THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEMS RESPONSE ANALYSIS REPORT FOR THE ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (ACSEE) 2016

133 BIOLOGY

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FOREWORD

The Report on Analysis of Candidates' Item Response in Biology subject in the Advanced Certificate of Secondary Education Examination (ACSEE) 2016 has been prepared and issued in order to provide feedback to the candidates, teachers, parents, policy makers and the public in general, on the performance of the candidates.

The ACSEE marks the end of two years of the advanced level of secondary education. It is a summative evaluation, which among other things shows the effectiveness of the education system in general and the educational delivery system in particular. Principally, the candidates' response to the examination questions is a strong indicator of what the educational system was able or unable to offer to the candidates in their two years of advanced secondary education.

The analysis presented in this report entails an understanding of some of the reasons behind the performance of the candidates in Biology subject. The report pinpoints some of the factors that made most of the candidates to score high marks in the questions. Such factors include; adequate Biology content knowledge, good understanding of question demand and good drawing skills. The report also highlights the factors which made a few of the candidates to score low marks. These include; inadequate Biology content knowledge, failure to comprehend requirement of the question, unclear explanation and description and poor drawing skills. It is expected that the feedback issued herein will enable the education administrators, school managers, teachers and candidates to identify the appropriate measures to be taken in order to continue to improve the candidates' performance in future examinations administered by the Council.

The National Examinations Council of Tanzania welcomes and highly appreciates constructive and genuine comments and suggestions from teachers, candidates and the public in general, that can be used for improving future reports.

Finally, the Council would like to express sincere appreciation to Biology subject Examination Officers, Examiners and all who participated in the preparation of this report.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

The analysis in this booklet is focused on Biology Advanced Certificate of Secondary Education Examination (ACSEE), 2016 which was done by 20,595 school candidates.

The analysis is based on two papers; namely, 133/1 Biology 1 and 133/2 Biology 2. The questions in all papers intended to measure candidates' theoretical competences on the contents stipulated in the 2010 Biology syllabus and were set as per 2011 examination format.

Paper 1 contained eleven (11) questions classified into two sections; namely, section A and section B. Section A had seven (7) compulsory short answer questions, each carrying eight (8) marks except question six which carried seven (7) marks. On the other hand, section B consisted of four (4) essay type questions, each carrying fifteen (15) marks and the candidates were required to attempt only three questions.

Paper 2 consisted of eight (8) essay type questions presented into four sections namely; A, B, C and D. The candidates were required to answer five (5) questions in this paper by choosing at least one (1) question from each section. Each question carried 20 marks. The analysis of the examination results shows that the general performance in Biology was good as out of 20,595 candidates who sat for the papers, 93.41 percent passed the examination.

The next section of the report analyses the performance of the candidates in each question. The performance in each question is ranked as weak, average or good if the percentage of the candidates who scored 35 percent or more of the marks allocated to the question lies in the range 0 – 34, 35 – 59 or 60 – 100 respectively. The section also pinpoints some possible reasons for observed performance of the candidates in each question. In addition, some candidates' answers have been extracted and used to exemplify the candidates' good and weak responses in each question. It is expected that this report will offer a beneficial feedback to all educational stakeholders by enabling them to identify the areas where the candidates have learning difficulties so that they can rectify the situation, for more success, in the teaching-learning process, and hence achieve best candidates' performance in the subject.
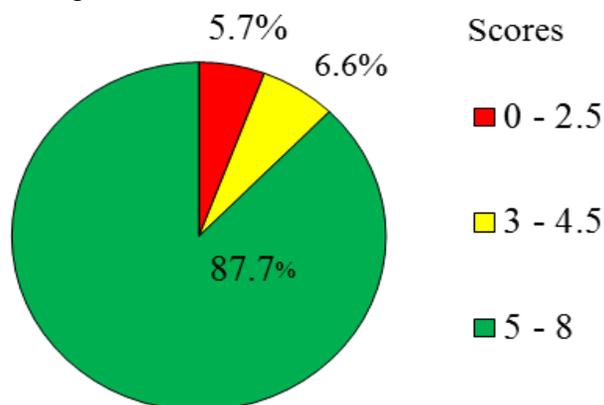
2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE PER QUESTION

2.1 133/1-BIOLOGY 1

2.1.1 Question 1: Cytology

In part (a), the candidates were required to draw the structure of a chloroplast and label any six parts. In part (b), they were required to state three structural adaptations shown by chloroplast to its role.

The analysis shows that out of 20,595 candidates who attempted this question, 87.7 percent scored from 5 to 8, and 6.6 percent scored from 3.0 to 4.5 marks out of 8 marks allocated to this question. However, a few (5.7%) scored from 0 to 2.5 marks as depicted in Figure 1.

Figure 1: Illustration of the candidates' performance in question 1.

The data displayed in Figure 1 reveal that the majority (94.3%) of the candidates scored 3 to 8 marks. Therefore, the general performance in this question was good. The candidates who scored 5 to 8 marks in this question, accurately drew the structure of the chloroplast with all its features such as, double membranes and the grana, clearly indicated. The labels were also correctly spelt. They also stated all or most of the required structural adaptations of the chloroplast. Extract 1.1 shows a sample of a good response from one of the candidates.

Extract 1.1

SECTION A

1. (a)
[Diagram of chloroplast with labels: Thylakoid, 70s ribosomes, Starch grain, Stroma, Intergrana lamella, Lipid droplet]

A well labelled diagram of chloroplast.

(b) Structural adaptations of chloroplast
(i) Chloroplast possess a bundle of thylakoids which form granna for absorption of light

(ii) Membranes of chloroplast are permeable to allow the respiratory gases to enter and leave chloroplast
(iii) Granna are held in position by lamella for maximum absorption of light

Extract 1.1 show a sample of good response from the candidate who was able to draw a well labelled diagram of chloroplast and correctly state its structural adaptions to its role, such as, possession of thylakoids for light absorption.

The majority of the candidates who scored from 3 to 4 marks were able to draw the structure of the chloroplast and label some parts, but failed to state the structural adaptations of the chloroplast to its role.

Despite the fact that performance in this question was good, the analysis further shows that there were a few candidates who scored from 0 to 2.5 marks. Some of these candidates incorrectly answered some of the parts of the question. For example, in part (a), some of the candidates incorrectly drew and labelled the diagram of chloroplast. Some of the incorrect labels included; *cell wall or free ribosomes* instead *of lipid droplet*s, *chlorophyll* instead *of starch grain, cytoplasm* instead *of stroma, interregnal lamella* instead *grana,* and *matrix* instead *of stroma.* Other candidates used a ruler to draw the structure of chloroplast and the diagram

looked more like a rectangle instead of a sphere. This indicates that the candidates had inadequate knowledge on Cytology, particularly in the structure of the chloroplast.

In part (b), some of the candidates did not adhere to the requirement of the question. This was evidenced by incorrect responses which focused on the structures found in chloroplast instead of the structural adaptations of the chloroplast to its role. Some of the responses include; *chloroplast has circular DNA, has membranous system, has ribosomes,* and *has double membranes*. Other candidates stated the adaptations of plant cell instead of chloroplast. Such responses are like; *cell vacuole is a site of food storage*, *has two cell walls which enclose the cytoplasm for division labour and prevent turgid when it is hypotonic solution,* and *it has nucleus which control its activities.* All these responses indicate that the candidates did not understand the requirement of the question. Extract 1.2 illustrates a sample of the candidates' weak responses.

Extract 1.2

Extract 1.2 shows a sample of weak responses from a candidate who drew a plant cell instead of chloroplast. He/she also stated some adaptations of a plant cell instead of the chloroplast. An example of adaptation includes the presence of cell vacuole for food storage.

2.1.2 Question 2: Cytology

In part (a), the candidates were asked to study the molecular formula given below:

$$H_2N \longrightarrow \underset{\underset{H}{\overset{\overset{R}{|}}{|}}{C} \longrightarrow COOH$$
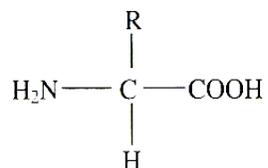
The candidates were then required to; (i) give the general name of the given molecular formula and (ii) state the simplest form of R in the given molecular formula. In part (b), they were required to state six properties of enzymes.

The statistics show that 100 percent of the candidates attempted this question, out of which 90.7 percent scored 5 to 8 marks, and 6.8 percent scored 3 to 4 out of the 8 marks allotted to this question. However, a few (2.5%) scored 0 to 2 marks. The performance is summarized in Figure 2.
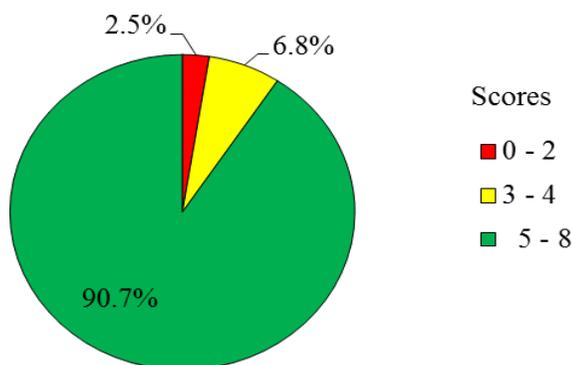
Figure 2: Summary of the candidates' performance in question 2.

From Figure 2 it can be deduced that the general performance of the candidates in this question was good since 97.5 percent scored from 3 to 8 marks. Most of the candidates who had good performance in this question demonstrated good mastery of the concepts taught under the topic of Cytology, particularly in Organic Constituents of the Cell and Enzymes. In part (a), they were able to give the general name and state the simplest form of R in the given molecular formula. In part (b), the candidates correctly stated the properties of enzymes. Extract 2.1 shows a sample of one candidate's good responses.

Extract 2.1

2. (a)(i) The name is Amino acid.		
(ii) The simplest form of R is Hydrogen (H) which form an amino acid called Glycine.		
(b) Propertieres of enzymes.		
☉. Enzymes are globular proteins.		
☉ Enzymes Catalyre reaction in a reversible reaction that is reactant may react to form product and product react to form reactant.		
☉ Enzyme they tend to react by lowering the activation energy of the reaction.		
☉ Enymes are highly specific in such a way that a single enyme can only catalyse only a single reaction.		
☉ Enzymes are highly efficient; That is only a small amount of it can bring about a vast number of products.		
☉ Enzymes controlled reaction are affected by changes in pH, temperature but also presence of inhibitors.		

Extract 2.1 is a sample of good responses from a candidate who was able to give the correct general name of the given molecular formula. He/she also stated the correct properties of enzymes such as; enzymes are globular in shape and they are highly efficient.

The majority of the candidates who showed average performance, majority failed to give the general name for the given molecular formula. However, they were able to state some properties of enzymes. On the other hand, some of these candidates lost some marks by listing the properties of enzymes without giving explanation.

Conversely, the candidates who showed weak performance failed to correctly answer all or most of the parts of the question especially in part (a). For example, some candidates wrote the general name of the formula given as *protein,* which is not correct. Other candidates incorrectly named the simplest form of R in the formula given as *alkyl group, methyl group, hydrocarbons amino acids* and *alanine.* This is an indication that the candidates lacked enough knowledge on Cytology, specifically on the Organic Constituents of the Cells and Enzymes.

In part (b), some candidates wrote incorrect properties of enzymes such as; *enzymes it spreed the rate of reaction, enzemse stimulated by hormone due to the*

presence of type of food, enzymes are crystalline in nature, enzymes are tasteless, enzymes are odourless, they are small in size, enzymes provide saliva from salivary glands, enzymes used as lubricant to lubricate the food for easy swallowing. All these responses indicate that the candidates were incompetent in knowledge contents regarding enzymes and their properties. Apart from incompetency in knowledge contents, some of the candidates had weak performance due to unclear sentences which they wrote. Extract 2.2 shows a sample one of the candidate's weak responses.

Extract 2.2

2a i/ Protein ii/ Amino acid		

b i/ Enzymes it spreed the rate of reaction
  ii/ Enzyme it is bu beind site of the substrate
  iii/ convert from one substrate form of original to another simp substrate
  iv/ increase the reactivity of the substrate.
  v, Enzyme is used in ph formation of protein in the body		

Extract 2.2 shows a sample of responses from a candidate who gave incorrect responses in part (a). In part (b) the candidate wrote the functions of enzymes such as conversion of substrates from one form to another instead of properties of enzymes.

2.1.3 Question 3: Cytology

In part (a), the question needed the candidates to discuss the effect of temperature on the rate of enzymic controlled reaction and in part (b), it needed them to draw the structure of ATP molecule and explain how it is formed.

The analysis reveals that candidates' performance in this question was good as out of 20,595 candidates who attempted this question, 58.6 percent passed, with 46.7 percent scoring 3 to 4.0 marks and few candidates (11.9%) scored 5 to 7 marks. On the other part, 41.4 percent scored 0 to 2.0 out of the 8 marks allocated to this question. However, in this question, none scored all the eight marks. Figure 3 displays the performance.
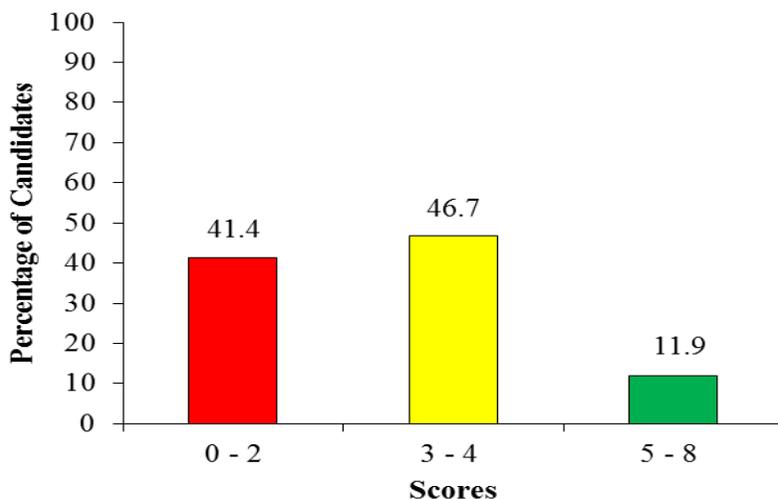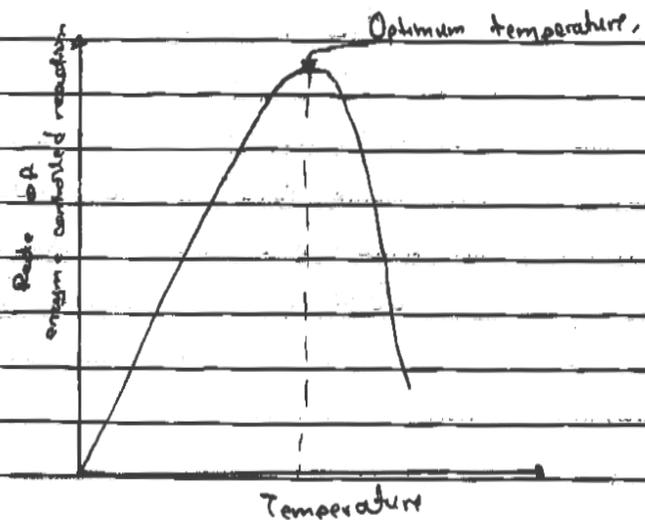
Figure 3: Illustration of candidates' performance in question 3.

The data from Figure 3 show that a total of 58.6 percent scored 3 to 8 marks. The few candidates who scored from 5 to 8 marks in this question had adequate knowledge on Cytology, particularly on enzymes and ATP. The candidates who scored all the marks were able to give a detailed discussion on the effect of the temperature on the rate of enzymic controlled reaction, and skilfully drew the structure of ATP and accurately explain its formation. Extract 3.1 illustrates this case.

Extract 3.1

3@	The effect of temperature on enzymic controlled reaction	
	⊕ Low temperature.	
	At low temperature, less than 5°C the enzymes	
	are inactivated and hence they fail to catalyze	
	the reaction, this result into fall of the rate	
	of reaction, The active site of an enzyme fail	
	to bind with the substrate, hence no formation	
	of substrate/enzyme complex	

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Extract 3.1 continues

3(a)   ⇒ Optimum temperature.

At optimum temperature, the rate of reaction is high, this is due to the enzymes are at its best medium and thus high chance of colliding of enzymes and substrate to form substrate/enzyme complex due to their vibration motion.

⇒ High temperature

Temperature above the optimum temperature decrease the rate of chemical reaction due to denaturation of enzymes by lossing their three dimension shape. The denaturation is due to high vibration of atoms of enzymes which result to break of bonds like ionic bond and disulphide bond.
In short,

Increase of temperature result into the increase of rate of enzyme controlled reaction upto the optimum temperature, above that the reaction rate decreases as shown below:-

Optimum temperature.

(y-axis: Rate of enzyme controlled reaction)

(x-axis: Temperature)

Extract 3.1 continues

3(a)	ATP is formed by adding phosphate groups to the Adenosine
	Addition of phosphate group to a adenosine molecule is called phosphorylation. This process need energy, either from the sun as in photosynthesis (photophosphorylation) or from respiration (oxidative phosphorylation)
	Addition of the last two phosphate group require about 30.6 kJ/mol energy while that of the first just require are half-of it.
	The addition of phosphate molecule to Adenosine diphosphate (ADP) is catalyzed by an enzyme called ATPase
	All of these reactions are condensation reaction which involve removal of water molecule

Extract 3.1 shows responses of a candidate who was able to correctly discuss the effect of temperature on the rate of enzymic controlled reaction. He/she was also able to give an explanation of ATP formation using ATP ase enzyme and 30.6kJmol⁻1

On the other hand, the majority of candidates who scored average marks, correctly discussed the effect of temperature on the rate of enzymic controlled reaction. However, they failed to draw the structure of ATP and explain its formation.

A few of the candidates with weak performance were incompetent in content knowledge on the topic of Cytology as they gave incorrect responses. Apart from incompetency in knowledge content, some of them wrote unclear sentences such as; *if the temperature is raised the enzyme production will be low* and *this is the effect of temperature was not to produce the energy in the body because the heat is the source of energy*. These show that the candidates were not conversant in using English language.

In part (b), the candidates drew an incorrect structure of ATP. For example, some of the candidates drew the structure of ATP with a hexose sugar (six carbons)

backbone instead of a pentose sugar (ribose). Also, the majority of the candidates overlooked the necessary conditions for the formation of ATP such as ATPase enzyme and energy value 30.6kJmol⁻. Extract 3.2 shows similar weak responses.

Extract 3.2

| Q3 | @ The rate of temperature on enzymitic control |
	=D When temperature is raised the enzyme production will be low,
	=D Whe tho rate of temperature is lowered the enzyme production will be affected and hence high enzymes produced.
	ⓑ
	[diagram: inorganic phosphate (pi), Adenocinediphosphate (ADP), denocinetriphosphate (ATP), ATP]
	Figure: Structure of ATP (Adenocinetripho sphate)
	=D ATP is formed from Inorganic phosphate where by Inorganic phosphate (pi) conbine with its another molecule to form Adenocinediphosphate (ADP)
	=D Adenocinediphosphate (ADP) conbine with one molecule of inorganic phosphate (pi) to form Adenocine triphosphate (ATP) hence energy.
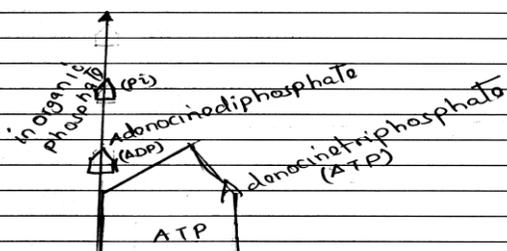
Extract 3.2 shows a sample of weak responses from a candidate who failed to explain the effect of temperature on enzymic controlled reaction. He/she also drew a weak diagram of ATP and wrote unclear statements on the formation of ATP.

2.1.4 Question 4: Principles of Classification

In part (a) the candidates were asked to (i) define the term taxonomic hierarchy and (ii) illustrate the concept of taxonomic hierarchy using man as an example. In part (b), the candidates were asked to explain four advantages of using artificial system of classification.

Statistics indicates that a total of 20,595 candidates attempted this question, of whom 57.5 percent scored from 5 to 8 marks, 30.8 percent scored from 3 to 4 marks and 11.7 percent scored from 0 to 2.5 out of the 8 allocated marks. These data are illustrated in Figure 4.
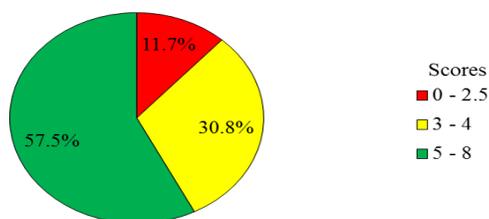
Figure 4: Illustration of the candidates' performance in question 4.

The data from Figure 4 show that the majority (57.5%) of the candidates had good performance in this question. The candidates succeeded to give the meaning of taxonomic hierarchy and illustrated the concept of taxonomic hierarchy using man as an example. They were also able to explain the four advantages of artificial system of classification. However, the details of their explanation varied. This implies that, the candidates had good mastery of the content knowledge in categories of classification. Extract 4.1 shows a sample of good responses from a candidate.

Extract 4.1

Extract 4.1 is a good response from a candidate who correctly stated the advantages of the artificial system of classification such as stability and less time consuming.

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On the other hand, the majority of the candidates who scored average marks, failed to state the meaning of the term taxonomic hierarchy and partially illustrated the concept of taxonomic hierarchy for a human being. However, the majority were able to explain at least three out of four asked advantages of artificial system of classification.

Conversely, a few (11.7%) of the candidates with weak performance provided a variety of incorrect definitions which did not relate to what was asked. The responses include taxonomic hierarchy *is classification of an organisms according to the environment*, *it is the process of transfer of hereditary material such as DNA within the*, it is *all environment that surround the man, the study of identification of unknown the scientific of organism* and *it is the hierarch which is used to classify the organism up to class level.* All these responses were indicators that the candidates lacked knowledge of taxonomic hierarchy. In addition, some of the candidates did not understand the requirement of the question as they tried to define and explain the concept of taxonomic keys instead of taxonomic hierarchy. For instance, some of the candidates wrote, taxonomic hierarchy *is the knowledge or tools used by biologists to identify the unknown organisms*; *deals with the characteristics that man have height, colour, shape; process of naming an organisms by using two names.* Other candidates had a problem of misspelling the technical terms. For example, the terms like *specie/speciense* instead of *species* and *mammals* instead of *mammalia* were observed in some of the candidates' scripts.

In part (b), some of the candidates incorrectly explained the advantages of artificial system of classification. Some of the incorrect explanations were: *it helps in understanding different organisms and their diseases and treatment of organisms; it is the basis of evolution; it shows the ancestral origin of organism; it is the basis of the theory of organic evolution;* and *it is not affected by the change in environment*. These definitions are incorrect as they do not relate to what was asked. Extract 4.2 shows a sample of candidates' weak responses.

Extract 4.2

```
4 (b)  FOUR ADVANTAGES OF ARTIFICIAL  CLASSIFICATION
   (i) It is not use long time
   (i) It help to  keep organisms to their actual  group
   (ii) It help to  know the scientific  name of each organism on their
   specific  group
   (iii) It help or it makes easy for scientists to study the character-
   istics of a specific  group
   (iv) Due to  artifical  classification


   @  Taxonomic hierarch:
      => That are the  process of classifies  a living organisms of
   the same group in thier specific class  or order  according to
   thier specific  or given  character  good example house fly and
   honey bee are in same class but they  are classified different.

   (ii) By using a Good example a man to illustrate the taxonomic
   hierarchy. There are  human  being which have a names
   like  amina - Red eye, black air  and soft skin.
          Philipo - white eye, black air  and hard skin
          stove - Red eyes, hard skin
          Felestor - white eyes, soft skin

4 (b)            Taxonomic hierarchy:
                      Human beings:
      eyes colour (a)
                        (b)
           Red colour        white colour
   Nature of skin  2a            2b
      soft skin  hardskin   soffskin  hardskin
       amina     steve     felistor  Philipo.
```

Extract 4.2 shows a sample of weak responses from a candidate who did not understand the demand of the question. In part (a) he/she tried to define and explain the concept of taxonomic keys instead of taxonomic hierarchy, whereas in part (b), he/she wrote the importance of grouping and naming organisms instead of advantages of the artificial system of classification.

2.1.5 Question 5: Gaseous Exchange and Respiration

Part (a) of the question required the candidates to state three similarities between respiration and photosynthesis. In part (b), the candidates were required to explain what will happen to the rate of respiration if (i) the temperature is raised above optimal point and (ii) health of an organism is impaired.

Statistics indicate that a total of 20,595 candidates attempted this question. The general performance was good because the majority (68.2%) scored 3 or more marks, out of which 35.0 percent scored from 3 to 4.5 marks and 33.2 percent scored from 5 to 8 marks. On the other part, 31.8 percent scored from 0 to 2 marks out of the 8 marks allocated to this question, as summarized in Figure 5.
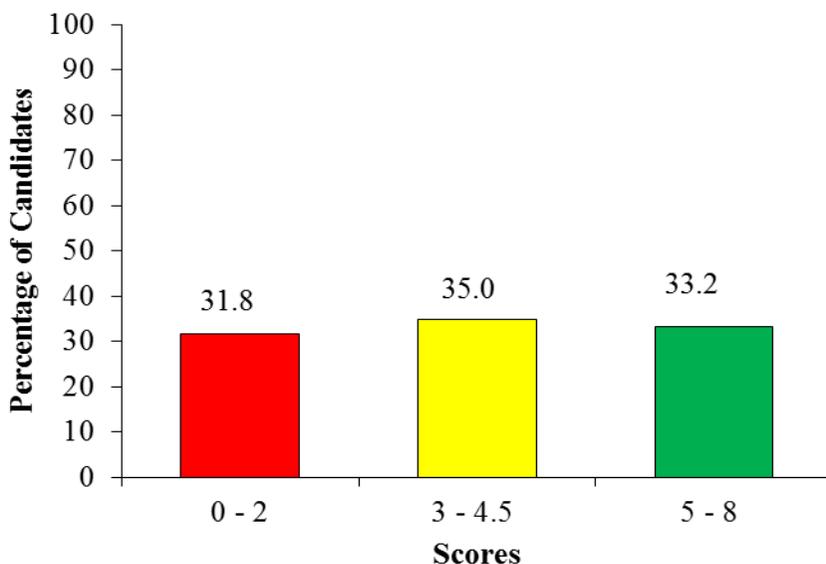
Figure 5: Candidates' performance in question 5.

Figure 5 shows that the percentage of the candidates whose performance was good, average and weak are nearly equal. The candidates who scored 5 to 8 marks in this question had enough knowledge on the concepts of respiration and photosynthesis. These candidates succeeded to identify the demand of the question, as they provided correct responses in most of the parts (a) and (b). Extract 5.1 shows a sample of good responses.

Extract 5.1

5.	Similarities between respiration and photosynthesis.
	-Both respiration and photosynthesis involve process of the electron transport.
	-Both are metabolic process aiming at producing energy in the cell
	-Both take place in membrane closed system.

Extract 5.1 continues

(b)	Rate of respiration of temperature is Raised above normal.	
	i/ Because respiration is an enzyme controlled reaction, enzymes in the different phases of respiration will be denatured by the high temperature. This denaturing causes the enzymes to lose their three dimensional structure and change the active site. Therefore the rate of respiration will be lowered by the high temperature.	
	ii/ When health of an organism is impaired the rate of respiration will increase so as to remove the toxic substance from body of organisms and fights against the new pathogens which entered in the body. The energy is released and help the white blood cells to kill all pathogens in the body. This is why the rate of respiration increases.	

> Extract 5.1 shows a sample of good responses from a candidate who had sufficient knowledge on respiration and photosynthesis. For example, the candidate gave correct similarities of respiration and photosynthesis, such as involvement of electron transfer in both processes.

Most of the candidates who scored average marks were able to state the similarities between respiration and photosynthesis in part (a) but failed either completely or partially to answer part (b) of the question.

A few of the candidates who scored low marks, had insufficient knowledge on photosynthesis and respiration as they gave few correct points and a variety of incorrect responses. For example in part (a), such incorrect responses include; both respiration and photosynthesis *use light from the sun so as to take place*; *both produce glucose as products during reaction,* and *both respiration and photosynthesis occur in the cell*. Such responses indicate that the candidates had insufficient knowledge on photosynthesis and respiration.

In part (b) (i), some of the candidates gave incorrect answers which did not relate to the asked question. For example, some of the candidates' responses were focused on the effect of temperature on the rate of breathing and energy production instead of rate of respiration. In part b (ii), the candidates' incorrect responses indicated that they had insufficient knowledge on the effect of temperature and health of organisms on respiration. Extract 5.2 shows a sample of weak responses.
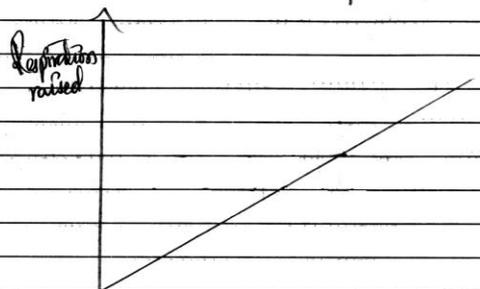
Extract 5.2

Extract 5.2 shows a sample of candidate's weak responses. The candidate failed to correctly answer parts (a) and (b) of the question. For example, she/he wrote that both photosynthesis and respiration are anaerobic respiration.

2.1.6 Question 6: Transportation

In part (a), the candidates were required to study the given figure below:
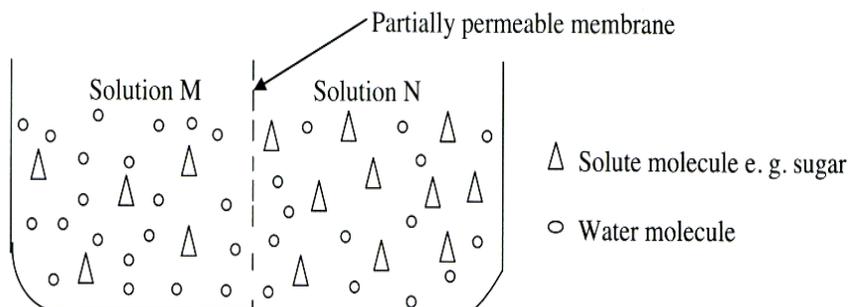
Then, they were asked to; (i) mention the solution which has higher water potential, (ii) mention the solution which has higher solute potential and in (iii) state the direction in which osmosis will occur. In part (b), the question required the candidates to state four roles of osmosis in living organisms.

A total of 20,595 candidates attempted this question, of whom 48.6 percent scored 5 to 7 marks while 43.9 percent scored 3 to 4 and only 7.5 percent scored 0 to 2.5 out of the 7 marks allocated to this question. Figure 6 summarizes the data.
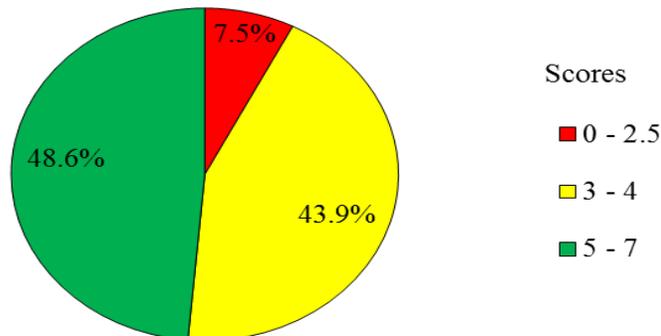
Figure 6: Summary of candidates' performance in question 6.

The results from Figure 6 indicate that the candidates' performance in this question was good. The candidates who scored 5 to 7 marks had sufficient knowledge on the concept of osmosis. In part (a), they were able to mention the solution which has higher solute potential and higher water potential. In part (b) the candidates were able to clearly state most of the roles of osmosis in living organisms. Extract 6.1 shows a sample of good responses.

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Extract 6.1

6(a)		
i.	Solution M has high Water potential because of Low Concentration of Solute molecules.	
ii.	Solution N has higher solute potential due to the presence of high Concentration of Solute molecules which Lowers the Water potential.	
iii.	Osmosis refers to the movement of Water molecules from the region of their **high** Concentration to the region of their Low Concentration across <u>semi-permeable</u> membrane. -Thus In figure 1 Osmosis will occur from Solution M to solution N. This is because Solution M has high Water potential than Solution N	

SOLUTION M   SOLUTION N   partially permeable membrane

△ Solute molecule erg Sugar

O Water molecule

DIRECTION OF OSMOSIS

Extract 6.1 continues

6 (b)	Osmosis has the following roles.	
	Helps in movement of Water and mineral salts	
	from the soil to the roots	
	Osmosis provides support; When the Water enters the ~	
	Cell of organism Like plants turgor pressure is developed hence	
	provide the support to the stem of plant.	
	Develops root pressure; When the water enters the plant	
	by osmosis a pressure generated Which helps in movement	
	of water to upper parts of the plant.	
	Helps in reabsorption of Water In animal; During ~	
	Counter current multiplier, Ascending Limb is permeable to	
	Ions Like Na^+ and cl^-, these ions cause Water from collecting	
	duct to move out by osmosis, hence Water passes out into	
	medulla and return Into the blood system.	

In extract 6.1 the candidate was able to state the roles of osmosis such as, to help in uptake of water and dissolved mineral salts from the soil.

The candidates who performed averagely, were capable of stating some of the roles of osmosis in the living organisms but failed to mention the solution which has a higher solute potential and one which has higher water potential. However, most of them were able to state the direction in which osmosis will take place.

Nevertheless, the majority of the candidates who failed, had misconception about osmosis, as in part (a) they showed that osmosis will occur from low concentration of water to high concentration. In part (b), incorrect responses which appeared in candidates' scripts include: *osmosis in living organisms helps in water storage in the plant during dry seasons* osmosis *enables breathing of air by an organism hence their survival; osmosis carry genetic materials; carry sex chromosomes of an individual; osmosis maintain reproductive potential and helps movement of carbon dioxide in the chloroplast for respiration;* and *osmosis maintain the shrinking of the cell*. These responses indicate that the candidates

had inadequate knowledge of what osmosis is. Extract 6.2 shows a sample of weak responses.

Extract 6.2

6 a)i)	N	
ii)	A	
iii)	M ⟶ B	
b)	ROLES OF OSMOSIS	
(i)	It helps in pumping of blood as from the heart to other parts of an organism	
(ii)	Enables the sugar supply throughout the body of an organism	
(iii)	It ensure the supply of essential needs by a plant such as water and mineral salts	
iv)	To enable breathing of air by an organism hence their survival.	

In extract 6.2 the candidate gave incorrect responses in all the parts of the question. He/she also incorrectly used letters A and B which were not in the question to indicate the solution with higher solute potential.

2.1.7 Question 7: Reproduction

In part (a), the question required the candidates to give five differences between mitosis and meiosis. In part (b), it required them to state two significant aspects of meiosis process in sexual reproducing organisms.

A total of 20,594 candidates attempted this question, of whom 35.6 percent scored 5 to 8 marks, 35.5 percent scored from 3 to 4.5 marks and 28.9 percent scored 0 to 2.5 marks out of the 8 allocated marks. The summary of the candidates' performance in this question is depicted in Figure 7.
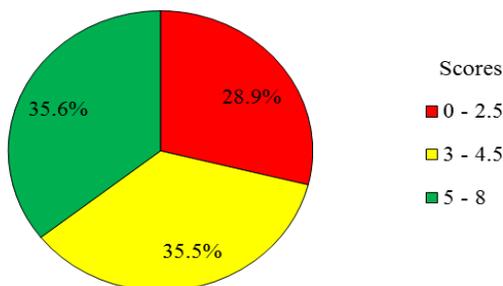
Figure 7: A summary of the candidates' performance in question 7.

The data from Figure 7 reveal that, the candidates' performance in this question was good as 71.1 percent scored from 3 to 8 marks. The candidates who performed well had sufficient knowledge on the topic of Reproduction particularly, on the concepts of mitosis and meiosis, as they clearly gave five differences between them. Moreover, the candidates successfully stated the two significant aspects of meiosis process in sexual reproducing organisms. Extract 7.1 shows a sample of one candidate's good responses.

Extract 7.1

7. (a) Difference between mitosis and meiosis		

Mitosis	Meiosis
(i) It has no two phases like meiosis	(i) It has two phases i.e Meiosis I and II
(ii) It results to two daughter cells	(ii) It results to four daughter cells
(iii) The daughter cells have the same number of chromosomes as the parental cell.	(iii) The daughter cells have haploid number of chromosomes
(iv) It occurs in all cells of the body	(iv) It occurs in reproductive cells only
(v) No crossing over in mitosis therefore no variation can occur	(v) There is crossing over hence daughter cells are not identical to each other

7 (b) Two significance of meiosis process in sexual reproducing organisms.

(i) It leads to variation among the organism of the same species.
    - The variation occur due to exchange of genetic materials during crossing over of homologous chromosomes.

Extract 7.1 continues

	(ii) It mantain the diploid nature of the cells in an organism. — This is because the fusion of haploid gametes results to a diploid zygote which under go mitosis to form other diploid cells of organism. — If the gametes could be diploid the zygote formed would be tetraplord and the diploid nature is lost .	

> In extract 7.1 the candidate was able to give the five differences between mitosis and meiosis. He/she also managed to state accurately two significance of meiosis in sexual reproducing organisms such as maintenance of diploid nature of the cell in an organism.

Most of the candidates who scored average marks managed to give not more than three differences between mitosis and meiosis in part (a). However, in part (b), most of them failed to state the significance of meiosis in sexual reproducing organisms.

Conversely, a few of the candidates who did not perform well in this question some did not understand the requirement of the question as in part (a) some of the candidates differentiated between sexual reproduction and asexual reproduction instead of mitosis and meiosis. For example, some of the incorrect responses were: *in mitosis only one parent is involved whereas in meiosis two parents are involve; in mitosis no cell combine together while in meiosis cells are combine together;* and *in mitosis no formation of zygote while in meiosis there is formation of zygote.* In part (b), some candidates failed to state the significance of meiosis in a sexual reproducing organism, instead they stated events which occur in meiosis such as crossing-over and independent assortment. Extract 7.5 shows a sample of a candidate's weak responses.

Extract 7.2

7(a)	The differences between Mitosis and Meiosis		
	Mitosis	Meiosis Meiosis	
	i/ It maintain the number g chromosome	It minimize number g chromosome	
	ii/ It produce large number g offspring	few offspring can be produce.	
	iii/ Only one parent involved.	Two parent involved.	
	iv/ Gamete does not involved.	It involve loss g gamete.	
	v/ There is not loss g energy	Energy are lossed.	
(b)	Significance g meiosis in sexual reproducing organism.		
	i/ Crossing over it bring.		
	ii/ Independent assortment.		

In extract 7.2 the candidate did not understand the demand of the question especially in part (a), he/she outlined the differences between sexual and asexual reproduction instead of mitosis and meiosis. In part (b), the candidate stated events which occur in meiosis instead of significance of meiosis in sexual reproducing organisms.

2.1.8 Question 8: Transportation

In part (a), the candidates were enquired to describe with the help of a diagram the movement of water and mineral salt across the root through the following ways; (i) symplast (ii) vacuolar and (iii) apoplast. In part (b), they were enquired to explain five roles of water in plants.

Majority 18,600 (90.3%) of the candidates attempted this question indicating their familiarity with the topic of Transportation, specifically in plants. Data analysis revealed that 55.4 percent scored 6 to 10 marks and only 1.9 percent scored 10.5 to 15 marks out of the 15 marks allocated to this question. However, 42.7 percent scored 0 to 5 marks as indicated in Figure 8.
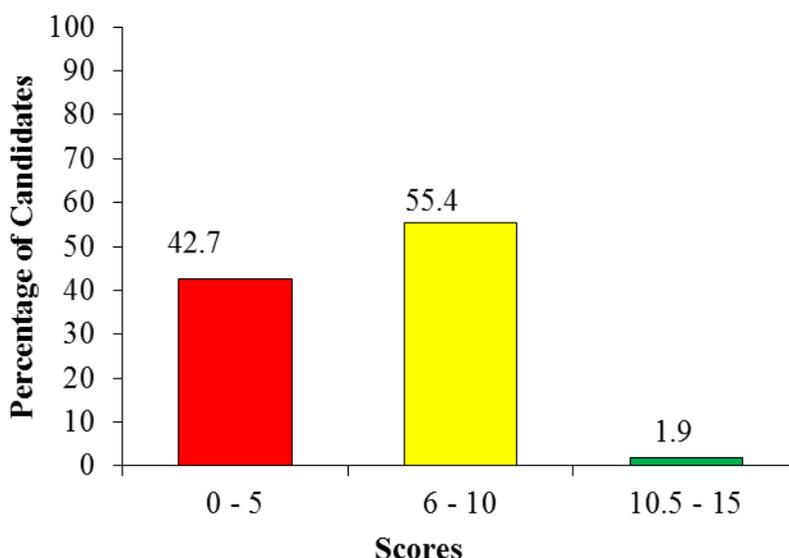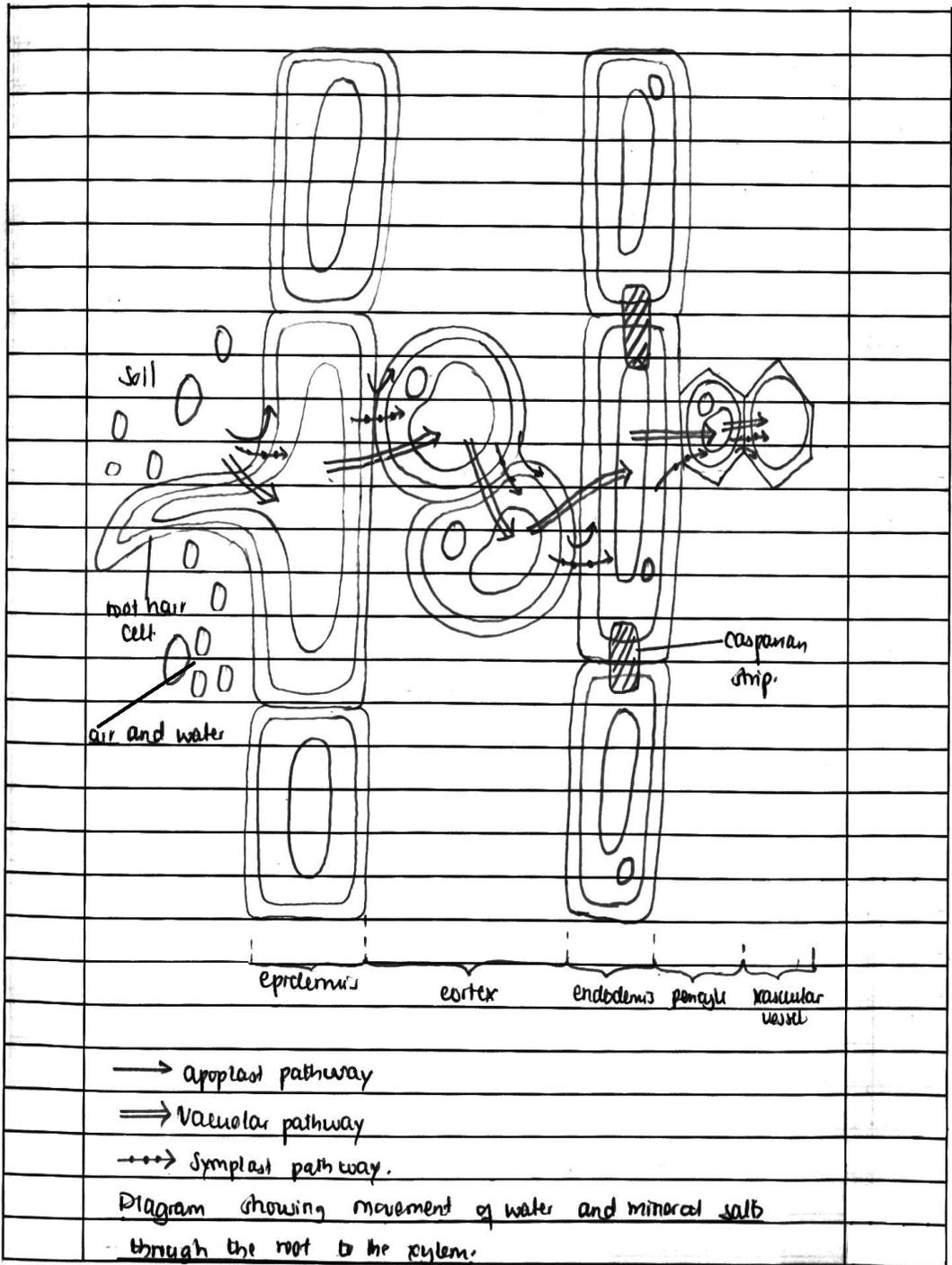
Figure 8: The candidates' performance in question 8.

The data from Figure 8 indicate that more than half (57.3%) of the candidates scored above 5 out of 15 marks. Thus, the general performance in this question was average. A few (1.9%) candidates who did well in this question had adequate knowledge on transportation in plants. Therefore, they were able to correctly describe the movement of water and mineral salts across the root through symplast, vacuolar and apoplast. Their descriptions were accompanied with a correct diagram which gave them more credit. Extract 8.1 shows one candidate's sample of good responses.

Extract 8.1

8.a	Symplast pathway in which water and mineral	
	salts f diffuse from one cytoplasm to the next cytoplasm	
	of adjacent cells through the plasmodesmata. This is due to	
	the difference in water potential between the neighbouring cells.	
	Vacuolar pathway in which water and mineral	
	salts diffuse from one vacuole to the vacuole of the next	
	cell, through the tonoplast; cell membrane and cell wall. Also	
	this flow is due to the difference in water potential	
	between the adjacent cells.	
	Apoplast pathway in which water and mineral salts	
	diffuse from one cell wall to the next. Also this is	
	facilitated by difference in water potential between the	
	adjacent cells.	

Extract 8.1 continues

Diagram showing movement of water and mineral salts through the root to the xylem.

Labels within diagram: soil; root hair cell; air and water; casparian strip; epidermis; cortex; endodermis; pericycle; xascular vessel

Legend:
→ apoplast pathway
⇒ Vacuolar pathway
⋯→ Symplast pathway.

Extract 8.1 continues

| 8 b)	The following are five roles of water to plants.	
	Useful for sexual reproduction in Lower plants It is a medium through which sperms flow from the male reproductive organs to the female so as to cause fertilisation This is seen in mosses, liverworts and fern plants during the gametophyte stage.	
	For germination of seeds. Imbibition water which enters the seed through the micropyle is used to soften the testa and cause it to burst releasing the embryo also water is used for hydrolysis of various food substates to produce energy and nutrients.	
	It's a major means for transport in the xylem and phloem. It is in water that materials to be transported are dissolved. Example: Sucrose solution in the phloem and mineral salts dissolved in water in the xylem vessels.	
	Useful for various physiological process such as photosynthesis during photolysis to release H^+, O_2 and electrons. Also a medium through which different process takes place.	
	Water provides turgidity to a plant giving it support (especially in herbs) and also for stamatal opening and closing by the guard cells. This movement of water causes also transpiration pull with which creates a continuous flow of water from the soil to the atmosphere through the plant.	

> In extract 8.1 the candidate used a diagram to describe the movement of water and mineral salt across the root through the symplast, vacuolar and apoplast ways. Also, he/she correctly explained the roles of water in plants such as photosynthesis, support and seed germination.

Some of the candidates who scored average marks, were able to describe the movement of water and mineral salt across the root through symplast, vacuolar and apoplast. However, they did not use a diagram as required by the question, thus they lost the marks allocated for the diagram. Others drew the structure of xylem instead of root and indicated the movement of water and mineral salts up to the stem. However, in part (b), they were able to explain at most, three correct roles of water in plants.

On the other hand, the few candidates who showed weak performance in this question failed to describe the movement of water and mineral salt across the root through symplast, vacuolar and apoplast ways. In part (a), incorrect responses such as: *in symplast way water is moving through plasmodesmata; in vacuolar way water from vacuolar through apoplast and symplas, symplast is the movement of water through parenchyma upward the plants; vacuolar is movement of water and mineral through vessels such as phloem and xylem* and *apoplast movement of water and minerals is across companion cells and tracheids* were observed in some of candidates' scripts. These responses signify that the candidates had insufficient knowledge on the topic of Transportation especially in plants.

In part (b), some of the candidates were able to explain one to two out of the five asked roles of water in plants. Incorrect responses which were observed in some of the candidates' scripts include: *in solvent water are used to solvent of molecule in plants; prevent falling of leaves* and *water help the plant to be wet and protome the growth of the plant.* Extract 8.2 shows similar weak responses.
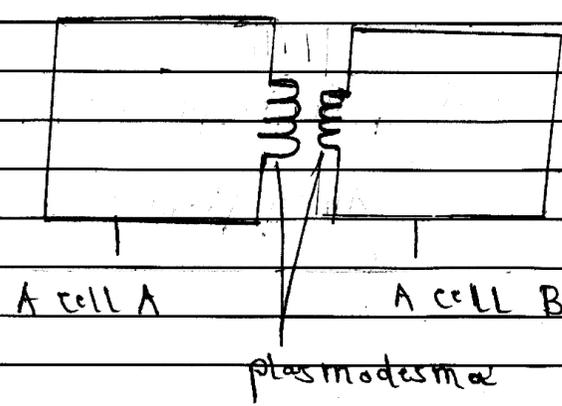
Extract 8.2

Extract 8.2 continues

8 a/ ii/ Vacuolar pathway is the pathyway in which water move from one vaculor to another vocular through A apaplast and symplast.

$H_2O \longrightarrow H_2O$
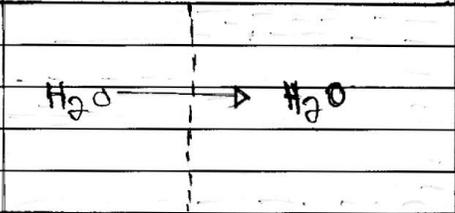
iii/ Apoplast, is the type of pathway in mineral salt and water move through the root from the soil

— movement of H_2O

→ water move through here from the soil
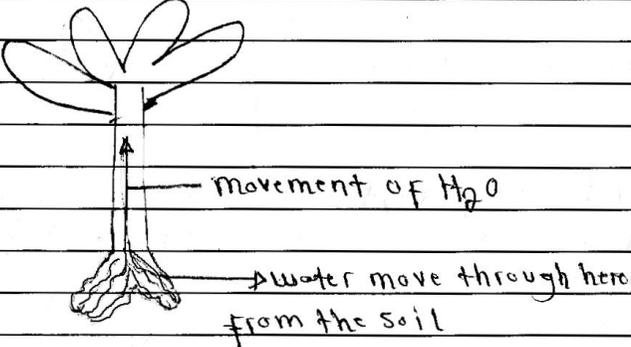
b/ i/ Help to make ¥ in the process of making food

ii/ Protome the growth of plants.

In extract 8.2 the candidate used irrelevant diagrams to describe the movement of water and mineral salts across the root. Also, he/she wrote unclear statements concerning the role of water in plants such as protome the growth of plants.

2.1.9 Question 9: Cytology

The candidates were required to study the following Figure 2:
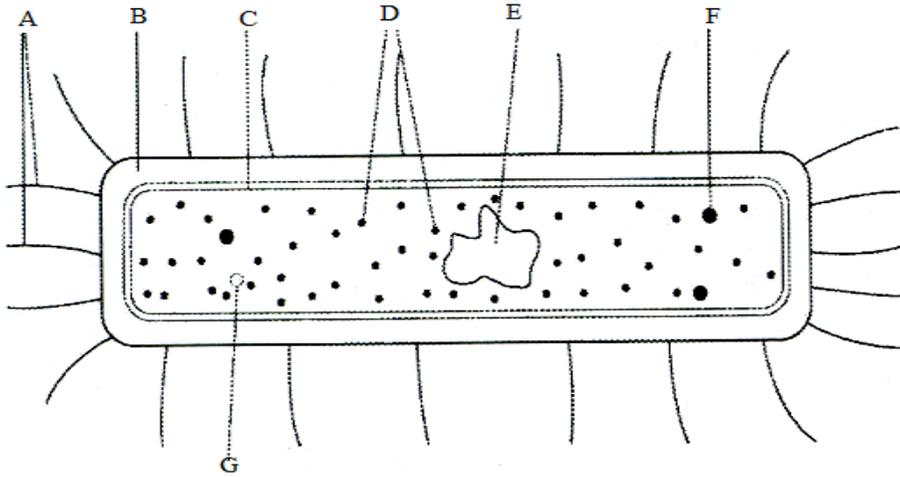
Figure 2

Then, in part (a) they were required to (i) identify the cell and (ii) name the parts labelled A, B, C, D, E, F and G. In part (b), they were required to outline five differences between the cell in Figure 2 and a trypanosome cell.

This question was opted by 63.1 percent, where by 40.6 percent scored from 5.5 to 10 marks, 39.6 percent scored from 0 to 5 marks and 19.8 percent scored from 10.5 to 15 marks out of the 15 marks allocated to this question. Figure 9 summarizes the general performance of the candidates in this question.
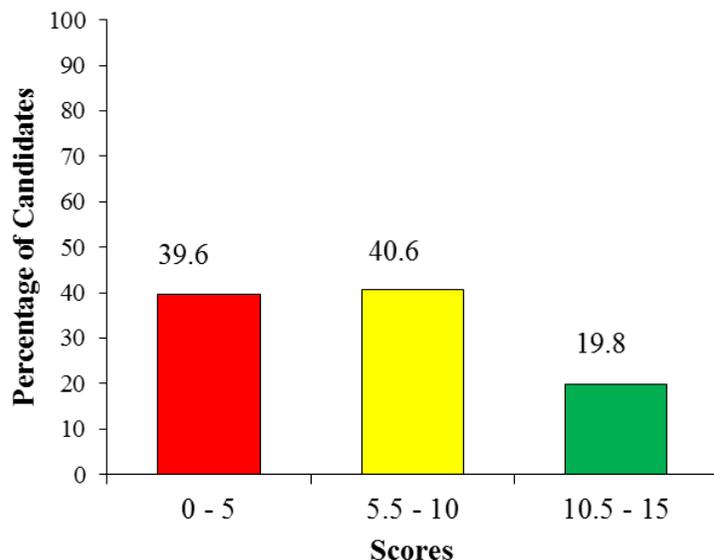
Figure 9: The candidates' performance in question 9.

The data from Figure 9 reveal that the performance of the candidates was good since out of 12,986 (63.1%) candidates who attempted this question, 60.4 percent scored 5.5 marks or above. This indicates that most of the candidates had adequate knowledge of the types of cells in the topic of Cytology. The candidates who scored all (15) marks managed to identify the cell and correctly named the labelled parts. In addition, they were able to differentiate bacterial cell from a trypanosome cell. Their responses were clearly elaborated and well structured. Extract 9.1 shows a sample of good responses.

Extract 9.1

9a i) The cell is a prokaryotic cell, typically a bacterial cell.	
ii) A = Pili	
B = Cell wall	
C = Cell Surface membrane	
D = 70's ribosomes	
E = Circular DNA	
F = Food reserve	
G = Plasmid	
9b Bacteria cell	**Trypanosome cell**
Has circular, naked DNA	Contains DNA enclosed by histone protein
Respiration occurs through mesosomes	Respiration occurs in mitochondria
Contains small 70's ribosome	Contains large 80's ribosomes
Has no cell organelles like Golgi apparatus and mitochondria which are bounded by membrane	Contains many membrane bounded cell organelles
Contains cell wall made by murein	Has no cell wall.
Contains plasmid	Has no plasmid

Extract 9.1 shows a sample of good responses from a candidate who was able to identify the cell as bacterial cell and correctly named the required labels. He/she also correctly differentiated a given cell from a trypanosome cell.

The candidates with average performance were able to identify the cell and correctly named the labelled parts. However, they didn't manage to give more than two differences between the cell given and trypanosome cell.

On the other hand, most of the candidates who showed weak performance in this question, incorrectly identified the cell in part (a) (i) of the question and as a result they were unable to name the labelled parts. A variety of guess answers for the name of the cell were such as; *euglena, plasmodium, Bacteriophage, Plasmodesmata, paramecium* or *ciliophora.* In part (a) (ii) incorrect names which were given for a part labelled A include: *Cilia, flagella, cell wall,* and *cell membrane* instead of pili. A part labelled B was named as *cell membrane* instead of cell wall; part G as *vacuole, cytoplasm, nucleus, endospore, lysosomes,* or *ribosomes* instead of plasmid, and part F was labelled as *capsid* instead of food reserve.

In part (b), some of the candidates failed to understand the requirement of the question since they wrote the differences between animal and plant cells instead of the differences between bacteria and trypanosome cells. Others lacked sufficient knowledge as they wrote incorrect differences such as: *bacteria possess villi for movement while trypanosome cell have one flagella for movement*; *bacteria have flagella while trypanosoma do not have flagella*; and bacteria *have DNA while trypanosome have no DNA.* Extract 9.2 shows such weak responses.

Extract 9.2

9a/i/ Euglena cell,		
ii/ A = macro villi		
B = outer membrane		
C = inner membrame		
D = ~~cytoplasm~~ Lipids drops		
E = ~~vacuol~~ Vacuoles		
F = Nuclear		
G = cytoplasm		

Extract 9.2 continues

b/	Differeut between Euglena cell and trypanosome cell		
	Euglena cell	trypanosome	
i/	Have macro vill	Have not macro vill	
ii/	Have double membane wall	Have one membrane wall	
iii/	Have Irregular shape of nuclear	Have regular shape of nuclear	
iv/	move through macro macrovill from one area to another	Have not move with macrvill from one area to ano	

Extract 9.2 shows a sample of weak responses from the candidate who failed to identify the cell, name its parts and differentiate it from a trypanosome cell. For example, he/she wrote euglena cell have microvilli and trypanosomes has no microvilli, as a difference between euglena and trypanosome cells.

2.1.10 Question 10: Transportation

The candidates were asked to use the diagram to describe how the structure of cardiac muscle is adapted to its function.

The statistical analysis reveals that this question was the second most chosen as a total of 16,994 (82.5%) candidates attempted it. However, it was the weakest performed question as more than three quarters (81.2%) failed, with 5.6 percent scoring a zero mark and 75.6 percent scoring from 1 to 5 marks. Very few (2.0%) scored from 10.5 to 14.5 marks out of the 15 marks allocated to this question, and none scored all (15) marks as summarized in the Figure 10.
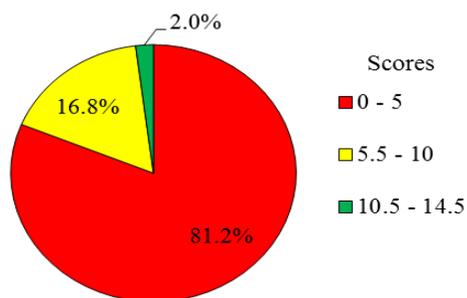
Figure 10: A Summary of the candidates' performance in question 10.

The data from Figure 10 reveal that, the majority (81.2%) of the candidates scored low (0-5) marks. The majority failed to describe how the structure of cardiac muscle is adapted to its function. In addition, some of the candidates lacked drawing skills as they drew diagrams which did not represent at all the structure of cardiac muscle. Most of the incorrect diagrams which were drawn lacked longitudinal and cross striations. Moreover, a good number of the candidates failed to describe the adaptations of cardiac muscle. Whenever descriptions were given, they were undetailed or incorrect. Examples of such incorrect descriptions include: *the heart has gely like structure for preventive abrasion and friction*; do *not have nerve impulse therefore have not fatigue to perform our function; presence of contractile protein that enable the contraction of the nucleu;, possess microvilli to increase surface area;* and *made up of smooth muscle which are help easy in contraction*. These responses signify that the candidates lacked enough knowledge in the topic of Transportation, specification structure and adaptations of mammalian heart. Extract 10.1 shows the typical weak responses.

Extract 10.1

34

Extract 10.2 continues

	iii/ Cardiac muscle are located throughout the cha-	
	mber of the heart and this enable them for the	
	efficient work on the substrate	
	Consider·	
	iv/ Cardiac muscle work only in the heart	
	organ.	

Extract 10.1 shows responses of a candidate who drew an incorrect diagram of cardiac muscle. He/she also gave incorrect description of its adaptation to its work such as cardiac muscle work only in the heart organ.

A few (2.0%) candidates who scored from 10.5 to 14.5 marks in this question were able to describe the structure of cardiac muscle and the adaptation to its function. Also, they supported their responses with a correct diagram of the cardiac muscle. Moreover, their responses were clear and well organised. However, they failed to score full (15) marks because they gave fewer than the required adaptations of the cardiac muscle. Extract 10.2 is a sample of a candidate's good responses.

Extract 10.2

10. Cardiac muscles are muscles which are found in the heart which contract and relax in order to pump blood to other parts of the body

The diagram of the structure of Cardiac muscles

The cardiac muscles are adapted to their functions in the following ways

large network of blood capillaries; They are surrounded by large network of blood vessels which supply blood which contain nutrients and oxygen and takes waste products from the cells released during metabolism.

Presence of mitochondria; It provides energy for the contraction and relaxation of the muscles.

Presence of actin and myosin; these increase the toughness of the cardiac muscles and hence making them to pump blood at high pressure.

Presence of permeable intercalated discs; the disc is permeable to ions, thus allow sodium ions to pass across it freely and hence causing an action potential on the adjacent cell and hence throughout the heart

It is myogenic; this means that it contraction and relaxation is an involuntary process and hence it can not be interfered by other process taking place in the body since it does not wait for impulse from the brain to perform its function

Presence of branches; this joins the cardiac muscles together and hence making them strong and performing their functions more efficiently

It has long refractory period; this help it to have an ample time to rest

Extract 10.2 continues

> before interpreting another stimulus.
> Presence of lubricants ; Presence of a
> fluid on the inner walls of the cardlike
> muscles help to prevent friction between layers
> of the cardiac muscles hence making
> them to contract and relax smoothly
> Presence of cross and longitudinal co-
> ss striation ; there are fibres which are
> found across or longitudinal to the
> muscles they increase toughness of the
> muscles
>   In general cardiac muscles are well
> adapted to their function which make
> them to contract and relax more effi-
> ciently during pumping of blood by
> the heart.

In extract 10.2, the candidate was able to describe the structure of cardiac muscle. He/she gave most of the required adaptations of the cardiac muscle such as presence of cross and longitudinal striations, which confer strength to the heart. He/she also had good drawing skills.

The candidates who scored from 3 to 7 marks missed some points due to few labels of the structure of the cardiac muscle or few points/undetailed descriptions of the structure of the cardiac muscle.

2.1.11 Question 11: Cytology

In part (a), the candidates were required to name the chemical composition of proteins. In part (b), they were required to explain six categories of protein based on their functions.

The data indicate that a total of 13,209 (64.1%) candidates attempted this question and their performance is as shown in Figure 11.
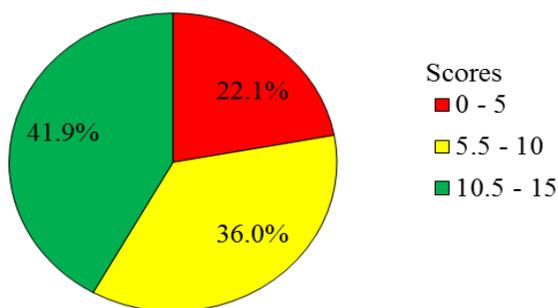
Figure 11: The candidates' performance in question 11.

The data from Figure 11 reveal that the majority (41.9%) of the candidates scored from 10.5 to 15 marks, 36 percent scored from 5.5 to 10 marks and 22.1 percent scored from 0 to 5 marks out of the 15 marks allocated to this question. The data indicate that the performance in this question was good.

The candidates with good performance demonstrated good understanding of the topic of Cytology. Thus, they accurately named the chemical composition of protein, and correctly explained six categories of protein based on their functions. Extract 11.1 is a sample of a candidate's good responses.

Extract 11.1

11.	(a) Chemically protein is composed of :-	
	(i) Hydrogen	
	(ii) Carbon	
	(iii) Oxygen	
	(iv) Nitrogen and	
	(v) sulphur	
	(vi) It has chemical bonds such as peptide bonds, disulphide bridge, hydrophobic interaction and hydrogen bonding.	
	(b) Protein are polymers q amino acids which is formed when amino acids join up by peptide bonds through condensation polymerization which involve the release q water.	
	Besides, the following are categories of proteins based on their functions. Enzymes, these are globular protei ns which are highly specifi to their subst	

11 (3)	rates, they can catalyse a reversible reaction, since they are protein in nature they are coded for by DNA, they are affected by temperature, substrate concentration, pH of the medium. Enzymes are biological catalyst they speed up the rate of reactions and also catalyse the substrates.
	Poison proteins, these are proteins that are mainly found in some insects and reptiles, such as spider, snake and also centipede. These proteins are for defence against enemies.
	Messenger proteins, they includes hormones which transmit or stimulate organ or gland to secrete another hormone. Hormones are chemical substances secreted by glands and have effect far away from where they are made.
	Contractile proteins, these are proteins which are specialized for contraction and relaxation purpose and hence bring about movement of the body or part of the body. e.g actin and myosin
	Food storage proteins, these are proteins which are purposely made for storage of food they includes albumin in egg yolk.
	Structural proteins, these are proteins which are used to make parts of the body for example hair, nails are made up of proteins. This is the one of the categories of proteins in terms of their functions

Extract 11.1 continues

11	. (b) Immuno-proteins, these are proteins which aid body defense against disease and infections that is they make more antibodies against diseases. In brief, categories of protein based on their functions includes enzymes, contractile proteins, poison proteins, messenger proteins, food storage protein, structural proteins as well as immuno-proteins.	

> In extract 11.1, the candidate correctly named the chemical composition of protein such as carbon, hydrogen, oxygen and nitrogen. Also, he/she explained six categories of protein based on their functions.

Although some of the candidates managed to score full marks in this question, others scored average marks because they were able to answer some parts of the question. For example, some of the candidates correctly answered part (a), and gave two to three points for part (b).

On the other hand, the candidates who showed weak performance in this question, in part (a), they gave a variety of incorrect answers which reveal that they had insufficient knowledge of the composition of protein. Examples of answers which were observed on candidates' scripts to list a few include; *protein is composed of amino acid, phospholipid, carbohydrate, cholesterol, R- group, organic base, water, amine group, carbon dioxide, carboxylic acid and ATP* all of which are incorrect. In part (b), some of the candidates did not understand the requirement of the question as they wrote the functions of the protein in the body of living organisms instead of explaining six categories of protein based on their functions. For example, responses such as *protein increase growth, protein protects different organs* appeared on candidates' scripts. Others wrote responses which did not relate to the asked question. Extract 11.2 is an example of those weak responses.

Extract 11.2

|		
11.	a) Chemical composition of proteins is	
	b) Protein – Are organic molecule which	
	used for body building. protein is very import	
	ant to human living organisms.	
	The following are the categories of protein	
	based on their functions.	
	protein used to reduce multinutrition; Due	
	to this this protein is very important to the livi	
	ng organism because if child or Man lack of	
	protein he/she suffer malnutrition so that is am	
	ong of function.	
	It protect body against infection, According	
	to this protein is very important because if we	
	lack protein if we got a wound can not be clear	
	because of absent of protein.	
	Used as a enzymes. Due to this is true because	
	some of enzymes are contain by protein and	
	that lead the protein to work well and to	
	reduce failure of body building	
	It is soluble in water; Due to this is true	
	because some of protein are soluble is water beca	
	use of their character, and protein it lead the	
	large problem if it can fail to function so that	
	is among of function.	
	It used to produce store energy in the body; Due	
	to this is true because protein used to store	
	energy and reduce the body to be affe	
	cted with diseases so that is coming of	
	function of the energy	

Extract 11.2 shows a sample of weak responses from the candidate who explained the roles of protein as protection of body and reduction of malnutrition, instead of classifying proteins based on their function.

2.2   133/2-BIOLOGY 2

2.2.1   Question 1: Comparative Studies of Natural Groups of Organisms

In part (a), the candidates were required to give five reasons to justify the Class to which the cockroach belongs, whereas in part (b), they were required to explain with examples seven advantages of insects to human beings.

A total of 19,910 (96.7%) candidates attempted this question and their performance was good as the majority (56.9%) scored from 7 to 11.5 marks, 28.2 percent scored from 12 to 20 marks, and a few (14.9%) scored from 0 to 6.5 marks out of 20 marks allocated to this question. These data are summarized in Figure 1.
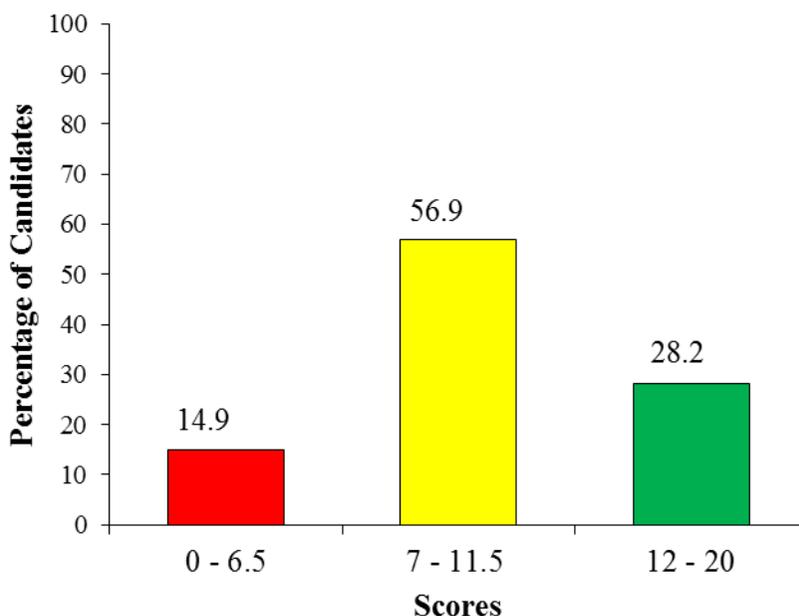
Figure 1: The candidates' performance in question 1.

Figure 1 shows that the candidates' performance was good as the majority (85.1%) passed the question. The 28.2 percent of candidates who performed well had adequate knowledge on the topic of Comparative Studies of Natural Groups of Organisms. In part (a), some of them managed to give the distinctive characteristics to justify that the cockroach belongs to the Class Insecta. In part (b), they were able to clearly explain, with examples, the advantages of insects to human beings. However, the majority of the candidates scored average marks because they either gave a few points to justify that the cockroach belongs to the Class Insecta or they did not give examples of insects which are useful to human being. Extract 1.1 shows a sample of good responses from one of the candidates.

Extract 1.1

1 (a)	cockroach
	Cockroach belong to class insecta
	This is due to the following reasons:
	(i) The body of cockroach is divided into three parts that is head, thorax and abdomen like other member of class insecta.
	(ii) Cockroach has three pairs of walking legs therefore it has six legs like other member of class insecta.
	(iii) cockroach has compound eyes which contain simple eyes inside like other members of class insecta.
	(iv) cockroach has simple wings for flight like most members of class insecta.
	(v) cockroach has one pair of antennae like other members of class insecta.
(b)	Advantages of insects to human being include the following.
	(i) Insects are source of food to human being like locust. human being obtain nutrients from insects also obtain nutrients from insect products like honey which is produced by bee.
	(ii) Insects produce useful products such as honey as raw materials in industries for making various products like cosmetics.

Extract 1.1 continues

b.	(iii) Insects are agents of pollination like bee and butterfly. They aid human being in the process of pollination hence insuaring the fertilization of crop plant this may lead into high produktivity and also may improve living standard of human being.	
	(iv) Some insects are used for decoration example butter-fly. The dried butterfly can. be used in various places like home for decoration also they can be used in offices for decoration hence making our environment boutiful.	
	(v) Insects provide employment oppertunity to the people example keeping bees which produce honey. People who engage themselves in keeping bees and production of honey from bees they earn income when they sell product like honey which come from bee hence employ themselves and this lead to improvement of their living standard.	
	(VI) Some of insects act like scavengers they help to clean our environment and make our environment clean and boutiful like ants, they facultate the decomposition of dead bodies since they feed on dead body hence assisting us in the process of cleaning environment	
	(VII) Insects are used in biological study and research example grass hopper, butterfly and cockroach also they can be used in fishing activities or hunting activities example grass hopper.	

In extract 1.1 the candidate gave correct justification as to why the cockroach belongs to Class Insecta. In addition, the advantages of insects to human beings, and examples such as provision of honey by honey bee were also correct.

Although, the majority of the candidates managed to score average marks, few of them performed weakly in this question as they lacked knowledge on characteristics of Class Insecta. In part (a), most of the candidates failed to identify the Class to which the Cockroach belongs. Others failed to explain why

cockroach belongs Class Insecta. Some candidates also confused the characteristic features of Class Insecta with other taxa of organisms. For example, the following misconceptions were observed on some of the candidates' scripts: *Have cell wall made up of cellulose;* and *they have asexual reproduction by means of binary fission,* which are characteristics features of Kingdom Plantae and Monera respectively. These responses imply that these candidates had inadequate knowledge of Comparative Studies of Natural Groups of Organisms. The responses also equally imply that, the candidates did not make thorough revision to comprehend the characteristics of the Classes to which different organisms including the cockroach belong.

In part (b), some of the candidates failed to differentiate insects from other organisms. This was evidenced by their incorrect responses such as: *insects can be agent of diseases like malaria e.g plasmodium; cause food spoilage e.g. termite; improve soil fertility through burrowing e.g health worm; used in fermentation e.g bacteria;* and *cause diseases to human e.g. mosquito.* Also, some of the candidates failed to identify the demand of the question as they wrote the characteristics of Class Insecta instead of the advantages of insects to the human being. In addition, a few of the candidates misspelt biological terminologies such that, the Class Insecta was incorrectly written as *Class Insecter; Class Insects;* or *Class Insector.* These responses imply that the candidates had difficulties in comprehending the biological terminologies. Extract 1.2 shows a sample of candidates' weak responses.

Extract 1.2

1 @	Reasons to justify the class to which cockroach belongs.
	2/ Class Insect.
	— It feed heterotrophically.
	— It have legs for locomotion from one part to another.
	— It reproduce asexually.
	— It have cell wall made up of cellulose.
	— It store food inform of glycogen.
(b)	Advantages of insects to human being.
	1/ They are used in biological studies, example cockroach.
	ii/ They decompose dead decaying organic matter in the soil and hence increasing fertility of the soil.
	iii/ Insects are used in manufacturing of different type of chemicals.
	iv/ Agents of different pests and diseases; example plasmodium which cause malaria.
	v/ Bacteria are used in fishing activities as food for different species of fishes.
1.(b)	vi/ When they die, insects increase soil fertility in the soil, example; butterfly
	vii/ Some insects helps in pollination of flowering plants to ensure growth and development of plants.

Extract 1.2 shows a sample of responses from a candidate who failed to give the characteristics of Class Insecta. He/she also failed to explain the advantages of insects to human beings. In addition, the candidate gave incorrect examples of insects.

2.2.2 Question 2: Comparative Studies of Natural Groups of Organisms

The question demanded the candidates to use diagrams and one example in each case to classify bacteria on the basis of their morphology.

The data indicate that the question was opted by 18,824 (91.4%) of the candidates, of whom 39.7 percent scored from 7 to 11.5 marks and 30.5 percent scored from 0 to 6 marks. However, 29.8 percent scored from 12 to 20 marks out of 20 marks allocated to this question. This trend indicates that the general performance of the candidates in this question was good. Figure 2 summarizes the performance.
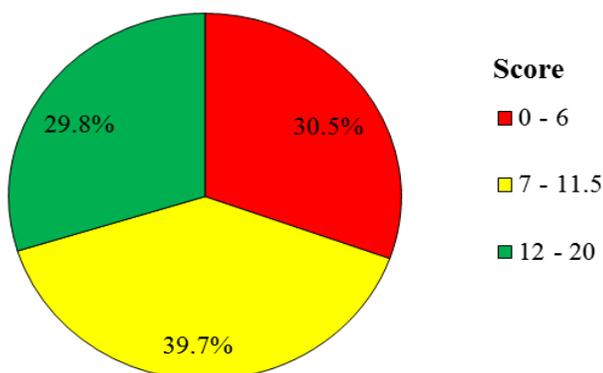
Figure 2: The candidates' performance in question 2.

The Figure 2 shows that the candidates' performance was good as a total of 69.5 percent scored 7 to 20 marks in this question. The candidates who performed well had enough knowledge on the Kingdom Monera, particularly on the classification of bacteria based on their morphology. In addition, they had good drawing skills. Therefore, they managed to classify/group the bacteria, draw their structures and give example in each group. Extract 2.1 shows a sample of good responses from one of the candidates.

Extract 2.1

2. The following is the classification of bacteria on the basis of their morphology (shape) as explained below with diagrams and examples

(i) Cocci bacteria (Singular Coccus bacteria).
   - These are spherical shaped bacteria example Staphylococcus bacteria. They can occur in groups or single one depending on the type of bacteria concerned.
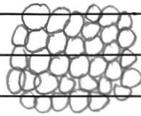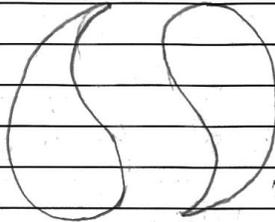

diagram showing the cocci bacteria

(ii) Comma shaped bacteria example Vibrio cholerae bacteria. These are type of bacteria which are have comma shaped as shown below in more details


Vibrio bacteria

(iii) Bacilli bacteria (Singular bacillus bacteria). Example Salmonella typhi which causes typhoid fever. These are type of bacteria which have rod shaped morphology.

Bacilli bacteria

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Extract 2.1 continues

|		
(iv) Spirilla bacteria. Example Treponema pallidum, These are type of bacteria awhich are found in our environment, they have spiral shape (morphology) as shown below		
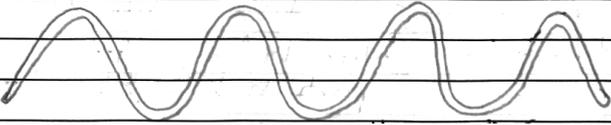
Spirilla bacteria.

Extract 2.1 shows a sample of a candidate's good responses. The candidate was able to classify bacteria based on their morphology. He/she was also able to use diagrams and one example to illustrate the answers. In addition, he/she had good drawing skills.

The candidates with weak performance in this question, identified a few types of bacteria based on their morphology but failed to give examples while some failed to draw their diagrams. The responses imply that these candidates had insufficient knowledge on the structures of bacteria.

In addition, a good number of the candidates in this category failed to understand the demand of the question. For example, some of them drew the structure of bacteria and described the function of each part. Others drew a growth curve of bacteria and labeled the growth phases such as; lag phase, stationary phase and decline phase. Also, some of the candidates classified bacteria according to gram stain test instead of their morphology.

Moreover, misspelling scientific terminologies was paramount as the candidates failed to understand that the names of bacteria are technical and therefore must be written with correct spelling. For example, some candidates wrote *Commas* instead of comma, *Baccili* instead of Bacilli *and Spirila* instead of Spirilla. The misspelled biological terminologies distorted the world wide scientifically agreed names. Extract 2.2 shows a sample of the candidates' weak responses.

Extract 2.2

2. Classification of bacteria on the basis of their morphology.
    (i) Commas shaped bacteria
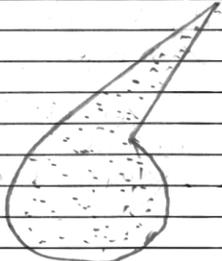
    (ii) Coil shaped bacteria.
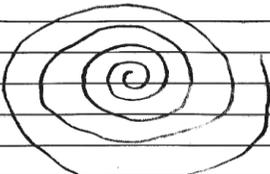
    A good Example is ~~bacteria~~ E-Colli bacteria

    (iii) Strep shaped bacteria
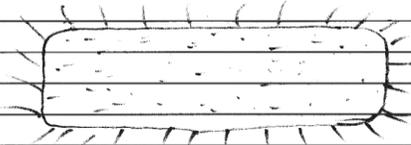
    Example :- Streptococu bacteria.

Extract 2.2 shows a sample of weak responses from a candidate who wrote incorrect names of bacteria. Also he/she drew irrelevant diagrams.

2.2.3 Question 3: Regulation (Homeostasis)

In part (a), the candidates were required to explain four major roles of the kidney whereas, in part (b) they were required to describe the structure of mammalian nephron.

The analysis shows that a total of 15,003 (72.9%) candidates chose this question, of which 40.1 percent scored from 7 to 11.5 marks and 32.4 percent scored from 12 to 20 marks out of 20 marks allocated to this question. The candidates who scored 0 to 6 marks were 27.5 percent. Figure 3 gives a representation of the data.
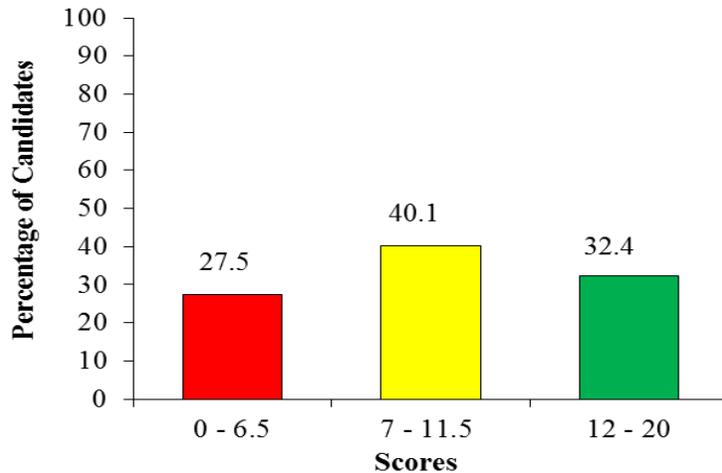
Figure 3: Illustration of the candidates' performance in question 3.

The data from Figure 3 show that the candidates' performance was good as a total of 72.5 percent passed in this question. The candidates who performed well in this question had enough knowledge on the topic of Regulation (Homeostasis). They were able to explain the major roles of the kidney and describe the structure of the mammalian nephron. Extract 3.1 shows the candidate's good responses.

Extract 3.1

3. (a) The kidney is one of the main body organ performing both hormonal and Osmo regulatory roles.

Roles of the kidney are
- Osmoregulation, the kidney maintains water balance of the body of an organism by either absorbing water back to the body or release of water outside the body.

- It maintains the blood pressure in the body, by varying concentration gradients between solutes and solvents in the body, the blood pressure is maintained by the kidney

- Excretion of nitrogenous wastes, the wastes like urea, ammonia and uric acid are excreted by the kidney thus avoiding their accumulation in the body to avoid cell pollution

Extract 3.1 continues

- Maintaining pH of the body fluids, this is done by eliminating ions like Cl^-, HPO_4^{2-} that may cause any slight change in body fluid pH which can slow down the body metabolism

3. b) • Bowman's capsule

Is the cup shaped organelles that is like a ball which has been pressed on on side. It holds the Glomerulus for filtration of the blood coming from the body tissues

• Glomerulus

Is the network of blood capillaries that is essential for filtration of blood coming from the body tissue. Large sized molecules like protein, plasma, cells are not allowed to pass through the glomerulus.

• Proximal convulted tubule

The tube in which selective reabsorption of essential molecule begins. The amino acids, glucose are absorbed here.

• Loop of henle

Both descending descending and ascending loops are responsible for absorption. The descending is permeable to water and loss permeable to salt (NaCl) while the ascending limb is large since body fluid flow at high pressure and is permeable to salt (NaCl) but less permeable to water

• Distal convulted tubule

This is the tubule in which selective reabsorption continues and is permeable to water. Under

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Extract 3.1 continues

|		
8.	(b) Vasopressin hormone, the permeability of the Distal Convoluted tubule can be varied.	
	• Collecting duct	
	The tube linked to a million of nephrons in which the unabsorbed Indewles are poured to be eliminated out as Urine	
	• Blood vessels	
	Afferent vessel carry blood rich in materials from the body tissues to the nephron while the efferent blood vessels carry blood rich in larger materials back to the body tissue	

In extract 3.1 the candidate managed to explain four major roles of the kidney such as removal of waste products. He/she also gave the correct descriptions of the structure of the mammalian nephron such as Loop of Henle and convoluted distal tubule.

Some of the candidates, who showed average performance, were able to respond accurately in describing the structure of the mammalian nephron. However, they failed to score full marks because they gave few undetailed explanations on the major roles of the kidney. Others were able to explain the roles of the kidney but failed to describe the structure of mammalian nephron.

Some of a few candidates with weak performance explained only two roles of the kidney while others failed to identify the requirement of the question as their explanations were focused on the functions of the liver instead of the kidney. For example, some of the candidates explained about the detoxification and deamination processes. In part (b), some of the candidates described the ultrafiltration and selective absorption processes which are the functions of the nephron instead of describing the structure of nephron. Others drew the structure of Bowman's capsule which is just a part of nephron. Extract 3.2 shows a sample of weak responses from one of the candidates.

Extract 3.2

3(a) i. Filtration.
This is the process of allowing the passage of some material in the ~~bowns bons~~ glomerulus filtrator
There was materials allowed to passage and other not allower such a materials allowed ~~at~~ are glucose, water, atibodies and same amount of hormone.

ii. Absorption
The materials allowed to pass in the glomerulus are absopbed the different part of the body for different purpose example absorption of water, hormone and solute all these was done inside the kidney.

iii. ~~Elimination~~ Assimilation/Assimilated.
The absorbed material in the body of an organism are assimilated in the body cells transported by the ~~body~~ blood vessess from one place to another and other material are taken to the area are needed.

iv. Secretion.
This is the process of releasing the hormone or nutrients from the area where eire consentratle & to the area uconcentrated such as insulin secretion of hormone and other body organ.

3(b)

MAMMALIAN NEPHRON
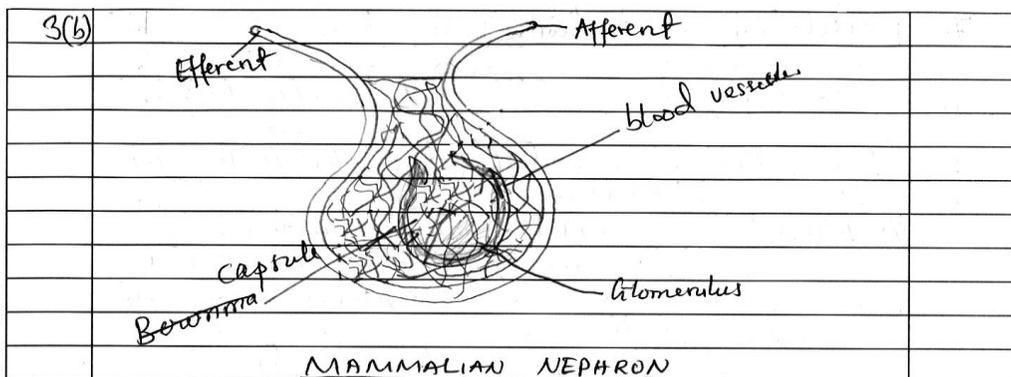
Extract 3.2 displays a sample of responses from a candidate who failed to explain the major roles of the kidney.

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2.2.4 Question 4: Regulation (Homeostasis)

In this question, the candidates were asked to explain different ways used by endotherms to keep their body temperature constant.

The analysis shows that the question was chosen by 16,738 (81.3%) candidates, of whom 43.7 percent scored from 7 to 11.5 marks and 38.9 percent scored from 12 to 20 marks. Only a few (17.4%) scored from 0 to 6.5 out of the 20 marks allocated to this question. This indicates that the general performance of the candidates in this question was good and is indicated in Figure 4.
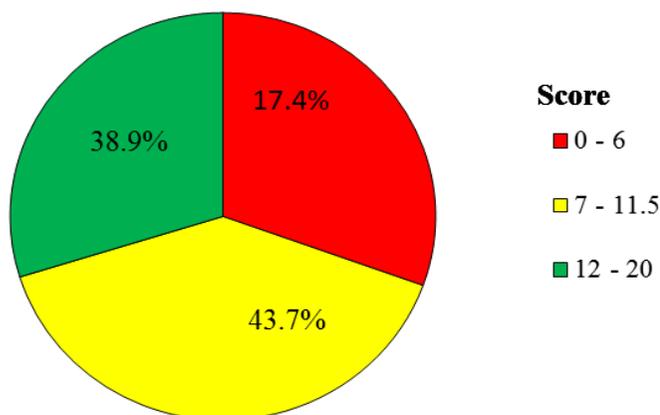
Figure 4: The candidates' performance in question 4.

Figure 4 shows that the candidates' performance was good. The candidates who performed well (scored 12 - 20 marks) demonstrated good understanding in a topic of Regulation, particularly in the aspect of temperature regulation. They were able to explain different ways used by endotherms to keep their body temperature constant; at high and low temperatures. Extract 4.1 shows a sample of a candidate's good responses.

Extract 4.1

Qn4 Endotherms Are those organisms that are able to regulate their body temperature either in high Tempe rature condition or low temperature Condition Example Human beings

Way used by endotherms to keep their body temperature costanta it devide into two conditions

A: High temperature condition: Organi sm may do the following

i/ Sweating: I's the ability of an org anism to release heat body thro ugh the skin which is mixtu re of water, electrolytes, Salts.

ii/ Vasodilation: Is the ability of an orga nism's body to adjust blood cap ilary or vessel more close to skin So as to easy to radiate heat.

iii/ Decrease in metabolism: In high tempera ture an endotherms decrease metabolism because metabolism it leads to the production heat

iv/ Relaxation hair erector musles: When hair erector musle is relaxed it leads to easly radiation of heat out side the body of an organisms.

v/ Panting! An endothrimic organism like dog they loose heat thro ugh the mouth by opening their mouth because their body are covered with hair and is impermiable to heat loss.

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Extract 4.1 continues

	B: Low temperature condition: Organism may do the followings in order to maintain their body temperature costant		
	i/ Vasocontriction: Is the ability of the blood vessel to go far from skin so a to prevent heat loss easly,		
	ii/ Increasing metabousm: An endotherm ie organism' body increase metabolism rate because metabolism it increase the body heat.		
	iii/ Shivering: An endothermic organism make shivering so as to generate heat is like vibration of the body of an organism.		
	iv/ Erection of hair erector musles: Ability of an endothermic organism to erect hair musle in order to close holes from the skin to prevent heat loss.		
	v/ Hibernation: Is the ability of organism that live in the soil example earthworm to go deep to the soil where there is heat.		
	vi/ Behaviour means: Organism may do regulate their body temperature by doing exercise, near to source of heat, covering with many clothes		

Extract 4.1 shows a sample of good candidate's responses. The candidate gave precise explanations of different ways used by endotherms to keep their body temperature constant such as erection of hair erector muscle in cold and sweating in hot environment.

The candidates with average performance were able to explain some ways used by endotherms in cold and hot temperature environment. However, their responses were not detailed.

On the other hand, some of the candidates with weak performance gave few points on the mechanisms used by endotherms to regulate their body temperature but they did not explain the points. Others failed to meet the demand of the question as their responses were focused on methods of losing and gaining heat, such as radiation, convection, conduction and evaporation, instead of ways of

maintaining constant temperature in endotherms. Others interchanged the mechanisms of regulation of temperature in the cold environment with that of the hot one. Extract 4.2 shows a sample of the candidates' weak responses in this question.

Extract 4.2

4	Endotherm organism: This are organism which need more heat or Absorbing heat inorder to maintain their body tempeture. For example of of endotherms organism are gizzard. The following are the ways of keep their body temperature Constant.
	Radiation: this is the heat energy Come from the Sun. The organism ar animals like gizzard they use the heat of the Sun to maintain their body Constant.
	Convenction. This is the heat which is Converted from heat energy to Mechanical or Chemical energy in order to maintain the body Constant of an organisms.
	Shevaring. This is the Situation where by animals are put the tongue in and out side in order to maintain their body Constant. For example dogs.
	Contraction or relaxation of hair erector pill muscle; Due to the process of Contraction and relaxation of hair this inthe body this is due to make the body temperature Constant.

Extract 4.2 continues

4. Covering; This is the process where by on small animals or the young animals are covering by feather, hairs or any materials in order to maintain their body temperature constant.		
Using water; Most of a organism they use water When the heat of the body is high so they use water in order make the temperature of the body to become constant.		
Dring a lot of water. This is due to reduce temperature		
Drinking a lot of w		

Extract 4.2 shows responses of a candidate who did not understand the requirement of the question. He/she explained cooling mechanism as drinking a lot of water instead of mechanisms of maintaining temperature.

2.2.5 Question 5: Growth and Development

In part (a), the candidates were renquired to explain the types of growth namely; (i) intermittent (ii) allometric (iii) isometric (iv) limited and (v) unlimited, and give one example in each case. In part (b), the candidates were enquired to state the roles of (i) water, (ii) air and (iii) optimum temperature in seed germination.

The analysis indicates that a total of 19,202 (93.2%) of the candidates opted for this question and their performance was good. The majority (64.4%) scored from 12 to 20 marks and 25.1 percent scored from 7 to 11.5 marks out of 20 marks allocated to this question. The candidates who scored from 0 to 6.5 marks were 10.5 percent. These data are summarized in Figure 5.
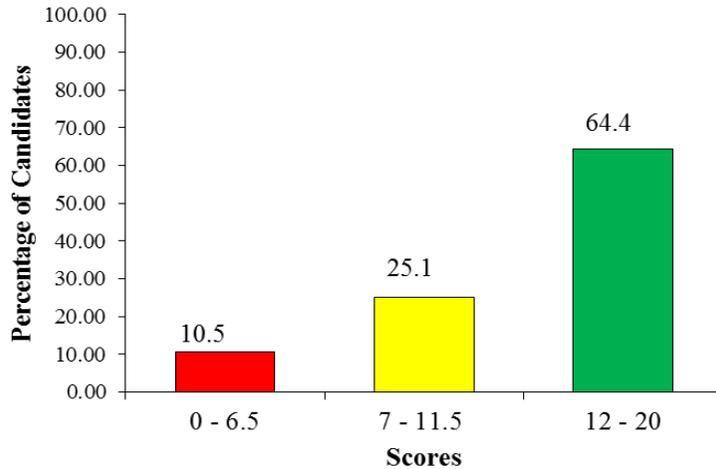
Figure 5: A summary of the candidates' performance in question 5.

Figure 5 shows that, the candidates' performance was good as the majority (64.4%) of the candidates scored high (12 to 20) marks. These candidates were knowledgeable enough to explain each type of growth and give correct examples. In addition, they were able to state the roles of water, air and optimum temperature in seed germination. Extract 5.1 shows a sample of one of the candidates' good responses.

Extract 5.1

Extract 5.1 continues

(v) Unlimited growth, is the type of growth where by organisms tend to growth until death. Example perennial plants.

5. (b) (i) Water; Used in the seed to hydrolize the food when the seed germinate. This
   • This also led the transportation of the nutrients to the seed and energy for germination.
   • Also activate enzymes.

(ii) Air;.
   • Help in production of energy for the seed germination
   • Also in oxidation of food during catabolism for production of energy.

(iii) Optimum temperature
   • Optimum temperature activate the enzymes to act.
   • Activate activation energy of enzymes to work best. High temperature will denatures enzymes so optimum temperature used.

Extract 5.1 shows a sample of responses from the candidate who managed to explain the types of growth and gave correct examples. Also, the responses given regarding the roles of water, air and optimum temperature in seed germination are correct.

Some of the candidates, whose performance was average, were able to explain the types of growth and stated at least the roles of two factors affecting seed germination. Others were able to state a few roles of water, air and optimum temperature in seed germination.

On the other hand, the candidates with weak scores (0 – 6.5 marks) had insufficient knowledge on the concept of growth. For example, some of them explained limited growth in different incorrect ways such as: *growth which has no*

end; *the type of growth patter with different measure;* and *the growth where by part of organisms work together.* In part (b), some of the candidates gave irrelevant responses. For example, regarding the role of water in seed germination, responses such as: *water is source of food for seed*; *water for washing seed;* and *water for scarification of the seed* were observed in some of the candidates' scripts. Also, incorrect roles of air which were written include: *to support secretion of enzymes for seed growth*; *to maintain humidity within the period of growth;* and *to gives strength and conducive environment for growth.* These responses reveal that the candidates lacked enough knowledge of the roles of different factors in seed germination. This may have resulted from ineffective practical activities during learning process of the topic of seed germination and plant growth. Extract 5.2 shows a sample of weak responses from one of the candidates.

Extract 5.2

Extract 5.2 continues

Isometric growth ; Is the type of growth pattern with the same measure . Example of Isometric growth are Deciduous plants.		
Allometric growth ; Is the type of growth patt er with different measure Examples of Allometric growth are, Barley grain.		
Intermittent growth ; Is the type of growth pattern which		

Extract 5.2 shows a sample of weak responses from a candidate who lacked knowledge of growth patterns and seed germination. He/she explained allometric growth as growth pattern with different measure.

2.2.6 Question 6: Genetics

The candidates were given information that in guinea pig (Cavia) there were two alleles for hair colour that is black and white, and two alleles for hair length that is short and long. In a breeding experiment, all F_1 phenotypes produced from a cross between pure breeding short-black-haired and pure breeding, long-white-haired parents, had short black hair.

The candidates were asked to (a) state which alleles were dominant and give reasons for the answer, (b) use the cross diagrams to show both F_1 and F_2 results.

The analysis shows that this was the least chosen question as 11,402 (44.6%) candidates attempted it. However, 65.0 percent of them scored from 12 to 20 marks and 25.6 percent scored from 0 to 6 out of 20 marks allocated to this question. The candidates who scored from 7 to 11.5 marks were 9.4 percent. The performance of the candidates in this question is also shown in Figure 6.
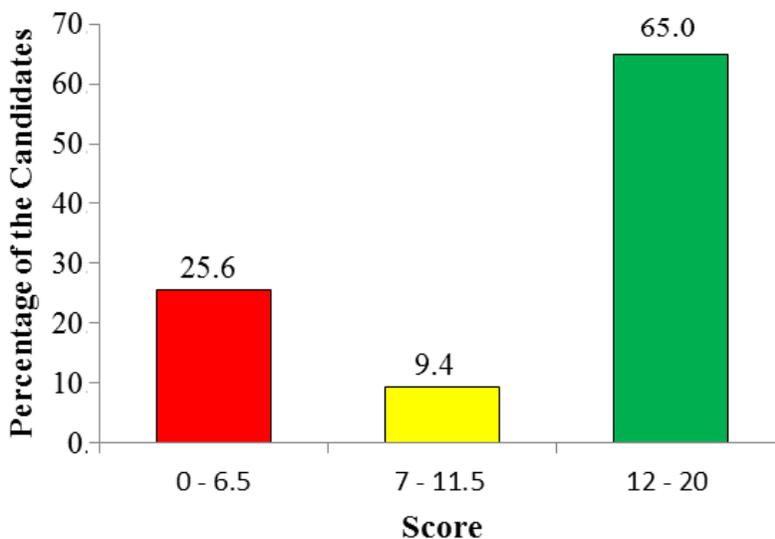
Figure 6: A summary of the candidates' performance in question 6.

Figure 6 shows that, the candidates' performance was good as the majority (65%) scored from 12 to 20 marks. The candidates who performed well demonstrated good mastery of the content knowledge taught under the topic of Genetics, particularly Mendelian principle of inheritance. In part (a), they were able to state with reason the dominant alleles. In part (b), they were able to carry out F_1 and F_2 crosses with all steps clearly shown. They also managed to illustrate that two pairs of characteristics while combining in F_1 separate and behave independently from one another in the subsequent generation. Extract 6.1 shows a sample of good responses from one of the candidates.

Extract 6.1

6	Given	
	Alleles for hair colour; Black and white.	
	Alleles for hair length; Short and Long	
	F_1 - All had short black hair.	
	(a) Allele dominant for hair colour is <u>Black</u>.	
	Allele dominant for hair length is <u>Short</u>.	
	This is because all F_1 phenotypes had	
	short and black hair. This suggests that	
	the alleles for long and white was masked	
	by these alleles and theny the alleles	
	for short and black hair are dominant.	
	(b) Let S is an allele for short hair	
	s is an allele for long hair	
	B is an allele for black hair	
	b is an allele for white hair	
	On crossing parents.	
	♂ ♀	
	Parental phenotype Short black haired ✕ long white haired	
	Parental genotype SS BB ✕ ssbb.	
	Meiosis	
	gametes All (SB) (sb)	
	Random fertilization	
	F_1 genotypes All SsBb	
	F_1 phenotype All short black haired.	

65

Extract 6.1 continues

6	(b)	On crossing F₁		♂			♀	

Parental phenotype   short black haired X short black haired

Parental genotype.   Ss Bb   X   Ss Bb.

On meiosis

♂   S   S   B   b

Gametes,   SB   Sb   SB   Sb.

Using punnet square.

♀ \ ♂	SB	Sb	SB	sb
SB	SSBB	SSBb	SsBB	SsBb.
Sb	SSBb	SSbb	SsBb	Ssbb
sB	SsBB	SsBb	ssBB	ssBb
sb	SsBb	Ssbb	ssBb	ssbb.

F₂ phenotypes.
  9 are short black haired
  3 are short white haired
  3 are long black haired
  1 B   long white haired.

F₂ Phenotypic ratio : 9:3:3:1 .

Extract 6.1 shows responses of a candidate who performed well in this question. The candidate was able to identify with reasons the dominant characters which are short and black. He/she also correctly carried out crosses to show the formation of F₁ and F₂.

The candidates who scored average marks, in part (a) of the question were able to state the dominant alleles. However, in part (b) some of the candidates skipped some steps, while carrying out crosses to show the formation of F_1 and F_2 generations. This made them to lose some marks.

The candidates who had weak performance lacked knowledge on the concept of independent assortment (Mendel's second law of inheritance) in Genetics as they wrote incorrect reasons to justify their answer in part (a). For example, one candidate wrote; *short black haired is dominant than long white haired due to expression in the pair.* In part (b), some of the candidates managed to carry out

crosses to show the formation of F_1 but not F_2 generations. Also, some of the steps shown by these candidates were incorrectly labeled. For instance, one of the candidates labeled the gametes as *phenotypes*. Also, some of the candidates used two different letters to indicate one character, contrary to genetic principles for drawing diagrammatic crosses which require a character to be represented twice by the same letter. A capital letter represents the dominant character, while the lower case letter represents a recessive character. For example, for hair colour they wrote; "*B = Black, W= White*" instead of B = black (dominant) and b = white (recessive). Some of the candidates used sex chromosome to represent the alleles of characters instead of BB for dominant alleles and bb for recessive alleles. For example, they wrote "XX = short black hair and *xx* = long black hair". Extract 6.2 shows a sample of weak responses from one of the candidates.

Extract 6.2

6.	let short haired black haired = XX
	log white haired = Xx
	Parents XX xx
	Phynotype X X X x x
	Gamates (X) (X) (x) (x)
	fertilization
	F₁ generation Xx Xx Xx Xx
	@ short black haired is dominant than long white haired because in first generation all are short black haired

6·b' from (a) Short black hair = XX
Long White hair = xx

Parent = X X X xx

Phenotype X x xx

Gametes Ⓧ   Ⓧ   Ⓧ   Ⓧ

fertilization

F_1 generation.
      Xx Xx Xx Xx

∴ f_1 generall = all are short black haired (Xx)

for F_2 generation
Parent Xx x Xx

Phenotype Xx Xx

Gametes Ⓧ   Ⓧ   Ⓧ Ⓧ

Extract 6.2 continues
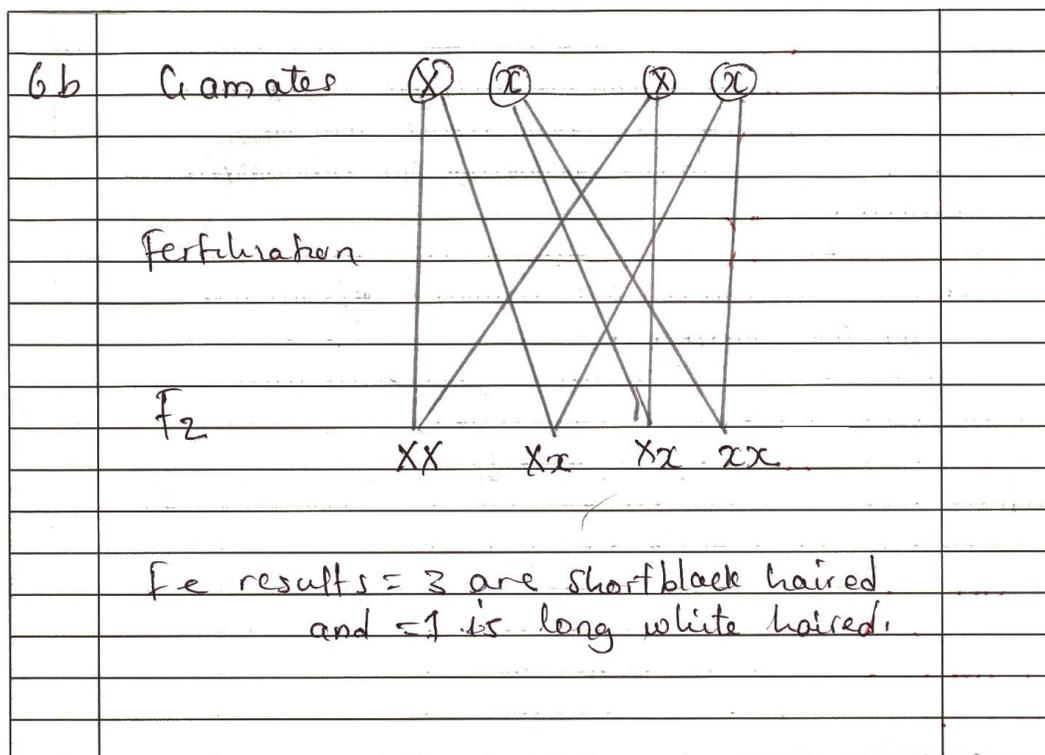
Extract 6.2 shows a weak responses of a candidate who failed to carry out crosses to show the formation of F_1 and F_2. He/she used same letters (XX/*xx*) to represent two different characters, which are height (short and long) and colour (black and white).

2.2.7 Question 7: Ecology

The question required the candidates to explain how different abiotic factors affect the population distribution.

The analysis indicates that, this question was attempted by 19,918 (96.7) of the candidates. The candidates' performance was average as majority (47.4%) scored 0 to 6.5 marks and 39.2 percent scored from 7 to 11.5 marks. However 13.4 percent score 12 to 20 marks out of the 20 marks allocated to this question. Figure 7 summarizes the performance of the candidates in this question.
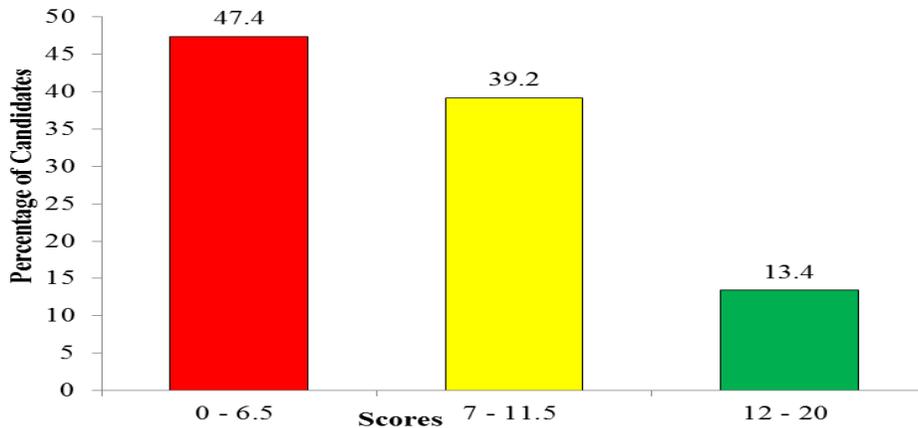
Figure 7: A summary of the candidates' performance in question 7.

Figure 7 shows that the candidates' performance was average as a total of 52.6 percent passed by scoring from 7 to 20 marks. The candidates who performed well in this question had good mastery of the content knowledge and good essay writing skills. They were able to explain how different abiotic factors affect the population distribution as Extract 7.1 shows.

Extract 7.1

7. Population distribution refers to the way population of living organisms vary from one geographical area to another. Abiotic factors are non-living components of environment. These are rainfall and water, Light, temperature, humidity, wind, soil factors (edaphic factors) such as soil pH, water retaining capacity (aeration), topographic factors such as land slopes, slope. The following is the explanation on how each factor affect population distribution i) Rainfall and water. Rainfall and water are vital for life of organisms. Water helps plants to photosynthesize and is an important component of body of living organisms. Areas with high rainfall and enough water will be largely populated. For example the tropical areas receiving much rain are well populated with trees and animals. Areas with low rainfall and scarcity of water are less populated. For example the Kalahari deserts and Saharan desert regions they are very poorly populated with animals.	

70

Extract 7.1 continues

ii) Light.

Light is essential for photosynthesis of plants. Areas which receive enough light will be well populated with plants and inturn populated by animals if all other conditions are suitable; whereby Areas which receive little light per year are —

iv) of transpiration is too low and therefore such areas will be less populated

v) Soil nutrients (Soil fertility)

In areas with soil that have high concentration of nutrient such as phosphates, nitrates, K^+, Na^+, Mg^{2+}, Ca^{2+} will be highly populated. This is because such plants for soils favours growth of vegetation which inturn ensures survival of animals.
   Areas with soil that is having low content of nutrient will be less populated, since it will have poor vegetation which supports few animals,

vi) Soil pH

Areas with optimum soil pH, for example pH of 6.5 to 7.5 favours growth of most plants, hence will be more populated
   Soil pH also affects microbial activities.
   Areas with soils of very low pH and very high pH have less population since microorganisms activities of decomposition are not favoured and hence no nutrients are present for plants leading to very low populations.

Extract 7.1 continues

7.	vii)	Soil texture and soil aeration.	
		The firmness of Soil and its ability to retain water affects distribution of population. Areas with well eaerated Soils will favour growth of plants which inturn favours animals and hence Such areas will be well populated.	
		Areas with poor aerated Soils, Soils that cause water logging, will be poorly populated Since plants are not favoured due to rotting of roots and also animals will not be favoured hence less population.	
	viii)	Topography	
		Areas with high slope are prone to soil erosion by moving water and thus poor vegetation hence less consumes supported and therefore less populated.	
		Areas with medium slope will be highly populated Since nutrients from soil are not washed away, Therefore more vegetation is favoured and hence more fauna is favoured.	
	ix)	Wind.	
		In very windy areas plants breaks and dies and hence animals will have less food. Such arease will be less populated	
		In areas with optimum wind, pollination, seed dispersal are favoured and hence Such areas will be well populated	

Extract 7.1 shows a sample of a candidate's good responses. The candidate had enough knowledge on the topic of Ecology. He/she gave correct explanation on how different abiotic factors such as soil texture, wind and topography affect the population distribution.

Most of the candidates who scored average marks, explained a few factors affecting population distribution. In addition, their explanations were not detailed.

On the other hand, the candidates who had weak performance wrote varieties of incorrect responses which do not relate with what was asked. Such responses

include; HIV, *gonorrhea, increase in number of living things, decrease in consumers and decomposers.*

These responses indicate that the candidates lacked knowledge of Ecology, specifically on abiotic factors and their effects on distribution of living organisms. Extract 7.2 shows a sample of one candidate's weak responses.

Extract 7.2

7	Abiotic fectors are non-living factors or compo nents in an enviroment	
	Populchon is the group of organisms of different specie with similar feeding habit occupying a certain geographical area ata particular time	
	how different abiohc fectors effect populahon distribuhon.	
	ⓘ Increase in abiohc fectors in a populchon ④ leads to decresse in the number of producers for example primary producers which are like plants will decresse	
	ⓘⓘ decresse in predahon since there will be few producers and primary consumers will also decresse leading to incresse in predahon	
	ⓘⓘⓘ Decresse in consumers and decomposers due to absence or decresse in primary producers hence the consumers and decomposers will have not room for the survival ability so they will start to decline	

Extract 7.2 continues

7 (iv) Decrease in population size. Since the abiotic components exceeds the biotic components as a result the population size will decrease

(2) Decrease in abiotic factors in an environment
(i) Stabilizedg food web and food chain. The feeding relationship will be stabilized in a given ecological niche since there will be plenty producers and consumers

(ii) Increase in predation This is due to the result of plenty of consumers and producers in a given ecological niche and stabilized food chain and food web will occur

(iii) Increase in consumers and decomposers This is due to presence of primary producers and primary consumers which will render the environment to contain secondary consumers and decomposers.

(iv) Increase in population size. The size of population will increase due to increase in number of producers consumers and decomposers.

In extract 7.2 the candidate explained how biotic factors affect the population distribution instead of abiotic. He/she explained factors such as increase in population size and increase in consumer and decomposers.

2.2.8 Question 8: Ecology

The question needed the candidates to describe types of communities (biomes) and their global distribution.

The analysis indicates that this question was attempted by 19,359 (94.0%) of the candidates. However, majority (56.1%) scored from 0 to 6 marks and 37.7 percent scored from 7 to 11.5 marks. Only a few (6.2%) candidates scored from 12 to 20 marks. The performance of the candidates in this question is also summarized in Figure 8.
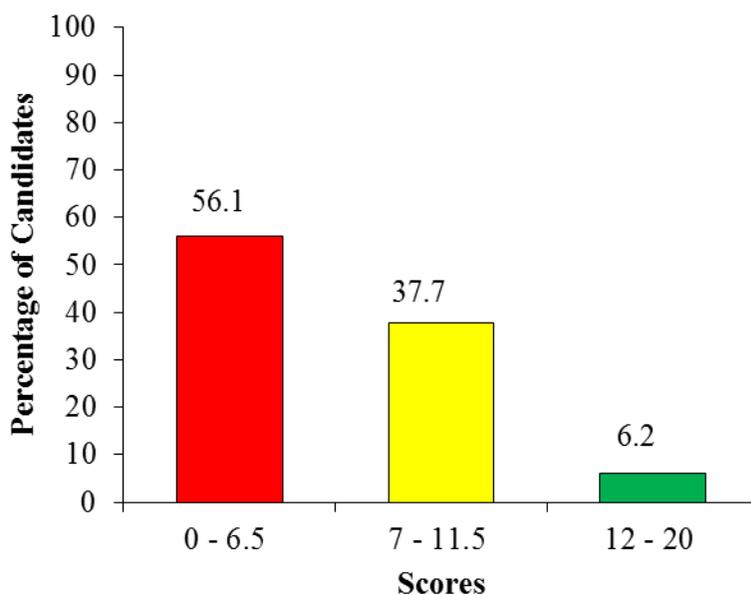
Figure 8: A summary of the candidates' performance in question 8.

The data from Figure 8 show that a total of 43.9 percent of the candidates scored from 7 to 20 marks. The candidates who scored full marks in this question had good knowledge of Ecology, especially on population dynamics. These candidates were able to describe types of biomes. Extract 8.1 shows a sample of good responses from one of the candidates.

08	Biomes are the distributed specified Climate areas for particular vegetation and has its own climatic condition. They includes.	
	Equatorial biome, this is the community found between 0° and 5° north and south of the equator It characterized by heavy or thick vegetations such as forests. also It receive to rain seasons in a year. It is warm climate. Example in Ghana, Southern Uganda	
	Tropical biome, Is the community which is found between 5° - 15° north and southern of the equator. It contain few large trees and long grasses, most wild animals are likely to be found It receive rainfall above 250mm anually. and Shrubs are also found in this climate Example Tanzania South America.	
	Desert biome, Is the biome found between 15° - 37° north and south of the equator, It has ry small amount of vegetation or not at all. There is high wind blowing, which can be due to human activities, also Ocean current example Saharan desert, Kalahani desert, Atakama desert, Namib desert.	

8	Oceanic biome, Includes all organisms found in the sea, lake or ocean, can be fish, crustacea, crocodile, snails, also there is planktons or algae and phytoplanktons and zooplanktons which support the aquatic animals include fish. Example Atlantic ocean, Indian ocean, pacific ocean, Red sea.
	Mediterranean biome, Is the biome found in Southern Africa this biome have moderate temperature,
	Coniferous rainforest biome is the biome in which there is thick conifers forest and also have high amount of rainfall per annum. It is found in Nothern America.
	Temperate biome, Is the biome which is cool and have moderate temperature, mode ate raifall also grasses are much found and few trees and animals. Mostly found in china, India.

Extract 8.1 is a sample of responses from the candidate who described the types of biomes such as equatorial, tropical and desert biomes.

Some of the candidates who scored average marks, were able to describe the types of biomes but failed to describe their global distribution, whereas others described the types and location but failed to identify the organisms found in each biome.

On the other hand, a few of the candidates who showed weak performance gave varieties of incorrect descriptions which did not reflect what was asked. For instance, some of the candidates described trophic levels such as; *producers, primary consumers, secondary consumers, tertiary consumers* and *decomposers.* Other candidates mentioned modes of nutrition such as; *herbivores, omnivores and carnivores.* All these responses indicate inability of the candidates to identify

the demand of the question. Extract 8.2 shows a sample of the candidates' weak responses.

Extract 8.2

08.	Community. This is the group of organisms of different species living in a particular place of the ecosystem. It have the following types.	
	(i) Producers. These are living organisms who have the ability to manufacture their own food. Example the green plants and green algae they undergo photosynthesis to manufacture their own food. The producers are so more distributed so that the organisms depend on them may survive.	
	(ii) Primary consumers. These are groups of organism in the ecosystem who eat on grasses without depending on another things for consuption. They are called herbivores which are the animals who eat on grasses only.	
	(iii) Secondary consumers. These are group of organisms who consume on both grasses that are producers and primary consumers. These groups are called omnivores who feed on both grasses and meat from herbivores.	

Extract 8.2 continues

08. (iv) Tertiary consumers. These are group of organisms who feed on both omnivores and herbivores. These are organisms who eat meat only from herbovores and omnivores. They are called Carvores.	
(v) Decomposers. These are groups of organisms who feed in all of the previous trophic levels. When the organisms from producers to tertiary consumers die, these groups of organisms decompose them and add organic matter to the soil which then important for the producers to grow and manufacture their food hence making energy in circulation.	
- The distribution from the producers decrease to the tertiary consumers. This is due to the competition for natural resources such as food. Also there is a loss of energy from one trophic level to another because all energy do not transfered to the next trophic level but some of energy are used by the organisms themselves and remaining are transfered to the next trophic level.	
- Decomposers are well distributed to many parts. This is because there is less competition among them because they eat on dead bodies which are from producers to tertiary consumers.	

Extract 8.2 shows a sample of one of the candidates' weak responses. The candidate described trophic levels such as producers, primary consumers, secondary consumers and decomposers instead of distribution of biomes.

3.0   ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH TOPIC

The analysis of the performance in different topics indicated that 8 out of 10 topics which were tested in Biology paper one and paper two had good performance and 2 topics had average performance. There was no topic which had weak performance. The topics that were well performed are; *Cytology, Principles of Classification, Comparative Studies of Natural Groups of Organisms, Gaseous Exchange and Respiration, Growth and Development, Reproduction, Regulation/Homeostasis* and *Genetics.* However, the topics of *Transportation* and *Ecology* had an average performance. **Appendices 1** and **2** summarize the candidates' performance in different topics in the ACSEE 2016. In the appendices, the performance in each topic has been regarded as weak (red coloured), average (yellow coloured) or good (green coloured), if the percentage of the candidates who scored from 35 percent or above of the marks allocated to the respective question lies in the interval from 0 to 34, 35 to 59 or 60 to 100 respectively.

4.0   CONCLUSION AND RECOMMENDATIONS

4.1   Conclusion

The performance of the candidates in Biology subject was good in ACSEE, 2016 as 93.41 percent passed the examination. The analysis of performance in each individual question indicated that good performance was attributed to such factors like candidates' adequate Biology content knowledge, good understanding of question demand and good drawing skills.

Although the general performance in Biology is good, the analysis of performance in each question also revealed a wide range of marks with only a few of the candidates scoring all the marks allotted to the given questions. Most of the candidates could give some correct information in almost all of the questions. However, although the candidates showed a general understanding of the tested topics, answers did not always contain sufficient details for all the marks to be awarded.

Generally, the factors which might have led the candidates fail to score all the marks include:
(a)   Candidates' insufficient knowledge on the topic concerned. This might have been contributed by:
  (i)   Failure of the candidates to extensively read Biology subject resources such as books, internet, online studies, journals and magazines.

(ii)   Failure of the candidates to thoroughly revise all the topics before the commencement of the national examination.

(iii) Lacks of enough classroom assessment accompanied with effective feedback to candidates to enable them internalize the content knowledge.

(iv)   Lack of enough laboratory work and field projects.

(v)   Inability of some teachers to thoroughly cover the syllabus contents in their teaching process.

(b) Inability to identify the requirement of question. Generally, this may have been contributed by:

(i)   Lack of enough home works, assignments, tests and examinations to the candidates accompanied by immediate teachers' feedback to enable them build up skills and experience in identifying the demand of the question.

(ii)   Failure of the candidates to read the questions carefully before attempting them in order to identify what they require.

(c) Lack of drawing skills which may have been attributed to lack of enough drawing activities to enable them build up the drawing skills.

4.2   Recommendations

Since the analysis of the candidates' responses has revealed that the candidates had problem in the areas of content knowledge, understanding/adherence to the task of the question and lack of drawing skills, the following are recommended:

(a)   In order to equip the candidates with content knowledge required for good performance, the following should be done:

(i)   Class based assessment should be strengthened to make sure that teachers provide candidates with enough continuous assessment such as practical work, assignments and tests accompanied with feedback in order to reinforce the candidates' mastery of the content knowledge and skills in each topic.

(ii)   Biology subject teachers should employ a variety of teaching-learning strategies which will motivate the candidates to learn Biology.

(iii) Candidates should be advised to make a thorough revision. This is to ensure that the candidates have enough knowledge needed in responding to the examination questions.

(b)   To resolve the problem resulting from the candidates' inability to identify what the question requires the candidates should be:

    (i)   Urged to read the questions carefully before attempting it.
    (ii)   Provided with assignments, tests and examinations accompanied with immediate teachers' feedback to enable the candidates build up skills and experience needed for identifying the demand of the question.

The Candidates' Performance Topic-wise in ACSEE 2016

S/N	Topic	ACSEE 2016		
		No of Question	Percentage of Candidates who Scored an Average of 35 Percent or Above	Remarks
1.	Growth and Development	1	89.50	Good
2.	Principles of Classification	1	88.30	Good
3.	Cytology	5	77.74	Good
4.	Comparative Studies of Natural Groups of Organisms	2	77.30	Good
5.	Genetics	1	74.40	Good
6.	Reproduction	1	71.10	Good
7.	Regulation/Homeostasis	2	71.00	Good
8.	Gaseous Exchange and Respiration	1	68.20	Good
9.	Transportation	3	56.20	Average
10.	Ecology	2	48.25	Average

The Candidates' Performance Topic-wise in ACSEE 2016