CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2008

BIOLOGY
(TRINIDAD AND TOBAGO)

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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 H_2O_2 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

<u>Question 2</u>

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 2

Question 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 oogensis, 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.

UNIT 2

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 Kreb'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 2

Question 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 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 neurons 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.