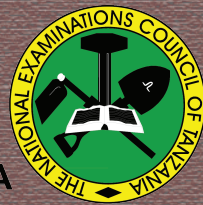


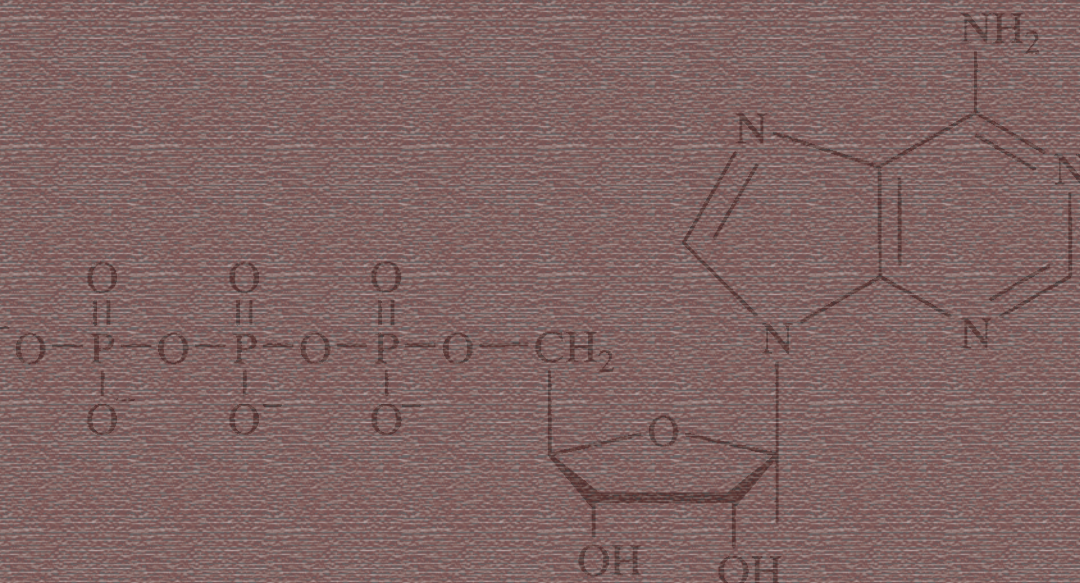


THE UNITED REPUBLIC OF TANZANIA  
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY  
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



**CANDIDATES' ITEM RESPONSE ANALYSIS  
REPORT ON THE ADVANCED CERTIFICATE OF  
SECONDARY EDUCATION EXAMINATION  
(ACSEE) 2025**

**BIOLOGY**





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**CANDIDATES' ITEM RESPONSE ANALYSIS  
REPORT ON THE ADVANCED CERTIFICATE OF  
SECONDARY EDUCATION EXAMINATION  
(ACSEE) 2025**

**133 BIOLOGY**

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## FOREWORD

The National Examinations Council of Tanzania (NECTA) is pleased to provide this Candidates' Item Response Analysis (CIRA) report on Biology for the Advanced Certificate of Secondary Education Examination (ACSEE), 2025. The purpose of this report is to provide feedback to all education stakeholders on the candidates' performance, which is a primary indicator of the effectiveness of classroom teaching and learning.

The report reveals that the performance in Biology ACSEE 2025 was good, as the majority, 36,977 (99.62%) of the candidates passed the examination. The candidates' good performance was a result of their good mastery of the fundamental concepts, principles, and skills of biological science as stipulated in the Biology syllabus.

The topics in which the candidates performed well are: Comparative Studies of Natural Groups of Organisms, Growth and Development, Ecology, Cytology, Reproduction, Nutrition, Transportation, and Genetics. On the other hand, the topics of Gaseous Exchange and Respiration, Regulation/Homeostasis, Evolution, and Coordination had an average performance. The average performance on these topics was attributed to candidates' insufficient knowledge of the concepts examined, failure to meet the demands of the questions and misspelling of scientific terms used in biological classification.

The Council expects that this report will help prospective candidates to rectify the mistakes identified during the course of learning before sitting for examinations. The feedback will also help teachers to identify areas where students encounter learning problems and take appropriate measures to improve teaching and learning strategies. This will, in turn enhance students' acquisition of competencies as stipulated in the syllabus for Biology subject and best performance in future examinations.

Finally, NECTA extends its gratitude to all who participated in preparing this report.



Prof. Said Ally Mohamed  
**EXECUTIVE SECRETARY**

## 1.0 INTRODUCTION

This report presents an analysis of the candidates' performance in ACSEE Biology subject, which was conducted in May 2025. The examination had three papers namely, 133/1 Biology 1, 133/2 Biology 2 and 133/3 Biology 3. Biology 1 and 2 were theory papers while Biology 3 was a practical paper. The practical paper was categorised into three alternative papers: 133/3A Biology 3A, 133/3B Biology 3B and 133/3C Biology 3C. Each candidate was required to sit for one paper only. The 133/1 Biology 1 and 133/2 Biology 2 each weighed 100 marks, while the 133/3 Biology 3 weighed 50 marks.

The 133/1 Biology 1 paper consisted of 11 questions divided into section A and B. Section A had eight (8) short-answer questions. The candidates were required to answer seven questions each of which carried 10 marks. Section B had three (3) essay questions. The candidates were required to answer any two (2) questions, each of which carried 15 marks. The 133/2 Biology 2 paper had six (6) essay/structured questions and the candidates were required to answer five (5) questions of their choice. Each question carried 20 marks. On the other hand, each practical alternative paper had three (3) questions. Question one (1) carried 20 marks while the other two questions carried 15 marks each. The candidates were required to answer all questions.

A total of 36,977 candidates sat for the examination where 36,836 (99.62%) passed, while 141 (0.38%) did not pass the examination. The pass grades are as presented in the following Table:

### The Candidates' Performance in Biology ACSEE 2025

	Grades					
	A	B	C	D	E	S
Total	632	5,193	14,026	12,593	3,985	407

The Table shows that most of the candidates (14,026) attained a C grade while a few (632) attained A grade.

The analysis shows that candidates' performance in 2025 has increased by 0.60 per cent when compared to ACSEE 2024 in which 31,244 (99.02%) out of 31,553 candidates passed the examination.

The next part of this report presents analysis of the candidates' performance on each question in 133/1 Biology 1, 133/2 Biology 2 and 133/3 Biology 3 in the 2025 ACSEE.

## **2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE ON EACH QUESTION**

The candidates were examined to demonstrate their competence in the appropriate application of biological knowledge, concepts, principles and skills in physiological, anatomical, ecological, and evolutionary processes. These competences were examined in papers 1 and 2. Paper 3 examined the competence of the use of scientific procedures and practical skills in studying biological investigations and carrying out dissections of small mammals, arthropods and frog. The analysis of the candidates' performance in Biology was based on each question of each paper. It indicated the topic examined, assessed competence, the question demand and the percentage of the candidates who responded to each question. In addition, the report shows the percentage of candidates with good, average and weak performance, supported by sample extracts from candidates' responses. The performance in a question is considered to be *good* if the percentage of candidates who passed ranges from 60 to 100, *average* if the percentage ranges from 35 to 59, and *weak* if the percentage is between 0 and 34. Furthermore, green, yellow and red colours are used in charts/tables to indicate good, average and weak performances respectively.

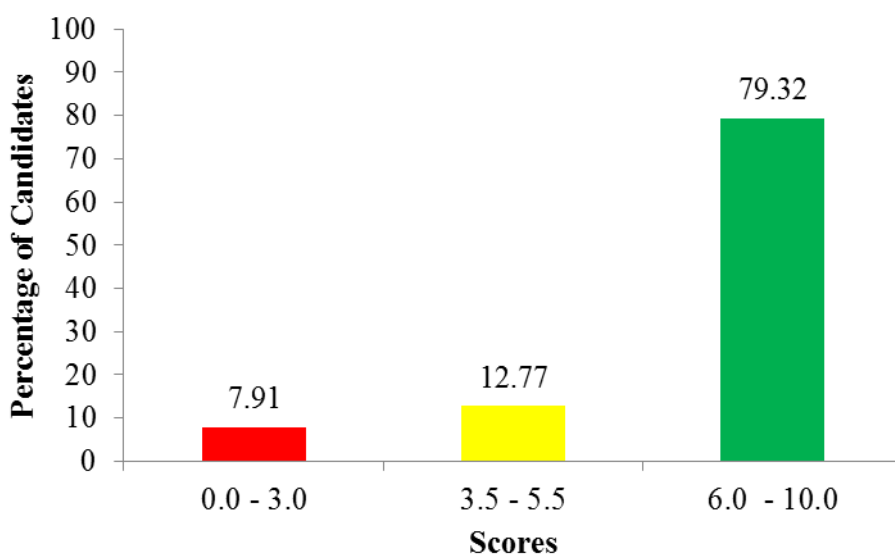
### **2.1 133/1 Biology 1**

The paper comprised questions set from seven (7) topics, namely; Cytology, Gaseous Exchange and Respiration, Coordination, Reproduction, Comparative Studies of Natural Groups of Organisms, Transportation, and Nutrition. The paper consisted of sections A and B. Section A consisted of short-answer questions while section B comprised essay-type questions. The following part presents the candidates' response analysis for each question.

### 2.1.1 Question 1: Cytology

The question measured the candidates' competence in analysing the functions and adaptations of organelles. It consisted of parts (a) and (b). In part (a), the candidates were required to explain briefly how folded inner membrane, matrix, circular DNA and ribosomes of the mitochondrion help in breaking down food to release energy. In part (b), they were required to state the importance of microtubules, Golgi body and lysosomes.

Data reveal that 36,925 (99.70%) candidates responded to the question. The analysis shows that 29, 289 (79.32%) scored from 6.0 to 10.0 marks, 4,714 (12.77%) scored from 3.5 to 5.5 marks and 2,922 (7.91%) scored low marks (0.0 to 3.0). Generally, candidates' performance on question 1 was good since more than three quarters (92.09%) scored from 3.5 to 10 marks. The analysis of the candidates' performance is shown in Figure 1.



**Figure 1:** *Distribution of Candidates' Scores on Question 1*

The candidates who scored high marks (6.0 – 10.0) were aware of the functions of organelles in eukaryotic cells. They demonstrated a good mastery of the adaptations of mitochondrion to its roles. Specifically, they explained correctly the significance of folded inner membrane, matrix, circular DNA, and ribosomes of the mitochondrion in respiration in part (a). Moreover, they stated the importance of microtubules, the Golgi body

and the lysosomes in part (b). Extract 1.1 is a sample of the candidates' correct responses to question 1.

01	a) (i) Folded inner membrane	
	- It increases surface area for chemical reactions to take place within the mitochondrion	
	(ii) Matrix	
	- It contains respiratory enzymes that catalyse the breakdown of food materials within the mitochondrion	
	(iii) circular DNA	
	- It assists in self replication to increase its number for respiration	
	(iv) Ribosomes	
	- It has ribosomes for synthesizing of protein molecules.	
01	b) (i) Importance of microtubules	
	• They provide means of transportation of materials within the cell since they are tubular	
	• They assist in the formation of cilia and flagella.	
	b) (ii) Importance of golgi body	
	• They are used to form lysosomes.	
	• They are used in formation of primary cell wall in plants	
01	b) (iii) Importance of lysosomes	
	• They are used to digest excess materials and unwanted materials through exocytosis.	
	• They are used in digestion of harmful materials taken into the cell.	

**Extract 1.1:** A sample of correct responses to question 1 in Biology 1

In Extract 1.1, the candidate explained correctly the significance of the folded inner membrane, matrix, circular DNA and ribosomes in the

mitochondrion in part (a). He/she also clearly stated the importance of microtubules, the Golgi body and lysosomes in part (b).

Candidates who scored average marks (3.5 - 5.5) responded correctly to either part (a) or (b). Some of the candidates attempted only part (b) of the question while others attempted part (a) and stated fewer than the required points in part (b). Most of them gave incorrect roles of matrix and circular DNA in mitochondria. For example, one of the candidates wrote that *matrix of mitochondrion suspends all organelles of a cell*. Others stated that *folded inner membrane reduces space in the matrix* instead of increasing surface area for respiration. In addition, some candidates wrote that *circular DNA provides synthesis of the food in the body*.

Likewise, in part (b), some of the candidates mixed the functions of the given parts of the cell. Some of the candidates mixed the function of centrioles with that of Golgi body, and that of microbodies with microtubules. For example, one of the candidates wrote that *microtubules are involved in detoxification of hydrogen peroxide to water and oxygen*, which is the role performed by microbodies. Others wrote that the *Golgi body produce basal bodies from which cilia and flagella develop*, which is the role of centrioles. These responses imply that the candidates had an inadequate understanding of the functions and adaptations of various organelles of the cell.

Candidates who scored low marks (0.0 - 3.0) gave incorrect responses on how the folded inner membrane, matrix, circular DNA and ribosomes in mitochondria help in releasing energy in part (a). For example, one of the candidates stated that *matrix helps in lubrication of food, ribosomes provide better storage of food*. Moreover, some of them drew and labelled the diagrams of mitochondrion and Golgi body which were not required.

Similarly, in part (b), the candidates had insufficient knowledge about cell organelles. Most of them gave incorrect importance to a particular organelle. One of the candidates wrote about the importance of smooth endoplasmic reticulum instead of the Golgi body such as *Golgi body is involved in the synthesis of phospholipid*. Others mistook the function of lysosome with that of ribosome as they wrote *lysosome is responsible for*

protein synthesis. Extract 1.2 is a sample of responses from the candidates' who answered the question incorrectly.

1. a) i) folded inner membrane	
Is a mitochondrion feature which helps in breaking down food to release energy since the folded inner membrane provide surface area for food absorption hence release energy.	
ii) Matrix.	
Is the mitochondrion feature which helps in breaking down food to release energy as in the matrix there is a storage facility of food.	
iii) Circular DNA	
It provides circular synthesis of the food in the body for that it is used in the body for that it is to be used by the body.	
iv) Ribosome.	
This is a kind of mitochondrion feature of which provide good and better storage of food.	
b) i) Microtubule.	
Used in synthesis of materials. Brings about development	
ii) Golgi body.	
Storage of materials. Improves the storage organs	
iii) Lysosomes	
Provide good development of organs. Good organs growth.	

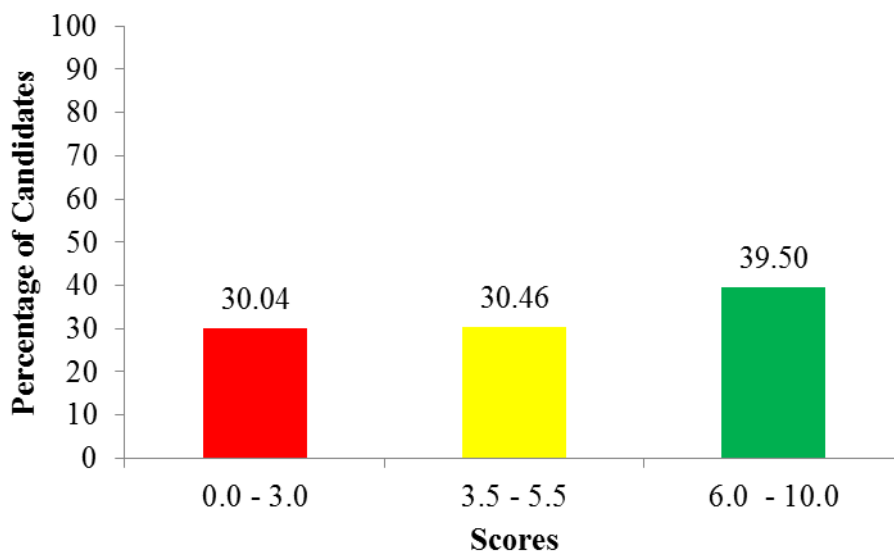
**Extract 1.2:** A sample of incorrect responses to question 1 in Biology 1

In Extract 1.2, the candidate gave incorrect responses in all parts of the question. For example, he/she wrote *folded inner membrane provides surface area for absorption*. He/she failed to understand that the membrane provides large surface area for effective respiration but not for the absorption of food in part (a).

### 2.1.2 Question 2: Cytology

The question measured the candidates' competence in identifying eukaryotic and prokaryotic cells. It consisted of parts (a) and (b). In part (a), the question demanded candidates to analyse the differences between yeast cells and bacterium cells. In part (b), the candidates were required to justify the need for a plant cell to have a vacuole.

The question was attempted by 35,781 (96.61%) candidates. The analysis indicates that 14,133 (39.50%) candidates scored from 6.0 to 10.0 marks, 10,899 (30.46%) scored from 3.5 to 5.5 marks, and 10,749 (30.04%) scored low marks (0.0 to 3.0). The general performance was good because more than half (69.96%) of the candidates scored 3.5 to 10 marks. The candidates' performance is presented in Figure 2.



**Figure 2:** *Distribution of the Candidates' Scores on Question 2*

The candidates who scored high marks (6.0 - 10.0) demonstrated mastery of the structures of eukaryotic and prokaryotic cells. In part (a), they correctly analysed the differences between yeast and bacterial cells. For instance, they stated such differences as: *yeast cell has many organelles than bacterium cell, and yeast cell has linear DNA while bacterial cell has circular DNA*. In part (b), they demonstrated a clear understanding of the functions of organelles such that they correctly justified the need for the

plant cell to have a vacuole. Extract 2.1 is a sample of candidates' correct responses to the question.

2. a) form	Yeast cells	Bacterium cells
Cell size	◦ They are large in size compared to those in bacteria	◦ They are small in size
Double membrane organelles	◦ They have double membrane bound organelles like Mitochondria.	◦ They do not possess double membrane bound organelles like Mitochondria.
Ribosome	◦ They have large with 80's sedimentation.	◦ They have small with 70's sedimentation.

2. a) form	Yeast cells	Bacterium cells
Respiration site	◦ Respiration occurs in mitochondria	◦ They respire through the mesosomes
Composition of cell wall.	◦ Their cell walls are made up of chitin	◦ Their cell walls are made up of peptidoglycan.
2. b)	There is a need for a plant to have a vacuole because	
	◦ It act as the temporary store for the waste products produced in the plants. Example; Excess water in plants.	
	◦ It influences production of anthocyanin which play an important role in colouration of flowers.	

**Extract 2.1:** A sample of correct responses to question 2 in Biology 1

In Extract 2.1, the candidate correctly analysed the differences between yeast and bacterial cells. Also, he/she justified the need for the vacuole to a plant cell such as *temporary storage of the waste products produced in the plant*.

The candidates who scored average marks (3.5 - 5.5) obtained some marks from either part (a) or (b). Also, there were some of the candidates who correctly analysed the differences between yeast and bacterial cells but failed to justify the usefulness of a vacuole to a plant cell in part (b). Some of the candidates mixed the roles of vacuole with that of other organelles, such as lysosome and mitochondria. For example, some of the candidates

explained *vacuole as the organelle responsible for breaking down food to release energy*, a role performed by mitochondria.

On the other hand, some of the candidates who scored low marks (0.0 - 3.0) gave two to three correct differences between yeast and bacterial cells and failed to explain why the vacuole is useful in a plant cell hence the loss of marks. The candidates who scored 0 marks wrote incorrect responses in all parts. Some of them wrote about the difference between plant and animal cells. For instance, one of the candidates wrote *yeast has small temporary vacuole while bacterium has large and permanent vacuole*. Others wrote *yeast cell excretes via cytoplasm while bacterial cell excretes via lysosome* while other candidates wrote *yeast cells contain chloroplast, some specified yeast as the cell found in plant*. There were also some of the candidates who wrote similarities between yeast and bacterium instead of their differences. For example, one of the candidates wrote that *both yeast and bacterium cells undergo fermentation, both are living organisms, both are small in size, and both are unicellular*. These candidates were not aware that yeast and bacterial cells are members of eukaryotic and prokaryotic cell respectively. Extract 2.2 is a sample of candidates' incorrect responses to the question.

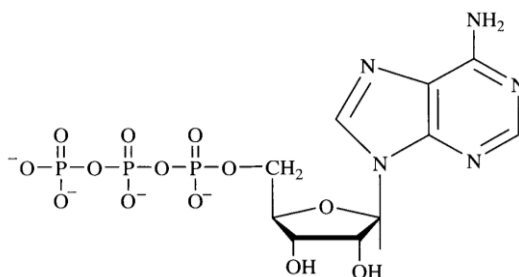
Q2a.	Yeast cells	Bacterium cells.
	i) They are no true nucleus.	They have true nucleus.
	ii) They don't cause harm and diseases.	They cause harms and diseases example Tuberculosis
	iii) They lack DNA hence they cannot replicate.	They have DNA hence they replicate inside the host.
	iv) They lack the enzymic system hence they are non-living.	They have enzymic system since they cause diseases and harms.
	v) They reproduce by fission or fusion process. in	They reproduce by asexual or sexual process.

**Extract 2.2:** A sample of incorrect responses to question 2 in Biology 1

In Extract 2.2, the candidate gave incorrect differences between yeast and bacterial cells. For example, he/she wrote *yeast cells are no true nucleus while bacterium cell have true nucleus*.

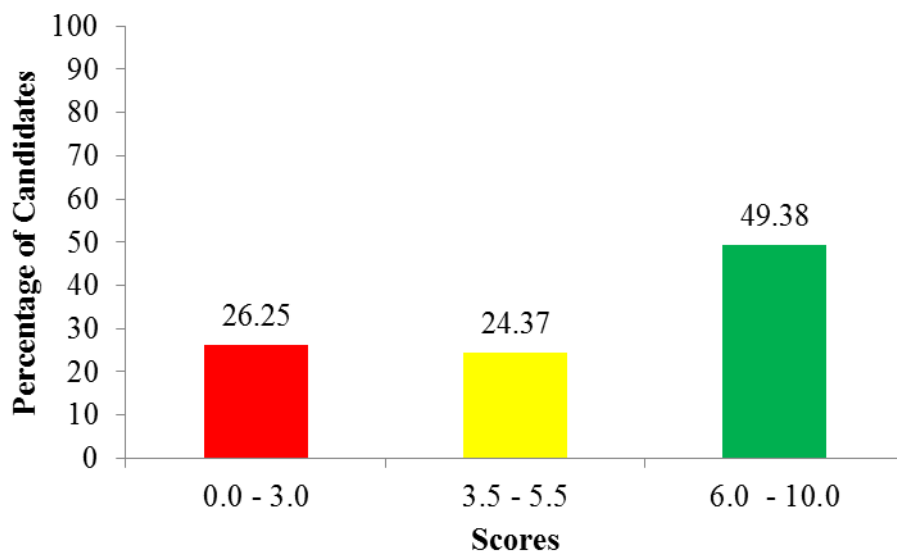
### 2.1.3 Question 3: Gaseous Exchange and Respiration

The question tested the candidates' competence in explaining the roles of ATP in organisms and factors which govern efficient gaseous exchange at respiratory surface. It had parts (a) and (b). In part (a), the candidates were provided with the following molecule:



The candidates were required to (i) identify the molecule and (ii) explain ways in which the molecule is important in the human body. In part (b), they were required to analyse features that are shared by the gills and the lungs.

The data show that 33,182 (89.59%) candidates attempted the question. The analysis shows that 16,385 (49.38%) scored from 6.0 to 10.0 marks, 8,087 (24.37%) scored from 3.5 to 5.5 marks, and 8,710 (26.25%) scored low marks (0.0 to 3.0). The candidates' performance on this question was good since 73.75 per cent of the candidates passed. The candidates' performance is shown in Figure 3.



**Figure 3:** *Distribution of the Candidates' Scores on Question 3*

Candidates who scored high marks (6.0 to 10.0) demonstrated mastery of the chemical composition and the role of Adenosine Triphosphate (ATP) in the human body. Therefore, they correctly identified the given molecule and explained its importance in part (a). Moreover, they analysed correctly the features shared by the gills and lungs in part (b). Extract 3.1 is a sample of the candidates' correct responses to the question.

3. a) i)	The molecule is ATP molecule (Adenosine Triphosphate).
	ii). <ul style="list-style-type: none"> <li>It provides energy for active transport in the body. The ATP energy is important in active transport as this involves movement against concentration gradient hence there should be energy provided. Example, the ions like chloride and Sodium are pumped actively using ATP energy in the loop of Henle to ensure counter current mechanism.</li> <li>It provides energy for metabolic activities in the body. The ATP energy is important during the different metabolic processes which are used to provide the useful materials within the body. Example, ATP is used during respiration process which is used to oxidise the foods in order to produce more energy in the body and metabolic water.</li> <li>It provides energy for muscular movement. Since the muscles in the body undergo contraction and relaxation so as to make body activities become successful, ATP energy is used to provide energy used for contraction and relaxation of muscles in different body parts like in Heart.</li> </ul>
3. b)	<ul style="list-style-type: none"> <li>They both have large surface area to increase the rate of gaseous exchange.</li> <li>They are both moist for dissolving of respiratory gases.</li> <li>They both have blood capillaries (Vasculanised) to increase the exchange of oxygen and carbon dioxide.</li> <li>They are both well ventilated to allow large amount of respiratory gases to pass.</li> </ul>

**Extract 3.1:** A sample of correct responses to question 3 in Biology 1

In Extract 3.1, the candidate correctly identified the molecule represented by the given figure as ATP and correctly explained its importance in the human body in part (a). He/she also correctly analysed the features shared by the gills and lungs in part (b).

The candidates who scored average marks (3.5 - 5.5) lacked sufficient knowledge about the chemical composition of ATP and factors governing

gaseous exchange at the respiratory surface. They analysed three to four correct features that are shared by the gills and lungs in part (b). However, in part (a), they scored less than the required points as they stated two to three points.

On the other hand, the candidates who scored low marks (0.0 - 3.0) obtained marks in either part (a) or (b). Most of them were able to correctly identify the given molecule and explained its importance to humans in part (a), but were unable to analyse the features shared by gills and lungs in part (b). The candidates who scored zero marks gave incorrect answers to all parts of the question. In part (a), they failed to interpret the structure of the ATP molecule which was represented by the figure. Some identified the given molecule as a *DNA molecule*. Others identified it as *nucleotide molecule*, *phospholipid molecule*, and *RNA molecule* instead of ATP molecule.

Likewise, in part (b), some of the candidates did not understand the question demand as they explained the adaptive features of the heart instead of the features shared by the gills and the lungs. For example, one of the candidates wrote that *both have pericardial fluid, which acts as lubricant, both have septum to ensure blood flows in one direction*. Others wrote features of lungs as such one candidate wrote *both have alveoli used for gaseous exchange, both have microvilli to increase surface area, both contain diaphragm*. Others explained the function of alveoli instead of the features shared by lungs and gills. Extract 3.2 shows a sample of the candidates' incorrect responses to the question.

3. a) D Protein	
-It provides energy in the body	
-It helps in formation of hormones	
-It helps in making cell membrane	
b) Features	
i) Bronchioles	
ii) Alveoli	
iii) Blood capillaries	
iv) Bronchitis	

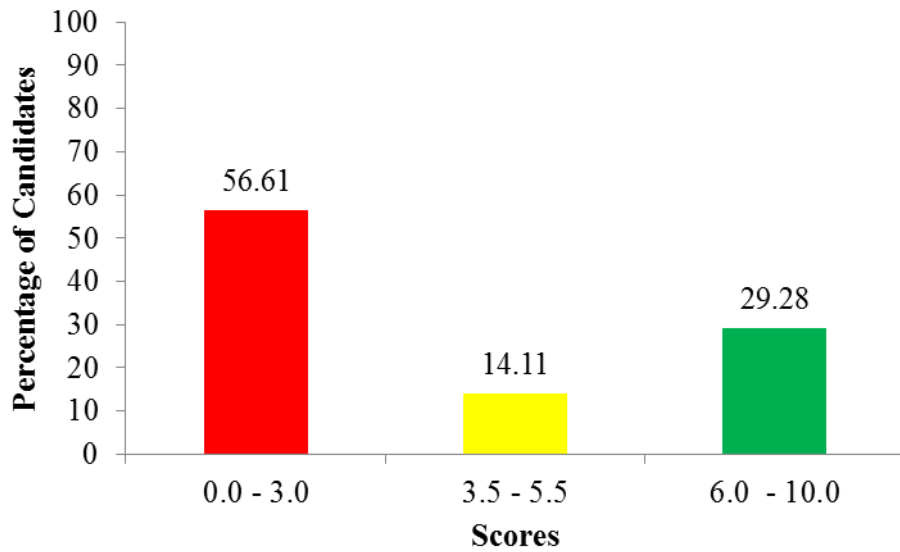
**Extract 3.2:** A sample of incorrect responses to question 3 in Biology 1

In Extract 3.2, the candidate identified the given molecule as *protein* instead of ATP and explained the functions of protein as *helps in formation of hormones* in part (a). Also, he/she listed parts of the mammalian lung as *bronchioles*, *blood capillaries* and *bronchitis* instead of analysing features that are shared by the gills and the lungs in part (b).

#### 2.1.4 Question 4: Coordination

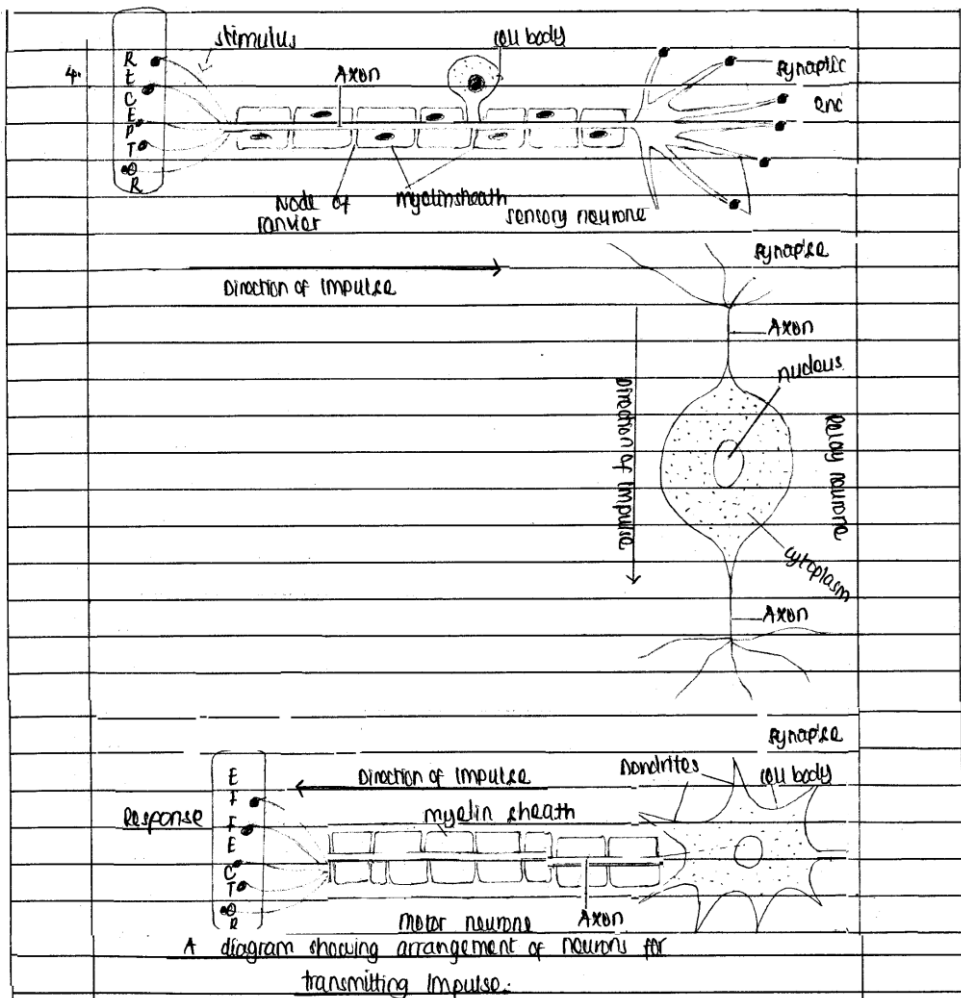
The question measured the candidates' competence in explaining the structure of nervous system. It required the candidates to draw well-labelled diagrams to show the arrangement of neurones for transmitting impulse from receptor to effector.

Data reveals that 11,020 (29.75%) candidates attempted this question. Analysis shows that 3,227 (29.28%) scored from 6.0 to 10.0 marks, 1,555 (14.11%) scored from 3.5 to 5.5 marks, and 6,238 (56.61%) scored low marks (0.0 to 3.0). This shows that the general performance in question 4 was average since 43.39 per cent of the candidates scored from 3.5 to 10.0 marks. The distribution of candidates' scores is presented in Figure 4.



**Figure 4:** *Distribution of the Candidates' Scores on Question 4*

The candidates who scored high marks (6.0 - 10.0) demonstrated a good mastery of the structure of the nervous tissue and neurotic pathway. They realised that neurotic pathway consists of the structures which are sequentially arranged for transmission of electric impulses which starts in the receptors via neurons and finally to the effectors. In addition, the three neurons were correctly positioned to receive, and conduct impulses in one direction from the receptor to the effector e.g. muscles which detect signal for response. Hence, they skillful drew diagrams showing the arrangement of the structures in the neural pathway from receptor to the effector. Extract 4.1 is a sample of candidates' correct responses to the question.




**Extract 4.1:** A sample of correct responses to question 4 in Biology 1

In Extract 4.1, the candidate drew well-labelled diagrams of neurotic pathway and correctly arranged the structures involved in conduction of impulses from receptor to effector via sensory, relay and motor neurone.

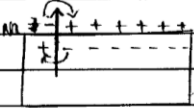
Candidates who scored average marks (3.5 - 5.5) lost some marks because they were not aware of the arrangement of neurones for transmitting impulse from receptor to effector. Some drew correct diagrams but labelled either one or two parts in the complete system. Others drew correct diagrams and indicated the direction of impulse. However, they did not label the diagrams.

Conversely, 56.61 per cent of the candidates who scored low marks (0.0 - 3.0) had an insufficient knowledge of the neuronic pathways. Thus, they wrote incorrect responses in all or most of the parts. Some of the candidates who scored 0 marks changed the position of relay neurone to that of motor neurone, and motor neurone to that of the sensory neurone in their arrangement. Others drew and illustrated sensory, relay and motor neurones separately while others drew labelled diagram of a chemical synapse instead of drawing labelled diagrams to show the arrangement of neurones for transmitting impulse from receptor to effector. Moreover, there were some candidates who described the arrangement of neurones for transmitting impulse from receptor to effector without drawing contrary to the demand of the question. Extract 4.2 is a sample of candidates' incorrect responses to the question.

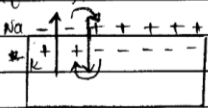
4. i) At resting potential there is high concentration of  $\text{Na}^+$  outside and  $\text{K}^+$  inside the neurone.



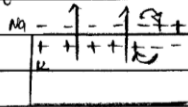
ii) When the neurone is stimulated,  $\text{Na}^+$  rush into the axon and cause depolarisation of neurone.



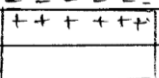
iii) Electric localized circuit are establish which cause further influx of  $\text{K}^+$  in the neurone.



iv) As progression of  $\text{K}^+$  in the neurone leads to the polarisation of the neurone.



v) As the neurone is polarised the out flow of  $\text{K}^+$  allow  $\text{Na}^+$  to enter hence repolarisation of the neurone.



**Extract 4.2:** A sample of incorrect responses to question 4 in Biology 1

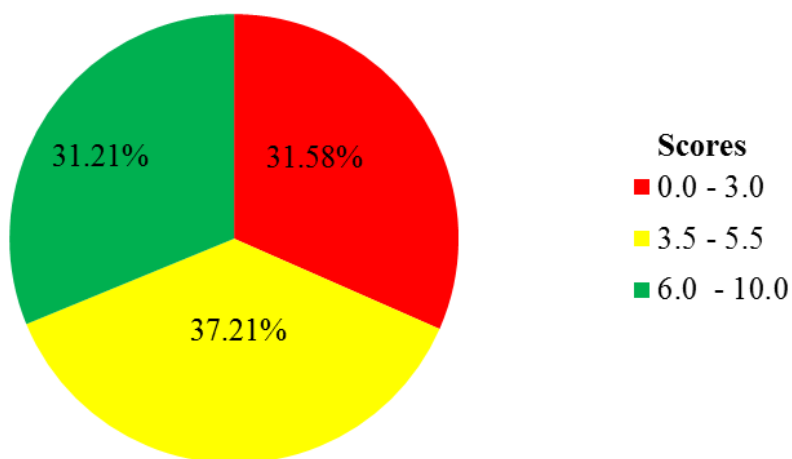
In Extract 4.2, the candidate described the transmission of impulses along an axon instead of drawing diagrams showing the arrangement of neurones for transmitting impulses from the receptor to the effector.

### 2.1.5 Question 5: Reproduction

The question measured the candidates' competence in describing gametogenesis in plants and animals. The candidates were required to differentiate spermatogenesis and oogenesis based on the following aspects: (a) Specific site of occurrence, (b) Number of cells formed, (c)

Result of cytoplasmic division during meiotic I and meiotic II, (d) Size of the cell formed, and (e) Transformation of the cells formed.

This question was attempted by 35,464 (95.76%) candidates. Data shows that 11,070 (31.21%) scored from 6.0 to 10.0 marks, 13,194 (37.21%) scored from 3.5 to 5.5 marks, and 11,200 (31.58%) scored from 0.0 to 3.0 marks. The general performance was good as 68.42 per cent of the candidates scored from 3.5 to 10.0 marks. The distribution of candidates' scores is shown in Figure 5.



**Figure 5:** *Distribution of the Candidates' Scores on Question 5*

Candidates who scored high marks (6.0 - 10.0) had adequate knowledge about the stages of gametogenesis. Therefore, they correctly differentiated spermatogenesis from oogenesis based on the given criteria. The candidates recognised that spermatogenesis occurs in the seminiferous tubules in testes of males while oogenesis occurs in the ovaries of females. Extract 5.1 is a sample of the candidates' correct responses to the question.

5. Items compared.	Spermatogenesis.	Oogenesis.
a) Specific site of occurrence.	It occurs in males in the testes.	It occurs in females in the ovary.
b) Number of cells formed.	Four cells are formed.	One cell is formed and three polar bodies.
c) Result of cytoplasmic division during meiosis I and meiosis II.	In meiosis I and meiosis II there is equal cytoplasmic division hence there is no formation of polar bodies.	In meiosis I and meiosis II there is unequal cytoplasmic division and formation of bodies.
d) Size of the cell formed.	The cell formed is small in size.	The cell formed is large in size.
e) Transformation of the cells formed.	The spermatid cells then transform into sperm cells (after maturation).	The ootid cells then mature and transform into an egg cell and the polar bodies disintegrate.

**Extract 5.1:** A sample of correct response to question 5 in Biology 1

In Extract 5.1, the candidate correctly differentiated between spermatogenesis and oogenesis based on the given criteria.

Candidates who scored average marks (3.5 to 5.5) gave correct differences to either two or three criteria. The incorrect answers were generally from parts (a) and (b). In part (a), they were not aware of the specific location of gamete production, and thus wrote incorrect responses. For instance, one of

the candidates wrote *spermatogenesis occurs in sperm and oogenesis occurs in ovum*. They failed to understand that the specific location for spermatogenesis is the seminiferous tubule in the testes while oogenesis for occurs in the ovaries. In part (b), one of the candidates wrote *spermatogenesis results 16 cells and oogenesis result 2 cells*. The candidates were conscious that spermatogenesis has a higher number of cells than oogenesis, but they mixed the idea of cell division between mitosis and meiosis.

However, 31.58 per cent of the candidates who scored low marks (0.0 - 3.0) obtained their marks in only one aspect or lost marks in all aspects. Those who scored 0 gave incorrect answers in all aspects. Some of the candidates mixed the concept of gametogenesis to that of fertilization. For example, one of the candidates wrote in part (e), that *transformation of cell formed is done by undergoing capacitation in spermatogenesis while oogenesis involves transformation from primary to secondary oocyte*. Others wrote the incorrect similarities between spermatogenesis and oogenesis. For example, one candidate wrote in part (e), that *both cells formed are transformed in circular way* and in part (a), *both gametes form 32 number of chromosomes*. These candidates lacked knowledge about the events which take place during gametogenesis process. Extract 5.2 is a sample of the candidates' incorrect responses to the question.

Ans:	Different of Spermatogenesis from Oogenesis based on	
	(i) Specific site of occurrence. Spermatogenesis occur to male during releasing of sperm while Oogenesis occur when the ovary receive an egg.	
	(ii) Number of cells formed. Spermatogenesis have (2n) 23 chromosomes while oogenesis have 46 chromosomes before separation of an egg.	

5.	(i) Result of cytoplasmic division during Meiotic I and meiotic II	
	- Spermatogenesis it result the formation of one cell during meiotic I and two daughter cell during meiotic II and oogenesis finally formation of two daughter cell at meiotic I.	
	(ii) Size of cell formed.	
	It form one cell spermatogenesis while oogenesis form two daughter cell with 46 chromosomes.	
	(iii) Transformation of the cell formed.	
	- It transfer cell and divide spermatogenesis while oogenesis it transfer cell from an egg to meet with sperm. and finally it goes to placenta for preparation of embryo	

**Extract 5.2:** A sample of incorrect responses to question 5 in Biology 1

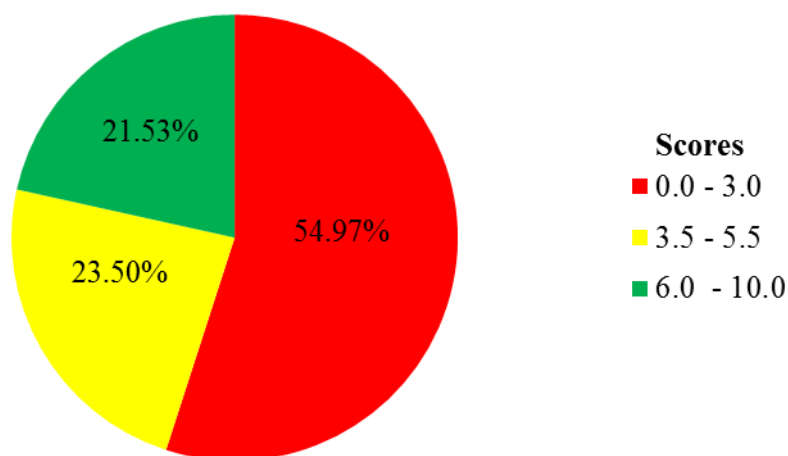
In Extract 5.2, the candidate incorrectly differentiated spermatogenesis from oogenesis. For example, in the size of the cell formed, he/she wrote *it form one cell spermatogenesis while oogenesis form two daughter cell with 46 number of chromosomes.*

### 2.1.6 Question 6: Gaseous Exchange and Respiration

The question measured the candidates' competence in describing the process of glycolysis. It required the candidates to explain with the help of a diagram, how a 6 carbon compound is converted to two molecules of a 3 carbon compound.

Data reveal that 33,838 (91.37%) candidates responded to the question. The analysis shows that 7,284 (21.53%) scored 6.0 to 10.0 marks 7,954 (23.50%) scored from 3.5 to 5.5 marks, and 18,600 (54.97%) scored low

marks (0.0 to 3.0). Generally, candidates' performance on question 6 was average since 45.03 per cent scored from 3.5 to 10.0 marks. The analysis of the candidates' performance is shown in Figure 6.



**Figure 6:** *Distribution of the Candidates' Scores on Question 6*

The candidates who scored high marks (6.0 to 10.0) were aware of the process of glycolysis. Thus, in part (a), they drew a correct diagram of glycolysis and gave explanation on how glucose (6C) molecule is converted into two molecules of pyruvates (3C). These responses indicate that, the candidates had good mastery on explaining the process of glycolysis. Extract 6.1 is a sample of the candidates' correct responses to this question.

6. - Glycolysis doesn't use oxygen, but uses ATP to attain activation energy and make glucose more available for reactions taking place.

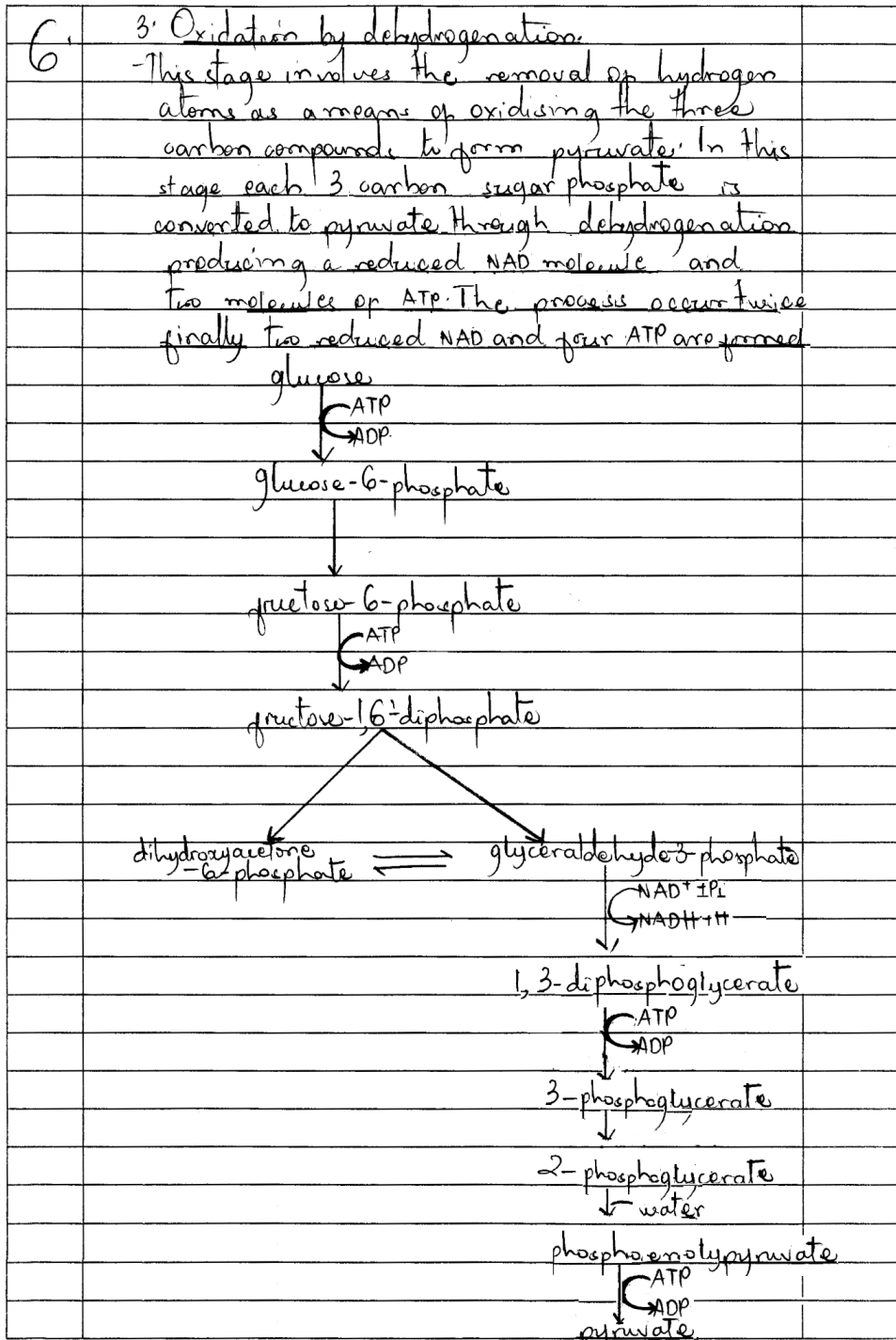
- Glycolysis involves three stages namely:
- Phosphorylation of glucose
  - Lysis
  - Oxidation by dehydrogenation.

### 1. Phosphorylation of glucose

- This stage involves the addition of phosphate group to the glucose.
- It involves action of several enzymes.
- Glucose is converted glucose-6-phosphate then later converted to fructose-6-phosphate with the aid of 2ATP which breaks down to release ADP and  $P_i$ .
- Later more phosphate ions are added to form fructose-1,6-diphosphate and that marks the end of phosphorylation of glucose stage.

### 2. Lysis

- This stage involves the breakdown of fructose-1,6-diphosphate into two isomers with the help of isomerase enzymes which are dihydroxyacetone-3-phosphate and glyceraldehyde-3-phosphate.



Extract 6.1: A sample of correct responses to question 6 in Biology 1

In Extract 6.1, the candidate explained how a 6 carbon molecule is broken down to two molecules of 3C compound. He/she also used a diagram to support his/her explanation.

The candidates who scored average marks (3.5 to 5.5) explained correctly some steps of glycolysis sequentially but were unable to draw the diagram. Others drew the diagram correctly but explained only one stage of glycolysis properly hence lost some marks.

The candidates who scored low marks (0.0 to 3.0) had inadequate knowledge about glycolysis. They were not aware that glycolysis involves three stages: the phosphorylation of the sugar, lysis, and oxidation by dehydrogenation. Thus, they failed to use a diagram to explain how a 6 carbon compound (glucose) is converted to two molecules of 3 carbon compound (pyruvate). On the other hand, some of these candidates described the Krebs cycle while others described alcoholic fermentation in yeast cell contrary to the demand of the question. The candidates who scored 1.0 to 3.0 either drew incomplete diagram showing breakdown of 6 carbon compound to 3 carbon compound without explanation or gave partial explanation without a diagram. Extract 6.2 is a sample of the candidates' incorrect responses to the question.

06.	Consider the Calvin cycle:	
	a) Carbon-dioxide fixation:	
	Carbon-dioxide from the atmosphere dissolves through the bundle sheath cells. It combines with a five (5) carbon compound which is Ribulose Biphosphate (RuBP) to form a six (6) carbon compound through the mesophyll cells aided by ribulose biphosphate carboxylase (RuBisCO).	
	$CO_2 + RuBP \rightarrow 6 \text{ Carbon}$	
	b) Dehydrogenation of RuBP.	
	After the formation of a 6-carbon compound a reduced hydrogen carrier NADPH <sub>2</sub> hydrolyses the 6-carbon compound to form two molecules of a 3-carbon compound. The first product is phosphoglyceric acid followed by phosphoglyceraldehyde.	
	<p style="text-align: center;"> <math>RuBP \xrightarrow[ATP \rightarrow ADP]{NADPH_2 \rightarrow NADP} 3PGA + 3PGAL</math> </p>	
	c) Regeneration of RuP.	
	After the formation of the products, it then follows that the first latter is used and recycled to combine with carbon-dioxide which yield RuBP by the aid of Ribulose biphosphate carboxylase.	

**Extract 6.2:** A sample of incorrect responses to question 6 in Biology 1

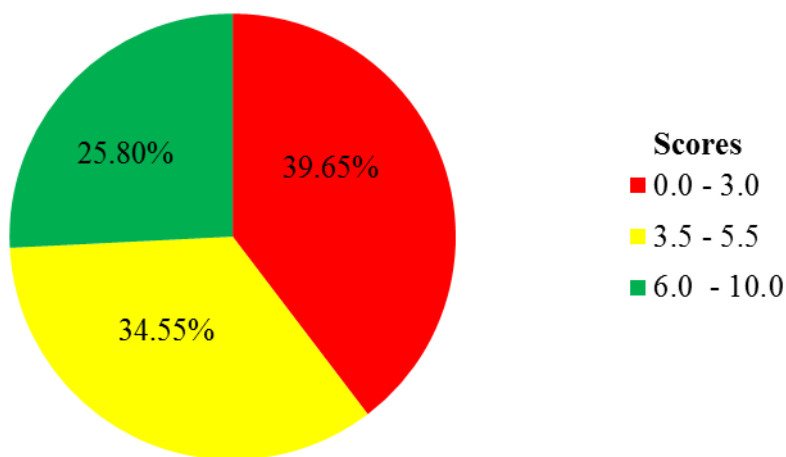
In Extract 6.2, the candidate described the Calvin cycle, a series of biochemical reactions that occur during photosynthesis instead of how a 6 carbon compound is converted to two molecules of a 3 carbon compound in respiration.

### 2.1.7 Question 7: Gaseous Exchange and Respiration

The question measured the candidates' competence in describing the types of respiratory substrates and their energy values, and stating the factors which cause variation of the basal metabolic rate of an individual. This question comprised parts (a) and (b). In part (a), the candidates were

required to evaluate the rate of respiration based on the criteria (i) size of organisms, (ii) age of organisms, (iii) health condition of organisms, and (iv) body temperature. In part (b), the candidates were required to justify the fact that when the same amount of lipid and glucose is respired, lipid releases more energy than glucose.

Data show that 36,316 (98.06%) candidates attempted the question. The analysis shows that 9,369 (25.80%) scored 6.0 to 10.0 marks, 12,549 (34.55%) scored from 3.5 to 5.5 marks, and 14,398 (39.65%) scored low marks (0.0 to 3.0). The candidates' performance on this question was good because 60.35 per cent of the candidates passed. The candidates' performance is as illustrated in Figure 7.



**Figure 7:** *Distribution of the Candidates' Scores on Question 7*

The candidates who scored high marks (6.0 to 10.0) correctly evaluated the rate of respiration based on the criteria provided in part (a). They were aware that during glycolysis, lipid produces large number of 2 carbon fragments, which, produce a large amount of energy on entering the Krebs cycle. Moreover, they realised that oxidation of fats produces large amount of hydrogen ions as each triglyceride consists of one molecule of glycerol and three fatty acids molecules, while carbohydrates consist of only two molecules of pyruvate. Extract 7.1 is a sample of the candidates' correct responses to question 7 (a).

7(a)	<p>i. Organisms with large body size have low rate of respiration</p> <ul style="list-style-type: none"> <li>- Since they have small surface area to volume ratio</li> <li>- Hence lose a small amount of heat therefore require low rate of respiration to replace heat or energy lost.</li> </ul> <p>- Organisms with small body size have high rate of respiration</p> <ul style="list-style-type: none"> <li>- Since they have large surface area to volume ratio</li> <li>- Hence lose large amount of heat, hence require high rate of respiration to replace the energy lost.</li> </ul>
	<p>ii. Age of organisms:</p> <ul style="list-style-type: none"> <li>- Younger organisms have high rate of respiration</li> <li>- Since they are metabolically active</li> <li>- They require much energy in their bodies for proper growth.</li> <li>- Older organisms have low rate of respiration</li> <li>- Since they are not metabolically active</li> <li>- Therefore require less energy in their bodies.</li> </ul>
	<p>iii. Health condition of organisms:</p> <ul style="list-style-type: none"> <li>- Organisms that are ill have high rate of respiration to produce immune cells to deal with the pathogens</li> <li>- Organisms that are fine have low rate of respiration compared to the ill ones.</li> </ul>
	<p>iv. Body temperature:</p> <ul style="list-style-type: none"> <li>- Since respiration is an enzymic controlled reaction</li> <li>- Organisms with optimum body temperature have high rate of respiration due to proper functioning of enzymes.</li> <li>- Organisms with body temperature lower than the optimum have low rate of respiration since enzymes are inactive.</li> <li>- Organisms with body temperature higher than the optimum have low rate of respiration since enzymes are denatured.</li> </ul>

**Extract 7.1:** A sample of correct responses to question 7 (a) in Biology 1

In Extract 7.1, the candidate correctly described the effects of the size, age, health condition and body temperature of organisms on the rate of respiration in part (a).

The candidates who scored average marks (3.5 to 5.5) gave two to three correct responses in part (a), but failed to give correct justification that when the same amount of lipid and glucose is respired, lipid releases more energy than glucose. Most of the candidates failed to evaluate the effect of body temperature on the rate of respiration. For example, one of the

candidates concluded that *rate of respiration increases when the temperature increases up to the maximum*. The candidate did not include the effect of higher temperature above optimum, which reduces the rate of respiratory enzyme and hence respiration.

However, 39.65 per cent of candidates scored low marks (0.0 - 3.0). They either gave incorrect responses to all parts of the question or gave some correct responses in part (a). The candidates who scored zero, were not conversant with factors affecting the rate of respiration and the type of respiratory substrates with their energy values. Therefore, in part (a), these candidates failed to evaluate the rate of respiration based on; size of organisms, age of organisms, health condition of organisms, and body temperature. Some of the incorrect responses given by the candidates were; *small organisms have low rate of respiration, and when the size increase the rate of respiration will increase*.

Likewise, in part (b), most of the candidates failed to justify the fact that when the same amount of lipid and glucose is respired, lipid releases more energy than glucose. Most of the responses explained the functions of lipid and its structure. Others wrote justification, which lacked clarity. For example, one candidate wrote that, *lipid releases more energy than glucose because it has more fats and oils*. Extract 7.2 is a sample of candidates' incorrect responses to question 7(a).

Q7(a)	(i) Size of organism.	
	• Rate of respiration based on size is when the organism is large rate of respiration becomes large	
	• But small organism its rate of respiration is also small due to the size of its body.	
	(ii) Age of organism.	
	• Young people have low rate of respiration due to its organs are <del>far</del> smaller and so it does not require alot of respiration process.	
	• Adult people have high rate of respiration due to their age is higher and so they need high rate of respiration	
	(iii) Health condition of organism.	
	• Sick people have low rate of respiration due to their health is not good and hence all energy tend to fight against the disease.	
	• Uncke people have high rate of respiration due to presence of enough energy to control rate of respiration.	
	(iv) Body temperature.	
	• High body temperature tend to have low rate of respiration hence it needs to cool the body so as to decrease the temperature.	
	• Low body temperature tend to have high rate of respiration so as to gain heat so as to attain body temperature.	

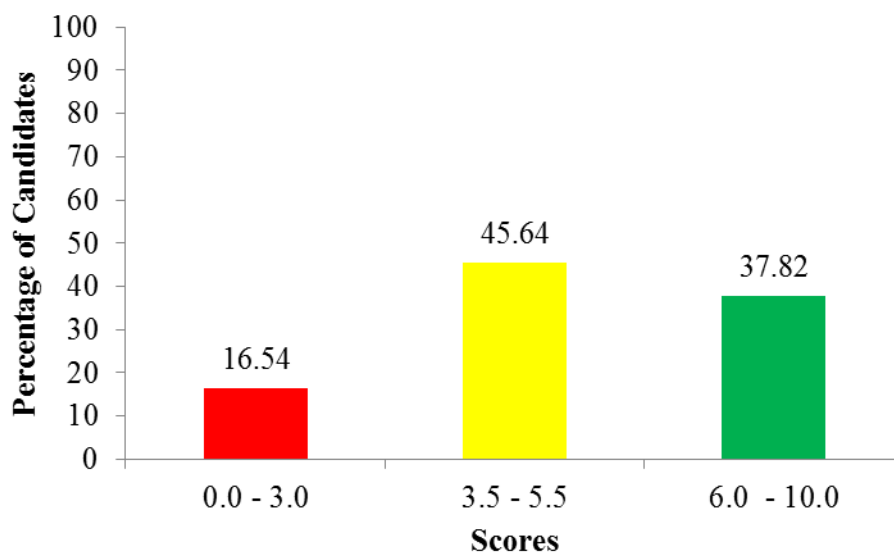
**Extract 7.2:** A sample of incorrect responses to question 7(a) in Biology 1

In Extract 7.2, the candidate gave incorrect responses on the factors that determine the rate of respiration in part (a). Additionally, he/she gave incorrect reasons as to why lipid respiration releases more amount of energy than glucose respiration.

### 2.1.8 Question 8: Comparative Studies of Natural Groups of Organisms

The question measured the candidates' competence in describing the structure of virus and prokaryotic cells, and the advantages and disadvantages of viruses. This question comprised parts (a) and (b). In part (a), the candidates were required to analyse features which are found in a virus but not in the bacterial cell . In part (b), the candidates were asked to justify the statement that viruses have merits and demerits in human life.

Data show that 11,020 (29.75%) candidates attempted this question. Analysis shows that 13,886 (37.82%) scored from 6.0 to 10.0 marks, 16,758 (45.64%) scored from 3.5 - 5.5 marks, and 6,072 (16.54%) scored low marks (0.0 to 3.0). Generally, candidates' performance on question 8 was good since 83.46 per cent of the candidates scored from 3.5 to 10.0 marks. The distribution of candidates' scores is presented in Figure 8.



**Figure 8:** *Distribution of the Candidates' Scores on Question 8*

The candidates who scored high marks (6 to 10), analysed correctly the features which are found in viruses but not in the bacterium. Moreover, they justified the merits and demerits of viruses in human life. This shows that the candidates mastered the structures of the organisms, thus distinguishing specific features found only in viruses but not in bacterial cell. Extract 8.1 is a sample of the candidates' correct responses to question 8.

8a. Features found in virus only.	
i. It has only one type of nucleic acid either DNA or RNA.	
ii. It is non living until it enters a host cell.	
iii. It uses the DNA of the host cell to replicate itself not like bacteria that uses its DNA	
iv. It is relatively smaller than bacteria	
b. Merits	
i. They can be used to make vaccine	
ii. Viral diseases like corona have obtained vaccines which induce production of antibodies.	
iii. They can be used in biological studies	
iv. They are carefully studied and examined by scientists to investigate the functions of cell.	
8b. Demerits	
i. They are disease causative agents to human	
Some of the diseases like chicken pox, corona disease are caused by virus and affect the health of people and some don't have cure at all.	
ii. Some virus cause chronic infections to man such as HIV-AIDS.	

**Extract 8.1:** A sample of correct responses to question 8 in Biology 1

In Extract 8.1, the candidate correctly analysed the features found in the virus but not in bacterium cell in part (a). He/she justified the merits and demerits of viruses in human life in part (b).

The candidates who scored average marks (3.5 to 5.5), either correctly analysed the features found only in viruses but not in bacterium cell in part (a) and failed to give correct response in part (b), or provided incorrect responses in part (a), with a clear justification in part (b). One of the candidates explained the importance of bacteria instead of viruses hence lost marks. For example, *Acetobacter are used in vinegar production,*

*Clostridium* are used in nitrogen fixation which are incorrect responses in part (b).

The candidates who scored low marks (0.0 to 3.0) had insufficient knowledge about unique features of viruses and their economic importance to human being. For example, in part (a), one of the candidates wrote that *viruses have hook for attachment to the host cell*. Others wrote that *the virus cell has gram positive and gram negative stains which are absent in bacterium*. On the other hand, some of the candidates explained the merits and demerits of viruses to plants instead of human being contrary to the demand of the question. For example, one of the candidates wrote that *viruses such as tobacco mosaic cause disease to tobacco plants, tomato leaf curl virus cause disease to tomatoes*. Other candidates failed to distinguish the components of other living organisms from viruses. For example, one of the candidates incorrectly wrote *virus coat is made by lignin* which is the specific component in plant cell wall. Others wrote that *viruses have flagella for movement while bacteria have cilia* which is the incorrect response. Extract 8.2 is a sample of the candidates' incorrect responses to the question.

8a)	Virus has flagellum for movement	
ii)	Virus has alia	
iii)	Virus has receptor sites to bind to the host	
iv)	Virus has plasmid	
b)	Demerits	
	o Virus causes destroy of plants	
	Merits:	
	o Lignin helps in fermentation process	

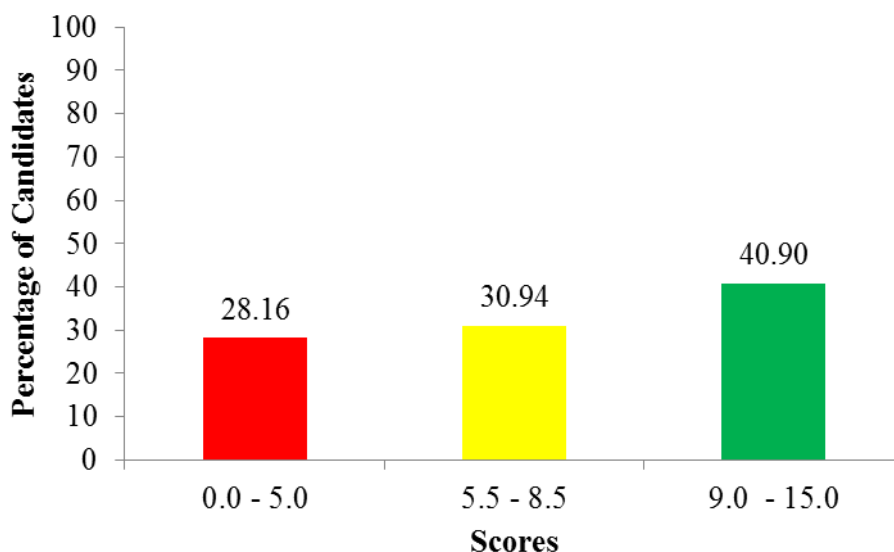
**Extract 8.2:** A sample of incorrect responses to question 8 in Biology 1

In Extract 8.2, the candidate wrote incorrect features which are found in other organisms but not in virus in part (a). For example, he/she wrote *virus has flagella and cilia* the structure found in bacteria and paramecium. Also, in part (b), he/she explained the merit of bacteria instead of viruses and demerit of virus to plant instead of relating it to human life.

### 2.1.9 Question 9: Transportation

The question measured the candidates' competence in analysing passive and active transport in living organisms. It required the candidates to evaluate the statement that osmosis and diffusion are ways for transporting materials in living organisms by giving benefits for each way.

This question was opted by 31,201 (84.25%) candidates. Analysis shows that 12,761 (40.90%) scored from 9.0 to 15.0 marks, 9,655 (30.94%) scored from 5.5 to 8.5 marks, and 8,785 (28.16%) scored low marks (0.0 to 5.0). The candidates' performance on this question was good because 71.84 per cent of the candidates passed. The distribution of candidates' scores in this question is summarized in Figure 9.



**Figure 9:** *Distribution of the Candidates' Scores on Question 9*

Candidates who scored high marks (9.0 to 15.0) were aware that both osmosis and diffusion are passive processes that occur naturally without the need for cellular energy. Therefore, they correctly evaluated the benefits of osmosis and diffusion in plants and animals. In addition, the candidates were aware of the principles of writing an essay-type question where they wrote relevant introduction, main body and conclusion. Extract 9.1 is a sample of the candidates' correct responses to question 9.

9.	Osmosis is the movement of water molecules from a region of low concentration to a region of high concentration of solute along a semi-permeable membrane.	
	Diffusion is the movement of particles from a region of high concentration to a region of low concentration.	
	Both diffusion and osmosis are passive means of transport as they don't require energy for transport and movement takes place along the concentration gradient.	
	The following are the advantages of osmosis to living organisms:	
	It's essential for water uptake by plants in the soil.	
	Plants absorb water and mineral salts from the soil through root hairs up to the root system due to difference in water potential enabling movement by osmosis.	
	In animals, water is reabsorbed from the kidneys back to the body through osmosis via the permeable water channels, this takes place when the body has lower water potentials.	
	In plants, osmosis is useful in seed germination. Water being an essential requirement, it's taken up by the seed through osmosis via the micropyle.	

9.	<p>In plants the opening and closing of stomata is aided by osmosis process.</p> <p>When the water potential of guard cells is lower than that of the surroundings, water is absorbed and cause turgidity in which the stomata opens. This is useful for gaseous exchange and transpiration.</p> <p>The following are advantages of diffusion to the living organisms:</p> <p>Gaseous exchange in animals takes place due to diffusion of gases from the alveoli to the tissues and from tissues to the alveoli depending on the concentration gradient, hence very useful.</p> <p>Absorption of food done by the ileum in mammals is through diffusion in which the thin and numerous villi speed up the rate of absorption and food is made available in the body.</p> <p>Exchange of materials between mother and foetus during pregnancy is through diffusion, such that a foetus gains nutrients and gets rid of wastes which promotes its growth.</p> <p>It's very important in excretion in plants as diffusion is one of the ways in which plants can get rid of their metabolic wastes to the surrounding along concentration gradient.</p> <p>Conclusively, both osmosis and diffusion are very useful processes in the living organisms as they ensure distribution of materials all over the cell for various functions.</p>	
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**Extract 9.1:** A sample of correct responses to question 9 in Biology 1

In Extract 9.1, the candidate correctly evaluated the benefits of osmosis and diffusion to living organisms.

The candidates who scored average marks (5.5 to 8.5), answered the question by only one side; either osmosis or diffusion. Many of the candidates failed to use proper terminology on defining the words osmosis and diffusion as the materials transported by osmosis should be water. For example, one of the candidates defined osmosis *as the movement of materials*, while the other one defined it as *the movement of solutes or solvent*.

The candidates who scored low marks from 0.0 to 5.0 gave incorrect responses in all or most parts of the question. They were not conversant with the importance of diffusion and osmosis in living organisms. For example, one of the candidates exchanged the role of osmosis to that of diffusion by stating that *osmosis is involved in diffusion of respiratory gases from lungs to the body tissues*. In addition, other candidates gave incorrect similarities between osmosis and diffusion. For example, *both processes transport materials through a semi permeable membrane, both involves rapid transportation of materials, both mechanisms are selectively permeable, both need small amount of energy*. Other incorrect responses given by the candidates were; *Diffusion simplify cooking when adding salts, osmosis is used for washing activities such as washing cars and bicycle, and it is used for drinking activities*. These candidates were incompetent on differentiating the roles of each osmosis and diffusion. Extract 9.2 is a sample of the candidates' incorrect responses to question 9.

Q Osmosis refers to the movement of concentration of a solvent from more concentrated to the less concentrated through semi-permeable membrane. The following are the benefits of Osmosis in living organisms.

Osmosis help for transportation of water. Osmosis used to transport water within the body of organism from more concentrated to the less concentrated.

Osmosis help for growth of plants. This is because people used to concept of osmosis to supply water in the plants in which plant absorb water hence growth occur.

Osmosis help for separation of a solvent. Osmosis separate the concentrated solvent and dilute solvent which are safe for use.

Osmosis help for Osmoregulation because water molecule move from the body which are concentrated to the part of the body which are not concentrated.

Diffusion; refers to the movement of water molecule from the site of dilute solvent to the site of concentrated solvent molecule. Benefit of diffusion

Diffusion used in agricultural activities, farmers used the concept of Diffusion to spray medicine to the plant body

9.	Diffusion used for washing activities, people use the concept of diffusion to wash the car, bicycle through spraying by using pipes.
	Diffusion used for drinking activities, people use the concept of diffusion to supply water in which people drink.
	Diffusion used for transportation, some living things are transported from one place to another place through diffusion.

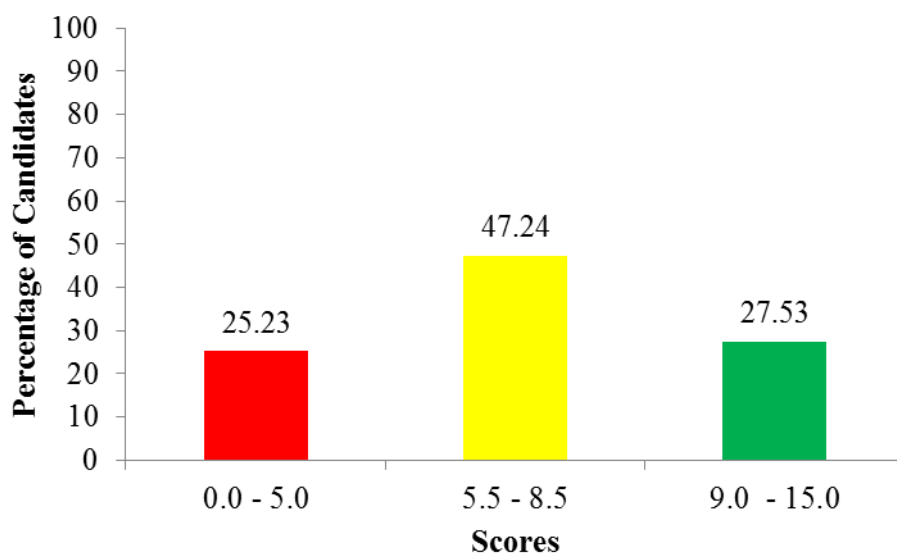
**Extract 9.2:** A sample of incorrect responses to question 9 in Biology 1

In Extract 9.2, the candidate wrote incorrect explanation of the benefits of osmosis and diffusion in living organisms.

### 2.1.10 Question 10: Nutrition

The question measured the candidates' competence in analysing light and dark reactions of photosynthesis. It demanded candidates to justify the fact that animals cannot survive without plants.

This question was opted by 35,459 (95.74%) candidates. Analysis shows that 9,763 (27.53%) scored from 9.0 to 15.0 marks, 16,749 (47.24%) scored from 5.5 to 8.5 marks, and 8,947 (25.23%) scored low marks (0.0 to 5.0). The candidates' performance on this question was good since 74.77 per cent of the candidates passed. The candidates' performance is as shown in Figure 10.



**Figure 10:** *Distribution of the Candidates' Scores on Question 10*

The candidates who scored high marks (9.0 to 15.0) were able to substantiate the advantages of plants to animals since plants are photosynthetic organisms, thus animals are dependent on them. The candidates gave correct justification of the fact that animals cannot survive without plants. Moreover, the candidates were capable of answering the question using essay type format; they started with introduction, body of the question and finalized with conclusion. Extract 10.1 is a sample of candidates' correct responses to question 10.

10.	<p>It is true that animals cannot survive without plants because all plants are the producers in the ecosystem. Plants are autotrophic organisms and animals are heterotrophic. The following are ways in which animals depend on plants:</p> <p>Plants provide chemical energy to animals. Animals have no ability of converting the light energy from the sun to chemical energy needed to perform metabolic activities, hence through the process of photosynthesis, plants manufacture chemical energy that is stored in the products like starch. Animals then feed on starch and use the chemical energy stored in the starch to perform metabolic activities. The energy runs all life processes such as movement and growth. Therefore animals depend on photosynthesis to get energy for various metabolic processes.</p>
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10.	Plants produce oxygen needed by animals for respiration. Plants during the process of photosynthesis produce oxygen as a by-product, which is used by animals during respiration to produce ATP energy.
	Plants act as carbon sinks
	Animals produce carbon dioxide during respiration as a waste product. Excess carbon dioxide in the atmosphere increases the layer of greenhouse gases that cause global warming on earth, thus plants take in carbon dioxide during photosynthesis, hence protect animals from the effects of global warming.
	Plants provide animals with organic form of carbon useful in manufacturing of other products.
	Animals are not able to use the inorganic form of carbon, like carbon dioxide, hence plants use carbon to manufacture organic compounds like proteins and carbohydrates when used by animals it help in many processes like the manufacture of amino acids.
	Also heterotrophic organisms depend on food substances such as carbohydrates.
	Conclusively, plants are very important to animals and in the ecosystem, hence they have to be protected and avoid activities like burning of forests, cutting down of trees without replanting them and which will enable to maintain proper interaction between plants and animals.

**Extract 10.1:** A sample of correct responses to question 10 in Biology 1

In Extract 10.1, the candidate demonstrated critical thinking in justifying the importance of plants in the survival of animals.

The candidates who scored average marks (5.5 - 8.5) evaluated correctly a few of the importance of plants to animals. In addition, they did not provide a relevant introduction and conclusion. Others wrote the introduction and conclusion correctly but gave one point for justification.

The candidates who scored low marks (0.0 - 5.0) were not conversant with the importance of plants to animals' life in such that the absence of those plant roles the animals will not survive. One of the candidates wrote the general roles of plants that their absence has no any harmful effect to animal's survival. For example, one of the candidates wrote plants *provide shelter, source of tourist attraction, plants used for making furniture, plants are needed to make cotton and for ornament*. Extract 10.2 is a sample of candidates' incorrect responses to this question.

10	<p>Plant are the living organism that found on the earth surface. All plant are grouped in kingdom plantae which divided into different phylum. Example angiospermatophyte phylum and other phylum.</p> <p>Without plant there is no for animal. It is true due to the following reasons:</p> <p>Plant help to increase soil fertility for support growth of different crops and also small microorganism that found in the soil hence soil are important for survive of animal.</p> <p>Plant help in hydrological cycle. This is the process that help in formation of rainfall through the process of water loss by plant by transpiration process help to increase the water content upper layer of the earth hence lead to occurrence of rainfall that support in agriculture and different process.</p> <p>Plant help to hold the soil tightly through its root hence help to reduce the erosion process of a soil when faced with different circumstance. Example flood and the work of group of livestock hence support stability of plant.</p> <p>Plant act as habitat for some animal. Example bird the tree and survive on plant by establish and build their nest and also other biodiversity.</p>
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	organism	hence	without plant
	animal	can not	survive
		in general	all of that are the.
		reason	have support animal
	cannot	survive.	without plant
	Example	support	rainfall formation and down

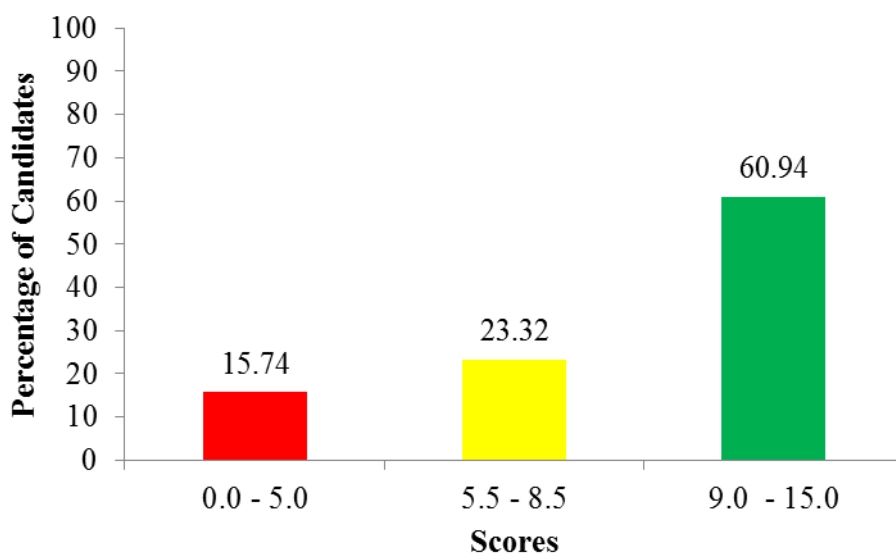
**Extract 10.2:** A sample of incorrect responses to question 10 in Biology 1

In Extract 10.2, the candidate explained the generalised roles of plants as he/she mainly focused on environmental importance of plants such as *preventing soil erosion and source of soil fertility* instead of how plants support the life of animals.

### 2.1.11 Question 11: Reproduction

The question measured the candidates' competence in describing life cycles of bryophytes. This question required the candidates to describe the life cycle of a bryophyte with the aid of a diagram.

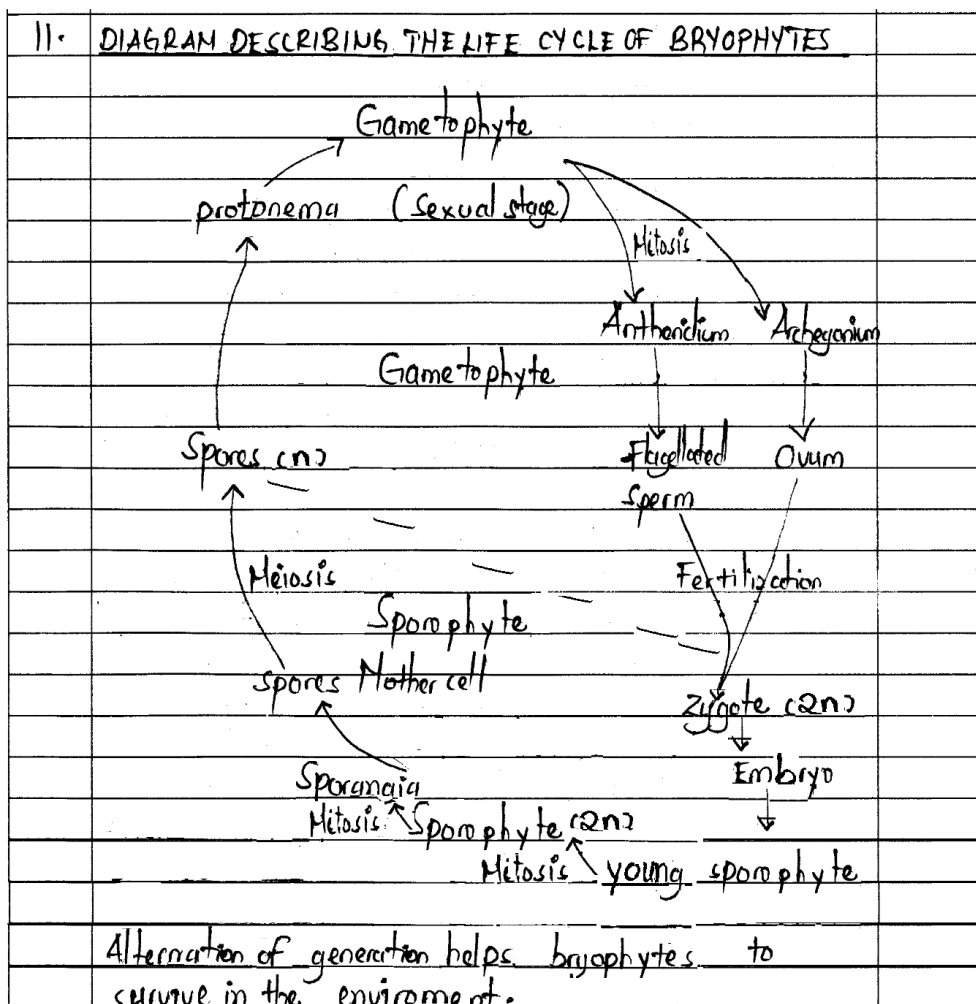
This question was opted by 7,406 (20.00%) candidates. Analysis shows that 4,513 (60.94%) scored 9.0 to 15.0 marks, 1,727 (23.32%) scored from 5.5 to 8.5, and 1,166 (15.74%) scored low marks (0.0 to 5.0). The candidates' performance on this question was good because 84.26 per cent of the candidates passed. The distribution of candidates' scores in this question is summarized in Figure 11.



**Figure 11:** *Distribution of the Candidates' Scores on Question 11*

The candidates who scored high marks (9.0 – 15.0) were aware of the concept of alternation of generation between a haploid gametophyte stage and a diploid sporophyte stage. Therefore, they correctly described how gametophyte and sporophyte generations alternate in bryophytes. They realised that gametophyte generation is haploid, sexual, and dominant phase in bryophytes such as moss plant. The candidates also explained about sporophyte generation, which is diploid, asexual and depends on gametophyte for support and nutrition. Moreover, the candidates drew well-labeled diagram of the life cycle of moss plant (bryophyte). Extract 11.1 is a sample of candidates' correct responses to question 11.

11.	<u>LIFE CYCLE OF BRYOPHYTES</u>	
	- In bryophytes, reproduction consist of gametophyte (n) and sporophyte generation (2n)	
	- Gametophyte generation forms gametes called antheridium and archegonium by mitosis.	
	- Antheridium and archegonium undergo mitosis to form bi-flagellated sperms and an ovum respectively.	
	- In the presence of water, bi-flagellated sperm swim from antheridium to archegonium and fuse to form a diploid zygote which matures into a diploid sporophyte generation.	
	- The sporophyte matures and form sporangia which undergoes meiosis to form haploid spores that give rise to gametophyte.	



**Extract 11.1:** A sample of correct responses to question 11 in Biology 1

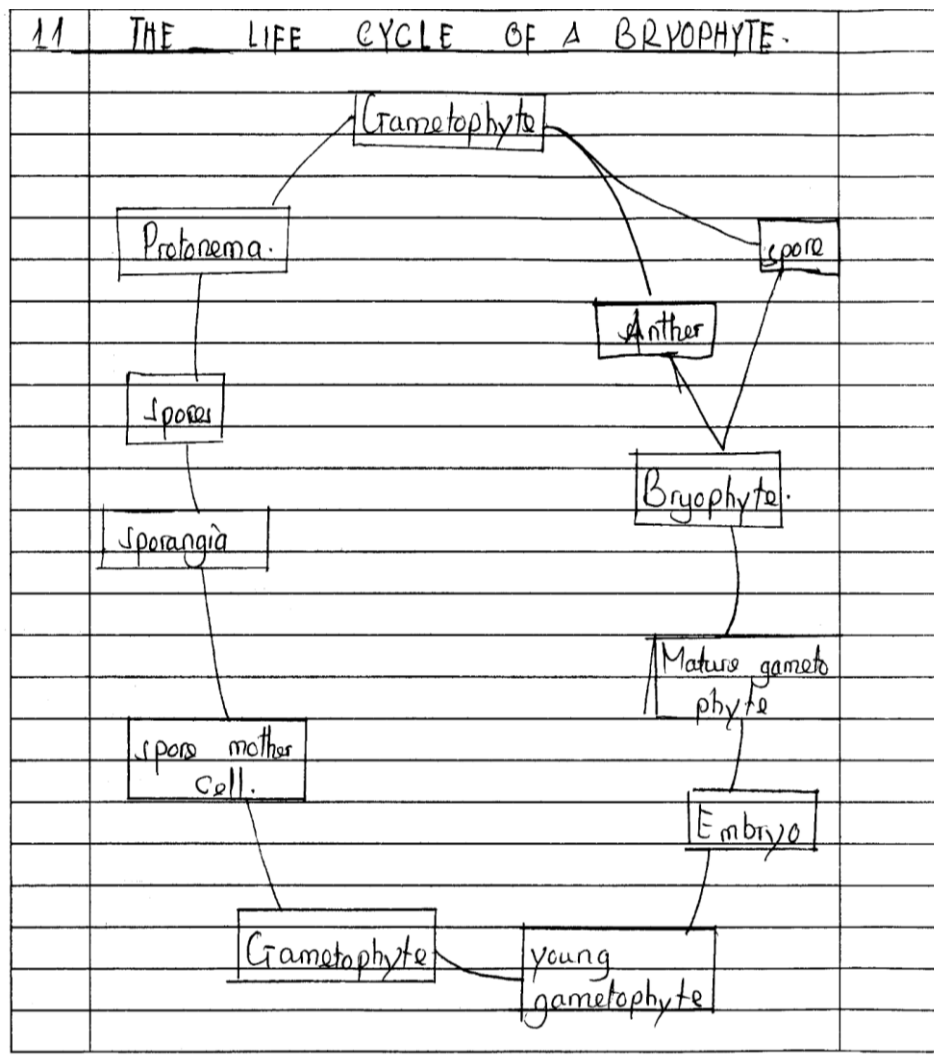
In Extract 11.1, the candidate correctly described the life cycle of a bryophyte by considering the features of its sporophyte and gametophyte generations. In addition, he/she used a well-labelled diagram for illustration.

Candidates who scored average marks (6.0 to 9.0) either they described the life cycle of a bryophyte without a diagram, or drew and labelled the diagram without description, hence lost marks.

Most of the candidates who scored low marks (0.0 to 5.0) either lacked or had inadequate knowledge of alternation of generation and the life cycle of

bryophytes. Those who scored from 1 to 5 marks described two to three stages of the life cycle, hence lost marks. Some of the candidates wrote a relevant introduction and conclusion but missed the facts in the description. Other candidates drew the life cycle of pteridophytes, while others drew the life cycle of angiosperms and gymnosperms. For example, one candidate wrote *microspore and megaspore form male and female gametes respectively which fuse together to form zygote and later seed and fruit*. Another candidate wrote that *microsporocyte and megasporocyte are important as they germinate to form moss plant*. Moreover, other candidates drew a diagram of the moss plant and liverwort instead of describing the life cycle. Such incorrect responses indicate that the candidates were incompetent on the concept of an alternation of generations and the life cycle of selected plants. Extract 11.2 is a sample of candidates' incorrect responses to question 11.

11.	Bryophyte belong to kingdom plantae. Kingdom to which bryophyte belong have phylum like Bryophyta, angiospermophyta, and filiano phyta.
	The life cycle of Bryophyte.
	• Their life cycle start <del>at</del> from gametophyte which divide to form anther and spore.
	• Protonema grow to form spores and sporangia which later form spore mother cell



**Extract 11.2:** A sample of incorrect responses to question 11 in Biology 1

In Extract 11.2, the candidate incorrectly described the life cycle of a bryophyte. For example, he/she explained that the *gametophyte releases anther and spore, which form bryophyte*.

## 2.2 133/2 Biology 2

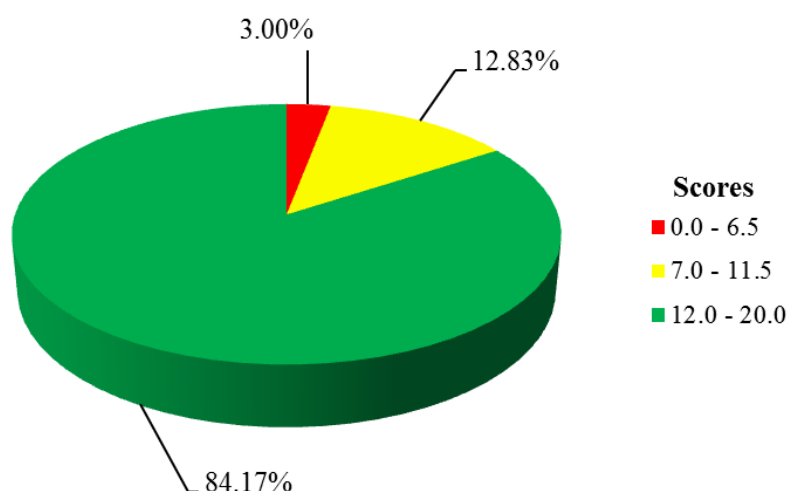
This paper comprised six topics, Comparative Studies of Natural Groups of Organisms, Regulation (Homeostasis), Growth and Development, Genetics, Evolution and Ecology. The questions in this paper were essay/structured type questions. The analysis in each question provides

demand for the question, statistical data on candidates' performance, and sample extracts from candidates' responses.

### 2.2.1 Question 1: Comparative Studies of Natural Groups of Organisms

The question measured the candidates' understanding of the advantages and disadvantages of members of the Kingdom Monera. It required the candidates to describe five merits and three demerits of bacteria in human life.

This question was opted by 36,707 (99.12%) candidates. Data reveal that 36,925 (99.70%) candidates responded to the question. The analysis shows that 30,896 (84.17%) scored from 12.0 to 20.0 marks, 4,711 (12.83%) scored from 7.0 to 11.5 marks, and 1,100 (3.00%) scored low marks (0.0 to 6.5). The candidates' performance on this question was good because the majority (97.00%) passed by scoring 7.0 to 20.0 marks. Figure 12 presents the distribution of the candidates' scores.



**Figure 12:** *Distribution of Candidates' Scores on Question 1*

The candidates who scored high marks (12.0 to 20.0) correctly described the merits and demerits of bacteria in human life. These candidates were conversant with the application of bacteria in human daily life, specifically how bacteria are advantageous and disadvantageous to human. Moreover, they demonstrated good essay writing skills as the introduction, main body

and conclusion were clearly informed. Additionally, the candidate had good command of the English language hence, clearly communicated their answers. Extract 12.1 is a sample of the candidates' correct responses to the question.

1.	<p>Bacteria are the organisms that belong to Kingdom Monera whereby they are prokaryotic in nature. Being prokaryotic, bacteria lacks true nucleus and nuclear bound membrane, has 70's ribosome, has circular naked DNA and possess cell wall made up of peptidoglycan. Bacteria have merits and demerits in human life. The following are the merits of bacteria in human life;</p>	
	<p>They are used in the production of dairy products. Bacteria can be used in the production of dairy products such as milk, cheese and yoghurt. This is because of their ability to produce lactic acid which upon oxidation produces lactose sugar that makes these products. Example of bacteria is lactobacillus bacteria.</p>	
	<p>Bacteria add nutrients in the soil. Bacteria can add nutrients to the soil due to their ability to convert atmospheric nitrogen into a form that can be used by plants so they add important nutrients for the better growth of the leguminous plants. The bacteria for this purpose is nitrogen fixing bacteria.</p>	
	<p>Bacteria is useful in sewage disposal. Sewage is the semi liquid waste from various sources. Bacteria are used in the sewage disposal due to their ability to decompose organic matter hence they will decompose sewage and making it simple and less harmful to the surrounding environment.</p>	
	<p>They are used in the production of antibiotics and vaccines. Bacteria may be used in the production of antibiotics and vaccines that are used in the treatment of various diseases. This is through the intensive study and research on bacteria their characteristics and how to address them.</p>	

1	<p>Bacteria are used in genetic engineering. Genetic engineering is the alteration of gene so as to retain the desirable traits. Bacteria can be used as the host of the gene as it develops and so attain the desired gene. For example in insulin production insulin hormone may be kept bind to the bacteria plasmid and hence produce more insulin for diabetic patients. Example E-coli bacteria. Furthermore, bacteria have several demerits which are elaborated as follows:</p> <p>Bacteria cause diseases to humans, plants and even other animals. Some of the bacteria are harmful since they cause disease such as cholera by vibrio cholerae, typhoid by salmonella typhi, syphilis by treponema pallidum. This can be dangerous if the bacteria is the one that is drug resistant.</p> <p>Bacteria may decrease or lower the nutrients availability in the soil. Some of the bacteria tend to convert the nitrites back to atmospheric nitrogen gas that can no longer be used by the plants for their effective growth. This lowers the nutrients availability of the soil. The bacteria responsible for this are the nitrogen denitrifying bacteria.</p> <p>Bacteria may cause food spoilage and poisoning. Most of the bacteria tend to decompose the organic food substances leading to their spoilage. Consumption of such foods may bring effects such as poisoning and death.</p> <p>Conclusively, not all bacteria are harmful and not all are beneficial therefore it is best to know how to cope and interact so that there can be a commensal relation whereby the host is not harmed.</p>
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**Extract 12.1:** A sample of correct responses to question 1 in Biology 2

In Extract 12.1, the candidate correctly described the merits and demerits of bacteria in human life.

The candidates who scored average marks (7.0 - 11.5), gave fewer correct merits and demerits of bacteria than the required points, hence losing some marks. Also, some candidates wrote their responses without an introduction

and a conclusion, resulting in the loss of marks for the organisation of the essay.

On the other hand, the candidates who scored zero lacked knowledge of the advantages and disadvantages of bacteria in human life in such a way that they gave incorrect responses on the merits and demerits of bacteria. Some of the candidates wrote the advantages of plants instead of bacteria. For example, one candidate wrote that *bacteria help to reduce the amount of carbon dioxide in the atmosphere*. Another candidate described the merits of fungi instead of that of bacteria. For example, one candidate wrote that, *they are saprophytes which are fed by other organisms*. Other candidates did not understand the demand of the question; hence they listed the type of bacteria and others drew the diagrams of bacteria instead of providing the merits and demerits. Those who scored low marks ranging from 1.0 to 6.5 wrote either a few correct points or unclear points. Some candidates just mentioned the merits and demerits of bacteria without any description hence losing marks. Other candidates wrote incorrect spelling of some words such as food *sporage* instead of food spoilage. Extract 12.2 is a sample of incorrect responses to

01;	a) Merits of Bacteria in human life.	
	i) It prevents human being against diseases.	
	ii) Helps in protecting the cell in human body against antigens.	
	iii) Helps in digestion as they act as Enzymes.	
	iv) Its ability to live in harsh condition where other organisms can not helps human being to fight against infections caused by other small parasites.	
	v) Bacteria is protein in nature.	
	b) Demerits of Bacteria in human life.	
	i) It cause bacteria	
	ii) It lowers the immunity of the body.	
	iii) It lead to the damage of cells in the body.	

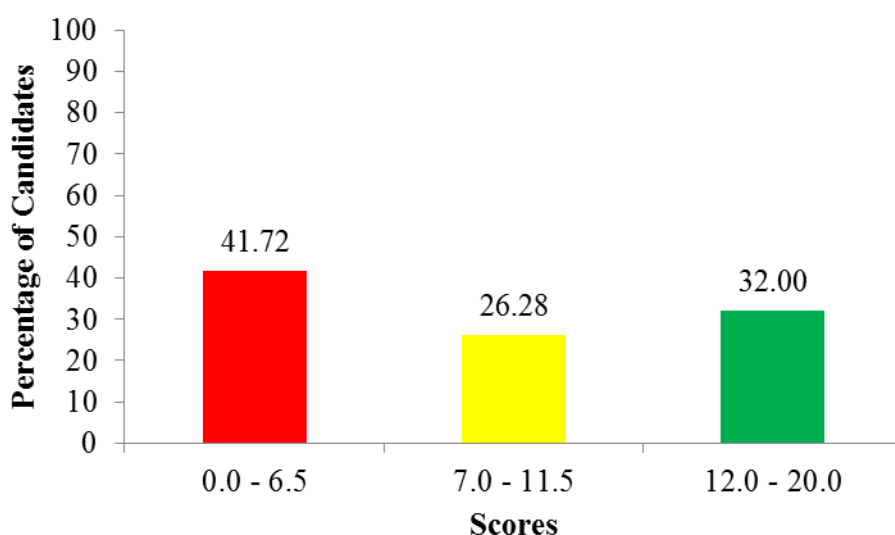
**Extract 12.2:** A sample of incorrect responses to question 1 in paper 2

In Extract 12.2, the candidate outlined the incorrect merits and demerits of bacteria. In addition, he/she presented the responses in point form instead of an essay with introduction, body and conclusion.

### 2.2.2 Question 2: Regulation (Homeostasis)

The question measured the candidates' competence in describing the mechanism of temperature regulation in endotherms. The candidates were given a scenario that "A certain scientist went to the Kalahari Desert with his dog for exploration. Despite the high temperature in the desert, they both survived." Then they were required to elaborate on four adaptive mechanisms that helped the scientist and the dog to survive.

Data show that this question was opted by 35,283 (95.27%) candidates. The analysis shows that 11,292 (32.00%) scored from 12.0 to 20.0 marks, 9,271 (26.28%) scored average marks (7.0 to 11.5), and 14,720 (41.72%) scored low marks (0.0 to 6.5). The candidates' performance on this question was average since 58.28 per cent passed by scoring 7.0 to 20.0 marks. Further analysis of their performance is presented in Figure 13.



**Figure 13:** *Distribution of Candidates' Scores on Question 2*

The candidates who scored high marks (12.0 to 20.0) were conversant with mechanisms for temperature regulation in endotherms. Hence, they correctly described the adaptive mechanisms that helped the scientist and the dog to survive in the desert. These responses indicate good mastery of the topic of regulation, particularly the maintenance of constant body temperature in warm environments. Extract 13.1 is a sample of candidates' correct responses.

2.	Desert is the environment which is known for high temperature hence human being can't survive if they do not have mechanisms for sustaining their body temperature hence a need of human body temperature to help fit in the environment. The following are the mechanisms:-
	<u>Vasodilation of arterioles -</u>
	- This refers to the adaptive mechanism in which the blood vessels next to the skin dilate, meaning that their diameters increase hence causing the blood flow to be very near to the skin this enable the organisms to lose a lot of heat to the surrounding through radiation.
	Hence preventing them from undergoing overheating that may cause various processes in the body to be interrupted. Therefore both the scientist and his dog underwent this adaptive mechanism and survive in the high temperature of the Kalahari desert.

	<u>Decrease in metabolic rates</u>
	Metabolic activities, result to the release of heat or formation of heat in the body of any living organism.
	Decrease in metabolic rates is the adaptive mechanism for both the scientist and the dog in the high temperature climate.
	Where by their metabolic rates take place so slowly that only a small amount of heat is formed in the body. This helps them not to undergo overheating in the hot desert. Hence be able to survive.
	<u>Relaxation of hair erector muscles</u>
	The hair erector muscles are found on the skin next to the skin pores. This is mostly applicable to the scientist.
	Where his hair erector muscles relax, and hair lie flat against the body reducing air trapped by the hair.
	Hence this makes heat to be released outside the body of the organism enabling the scientist and the dog to survive in the hot desert without overheating.

2.	<u>Panting and licking</u>	
	This is the adaptive mechanism for the dog only where cooling by evaporation of water took place from mouth and nose. In this adaptive mechanism, the dog opens its mouth putting its tongue outside.	
	Hence allowing heat to leave its body.	
	But also at the same time some saliva come out hence providing cooling effect for the dog.	
	Also the dog licks some of its body parts leaving saliva on it.	
	As saliva evaporates it provides cooling effect to the dog hence enabling the dog to survive in the hot desert without over heating.	
	The bodies of every organisms have various mechanisms that they can adapt so as to deal with a certain given condition to ensure survival of the organism.	

**Extract 13.1:** A sample of correct responses to question 2 in paper 2

In Extract 13.1, the candidate correctly described the adaptive mechanisms that enabled the scientist and the dog to survive in the desert.

The analysis also revealed that candidates who scored average marks (7.0 - 11.5) were able to mention the mechanisms but provided partial explanations in some points. For example, some of the candidates listed mechanisms of temperature regulation in endotherms such as *vasodilation and relaxation of erector muscles*, without elaboration. Other candidates elaborated on one to two adaptive mechanisms, hence lost some marks.

The analysis further revealed that 41.72 per cent of the candidates scored low marks (0.0 to 6.5) in this question. Most of them demonstrated inadequate knowledge because they provided incorrect responses to elaborate the adaptive mechanisms that helped the dog and the man to survive in the desert. Others failed to understand the question demand and incorrectly gave the mechanism of temperature regulation in cold conditions. For example, one of the candidates wrote, *vasoconstriction, contraction of erector muscles, shivering and increased metabolic rate*. Other candidates explained about *water and food consumption, excretory adaptation, aestivation and torpor*; which are found in other animals

instead of adaptive mechanisms that helped the man and the dog to survive in the desert. Extract 13.2 is a sample of candidates' incorrect responses to the question.

2	Osmoregulation is the maintainance of constant osmotic pressure between the environment and the internal cells of an organism. Osmoregulation is by the hypothalamus. Mammals are usually living in areas that have enough water but on going to arid and semi-arid areas such as deserts they face the problems of dehydration and lack of water. In order to cope up with this problem there are various adaptations they can acquire during their stay in arid and semi arid areas
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2	<p>The following are the adaptations of mammals to arid and semi-arid conditions;</p>	
	<p>They should have long tubules in order to conserve water. In order to survive in the desert much water is required however there is no much water therefore they should have long renal tubules to ensure maximum reabsorption of water in the kidney. Also they should possess long loop of Henles which will enable them to conserve large amount of water that will be used for later use.</p>	
	<p>Should have tissues tolerant to dehydration. Dehydration is the loss of water or presence of little amounts of water. Since there is no water availability in the desert, in order to survive their body tissues should be tolerant to dehydration meaning that they could stay for a long period of time without water. For example: camel can tolerate upto three months without water.</p>	
	<p>Use of the metabolic water. The bodies of mammals have some of metabolic activities that make and produce water as product, when this water is stored it is called metabolic water as it comes from the metabolic activities. This water may come from the respiration activities of lipids especially. Therefore this water can be used to sustain life for some period of time.</p>	
	<p>Should produce non toxic nitrogenous waste <sup>that</sup> does not require much water to excrete. While living in the desert it is necessary to conserve much water therefore they produced non toxic nitrogenous wastes that did not require much water to excrete. This will help to minimize water loss and conserve the water available.</p>	
	<p>Conclusively, by following adaptations the body can be able to survive in diverse conditions and environment but these are maintained by the hypothalamus.</p>	

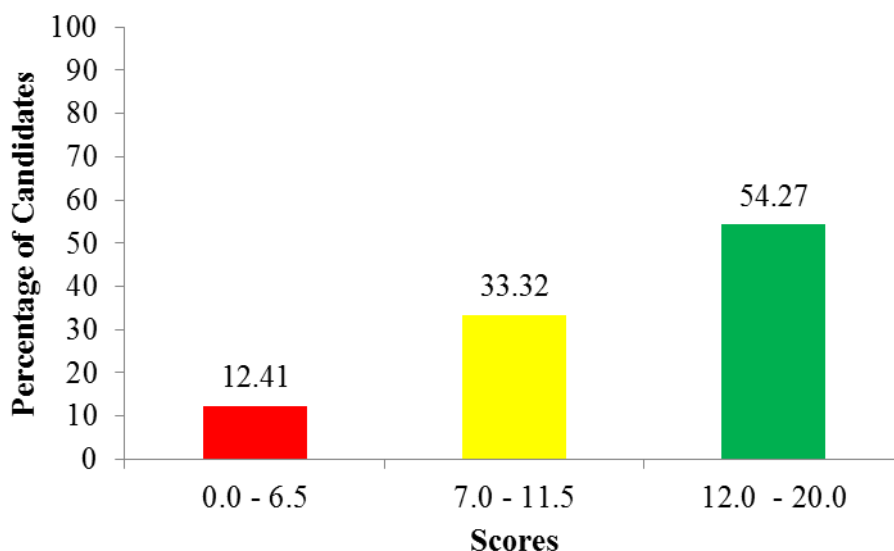
**Extract 13.2:** A sample of incorrect responses to question 2 in paper 2

In Extract 13.2, the candidate wrote about adaptive features for regulating salt and water in the human body. For example, he/she wrote that *they should have long tubules* instead of adaptive mechanisms that helped a man and a dog to survive in the desert areas.

### 2.2.3 Question 3: Growth and Development

The question measured the candidates' competence in describing mitosis and growth patterns. It consisted of parts (a) and (b). In part (a), candidates were required to describe the process of metamorphosis in a housefly. In part (b), they were required to justify the statement that mitosis is a helpful process in multicellular and unicellular organisms.

This question was opted by 35,097 (94.77%) candidates. The analysis shows that 19,047 (54.27%) scored from 12.0 to 20.0 marks, 11,167 (33.32%) scored from 7.0 to 11.5 marks, and 4,883 (12.41%) scored low marks (0.0 to 6.5). The candidates' performance on this question was good since 87.59 per cent passed by scoring 7.0 to 20.0 marks. Figure 14 presents the distribution of the candidates' scores.



**Figure 14:** *Distribution of Candidates' Scores on Question 3*

The candidates who scored high marks (12.0 to 20.0) demonstrated a clear understanding of the process of metamorphosis and mitosis process as well.

They correctly explained the stages of complete metamorphosis as they occur in the housefly. In addition, the candidates were aware of how mitosis supports growth and used the knowledge to correctly assess that mitosis is a helpful process in multicellular and unicellular organisms. In addition, they presented a well-organised essay. Extract 14.1 is a sample of candidates' correct responses to question 3.

3	<p>@ A housefly undergoes complete metamorphosis. Metamorphosis is the process in which an organism undergo various sequential stages of growth from larva or nymph to adult. Metamorphosis describes the life cycle of insects and other animals.</p> <p>Complete metamorphosis is grouped into four growth stages namely:</p> <ul style="list-style-type: none"> <li>- Egg</li> <li>- Larva</li> <li>- Pupa</li> <li>- Adult.</li> </ul> <p>The following are the descriptions of the following stages of the life cycle of the housefly as follows:</p> <p>After mating of the male and female adult houseflies, the female housefly lays its fertilized eggs on mostly dead decaying matter like rotten food materials.</p> <p>Then the eggs hatch to release the larval stage of housefly known as maggots. The maggots undergo an active growth and feeding stage in which they feed on the nutrients from the surroundings where they were hatched.</p> <p>Then after some few days the maggots develop to the pupa stage.</p> <p>In this stage, the organisms tissues are rearranged completely obtaining energy from burning of food eaten during the larval stage. After three to six days an adult housefly emerges from pupa.</p>
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3 (b) Mitosis is a process of cell division in which a diploid cell divides to form identical two daughter cells each with the same number of chromosomes as the parent cell.

Mitosis takes place in multicellular and unicellular organisms for example in the somatic cells of animals and meristems in plants. It is true that mitosis is a very helpful process and its justified as follows:

It is beneficial in the growth process of organisms. In most multicellular organisms, mitosis causes multiplication of cells to form identical daughter cells in which when they accumulate, and cause growth of the organism.

For example in plants, meristematic cells found at the tips of roots and shoot undergo mitosis to result to increase in length of the plant.

Helps in reproduction process in organisms.

Mitosis is significant in asexual reproduction whereby most unicellular and some multicellular organisms undergo division of cells to form their identical offsprings and enhance life continuity.

The reproduction of new organisms utilises mitosis as a form of reproduction.

It is useful in the regeneration of body parts.

Some multicellular organisms have the ability to regenerate organs in which mitosis takes place in their somatic cells to produce similar organ.

For example lizard's tail can be regenerated when cut off.

3	<p>(b) Its useful in maintaining genetic stability of the population.</p>
	<p>Mitosis results to formation of identical daughter cells with same genetic makeup as their parental cells hence very useful to maintain a certain desired trait in an organism or population to its offspring hence maintain genetic stability</p>
	<p>Helps in the healing of wounds and cell replacement        Most multicellular organisms like animals may face injuries which cause impairment in the body but with the help of mitosis the identical copies of the cells lost in the wound can be made to cover up the layer lost and prevent further damage and infections.        For example: Human beings get hurt and cause wounds on various parts of the body and can get healed again.</p>
	<p>Conclusively, as stated above, the process of mitosis has several benefits to both multicellular and unicellular organisms that exist in the ecosystem. Thus the life of these organisms would be impossible if there is no mitosis.</p>

**Extract 14.1:** A sample of correct responses to question 3 in paper 2

In Extract 14.1, the candidate correctly described the complete metamorphosis in the housefly. He/she wrote correctly the stages which occur during metamorphosis. In addition, the candidate gave the correct importance of mitosis.

The candidates who scored average marks (7.0 to 11.5) provided correct responses to some parts. These candidates demonstrated partial knowledge about metamorphosis in houseflies and mitosis, hence lost some marks allotted in that part.

The analysis further indicated that 12.41 per cent of the candidates scored low marks (0 to 6.5) because of insufficient knowledge about the process of metamorphosis and mitosis. In part (a), some of the candidates failed to recognise that the housefly undergoes complete metamorphosis. Consequently, they described the incomplete metamorphosis. Hence, they skipped the larval stage in their description. For example, one of the candidates described the stages as egg, pupa and adult, which is an incorrect process. Other candidates gave an incorrectly sequence of the stages of metamorphosis as *egg, pupa, larva and adult* instead of egg, larva, pupa and adult. In addition, some of the candidates misspelt some of the words, which led to meaningless sentences. For example, one student wrote *tag* instead of egg in the first stage of metamorphosis.

Similarly, in part (b), the candidates gave incorrect responses to the importance of mitosis. For example, one candidate wrote that *mitosis contain hereditary information which pass from one generation to another*. Another candidate wrote that *mitosis help to degenerate parts of the body*. Also, another candidate wrote that, *mitosis is a helpful process in multicellular and unicellular organism that serves as function in the body of an organism*.

Moreover, most of the candidates mistook mitosis for meiosis. Hence, they described the significance of meiosis, such as a *source of genetic variation, reduces number of chromosomes and production of gametes*. Others described stages of mitosis instead of the importance of mitosis in multicellular and unicellular organisms. For example, some candidates described *prophase, metaphase, anaphase, and telophase*. Such incorrect responses indicate that some of the candidates were incompetent on the topic of Growth and Development. Extract 14.2 is a sample of candidates' incorrect responses to the question.

03	<p>g) The process of metamorphosis in housefly          → the housefly it involves three process which          has a incomplete metamorphosis. The following are          the process of the housefly metamorphosis.</p> <p>i) Egg          - In housefly metamorphosis the egg of the first          process and it is the non-feeding.</p> <p>ii) Nymph.          - The housefly metamorphosis it involves the three          process which each stage look differently so it is          independent process. The second process it is Nymph          stage in this process the organism formed it is the          feeding stage.</p> <p>iii) Adult          - The housefly metamorphosis it involves the different          stage or process the last stage is Adult where          by the complete housefly is formed and -          this stage is feeding.</p>	
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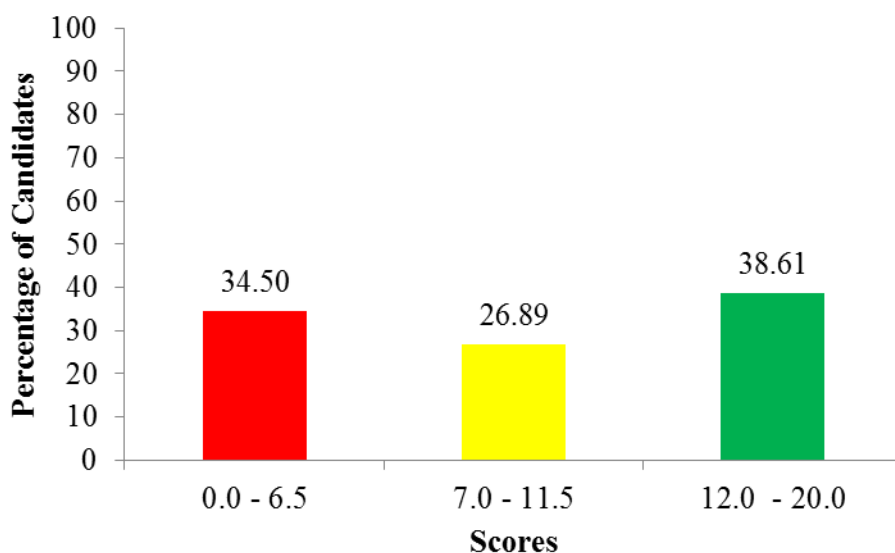
**Extract 14.2:** A sample of incorrect responses to question 3(a) in paper 2

In Extract 14.1, the candidate described incomplete metamorphosis instead of the complete metamorphosis exhibited by the housefly in part (a). Also, he/she wrote incorrect importance of meiosis, such as *it causes genetic variation*, instead of the importance of mitosis in part (b).

#### 2.2.4 Question 4: Genetics

The question measured the candidates' competence in analysing the monohybrid and dihybrid crosses. In this question, the candidates were given a genetic cross between purple flowered plant with short stem and red flowered long stem that produced short purple stem plants in the first filial generation. Test crossing of the individuals in F<sub>1</sub> produced individuals with the ratio of 1:1:1:1. Then, the candidates were required to use appropriate letters to carry out a cross to show the formation of the ratio.

Data show that this question was the least opted, with 27,706 (74.81%) candidates attempting it. The analysis shows that 10,696 (38.61%) scored from 12.0 to 20.0 marks, 7,451 (26.89%) scored average (7.0 to 11.5) marks, and 9,559 (34.50%) scored low marks (0.0 to 6.5). The candidates' performance on this question was average since 65.50 per cent passed by scoring from 7.0 to 20.0 marks. Figure 15 depict the distribution of candidates' scores.



**Figure 15:** *Distribution of Candidates' Scores on Question 4*

The candidates who scored high marks (12.0 - 20.0), most of them showed mastery of Mendelian principle of inheritance particularly in dihybrid crosses. They clearly described how the purple short stemmed plants were produced in the first filial generation. They correctly determined the alleles which influenced the expression of each trait, the actual allele combinations which constitute the genotype of both parents. In addition, the candidates correctly performed genetic crosses, the labels of each cross and interpretations of the results were correct.

Similarly, the analysis indicated that the candidates were aware of the test cross. They correctly used genetic crosses to illustrate the mode of inheritance, which led to the formation of short purple stem plants in  $F_1$  and the ratio of 1:1:1:1 in test crossing the  $F_1$ . This indicated that the candidates were competent in Mendelian principles of inheritance, specifically

dihybrid inheritance. Extract 15.1 is a sample of the candidates' correct responses to question 4.

4.	<p>Given that, the first filial generation had purple short stem plants then the purple short stem plants were dominant over red flowered long plants.</p> <p>Let,  P stand for purple flowered plant  p stand for red flowered plant  T stand for short stem.  t stand for long stem.</p> <p>The genotypes will be PPTT for purple flowered short stem and pptt for red flowered long stem.</p> <p>The cross between purple flowered short stem and red flowered long stem is illustrated below;</p>
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4.	<p>Parental : Purple flowered × red flowered  phenotype : short stem long stem</p> <p>Parental : PPTT × pptt  genotype :</p> <p>meiosis :</p> <p>gametes : <span style="display: inline-block; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">PT</span> <span style="display: inline-block; border: 1px solid black; border-radius: 50%; padding: 2px 5px;">pt</span></p> <p>Random fertilization :</p> <p>F<sub>1</sub> offsprings : PpTt  F<sub>1</sub> phenotype : purple flowered short stem plants</p>
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**Extract 15.1:** A part of a sample of correct responses to question 4 in paper

In Extract 15.1, the candidate used correct letters to present the alleles for dihybrid characters used in genetic crosses. He/she correctly indicated the parental genotype, gametes and finally the fertilization which resulted to the first filial generation.

The candidates who scored average marks (7.0 - 11.5) carried out correct cross to produce  $F_1$  but failed to show the ratio of 1:1:1:1 in test crossing. These candidates failed to recognise the involvement of a recessive parent in a test cross. Consequently, they failed to justify how the ratio of 1:1:1:1 was obtained. However, there were some candidates who made crosses without interpretation of results obtained in the test cross. This justifies that the candidates had partial knowledge about Mendelian principles of inheritance.

Candidates who scored low marks (0.0 - 6.5) either managed to carry one cross and hence scoring a few marks or missed out on all the questions thus scoring 0 mark. Others used correct letters for the alleles but they did not perform crosses. Other candidates failed to use proper letters for the allele to be used in the crosses. Some candidates incorrectly wrote one letter to represent the allele of two characters such as length and colour. These candidates were not aware that a particular character is determined by a specific allele, whose expression influences the observable traits or characteristics of an individual.

Not only that, but also the candidates failed to identify the proper allele for dominant and recessive characters by either writing all capital letters or small letters or interchanging the letters. Consequently, they ended up with incorrect parental genotypes, and the offspring. For example, some of them incorrectly wrote the genotype for a purple-flowered plant with a short stem and red-flowered plant with a long stem in the first filial generation as PpSs and PPSS instead of PPSS and pps. Others incorrectly wrote a single allele in the parental genotype. For example, one candidate crossed *P* with *S*. These candidates were not aware of the Mendel's first law which states that each individual trait is controlled by two factors (alleles) one inherited from each parent. Extract 15.2 is a sample of the candidates' incorrect responses to question 4.

Qn	Qn 04	
4.	Solution	
	The ratio of individual in F <sub>1</sub> generation = 1:1:1:1	
	Let purple flowered plant with short stem be PP red flowered long stem be RR	
	genotype purple flowered plant x Red flowered plant	
	phenotype PP RR	
	meiosis	
	Gametes P P R R	
	Random fertilization	
	F <sub>1</sub> generation PR PR PR PR	
	In the first F <sub>1</sub> generation both are purple short stem plants that PR:PR:PR:PR which its ratio is 1:1:1:1	

**Extract 15.2:** A sample of incorrect responses to question 4 in paper 2

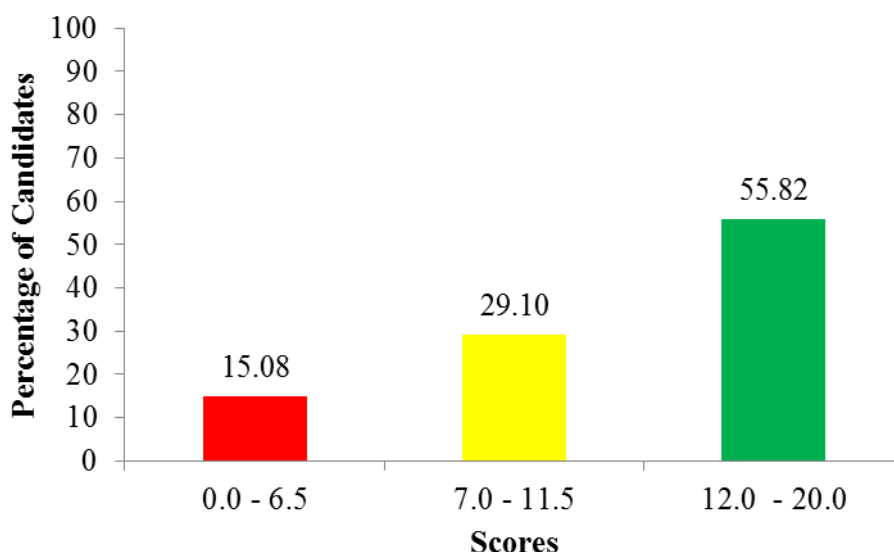
In extract 15.2, the candidate failed to indicate which character was dominant over the other. He/she considered the genotype of both parents to be homozygous dominant such as PP x RR. In addition, the candidate used monohybrid cross instead of dihybrid.

### 2.2.5 Question 5: Ecology

The question measured the candidates' competence in ecological pyramids and their limitation. It required the candidates to justify by giving three advantages and limitations of each type of the ecological pyramids.

The analysis shows that, this question was opted by 31,716 (86.64%) candidates of whom 17,704 (55.82%) of the candidates scored high marks

and ranging from 12.0 to 20.0. The candidates who scored average (7.0 - 11.5) marks, were 9,227 (29.10%), while a few 4,785 (15.08%) of the candidates scored low marks ranging from 0 to 6.5. The candidates' performance in question 5 was good since 84.92 per cent passed by scoring 7.0 to 20.0 marks. Figure 16 summarises the distribution of candidates' scores.



**Figure 16:** *Distribution of Candidates' Scores on Question 5*

The candidates who scored high marks (12.0 to 20.0) correctly analysed the types of ecological pyramids and justified their advantages and limitations to the ecosystem. These responses indicate that the candidates had adequate knowledge about types of ecological pyramids. Extract 16.1 is a sample of the candidates' correct responses to question 5.

5.	<p>Ecological pyramids are the graphical representation that aims to depict the number, biomass and energy of organisms at each trophic level. In the three types of ecological pyramids there are having their advantages and limitations as follows;</p> <p>Pyramid of number is the graphical representation depicting the total number of individuals at each trophic level. The following are the advantages of the pyramid of number.</p> <p>The collection of data is simple; Data collected for the pyramid of number is very simple and environmental friendly.</p> <p>It is cheap in terms of resources and time; Since it does not involve complex issues pyramid of numbers can be obtained quickly even with minimal work force or labour, at short period of time.</p> <p>The data collection for the drawing can be easily done by using simple sampling techniques without killing any organisms.</p> <p>The following are the limitations of pyramid of numbers;</p> <p>It does not consider the size of the organisms. The</p>
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5 pyramid of numbers only consider the number of individual and ignores the sizes of the organisms involved.

It ignores the juveniles and immature forms that may have ecological value. The pyramid of numbers tends to ignore the number of young organisms rather considers only adults leaving behind some ecological values.

For the trophic levels having very large number of organisms it may be impossible to depict the exact value through the scaling that is used to draw the pyramid of numbers.

Pyramid of biomass is the graphical representation depicting the total biomass of individual at each trophic level. The following are the advantages of pyramid of biomass;

It considers the size of the organisms available. To solve the problem in pyramid of numbers, pyramid of biomass consider the size of the organisms at that trophic level.

It is more accurate. Pyramid of biomass is more accurate because it involves drying the organisms and obtaining dry mass that is not affected by water contents of the body.

It provides a more detailed information about a particular trophic level. Through the pyramid of biomass more detailed information about a trophic level may be obtained such as dry mass rather than only obtaining the number.

The following are the limitations of pyramid of biomass

The method used is destructive; in order to obtain data for pyramid of biomass it involves killing

5	of organisms then drying them in order to obtain dry mass hence it is environmental unfriendly.	
	It may not depict reality because not all the organisms can be included. The data from pyramid of biomass contain much approximation since only few organisms were involved in the sample hence does not depict the reality of a particular trophic level.	
	The data may be affected if it will be collected at different seasons therefore seasoning bias the data. This is because if data are taken during dry conditions and some taken during rainy seasons the combination won't depict reality.	
	Pyramid of energy is the graphical representation depicting the energy of organisms at each trophic level. The following are the advantages of pyramid of energy:	
	It considers the rate of production per unit area.	
	Pyramid of energy considers the rate of production per unit area or volume unlike pyramid of biomass and number.	
	It is dynamic. Pyramid of energy is dynamic because it can accommodate changes such as input of solar energy.	
	It is less susceptible to errors hence very accurate.	
	The pyramid of energy shows the flow of energy in the ecosystem therefore it is very accurate.	
	The following are the limitations of pyramid of energy;	

5	<p>It is destructive; In order to obtain data it involves killing of organisms rendering it unfriendly and destructive to the ecosystem.</p> <p>Not all organisms will be included in the experiments therefore it may not depict the exact truth about each trophic level since it is not possible to kill all organisms for the experiments to be done.</p> <p>It is expensive as it requires tools and skills to construct and interpret. Pyramids of energy are tedious in terms of collection of data, labourious in terms of calculations and requires much skills in order to obtain required information.</p> <p>Conclusively, no single type of ecological pyramid is perfect on its own therefore in order to obtain accurate information concerning particular trophic level, consideration must be done to all the ecological pyramids as the limitations shown by one pyramid are solved by another pyramid.</p>
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**Extract 16.1:** A sample of correct responses to question 6 in paper 2

In Extract 16.1, the candidate provided the correct advantages and limitations of the pyramid of numbers, pyramid of biomass and pyramid of energy.

The candidates who scored average marks (7.0 - 11.5) described correctly one to two ecological pyramids. Some of them correctly described the advantages of the pyramids but failed to state their limitations. Others wrote correct limitations of the pyramids but failed to give the correct advantages.

On the other hand, the candidates who scored low marks (0.0 - 6.5), some of them listed the types of the ecological pyramids without explaining their advantages and their limitations. Others gave irrelevant introduction with incorrect advantages and limitations while others gave partial descriptions of the advantages and limitations of the pyramids.

Some of the candidates mixed up the advantages and limitations of ecological pyramids. For example, one candidate wrote the limitation of the pyramid of energy such as *it is expensive in terms of materials and skilled personnel, involves killing of organism* as the limitations of pyramid of number. Other candidates wrote the advantage of pyramid of number such as, *data collection is easily done by using simple sampling techniques and organism killing are safe*, as the advantage of pyramid of biomass. Extract 16.2 is a sample of the candidates' incorrect responses to question 5.

5:	i) <u>Primary ecological pyramid.</u>	
	This is the first ecological pyramid, which show how energy flow from the bottom to top, with decreasing in number of organisms.	
	<u>Advantages of primary ecological pyramid.</u>	
	i) Help to show energy flow from primary producer to the consumers.	
	ii) Help to ensure the presence of all organisms required for ecological succession to be available, since is the first ecological pyramid.	
	iii) It can be easily interpreted.	
	<u>Disadvantages of primary ecological pyramid.</u>	
	i) It leads to loss of much energy on the environment.	
	ii) It is very difficult to acquire and reach a conclusion.	
	iii) poor population control.	

5.	ii) <u>Secondary ecological pyramid:</u>	
	This is the type of ecological pyramid which shows that the energy of the consumer is large compared to the energy of the producers	
	<u>Advantages of secondary ecological pyramid:</u>	
	i) This ensure the proper use of resources on the environment.	
	ii) This means that there will be no, high energy wasted among the organisms.	
	iii) It help to show that there is good maintenance of resource for the future generation.	
	<u>Disadvantages of secondary ecological pyramid:</u>	
	i) It shows there is death of many organisms, because producers are few than the consumers.	
	ii) Leads to loss of population increase on the environment, and over utilization of resources.	
	iii) It is very difficult to control.	

5.	<p>ii) Tertiary ecological pyramid.</p> <p>This is the ecological pyramid which shows that the number of producers is equal to the number of consumer. whereby bacteria act as decomposer.</p> <p>Advantages of tertiary ecological pyramid.</p> <p>i) Ensures chance of survival, since producers are large in number.</p> <p>ii) It is very successfully to meet the needs of the future generation.</p> <p>iii) This supports population increase on the environment.</p> <p>Disadvantages of tertiary ecological pyramid.</p> <p>j) Can lead to misuse of resources, since are present in plenty quantity, people tend to use it bad.</p> <p>ii) May lead to harmful conditions, like lions will kill many antelopes on the environment.</p> <p>iii) Presence of many producers and resources leads to population explosion.</p>	
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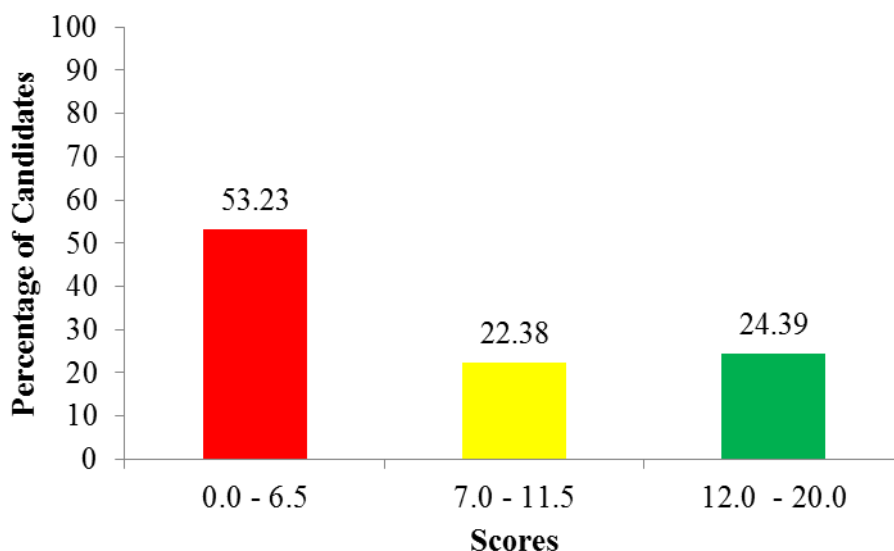
**Extract 16.2:** A sample of incorrect responses to question 5 in paper 2

In extract 16.2, the candidate described the advantages and limitations of trophic levels such as primary, secondary, and tertiary, instead of ecological pyramids.

## 2.2.6 Question 6: Organic Evolution

The question measured the candidates' competence in describing the types of fossils. The candidates were required to describe the formation of the following types of fossils: coprolite, compressed and carbonised plant fossils, imprints, mould and casts, and entire organisms. In addition, they were required to give an example for each type of fossil.

The question was opted by 18,649 (49.64%) candidates. The analysis shows that 4,548 (24.39%) of the candidates scored high marks (12.0 to 20.0), out of whom 2,192 per cent scored 0 marks. The candidates who scored average marks (7.0 to 11.5) were 4,174 (22.38%), and 9,927 (53.23%) scored low marks (0.0 to 6.5) marks. The performance in this question was average because 46.77 per cent of the candidates passed scoring 7.0 to 20.0 marks. Further analysis of the candidates' performance is shown in Figure 17.



**Figure 17:** *Distribution of Candidates' Scores on Question 6*

The candidates who scored high marks (12.0 to 20.0) provided most or all correct descriptions about the formation of the provided types of fossils and gave relevant examples of each type. These responses indicate that the candidates had adequate knowledge about the formation of the various types of fossils. Extract 17.1 is a sample of the candidates' correct responses to the question.

6. The formation of types of fossil and their examples:

(a) Coprolites:

These are faecal pellets that are formed after prevented from decomposing and later get compressed in sedimentary rocks. They often contain some evidence of the food eaten. The example for this is Cenozoic mammalian faecal remains.

(b) Compressed and carbonised plant fossil  
These are fossil which are formed when air is in the plant cell are leached out and the remaining matter is reduced to the carbon film. The plants have an inner structure of rigid organic walls which may be preserved in this manner, revealing the framework of the original cell. The plants are often fossilized through carbonization. Example is a coal.

(c) Imprints; This are fossils in the form of footprints, trails, tracks and tunnels of different organisms in mud that are baked and filled with sand and covered further sediments. For example is footprints of dinosaurs.

(d) Mould and casts; This is formed when organisms buried in sediments slowly decompose and dissolve away leaving a cavity or mould that contain exact imprints of the organisms, shape and size. When this hollow space

6. (d) is filled with sediment. If the slope of the mould forming a cast-fossil, may show characteristics of the original organism or part of the body of an organism as organic material remains in the cast. For example are the pith cast of the calamites, located in west Virginia and the casts of footprints in Laetoli site near Olduvai Gorge in Tanzania.
(e) Entire organism; in this type of fossil the entire organism is preserved. The preserving material can be resin, amber, tar, or peeps. Examples include insects trapped in tree resin (amber) and woolly mammoth found in Siberia.

**Extract 17.1:** A sample of correct responses to question 6 in paper 2

In extract 17.1, the candidate gave correct description of the provided types of fossils and gave one example for each.

The analysis revealed that 22.38 per cent of the candidates who scored average marks (7.0 to 11.5) gave some clear descriptions of formation of two to three provided types of fossils. Most of them were able to explain correctly the formation of coprolite and entire organism fossils compared to other types of fossils. Other candidates failed to give examples.

Further analysis indicates that, 53.23 per cent of the candidates who scored low marks (0.0 to 6.5) either lacked knowledge or had inadequate knowledge about formation of fossils. They incorrectly described other concepts related to organic evolution such as adaptation and speciation. For example, one of the candidates wrote the idea of speciation that *compressed and carbonized plant fossils as formed through one species which splits into two or more separate species due to geographical isolation*. These candidates lacked understanding that fossils are remains or traces or imprint of ancient plants and animals that lived millions of years ago.

Other candidates scored low marks because they had insufficient knowledge about the formation of fossils. They wrote correct explanation about the formation of fossils, in the wrong types of fossils. For example, one of the candidates wrote the correct point for imprint in place of mould, or casts, which *are fossils that are formed by footprints and trails of different organisms in mud and baked and filled with sand and covered by further sediments*. This response shows that the candidates mixed the description about the formation of the different types of fossils.

Moreover, some of the candidates provided irrelevant information about the formation of fossils. For example, some of them wrote that *coprolite is a kind of fossil whereby remains are fossilised by presence of chemical reacting over a long period of time*. Another candidate explained *coprolite as the facial remains of an organism where some parts of an organism do not decompose but remain such as the skull*. There were candidates who explained mould and casts *as they had skeleton of the organism that the moulds remain and they do not fossilise, example include skeleton and bones*. This shows that, these candidates were not conversant with the formation of various types of fossils. Extract 17.2 is a sample of the candidates' incorrect response to the question.

6.	a) coprolite; these are fossils in which the soft body parts of organism remain are mixed up with the sedimentary rocks example bones.	
	b) compressed and carbonized plant fossils; these are fossils which are preserved by the carbons which makes them stay longer and hence are very compressed to each other which involves plants such as leaves.	
	c) Imprints; these are fossils which are filled in the empty space of moulds after they are carried away. such as leaves.	
	d) Moulds and cast; These are fossils which they are carried away by soil erosion leaving the space empty that is mould and the cast is <sup>the</sup> filled mould by the imprints.	
	e) Entire organisms; Are fossils which originate from the outer parts of the organisms such as shell of different organism.	

**Extract 17.2:** A sample of incorrect responses to question 6 in paper 2

In Extract 17.2, the candidate gave incorrect information about formation of fossils. For example, he/she wrote moulds and casts fossils *are those carried away by soil erosion leaving the space empty*. In addition, the examples given by the candidate were incorrect.

### 2.3 133/3 Biology 3

The 133/3 Biology 3 was a practical examination with three alternative papers, namely 133/3A Biology 3A, 133/3B Biology 3B and 133/3C Biology 3C. Each candidate was required to attempt one of these alternatives. Each alternative paper comprised of three (3) questions. Questions 1 and 3 were set from the topic of Comparative Studies of Natural Groups of Organisms, whereas question 2 was set from the topic of Cytology. Question 1 carried twenty (20) marks while question 2 and 3

carried fifteen (15) marks each. The pass mark for question 1 was from 7.0 to 20 marks while for questions 2 and 3, it was 5.5 to 15 marks. The analysis of the candidates' performance in Biology 3 starts with question 1 for all three alternative papers, followed by question 2, and finally question 3.

### **2.3.1 Question 1: Comparative Studies of Natural Groups of Organisms**

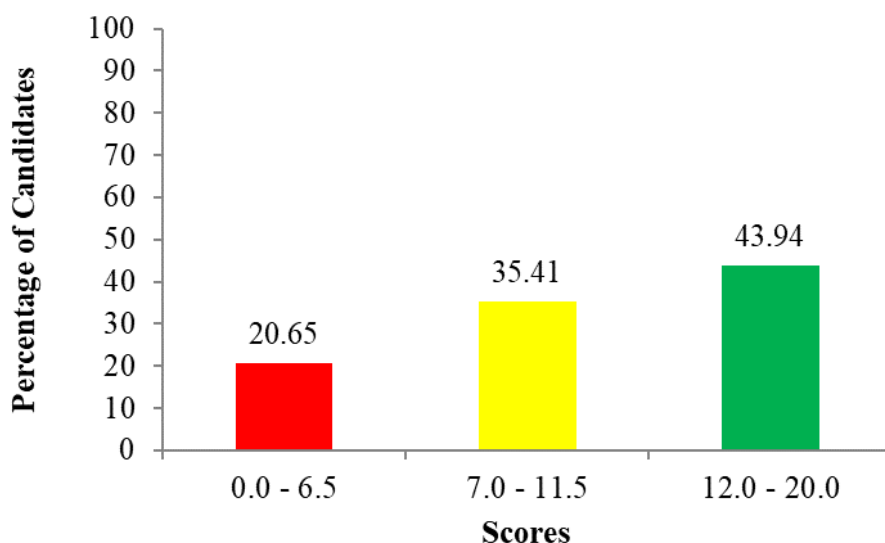
The question measured the candidates' competence in dissections of arthropods, small mammals and amphibians to display various systems. Specifically, in Biology 3A, the candidates were provided with specimen C<sub>1</sub> (rat/ mouse/guinea pig) and instructed to dissect it and display the viscera *in situ*. Then, in part (a), the candidates were required to draw a diagram of the dissected specimen and label ten parts. In part (b) (i) they were also required to identify two associated organs attached to the digestive system of specimen C<sub>1</sub> and in (b) (ii) to suggest one role played by each organ identified in (b) (i). In addition, in part (c), the candidates were required to draw the digestive system of specimen C<sub>1</sub> and label its main parts and the associated organs. In part (d) (i), they were required to identify the structure responsible for the deamination in specimen C<sub>1</sub> and in (d) (ii), they were required to give the other two functions performed by the structure named in (d) (i).

In Biology 3B, the candidates were provided with specimen Q (cockroach) and required to dissect it and display the digestive system to their right-hand. In part (a), they were required to draw a neat diagram of the dissected specimen and label ten parts. In part (b), the candidates were required to provide two functions performed by (i) the fore gut and (ii) the mid gut of the digestive system. In part (c), the candidates were required to explain briefly why the hind gut must remain intact in the lifespan of the cockroach. In part (d), the candidates were required to explain one advantage and disadvantage of cockroaches to human beings.

In Biology 3C, the candidates were provided with specimen R (frog/toad) and required to dissect it to display the viscera general and pin the digestive system to the right-hand side of the candidate. In part (a), the candidates were required to draw a neat diagram of the dissected specimen and label ten parts. In part (b), the candidates were required to carefully observe the

dissection and then provide one function of two parts which make up (i) the urinogenital and (ii) the digestive systems in frog while in part (c), the candidates were required to account for four features which enable frog to survive in its habitat.

A total of 37,027 (100%) candidates attempted question 1 in either alternative 3A, 3B or 3C. The analysis shows that 16,269 (43.94%) scored from 12.0 to 20.0 marks, 13,112 (35.41%) scored from 7.0 to 11.5 marks, and 7,646 (20.65%) scored low marks (0.0 to 6.5). The candidates' performance on this question was good since about three quarters (79.35%) passed by scoring 7.0 to 20.0 marks. Further analysis of the candidates' performance is shown in Figure 18.

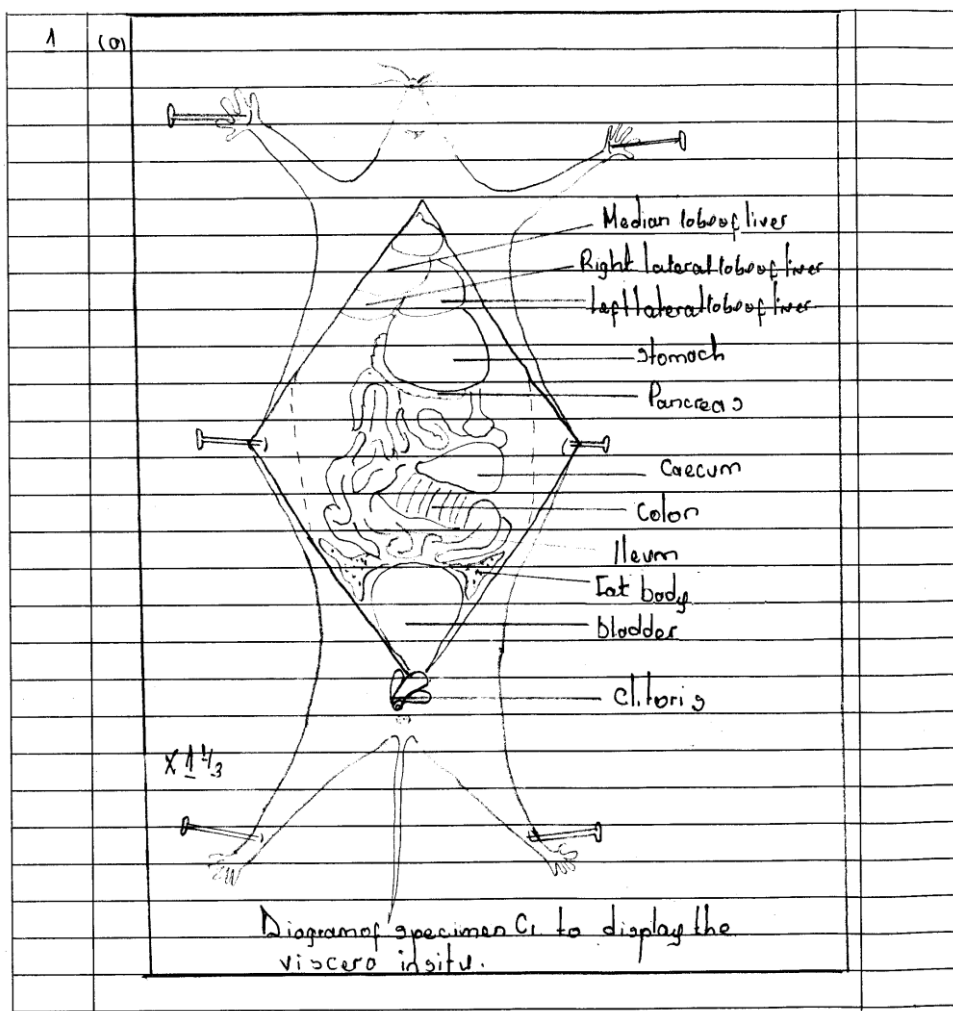


**Figure 18:** *Distribution of Candidates' Scores on Question 1*

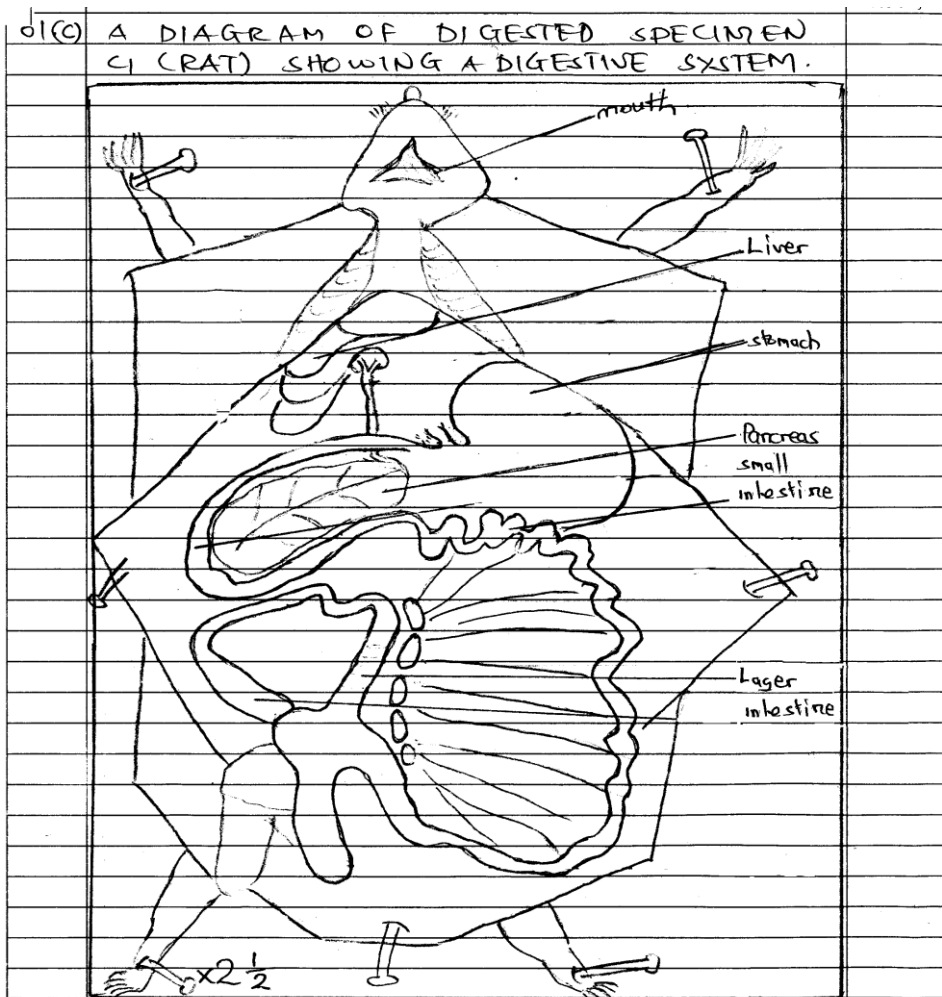
The candidates who scored high marks (12.0 to 20.0) in all the three alternatives, 3A, 3B, and 3C, were conversant with dissection, particularly of small mammals, arthropods, and frogs, as they displayed the required systems correctly. Also, the candidates demonstrated skilful drawings of the dissected specimens which earned them all the 5 marks allocated to the on-spot assessment.

The analysis of the candidates' responses in Biology 3A shows that the candidates who scored high marks (12.0 to 20.0) demonstrated mastery of dissection of rat/mouse/guinea pig to display the viscera *in situ* correctly.

In part (a), the candidates drew a diagram of the dissection and labelled correctly. In addition, the caption and magnification were appropriate to the diagrams. Also, they correctly identified the two associated organs attached to the digestive system of rat/mouse and suggested the digestive role played by each associated organ in part b (i) and b (ii), respectively. Additionally, the candidates demonstrated a skillful drawing of the digestive system and correctly labelled its main parts and the two associated organs in part (c). Moreover, the candidates recognised the role of the liver that it is involved in deamination in rats in part (d) (i) and provided other two correct functions of the liver in part (d) (ii). Extract 18.1(a) is a sample of correct responses from one of the candidates.



1.	(b) (i) The two parts are which are associate are:	
	→ Pancreas	
	→ Liver	
	(ii) <u>Liver</u>	
	→ It produces bile which is essential in emulsifying fats into fatty acids and glycerol	
	<u>Pancreas</u>	
	→ It produces pancreatic juice which contain enzymes like pancreatic amylase, lipase for digestion of starch and fats respectively in the digestion process	
	(d) (i) Structure responsible for deamination is	
	<u>Liver</u> .	
	(ii) Other functions performed by liver are like:	
	→ Breakdown of dead red blood cells from the blood and to be removed from the blood. (scrap out cells from the blood removal)	
	→ Production of bile which aid in digestion of fats into fatty acids and glycerol.	

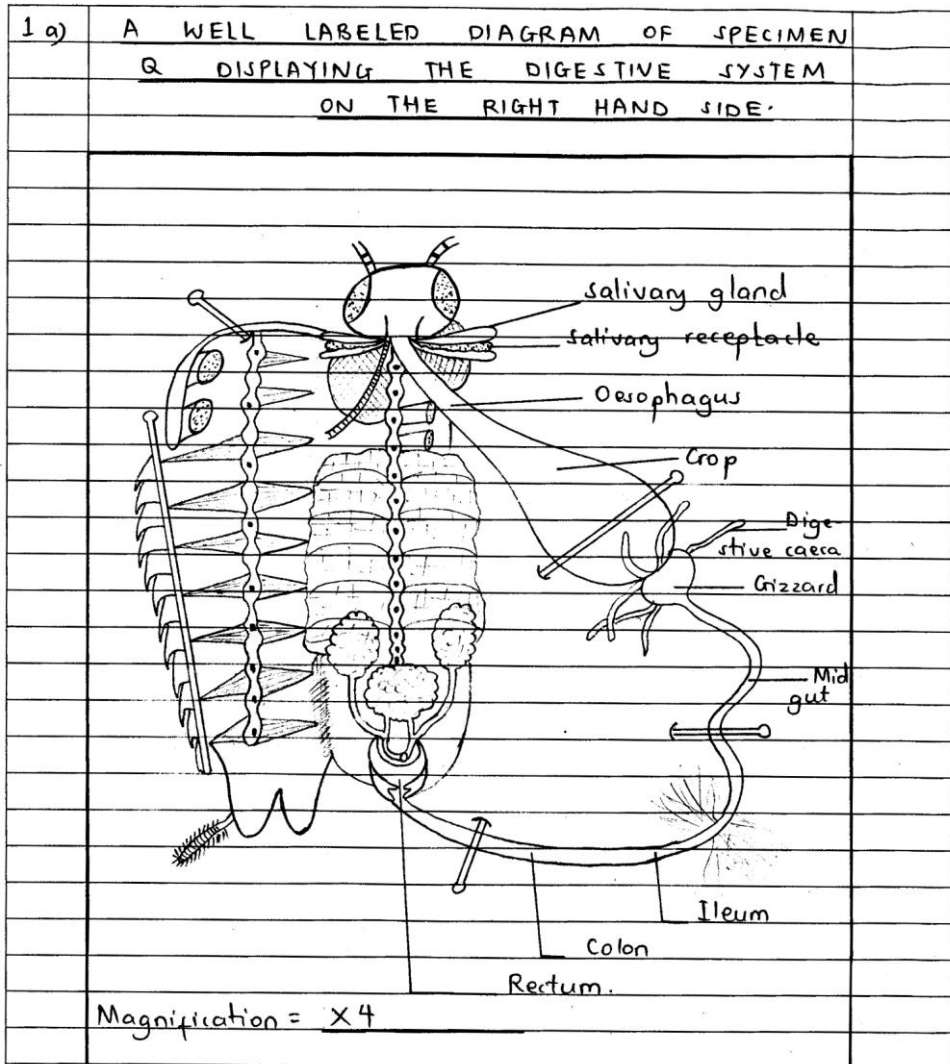


**Extract 18.1 (a):** A sample of correct responses to question 1 in paper 3A

In Extract 18.1 (a), the candidate drew a neat labelled diagram of a dissected rat in parts (a) and (c). Also, he/she gave correct responses in all parts of the question.

The analysis of the candidates' responses in Biology 3B reveals that the candidates who scored 12.0 to 20.0 marks demonstrated mastery of the dissection of the cockroach and displayed the digestive system to their right hand side. They drew the diagram of the dissected specimen and correctly labelled ten parts. The caption and magnification were relevant to the diagram. In addition, they were aware of the parts which comprise the foregut and midgut of the digestive system and gave the correct functions

performed by these parts in the cockroach. In addition, they provided correct reasons why the hindgut must remain intact in the lifespan of the cockroach. Moreover, the candidates demonstrated an understanding of the economic importance of cockroaches to human beings and therefore, provided its correct advantage and disadvantage. Extract 18.1(b) is a sample of correct responses from one of the candidates.



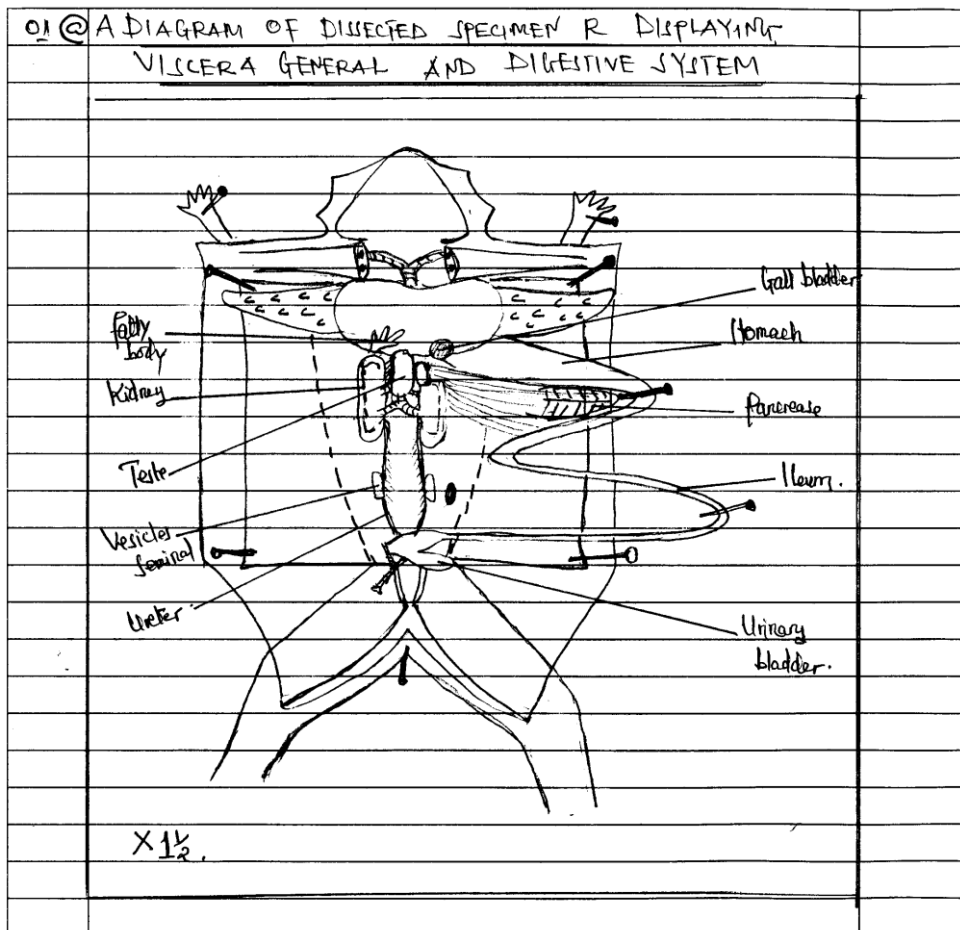
1b i)	due to presence of pharynx - Aids in mixing of food and saliva Crop - helps in temporary storage of ingested food	
ii)	MID GUT <u>Digestive caecum</u> - It helps in the absorption of food substance in the body.	
	<u>Mesenteron</u> - It aids in completion of chemical digestion.	
c)	The hind gut contains the <u>colon</u> and <u>rectum</u> . - They are responsible for absorption of water, salts. - They are also attached to <u>malphigian tube</u> helping in the passage of waste.	
d)	<u>Advantages</u> . - It helps in <u>biological research</u> and experiments.	
	<u>Disadvantages</u> . - It is a <u>vector of diseases</u> .	

**Extract 18.1 (b):** A sample of correct responses to question 1 in paper 3B

In Extract 18.1 (b), the candidate drew a neat labelled diagram of a dissected cockroach and gave the functions of the digestive parts and the economic importance of cockroaches to human beings. He/she gave the correct caption and magnification.

Likewise, in Biology 3C, the candidates who got high scores (12.0 - 20.0) demonstrated mastery of the dissection of the frog/toad and correctly displayed the viscera general with the digestive system pinned to their right hand side. They drew the diagram of a dissected frog/toad with relevant captions and magnification, and correctly labelled the required ten parts in part (a). In addition, they were aware of the parts that constitute the

urinogenital and the digestive systems in frog/toad, and provided two correct functions performed by those parts of the systems. Moreover, the candidates demonstrated an understanding of the habitat of frog/toad and correctly gave four features which enable the frog to survive in its habitats. Extract 18.1 (c) is a sample of candidates' correct responses to this question.



1(b)	(i) parts which make up the urinogenital system.
	(a) <u>Kidney</u> .
	- Kidney is concerned with the filtration and removal of <del>excess</del> excretory waste.
	(b) <u>ureters</u> .
	- It is responsible for the transportation of excretory products from the kidney to the bladder.
	(ii) parts which make up the digestive system.
	(a) <u>stomach</u> .
	- stomach acts as the temporary storage of food substances.
	(b) <u>Ileum</u> .
	- Ileum possess microvilli which are responsible for absorption of nutrients.
(c)	Habitat for specimen R are both Aquatic and terrestrial habitats.
	- The following are the features that enable specimen R to survive in its habitat.
	(i) specimen R have webbed feet for swimming (when in water).
	(ii) specimen R have protruding eyes for binocular vision.
1(c)	(iii) Have lungs for gaseous exchange.
	(iv) Specimen R have long and strong legs for jumping.

Extract 18.1 (c): A sample of correct responses to question 1 in paper 3C

In Extract 18.1 (c), the candidate drew a correct diagram of a dissected frog/toad displaying the viscera general with a digestive system displayed to the right hand side. In addition, the labelling, caption, and magnification were correct. Moreover, the responses in other parts of the question were correctly presented.

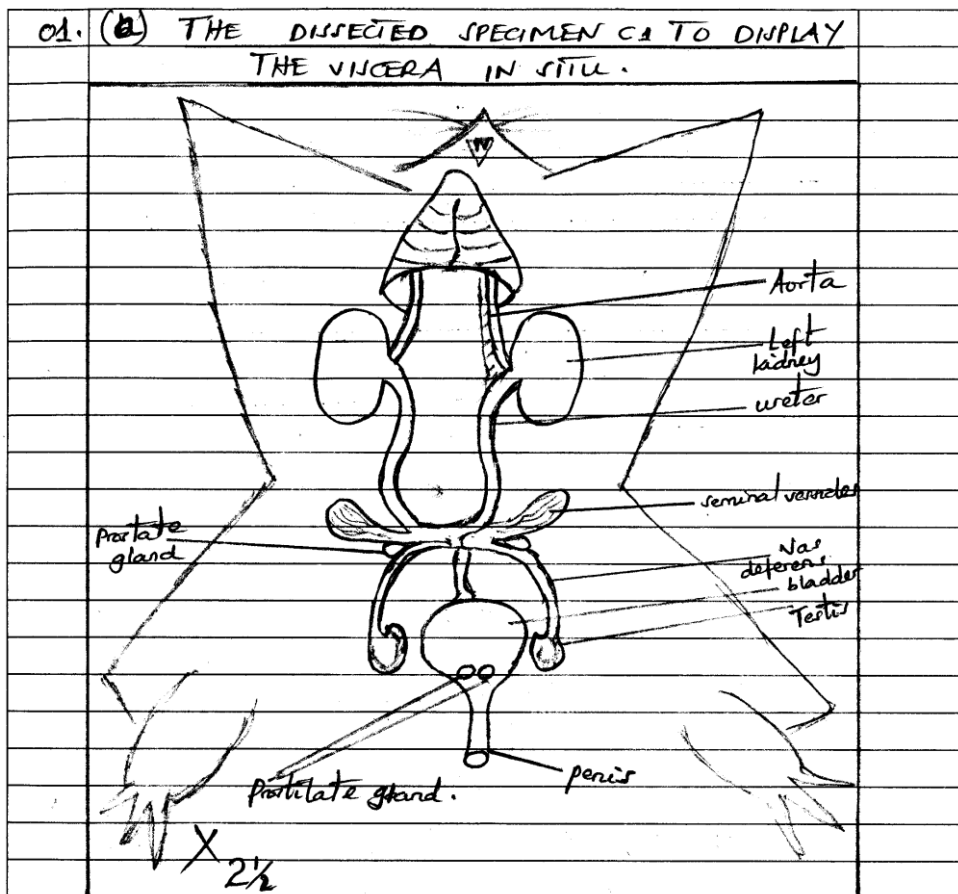
Despite the good performance of the majority of candidates in question 1 of the alternatives 3A, 3B and 3C, about 20.65% of the candidates got low scores ranging from 0.0 to 6.5 marks. The analysis shows that weak performance was attributed to insufficient skills in the dissection of arthropods, small mammals and amphibians to display the required systems. Some of the candidates failed to perform the correct dissection of the rat, frog and cockroach. Their dissection had some structures either damaged or not displayed.

Some candidates showed a few correct labels of the dissected specimens. Others wrote incorrect labelling or labelled lines crossing each other. In addition, some candidates failed to adhere to the principles of writing captions. For example, some of them wrote the caption above the diagram in capital letters without underlining. Principally, the caption should be written either above the diagram in capital letters and underlined or below the diagram in small letters with the first letter capitalized. Moreover, other candidates wrote an incorrect caption. For example, they wrote that *dissected specimen C<sub>1</sub>, the dissected specimen C<sub>1</sub> to display the viscera in situ, dissected female rat* instead of a diagram of the dissected male/female specimen C<sub>1</sub> (rat/mouse) showing the viscera *in situ*.

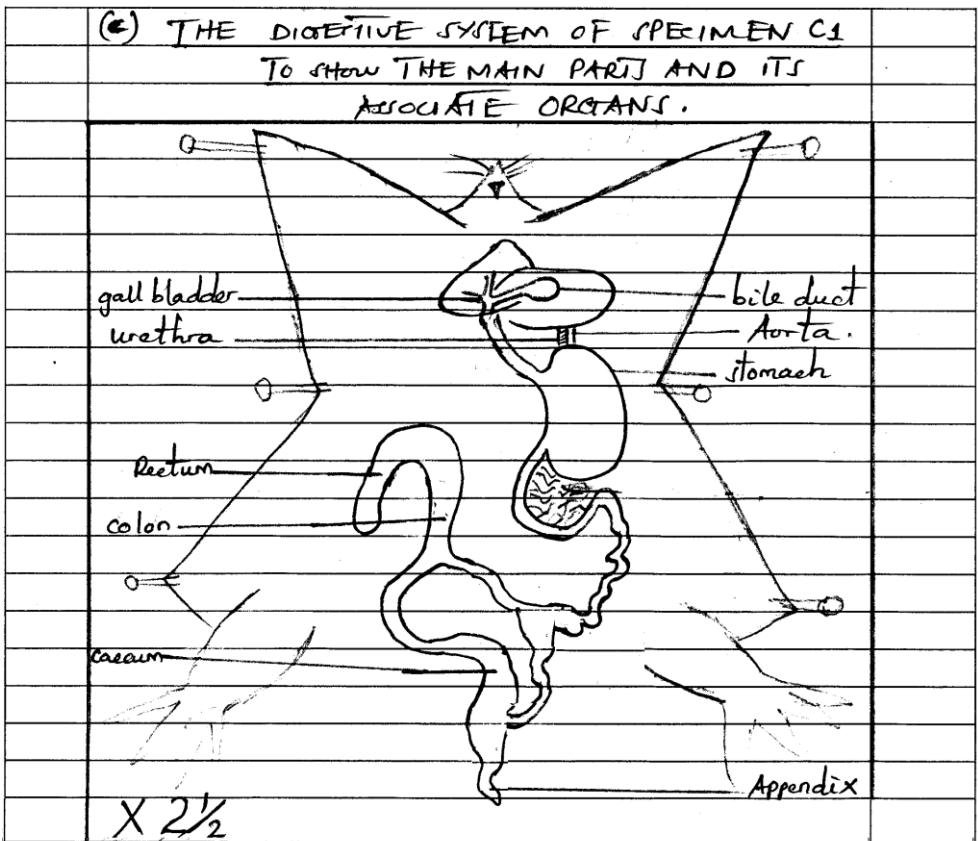
Specifically, in Biology 3A, the candidates who scored low marks (0.0 - 6.5) failed to perform the dissection and/ or drew the diagram improperly. This is because the candidates were not competent in dissection or lacked carefulness and exposed the deeply embedded organs or disturbed the organs and tissues covering them.

Additionally, in part (b) (i) some of the candidates gave incorrect parts of the digestive system such as colon, rectum, and the ileum instead of identifying the associated organs attached to the digestive system of small mammals.

Also, in part b (ii), the candidates failed to provide the correct roles of each associated organ. They wrote incorrect responses related to excretion, respiration, and transportation instead of digestion in rat/mouse/guinea pig. Apart from that, most of the candidates drew an incorrect digestive system in part (c). Some of them drew incomplete diagrams with some parts missing. For example, most of the diagrams did not show the mouth as part of the digestive system, which signifies that the candidates failed to recognise that mechanical digestion starts in the mouth. On top of that, most of the candidates demonstrated a lack of knowledge about the role of the liver in mammals, as they failed to recognise it as the structure responsible for deamination process in (d) (i). Likewise, in (d) (ii), they provided incorrect functions of the liver other than deamination. Extract 18.2 (a) is a sample of the candidates' incorrect responses to the question.



b	- Stomach	
	- Mouth	
i)	Stomach	
	- Storage of ingested food temporary.	
ii)	Mouth	
	- Converting starch into Maltose.	



(d)	ii) Gizzard.	
	ii) - Grinding ingested food.	
	- Increasing surface area for digestion to take place.	

Extract 18.2 (a): A sample of incorrect responses to question 1 in paper 3A

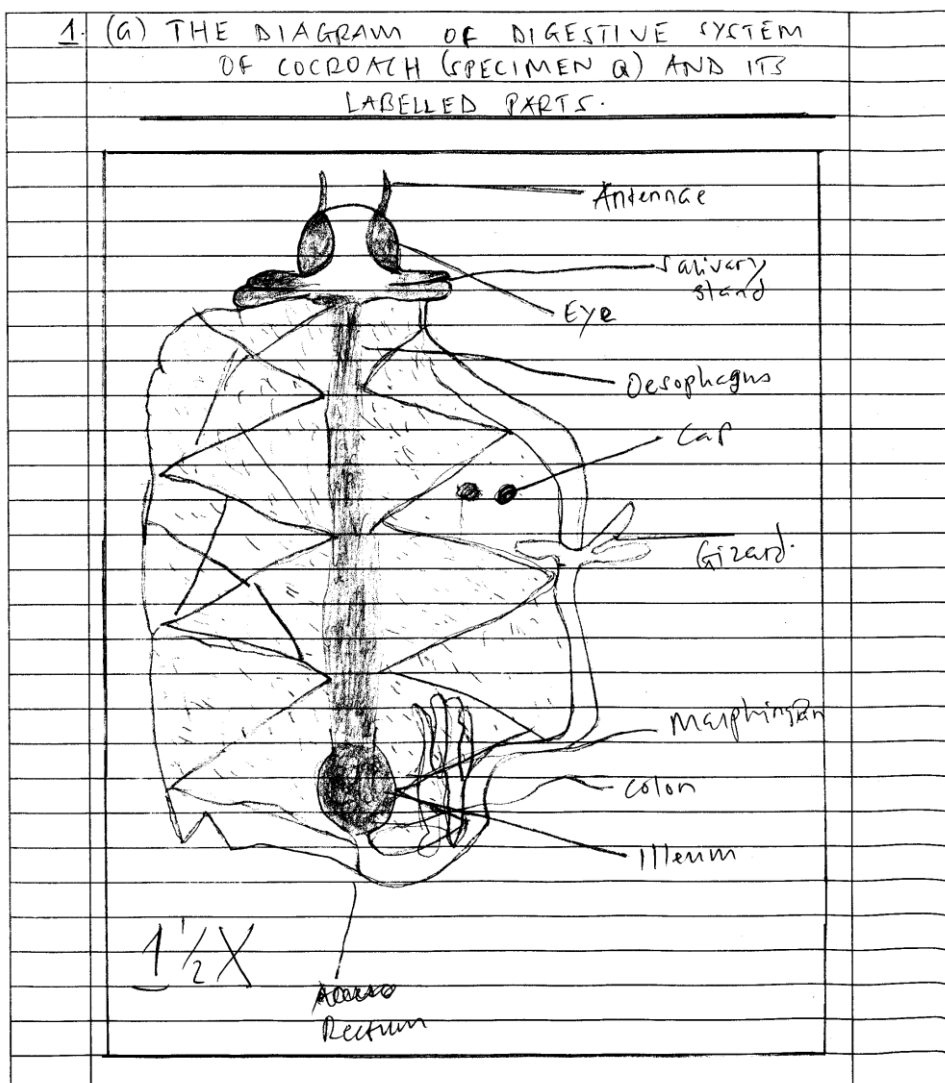
In Extract 18.2 (a), the candidate drew an incorrect diagram of the *viscera insitu* dissection and labelled the parts, such as the kidney, which are not part of the *viscera insitu*. In addition, the candidate provided incorrect associated organs of the digestive system, such as the mouth and stomach, in part (b) and drew an incorrect diagram with incorrect labels of the main parts of the digestive system in part (c). Likewise, in part (d) the candidate gave incorrect functions of the structure responsible for deamination process in rat.

In Biology 3B, the analysis revealed that the low scores were attributed to insufficient skills in dissecting the arthropods, particularly the cockroach, to display the digestive system. The candidates who scored 0 marks failed to perform the dissection required. The analysis further revealed that the candidates who scored from 1.0 to 6.5 failed to correctly dissect the cockroach and drew the diagrams with the digestive system deflected to the right hand side of the specimen instead of the right hand side of the candidate. Additionally, a few labels on the diagram were correct. The incorrect labels include: *digestive caeca* labelled as the *gizzard*, and the *rectum* labelled as the *ileum*. Others wrote incorrect labels which were not part of the digestive system of the cockroach. For example, one of the candidates labelled *stomach*, *mushroom-shaped body*, and *ejaculatory duct*. Moreover, some of the candidates wrote an incorrect magnification of a cockroach such as x5 instead of x3 or x4.

Similarly, in part (b) some of the candidates failed to identify the roles played by digestive parts in cockroach. They either provided incorrect functions or interchanged the functions of the foregut and midgut. The incorrect functions provided for fore gut include *water conservation*, and *reabsorption of water and salt*, which are the functions of the hindgut. The interchanged functions were such as secretion of digestive enzymes in the fore gut, which is the function of the mesenteron found in the midgut. Also, storage of ingested food in midgut, which is the function of the crop found in the foregut.

Moreover, in part (c), the candidate failed to give a correct reason for the hindgut to remain intact in the lifespan of the cockroach. One of the candidates wrote that the role of the foregut in a cockroach, such as *the gut*, *helps storage of digested food*, and *mechanical digestion*. Others provided responses which were about the life cycle of cockroach. For example, one

candidate gave an explanation on the stages of the life cycle of cockroach such as *production of eggs, the larva, pupal and adult stages* and related the feeding habit in those stages to the digestive system. These responses indicate that the candidates were not aware of the significance of the structures of the digestive system in cockroach particularly the hindgut. Similarly, in part (d), some candidates were not aware of the economic importance of cockroaches to human being as they provided incorrect advantages and disadvantages. Extract 18.2 (b) is a part of a sample of candidates' incorrect responses to this question.



1.	(b)(i) foregut	
	comprises of the following.	
	(a) Salivary gland	
	- They secrete salivary amylase for hydrolyzing starch to maltose.	
	(b) Oesophagus.	
	- This is the part of foregut which comprises nervous for opening elastic tube that allow movement of food particles.	
	(ii) Midgut.	
	This is the middle part of the digestive system of cockroach.	
	It include the following.	
	(a) Gizzard.	
	- Site for chemical digestion as there is secretion of chemical enzymes.	
	- For grinding solid food particles.	
	(b) Crop.	
	- It contain hydrochloric acid for killing of bacteria.	

**Extract 18.2 (b):** A part of sample of incorrect responses to question 1 in paper 3B

In Extract 18.2(b), the candidate drew an incorrect diagram with incorrect labels of the digestive system. Also, he/she gave incorrect parts of the foregut and midgut, and their respective functions.

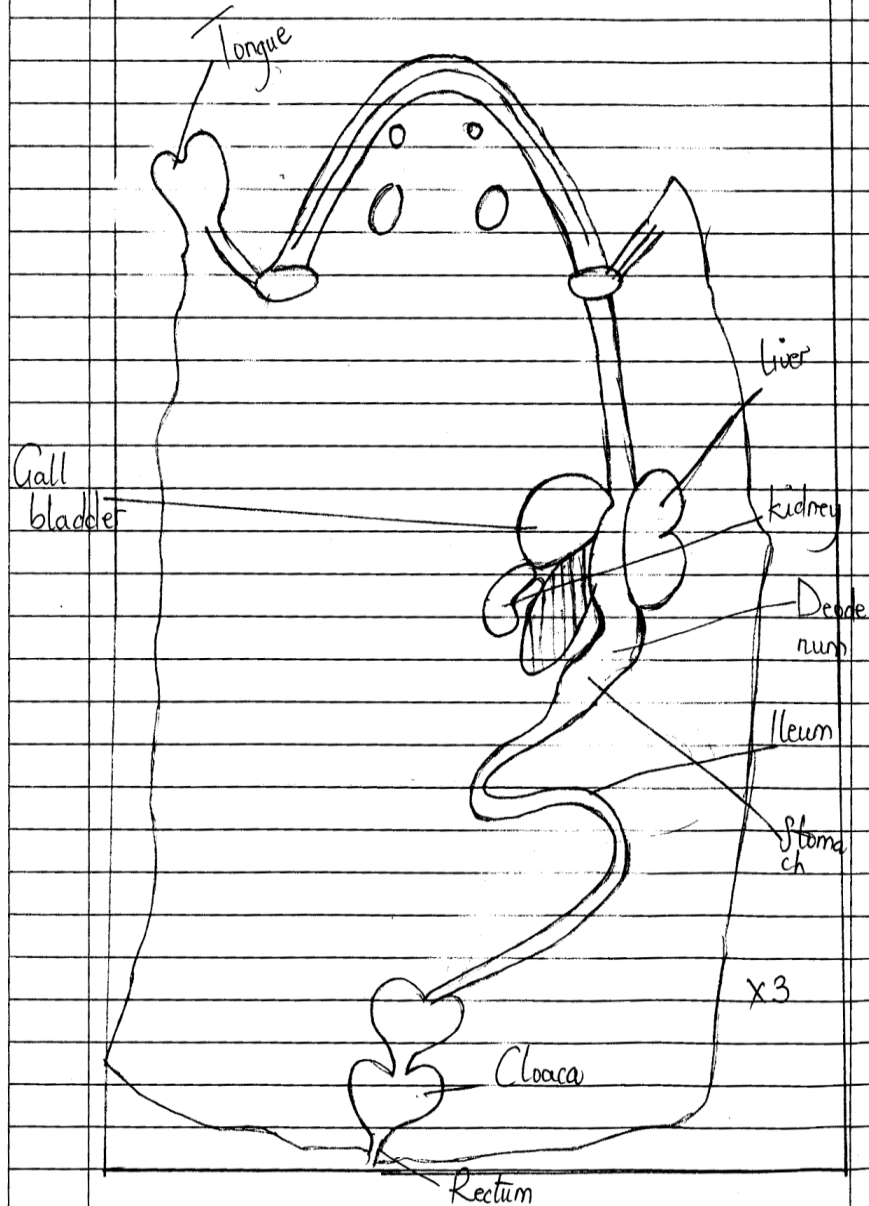
In Biology 3C, the analysis indicated that candidates who scored low marks demonstrated inadequate skills in dissecting a frog/toad. Some of them drew incorrect diagrams with the digestive system deflected to the right hand side of the specimen, contrary to the requirement of the question. Others failed to give a relevant caption and magnification in part (a). Some of the incorrect captions include *the diagram of the dissection of the male frog that show several nerve system* instead of a diagram of a dissected female/male specimen R to show viscera general. Also, some gave either incorrect or a few correct labels. This indicates that the candidates were not

familiar with the general viscera of the frog in part (a). Not only that, but also, in part (b), some candidates were not aware of the parts that compose the urinogenital and digestive systems in frog/toad. They provided incorrect parts of the urinogenital system such as the *penis* and *vagina*.

Moreover, in part (c), the candidates demonstrated a lack of knowledge about the adaptive features of frog/toad that enable it to survive in its habitat. Most of the responses provided by the candidates were partial they stated the structures possessed by the frog, such as *long hind legs*, *protruding eyes*, and *webbed feet*, but failed to explain how those structures enable the frog to survive in its habitat. Others wrote incorrect features, such as *it has compound eyes for seen* and *it has a tongue for touch*. This implies that the candidates were not competent in adaptations of frog to its habitat. Extract 18.2 (c) is a sample of the candidates' incorrect responses to this question.

1a

1. THE DIAGRAM OF THE DISSECTION WHICH SHOW THE VISCERA GENERAL OF SPECIMEN R.



1b	i) Urinogenital system	
	- Rectum : It used to removal of waste from the body	
	- Cloaca : It used to store waste in temporary	
	ii) Digestive system	
	- Stomach	
	It used to store food	
	- Ileum	
	It used for secretion of bile	
1c	The features which enable the specimen R. to survive in its habitat are	
	i) They have legs used for locomotion	
	ii) They have compound eye for vision	
	iii) They have smooth skin	
	iv)	

**Extract 18.2 (c):** A sample of incorrect responses to question 1 in paper 3C

In Extract 18.2(c), the candidate drew an incorrect diagram of the dissected frog/toad to show the visceral general and made incorrect labelling. In addition, he/she incorrectly identified parts of the urinogenital system and the functions of all parts of the urinogenital and digestive systems, as well as incorrectly identified the features that enable the frog to adapt to its habitat.

### 2.3.2 Question 2: Cytology

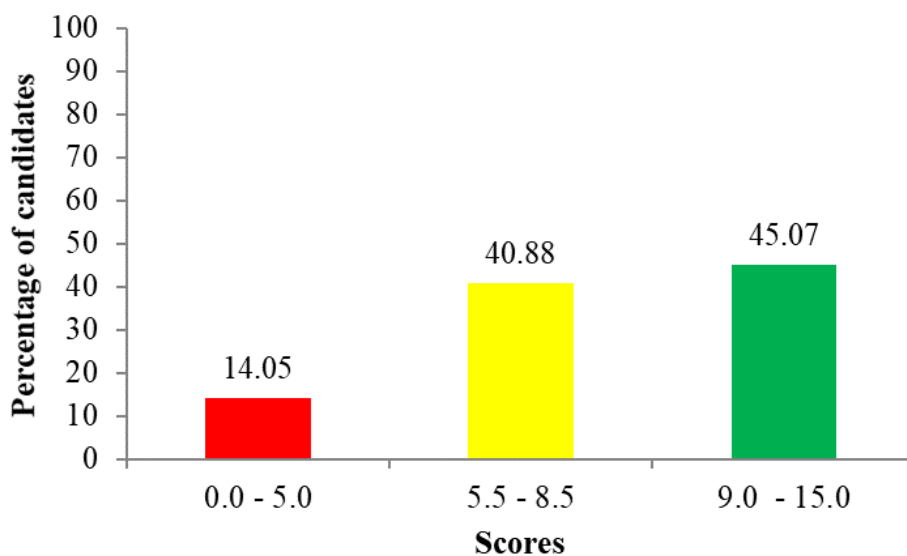
In Biology 3 alternatives A, B and C, the question examined the candidates' competence in carrying out biochemical tests to identify the food substances present in sample solutions. The candidates were provided with the chemical reagents, which were Iodine, Benedict's, Copper II sulphate, Sodium hydroxide, dilute hydrochloric acid and Sudan III solutions. They were also provided with the sample solution containing various food substances. Then candidates were instructed to perform a biochemical experiment to identify the food substances present in those solutions and present an experimental report in a tabular format using the provided format.

In Biology 3A, the candidates were provided with solution P<sub>1</sub>, which contained a mixture of starch and egg albumen. In part (a), the candidates were required to identify the food substances present in P<sub>1</sub> and write an experimental report in a tabular form using the format provided. In part (b), the candidates were asked to suggest two natural sources from which each food substance identified could have been extracted. In part (c), they were required to identify one characteristic of each food substance identified in 2(a). Further, in part (d), the candidates were required to name enzyme and secretion which facilitates the digestion of each food substance identified in 2(a).

Similarly, in Biology 3B the candidates were provided with solution S<sub>1</sub> containing glucose, and solution S<sub>2</sub> containing protein. In part (a), the candidates were required to identify the food substances present in solution S<sub>1</sub> and S<sub>2</sub> and write an experimental report in a tabular form using, format provided. In part (b), they were required to explain the basis of the test for each positive result obtained in 2(a). Also, in part (c) the candidates were required to give reasons why boiling was important in some procedures of the experiment.

In alternative Biology 3C, the candidates were provided with solution S<sub>3</sub> containing a mixture of starch and egg albumen and solution S<sub>4</sub> containing glucose. In part (a), the candidates were required to identify the food substances present in solutions S<sub>3</sub> and S<sub>4</sub> and prepare an experimental report in the provided format. In part (b), the candidates were required to (i) name the enzyme(s) responsible for digestion of the food substance(s) identified in solution S<sub>3</sub>, (ii) provide one environmental condition specific for the named enzyme(s) to work properly in digestion of the food substance(s) identified in solution S<sub>3</sub>.

A total of 37,028 (100%) candidates attempted question 2 in either alternative 3A, 3B or 3C. The analysis shows that 16,690 (45.07%) scored from 9.0 to 15.0 marks, 15,134 (40.88%) scored from 5.5 to 8.5 marks, and 5,204 (14.05%) scored low marks (0.0 to 5.0). The candidates' performance on this question was good since 85.95 per cent passed by scoring 5.5 to 15.0 marks. Further analysis of the candidates' performance is shown in Figure 19.



**Figure 19:** *Distribution of Candidates' Scores on Question 2*

The candidates who scored high marks ranging from 9.0 to 15.0 demonstrated adequate competence in the topic of Cytology tested in all three alternatives 3A, 3B and 3C. These candidates were conversant with biochemical experiments for identification of the food substances present in sample solutions. They demonstrated mastery in using relevant chemicals with accurate measurements in performing food test procedure. Also, they were able to make correct observation and inferences of experiment results and demonstrated their expertise in report writing.

The analysis of the candidates' responses in Biology 3A reveals that 45.07 per cent of the candidates who scored high marks (9 to 15) managed to carry out the food test experiments and critically analyzed the food substances present in solution P<sub>1</sub>. These candidates demonstrated application of correct skills in the investigation of starch, protein, reducing sugar, non-reducing sugar and lipid in the solution P<sub>1</sub>. They used relevant chemicals accurately in respective test and correctly made the observations and inferences which finally revealed that solution P<sub>1</sub> contained starch and protein.

Also, the candidates were aware of the natural sources as they correctly identified various sources of protein and starch. Moreover, the candidates correctly gave the characteristics of protein and carbohydrate.

Additionally, the candidates were conversant with enzymes and secretions which facilitate digestion of protein and starch as they responded correctly. Extract 19.1(a) is a sample of the candidates' correct responses to the question.

Food Tested	Procedure	Observation	Inference
Starch	To 2cm <sup>3</sup> of solution P <sub>1</sub> in a clean and dry test tube, 3 drops of Iodine solution were added and shaken.	The colour of solution P <sub>1</sub> changed to blue-black.	Starch is present in solution P <sub>1</sub> .
Reducing sugar	To 2cm <sup>3</sup> of solution P <sub>1</sub> in a clean and dry test tube 2 ml of Benedict solution was added and then heated until no further colour change.	The solution P <sub>1</sub> retained blue colour of Benedict solution.	Reducing sugar is absent in solution P <sub>1</sub> .
Non-reducing sugar	To 2cm <sup>3</sup> of solution P <sub>1</sub> in a clean and dry test tube, 1cm <sup>3</sup> of dilute HCl solution was added and then heated and then cooled then 2cm <sup>3</sup> of dilute NaOH solution was added followed by 2cm <sup>3</sup> of Benedict solution and then heated until no further colour change.	The solution on P <sub>1</sub> retained blue colour of Benedict solution.	Non-reducing sugar is absent in solution P <sub>1</sub> .

Qa	Food	Procedure	Observation	Inference
	Tested			
	Protein	To 2cm <sup>3</sup> of solution P <sub>1</sub> in a clean and dry test tube 2 cm <sup>3</sup> of dilute NaOH solution was added and then 3 drops of 1% Copper (II) sulphate were added and solution was shaken after addition of each drop	The colour of solution P <sub>1</sub> changed to purple	Protein present in solution P <sub>1</sub>
	Lipid	To 2cm <sup>3</sup> of solution P <sub>1</sub> in a clean and dry test tube 2cm <sup>3</sup> of Sudan III solution was added and shaken vigorously and left to settle for 5 minutes	The solution P <sub>1</sub> developed red homogeneous solution of Sudan III	Lipids absent in solution P <sub>1</sub>
	(C) i) Starch - Maize and Wheat			
	ii) Protein - Beans and groundnuts			

2 (a)	<u>Characteristics of</u>	
	<u>i) Starch</u>	
	- They are insoluble in cold water but soluble in hot water	
	- They are formed from monosaccharides through condensation reaction.	
	<u>ii) Protein</u>	
	- They are denatured by strong heat, mechanical forces, strong acids, bases and salts and organic molecules	
	- They are formed from individual amino acids by condensation.	
(a)	<u>i) Starch</u>	
	Enzyme: Salivary amylase	
	Secretion: Saliva secretion	
	<u>ii) Protein</u>	
	Enzyme: Pepsin	
	Secretion: Gastric juice secretion	

**Extract 19.1 (a):** A sample of correct responses to question 2 in paper 3A

In Extract 19.1 (a), the candidate carried out the correct biochemical experiments to identify the food substances, particularly proteins and starch, present in the solution. Also, he/she correctly gave natural sources of starch and protein and their characteristics.

In Biology 3B, the candidates who scored from 9.0 to 15 marks managed to carry out the experiments and critically investigated the food substances present in solution S<sub>1</sub> (glucose solution) and solution S<sub>2</sub> (egg albumen solution). These candidates applied their knowledge and skills in the investigation of starch, protein, reducing sugar, non-reducing sugar and lipid in the solutions S<sub>1</sub> and S<sub>2</sub> concurrently. They used relevant chemicals accurately in respective test and correctly made the observations and inferences, which finally revealed that solutions S<sub>1</sub> and S<sub>2</sub> contained reducing sugar and protein.

Also, the candidates provided the correct basis of the test for reducing sugar and protein, and the food substances that indicated a positive result in the experiment. Additionally, they correctly gave the importance of boiling in the food test procedure, particularly for Benedict's test. Extract 19.1(b) is a sample of the candidates' correct responses to the question.

2.	Food tested	Procedure s.	observation	Inference
	Starch.	2mls of samples Solution S <sub>1</sub> and S <sub>2</sub> were poured in clean and dry testtube then followed by addition of 2 drops of Iodine solution. In each testtube and solutions were shaken.	Both solution retained a brownish colour of Iodine solution.	Starch was absent in both solution S <sub>1</sub> and S <sub>2</sub>
	Reducing Sugar.	2mls of samples Solutions S <sub>1</sub> and S <sub>2</sub> were poured in a clean and dry testtubes then followed by the addition of 2mls of Benedict's solution in each testtube and the two solution were heated for about 2 minutes.	S <sub>1</sub> show a series of colour change from blue to green to yellow to orange and finally brick red. S <sub>2</sub> retained a blue colour of Benedict solution.	Reducing Sugar was present. Reducing sugar was absent.

Food tested	Procedures	Observation	Inference
Non-Reducing Sugar	2mls of a sample solution $S_1$ and $S_2$ were poured in a clean and dry test tube then followed by addition of 1ml of HCl in each test tube and the solution were heated and cooled then followed by the addition of 2mls of NaOH and 2mls of Benedict's solution and the solutions were heated for about 2 minutes in each test tube.	$S_1$ show series of colour change from blue to green to yellow and finally to few brick red ppt.	Non-reducing sugar was absent.
	$S_2$ retained a blue colour of Benedict solution.	$S_2$ retained a blue colour of Benedict solution.	Non-reducing sugar was absent.
Protein	2mls of a sample solution $S_1$ and $S_2$ were in clean and dry test tube and then followed by addition of 2mls of NaOH and 2 drops of 1% of $CuSO_4$ in each of the test tube.	$S_2$ solution turned to purple colour.	Protein was present in $S_2$ .
		$S_1$ solution retained a blue colour of $CuSO_4$ .	Protein was absent in solution $S_1$ .

Food tested	Procedures	Observation	Inference
Non-Reducing Sugar	2mls of a sample solution $S_1$ and $S_2$ were poured in a clean and dry test tube then followed by addition of 1ml of HCl in each test tube and the solution were heated and cooled then followed by the addition of 2mls of NaOH and 2mls of Benedict's solution and the solutions were heated for about 2 minutes in each test tube	$S_1$ show series of colour change from blue to green to yellow and finally to few brick red ppt	Non-reducing sugar was absent
		$S_2$ retained a blue colour of Benedict solution.	Non-reducing sugar was absent
Protein	2mls of a sample solution $S_1$ and $S_2$ were in clean and dry test tube and then followed by addition of 2mls of NaOH and 2 drops of 1% of $CuSO_4$ in each of the test tube	$S_2$ solution turned to purple colour	Protein was present in $S_2$
		$S_1$ solution retained a blue colour of $CuSO_4$	Protein was absent in solution $S_1$ .

2b	Basis for food tested.	
	i. Reducing sugar.	
	A series of colour change shown because a sample solution was able to hydrolyse Cu II to Cu I which present in Benedict solution.	
	ii) Non - Reducing sugar.	
	Addition of HCl in sample hydrolyse the sample from sucrose to glucose and fructose which are both reducing sugar then solution it is neutralized with NaOH which will be able to give positive result with Benedict solution.	
	iii) Protein	
	In presence of Nitrogen (N) in peptide bond of a sample solution form a purple colour. Complex solution with $\text{CuSO}_4$ in alkaline medium.	
2c	Boiling is important in some procedures so as to speed up the rate of chemical reaction for easy hydrolysis of sample into simple form.	

**Extract 19.1 (b):** A sample of correct responses to question 2 in paper 3B

In extract 19.1 (b), the candidate correctly reported the procedures, observation and inferences used to identify reducing sugar and protein. He/she also gave the correct basis of the test for the protein and reducing sugar in parts (a) and (b). Additionally, he/she correctly gave the importance of boiling in an experiment to speed up the rate of chemical reaction.

Further analysis indicated that in Biology 3C, the candidates who scored high marks (9.0 - 15.0) managed to investigate the food substances present in solution S<sub>3</sub> (mixture of starch and egg albumen) and solution S<sub>4</sub> (glucose) in part (a). These candidates applied their skills in the investigation of starch, protein, reducing sugar, non-reducing sugar and lipid in the solution S<sub>1</sub> and S<sub>2</sub> concurrently. They accurately used chemicals provided, relevant procedures and correctly made the observations and inferences, which finally revealed starch and protein in solution S<sub>3</sub> and reducing sugar in solution S<sub>4</sub>. In addition, the candidates gave the correct names of the enzymes responsible for the digestion of starch and protein identified in solution S<sub>3</sub>.

Furthermore, the analysis indicated that most of the candidates had adequate knowledge of the enzymes and their characteristics. They correctly gave the environmental condition specific for the enzymes to work properly in digestion of starch and protein. Extract 19.1(c) is a sample of the candidates' correct responses to the question.

0. as				
FOOD TESTED	PROCEDURE	OBSERVATION	INFERENCE	
STARCH	2cm <sup>3</sup> of sample solution S <sub>2</sub> and S <sub>4</sub> were put in clean and dry test tube followed with addition of three drops of iodine solution	In sample solution S <sub>2</sub> , changed the colour into blue black colour	starch was present	
	than solutions were shaken gently.	In sample solution S <sub>4</sub> retain the brown colour of iodine solution	starch absent	
REDUCING SUGAR	2cm <sup>3</sup> of sample solution S <sub>2</sub> and S <sub>4</sub> were put in clean and dry test tube followed with addition of 2cm <sup>3</sup> of Benedict's solution and solution were heated to boil	In sample solution S <sub>2</sub> retain the blue colour of Benedict's solution	reducing sugar absent	
		In sample solution S <sub>4</sub> , the solution changed to series of colour change from blue, green, yellow, orange and finally brick red	reducing sugar present	

2	FOOD TESTED	PROCEDURE	OBSERVATION	INFERENCE
	NON-REDUCING SUGAR	2cm <sup>3</sup> of sample solution S <sub>3</sub> and S <sub>4</sub> were put in clean and dry test tube, then 1cm <sup>3</sup> of dilute hydrochloric solution were added and the solution were heated to boil, after cooling 2cm <sup>3</sup> of sodium hydroxide solution were added to the solution S <sub>3</sub> and S <sub>4</sub> followed with 2cm <sup>3</sup> of Benedict's solution, then the mixture were heated to boil	In sample solution S <sub>3</sub> , the solution retain the blue colour of Benedict's solution	Non-reducing sugar absent
			Series of colour change from blue, green, yellow, orange finally brick red ppt occurred in sample solution but were few	Non-reducing sugar absent
	PROTEIN	2cm <sup>3</sup> of sample solution S <sub>3</sub> and S <sub>4</sub> were put in clean and dry test tube then 2cm <sup>3</sup> of sodium hydroxide were added followed with three drops of 1% of copper (II) sulphate then the mixture were	In sample solution S <sub>3</sub> , the solution change into purple colour	Protein present
			In sample solution S <sub>4</sub> , the solution retain the blue colour	Protein absent

	FOOD TESTED	PROCEDURE	OBSERVATION	INFERENCE
2a)		shaken vigorously	of copper(II) sulphate	
b)	Enzyme responsible			
	STARCH			
	Enzyme responsible			
	- Salivary amylase in mouth			
	- Pancreatic amylase in pancreas			
	- Maltase			
	Protein			
	Enzyme responsible			
	- Pepsin and rennin in stomach			
	- Pancreatic trypsin in pancreas			
	- Trypsin in small intestine			
bii)	Salivary amylase in basic/alkaline condition			
	* Pancreatic amylase in alkaline condition and maltase in alkaline condition			
	Pepsin and rennin work in acidic condition			
	Pancreatic trypsin in acidic condition			
	Trypsin work in acidic condition			

Extract 19.1 (c): A sample of correct responses to question 2 in paper 3C

In extract 19.1 (c), the candidate correctly reported the procedures, observation and inferences used to identify starch, reducing sugar and protein in part (a). He/she provided the correct name of the enzymes responsible for the digestion of food substances identified in solution S<sub>3</sub>. Also, the candidate provided the correct environmental conditions specific for each enzyme to work properly in the digestion of starch and proteins.

Further analysis indicated that a few (14.05%) of the candidates scored low (0 to 5) marks in this question. These candidates were incompetent in the food test experiment and demonstrated poor skills in report writing in alternatives 3A, 3B or 3C. In Biology 3A, the candidates failed to carry out food test experiments to identify the food substances present in P<sub>1</sub>. These indicate that some of the candidates lacked skills in investigating starch, protein, reducing sugar, non-reducing sugar and lipid. In part (a), of the question, some of the candidates wrote incorrect chemicals used in a particular procedure. For example, they used sodium hydroxide to test for reducing sugar instead of protein and non-reducing sugar. One of the candidates applied iodine to test for the protein instead of the starch. Another candidate used Benedict's solution incorrectly to test for lipids in solution P<sub>1</sub>, which in turn gave wrong results.

However, the candidates were unaware of the measurement required for the particular test, as some chemicals were not used accurately, and others were used excessively. Some of the candidates wrote wrong units of measurement, such as mile and sm<sup>2</sup>, which measure distance and area instead of using ml and cm<sup>3</sup>, which are correct measures of volume.

In addition, some of the candidates wrote incorrect observations because they failed to identify the appropriate colour change. Examples of incorrect observations were *the solution not changed*, *the solution retained the colour of iodine*, *the solution acquired the colour of benedict solution*, *the solution retained the colour of Sudan III solution* instead of brown, blue and red colours respectively. These responses indicated that the candidates lacked knowledge about the specific colour in the food test experiment. Therefore, they failed to make a correct inference.

Consequently, most of the candidates failed to identify the food substance contained in solution P<sub>1</sub> hence suggested incorrect natural sources of food which as well as the characteristic of each food substance in part 2 (b) and

(c). Also they wrote incorrect name of the enzyme and secretion provided in part 2 (d). Extract 19.2 (a) is a part of a sample of incorrect responses to question 2 in Biology 3A.

Q2	FOOD TESTED	PROCEDURE	OBSERVATION	INFERENCE
	PROTEIN	To about 2mls of sample solution P <sub>2</sub> in a dry test tube followed by drops of NaOH then followed by copper (II) sulphate	The colour of the solution was changed to blue	protein was absent.
	LIPID	To about 2mls in a clean and dry test tube a solution P <sub>2</sub> was added followed by Sudan (III) solution	The solution retained the colour of Sudan (III)	lipid was absent.
	REDUCING SUGAR	To about 2mls of a sample solution P <sub>2</sub> added in a test tube followed by a solution of Benedict's	The solution changed the colour to blue	Reducing sugar was absent.
	NON-REDUCING SUGAR	To about 2mls of a sample solution P <sub>2</sub> taken into a clean and dry test tube followed by benedict's solution then HCl heated then cooled and followed by addition of NaOH then heated	The mixture of the content become blue	Non-reducing sugar was absent

Extract 19.2 (a): A part of a sample of incorrect responses to question 2 in paper 3A

In Extract 19.2 2(a), the candidate was not knowledgeable about the correct measurements and procedures used for carrying out the identification of food substances. For example, the candidate did not apply heat while testing for reducing sugar.

The candidates who scored low marks (0.0 - 5.0) in Biology 3B either failed to test the food or wrongly reported the procedures used in the testing of food or altogether. Some of them used incorrect chemicals and wrote wrong procedures, observations and inferences.

In addition, some candidate failed to correctly explain the basis of the test for each positive result obtained in solution S<sub>1</sub> and S<sub>2</sub> which are reducing sugar and protein respectively. For example, *basis of the test for reducing sugar- hydrochloric acid is added in the sample solution to break the bond, whereas sodium hydroxide is added in order to neutralise the acid.* For the basis of the test for protein the candidate wrote that *sodium hydroxide solution is added in the sample solution to neutralise the acid whereas CuSO<sub>4</sub> act as enzyme which convert protein to amino acid.*

This response signifies that the candidate was not aware of the reducing property of simple carbohydrates and the principles for testing it. They failed to recognise that Benedict's solution contains cupric ions (Cu<sup>2+</sup>), which are reduced to cuprous ions (Cu<sup>+</sup>). These cuprous form copper (I) oxide, which reacts in the mixture and precipitates out as a brick-red coloured compound.

Additionally, some of the candidate gave incorrect reason as to why boiling is important in some procedures of food test particularly, Benedict's test. The examples of their responses include *boiling is important in some procedures of experiment because it help to break polypeptide bond and hydrogen, the purpose of boiling in some procedure is to break the bond, means to change the complex one into simple one for instance non-reducing sugar.* This implies that the candidate had inadequate knowledge about procedures for testing protein.

On the other hand, some candidates were not aware that when Benedict's is boiled, its reducing property is activated as copper (II) sulphate is converted to into copper (I) sulphate for testing reducing sugars. On the other hand, when testing non-reducing sugars, the purpose of heating it to

speed up the hydrolysis reaction of complex sugar to monosaccharide in the presence of the dilute hydrochloric acid which breaks the glycosidic bond. Extract 19.2(b) is a sample of the candidates' incorrect responses to the question.

2:	Food tested	Procedure	Observation	Inference.
	Reducing Sugar	2cm <sup>3</sup> of Food Sample was put into clean and dry test tube followed by 2cm <sup>3</sup> of Benedict solution	The <del>same</del> colour was blue yellow, green Orange and brick red was observed in a solid sample	Reducing sugar was present.
	Non-reducing Sugar	2cm <sup>3</sup> of Food Sample was put into a dry and test tube then followed by 1cm <sup>3</sup> of dilute Hydrochloric acid (HCl) then allowed to cool followed	Food Sample Solution blue, yellow, green, Orange and Brick red colour was observed	Non-reducing sugar was present.

Food tested	Procedure	Observation	Inference
	by 2cm <sup>3</sup> of Sodium hydroxide (NaOH) then heat followed by 2cm <sup>3</sup> of Benedict's solution then shake vigorously.		
Protein	2cm <sup>3</sup> of food sample S <sub>1</sub> and S <sub>2</sub> was put into a clean and dry test tube followed by 2cm <sup>3</sup> of (NaOH) Sodium Hydroxide then heat the followed by 1% of Copper Sulphate (CuSO <sub>4</sub> ) then shake strongly.	Purple colour was observed in a solid sample	Protein was present.
Lipid	2cm <sup>3</sup> of food sample S <sub>1</sub> and S <sub>2</sub> was put into a clean and dry test tube followed by Sudan III solution put into a water bath.	No ring formed	Lipid was absent

2	<p><b>Reducing sugar</b>          It reducing the Copper II ions and Copper(I) oxide colour in Benedict solution into Copper(I) oxide and the colour change series occur from green yellow and brick red.</p> <p><b>Non-reducing sugar</b>          Basis if reduced by heating with dilute hydrochloric acid to form colour by the series occur from blue, green yellow and brick red.</p> <p><b>Protein:</b>          Basis, Benedict solution was used to form a purple colour. Protein was present.</p>	
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**Extract 19.2 (b):** A sample of incorrect responses to question 2 in paper 3B

In Extract 19.2 (b), the candidate wrote incorrect measurements and procedures used in carrying out a biochemical experiment. Also, he/she provided an incorrect basis for the test for reducing sugar and non-reducing sugar.

Similarly, candidates who scored from 0.0 - 5.0 in Biology 3C failed to correctly report the procedures used in food test investigation. Some of them wrote incorrect chemical used and others reported wrong procedures, observation and inferences.

In addition, some of the candidates failed to identify the enzymes responsible for the digestion of the food substances present in solution S<sub>3</sub>. Other candidates listed the enzymes but did not indicate the food substances they act upon in solution S<sub>3</sub>. In addition, the candidate lacked knowledge about the environmental conditions specific to each enzyme for digesting the food in solution S<sub>3</sub>; instead, they provided the site where the enzymes are found. Extract 19.2(c) is a sample of incorrect responses to question 2 in Biology 3C.

2 a	Food tested	Procedure	Observation	Inference
	Reducing sugar	A small amount of solution S <sub>3</sub> and S <sub>4</sub> was added in a clean and dry test-tube. A series of 3 drops of benedict solution was added.	Both solutions S <sub>3</sub> and S <sub>4</sub> change colour of benedict solution and colour from yellow, pink orange and finally brick red.	Reducing sugar was present.
	Non-reducing sugar	A small amount of solution S <sub>3</sub> and S <sub>4</sub> was added in a separate test tube then dilute hydrochloric acid was added then heated and cooled, sodium hydroxide and benedict solution was added and heated.	Both solutions show a series of colour from yellow, pink, orange and finally brick red.	Non-reducing sugar was present in each solution.

Food tested	Procedure	Observation	Inference
Protein-	2 cm <sup>3</sup> of solution S <sub>3</sub> and S <sub>4</sub> was putted in a separate test tubes then sodium hydroxide was added followed by CuSO <sub>4</sub> .	In S <sub>3</sub> solution a purple colour was observed In S <sub>4</sub> solution	Protein was present Starch was absent
b (i) Amylase enzyme			
• Pepsin and renin			
(ii) The environmental condition specific for enzymes are:			
• Amylase found in the mouth			
• Renin and pepsin found in the stomach.			

**Extract 19.2 (c):** A sample of incorrect responses to question 2 in paper 3C

In Extract 19.2(c), the candidate wrote incorrect procedures in a biochemical experiment. In addition, he/she wrote incorrect enzymes and confused the environmental condition with parts of the digestive system.

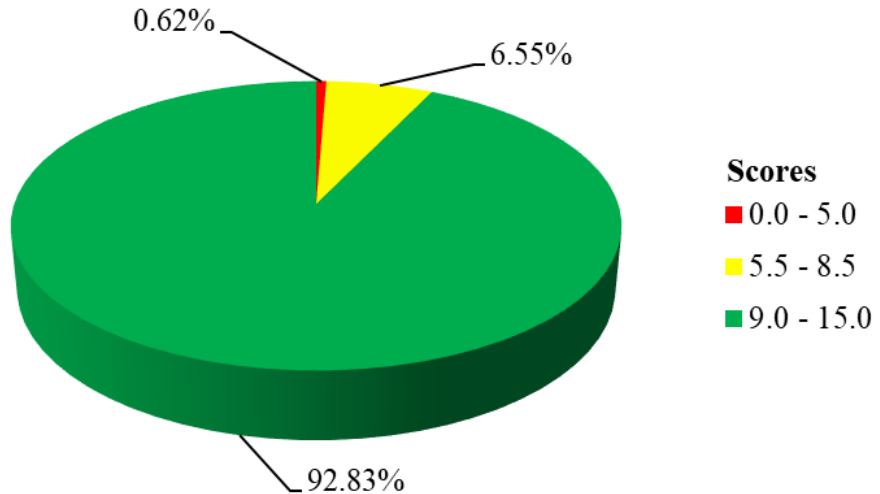
### 2.3.3 Question 3: Comparative Studies of Natural Groups of Organisms

Question 3 in alternative 3A, 3B and 3C measured the candidates' skills and competence in classifying organisms into their respective taxonomic groups. In Biology 3A, the candidates were provided with specimens E (termite), F (millipede), G (centipede), H (grasshopper), and I (spider). They were instructed to study them and then (a)(i) identify the specimens E, F, G, H and I by their common names (a)(ii) give the habitat of each specimen E and H, (b)(i) state the common hierarchy to which specimen E, F, G, H and I belong, (b)(ii) give two advantages and disadvantages of the members belonging to the hierarchy in (b)(i) to human being, (c)(i) place specimens E, F, G, H and I to their respective classes, (c)(ii) account for three observable characteristic features of specimen H at class level.

Similarly, in Biology 3B, candidates were provided with specimens J (Moss plant), K (Maize plant/seedling) and L (Bean plant). They were instructed to study them and then (a) identify the specimens J, K, and I by their common names, (b) explain how does each of the specimen J and K adapted to its habitat by giving two points, (c)(i) classify each of the specimen J and K to class level, (c)(ii) give two reasons as to why specimen J and K placed in the classes they belong, (d) give two points in what ways do specimens K and L differ.

Likewise, in Biology 3C, candidates were provided with specimens, M<sub>1</sub> (Maize grain), M<sub>2</sub> (Bean fruit) and M<sub>3</sub> (Female cone). They were instructed to study them carefully then (a)(i) identify each of the specimen M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> by their common names, (a)(ii) state from which part of a plant the specimens M<sub>1</sub> and M<sub>2</sub> develop, and by giving reasons to support the answer, (b)(i) give the name of the plants where specimens M<sub>1</sub>, M<sub>2</sub>, and M<sub>3</sub> are obtained, (b)(ii) identify the Kingdom, Phylum/Division and Class in which each plant named in 3(b) (i) belong, (c) state one observable feature which is the typical characteristics of the class to which each of the specimens M<sub>1</sub>, M<sub>2</sub>, and M<sub>3</sub> belongs.

This question was attempted by 37,028 (100%) candidates. The analysis shows that 34,374 (92.83) scored from 9.0 to 15.0 marks, 2,423 (6.55%) scored from 5.5 to 8.5 marks, and 231 (0.62%) scored low marks (0.0 to 5.0). The candidates' performance on this question was good since 99.38 per cent passed by scoring 5.5 to 15.0 marks. The analysis of their performance is shown in Figure 20.



**Figure 20:** *Distribution of Candidates' Scores on Question 3*

The candidates' good performance in this question was attributed to their adequate competence about the topic of Comparative Studies of Living Organisms tested in alternatives 3A, 3B and 3C. In Biology 3A, the candidates who scored high (9.0 - 15.0) marks demonstrated mastery of classifying living organisms, particularly the termite, millipede, centipede, grasshopper, and spider. The analysis revealed that most of the candidates correctly stated the habitat of the termite and grasshopper. Also, they correctly stated the common groups to which termite, millipede, centipede, grasshopper, and spider belong and gave two advantages and disadvantages of the members belonging to those groups to human beings. In addition, most of the candidates correctly placed the termite, millipede, centipede, grasshopper, and spider in their respective classes, and correctly stated three observable characteristics features of grasshopper at the class level. Extract 20.1(a) is a sample of the candidates' correct responses to this question.

3. a) i)		
	Specimen	Common name
	E	Termite
	F	Millipede
	G	Centipede
	H	Grasshoper
	I	Spider
3 a) ii)	Specimen	habitat
	E	Terrestrial habitat (in the soil)
	H	Terrestrial habitat (In grasslands)
3. b) i)	They all belong to <u>phylum</u> <u>Arthropoda.</u>	

3. b) ii) Advantages

a) They help to increase soil aeration and soil fertility.

b) They may act as pollinators

Disadvantages

a) They may sting human beings and cause pains or even deaths due to the poisons. Example centipede

b) They may act as vectors for disease causing microorganism, hence facilitate spread of diseases.

3. c) i) 

Specimen	respective class
E	class insecta
F	class diplopoda
G	Class chilopoda
H	class insecta
I	class arachnida.

3. c) ii) Observable characteristics of class Insecta (specimen H).

a) Their bodies are divided into three divisions which are head, thorax and abdomen.

b) They have three pairs of walking legs.

c) They contain a pair of antennae used for detecting danger.

**Extract 20.1 (a):** A sample of correct responses to question 3 in paper 3A

In extract 20.1 (a), the candidates correctly provided the common names of the specimens E, F, G, H, and I, and stated the correct habitat of the

termite and grasshopper. Also, he/she correctly placed the specimens E, F, G, H, and I in classes insecta, diplopoda, chilopoda, insect and arachnida, respectively.

Further analysis showed that in Biology 3B, the candidates who scored high marks (9.0 - 15) had adequate skills to perform the classification of living organisms. Most of them correctly identified the common names of the specimens J, K and L as Moss plant, Maize plant/seedling and Bean plant/seedling, respectively. Also, they correctly gave the adaptive features of the specimens J (Moss plant) and K (Maize plant/seedling) to their habitats, and classified each of the specimens to the class level by giving two reasons for each. Additionally, most of the candidates were able to differentiate the specimens K and L. Extract 20.1(b) is a sample of the candidates' correct responses.

3.a)	Specimen	Common names.		
	J	Moss plant		
	K	Maize seedling		
	L	Beans seedling.		
b)	Adaptation of specimen J			
	-It has a limited height to overcome the problem of lack of vascular bundles.			
	-It has false roots for anchorage and support.			

3b) Adaptations of specimen K:			
- It has true roots for anchorage and support.			
- It has chlorophyllous leaves for the manufacturing of its own food.			
c i)			
Specimen	Kingdom	Division	Class.
J	Plantae	Bryophyta	Musci
K	Plantae	Angiospermophyta	Monocotyledoneae.
ii)			
- Specimen (J) - Moss plant			
I: It lacks true leaves, stem and roots.			
II: Its body is differentiated into seta and capsule that holds the spores.			
- Specimen (K) - Maize seedling			
I: It has a fibrous root system.			
II: It has leaves with parallel venation.			
d)			
Features	Specimen K	Specimen L	
Leaf anatomy	Has a parallel leaf venation	Has net-like leaf venation.	
Root system	Has a fibrous root system	Has a tap root system.	

**Extract 20.1 (b):** A sample of correct responses to question 3 in paper 3B

In Extract 20.1 (b), the candidate correctly identified the common names of the specimens J, K and L as Moss plant, Maize plant/seedling and Bean plant/seedling, respectively. Also, he/she correctly provided the adaptive features of the specimens J (Moss plant) and K (Maize plant/seedling) to their habitats and classified each of the specimens to the class level by

giving two reasons for each. This indicates that the candidate was competent in the classification of plants.

The analysis further revealed that the candidates who scored high marks in Biology 3C were skillful about classification of living organisms. Most of them correctly identified the common names of the specimens M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> as Maize grain, bean fruit, and female cone, respectively. Also, they correctly stated the part of the plant from which specimens M<sub>1</sub> and M<sub>2</sub> had develop and provided a correct reason to support their answers. Additionally, they correctly gave the name of the plant where specimens M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> were obtained and properly classified those specimens to the class level. On top of that, they correctly stated one observable feature, which is typical characteristics of the class to which each of the specimen M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> belong. Extract 20.1(c) is a sample of the candidates' correct responses to the question.

3a	i) Specimen M <sub>1</sub> - Maize grain Specimen M <sub>2</sub> - Bean fruit Specimen M <sub>3</sub> - Female cone.
3a	ii) The Specimen M <sub>1</sub> and M <sub>2</sub> develop At ovary of a plant.
3. b)	i) Name of the plant. M <sub>1</sub> - Maize plant M <sub>2</sub> - Bean plant M <sub>3</sub> - Pine tree
	ii) Plant Name    Kingdom    phylum    class.
	M <sub>1</sub> (Maize plant)    Plantae    Angiospermatophyta    monocotyledonae
	M <sub>2</sub> (Bean plant)    Plantae    Angiospermatophyta    Dicotyledonae
	M <sub>3</sub> (Pine tree)    Plantae    Coniferophyta    Pinopsida
3. c)	i) Specimen M <sub>1</sub> - They are ferns, embryo has one cotyledone hence their monocots
	ii) Specimen M <sub>2</sub> - They are ferns and embryo has two cotyledone which describe it is dicotyledone.

**Extract 20.1 (c):** A sample of correct responses to question 3 in Biology 3C

In Extract 20.1 (c), the candidate correctly identified the common names of the specimens M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> as maize grain, bean fruit, and female cone, respectively and classified them to the class level. Also, he/she correctly stated the part of the plant from which the specimens M<sub>1</sub> and M<sub>2</sub> develop.

Although the candidates' performance on this question was good, further analysis indicated that a few (0.62%) of the candidates scored low marks, ranging from 0.0 to 5.0 of whom two candidates scored zero. This weak

performance was attributed to inadequate skills and knowledge about the topic of Comparative Studies of Natural Groups of Organisms.

In Biology 3A, a few candidates who got low marks provided the incorrect habitat of specimen E (termite). For example, one candidate wrote that *specimen E is found in moist areas* instead of a terrestrial environment. Also, in part (b), some candidates failed to identify the common group to which specimens E, F, G, H and I belong. They either wrote an incorrect taxon or misspelt the scientific terminology as *Anthlopoda* instead of Arthropoda. Other candidates gave the importance of taxonomic hierarchy in classification instead of the advantages of the common hierarchy to which the specimens E, F, G, H and I belong. For example, *make good communication among scientists*. This indicates that the candidates were not competent in the classification of animals, particularly Arthropods.

In part (c), they failed to place the specimens into their respective classes. For example, some of the candidates wrote incorrect taxa such as *specimen F(Millipede)-class chilopoda*, *specimen G (Centipede)- class Diplopoda*. Others gave the general features of the phylum Arthropoda instead of naming the classes to which the specimens belong. Also, some of the candidates wrote observable features of each specimen instead of placing the specimens in their respective classes. Examples of incorrect responses include: *termite has body divided into three parts, they lack wings; millipede has cylindrical body, and numerus legs per segment, while centipede have flattened body and one pair of leg per segment*. These responses indicate that these candidates were either not aware of the terminology of the classes such as Insecta, Diplopoda, Chilopoda and Arachnida or misunderstood the demand of the question. Extract 20.2(a) is a sample of the candidates' incorrect responses.

Q3. (b) i) The common hierarchy from which the specimen E, F, G, H and I belongs are.

specimen	hierarchy.
E	Arthropoda.
F	Arthropoda.
G	Arthropoda.
H	Arthropoda.
I	Arthropoda.

ii) The advantages and disadvantages of the members belonging to hierarchy in 3(b)i) to human being.

Advantages.

- It play a great role in balancing the ecosystem among organisms, for example through identification of the kingdom, phylum, class, order, genus, family and species of an organism.

Q3. (b) ii) Disadvantages.

- The names of organisms are difficult to pronounce, the scientific name of organism are very difficult to pronounce.
- It makes difficult in identification of the dichotomous key of different organisms with the same genus, species, order etc.

ii) To account for three observable characteristics feature of specimen H at class level.

- Specimen H - Grasshopper
- The class of the specimen is Insect
- The following are the observable characteristics feature of specimen H.

Extract 20.2 (a): A sample of incorrect responses to question 3 in paper 3A

In Extract 20.2 (a), the candidate wrote the word arthropoda for each specimen instead of specifying the common group to which the specimens belong, which were Kingdom Animalia and Phylum Arthropoda. Also, he/she gave incorrect disadvantages of the members of Phylum Arthropoda to human beings, and observable characteristic of class Insecta.

Similarly, in Biology 3B most of the candidates who scored low marks (0.0 -5.0) gave incorrect common names of the specimens. For example, one candidate wrote *K - Maize* instead of Maize plant/seedling and *L - Bean* instead of bean plant/seedling. In addition, they wrote incorrect adaptive features of specimens J and K to their habitats, while others failed to classify specimens J and/or K to the class level. Moreover, some of the candidates incorrectly differentiated specimens K and L. Extract 20.2(b) is a sample of the candidates' incorrect responses to the question.

3	ii) Roots; The root of specimen K they have tap root system but the root of specimen L they have the fibrous root system.		
	c) i)		
	SPECIMEN	KINGDOM	PHYLUM / DIVISION
	J	Plants	Phyllocladophyta
	K	Plants	Angiosperma phyta
			CLASSES
			Mono cotyledonae
			Monocotyledonae
	d) ii) Specimens J and K placed in the classes belong because		
	- They have the same features are the same example they are mono cotyledonae		
	- All specimens they are have the parallel veins and it does not produce the flowers.		
	b) The habitat of specimen J and K adapted is it grow in equatorial climate and it undergo the photosynthesis for		

**Extract 20.2 (b):** A sample of incorrect responses to question 3 in paper 3B

In Extract 20.2 (b), the candidate failed to place specimen J into division Bryophyta, and he/she provided incorrect differences between maize and bean seedlings.

Similarly, in Biology 3C, the candidates who scored low marks (0.0 to 5.0) demonstrated a lack of competence in the classification of living organisms. Some of the candidates gave incorrect common names of the specimens, M<sub>1</sub> (Maize grain), M<sub>2</sub> (Bean fruit) and M<sub>3</sub> (Female cone). In addition, some of the candidates incorrectly stated part of the plant from which specimens M<sub>1</sub> and M<sub>2</sub> develop with wrong reasons. For example, *the part of a plant from which the specimen M<sub>1</sub> and M<sub>2</sub> developed is plant flower*. On top of that, they incorrectly stated one observable feature, which is the typical characteristics of the class to which of the specimens M<sub>1</sub>, M<sub>2</sub>, and M<sub>3</sub> belong. Some of the incorrect responses given by the candidates includes: *observable feature of specimen M<sub>1</sub>-the pericarp and seed coat of the specimen M<sub>1</sub> are fused each other, specimen M<sub>3</sub>: female cone, feature: they have one cotyledon*. Extract 20.2(c) is a sample of the candidates' incorrect responses to the question.

Q	(c) • observable feature of specimen M <sub>1</sub>	
	→ The pericarp and seed coat (testa) of specimen M <sub>1</sub> are fused each other	
	• Observable feature of specimen M <sub>2</sub>	
	→ The pericarp and seed coat (testa) of specimen M <sub>2</sub> are separated from each other	
	• Observable feature of specimen M <sub>3</sub>	
	→ The specimen M <sub>3</sub> has no flower as it bear cone for reproduction.	

**Extract 20.2 (c):** A sample of incorrect responses to question 3 in paper 3C

In Extract 20.2 (c), the candidate stated incorrectly observable features which are typical characteristics of Class Monocotyledoneae and Dicotyledoneae in part (c).

### 3.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE ON EACH TOPIC

The ACSEE 2025 Biology examination covered 12 topics. Seven topics were tested in the 133/1 Biology 1 paper and six topics in the 133/2 Biology 2 paper. Two topics (one from paper 1 and one from paper 2) were also tested in 133/3 Biology 3, which was a practical paper. The analysis of the candidates' performance shows that the candidates had good performance on eight topics and average performance on four topics. The performance is as follows:

The candidates showed good performance on the topics of *Comparative studies of natural groups of organisms* (89.87%), *Growth and Development* (87.59%), *Ecology* (84.92%), *Cytology* (82.67%), *Reproduction* (76.84%), *Nutrition* (74.77%), *Transportation* (71.84%), and *Genetics* (65.50%). However, the candidates demonstrated average performance on the topics of *Gaseous exchange and respiration* (59.71%), *Regulation/Homeostasis* (58.28%), *Evolution* (46.77%) and *Coordination* (43.39%) as shown in Appendix A.

The comparison of the candidates' performance on each topic in Biology between ACSEE 2024 and ACSEE 2025 shows that the topics of *Comparative studies of natural groups of organisms*, *Reproduction* and *Genetics* have maintained a good performance, while *Regulation/Homeostasis* and *Gaseous Exchange and Respiration* maintained an average performance.

The performance on the topics of *Ecology*, *Cytology* and *Growth and Development* have improved from average to good, and the topics of *Nutrition* and *Transportation* have improved from weak to good performance.

On the other hand, the performance on *Coordination* and *Evolution* have dropped from good to average as shown in Appendix B.

### 4.0 CONCLUSION

The candidates' performance in the ACSEE 2025 in Biology was good since 99.62 per cent passed the examination. In Biology paper 1 the candidates had good performance in questions 1 (92.09%), 2 (69.98%), 3 (73.75%), 5 (68.42%), 7 (60.35%), 8 (83.46%), 9 (71.84%), 10 (74.77%), and 11 (84.26%). The average performance was observed in question 4

(43.39%) and 6 (45.03%). In Biology paper 2, the candidates had good performance in questions 1 (97.00%), 3 (87.59%), 4 (65.92 %), and 5 (84.92%). The average performance was observed in questions 2 (58.28%) and 6 (46.77%), while in Biology paper 3, the candidates had good performance in all three questions as follows: questions 1 (79.35%), 2 (85.95%), and 3 (99.38%). This good performance is a result of the efforts made by teachers and students in the teaching and learning process. However, an average performance of some candidates has been attributed to the following factors:

- (a) Candidates' insufficient knowledge on the tested concepts. This is a result of a lack of peer and self-assessment among students throughout the learning process.
- (b) Candidates' inability to conduct various experiments, such as the dissection of animals. This might have been caused by either student's lack of enough practices in performing practical experiments.
- (c) Candidates' incompetence in the drawing skills of structures and systems of various organisms. This might have been caused by students' inadequate practice of the principles of drawing skilful biological diagrams.
- (d) Provision of incorrect responses contrary to the question demand. This is a result of either failure of the candidates to read carefully the questions and understand the demand before attempting them, or lack of competence in a particular topic, thus answering by guessing.

## 5.0 RECOMMENDATIONS

The following are recommendations for teachers and learners to improve the performance of prospective candidates:

- (a) Recommendations for teachers
  - (i) Charts, diagrams, and pictures should be used in guiding students in observation of microscope slides of neurones (nerve cells) and discuss their structure. Also, engage students to draw well-labelled diagrams of nervous tissues for improvement in the topic of *Coordination* whose performance dropped from good to average.
  - (ii) Pictures, diagrams and photographs of fossils should be used and guide students to observe and identify different types of fossils. Also, visiting Museum of natural history to observe different types of fossils. Students should be guided to make plenary discussion on the type of fossils to improve the students' performance in the topic of *Evolution* whose performance has dropped from good to average.
  - (iii) A variety of animals, diagrams and photographs showing response to changes in temperature should be used to guide students in investigation and discussion on mechanisms of temperature regulation in endotherms in the topic of *Regulation/ Homeostasis* whose average performance maintained for better performance.
  - (iv) Charts and video clips on glycolysis should be used to guide students in groups to observe the stages and the structure of ATP for improvement in the topic of *Gaseous Exchange and Respiration* in which the performance has not shown significant improvement.

- (b) Students are advised to:
- (i) Engage in peer and self-assessment to evaluate their own work and that of their peer to fostering a deeper understanding of the subject matter and developing analytical skills.
  - (ii) Read the question carefully to clearly understand the requirements before attempting it.
  - (iii) Practice dissection of small mammals, cockroaches, and frogs and display the nervous system to help develop deeper understanding of the features of those systems.
  - (iv) Practice drawing of various biological diagrams using the principles of drawing and calculating the magnification of various organisms to improve their drawing skills.

## The Summary of Candidates' Performance per Topic in ACSEE 2025

S/N	Topic	Question Number	Percentage of Candidates Who Scored an Average of 35% or Above	Average Performance in Each Topic	Remark
1	<i>Comparative Studies of Natural Groups of Organisms</i>	8(P1)	83.46	89.87	Good
		1(P2)	97.00		
		1(P3)	79.35		
		3(P3)	99.38		
2	<i>Growth and Development</i>	3(P2)	87.59	87.59	Good
3	<i>Ecology</i>	5(P2)	84.92	84.92	Good
4	<i>Cytology</i>	1(P1)	92.09	82.67	Good
		2(P1)	69.96		
		2(P3)	85.95		
5	<i>Reproduction</i>	5(P1)	68.42	76.34	Good
		11(P1)	84.26		
6	<i>Nutrition</i>	10(P1)	74.77	74.77	Good
7	<i>Transportation</i>	9(P1)	71.84	71.84	Good
8	<i>Genetics</i>	4(P2)	65.50	65.50	Good
9	<i>Gaseous Exchange and Respiration</i>	3(P1)	73.75	59.71	Average
		6(P1)	45.03		
		7(P1)	60.35		
10	<i>Regulation/ Homeostasis</i>	2(P2)	58.28	58.28	Average
11	<i>Evolution</i>	6(P2)	46.77	46.77	Average
12	<i>Coordination</i>	4(P1)	43.39	43.39	Average

### Comparison of the Candidates' Performance by Topic between 2025 and 2024

S/N	Topic	2025			2024		
		Number of Question	Percentage of Candidates Who Scored an Average of 35% or Above	Remark	Number of Question	Percentage of Candidates Who Scored an Average of 35% or Above	Remark
1	<i>Comparative Studies of Natural Groups of Organisms</i>	4	89.87	Good	3	92.34	Good
2	<i>Principles of Classification</i>				1	91.12	Good
3	<i>Growth and Development</i>	1	87.59	Good	1	34.91	Average
4	<i>Ecology</i>	1	84.92	Good	1	45.62	Average
5	<i>Cytology</i>	3	82.67	Good	2	45.62	Average
6	<i>Reproduction</i>	2	76.34	Good	3	60.37	Good
7	<i>Nutrition</i>	1	74.77	Good	1	21.54	Weak
8	<i>Transportation</i>	1	71.84	Good	1	4.05	Weak
9	<i>Genetics</i>	1	65.50	Good	1	94.98	Good
10	<i>Gaseous Exchange and Respiration</i>	3	59.71	Average	2	51.87	Average
11	<i>Regulation/ Homeostasis</i>	1	58.28	Average	1	57.81	Average
12	<i>Evolution</i>	1	46.77	Average	1	94.13	Good
13	<i>Coordination</i>	1	43.39	Average	1	87.05	Good

