CHAPTER 8
LIFE SCIENCES

The following report should be read in conjunction with the Life Sciences question papers of the November 2017 Examination.

8.1 PERFORMANCE TRENDS (2014 – 2017)

The number of candidates who wrote the Life Sciences examination in 2017 decreased by 29 339 in comparison to that of 2016. The performance of the candidates in 2017 reflects a marked improvement at the 30% level to 74,4% and at the 40% level to 52,1%.

Table 8.1 Overall achievement rates in Life Sciences

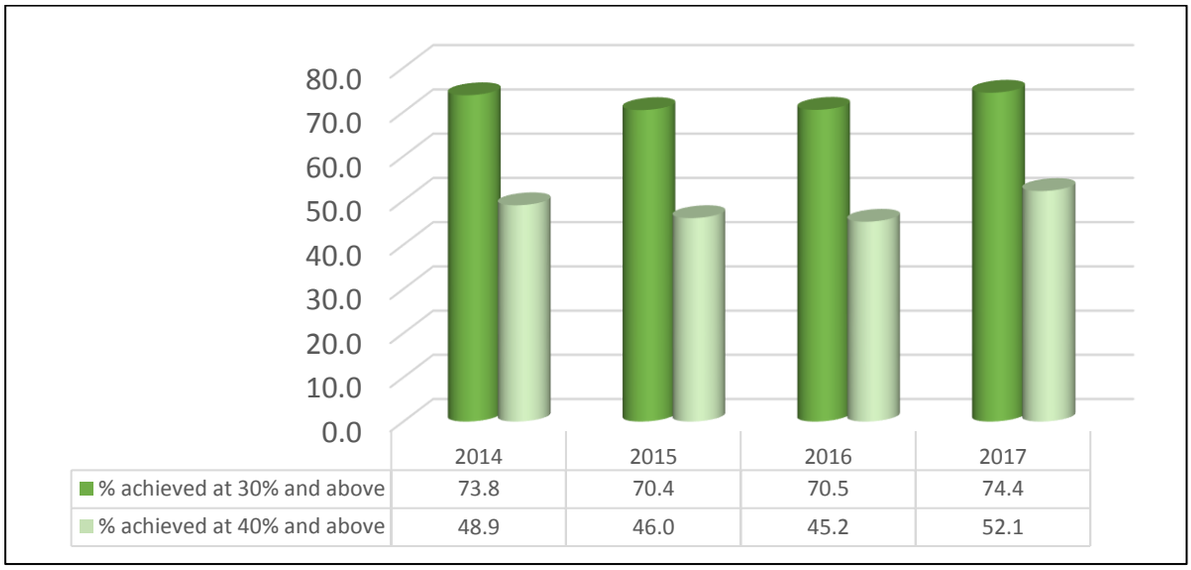
Year	No Wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2014	284 298	209 783	73.8	139 109	48.9
2015	348 076	245 164	70.4	160 204	46.0
2016	347 813	245 157	70.5	157 224	45.2
2017	318 474	236 809	74,4	166 071	52,1

Over the years there has been an improvement in the writing of essays and the drawing of graphs. There are, however, certain areas that require more attention in order for the results to improve in a meaningful way.

A strengthening of content knowledge in topics, such as Genetics and Evolution, will greatly enhance the performance in especially Paper 2. These two topics comprise approximately 110 of the 150 marks in Paper 2. One of the challenges in improving performance is that there are many teachers who are not confident in these two topics. 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.

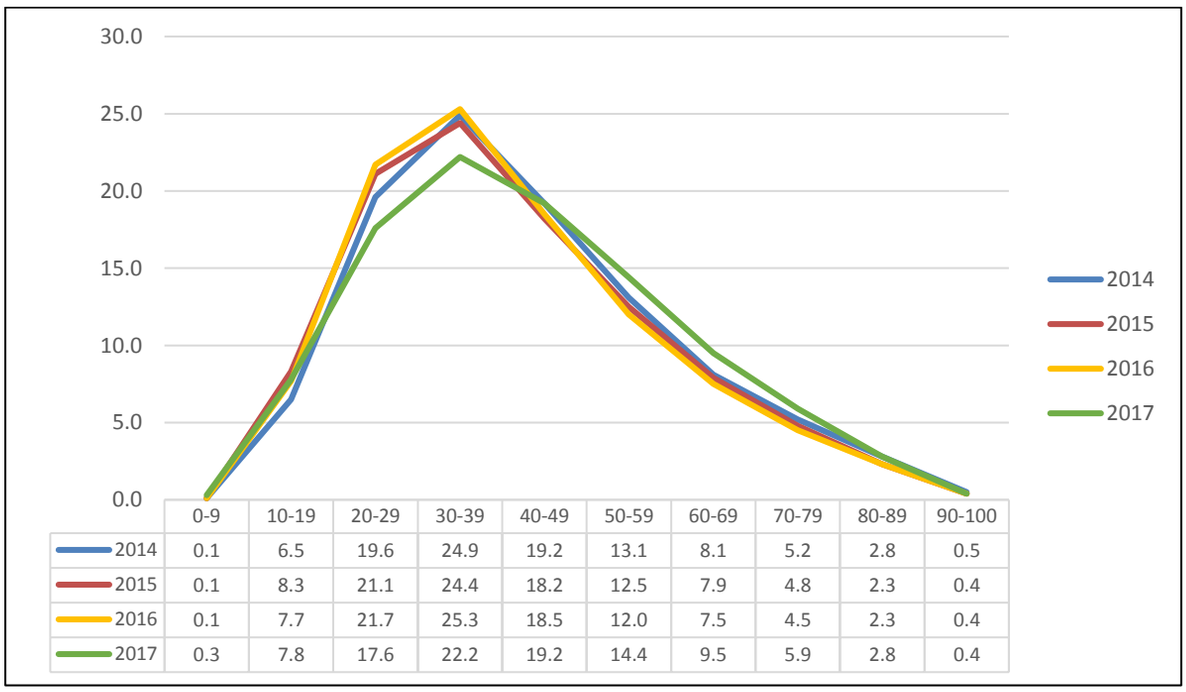
Another area of poor performance remains the questions on scientific investigations which appear in Paper 1 and Paper 2. If this area can be strengthened from the earlier grades, performance can improve. This is also an area in which teachers must first be supported.

Graph 8.1.1 Overall achievement rates in Life Sciences (percentage)



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

Graph 8.1.2 Performance distribution curves in Life Sciences (percentage)



	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	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

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

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

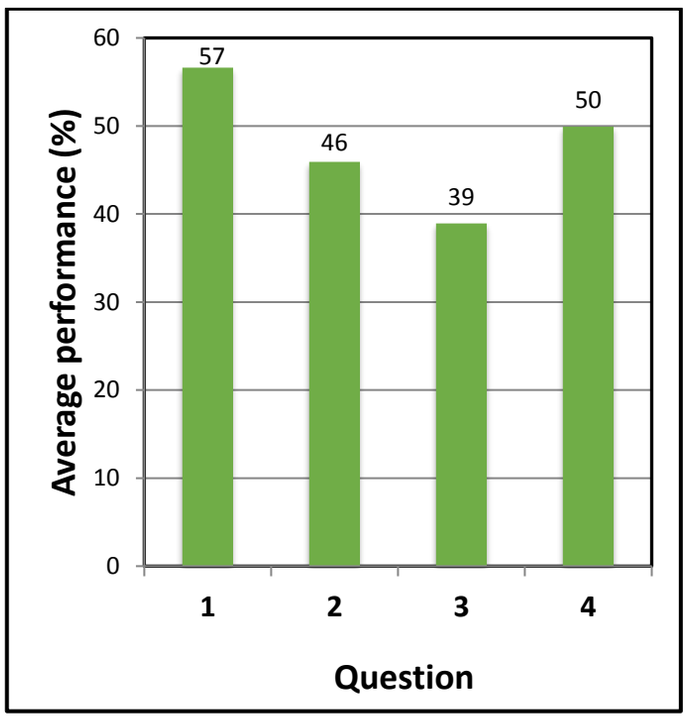
(d) The candidates' performance indicates that the work on environmental studies, which was taught in Grade 11, was not revised properly or covered again in Grade 12.

(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

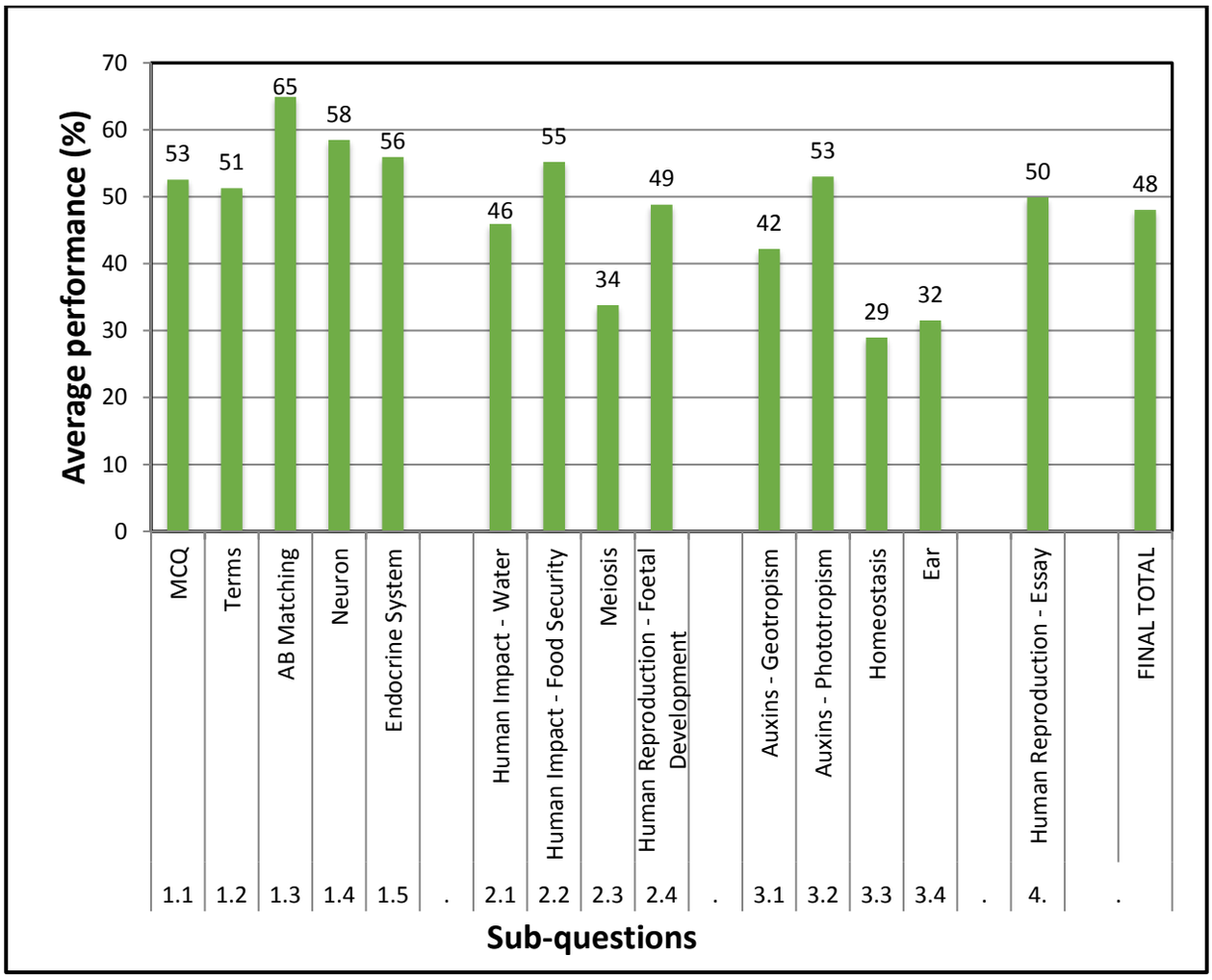
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 8.3.1 Average marks per question expressed as a percentage: Paper 1



Q1	Multiple Choice, Terminology, Matching Items, the Neuron and Homeostasis
Q2	Human Impact (Water Availability and Food Security), Meiosis and Foetal Development
Q3	Plant Hormones, Endocrine System, the Ear
Q4	Spermatogenesis, Formation and Transport of Semen, Structural suitability of Sperm

Graph 8.3.2: Average performance per sub question: Paper 1



The worst performance by candidates was recorded in the sub questions on Homeostasis (scientific investigation), the Ear, Meiosis, Geotropism and Human Impact on the Environment.

8.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE CHOICE, TERMINOLOGY, MATCHING ITEMS, THE NEURON AND HOMEOSTASIS

Common errors and misconceptions

(a) Poor performance in Q1.1 showed that candidates lacked a basic knowledge of terminology. Candidates lost marks since they were unable to:

- Correctly identify correct functions for different parts of the eye
- Differentiate between receptors and effectors; the cerebrum and the cerebellum

- Apply knowledge in multiple-choice items that assessed higher cognitive skills.

(b) In Q1.2, biological terms remain problematic for many candidates. Candidates were not able to differentiate between *internal* and *external* fertilisation; *aldosterone* and *ADH*; *LH* and *progesterone*. In addition, candidates were not able to differentiate between the process of crossing over and the *chiasma* as the point of crossing over.

(c) In Q1.3, candidates were not able to differentiate between *vivipary* and *ovovivipary* or between *precocial* and *altricial* development. This once again attests to the poor attention paid to the teaching and learning of terminology.

(d) Many candidates lost marks in Q1.4 either because they could not differentiate between a *motor neuron* and a *sensory neuron* or they could not correctly match functions to the relevant parts of the neuron represented.

(e) It is also evident from Q1.2.7, which required a disorder related to the eye (astigmatism), and from Q1.4.4, which required a disorder related to the neuron (multiple sclerosis), that the relevant disorders are not being taught and learnt effectively.

(f) In Q1.5.3, candidates confused the hormone *glucagon* with the carbohydrate *glycogen*.

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 Report of the previous years.

(b) 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.

(c) Learners should be given sufficient practice to understand the instructions contained in questions. Some questions prescribe that only a LETTER is required, whereas at other times a LETTER and a NAME is required.

(d) 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: HUMAN IMPACT (WATER AVAILABILITY AND FOOD SECURITY), MEIOSIS AND FOETAL DEVELOPMENT

Common errors and misconceptions

(a) In Q2.1.3, many candidates were not able to perform the required calculation on percentage increase in the amount of water in the dams in the North West.

(b) In Q2.1.5, which required strategies to reduce the water shortages, many candidates lost marks because they:

- Provided strategies related to water restrictions when the question specifically asked for strategies *other than* water restrictions.
- Provided strategies relevant to individuals or households rather than providing strategies relevant to the level of the provincial government, as required by the question.
- Stated strategies without stating how they contribute to a reduction in the water shortage. In other words, candidates stated rather than explained the strategies.

(c) In Q2.1.6, candidates did not express their answers in a cause-effect sequence which is what is required in a question that asks one to *explain*. They listed issues that are outcomes from building a dam without linking them to how they negatively impact on the environment.

(d) In Q2.2.1, many candidates did not get full credit since they provided incomplete definitions of *food security*.

(e) In Q2.2.2, candidates provided a *word* or a complete *sentence* rather than a *phrase* and therefore did not receive credit.

(f) In Q2.2.4, many candidates did not realise that they had to select the correct answer from the three options provided in the brackets despite this format having been used in past examination papers.

(g) In Q2.2.5, just as in Q2.1.6, candidates did not express their answer in a cause-effect sequence which is what is required in a question that asks one to *explain*. They listed issues which are related to the armyworm and its activities without linking them to how they negatively impact on the economy.

(h) Q2.3.2, which required visible reasons for the identification of Telophase II, was very poorly answered. Many candidates provided general characteristics of Telophase II. Some of these characteristics did not receive credit since only characteristics that are unique to Telophase II and which do not apply to any other phase, could receive credit. See below for some examples of answers that did not receive credit, with a corresponding reason.

Reason for identification of Telophase II	Reason for not receiving credit
Cells are genetically different	The cells are genetically different in all phases from Telophase I onwards not just in Telophase II
The resulting cells are haploid	The cells are haploid in all phases from Telophase I onwards not just in Telophase II

(i) In Q2.3.4, most candidates were able to identify *crossing over* as one source of variation. Many candidates were not able to identify the *random arrangement of chromosomes* as another source of variation. They often cited *random assortment* or *independent assortment* instead and therefore did not receive credit.

(j) In Q2.4.4, which asked about the negative impact on foetal development, many candidates simply said that development would be affected or that there would be underdevelopment which was a repetition of what was in the question and therefore they did not receive credit. They were required to explain an example of such underdevelopment. Here again, candidates did not express their answers in a cause-effect sequence which is what is required in a question that asks one to *explain*.

Suggestions for improvement

(a) Calculating the method to increase or decrease a percentage should be emphasised as follows:

- For the two values provided, find the numerical difference (if not already given).
- Then divide this difference by the original or first value.
- Then multiply by 100 to obtain a percentage increase or decrease.

(b) Give learners more practice in questions that need an explanation. Answers to explanation questions from past marking guideline documents should be used to show learners how these answers should be formulated and how marks are allocated.

Learners must express their answers in a cause-effect sequence which is often what is required in a question that asks one to *explain*. In Q2.1.6, for example, the question required a learner to first state the immediate outcome of building a dam and then linking it to how it negatively impacts on the environment. Two possible answers from the marking guideline document below illustrate this.

Immediate outcome of building a dam	Negative impact on the environment
Habitats are destroyed✓	which will lead to a loss in biodiversity✓
When flood gates are opened, flooding may occur in the areas downstream from the dam✓	resulting in erosion✓/loss of top soil

(c) Learners should be taught how to write full definitions to receive full credit. A full definition of *food security*, for example, involves the following elements:

- Access by all people
- To good quality food
- In sufficient quantities
- At all times

(d) Using extracts, teachers should allow learners to distinguish between a *word*, a *phrase* and a *sentence*. In relation to Q2.2.2, for example, which asks about alien species, the following applies:

Word: Endemic

Phrase: Endemic to North and South America

Sentence: A crop-destroying caterpillar species (commonly known as the army worm) endemic to North and South America is spreading rapidly in Africa, including South Africa, and is raising concerns about food security.

(e) In addition to knowing the general characteristics of each phase of meiosis, learners should also learn which of those characteristics are unique to that phase and no other phase. Only then can these characteristics be used as reasons for the identification of a phase. For example, a *correct answer* for the identification of Metaphase I is that the 'chromosomes arrange at the equator in homologous pairs'. This happens only in Metaphase I and in no other phase. An *incorrect answer* would be that the 'chromosomes arrange at the equator'. Even though it is characteristic of Metaphase I, it is not a unique characteristic of Metaphase I since it is also true for Metaphase II. The difference is that in Metaphase II, the chromosomes arrange at the equator in a single row and not in homologous pairs.

(f) Teachers should unpack the following terms for learners: random arrangement of chromosomes, random assortment of chromosomes and independent assortment. Although these terms are related, each has a different meaning.

Random arrangement of chromosomes

- This is characteristic of Metaphase I and II of meiosis.
- The chromosomes could come to lie at the equator randomly/in different combinations.
- In humans, where the diploid number of chromosomes is 46, there are more than 8 million combinations.
- This will result in genetic variation in the gametes produced at the end of meiosis.

Random assortment of chromosomes

- The chromosomes or chromatids move away from the equator during Anaphase I and II until they reach the poles during Telophase I and II respectively.
- The combination in which the chromosomes or chromatids move to the poles depends on the random arrangement of chromosomes at the equator during Metaphase I or II.
- The random assortment of chromosomes in itself is not a source of variation since it is dependent on the random arrangement of chromosomes at the equator.

Independent assortment

- A pair of alleles of a gene, which controls each characteristic, is found on homologous chromosomes.
- Each pair of chromosomes arranges at the equator independently of another pair because of the random arrangement of chromosomes.
- The way in which one pair of chromosome therefore assorts into the resulting gametes will not influence the way in which another pair assorts into the gametes.
- The inheritance of any characteristic therefore occurs independently of any other characteristic.
- This is independent assortment and is due to random assortment of chromosomes caused by the random arrangement of chromosomes at the equator.

QUESTION 3: PLANT HORMONES, ENDOCRINE SYSTEM, THE EAR

Common errors and misconceptions

(a) In Q 3.1.1, candidates provided very poorly constructed definitions and therefore lost marks. Many gave definitions of *phototropism* or *geotropism* instead of the general term *tropism*.

(b) Candidates lost marks for the drawing in Q3.1.2, because they did not:

- Have a caption or had an incorrect caption
- Provide appropriate labels
- Show the new direction of growth of the radicle and plumule

(c) In Q3.2.2, many candidates provided an *explanation* rather than a *description*. It was also clear that some candidates did not know the meaning of *unilateral light*.

(d) There was a general problem to identify the *independent variable* and the *dependent variable* and how the dependent variable was measured in Q 3.3.2.

(e) In Q3.3.5, candidates lost marks because they could not:

- Interpret information in the table
- Relate thyroxin to metabolism
- Relate metabolism to oxygen consumption
- Relate metabolism to weight loss

(f) It is evident that there is still confusion between *reliability* and *validity* in Q3.3.6.

(g) In Q3.4.1, part D was often identified as the *oval window* instead of the *round window*.

(h) In Q3.4.3, due to poor reading and interpretation of the question, many candidates included an account on the role of the *sacculus* and *utriculus* in balance when the question only asked for the role of the semi-circular canals. In addition, many learners indicated that impulses would be transmitted to the cerebrum instead of the cerebellum. The question asked 'how balance is maintained'. Many candidates stopped at the impulses reaching the cerebellum and did not speak about impulses then being sent to the muscles to restore balance.

(i) Many candidates found it difficult to apply their knowledge in Q3.4.4. This may be due to either a lack of the required knowledge, or difficulty in unpacking the question.

(j) In Q3.4.5, candidates provided a function of structure A rather than indicating the consequence of the fusion of part A. Although the consequence can be gauged from the function, the answer must be formulated to meet the requirements of the question. Many candidates were not able to arrange their answers appropriately in a cause-effect sequence.

Suggestions for improvement

(a) *Tropism* should be defined as a growth movement of plant organs in response to an external stimulus. Take note of the following in the definition:

- *Growth* movement is important in the definition as there are other movements known as nastic movements that are not accompanied by growth and is therefore not a tropism.
- *Plant organs* are mentioned since the entire plant may not respond to the external stimulus. For example, unilateral light will only influence the growth movement of the stem and not the root.
- *External* stimulus is mentioned since movements caused by internal stimuli in plants are called nastic movements and not tropisms. Many candidates did not address one or more of the aspects required by the question or did not address all three aspects adequately and were therefore not awarded the synthesis mark for comprehensiveness.

(b) Many candidates gave irrelevant information, for example a detailed description of fertilisation when this was not required, and hence lost the mark for relevance.

(c) When candidates provided accounts on spermatogenesis or the formation and transport of sperm that were out of sequence, they lost a mark for logical sequence.

(d) For spermatogenesis, many candidates provided information in excess of what is required by the examination guideline document.

(e) Many candidates provided incomplete answers for the structural suitability of the sperm. They often mentioned the name of the part without stating the role it plays and hence only received 1 of the 2 marks for each answer. Other candidates provided more than three adaptations. Only the first three were marked since the question asked for just THREE adaptations. Even if their fourth answer was correct, it did not receive credit.

Suggestions for improvement

(a) Teachers should offer more opportunities for learners to write answers in essay form. Teachers 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 deliberately 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) Learners should be advised that two marks are generally allocated to each structural adaptation of the sperm, one mark for the part/structure and the second mark for the role it plays, as shown in a few of the answers below:

Structure	The role it plays
The acrosome✓	contains enzymes to dissolve a path into the ovum✓
The tail✓	enables sperm cells to swim✓ to the ovum
Many mitochondria✓in the middle piece	to provide energy✓ for the sperm movement

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 lost marks for not following the instructions in the questions.

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

(c) Some candidates had problems distinguishing between action verbs, especially between *describe* and *explain*.

(d) 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.

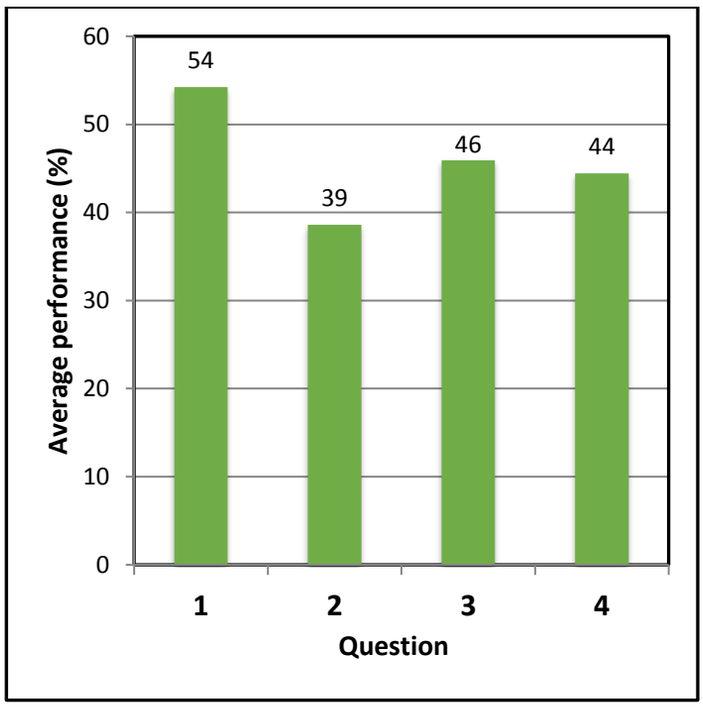
(e) Candidates' performance indicates that they are still experiencing difficulty in certain aspects of genetics and evolution.

(f) 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

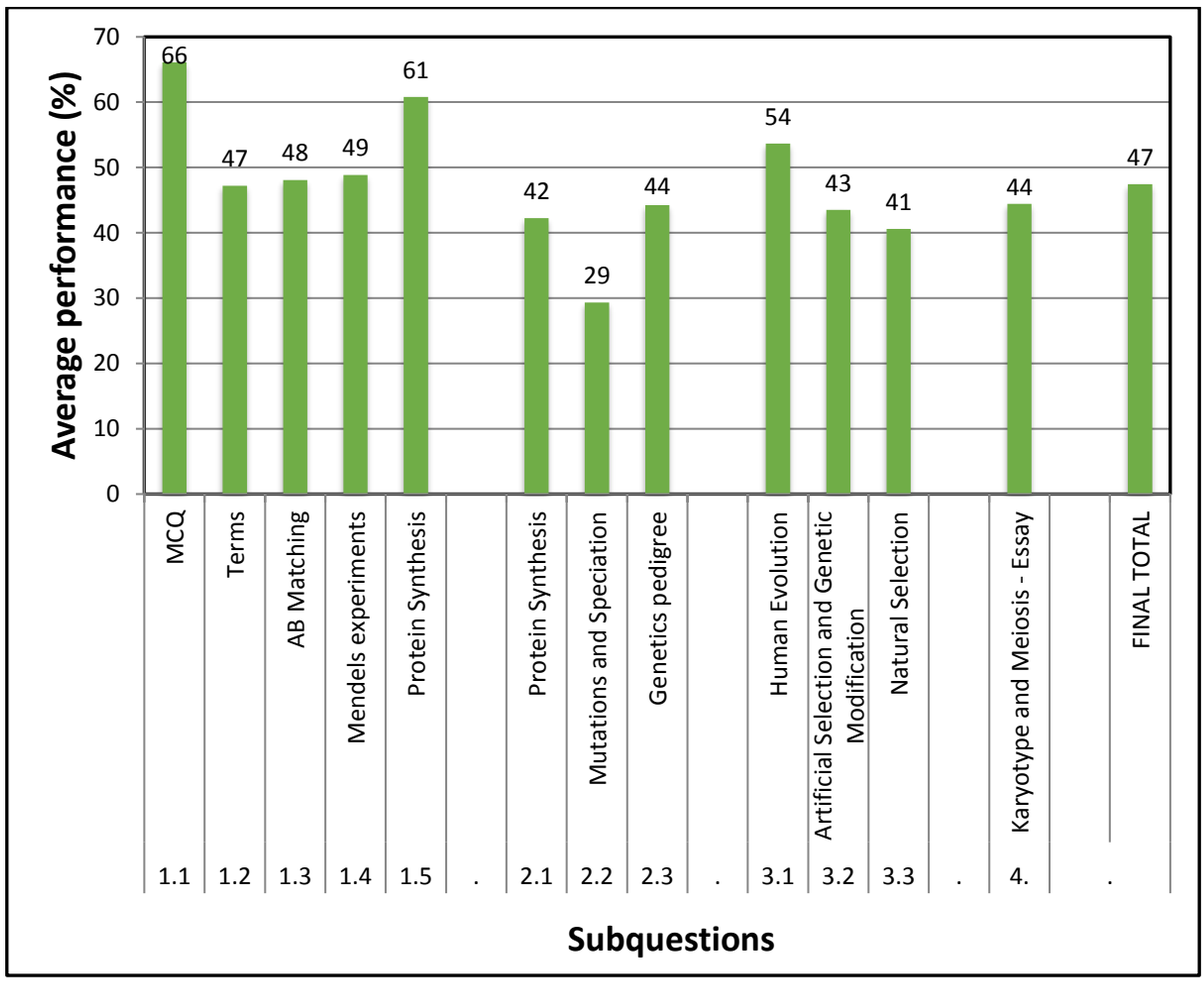
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

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



Q1	MCQ Terms AB Matching Mendel's experiments Protein Synthesis
Q2	Protein Synthesis Mutations and Speciation Genetics pedigree
Q3	Human Evolution Artificial Selection and Genetic Modification Natural Selection
Q4	Karyotype and Meiosis - Essay

Graph 8.6.2 Average performance per subquestion: Paper 2



The worst performance by candidates was in Q2 on mutations and speciation and protein synthesis. In Q3 performance in natural selection, artificial selection and genetic modification were problematic.

8.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: MULTIPLE CHOICE, TERMINOLOGY, MATCHING, MENDEL'S EXPERIMENT AND PROTEIN SYNTHESIS

Common errors and misconceptions

(a) Poor performance in some items in Q1.1 was evidence that candidates:

- Were not familiar with the concept of *multiple alleles* in blood group in humans
- Did not recall the various reproductive isolating mechanisms

- Could not use given information and interpret a key to identify the required genotypes and phenotypes

(b) In Q1.2, biological terminology once again posed a great challenge to many candidates. They also had trouble with the correct spelling of the terminology. They could not differentiate between *continuous* and *discontinuous variation*, *biogeography* and *biodiversity*, *genetic modification* and *artificial selection*.

(c) In Q1.2.2, some candidates incorrectly referred to the use of biological processes, organisms or systems to improve the quality of human life, as 'genetically modified organisms' instead of genetic modification. The question clearly referred to a *process* and not the *result* of the mentioned process.

(d) In Q1.2.9, many candidates were not familiar with the difference between a family name, a species name and a common name. Hominidae was confused with hominids, *Homo sapiens* and hominins.

(e) In Question 1.4.1(a), candidates failed to give the correct term for the inherited factors and incorrectly used the term *genetics* instead of *genes* or *alleles*.

(f) In Question 1.4.2, candidates had to give the female structure of the flower where meiosis occurs. Many candidates wrote *ovum* or *oogenesis* instead of *ovary*.

(g) In Question 1.4.3 (a) and (b), some candidates could not interpret information from the table and therefore could not give the correct number of the characteristics of the pods used. They incorrectly wrote the names of the characteristics (texture colour) and the variation of these characteristics (round, wrinkled, yellow and green) instead of the *number* and lost marks for not following the instruction in the question. Some could not differentiate between a *characteristic* and an *allele*.

(h) In Q 1.4.5 again, candidates lost marks since they provided the actual phenotypes rather than the *number* of different phenotypes that will result.

(i) In Q1.5.1, candidates identified the process as protein synthesis whereas the question asked them to identify a process that occurs during protein synthesis and some also incorrectly identified it as *transcription* instead of *translation*.

(j) In Q1.5.2(c), candidates incorrectly answered *hydrogen bond* instead of *peptide bond* as they were clearly confused between the bonds (peptide) that exists between amino acids with the bond that exists between nitrogenous bases in a DNA molecule (hydrogen bond).

(k) In Q1.5.3, some candidates still gave names when letters were asked for.

Suggestions for improvement

(a) There needs to be a greater emphasis on the learning of appropriate terminology related to the various topics, together with the correct spelling of these terms. Poor spelling often changes the meaning of the term and hence learners lose marks. Teachers should use the following strategies to improve the teaching of terminology:

- Learners must be made aware of the principles of marking, e.g. poor spelling often changes the meaning of the term, and learners will not be credited.
- Identify new terms in every lesson and write them on the board. Teachers should also pronounce the terminology correctly.
- Instruct learners to take down terms at the back of their notebooks, noting the correct spelling.
- Clarify the difference between related terminology, e.g. *biogeography* and *biodiversity*.
- Encourage learners to write down the meanings of these words by being attentive during the lesson or by finding the meaning in a dictionary or textbook.
- Make learners aware of the meanings of new terms by using them in sentences.
- Include biological terms in all daily assessment tasks.
- Ensure that by the end of the year, all learners have a comprehensive glossary of all terms.

(b) Teachers should also highlight the differences between different concepts, e.g. *characteristic* and *allele, ovum, ovule* and *ovary; peptide bond* and *weak hydrogen bond* and state clearly where each is applicable.

(c) Teachers should give learners multiple opportunities to answer questions based on data provided. Guidance should be provided to learners on how to read/interpret the data given in order to use the clues provided to answer the questions set, such as in Q1.4 on genetics and 1.5 on protein synthesis.

(d) Teachers should teach learners to read questions with understanding to enable them to follow the instructions in the question papers. If they are required to give the 'letter only', then they should do just that.

QUESTION 2: NUCLEIC ACIDS, GENETICS AND MEIOSIS

Common errors and misconceptions

(a) In Q2.1.1, some candidates could not differentiate between *codons* and *nitrogenous bases*. This was evident as some candidates gave the answer for the number of codons for phenylalanine as 3, showing that they counted the number of nitrogenous bases in one codon for phenylalanine.

(b) It is evident from Q2.1.2 and 2.1.3 that candidates still have a problem differentiating between a *codon* and an *anticodon*. In addition, they are not able to use information from a table to identify the required amino acid using a given codon or anticodon.

(c) In Q2.1.4, some candidates could not describe the mutation that occurred and failed to explain the effect of the mutation. Action verbs such as *describe* and *explain* are problematic for

candidates. Candidates are also still giving 'point mutation' as an answer. This is no longer in the *CAPS* and *Examination Guideline* but is obviously still being taught.

(d) Candidates did not use the given table to find out if the new codon formed after the mutation codes for a different amino acid. Most candidates were of the opinion that a mutation will always lead to a formation of a different protein, which was not the case in this question.

(e) The majority of the candidates failed to apply their knowledge in Q2.2. In fact, Q2.2 was the most poorly answered question in Paper 2. This question was on speciation and mutation and it was a higher-order question. Candidates provided a general account on speciation without contextualizing it to the specific example given in the question.

(f) In Q2.2.1, many candidates could not give the correct definition of a *population*. They said it is a group of organisms that could interbreed, but failed to add that they could produce fertile offspring and found in the same area at a particular time.

(g) In Q2.2.2, candidates used the term 'random assortment of chromosomes' instead of 'random arrangement of chromosomes'.

(h) In Q2.2.3, candidates gave a generic description of speciation through geographical isolation without applying it to the given example in the question. The question did not require the entire account on speciation anyway.

(i) Most candidates referred to organisms *adapting* to the environmental conditions which makes this deterministic. However, these organisms already possessed the favourable characteristics that arose through mutation that made them better suited to the environment.

(j) In Q2.2.5, candidates could not give a correct description to confirm that squirrels belong to different species. They could not link the concept that different species cannot interbreed to produce fertile offspring.

(k) In Q2.3, the interpretation of a pedigree diagram with a sex-linked disorder is still a challenge for many candidates. They did not mention the gender of Senzo as part of the phenotype. They did not give the correct recessive allele, i.e. some wrote $X^H X^h$ instead of using the letter $X^D X^d$ as given in the question. They also failed to explain why males are mostly affected by the disease.

Suggestions for improvement

(a) Learners must be taught to read questions carefully, noting what exactly is required of them. They should be taught what it means when the words *describe* and *explain* are used (refer to suggestions for improvement in the report for P1). They must also take note of the mark allocation for a question.

(b) Learners should be given sufficient exercises on how to do 'base pairing in protein synthesis' i.e. from DNA to mRNA (codons) to tRNA (anticodons) to amino acids, and the reverse process.

(c) Teachers and learners must closely consult the *Examination Guidelines* and the *CAPS* document where the two types of mutations given are 'chromosome' and 'gene' mutations. Further details on gene mutations such as point and frame-shift mutations are not required.

(d) Learners must be taught to apply protein synthesis to the context of the question asked, for example a mutation may or may not result in a change to the protein manufactured. This is the result of an amino acid sometimes having more than one codon or anticodon that codes for it.

(e) Teachers need to clearly distinguish among 'allele', 'chromosome' and 'characteristic/trait'.

(f) Learners must have copies of the *Examination Guidelines* and teachers should also interpret the *Guidelines* and indicate the relation of some topics, for example, speciation, variation, mutation and meiosis to learners.

(g) When learners are required to give THREE causes of variation, the principle of marking the first three only applies. Teachers must apply this rule in their class tests and school-based assessments so that learners become familiar with this principle.

(h) Teachers need to explain the difference between 'random assortment', 'random arrangement' and 'independent assortment' to prevent confusion in the classroom and in assessments. See report for Paper 1 where these terms have been clarified.

(i) Teachers should provide multiple opportunities for learners to answer questions based on an application of the concept of speciation. Guidance must be given on how to contextualize the general account to the specific example stated in the question.

(j) The Y chromosome in males must specifically be referred to as being shorter than the X chromosome and as such unable to carry the full complement of alleles found on its gonosome partner (X chromosome) and that the allele for some traits does not appear there. The Y chromosome therefore, has an absence of some alleles, especially in sex linked disorders studies.

QUESTION 3: HUMAN EVOLUTION, ARTIFICIAL SELECTION AND GENETIC MODIFICATION AND NATURAL SELECTION

Common errors and misconceptions

(a) In Q3.1, the interpretation of data on human evolution has improved compared to previous years. Most candidates knew the types of evidence used to support human evolution in Q3.1.1. However, some gave examples of cultural evidence, such as tools and this was not credited as the question asked for types of evidence and not examples.

(b) In Q3.1.3, candidates had difficulty in giving the correct response on how the brain volume of a fossil could be estimated. They could not distinguish between the *skull* and the *cranium*. Instead of measuring the *volume* of the *cranium,* they referred to *size* of the *skull*.

(c) In Q3.1.5 (a), candidates could not interpret what was given in the table. They only gave the period of existence of *Homo habilis* and *Homo erectus* from the table. From this information, they were required to deduce and state that there was a period of overlap of their existence.

(d) In Q3.1.6, when drawing of the graph, candidates did not provide the correct caption although it could be extracted from the question easily. They did not read the question well as they plotted all the data in the table instead of just plotting the data for the genus *Homo*. Candidates did not adhere to plotting bars of the same width with equal spacing between the bars. They also lacked the skill of providing the correct scale, e.g. in the Y axis, some learners would just transcribe the data as found in the table, as a result some had 1500 first and then 1400. There is still some confusion between a bar graph and a histogram.

(e) In Q3.2.4, candidates showed poor application of knowledge. They did not understand the extract resulting in them just copying from the text. Even though the process of marcotting was explained in the text, they could not link the marcotting process to artificial selection. They also failed to explain how the marcotting process differs from genetic modification.

(f) In Q3.3.1, some candidates mentioned beach and mainland the variable instead of stating that the variable is the habitat, similarly, for fur colour, they wrote light or dark fur. When a variable is asked for, learners are expected to provide a single term, not the specific variations of that variable.

(g) In Q3.3.3, candidates did not understand that reliability had already been ensured in various ways. They therefore gave generic answers instead of looking for the correct information in the experimental procedure. The focus was on what was done and not what can be done.

(h) In Q3.3.4, candidates confused the answer and instead of giving a conclusion they gave the result.

(i) In Q 3.3.6, candidates failed to identify the shortcomings of a simulation. This shows that learners are lacking practical skill no 7 which deals with designing investigations and includes identifying the shortcomings of an experimental design.

Suggestions for improvement

(a) 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.

(b) Teachers should provide multiple opportunities for learners to interpret textual and other information. Special attention should be given to strategies that will assist learners with identifying the key information in the text so that it could be used as clues in the answering of the questions. Teachers must select appropriate material from other sources, for example newspapers and science journals, and not only from textbooks.

(c) 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.*

(d) Independent and dependent variables should be identified from the aim of the investigation. For example, in Q3.3, scientists investigated the relationship between the chances of mice having been attacked and the colour of the fur of mice in two different habitats. The independent

variables are *fur colour* and *habitat* and the dependent variable is *the chances of mice having been attacked*. See the Paper 1 report for a clear difference between *independent* and *dependent* variable.

(e) 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. See the Paper 1 report for a clear distinction between these two concepts.

QUESTION 4: KARYOTYPE AND MEIOSIS

Common errors and misconceptions

(a) Most learners performed fairly well in the part dealing with behaviour of chromosomes during Meiosis I but description of the arrangement of chromosomes in a normal karyotype was poorly answered.

(b) Some candidates did not understand that the question asked for the *behaviour of chromosomes* in Meiosis I and gave a full description of the process of Meiosis I, e.g. nucleolus disappearing in Prophase I and cytokinesis occurring in Telophase I.

(c) Candidates were able to state that there are 46 chromosomes and that males have XY and females XX chromosomes and that chromosomes are arranged in homologous pairs. Many candidates failed to mention that homologous chromosomes are similar in length, carry genes for the same characteristics and have alleles of a particular gene at the same loci.

(d) Candidates stated that a chromosome consists of chromatids and the centromere but did not state that a chromosome is made up of a pair of chromatids *joined* by centromere.

(e) Candidates stated that there are 23 chromosomes in a karyotype rather than 23 *pairs* of chromosomes. They made the same mistake with the autosomes saying that there are 22 autosomes instead of 22 *pairs* of autosomes.

(f) Instead of focusing on a normal karyotype, candidates described what happens in an abnormal karyotype and mentioned nondisjunction which leads to Down's Syndrome. This led to candidates not being awarded the mark for relevance.

(g) Some candidates also described Interphase and DNA Replication which were irrelevant to the essay since Interphase is not a part of meiosis, but occurs in preparation for meiosis.

Suggestions for improvement

(a) Teachers need to emphasize 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 and synthesis refers to the style/format of the 'essay' and not to a process that needs to be described.

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

(c) Teachers should emphasize the importance of *logic* in essays where *processes* are involved. Events must be presented in the correct sequence to get credit for logical sequence.

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

(e) The events of the different phases of meiosis should be taught using annotated diagrams to clearly show what happens during each phase.

(f) Teachers must emphasise that the phases of Meiosis I start from prophase and not interphase.

(g) Teachers must refrain from using words like *middle*/*centre* for the word *equator* in Metaphase.

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

(i) 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 used from grades 10 to 12.