CHAPTER 8

LIFE SCIENCES

The following report should be read in conjunction with the Life Sciences question paper of the November 2018 examinations.

8.1 PERFORMANCE TRENDS (2014–2018)

The number of candidates who wrote the Life Sciences examination in 2018 decreased by 8 433 when compared to that of 2017. The performance of the candidates in 2018 shows a slight improvement at the 30% level from 74,4% to 76,3% and a slight decrease at the 40% level from 52,1% to 51,7%. The pass rate at the 30% level represents the highest pass rate in the last five years.

Table 8.1.1 Overall Achievement Rates in Life Sciences

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2014	284 298	209 783	73,8	139 109	48,9
2015	348 076	245 164	70,4	160 204	46,0
2016	347 813	245 157	70,5	157 224	45,2
2017	318 474	236 809	74,4	166 071	52,1
2018	310 041	236 584	76,3	160 208	51,7

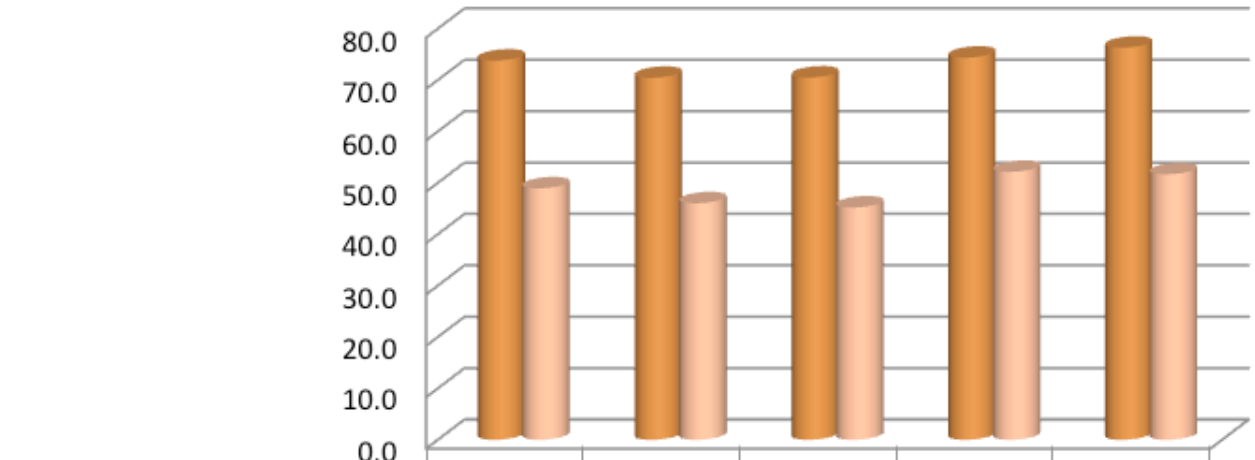
Over the years there has been an improvement in the writing of essays and the drawing of graphs. Some of the skills in graph drawing such as using an appropriate scale as well as the logical arrangement of ideas in essay writing still remain a challenge.

A strengthening of content knowledge, in topics such as Reproduction in Paper 1 and Genetics and Evolution in Paper 2, will greatly enhance the performance in the subject. Reproduction covers 45 marks out of 150 in Paper 1 and Genetics and Evolution cover 110 out of 150 marks in Paper 2.

One of the challenges in improving performance is that there are many teachers who are not confident in especially genetics and evolution. Teacher workshops should focus strongly on these topics. In addition, Evolution is scheduled for late in the third term. Most teachers who lag behind in the teaching of other topics in the year end up with too little time to do justice to this topic.

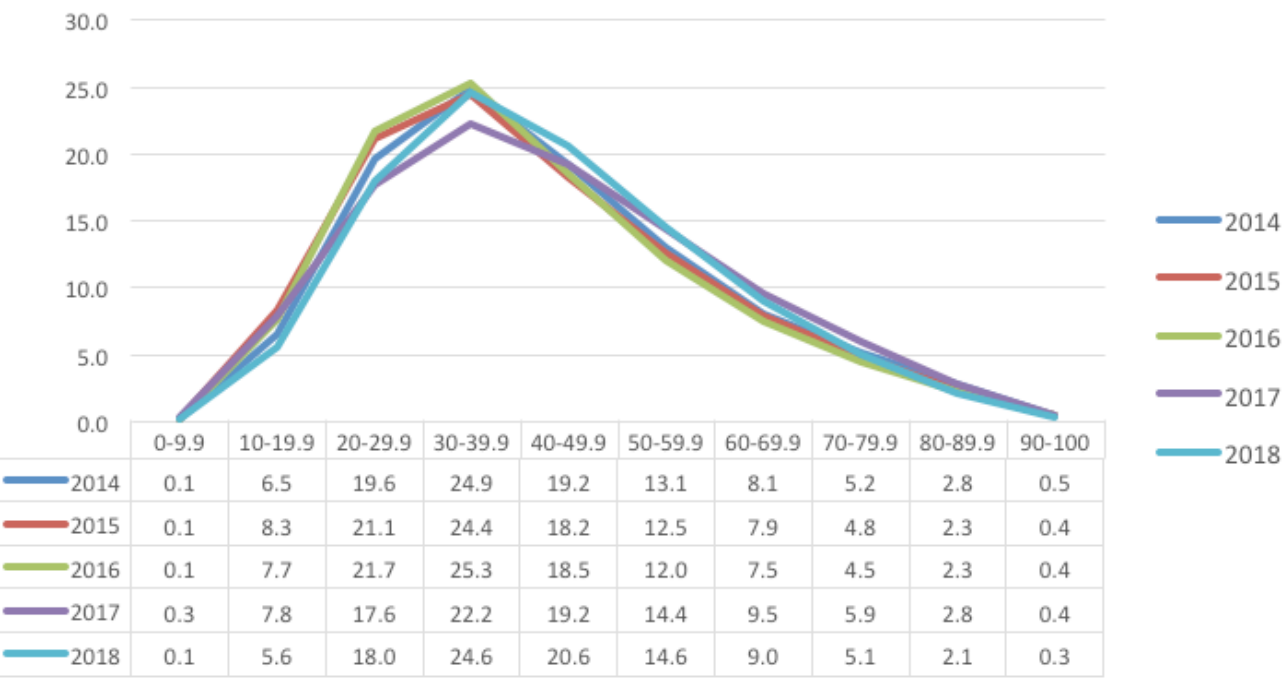
Another area of poor performance remains the questions on scientific investigations as evidenced once again in Papers 1 and 2 of 2018. If this area can be strengthened from the earlier grades, performance can improve. This is also an area in which teachers must first be supported.

Graph 8.1.1 Overall Achievement Rates in Life Sciences (Percentage)



	2014	2015	2016	2017	2018
% achieved at 30% and above	73.8	70.4	70.5	74.4	76.3
% achieved at 40% and above	48.9	46.0	45.2	52.1	51.7

Graph 8.1.2 Performance Distribution Curves in Life Sciences (Percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2014	0.1	6.5	19.6	24.9	19.2	13.1	8.1	5.2	2.8	0.5
2015	0.1	8.3	21.1	24.4	18.2	12.5	7.9	4.8	2.3	0.4
2016	0.1	7.7	21.7	25.3	18.5	12.0	7.5	4.5	2.3	0.4
2017	0.3	7.8	17.6	22.2	19.2	14.4	9.5	5.9	2.8	0.4
2018	0.1	5.6	18.0	24.6	20.6	14.6	9.0	5.1	2.1	0.3

8.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

a. Some candidates were not familiar with basic terminology in the different topics. This resulted in poor performance, even in the lower-order questions.

b. Poor performance is still being recorded in questions based on scientific investigations despite the support provided in the diagnostic reports of previous years.

c. There was also poor performance in homeostasis as well as making drawings in meiosis.

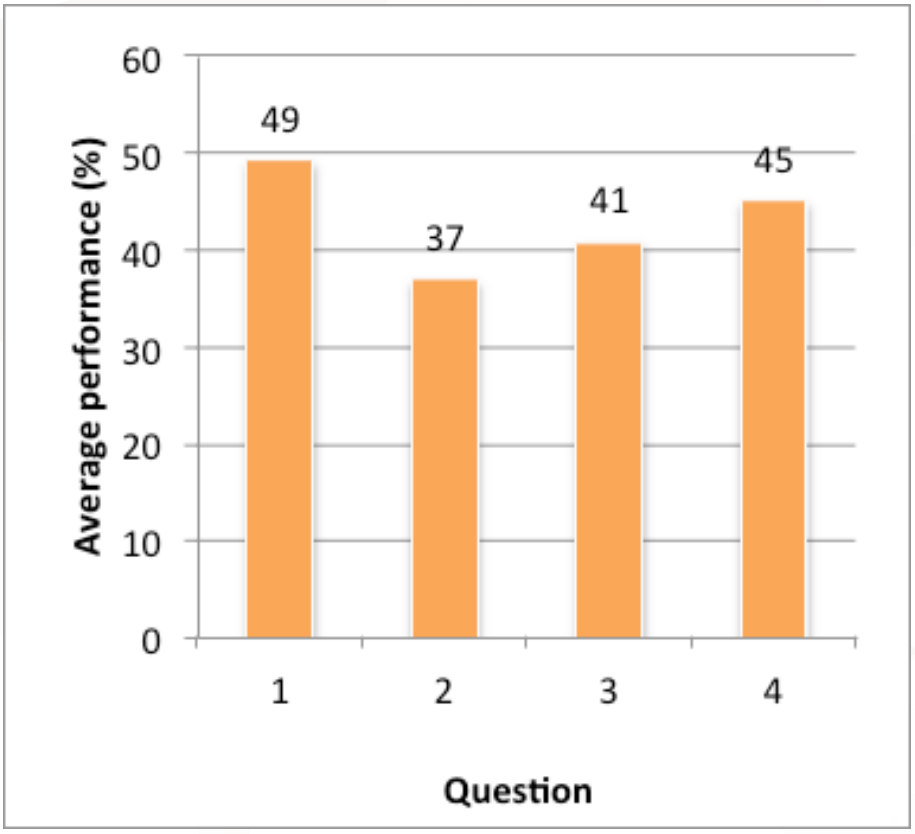
d. The candidates' performance indicates that the work on environmental studies, which was taught in Grade 11, was not revised properly or covered again in Grade 12.

e. Since textbooks do not always carry accurate information, teachers should always be guided by the CAPS and examination guideline documents for Life Sciences.

8.3 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 1

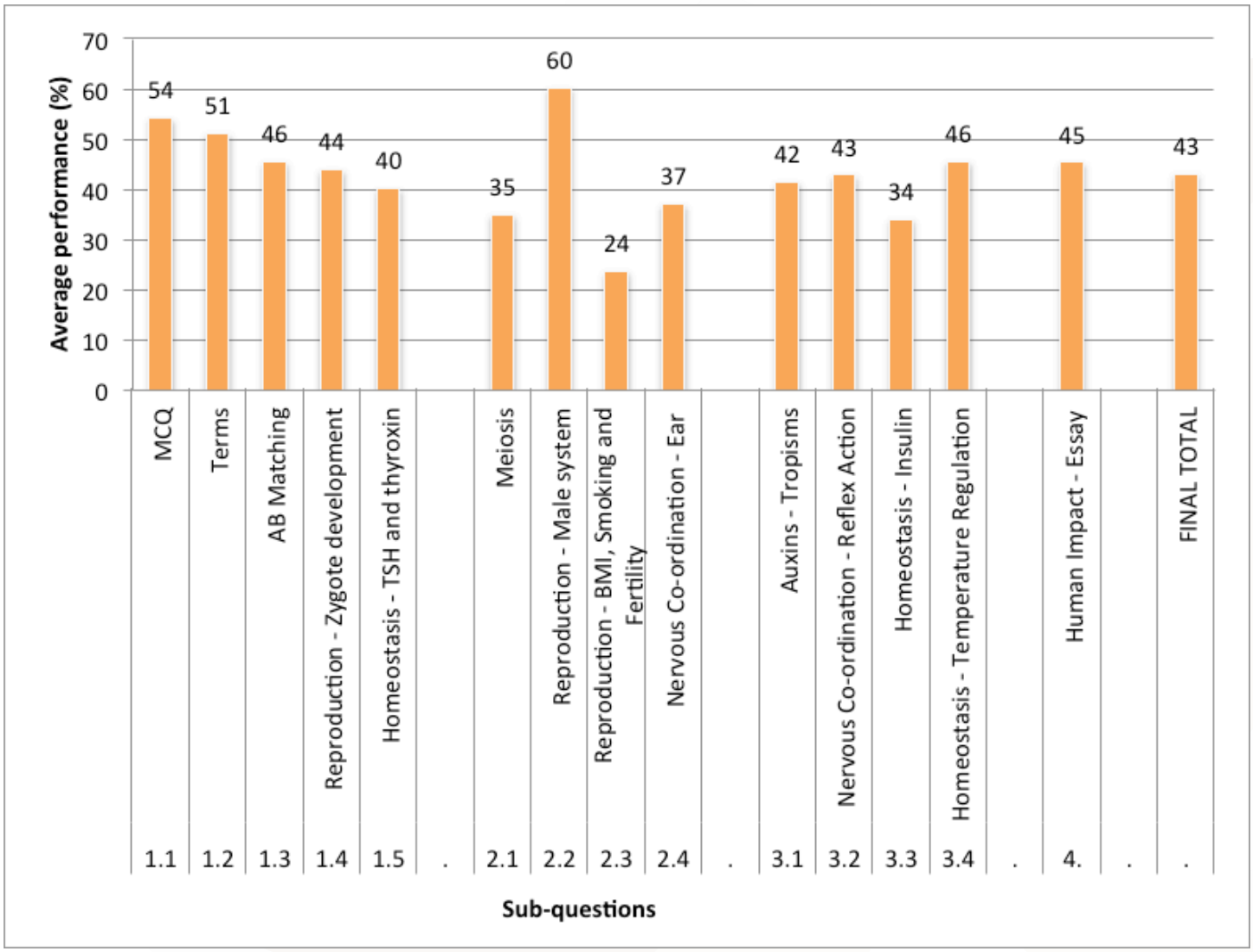
The graph below is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 8.3.1 Average Marks per Question Expressed as a Percentage: Paper 1



Q1	Multiple Choice, Terminology, Matching Items, Foetal development and Homeostasis
Q2	Meiosis, Reproduction and the Ear
Q3	Auxins, Reflex Action, Insulin and Temperature Regulation
Q4	Human Impact

Graph 8.3.2: Average Performance per Subquestion: Paper 1



The worst performance by candidates was recorded in the subquestions on reproduction (based on an investigation), insulin and meiosis.

8.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE CHOICE, TERMINOLOGY, MATCHING ITEMS, FOETAL DEVELOPMENT AND HOMEOSTASIS

Common Errors and Misconceptions

a. In Q1.1, candidates lost marks since they were unable to apply knowledge in multiple-choice items that assessed higher cognitive skills such as in Q1.1.7, Q1.1.8 and Q1.1.10.

b. In Q1.2, biological terms remain problematic for many candidates. From the answers provided, it was evident that candidates confused the following terms:

* Altricial and precocial
* Cerebrum and cerebellum
* Choroid and chorion
* Corpus callosum and corpus luteum

c. In Q1.3, candidates were not able to differentiate between the following:

* Prophase I and Prophase II: Cross over only occurs in Prophase I and not in Prophase II
* Astigmatism and cataract
* Ovipary and ovovivipary

d. Many candidates lost marks in Q1.4 due to a lack of knowledge of the stages in the development of the foetus after fertilisation has taken place. In Q1.4.2, candidates identified meiosis rather than mitosis as the type of cell division represented. Candidates were not able to differentiate between the functional and non-functional extra-embryonic membranes associated with the human foetus in Q1.4.3. Hence, some responses were allantois and yolk sac instead of the chorion and the amnion.

In Q1.4.6, candidates lost marks when they gave the answers 46 + 1 or 23 + 24 whereas the answer was 47. The final answer was required and not a calculation that would lead to the final answer.

e. Candidates provided the name of the hormone when the name of the gland was required and vice versa.

Suggestions for Improvement

a. There needs to be a greater emphasis on the teaching and learning of appropriate terminology related to the various topics, together with the correct spelling of these terms. Teachers should use various strategies to improve the teaching of terminology, many of which have been outlined in the Diagnostic Reports of the previous years.

b. A concerted attempt should be made to differentiate between closely related terms.

c. Learners must be taught to follow the instructions as prescribed in Q1.3. Answers should be written as A only (not A), B only (not B), both A and B (not A + B; A, B; A and B or A/B). Teachers should enforce this in all assessment activities at school.

d. Since human reproduction is a topic that makes up about a third of Paper 1, learners must have a thorough knowledge of the following essential aspects of the topic in order to be successful:

* Structure of male and female reproductive systems (Assessed in Q1.4.5 and Q2.2.5)
* Changes during puberty (assessed in Q2.2.1)
* Menstrual cycle under hormonal control (assessed in Q1.1.1)
* Fertilisation (assessed in Q1.4.1)
* Events after fertilisation leading to foetal development (assessed in Q1.4)
* Role of the extra-embryonic membranes and the placenta (assessed in Q1.1.5 and Q1.4.3)

e. The role of mitosis and meiosis in reproduction must be clarified so that learners do not confuse these two types of cell division as it relates to the topic.

f. It should be emphasised that in humans the allantois and yolk sac are non-functional since the functions of nutrition, gas exchange and excretion are now carried out by the placenta.

g. Certain sections of work, especially those that involve structure (such as the male and female reproductive systems) and processes (such as the process of fertilisation or the development of the foetus after fertilisation), are best taught using diagrams.

h. Teachers should give learners multiple opportunities to label drawings and write in the functions next to the labels. The blank diagrams found in the Mind the Gap study guide will prove useful in this regard.

i. In order to organise information for better storage and retrieval, tables are a useful tool. A table should be developed of the glands of the endocrine system, the hormones they produce and the functions of each hormone. This could assist in ensuring that learners do not confuse the name of the gland with the name of the hormone.

j. Q1.5 assessed candidates' knowledge of the negative feedback mechanism between TSH and thyroxin. Learners are also required to know the negative feedback mechanisms that assist in homeostasis with regard to CO2 levels, salt levels, water levels, glucose levels and temperature regulation.

The *Mind the Gap* study guide presents a useful format for recording, understanding and recalling the different negative feedback mechanisms using a generic format. It consists of the following steps:

Step 1: An imbalance occurs

Step 2: A control centre is stimulated

Step 3: Control centre responds

Step 4: Message sent to target organ(s)

Step 5: The target organ responds

Step 6: It opposes/reverses the imbalance

Step 7: Balance is restored

If we apply this to the negative feedback mechanism that restores thyroxin levels when it is too low, the steps are then made specific as follows:

Step 1	The thyroxin level in the blood decreases
Step 2	The pituitary is stimulated
Step 3	Pituitary gland increases its secretion of TSH
Step 4	TSH travels by the blood to the thyroid gland
Step 5	TSH stimulates the thyroid gland to increase its secretion of thyroxin
Step 6	The thyroxin level in the blood increases
Step 7	and returns to normal

These steps can be applied in a similar way to the other negative feedback mechanisms.

QUESTION 2: MEIOSIS, REPRODUCTION AND THE EAR

Common Errors and Misconceptions

a. In Q2.1.1, many candidates were not able to correctly identify the phases of meiosis represented in the diagram. This is evidence that they are not able to recognise the events of each phase. In some cases, for example, they identified the phase in diagram A as prophase II rather than prophase I. This indicates that they are not aware of the differences between meiosis I and meiosis II.

b. The poor performance in Q2.1 was mainly due to Q2.1.2, which required a drawing of the gametes that result from the cell in diagram C. Many candidates lost marks because they:

* Drew two separate nuclei without cell membranes, thereby not representing cells
* Drew one cell or four cells instead of two cells
* Drew the chromosomes incorrectly in terms of number, size and shading
* Drew replicated chromosomes with centromeres instead of unreplicated chromosomes
* Provided incorrect labels

c. Q2.2 was the best answered question. Where the performance of candidates was poor, it is because they were unable to:

* Access the required information from the extract for Q2.2.2 and Q2.2.4
* Provide the percentage expressed to two decimal places but rounded it off to a whole number instead
* Relate the problem of undescended testes to its influence on the optimum temperature required for sperm production

d. Q2.3 was the worst answered question and this could be linked to poor scientific investigation skills relating to:

* Experimental design
* Identification of independent and dependent variables
* Reliability and validity
* Reading from a graph
* Doing a calculation

e. Q2.3.4 required the identification of a factor that was kept constant. This type of question requires the identification of factors other than the independent variable(s) that may influence the results/dependent variables. Many candidates were unable to do this. Many candidates did not receive credit for factors that should be kept constant, since the question asked for factors that were kept constant.

f. In Q2.3.5 which was based on reliability, learners provided generic answers that may not be related to the data or the specific context of the investigation. For example, increasing sample size did not apply since no information was given to indicate that a larger sample was used in the other country. Candidates were not able to identify from the information provided that the investigation was repeated and that it produced similar results. Based on the information provided in Q2.3.6 this was the factor that increased the reliability of the results of the investigation.

g. In Q2.4.1 candidates often lost marks because of incomplete answers, for example they stated that:

* Part A transmits sound waves but did not indicate that this is towards the tympanic membrane

* Part E equalizes pressure but did not indicate that this is on both sides of the tympanic membrane

* Part F releases pressure but did not indicate that this is from the inner ear

h. In Q2.4.2, candidates seemed unable to differentiate amongst a stimulus, sound waves, vibrations, pressure waves and an impulse and thus used these terms in the wrong context.

i. Candidates were required to *explain* the effect if the receptors were damaged not just state the effect. As a result, many candidates simply wrote hearing will be impaired without describing the cause and thus only received one of the 3 marks.

j. Most candidates were not able to write an account on the amplification of sound. They identified the parts involved but not the features of the parts that made amplification possible.

k. Some candidates had no knowledge of how balance is maintained by the cristae of the semi-circular canals or they provided a full account of balance that also included the role of the maculae of the sacculus and utriculus when this was not relevant.

Suggestions for Improvement

a. Teachers should use strategies that would familiarise learners with the sequence of phases in meiosis as well as the defining events of each phase. The defining events must be observed in the form of diagrams. Blank diagrams from the Mind the Gap study guide could be used. The diagrams in the first column should first be labelled by the learners. Thereafter the defining characteristics of each phase should be written alongside the diagram for each phase. This is a more active form of learning rather than giving learners a sheet where all this information already appears. Another strategy is the use of cards, each of which has a diagram of one of the phases. The cards are then given to learners in a jumbled order for them to sequence. Once this is done, they are required to identify each phase with observable reasons. In addition to the above, the corresponding phases of meiosis I and meiosis II can be placed alongside each other (e.g. prophase I next to prophase II) so that differences can be observed between corresponding phases of meiosis I and meiosis II.

b. Questions on the drawing of diagrams representing different phases of meiosis have appeared in many past examination question papers. Teachers should collate 4-5 such questions from past examination papers to provide practice for learners. In this way learners can master this skill in different contexts.

c. Teachers should help learners differentiate amongst the terms replicated chromosome, unreplicated chromosome, chromatid and daughter chromosome as follows:

Term	Description
Unreplicated chromosome	This refers to a chromosome as it appears before DNA replication takes place.
Replicated chromosome	This refers to a chromosome as it appears after DNA replication takes place. Because of DNA replication all chromosome material is doubled. Hence, each replicated chromosome is made up of two chromatids, joined by a centromere.
Chromatid	This refers to each of the two threads of a replicated chromosome.
Daughter chromosome	This refers to each chromatid after it splits from its sister chromatid during anaphase II and is moving towards the poles.

d. Give learners more practice in questions based on an extract. As an *English Across the Curriculum* strategy, this can be done in the form of a listening exercise where the teacher reads an extract based on the relevant topic after learners have read the questions based on the extract. Learners then answer the questions in writing. Alternatively, it could be done as a reading exercise where learners read the questions first and then the extract. Thereafter, they answer the questions in writing.

e. From the earlier grades, learners should be exposed to scientific investigations, both hands-on and minds-on. Through these investigations learners should become familiar with:

* The aim of an investigation
* Hypothesis formulation
* Experimental design
* Identification of independent and dependent variables
* Reliability
* Validity
* Representing data in tables and graphs
* Interpreting data in tables and graphs
* Doing calculations
* Making conclusions

f. When there are questions on reliability and validity, learners must check if these are asked in the context of what was already done as opposed to what should be done in future to increase reliability and validity. If the question asks *what was done* – then the answer or a clue to the answer will come from the information contained in the question. If the question asks *what should be done* – then the answer must be formulated by the learner. It cannot come from the information contained in the question.

g. In the process of hearing, learners need to know that *sound* coming from a source is the *stimulus*. This stimulus moves as *sound waves* from the source through the auditory canal until it reaches the tympanic membrane. From here the stimulus of sound moves as *vibrations* through the tympanic membrane, ossicles and oval window. When the vibrations pass into the endolymph of the inner ear then the stimulus is in the form of *pressure waves* which then stimulate the organ of Corti. This is when the stimulus is converted into an *impulse* which can be transmitted to the cerebrum.

h. When answering questions based on hearing, learners must state that the impulse is transmitted by the auditory nerve to the cerebrum (not just 'brain'). In the same way, when answering questions based on balance, learners must state that the impulse is transmitted by the auditory nerve to the cerebellum (not just 'brain').

i. Teachers must emphasise that the parts involved in amplification are the tympanic membrane, the ossicles and the oval window. The following features of the structures involved help in the amplification process:

* The sound vibrations move from the large tympanic membrane to the smaller oval window
* The ossicles that transmit the vibrations decrease in size from the hammer to the anvil to the stirrup

The above features concentrate/intensify the sound vibrations causing it to be amplified.

j. For the process of balance, learners must clearly understand the separate role of the cristae and maculae so that they give both aspects if a general account on balance is required or the relevant part when only one aspect is asked for. The following table may help in this regard.

Part of ear	Receptors	Stimulus
Semicircular canals	Cristae	Changes in speed and direction
Sacculus and utriculus	Maculae	Changes in the position of the body

When the above receptors are stimulated the stimulus is converted into an impulse that is transmitted through the vestibular branch of the auditory nerve to the cerebellum. Here the impulse is interpreted and impulses are sent to the muscles of the body (the effectors) to restore balance.

QUESTION 3 AUXINS, REFLEX ACTION, INSULIN AND TEMPERATURE REGULATION

Common errors and misconceptions

a. In Q3.1.4, candidates provided very poorly constructed explanations for the growth response represented. Some provided an explanation involving phototropism whereas it should have been explained in terms of geotropism.

b. Some candidates did not receive full credit in Q3.2.7 since they assumed that pathway B was a reflex action. A careful study of the diagram would have revealed that the impulse is being transmitted to the brain. Fortunately, they could obtain at least 4 of the 6 marks since there was an overlap between pathway A involving a reflex action and pathway B.

c. In Q3.3.2, many candidates were not able to analyse new information provided in the form of graphs to make comparisons regarding many small meals versus a few large meals. Whereas the question asked for the comparison to focus on the effect on insulin levels, candidates were giving differences based on glucose levels.

In addition, some learners lost a mark since they did not present the differences in the form of a table. Suitable answers could have been obtained by comparing the following:

* Maximum insulin concentration
* Minimum insulin concentration
* Frequency of rise and fall in insulin concentration
* Range of insulin concentration fluctuation
* Minimum insulin concentration in relation to minimum level of glucose

d. In Q3.3.3, candidates were not able to link the eating habit (few large meals versus many small meals) to the resulting glucose level in the blood and hence the amount of insulin required to restore glucose levels to normal.

e. Many candidates answered the question in the opposite and did not obtain credit. They explained why the skin temperature of person B was lower rather than explain why the skin temperature of person A was higher.

Suggestions for improvement

a. The definition of a tropism as well as the definitions of phototropism (with light as the stimulus) and geotropism (with gravity as the stimulus) should be clearly outlined to learners.

It is also important to emphasise that auxins have opposite effects in stems and roots, e.g. a high concentration of auxins in the stems promote growth and that a low concentration of auxins in the roots inhibit growth.

Also important is that bending occurs in plant organs when the auxin concentration is different on two sides of a stem or on two sides of a root.

b. A better understanding of negative feedback mechanisms can be achieved using the 7-step process described earlier in this report under Question 2 and which is also elaborated in the *Mind the Gap* study guide under the section on homeostasis.

In addition, when the homeostatic control of glucose level is being studied, teachers should link this to the condition of diabetes.

c. Topics such as temperature regulation should be taught with the use of diagrams. In this way learners will become familiar with the parts involved and will be able to differentiate between diagrams showing temperature control on a hot day versus a cold day, based on observable features.

QUESTION 4 ESSAY ON HUMAN IMPACT

Common errors and misconceptions

a. In the essay in Q4, many candidates did not present their answers clearly under the following expected headings:

* Effect of human activities on global warming
* Impact of global warming on weather patterns
* How weather changes affect food security

b. Candidates often lost the mark for:

* Relevance by including irrelevant information such as ozone depletion, eutrophication and acid rain.
* Logical sequence since they did not present information in a logical fashion. The information was not provided clearly under each of the expected headings.
* Comprehensiveness by answering one or two aspects of the essay in detail or by answering all three parts but not in sufficient detail.

Suggestions for improvement

a. Teachers should offer more opportunities for learners to write answers in essay form. They should inform learners that the essay in Life Sciences does not require an introduction and a conclusion.

b. Greater exposure to answering paragraph-type questions will be a useful step to prepare learners for the writing of essays.

c. Teachers should use the current and past examination essay questions as examples to effectively teach learners the skill of interpreting the question to determine what is required. Key words in the question should be underlined.

d. Learners should be reminded that synthesis is made up of three parts: relevance, logical sequence and a comprehensive answer. The allocation of the synthesis marks should be explained to them and used from Grades 10 to 12.

e. Subject advisors should train teachers on the application of the criteria for synthesis. This can be done by giving different teachers the same sample script to mark to which synthesis marks are allocated. This should be followed by a discussion with reasons on whether the answer in the sample script should be awarded a mark for each aspect of synthesis.

8.5 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 2

General comments

a. Many candidates were not familiar with basic terminology in the different topics. This resulted in poor performance even in lower-order questions.

b. Some candidates had problems distinguishing between action verbs, especially between *describe* and *explain*.

c. Certain problem areas mentioned in previous reports, for example investigations which form part of the work throughout the year, remain a challenge to some candidates.

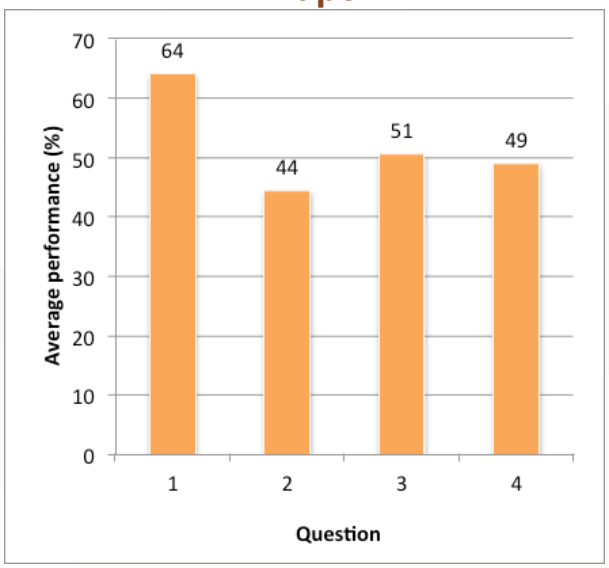
d. Candidates' performance indicates that they are still experiencing difficulty in certain aspects of meiosis, genetics and evolution.

e. Since textbooks do not always carry accurate information, teachers should always be guided by the *CAPS* and *Examination Guideline* documents for Life Sciences.

8.6 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 2

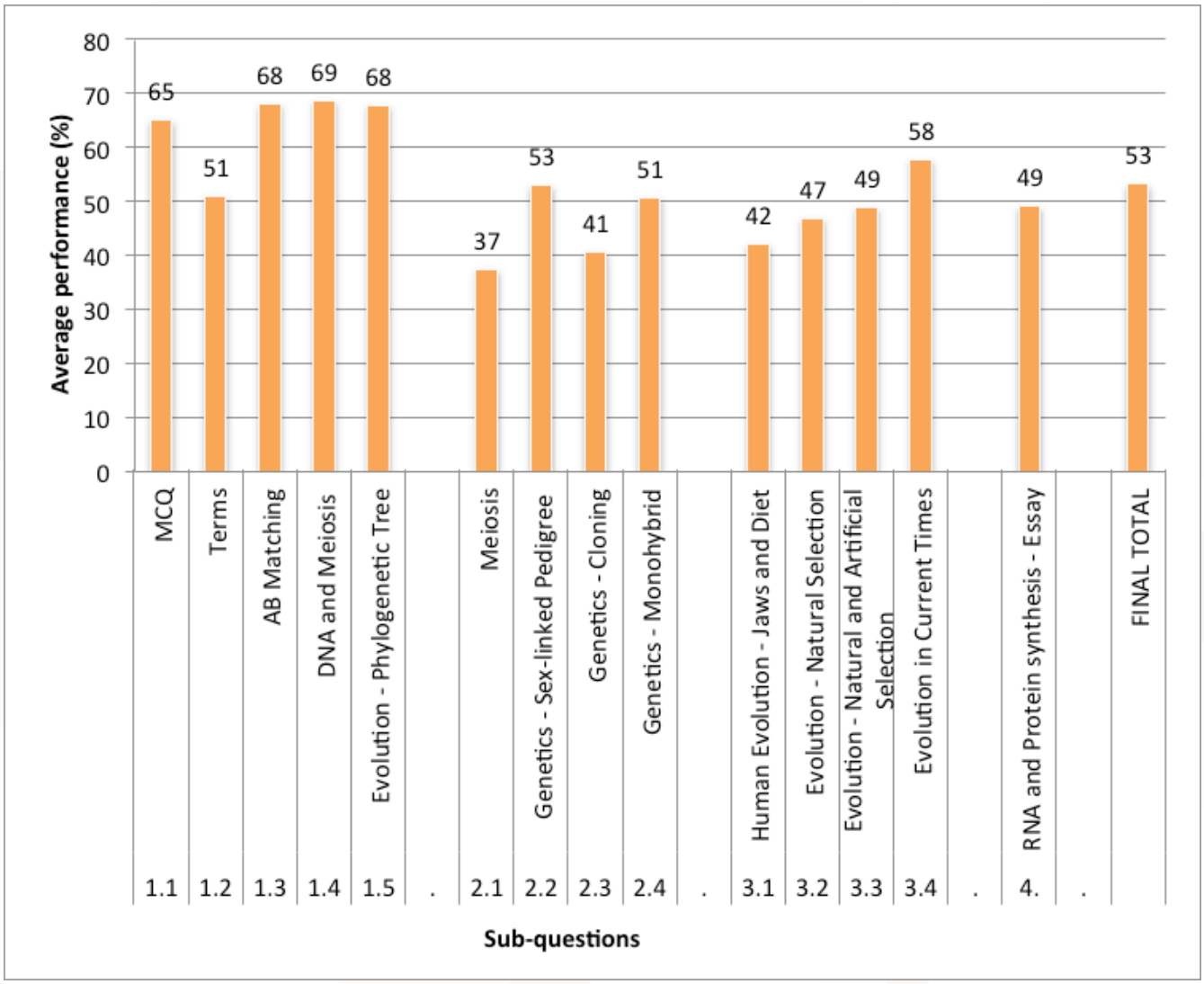
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 8.6.1 Average marks per question expressed as a percentage: Paper 2



Q1	MCQ, Terms, AB Matching, DNA & Meiosis, Phylogenetic Tree
Q2	Meiosis, Genetics
Q3	Human Evolution, Natural Selection, Evolution in Current Times
Q4	RNA & Protein Synthesis - Essay

Graph 8.6.2 Average performance per subquestion: Paper 2



The worst performance by candidates was recorded in Q2.1 on meiosis, Q2.3 on cloning and Q3.1 on human evolution. The best performance was recorded in Q1.

8.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1 MULTIPLE CHOICE, TERMINOLOGY, MATCHING ITEMS, DNA AND CHROMOSOMES AND PHYLOGENETIC TREE

Common errors and misconceptions

a. In Q1.2, candidates experienced difficulty with the correct spelling of biological terminology. Poor spelling often changes the meaning of the term causing candidates to lose marks.

b. Some candidates could not differentiate between different terms e.g. genotype and gene pool instead of genome; multiple alleles instead of alleles.

c. In Q1.2.4, candidates incorrectly noted natural selection as the process whereby new species are formed. The correct answer was speciation. Allopatric speciation was not accepted as this term refers to a specific type of speciation. This once again attests to the poor attention paid to the teaching and learning of terminology.

d. Some candidates lost marks in Q1.4.2 because they could not provide the correct answer for the number of chromosome pairs found in a normal human somatic cell. They gave the answer as 46 and was not credited. The question asked for the answer in pairs and hence the only answer was 23 pairs.

e. In Q1.4.3, some candidates gave the letter and name when the question asked for only the letter. In cases where the candidates gave the name only and not the letter, they were not credited.

f. In Q1.5.3, candidates could not differentiate between a pedigree diagram and phylogenetic tree.

Suggestions for improvement

a. There needs to be a greater emphasis on the teaching and learning of appropriate terminology related to the various topics, together with the correct spelling of these terms. Teachers should use various strategies to improve the teaching of terminology which have been outlined in the Diagnostic Reports of the previous years.

b. Teachers must use the correct terminology when teaching and incorrect spelling must not be credited from the onset of studying Life Sciences. Poor spelling often changes the meaning of a term and may result in the loss of marks.

c. Learners must follow the instructions as prescribed in Q1.3. Answers should be written as A only (not A), B only (not B), both A and B (not A + B; A, B; A and B or A/B). Teachers should enforce this in all assessment activities at school.

d. Teachers should clearly clarify differences between related terminologies e.g. alleles and multiple alleles; haemophilia and haemophiliac; genome, gonosome and genes.

e. Teachers should give learners multiple opportunities to label drawings and write in the functions next to the labels. The blank diagrams found in the *Mind the Gap* study guide will prove useful in this regard.

QUESTION 2 MEIOSIS, SEX-LINKED PEDIGREE DIAGRAM, CLONING AND MONOHYBRID CROSS

Common errors and misconceptions

a. In Q2.1, candidates who lacked basic knowledge of concepts such as *non-disjunction*, *Down syndrome* and *crossing-over,* performed poorly in this question as the question expected candidates to apply their knowledge and use their reasoning skills in answering the questions on the above-mentioned concepts.

b. Candidates could identify that non-disjunction occurred but most attributed this to anaphase II instead of anaphase I which was not the case in this question, given the nature of shading of the chromosomes.

   Instead of explaining that non-disjunction of a homologous pair resulted in two chromosomes moving to one pole and none moved to the other pole, they just repeated the question and mentioned that were two chromosomes in the two cells and none in the other two cells which is already shown in the diagram.

c. In Q2.1.2, candidates had to describe how *Down syndrome* may result if gamete A was involved in fertilisation. They did not read the introductory sentence and question and incorrectly identified gamete A as a female gamete although it was mentioned in the introductory sentence that the diagrams represented the distribution of chromosome pair 21 at the end of meiosis in a human male.

   Many could not identify that gamete A had 24 chromosomes (or an extra chromosome at pair 21) and that when gamete A fused with a normal ovum it would lead to a zygote with 3 chromosomes at position 21 instead of two.

   They did not explain how three copies of chromosome 21 was a result of the fusion of the abnormal sperm cell with a normal ovum at fertilisation.

d. Some candidates failed to explain in Q2.2.2, how individual number 5 inherited the disorder. Instead, they described the mother's genotype and why she has the disorder without understanding that if she has two recessive alleles (X^dX^d), her son will inherit the X^d allele from his mother. Learners wasted time explaining about the father's genotype. Some also used the terms *allele, gene* and *chromosome* interchangeably and therefore incorrectly.

e. Candidates could not reason in Q2.3.3 that an ear cell was used in the *cloning* of the calf because an ear cell is a somatic/diploid cell and contains all the genetic information and that an ovum is a haploid cell which contains only half of the genetic information.

   They only referred to the somatic cell of a donor being removed instead of the nucleus of the somatic cell and the nucleus of the ovum being removed. Some confused cloning in Q2.3.4 with genetic engineering and were referring incorrectly to stem cells being used.

f. In Q2.4.3, they confused *Mendel's Law of Dominance* with the required *Law of Segregation.* They also confused *alleles* and *genes*. Most candidates referred to two alleles instead of two alleles for a trait and also wrote that the chromosome pairs/ chromosomes separated instead of separated during meiosis.

g. Some candidates still used their own letters for the genotype in Q2.4.4 and therefore lost marks. Care must be taken on the position of *meiosis* and *fertilisation* in the format of a genetic cross.

Suggestions for improvement

a. Teachers must encourage learners to clearly state every fact and not only mention an extra chromosome without indicating in gamete A or at position 21.

b. Careful attention to defining the term 'cloning' as well as the details of the process of cloning is recommended. The memorandum can be used as a guideline here for a short, concise and precise summary of the cloning process.

   Learners must be given more practice in writing information in paragraph form especially for the different processes encountered in the various topics.

c. Learners often use the terms chromosome, chromatid, replicated chromosome, unreplicated chromosome and daughter chromosome in the incorrect context. Refer to the suggestions for improvement under Q2 of Paper 1 for a clarification of these terms.

d. Teachers should use the memorandum to teach a concise description of the process of cloning, as well as for stating Mendel's Law of Segregation.

QUESTION 3 HUMAN EVOLUTION, NATURAL SELECTION, NATURAL AND ARTIFICIAL SELECTION AND EVOLUTION IN CURRENT TIMES

Common errors and misconceptions

a. In Q3.1.1, instead of giving observable differences in the jaw of the chimpanzee and Homo sapiens, some candidates referred to more and less prognathous when this feature was not observable in the given diagram.

   Some candidates gave differences between the pelvis of the chimpanzee and Homo sapiens, which indicates that they did not read the question carefully.

b. Many candidates failed to provide a definition for transitional species (Q3.1.3(a)) and they did not include intermediate characteristics in their explanation. As a result, they struggled to provide the structural features to support *Australopithecus* as a transitional species between the chimpanzee and Homo sapiens in Q3.1.3 (b).

   They also compared different features, for example, teeth in one species and jaw shape in the other species as opposed to looking at a common feature in all three species e.g. considering the shape of the palate in *Australopithecus* and comparing it to that of the chimpanzee and Homo sapiens.

c. In Q3.2.2, some candidates gave a general explanation of Darwin's theory of evolution through natural selection without referring to the king snakes and hence lost most of the marks.

d. Some candidates could not extract information from the graph and conduct the necessary calculation to determine the percentage increase in the oil content.

e. Some candidates were still confused as to how to identify the independent and dependent variables. This shows that these candidates did not refer to the aim of the investigation to determine the two variables.

   Even when the variables were correctly identified, the answers were incomplete and consequently they lost marks. They gave answers such as herbicide instead of type of herbicide and time instead of time it takes to develop resistance to herbicide.

f. In Q3.4.4, many candidates could not apply their knowledge about validity and reliability.

g. Some candidates drew a line graph or a bar graph, thus losing most of the 6 marks in Q3.4.5.

   Many candidates did not use a ruler to draw the bars and as a result a mark was lost for scaling which includes the width of the bars and the spaces between the bars.

Suggestions for improvement

a. Learners should be made aware that questions should be read carefully before attempting to answer them.

b. Teachers need to provide learners with more data response questions to practice on and should include at least one of these types of questions in each test. Newspaper articles or internet websites such as *Science Daily* have good resource material that could be used to train learners on comprehension skills.

c. Examination techniques should be considered and taught to learners by teachers. For example, if asked for a comparison in a question, be sure to refer to both organisms given in the question in your answer. Learners must be taught to compare features directly, where the same feature is written in both columns of the table in directly the same row, with just the difference between the feature being given.

d. The concept of transitional species should be emphasised in Grade 10 when learners are taught History of Life, where the *Archeopteryx* is a transitional fossil between reptiles and birds.

e. Learners must be taught to refer to the specific example provided when explaining natural selection in an application question, rather than providing a general account on natural selection. The table below shows how a general account can be made more specific.

General account on natural selection (As required in a Level A recall question)	Specific account on natural selection (As required in a Level C application question)
There is variation in the offspring✓	There is variation in the colour of kingsnakes✓
Some have favourable characteristics✓	Some kingsnakes are bright in colour✓/resemble the coral snakes
Some have unfavourable characteristics✓	Some kingsnakes are dull in colour✓
Those with unfavourable characteristics die✓	Those with dull colours are killed✓ by predators
Those with favourable characteristics survive and reproduce✓	Those with bright colours are not eaten✓/they survive and reproduce
They pass the allele for the favourable characteristic to their offspring✓	They pass the allele for bright colour to their offspring✓
In this way the proportion of offspring with favourable characteristics increase over many generations✓	In this way the proportion of offspring with bright colours increase over many generations✓

f. Learners should be taught how to do percentage increase calculations using the following formula: (new value minus old value) divided by the old value x 100.

g. Dependent and independent variables must be identified from the aim of an investigation and must be written in full. Do not use column headings from a table as a primary way of identifying the dependent variable. The column heading may not correctly reflect the dependent variable – it may sometimes be a way of measuring the dependent variable. For example, a table may have information on the 'number of bubbles released by a plant per minute' but this is simply a measure of the rate of photosynthesis which is the actual dependent variable.

h. Teachers must encourage learners to read the given text with understanding, and even underline the important information to note, before attempting to answer the questions. Learners *must study the information and data first before attempting the questions.* Independent and dependent variables should be identified from the aim of the investigation.

i. Teachers need to teach learners to differentiate between validity and reliability in scientific investigations, because the principles of validity and reliability are fundamental cornerstones of the scientific method.

j. Drawing of graphs in grade 10, 11 and 12 cannot be over-emphasised. Teachers should provide learners with the marking criteria that will be used to mark the graph. In this way, learners will become familiar with the different components of graph drawing for which they will receive credit.

QUESTION 4 RNA AND PROTEIN SYNTHESIS

Common errors and misconceptions

a. Candidates described the whole process of transcription. They discussed protein synthesis in general without focusing directly on the involvement of the different types of RNA in protein synthesis. This showed that the learners lack the skill of extracting core information relevant to the question. They merely wrote everything they knew about the question and this led to many learners losing the mark for relevance when awarding the synthesis mark.

b. The candidates' responses also displayed a lack of planning in terms of structuring their essays, for instance when discussing RNA structure the plan should have included the general structure of RNA, then the structure of messenger RNA and transfer RNA. This would have guided them on the second part of the essay to focus only on the involvement of the different types of RNA in protein synthesis instead of explaining the entire process.

c. Many candidates used the terms nucleotides and nitrogenous bases in the incorrect context. They also associated the terms codons and anticodons with the incorrect type of RNA.

d. A large number of candidates only stated that RNA has the nitrogenous base uracil instead of thymine, but did not give the other 3 nitrogenous bases, and so could not be credited with a mark.

e. Candidates incorrectly identified the *peptide* bond as occurring between mRNA and tRNA, instead of being between adjacent amino acids. They also incorrectly identified the bond as being a polypeptide bond.

f. Several candidates compared DNA and RNA which also caused them to lose the mark for relevance.

g. Some candidates wrote key words instead of writing full sentences.

h. Candidates also lost the mark for logical sequence where they muddled the involvement of the different types of RNA in protein synthesis. For example, they wrote on translation first and then on transcription.

Suggestions for improvement

a. Teachers need to emphasise to learners that the format of the Life Sciences essay is not similar to that of a 'language essay', i.e. there is no need for an introduction and conclusion.

b. The skill of writing an essay should start from Grade 10. Teachers must give essay questions on each chapter as practice and also review answers until the skill is mastered.

c. Learners should be guided on how to break down the question into the different sections by identifying what is being asked. They should be taught to write each section as a separate paragraph and stick to the section within that paragraph to obtain the mark for logic and relevance.

d. Teachers should emphasise the importance of *logic* in essays where *processes* are involved. Events must be presented in the correct sequence to obtain credit for logical sequence.

e. Teachers should use the current and past examination essay questions to effectively teach learners the skill of interpreting the question to determine what is required. Key words in the question should be underlined.

f. Teachers must use the *Mind the Gap* study guide to assist learners in the use of mind maps in the planning of an essay.

g. Learners should be reminded that synthesis is made up of three parts: relevance, logical presentation and a comprehensive answer. The allocation of marks for synthesis should be explained to them and implemented from grades 10 to 12.