosynthesis*.

Module 2

Question 2

Syllabus Objectives: 1.3, 1.4, 3.7, 3.8

Highest Mark: 15 Mean Mark: 7.84 Lowest Mark: 0

This question tested candidates' ability to do a detailed drawing of a section of vascular tissue based on a photomicrograph. In addition, analytical skills as well as understanding of the difference between systolic and diastolic blood pressures were examined based on graphical data.

Overall, performance on this question was reasonable with just over 25 per cent of the responses being awarded ten or more marks.

Part (a) (i) was not well done. Doing the drawing at the actual size proved to be more challenging than expected. In addition, many candidates failed to state a title and of those who did, some did not give an appropriate title. The quality of the drawings was not of a high standard and it was evident that several candidates were unclear as to what constitutes a

detailed drawing. Part (a) (ii) was quite well done with the majority being able to correctly identify all four structures as *phloem*, *sieve plate*, *companion cell* and *xylem*. Many candidates did not score full marks for Part (b) (i) as they were unable to correctly distinguish between systolic and diastolic blood pressure. For example, systolic blood pressure was described as high blood pressure instead of *maximum pressure on the arterial wall*. Similarly diastolic blood pressure should have been described as *minimum pressure on the arterial wall* instead of low blood pressure. Though some made a link to the contraction of the ventricle, the majority made vague references to the heart contracting.

In Part (b) (ii), many candidates were able to deduce that the overall trend was an increase in blood pressure with age for both males and females. However, some did not focus on the overall trend and opted to give a description of the changes in blood pressure with age. Part (b) (iii) was generally well done as most candidates correctly suggested a *gender difference*.

Module 3

Question 3

Syllabus Objectives: 1.3, 3.4

Highest Mark: 15 Mean Mark: 8.45 Lowest Mark: 0

This question was designed to test candidates' ability to plot a histogram based on mortality rates for various cancers and to interpret the data. The second part of the question focused on knowledge and understanding of the concept of VO_2 max.

Overall, this question was fairly well done with approximately 35 per cent of candidates gaining ten or more marks; full scores were attained by about one per cent of candidates.

Part (a) (i) was generally well done with about 80 per cent of candidates being able to score full marks. It is clear that most candidates have mastered the skill of plotting a histogram (a form of a bar graph) and also, were able to interpret the data to attain full marks for Part (a) (ii). A small percentage of candidates plotted a line graph while others either failed to plot all the data or did so incorrectly. In a few cases, the bars were not clearly defined as pencil lines were faint and almost imperceptible.

Part (b) was low scoring as candidates were unable to define VO_2 max as being a *maximum rate of oxygen consumption attainable during maximal or exhaustive exercise*. Explanations of the change in shape of the graph were equally poor as few were able to clearly state that *continuing increase in exercise intensity does not result in an increased rate of oxygen consumption*. Similarly, few candidates were able to state two factors which affect VO_2 max. Full marks would have been awarded for mention of any two of the following factors: *genetics which defines the upper limit, VO_2 max declines with age, level of fitness — VO_2 max*

improves with training, gender — men have a higher VO_2 max rate than women or that at high altitudes VO_2 max declines.

Section B – Essay Items

Module 1

Question 4

Syllabus Objectives: 4.3, 4.5

Highest Mark: 15 Mean Mark: 8.62 Lowest Mark: 0

This question tested candidates' ability to explain the concept of 'biodiversity' and understanding of why biodiversity loss is a major concern. The second part of the question focused on knowledge of conservation methods and their limitations.

Performance on this question was quite good with approximately 48 per cent of candidates being awarded ten or more marks and one per cent gaining full marks.

Candidates did not perform well on Part (a) (i). About 70 per cent of the responses were awarded at least one of the two allotted marks for mentioning *species diversity*. For many, full marks were not awarded as candidates failed to include genetic or ecosystem diversity. Part (a) (ii) was the most challenging as the majority of candidates did not address the issue of biodiversity loss and failed to recognize the value of biodiversity both to humans and ecologically. Hence, many did not adequately discuss why biodiversity loss is a major concern and instead devoted more time to dealing with the benefits. Greater emphasis was placed on ecosystem disruption instead of other factors. In citing the benefits, many failed to clearly indicate which one was direct versus indirect. Acceptable responses for biodiversity loss were *essential for benefits provided to humans, impact of loss on ecosystem functioning, loss of concern in relation to climate change and pollution, and importance of the need to conserve*. In citing benefits, many options were available to candidates including *a range of goods and services provided, economic importance, ecological value, tourism, recreation and future potential* among others.

Part (b) (i) was mostly well done. About 80 per cent of candidates were able to distinguish between *in situ* and *ex situ* conservation and to give appropriate examples to gain at least three of the four marks. Responses for Part (b) (ii) were quite good with about 80 per cent being awarded at least two of the three marks. Expected limitations included *difficulty in recreating natural habitat, expensive to maintain organisms out of natural environment, loss of genetic diversity, organisms difficult to maintain in artificial environment and risks of exposure to pathogens*.

Module 2

Question 5

Syllabus Objectives: 4.1, 5.2, 5.3, 5.4

Highest Mark: 15 Mean Mark: 7.03 Lowest Mark: 0

The concept of homeostasis and key components of a homeostatic system as well as the role of collecting ducts in kidney function were the main topics examined in this question.

The question was fairly well done with approximately 28 per cent of the candidates gaining ten or more marks.

For Part (a) (i), the majority of candidates gave an accurate explanation of the concept of *homeostasis*, describing it as *maintenance of an internal steady state in living organisms*. Components of a homeostatic system were generally well explained with most candidates being able to state that a *receptor detects changes in an internal environment*, that a *set point is the optimum condition under which the system operates* and that an *effector responds to changes to restore balance or to bring a system back to set point*.

A lack of knowledge of the structure of the collecting duct was evident by the poor responses given for Part (b) (i). Many candidates were able to score at least one mark for stating that the duct was long or thin. Very few applied the knowledge gained from practical exercises to describe the cellular nature, for example *consisting of cuboidal epithelial cells*. In commenting on the role of the collecting duct, several focused on general kidney functions instead of focusing on the regulation of water/ions or transport of the filtrate from cortex to renal pelvis. However, many were able to state that *it transports filtrate* to gain at least one mark. The majority gave good responses to explain how ADH regulates the function of the collecting duct mentioning that *ADH targets the membrane of the duct to make it more permeable thereby allowing water molecules to be reabsorbed*. Not as many mentioned *the role of the hypothalamus in monitoring the water content of the blood and in synthesising ADH — that is, ADH is then transported to the pituitary from which it is secreted in response to detection of low water potential*.

Module 3Question 6

Syllabus Objectives: 2.3, 3.5, 4.5

Highest Mark: 15 Mean Mark: 7.51 Lowest Mark: 0

This question tested candidates' knowledge of the effects of cigarette smoke on the cardiovascular system. The second part of the question focused on knowledge of T lymphocytes and how they function.

Overall, this question was fairly well done with about 36 per cent of candidates being awarded ten or more marks and three per cent attaining full scores.

Part (a) proved challenging as less than 40 per cent of candidates were able to score the full four marks. While many commented on the cardiovascular diseases, they were unable to link them to cigarette smoke. Effects such as *atherosclerosis, damage to blood vessels, impairment of oxygen transport, impairment of blood clotting, and elevated blood pressure and heart rate* were some of the more typical answers. Part (b) (i) was fairly well done as most candidates correctly stated that *T lymphocytes originated in the bone marrow and matured in the thymus.*

Overall, Part (b) (ii) was quite well done as candidates displayed a good knowledge of the types of T lymphocytes and their respective functions. More than 90 per cent were able to score at least five of the six marks for stating three types of T lymphocytes, *helper, cytotoxic and suppressor cells*, and for describing their respective functions. Part (b) (iii) was reasonably well done as many candidates were able to explain that *HIV infects T helper cells rendering them ineffective to fight infections.* However, some did not make the link to the T helper cell.

Paper 032 – Alternative to School-Based Assessment

Despite an obvious improvement in general performance, the quality of preparation of candidates for this paper continues to be of concern.

Module 1

Question 1

Syllabus Objectives: 1.2

Highest Mark: 14 Mean Mark: 8.43 Lowest Mark: 2

This question was designed to test candidates' ability to do a detailed drawing as well as their knowledge of the structures in a section of a dicot leaf. Knowledge of trophic levels, using a wetland food web, and understanding of abiotic and biotic factors were examined in the second part of the question.

Overall, this question was not done at the expected standard. While most candidates were awarded one mark for doing a detailed drawing and showing cellular details, they were unable to score additional marks for neatness, accurately drawn cells, tissues in the correct proportions and an appropriate title and correct magnification. Part (b) (i) was well done with the majority of responses being awarded full marks for correctly identifying components of the food web. Part (b) (ii) was fairly well done with candidates gaining at least one of the two marks for naming an abiotic factor and explaining how it affects the heron. Treatment of the biotic factor was not as good since in many instances candidates were unable to explain how the named biotic factor affected the heron.

Module 2

Question 2

Syllabus Objectives: 1.3, 1.6

Highest Mark: 15 Mean Mark: 6.5 Lowest Mark: 0

In this question, emphasis was placed on examining, planning and design skills. Knowledge of synapse transmission and ability to describe highlighted events were also examined.

Overall, this question was reasonably well done despite the below average mean. For Part (a) (i), most candidates correctly assembled the apparatus but few provided good sketches. In Part (a) (ii), most candidates experienced challenges with the formulation of a null hypothesis. Part (a) (iii) was not well done as many candidates failed to provide a clear

account according to the guidelines given. For Part (b), most candidates were able to give a concise description of almost all the highlighted events.

Module 3

Question 3

Syllabus Objectives: 1.2, 1.2, 1.4

Highest Mark: 15 Mean Mark: 12.2 Lowest Mark: 8

Candidates' ability to plot a line graph and interpret data were tested in this question.

This question was generally well done by most candidates as evidenced by the above average mean and the fact that about 84 per cent of the candidates gained ten or more marks. For Part (a), candidates had no problems interpreting the data but gave specific details of the trends instead of focusing on general aspects. A similar failing was seen in responses for Part (b) (ii). Performance on Part (b) (i) was quite good with candidates being able to produce good graphs to score full marks.

General and Specific Recommendations for Teachers

Teachers should continue to encourage students to cover all objectives and guide them as to appropriate and adequate interpretation of questions especially with respect to rubrics.

In general, the practical activities indicated a true practical approach with wide syllabus coverage. However in several instances, the activities selected were inappropriate for the skill being tested. With respect to organization of the reports, many books were well organized with a detailed table of contents and correctly numbered pages. Placement of the marks awarded and the skill being assessed, for each practical exercise, in the table of contents contributed significantly to alleviating the frustration of having to painstakingly search for the information during moderation. However, there were too many cases of incorrectly completed moderation sheets, inadequate cover pages and barely legible handwriting. Also, laboratory books should be securely bound to prevent students' work from falling out of the books.

Planning and Design

While some improvement in this skill was evident, many of the concerns raised in the 2012 moderation exercise are still applicable. For some centres it was noted that teachers continue to use CSEC level and/or textbook practical exercises for CAPE practical exercises; it is suggested that this practice be discontinued.

Students should be encouraged to submit original work for the P&D activity. Planning and design experiments should not be copied from the textbook. All students, in a given centre, should not have the same hypothesis, aim, material/apparatus list and method. Teachers are reminded to provide students with problem statements, questions or observations which allow them to design original practical exercises for P&D. Students should be instructed to work with one variable at a time. Students should be given an observation which should be used to generate the hypothesis, aim and method; the aim of the experiment should be very specific to the observation under investigation. A significant percentage of students demonstrated that they do not have a clear understanding of what constitutes a proper hypothesis. For example, the stated hypotheses are sometimes too lengthy. The method should be written in the instructional tense.

A control needs to be included. Also, the specific quantities of substances to be used should be stated. Students attempted to use biological principles in explaining predicted results but the supporting information was often insufficient and done at the CSEC level.

Planning and design activities should reflect original and creative thoughts. While many practical exercises quoted an adequate sample size, very few included repetition of the activity in the design of their method. For some schools, the grading of practical exercises by teachers has improved but overall, the standard of marking was found to be lenient.

Analysis and Interpretation

There were many books in which the laboratory exercises used for the A&I activity were inappropriate. For example, microscopy, meiosis models, drawings and electron micrographs. Again teachers are reminded that the aim of the experiment should be specific, relevant and testable. A noticeable improvement in the quality of the discussion, compared with 2012, was noted.

Good reports gave detailed background information and students linked the theory to the methodology being used. In analysing the data reported in the laboratory results, it was found that students continue to be weak in the areas of clearly indicating the trends seen and using the theory to explain the results obtained in relation to the aim. Also, students did not clearly understand the difference between a limitation, a precaution and a source of error. Too often when students stated a limitation, they did not outline how this would affect the results. In constructing the conclusion, students should make a link to the aim and do so as concisely as possible. Teachers should ensure that the skill being tested is taught before it is assessed; this was not evident in some books.

Drawings

Although drawing was not a skill assessed for Unit 2, a brief review of students' samples indicated that the drawing quality was at a lower standard compared with that of Unit 1. For Unit 1, the quality of the drawings, though improved compared with 2012, was still not at the

standard expected for this level. For example, the magnification was not calculated and recorded for many drawings. Teachers need to ensure that students can use the graticule properly in order to correctly determine the actual size of the specimen being drawn. All calculations of the magnification must be shown.

While there was an increase in the number of drawings with stated magnifications, in many instances the values given were incorrect. Teachers are reminded that the magnification should be shown at the end of the title. Also, titles are in need of improvement as several students neglected to include the view and name of the specimen being drawn. Students must be reminded that a *title should be a full, clear and concise explanation of what is being illustrated*. The use of the word *diagram* is not acceptable in the title. Copies of textbook drawings are still being presented for assessment. This practice is not allowed and therefore textbook drawings were not considered during moderation.

Drawings should have clean, solid, continuous lines. Many drawings had unnecessary detail. Teachers are reminded that plan drawings should not show the individual cells of tissues. No shading should be used and stippling should be done appropriately so as not to detract from the drawing quality. Low power drawings should show the *distribution of tissues*. High power drawings, *showing cellular details*, should be done separately instead of being included as part of a hybrid plan-cell drawing. Correct proportions and faithfulness in reproducing the details of the specimen need to be emphasized. Label lines need to be parallel and justified. Students continue to ignore the requirement that the lettering of the labels should be either in lower or upper case script and not a mixture of styles. Drawings of any reproductive organs should be annotated. Annotations, when done, were found to be inadequate. A well-annotated drawing should include brief notes (simple phrase or a few words) on structure and/or function.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®**

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BIOLOGY

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GENERAL COMMENTS

The CAPE Biology examination is based on three papers for each unit covered in the syllabus: Paper 01, a multiple-choice paper consisting of 45 compulsory items, 15 from each of the three modules; Paper 02 consisting of six compulsory questions, two from each of the three modules; and Paper 032, an alternative practical paper for candidates who do not register for the School-Based Assessment (SBA). Paper 02 is divided into two sections: Section A with three structured questions, one from each module, and Section B with three essay questions, one from each module. Each question on Paper 02 is worth a total of 15 marks.

The modules in each unit are:

Unit 1

Module 1	Cell and Molecular Biology
Module 2	Genetics, Variation and Natural Selection
Module 3	Reproductive Biology

Unit 2

Module 1	Bioenergetics
Module 2	Biosystems Maintenance
Module 3	Applications of Biology

DETAILED COMMENTS

Paper 01 – Multiple Choice

For both units, there was a decline in the overall performance of candidates for Paper 01 mainly due to decline in the percentage of candidates in the Grade 1 category (5 per cent for Unit 1 and 25 per cent for Unit 2). For both units, performance on the questions was as expected with few questions proving to be challenging.

UNIT 1

Paper 02 – Structured/Essay Items

Section A – Structured Items

Module 1

Question 1

Syllabus Objectives: 1.8, 1.9, 2.1, 2.2

Highest Mark: 15 Mean Mark: 6.10 Lowest Mark: 0

The first part of this question examined candidates' knowledge of levels of organization of protein structure using haemoglobin as an example. In addition, in the second part of the question, candidates were required to apply this knowledge to explain the essential role of haemoglobin. The third part of the question focused on candidates' ability to identify features shown in a drawing of an electron micrograph of a general plant cell as well as their ability to interpret a given magnification.

Overall performance on this question was below average as evidenced by the low mean mark and with only 18 per cent of the candidates gaining 10 or more marks; less than one per cent attained full scores. Nonetheless, some candidates demonstrated a sound knowledge of the topics being examined and showed good understanding of key concepts.

Despite the straightforward nature of Part (a), some candidates were unable to provide clear explanations of the secondary and tertiary levels of protein structure; most were able to distinguish between the primary and quaternary structure of the protein; it should be noted that similar questions have been used for past examinations. A few candidates (about three per cent) did not score any marks as they provided no response. Part (b) proved challenging for some candidates who were unable to relate the essential role of haemoglobin, that is, transport of oxygen, to the levels of protein structure. While most stated the essential role, points such as the fact that the *quaternary structure increases the capacity to transport oxygen* or that *there is cooperative binding* were often omitted.

Part (c) (i) was excellently done as about 80 per cent of the candidates were able to correctly identify the labelled structures of the plant cell. However, Part (c) (ii) posed a real challenge for many as more than 50 per cent of the candidates were unable to either accurately measure the maximum length of the designated organelle or, for those who did, were unable to use the given scale to determine the actual length of the organelle; a few made errors in the calculations but were awarded marks for stating the correct formula. This below than expected standard of performance is puzzling as this skill is covered in the practical exercises and has been examined in previous examination papers.

It is suggested that use of visual aids and models to demonstrate levels of organization of protein structure may enhance student learning. Also, continual re-enforcement of practical skills is essential.

Module 2

Question 2

Syllabus Objectives: 1.1, 1.2, 3.2

Highest Mark: 15 Mean Mark: 8.03 Lowest Mark: 0

This is a standard question testing knowledge and understanding of protein synthesis and codominance – a pattern of inheritance. Also, ability to use a genetic diagram to represent a given genetic cross was examined.

Overall, this question was fairly well done with approximately 40 per cent of the candidates attaining 10 or more marks. This was mainly due to the performance on Part (a) since the genetic component, Part (b), continues to be challenging for some candidates. With respect to Part (a) (i), for which candidates were required to compare features of transcription and translation, many candidates were unable to give a comprehensive comparison. In particular, they were not able to identify the enzymes/cofactors or state the correct function of transcription. Though Part (a) (ii) was generally well done, some candidates did not do a sketch of the tRNA molecule using the representation in the given diagram as was expected but instead did sketches recalled from their textbooks.

In Part (b) (i), a few candidates were unclear as to the difference between key terms such as *gene* versus *allele*, *codominance* versus *incomplete dominance* and, *dominant* versus *homozygous*. In addition, many misinterpreted what was expected of rubrics such as *deduce* and *justify*. Part (b) (ii) proved to be the most challenging part of this question. About 50 per cent of responses for Part (b) (ii) a) identified the blood type rather than stating *alleles homozygous* for blood type B. In giving an explanation to justify the answer, some candidates did not refer to the alleles to explain *codominance* or gave unclear, poorly-written explanations. Poor representations of the Punnett square were seen in many responses for Part (b) (ii) b) with either the use of incorrect symbols or incorrect representation of the male and female genotypes. A few represented the material as a dihybrid cross or even a ‘sex-linked’ cross.

Greater effort must be made to ensure that students are familiar with and understand basic ‘genetic’ terminology and have the necessary skills for doing genetic diagrams.

Module 3

Question 3

Syllabus Objectives: 2.6, 3.2, 3.3

Highest Mark: 13 Mean Mark: 5.52 Lowest Mark: 0

For this question, candidates were required to do a detailed drawing of a section of a seminiferous tubule and to analyse and interpret graphical data on pollen germination.

Overall performance on this question was lower than expected with only 13 per cent of the candidates gaining 10 or more marks and less than one per cent being awarded full marks; mean score was below average. Both Parts (a) and (b) proved to be problematic for candidates as they were either unable to do a proper detailed drawing or correctly interpret the graph or both, as seen in some of the responses. In Part (a) (i), some candidates were unable to score full marks as they failed to accurately represent observable details even though they understood that details should be shown. Others gave a diagrammatic representation or did a plan drawing instead of doing a detailed drawing. Also, correct labelling of features drawn was problematic. It is clear that the drawing skills of candidates are not at the expected level and this is also evident in the SBA exercises. While Part (a) (ii) tested basic knowledge of key stages of spermatogenesis, several responses did not score full marks as answers were incomplete. This outcome was unexpected especially as the stages were observable in the given photomicrograph and only an outline was needed.

The majority of candidates were able to give an accurate description of the graphical data presented in Part (b) and to correctly quote numerical values to support descriptions, for example, *absence of germination at zero per cent sucrose concentration or maximum germination of about 40 per cent at six per cent sucrose concentration*. Marks were awarded for mention of the *decline in percentage germination beyond six per cent sucrose concentration or the fact that beyond eight per cent sucrose concentration, germination rate remained constant*. Part (b) (ii) proved to be the most challenging part of this question. Based on the responses, it was evident that the poor performance was due to failure of candidates to link the response shown in the graph, that is, pollen germination, to the pollination process and then to explain the significance of this. In addition to the obvious point that *sucrose facilitates pollen grains sticking to the stigma*, other expected points included *sucrose is essential for pollen germination; sucrose helps to nourish growth of the pollen tube; and sucrose concentration increases chances of pollen tube formation*. It is clear that interpretation of the term *pollination process* was problematic as many viewed this as simply the transfer of pollen grains to the stigma and did not consider pollen germination as part of the process. In teaching this topic it should be made clear that when a pollen grain lands on the receptive tissue of a pistil known as the stigma, the flower has been *pollinated*. However, this is only the first step in a complicated process that, if successful (for example if germination occurs), leads to fertilization. It is generally accepted that fertilization begins when the pollen tube begins to grow and move towards the egg.

Module 1

Question 4

Syllabus Objectives: 1.1, 3.2,

Highest Mark: 15 Mean Mark: 7.28 Lowest Mark: 0

This question tested candidates' knowledge of the structure of the water molecule and understanding of the solvent property of water. Also, they were required to discuss two major roles of water in cell function. The last part of the question focused on endocytosis and exocytosis.

Overall performance on this question was satisfactory with 28 per cent of the candidates gaining 10 or more marks. Part (a) (i) was well done as many candidates were able gain at least three of the five marks. Common errors included the incorrect use of the term 'atom' as synonymous with 'molecule' and explanation of various properties of water instead of its solvent property. Expected points for the structure were: *water consists of one oxygen and two hydrogen atoms, hydrogen atoms are covalently bonded to oxygen atom, structure is bent*, and for the solvent property: *water is a polar molecule hence it attracts other polar molecules (or ions) and surrounds them*. The responses to Part (b) were of a high standard as most candidates were able to discuss two major roles of water in cell function such as in *transport of substances, providing an environment for metabolic reactions, maintaining the shape and size of a cell, gas exchange, acting as a buffer*. However, a few incorrectly discussed the general properties of water. Part (c) was fairly well done with the majority of candidates being able to give at least one distinguishing feature between the two processes. Credit was given if correct examples were used to distinguish between the two processes. Some mistakes included incorrect descriptions of the processes and reference to the processes as 'entering or leaving the body' instead of being at the cellular level.

Module 2

Question 5

Syllabus Objectives: 4.4, 5.8, 5.10

Highest Mark: 15 Mean Mark: 4.44 Lowest Mark: 0

This question tested candidates' knowledge of a fundamental aspect of the theory of natural selection, that is, Darwin's observations and deductions. Also, an understanding of speciation in relation to natural selection was examined. Finally, candidates were asked to discuss potential threats of the use of genetically modified crops and to give a definition of the term *genetically modified organism*.

Overall, performance on this question was much lower than expected with a low mean mark and only 6.5 per cent of the responses being awarded 10 or more marks. For Part (a), many candidates did not give four observations and three deductions as asked. Also, in several responses, the points given were either not clearly identified as being an observation or deduction or were incorrectly identified. In addition, misconceptions in the meaning of terms such as *species* and *fitness* were evident. Part (b) was not well done as some candidates did not explain geographical speciation in context of the theory of natural selection and instead gave separate explanations or, as was seen in a few responses, explained types of natural selection. The concept of how barriers can lead to speciation appears not to be well understood. The concept of evolution is always a challenge for students to comprehend and therefore more time should be spent teaching this topic. Generally, Part (c) was well done with most candidates being able to state three threats. Marks were lost if the points were not discussed or if the definition was incomplete.

Module 3

Question 6

Syllabus Objectives: 1.1, 1.3, 3.7, 3.8

Highest Mark: 12 Mean Mark: 5.76 Lowest Mark: 0

For this question, candidates were required to give a definition of vegetative propagation, explain why it is not considered to be a form of sexual reproduction and comment on why this type of asexual reproduction is beneficial in agriculture and horticulture. The second part of the question focused on understanding *combine oral contraceptives* (COC) and how this type of contraceptive method should be used in context of a given scenario and in relation to the menstrual cycle.

Overall, this question was not well done as only eight per cent of the candidates were able to score between 10–12 marks. Part (a) (i) was quite well done as the majority of the candidates were able to attain full marks by explaining that *vegetative propagation does not involve gamete formation, that only parent is needed and that offspring are genetically identical to the parent*. Also, performance on Part (a) (ii) was quite good as most candidates successfully commented on the benefits in agriculture and/or horticulture. Typical responses included: *easy to do, can get a greater yield in a shorter time frame - hence more economical, can be used to preserve more desirable characteristics* or that *it is useful for propagating plants that are difficult to germinate*.

In comparison, Part (b) was not as well done. Most candidates were able to achieve at least two marks for Part (b) (i) for mentioning that the COC, which consists of *progesterone and oestrogen, altered the body's hormonal balance* as well as *promoted the thickening of the cervical mucus to form a plug thereby preventing the sperm from entering the uterus*. Many did not highlight the fact that the COC *prevented ovulation* or that it resulted in a *thinning of*

the uterine lining – hence reducing the probability of fertilization and implantation. Notable misconceptions were reference to the ‘morning after pill’ and the view that COC ‘tricked the body into feeling pregnant’. Part (b) (ii) was the most challenging as many candidates were unable to give a comprehensive answer to score full marks. Most referred to the correct procedure for use of COC but neglected to relate this to the menstrual cycle as expected. Instead they gave descriptions of the cycle. Based on the quality of the responses and apparent lack of knowledge as to how COC functions, it is clear that the absence of an explanation for the relevant objective is a contributing factor.

UNIT 1

Paper 032 – Alternative to the School-Based Assessment (SBA)

Module 1

Question 1

Syllabus Objectives: 1.10, 4.5

Highest Mark: 15 Mean Mark: 9.94 Lowest Mark: 0

Two skills were examined in this question — the ability to conduct a glucose test including making accurate records of findings and the ability to interpret graphical data.

Performance on this question was good; 62 per cent of the candidates scored 10 or more marks, with the mean being almost 10, and only 10 per cent scored less than seven marks. For Part (a), candidates competently conducted a semi-quantitative test for glucose using a solution of unknown concentration. Results recorded were as expected and most were able to justify their deduction of the concentration of sugar in solution of unknown concentration. In comparison, not as many candidates were able to correctly do the required calculation suggesting that the concept of serial dilution was not well understood. For Part (c) (i), candidates provided a reasonable description of the effect of temperature on the activity of the enzyme with most candidates scoring at least two of the three assigned marks. Similarly most candidates accurately determined the optimum temperature from the graph for Part (c) (ii). Part (c) (iii) proved the most difficult for candidates; few were able to give a suitable explanation for the steep decline in enzyme activity shown in the graph. Very few made mention that *an enzyme, as a protein, is denatured by the high temperatures* and even fewer made the link to the fact this is due to the fact that *the tertiary structure of the protein is disrupted at high temperatures*.

Module 2

Question 2

Syllabus Objectives: 2.2, 3.2, 3.3

Highest Mark: 15 Mean Mark: 7.78 Lowest mark: 0

Knowledge of the stages of mitosis and the ability to identify these stages from photomicrographs was examined in the first part of the question. Data of a dihybrid cross was used to assess understanding of the chi-square test.

This question was fairly well done as 36 per cent of the candidates scored 10 or more marks; with the mean score being just about average. For Part (a) (i), candidates were able to correctly identify the given stages with most scoring at least six of the eight assigned marks. In Part (a) (ii), only about half of the candidates could name two features that would be clearly observed during mitosis if the specimen was examined at a higher magnification of a compound microscope. A common error was to name features already visible at the existing magnification. For Part (b) (i), approximately one-third of the candidates successfully calculated the chi-square value to gain the full three marks. In Part (b) (ii), candidates were expected to recognize that the calculated chi-square value *supported acceptance of the null hypothesis* and therefore to conclude that the *observed ratio conformed to the expected ratio*. Most candidates were unable to do this and therefore failed to access any of the three marks allotted to this section.

Module 3

Question 3

Syllabus Objectives: 2.8, 3.2

Highest Mark: 15 Mean Mark: 8.54 Lowest Mark: 2

This question evaluated candidates' ability to examine a tissue section and ability to make a labelled plan drawing. Data on the lipid and sugar content of seeds during germination was used to test candidates' ability to draw a graph and to test their analytical skills.

This question was fairly well done as 36 per cent of the candidates scored 10 or more marks, with the mean score being slightly about average. For Part (a), many candidates were able to make a labelled plan drawing to show the distribution of tissues in the mammalian ovary. However, some failed to represent the tissues in their correct proportions and had very poor line quality. Many omitted magnifications and a title. Nonetheless, most were able to provide accurate labels. In Part (b) (i), most were able to construct a good line graph from the data provided and thus gained the full allotted five marks. Part (b) (ii) was also well done as almost all gave an appropriate description of the trend for changes in the sugar content of the

seeds. In Part (b) (iii), only a few candidates were able to suggest reasons for the changes in the lipid and sugar content as germination progresses. Most candidates failed to recognize that the seed resources were being converted and mobilized initially then declining as the seed utilized them for germination.

UNIT 2

Paper 02 – Structured/Essay Items

Section A – Structured Items

Module 1

Question 1

Syllabus Objectives: 1.5, 1.6, 2.3, 2.5

Highest Mark: 15 Mean Mark: 6.09 Lowest Mark: 0

The first part of this question examined candidates' knowledge of the structure of a mitochondrion. The second part of the question tested their ability to analyse and interpret graphical data.

Overall, the question was not well done as only 13 per cent of the responses were awarded 10 or more marks. Also, the mean score was below average. Generally, Part (a) (i) was quite well done with many candidates being able to identify at least two of the four labelled structures and to correctly indicate the location of the Krebs cycle. Nonetheless, some misconceptions and errors were noted; for example, some candidates identified chloroplast structures, stalked particles were thought to be phospholipids, and mitochondrial DNA was described as chromosomes. Typically chromosomes are thread-like structures located inside the nucleus of eukaryotic cells. Mammalian mitochondrial DNA is a closed-circular, double-stranded DNA molecule which is not enveloped, does not have normal histones and therefore is not packaged into chromatin.

Part (b) (i) was exceptionally well done with more than 80 per cent of the responses being awarded full marks for stating that the *rate of photosynthesis increased rapidly up to an optimum temperature (36 °C), beyond which it declined sharply*. However, some candidates appeared unable to make the distinction between optimum temperature and ideal conditions. Part (b) (ii) proved to be the most challenging as approximately 75 per cent of the responses gained only one mark, and about five per cent of candidates scoring full marks. The main challenge was an inability to interpret and explain the effect of increasing the carbon dioxide concentration on the rate of photosynthesis, and how this information could be used by farmers (Part (b) (iii)). Most were able to give the effect of concentration on the net

photosynthetic rate, for example, *increased levels of CO₂ resulted in a higher photosynthetic rate or that a higher optimum temperature was seen*. In many responses, separate descriptions were given. Few gained full scores by commenting on the significance of *increasing carbon dioxide levels – result in increased yield* or that knowledge of the optimum temperature can be used to *control the temperature in the greenhouse at an optimum level*.

Module 2

Question 2

Syllabus Objectives: 1.1, 3.3, 3.8

Highest Mark: 15 Mean Mark: 6.23 Lowest Mark: 0

This question tested candidates' ability to interpret graphical data, use a labelled diagram to illustrate pathways of water movement from soil into root cells, and identify structures from a diagram of longitudinal section of the mammalian heart.

Overall, performance on this question was below average as only 16 per cent of the responses were awarded 10 or more marks and the mean score was below average. About 70 per cent of the candidates gave comprehensive answers for Part (a) to gain all four marks. Of the remaining 30 per cent, about 50 per cent did not recognize that temperature was constant over the given time period, and hence both independent variables, with KCN uptake being the dependent variable. In addition, several misinterpreted the vertical arrow as being that time was held constant instead of KCN being added, as indicated. Performance for Part (b) was not at the expected standard given that the subject material is well covered in the texts. About 15 per cent of the candidates drew the cross section of the root even though the question gave specific and clear guidelines; failed to adhere to the instruction to limit the illustration to six to eight cells and did not realize that the diagram should be done at 'a high power level' to show details. A greater challenge for many candidates, was to show the pathways. In many responses, the symplastic pathway was omitted while other pathways were not accurately represented. Part (c) was well done by about 90 per cent of the candidates. Incorrect identification of the structures was the main reason for poor performance; occasionally there were spelling errors for the technical terms, for example 'tricupid' for *tricuspid* and 'barcupid' for *bicuspid*.

Providing an explanation of how arterial pressure is affected by a defective heart valve proved more problematic than expected for approximately 50 per cent of the candidates. However, a few were able to furnish good answers by mentioning *backflow* and *decrease in arterial pressure*. Only the more competent candidates, who scored between 12 and 15 marks for the question overall, managed to gain the full two marks for Part (c) (ii).

Module 3

Question 3

Syllabus Objectives: 2.1, 3.1, 3.4

Highest Mark: 15 Mean Mark: 10.29 Lowest Mark: 1

This question was designed to test candidates' ability to plot a line graph using data on obesity in pre-school children. In the second part of the question, candidates were required to use annotations to describe steps in phagocytosis and to outline the role of a macrophage as an antigen-presenting cell.

Performance on this question was very good with 65 per cent of the candidates scoring 10 or more marks, of which two per cent gained full marks, with a mean mark of 10 and with only seven per cent of the candidates scoring six marks or less. For Part (a) (i), many responses were awarded full marks. Marks were not awarded for omitting the title, not labelling the axes and not plotting a line graph. Similarly, most candidates were able to interpret the data and to provide good quality answers for Parts (a) (ii) and (iii). The high standard of the responses for Part (a) suggests that candidates have mastered the skill of plotting line graphs as well being able to competently analyse and interpret the data. For Part (b) (i), while most candidates demonstrated knowledge of phagocytosis, some were unable to provide comprehensive or correct annotations; Step 2 seemed particularly problematic. Also, Part (b) (ii) was somewhat challenging as many were unable to score full marks by stating that *some of the digested bacterial fragments combine with proteins and that the complex is displayed on the surface of the macrophage for presentation to lymphocytes.*

Section B – Essay Items

Module 1

Question 4

Syllabus Objectives: 3.2, 3.3, 4.1

Highest Mark: 15 Mean Mark: 7.29 Lowest Mark: 0

This question examined knowledge and understanding of energy losses across trophic levels and the importance of food web complexity. In addition candidates were required to describe six biotic interactions that occur in an ecosystem.

Overall, this question was reasonably well done with approximately 26 per cent of the responses being awarded 10 or more marks and with an average mean value. Generally, for Part (a), candidates demonstrated an understanding that only *a fraction of the energy available at one trophic level is transferred to the next trophic level* by giving a

comprehensive account of the various ways in which energy is lost across trophic levels, for example, through *respiration, digestion, excretion*. Part (b) was not as well done as expected; responses were to be lacking relevant and accurate information. Some candidates were unable to provide a clear explanation of a 'food web' that is a mesh of *interlinking food chains* and instead either gave a description of a food chain or referred to a food web as a diagram or illustration of feeding relationships. Comments on the importance were sometimes vague or incomplete. Expected points include *greater variety of food available for consumption, associated with high biodiversity, increased ecosystem stability or enhancing efficiency of energy flow and nutrient cycling*. Despite the very straightforward nature of the question, Part (c) was not well done as several candidates did not attain full marks because they did not describe all six biotic interactions or their descriptions were incorrect. Also, a few did not recognize that biotic relations involved living organisms. *Feeding, predation, competition, mutualism* and *parasitism* were some of the more common points; others such as commensalism and altruism were often omitted.

Module 2

Question 5

Syllabus Objectives: 2.4, 2.5, 4.1

Highest Mark: 15 Mean Mark: 5.66 Lowest Mark: 0

Translocation in plants and action potential are the two main topics examined in this question.

This question was not well done as approximately 19 per cent of the candidates gained 10 or more marks. Also, mean score was below average. The majority of candidates were able to give a concise explanation of the term *translocation*. Some errors included giving a definition of *transplanting* or referring to the xylem instead of the phloem. Several candidates were able to give an appropriate explanation of the scenario given in Part (a) (ii). An acceptable explanation should have included the fact that the *flow of sap is from source (leaves) to sink (e.g. roots) and that this flow is under pressure. The spiral slash prevents bulk flow to the root and thus more sap is available to go to other parts, for example fruit thus making it sweeter*. Part (b) (i) was not well done as many candidates did not score full marks. This was unexpected given that the topic examined is a fundamental aspect of the function of a neurone and specific guidelines were given in the question. While most were able to attain four or even five marks, accounts were incomplete as key points were omitted. Others included descriptions of repolarisation despite being told that it was not required. Part (b) (ii) was fairly well done with most responses gaining at least two marks for stating that *Lidocaine interferes with the depolarisation of the neurone and blocks the movement of sodium ions across the cell membrane and therefore no action potential is generated*.

Module 3

Question 6

Syllabus Objectives: 3.2, 4.5

Highest Mark: 15 Mean Mark: 5.19 Lowest Mark: 0

The association between excessive dietary fat intake and hypertension was examined in the first part of the question, while the second part focused on chronic bronchitis and emphysema.

Overall performance for this question was below the expected standard as only 11 per cent of the candidates gained 10 or more marks and the mean value was below average. Part (a) proved challenging as many candidates failed to link excessive consumption of dietary fat with high levels of low-density lipoprotein (cholesterol) in the blood which contributed to plaque formation and thus increased risk of developing atherosclerosis, is a condition that causes the walls of the arteries to thicken. Many candidates failed to get full marks as descriptions of plaque formation were vague and incomplete. Plaque formation is a complicated process and begins with the *damage of the endothelium; high cholesterol or high blood pressure can damage the endothelium, creating a place for cholesterol (LDL) to enter the artery's wall. As cholesterol starts to accumulate in the wall of the artery, white blood cells stream in to digest the LDL cholesterol. Over years, the toxic mess of cholesterol and cells becomes a cholesterol plaque in the wall of the artery. The growth of cholesterol plaques slowly blocks blood flow in the arteries resulting in an increased blood pressure (hypertension).* Part (b) was reasonably well done as most candidates were able to distinguish between chronic bronchitis and emphysema to provide clear explanations of how these conditions were linked to cigarette smoking.

UNIT 2**Paper 032 – Alternative to the School-Based Assessment (SBA)****Module 1**

Question 1

Syllabus Objectives: 2.8, 4.4

Highest Mark: 16 Mean Mark: 8.97 Lowest Mark: 2

In this question emphasis was placed on examining planning and design skills. Candidates' ability to interpret graphical data was also tested.

Overall, this question was quite well done as 52 per cent of the responses were awarded 10 or more marks. For Part (a), candidates were expected to design an experiment to investigate the effect of temperature on the rate of respiration in germinating peas, using a given list of apparatus and material, and to state two precautions. Very few candidates were able to use the given apparatus and material to design an appropriate simple respirometer but did manage to gain some marks for outlining the correct procedure. Most candidates indicated that the rubber and glass connections must be airtight as a precaution but could not state a valid second precaution. In Part (b) (i), many candidates could only give a partial description of the similarity between the trend observed for the rate of human population growth and the rate of species extinction shown. However, most could compare the rate of change in species extinction for the two periods stated and were able to state a threat to world biodiversity, though not always fully commenting on how the identified factor affected biodiversity.

Module 2

Question 2

Syllabus Objectives: 2.1, 2.3, 5.3

Highest Mark: 11 Mean Mark: 5.86 Lowest Mark: 1

This question tested candidates' ability to make a detailed drawing of a selected section of the cross-section of a renal corpuscle and to identify key structures. Ability to interpret features of vascular tissue in plants from a photomicrograph was included in this question.

Performance on this question was below the expected standard as only seven per cent of the candidates scored 10 or 11 marks; mean mark was well below average. Drawings for Part (a) (i) were adequate although in some responses, neat, clean lines were absent and tissues were not always in correct proportions. Most candidates were able to correctly identify two of the

three labelled structures in the corpuscle. In Part (b) (i), candidates were required to compare features of the companion cell with the sieve tube element as shown in the given figure. This part of the question was successfully done by most candidates. However, for Part (b) (ii), many could not identify the plasmodesma shown but could state its function. Very few candidates scored the full three marks on Part (b) (iii) finding it difficult to measure the widest point on the sieve tube element accurately and to correctly use the scale bar provided.

Module 3

Question 3

Syllabus Objectives: 1.3, 1.4, 3.6

Highest Mark: 14 Mean Mark: 9.41 Lowest Mark: 2

The ability to construct a bar graph, analyse and interpret data were tested in this question. The second part of the question examined knowledge of the transmission cycle of dengue fever.

This question was generally well done as 48 per cent of the candidates scored 10 or more marks and the mean mark was slightly above average. For Part (a), candidates were provided with a table of data on the mortality rates for some diseases in CAREC affiliated countries. Most gave incomplete explanations of the term *mortality rate*. The majority were able to construct good bar graphs to score at least four of the six marks for this question. Common errors seen were poor titles or improperly labelled axes. Almost all candidates successfully answered Part (a) (iii). For Part (a) (iv), candidates recognized that mortality dramatically increased but found it challenging to suggest two reasons to account for this trend. Part (b) was a very straightforward question focusing on the transmission of dengue fever using a diagram. Candidates were able to identify the causative agent as a virus, DENV. Most candidates could identify the events occurring in the life cycle shown as well as name *infectious/pathogenic* as the category of disease to which dengue belonged.

General and Specific Recommendations for Teachers

Teachers should continue to encourage students to cover all objectives and to guide them as to appropriate and adequate interpretation of questions especially with respect to rubrics.

General Issues Concerning Paper 032

Despite an improvement in general performance over the past few years, the quality of preparation of candidates for this paper continues to be of concern especially as there is a noticeable decline in the standard of performance for 2014.

General Comments on the SBA

Summary SBA

As in the previous year, the practical activities indicated a general practical approach with wide syllabus coverage. However, there is still some persistence in selecting activities which are not the most appropriate for the skill being tested. Also, this year, there has been a noticeable decline in the quality of drawings being presented. However, there is a definite improvement in the quality of planning and design activities.

Planning and Design

In spite of the improvement seen in this skill, the following comments are still applicable:

- The use of CSEC level and textbook practical exercises should be discouraged.
- Candidates should be encouraged to submit original work for the Planning and Design (P/D) activity. P/D experiments should not be copied from the textbook. All candidates in a given centre should not have the same hypothesis, aim, material/apparatus and method. It has been noted that teachers are now providing candidates with problem statements, questions or observations which allow students to design original labs for P/D. However, students should be instructed to check one variable at a time and to make the aim of the experiment very specific. Students should be reminded that the given observation should be used to generate the hypothesis, aim and method. A significant portion of students demonstrated that they do not have a clear understanding of what constitutes a proper hypothesis, for example, the hypotheses stated were sometimes too lengthy or badly worded.
- The method should be written in the instructional tense. Poor quality of expression was often an issue in the reports presented.
- A greater attempt to include a control was evident. However, students are not able to distinguish between controlled variables and the experimental control.
- The specific quantities of substances to be used should be stated.
- Candidates attempted to use biological principles in explaining predicted results but the supporting information was often basic and at the CSEC level.
- P/D activities selected this year did not reflect much originality or creative thought.
- While many exercises use an adequate sample size, very few include repetition of the activity in the design of their method.
- The marking by teachers, for some schools, has improved. However, overall the standard of marking continues to be lenient.

Analysis and Interpretation

For many samples inappropriate practical exercises were used, for example microscopy, meiosis models, drawings and electron micrographs particularly for the Unit 1 samples.

Teachers are reminded that the aim of the experiment should be properly worded that is, it should be specific, relevant and testable. There was a marked improvement in the quality of the discussion compared to 2013. Good reports had detailed background information and candidates linked the theory to the methodology being used. Analysis of results is still an area of weakness as trends were not always clearly described and explained using the relevant theory and in relation to the stated aim. There is evidence that candidates generally do not have a clear understanding of the difference between a limitation, a precaution and a source of error. Too often, where candidates stated a limitation they did not outline how this would affect the results. In constructing the conclusion, candidates should relate the discussion to the aim and do this in a concise manner. There was some indication that this year more of the students were being exposed to the skill being tested before being assessed.

Drawings

Although drawing was not assessed for Unit 2, a glance through the candidates' samples indicates that the drawing quality was not very faithful representations of what was being observed. For Unit 1, the quality of the drawings was still not at an acceptable standard.

Greater use of magnification on the drawings was observed this year but many of the values were incorrect. In many instances the magnification is still not calculated and recorded. Teachers need to ensure candidates can use the eyepiece graticule to correctly measure the actual size of the specimen being drawn. All working for calculations of the magnification must be shown and the magnification should be shown at the end of the title. Titles are not including the view and name of the specimen being drawn. The use of the word 'diagram' is not acceptable in the title. Copies of textbook drawings are still being presented for assessment, although less frequently than in 2013. These are not acceptable and were awarded zero during moderation. Use of clean, solid, continuous lines should be encouraged. Fewer drawings had unnecessary detail, for example showing the individual cells on a tissue plan; low power drawings should show the distribution of tissues only. Encouragingly, very little shading was evident; instead candidates opted to use stippling. This should be done appropriately so as not to detract from the drawing quality. High power drawings (cellular details) should be done separately instead of being included as part of a hybrid plan-cell drawing. Correct proportions and faithfulness in reproducing the specimen needs to be emphasized. Label lines need to be parallel and justified. More candidates made an attempt to meet the requirement that the lettering of the labels should be either in lower or upper case script. Use of annotations and quality were much improved this year but students must be reminded that a well annotated drawing should include brief notes on both structure and function.

Organization of the Reports

Many books were well organized with a detailed table of contents and correctly numbered pages. Placement of the marks awarded and the skill being assessed for each lab in the table of contents assisted in making the moderation exercise a less frustrating task.

However, there were too many instances of incorrectly completed moderation sheets, inadequate cover pages and barely legible handwriting. Laboratory reports should be securely bound to prevent the candidates work from falling out of the books.