CHAPTER 9

LIFE SCIENCES

The following report should be read in conjunction with the Life Sciences question papers of the November 2015 Examination.

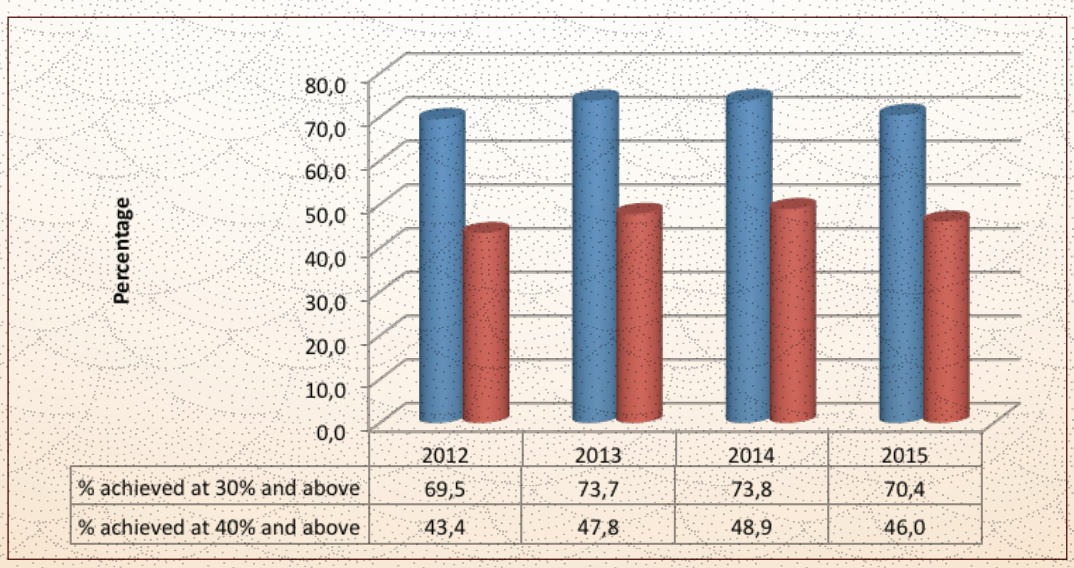
9.1 PERFORMANCE TRENDS (2012 – 2015)

The number of candidates increased by 63 777 in comparison to that of 2014. The general performance of candidates decreased this year as indicated by 70.4% of candidates achieving 30% and above, with 46.0% achieving 40% and above.

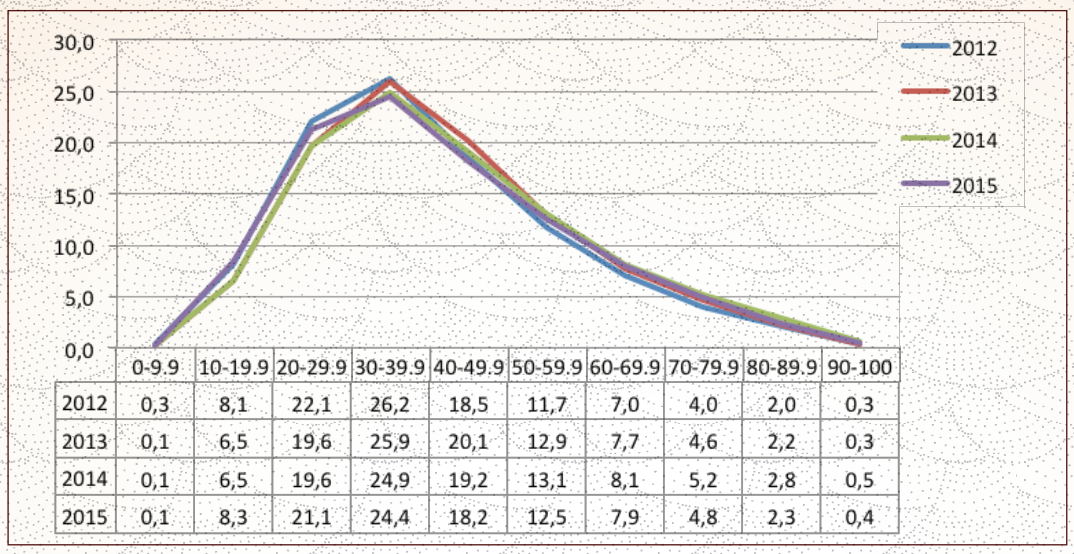
Table 9.1 Overall achievement rates in Life Sciences

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
2012	278 412	193 593	69.5	120 734	43.4
2013	301 718	222 374	73.7	144 355	47.8
2014	284 298	209 783	73.8	139 109	48.9
2015	348 076	245 164	70.4	160 204	46.0

Graph 9.1.1 Overall achievement rates in Life Sciences



Graph 9.1.2 Performance Distribution Curves in Life Sciences



	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
2012	0,3	8,1	22,1	26,2	18,5	11,7	7,0	4,0	2,0	0,3
2013	0,1	6,5	19,6	25,9	20,1	12,9	7,7	4,6	2,2	0,3
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

From the above graphs, it is evident that after the improvement in the previous three years, there has been a disappointing decrease in the performance of candidates in 2015.

9.2 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 performances, even in the lower-order questions.

(b) Some candidates had problems distinguishing between action verbs such as state, suggest, describe, explain and discuss.

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

(d) Some parts of the work e.g. the functioning of the autonomic nervous system and homeostasis (control of the carbon dioxide levels), were poorly answered.

(e) Candidates' performance indicates that the questions on environmental studies which were taught in Grade 11 were not revised properly or covered again in Grade 12.

(f) Since textbooks do not always carry accurate information, teachers should always be guided by the CAPS document and Examination Guideline for the Life Sciences.

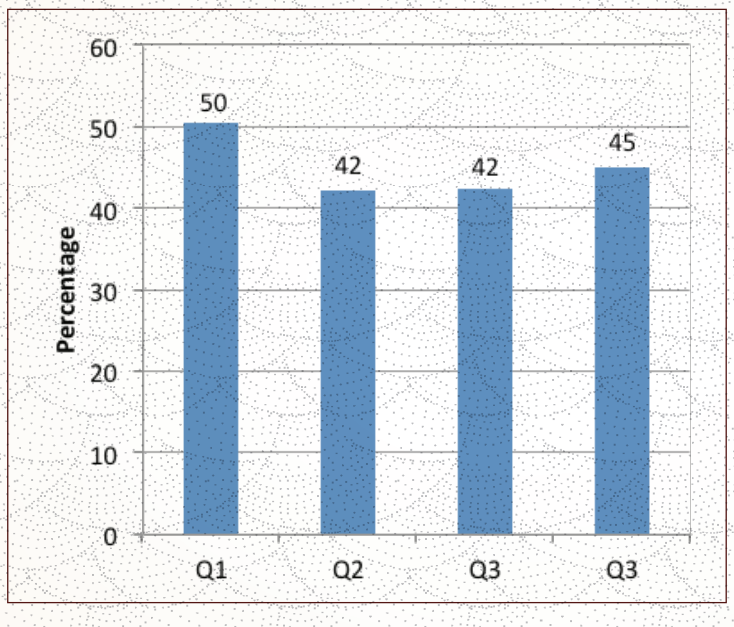
(g) Candidates generally performed better in Question 1 when compared to the marks they acquired in the rest of the paper.

(h) Although some candidates performed well and obtained high scores in the essay, many candidates could not identify the aspects that needed to be described in the question and wrote on everything, losing marks for the synthesis.

9.3 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 1

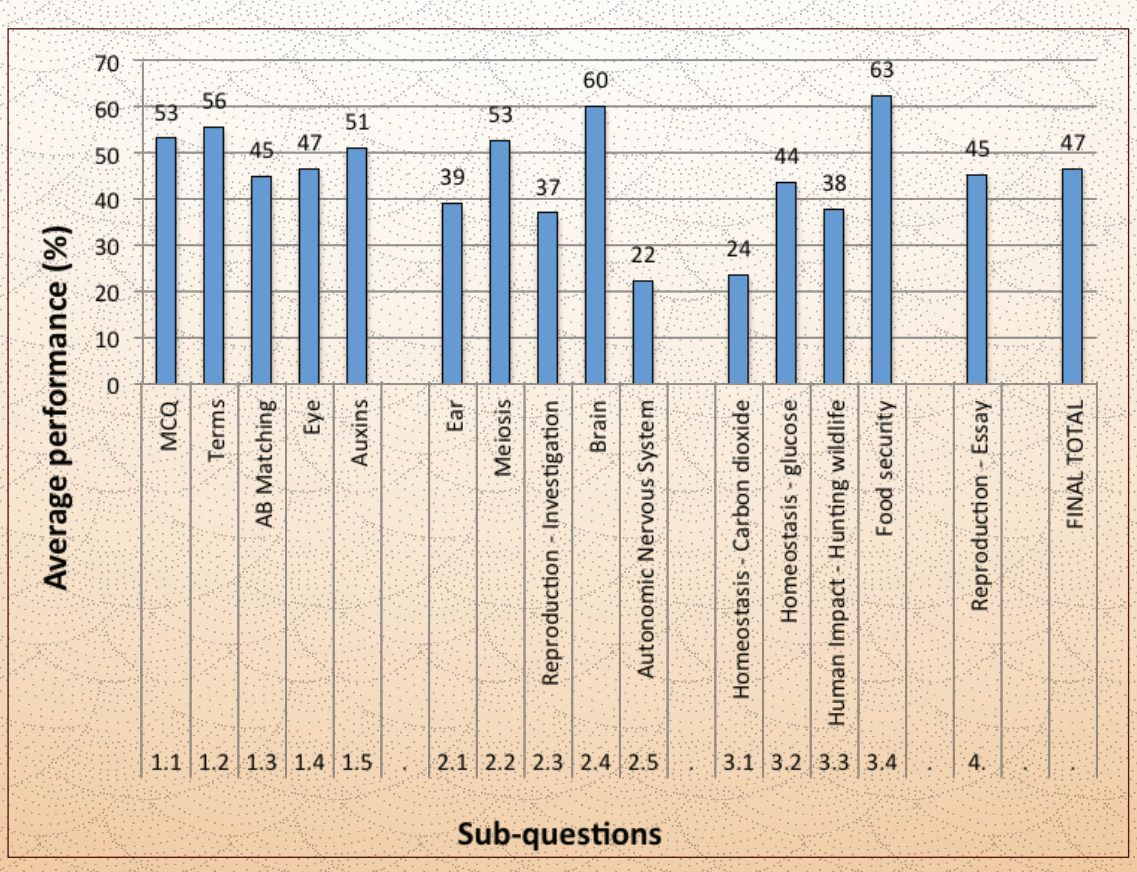
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 9.3.1 Average marks per question expressed as a percentage: Paper 1



Q1	Multiple Choice, Terminology, Matching, Eye and Plant Hormones
Q2	Ear, Meiosis, Scientific investigation on Reproduction and the Nervous System
Q3	Homeostasis, Scientific investigation and Human Impact on the Environment
Q4	Human Reproduction

Graph 9.3.2: Average performance per sub-question: Paper 1



The worst performance by candidates was recorded in the sub-questions on the functioning of the ear, the investigation on reproduction, the functioning of the autonomic nervous system, homeostasis (carbon dioxide) and human impact.

9.4 ANALYSIS OF LEARNER-PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1 MULTIPLE CHOICE, TERMINOLOGY, MATCHING, EYE AND PLANT HORMONES

Common errors and misconceptions

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

- Correctly identify the functions of adrenalin.
- Differentiate between internal and external fertilisation.
- Differentiate between reliability and validity.
- Interpret the graph provided.

(b) In Q1.2, biological terms remained problematic for many candidates. Some candidates did not use the correct scientific names but used common names instead.

(c) In Q1.3, candidates did not follow the instructions when answers were given. For example, they wrote *A+B* or *A, B* and sometimes *A/B* instead of *both A and B*. In Q1.3.1, candidates were not able to differentiate between the characteristics of internal and external fertilisation.

(d) Many candidates lost marks in Q1.4 because they only wrote the letter or name instead of the LETTER and the NAME of the part represented. In Q1.4.1(a), many candidates lost marks as they provided the answer *ciliary body* instead of *ciliary muscle*.

(e) In Q1.5.1, candidates provided the answer *geotropism* instead of *phototropism* although the information in the drawing showed the stimulus above the plant hence alluding to light as a stimulus rather than gravity. Many candidates also lost marks in Q1.5.5, indicating a lack of knowledge about apical dominance.

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. Teachers should use the following strategies to improve the teaching of terminology:

- Identify new terms in every lesson and write them on the board.
- Instruct learners to take down terms at the back of their notebooks, noting the correct spelling.
- Encourage learners to write down the meanings of these words, as ascertained by being attentive during the lesson or by finding the meaning in a dictionary or textbook.
- Break down the term where possible, giving the meanings of prefixes, suffixes and other components: for example, inter = between and therefore interphase refers to the phase *between* two successive divisions of the cell.
- 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) 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). In future, learners will receive credit only if they follow the instructions. Teachers should enforce this in all assessment activities done at school.

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

(d) Teachers should give learners multiple opportunities to label drawings and write in the functions next to the labels. Refer to the blank diagrams found in the *Mind the Gap* Study Guide. This can improve performance in questions based on diagrams such as the eye in Q1.4.

(e) Teachers should pay more attention and emphasis to the teaching of the action of auxins in geotropism, phototropism and apical dominance.

QUESTION 2 EAR, MEIOSIS, SCIENTIFIC INVESTIGATION ON REPRODUCTION AND THE NERVOUS SYSTEM

Common errors and misconceptions

(a) In Q2.1.2, many candidates were not able to describe the consequences of a blocked Eustachian tube. In many cases, they described *hearing* instead.

(b) In Q2.1.3, which required the role of the semi-circular canals in balance, many candidates lost marks because they:

- Included information about the sacculus and utriculus (maculae) rather than the semi-circular canals (cristae);
- Provided a function rather than an explanation; and
- Confused the cerebrum with the cerebellum as the recipient of the impulses.

(c) In Q2.2.2, candidates lost marks for writing *metaphase* when the required answer was *metaphase II*. As a reason for the identification for the phase, many candidates wrote that *chromatids* line up at the equator in a single row instead of the *chromosomes*.

Q2.2.4 was poorly answered because candidates were not able to deduce the appearance of the chromosomes at anaphase I from the given diagram of metaphase II. They lost marks for the following reasons:

- The chromosomes were not appropriately shaded;
- Incorrect number of chromosomes were shown;
- Chromosomes were shown aligned at the equator instead of moving apart; and
- Chromatids were shown moving apart rather than chromosomes.

(d) In Q2.3.1, many candidates provided steps that reflected 'conducting an investigation' rather than 'planning' an investigation. For example, they wrote 'record results in a table' rather than 'decide how to record the results'.

In Q2.3.2(a), candidates used the data in the table to *describe* the change in the follicle diameter instead of *explaining* the changes.

In Q2.3.2(b), some candidates did not understand the negative feedback mechanism between progesterone and FSH, and the consequent impact on the follicle sizes.

(e) In Q2.5, the poor performance indicates that most candidates lacked basic knowledge of the autonomic nervous system. Some confused it with a reflex arc and a reflex action.

Suggestions for improvement

(a) Teachers should guide learners on how to answer questions based on predicting the effect of a particular part (such as the Eustachian tube) that fails to function. A successful answer depends, in the first instance, on the learners' knowledge of the function of the particular structure. It can easily be deduced thereafter what would happen if that function was not performed.

(b) Teachers should emphasise the difference between the role of the cristae and maculae in maintaining balance. It would be useful to use annotated diagrams that contain information on each part of the ear that plays a role in balance, the receptors that they contain and the change that stimulates each type of receptor.

(c) Teachers should provide learners with multiple opportunities to label diagrams of different phases of meiosis. Blank diagrams provided in the *Mind the Gap* Study Guide can be used for this purpose. The name of the phase must indicate if it is a part of meiosis I or meiosis II. For example, metaphase 1 is a phase in meiosis I, whereas metaphase II is a part of meiosis II.

The events of the different phases of meiosis should be taught using annotated diagrams to clearly show what happens during each phase. The effects of crossing over should be followed through the different phases using the shading of chromosomes.

(d) Learners should be taught to differentiate between the planning and conducting phases of an investigation as well as ways of clearly expressing the steps involved in both phases. In Q 2.3.1, for example, the table below shows how answers on similar aspects will differ under planning and under conducting.

Planning	Conducting
Decide on the sample size	Use a sample of 50 women
Decide on the age-group of the participants	Use women in the investigation that are between the ages of 20 and 25
Decide on how to record the results	Record the results in a table
Decide on the duration of the investigation	Measure the follicles over 25 days

Note that the first column on 'planning' refers to aspects that need to be decided upon, while the second column on 'conducting' refers to decisions already taken after planning has occurred and is now part of the investigative method.

Further to the above, learners should be clearly shown how an answer to the question asking for a *description* of the changes in the follicle diameter would be different from a question requiring an *explanation* for the changes in the follicle diameter as required in Q 2.3.2(a). A description requires a statement of the changes in the follicle size over time whereas an explanation has to include a reason for the change in size. In this question, the reason relates to the absence of fertilisation after the ovum was released from the follicle during ovulation.

Teachers should also spend more time on teaching the negative feedback mechanism that exists between FSH and progesterone, as this information was required to formulate an answer to Q 2.3.2(b).

(e) Teachers should ensure that learners are aware of how the autonomic nervous system operates which is as follows:

- Every organ and gland is controlled by two sets of nerves;
- That act antagonistically to each other;
- To control involuntary events;
- Sympathetic nerves generally stimulates a response;
- Whereas the parasympathetic nerves generally inhibits a response.

QUESTION 3 HOMEOSTASIS, SCIENTIFIC INVESTIGATION AND HUMAN IMPACT ON THE ENVIRONMENT

Common errors and misconceptions

(a) Many candidates were not able to obtain full marks in Q 3.1. In many cases, it was evident that the negative feedback mechanism for controlling carbon dioxide concentration in the blood, was not studied.

(b) In Q3.2, many candidates were not able to interpret the graph on glucose levels. For Q3.2.4(b), many candidates incorrectly compared Thabiso's glucose level to that of Mo's rather than comparing it to the normal glucose level of an individual.

(c) In Q3.2.5, many candidates *described* the changes in the glucose level instead of *explaining* the changes in the glucose level for Mo during period X. As a result of this, they did not receive full credit.

(d) In Q3.3.3, many candidates just mentioned the words 'trade and consumption' from the text. They answered the question as if it required 'reasons for the killing of wildlife' and were, therefore, not credited. The question however, required reasons for an 'increase in the killing of wildlife'.

(e) In Q3.3.5, many candidates received partial credit since they gave a reason for the hunting/killing of the very old animals, but not for the weak animals.

(f) Most candidates received close to full credit for the drawing of the bar graph in Q3.4.5. Some candidates, however, still lost marks for the following:

- Drawing a histogram instead of a bar graph;
- Drawing a bar graph for all provinces instead of the three provinces specified;
- Unequal width of bars and spacing between the bars;
- Incorrect scale on the Y-axis; and
- A caption for the graph that does not include both variables.

Suggestions for improvement

(a) Teachers should ensure that learners have a good knowledge of the broad principles of a negative feedback mechanism first before going on to teach the specific mechanisms required, such as the control and/or restoration of the carbon dioxide concentration in the blood as required by Q3.1.

	Broad principles for a general negative feedback mechanism	**Specific mechanism for controlling CO_2 level in the blood when it increases above normal levels**
1	An imbalance is detected	Receptor cells in the carotid artery in the neck are stimulated by high levels of CO_2
2	A control centre is stimulated	The medulla oblongata in the brain is stimulated when it receives impulses from the receptor cells
3	Control centre responds by sending a message to target organ/s	Medulla oblongata sends impulses to the breathing muscles and heart muscles
4	The target organ responds	Breathing muscles contract more actively – increasing the rate and depth of breathing. The heart beats faster
5	It opposes/reverses the imbalance	More CO_2 is taken to and exhaled from the lungs
6	Balance is restored	The CO_2 level in the blood returns to normal

All other negative feedback mechanisms required by the syllabus can be taught within the framework of the six broad principles reflected in the above table. Teachers should consult the *Mind the Gap* Study Guide which contains a description of the other negative feedback mechanisms compiled against the 6broad principles.

(b) Teachers should emphasise to learners that if Person A has a glucose level that is higher than that of Person B, it does not mean that Person A is diabetic. Learners must make use of important information provided in the opening statement of a question. In Q 3.2.4, for example, the range for the normal glucose level was given as being between 80-120 mg/100cm^3. Learners should be taught that a person is considered diabetic only if his/her glucose level increases above 120 mg/100cm^3.

(c) Learners should be clearly shown how an answer to a question asking for a *description* of the changes in the glucose level would be different from a question requiring an *explanation* for the changes in the glucose level as required in Q3.2.5. A description requires a statement of changes in the glucose level whereas an explanation has to also include a reason for the change in the glucose level. In this question, the reason would relate to the action of insulin secreted by the pancreas when the glucose level rises above normal levels.

(d) Teachers should ensure that the section on Human Impact is properly taught and assessed in Grade 11 and should be thoroughly revised in Grade 12. Learners should have greater exposure to questions based on information from extracts as these will better prepare them to answer questions based on Human Impact on the environment.

(e) Teachers should differentiate between the reasons for killing *old animals* as against killing the *weak animals*. The common factor in both cases is that both the weak and the old animals have a low chance of survival and, therefore, are unlikely to reproduce, increase the population size and thus ensure the survival of its kind.

In the case of the old animals, they are *close to the end of the life span* whereas with the weak animals, they have *a short life span* since they may die even at a young age from disease or from predation.

(f) When learners are asked to draw a graph, teachers should provide them with the checklist 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. Further, learners should be able to clearly see where they have lost marks after the teacher marks a graph drawn by a learner. Teachers must ensure that learners are exposed to multiple opportunities to draw graphs of different kinds in the course of the year and in the earlier grades.

QUESTION 4 HUMAN REPRODUCTION

Common errors and misconceptions

(a) Many candidates did not interpret the essay question appropriately and, therefore, did not identify the three aspects required by the question, namely:

- The structural suitability of sperm;
- The process of fertilisation; and
- The development of the zygote until implantation.

As a result of the above, many candidates did not address one or more of the aspects required by the question and were, therefore, not awarded the synthesis mark for relevance.

(b) Candidates did not give complete answers for the structural suitability of the sperm cell. They often named the part of the sperm cell without indicating how it is suited for fertilisation.

(c) Some candidates had an inaccurate understanding of the events of fertilisation. They spoke of the sperm cell fusing with the ovum whereas it is only the nucleus of the sperm cell that enters the ovum and fuses with the nucleus of the ovum.

(d) Many candidates did not provide information on the development of the zygote in the correct sequence and, therefore, lost the synthesis mark for logical sequence.

(e) Many candidates provided information that was not required by the essay, for example, on copulation, hormonal control, spermatogenesis and oogenesis. These candidates, therefore, lost the synthesis mark for relevance.

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) Teachers should use as examples 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.

(c) Learners should be advised that since two marks are generally allocated to each structural suitability, one mark is allocated to the part/structure and the second mark for the way it is suited to the function, for example, for the structural suitability of the sperm:

- The front of the head of the sperm cell contains an acrosome ✓
- which carries enzymes to dissolve a path into the ovum ✓
- The nucleus of the sperm ✓
- carries genetic material of the male into the ovum during fertilisation ✓

- The middle piece of the sperm contains mitochondria ✓
- which release energy so that sperms could swim ✓
- The presence of a long tail ✓
- enables sperm cells to swim towards the ovum ✓

(d) Teachers must make use of *Mind the Gap* Study Guide to explain to learners how mind maps may be used in the planning of an essay.

(e) 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. The synthesis mark for the essay in Q4 was applied as follows:

Criterion	Relevance (R)	Logical sequence (L)	Comprehensive (C)
Generally	All information provided is relevant to the topic.	Ideas are arranged in a logical/cause-effect sequence.	All aspects required by the essay have been sufficiently addressed.
In this essay in Q4	Only information regarding the following is provided: - The structural suitability of the sperm cell - Events during fertilisation - Events after fertilisation until implantation There is no irrelevant information.	All structures are related to the respective functions of the sperm cell. The sequence of events in fertilisation and post fertilisation until implantation is in the correct order.	At least the following points should be included: - The structural suitability of the sperm cell (4/6) - Events during fertilisation (3/5) - Events after fertilisation until implantation (4/6)
Mark	1	1	1

(f) 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.

(g) Subject advisors should workshop teachers on the application of the criteria for synthesis. This can be done by giving different teachers the same sample script to mark and 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.

9.5 OVERVIEW OF LEARNER-PERFORMANCE IN PAPER 2

General comments

(a) Essay writing has improved, but many candidates still lacked the skill of putting a good essay together.

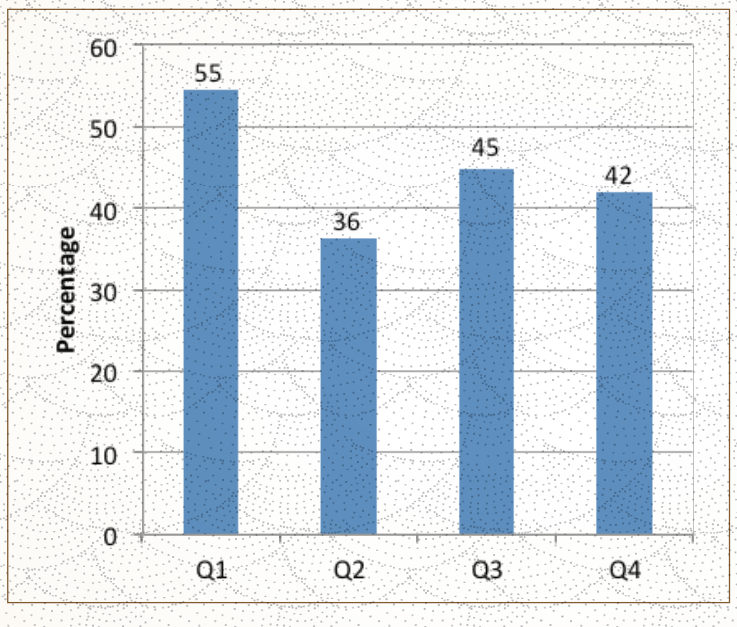
(b) Many candidates were not familiar with basic terminology in the different topics. This resulted in poor performance even in the lower-order questions.

(c) Poor performance was recorded in questions based on scientific investigations and hypothesis testing.

9.6 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 2

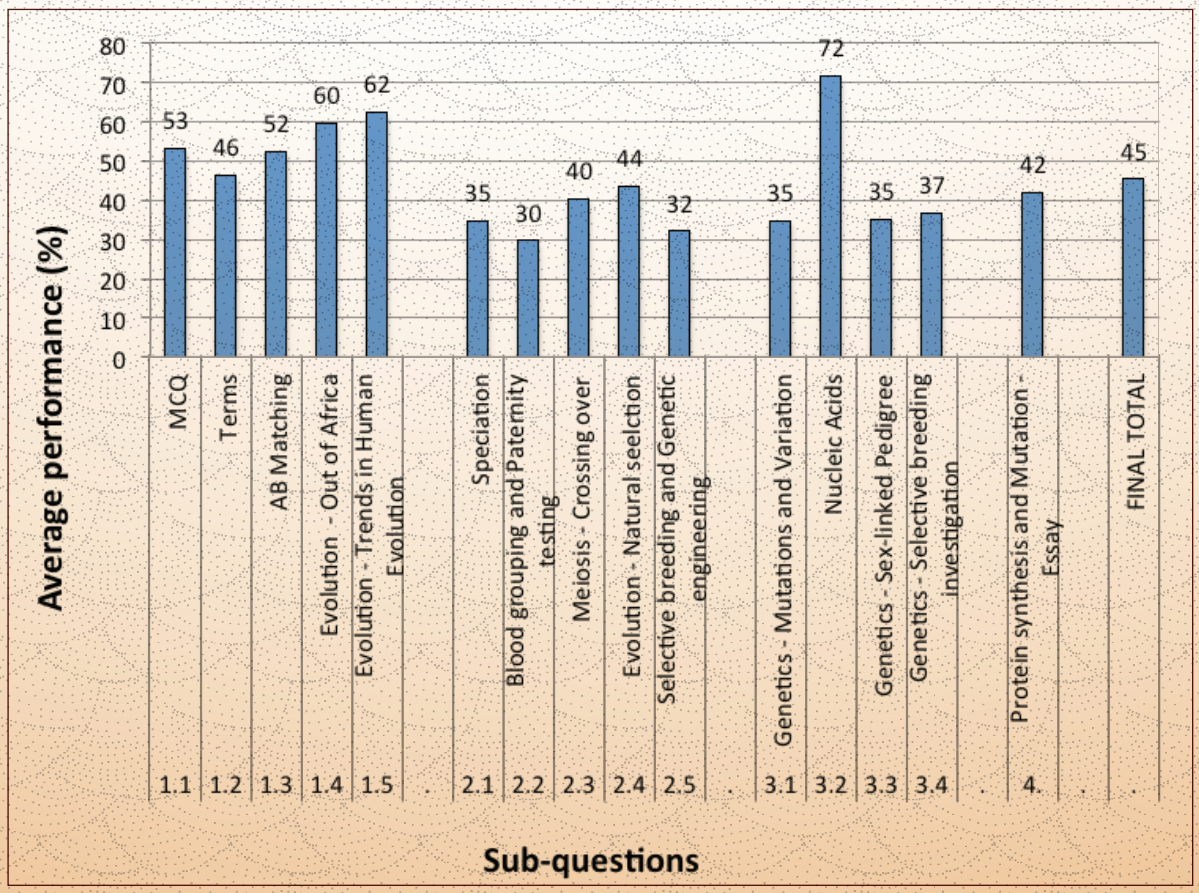
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 9.6.1 Average marks per question expressed as a percentage: Paper 2



Q1	Multiple choice, Terminology, Matching and Evolution
Q2	Evolution, Meiosis and Genetics
Q3	Nucleic acids, Genetics, Scientific Investigation
Q4	Protein Synthesis

Graph 9.6.2 Average performance per sub-question: Paper 2



The worst performance by candidates was in Q2 on speciation, blood groups, paternity testing and selective breeding, and in Q3 on mutations and variations, sex-linked pedigree diagram and selective breeding.

9.7 ANALYSIS OF LEARNER-PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1 MULTIPLE CHOICE, TERMINOLOGY, MATCHING AND DATA RESPONSE ON EVOLUTION

Common errors and misconceptions

(a) Performance in Q1.1 showed that candidates lacked basic knowledge of terminology. Performance was poor in Q1.1.2 (not able to differentiate between the *chromosome* and *chromatids*), Q1.1.3 (did not understand that components of nucleotides are the same for all species), Q1.1.4 (unable to perform the required calculation), Q.1.1.6 (unable to differentiate between *continuous* and *discontinuous* variation), Q1.1.7 (confused the terms hypothesis, aim and theory) and Q1.1.8/9 (did not show a clear understanding of a *dihybrid cross*).

(b) Q1.2 on biological terminology once again posed a great challenge to many candidates. This poor understanding of basic terminology and concepts has an adverse effect on their interpretation of and responses to questions. Terms such as *biogeography*, *centriole* and *phylogenetic tree* seemed not to have been known by many candidates. In addition, they confused the term *homozygous* for *homologous*.

(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). In future, learners will receive credit only if they follow the instructions. Teachers should enforce this in all assessment activities done at school.

In Q1.3.4, candidates were not able to differentiate between the term genome and genotype. From the performance in Q1.3.1 it was clear that candidates were not exposed to the role of Franklin and Watson in the discovery of DNA.

(d) In Q1.4, candidates performed poorly since they were not able to use the clues provided in the map. In Q1.4.2, many candidates provided the scientific name for the organism rather that providing the common name for the fossil representing that particular species. For example, they provided the scientific name *Australopithecus africanus* rather that providing the common name of each fossil of this species such as Mrs Ples, Taung child or Littlefoot.

(e) In Q1.5.1(b), candidates provided the species name only (*sapiens*) instead of attaching it to the name of the genus (*Homo sapiens*).

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. Teachers should use the following strategies to improve the teaching of terminology:

- Identify new terms in every lesson and write them on the board.
- Instruct learners to take down terms at the back of their notebooks, noting the correct spelling.
- Encourage learners to write down the meanings of these words, as ascertained by being attentive during the lesson or by finding the meaning in a dictionary or textbook.
- Break down the term where possible, giving the meanings of prefixes, suffixes and other components: for example, inter = between and therefore interphase refers to the phase *between* two successive divisions of the cell.
- 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 words that sound similar, e.g. *homologous*/*homozygous*, *biogeography*/*biodiversity* and *genome*/*genotype*.

(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). In future, learners will not receive credit if they do not follow the instructions. Teachers should enforce this in all assessment activities.

(d) Teachers should give learners multiple opportunities to answer questions based on data provided. Guidance must be provided to learners on how to read/interpret the data given so as to use the clues provided in answering the questions set.

QUESTION 2 EVOLUTION, GENETICS, MEIOSIS AND NUCLEIC ACIDS

Common errors and misconceptions

(a) In Q2.1.2, most learners provided a general account on speciation without contextualising it to the specific example given in the question. For example, they failed to mention that the geographical barrier in this case was the sea.

(b) Performance in Q2.2.1 was poor since the candidates either included a comparison of the father and child but not the mother or included a description of DNA profiling instead of an analysis of blood groups in their account on paternity testing. Some candidates provided general information about blood groups without explaining how it can be used to determine paternity.

(c) In Q.2.2.2, candidates lost marks in the representation of a genetic cross since they used the incorrect notation to write down the genotypes for the various blood groups instead of using the alleles $\mathbf{I^A}$, $\mathbf{I^B}$ and **i** to compose the genotypes.

(d) In addition, some candidates lost marks since they did not use the correct format for representing a genetic cross. They either omitted the labels for P_1 and F_1/*meiosis* and *fertilisation* or they inserted the labels *meiosis* and *fertilisation* in the inappropriate places.

(e) In Q2.3.1, candidates provided the label *prophase* rather than *prophase 1*.

(f) In Q2.3.2, many candidates stated that the *chromosomes* overlap rather than the *chromatids* overlap. In addition, many learners provided a definition of crossing over rather than a description of the process and thus did not receive full credit.

(g) In Q2.3.3, many candidates stated the importance of crossing over in contributing to variation but since the question asked for an explanation, they lost 1 mark since they did not state that this variation is significant in generating new phenotypes that could manifest as either favourable or unfavourable characteristics.

(h) Many candidates were not able to draw and label the diagram required in Q2.3.4. Some candidates who attempted the drawing lost marks because they did not label the chromatid Y that was asked for in the question or did not indicate the position of the alleles after crossing over.

(i) Most candidates simply described the process of natural selection in Q2.4.2 without contextualising it to the specific example of the Bongo/antelope given in the question. They mentioned 'variation' without describing the variation as it applied to the Bongo/antelope in the question. In cases where the variation was described, many candidates did not identify the favourable and unfavourable characteristics arising from this variation. Many candidates also failed to identify the appropriate selection pressure that was at play in this specific example which in this case was the connection between the dense forest vegetation and the advantage of having horns that could be laid back, preventing the antelope from becoming entangled and thus susceptible to predation.

(j) In Q2.5.1, candidates more frequently provided differences instead of similarities. The answers provided by the candidates indicate that the concepts of *selective breeding* and *genetic engineering* are not well understood.

(k) Whereas Q 2.5.2 required an explanation (a statement linked to a reason), most candidates gave two or more statements not linked to a reason.

Suggestions for improvement

(a) Teachers should provide multiple opportunities for learners to answer questions based on an application of the concept of speciation. Particular guidance must be provided on how to contextualise the general account to the specific example stated in the question.

(b) The role of blood grouping is specified as a required aspect in the 2014 Exam Guideline Document for the Life Sciences. Advisors should workshop teachers on this aspect so that it is not neglected in the teaching and learning process.

(c) Subject advisors should ensure that the attention of the teachers is drawn to the correct allelic notation that should be used when writing genotypes for the various blood groups as prescribed in the 2014 Exam Guideline Document for the Life Sciences. The alleles $\mathbf{I^A}$, $\mathbf{I^B}$ and **i** must be used.

Teachers should ensure that all learners are familiar with the correct format that should be used when representing a genetic cross.

(d) Teachers should provide learners with multiple opportunities to label diagrams of different phases of meiosis. Blank diagrams provided in the *Mind the Gap* Study Guide can be used for this purpose. The name of the phase must indicate if it is a part of meiosis I or meiosis II. For example, prophase I is a phase in meiosis I, whereas prophase II is a part of meiosis II.

(e) In the process of crossing over and in meiosis in general, teachers must ensure that learners can differentiate between a *chromosome* and a *chromatid*. A chromosome consists of two chromatids joined by a centromere. During crossing over, it is the chromatids of two adjacent homologous chromosomes that overlap.

Further to the above, learners should be clearly shown how an answer to the question asking for a *definition* of crossing over would be different from a question requiring a *description* of the process of crossing over. In the description, all the steps involved in the process must be provided and in sequence.

(f) Teachers should deal with the importance in crossing over in contributing to variation in more detail so that this understanding could assist in an understanding of evolution through natural selection.

(g) Learners should be provided multiple opportunities to draw labelled diagrams. The diagrams drawn should also be appropriate to the specifications of the question.

(h) Teachers should provide multiple opportunities for learners to answer questions based on an application of the concept of natural selection. Particular guidance must be provided on how to contextualize the general account to the specific example stated in the question. In any example, the learner must be able to describe the variation and be able to differentiate between the characteristic that is favourable from that is unfavourable. In addition the selection pressure for natural selection should be identified for the specific example cited in the question.

The table that follows indicates how a general account (based on recall) can be adapted to answer an application question (as in Q2.4).

General Account on Natural Selection	Natural Selection in the Bongo/antelope
There is variation among the offspring	There is variation among the Bongo population
Some have desirable characteristics and some do not	Some have horns that can be laid on their backs while others cannot lay their horns down on their backs
Sometimes there is a change in the environmental conditions which acts a selection pressure	The antelope has to move through dense vegetation without becoming entangled to avoid being trapped and then caught by predators
Organisms with characteristics that make them less suited to the environment, die	Those with horns that cannot be laid on their backs become entangled and die
Organisms with characteristics which make them more suited to the environment, survive	Those with horns that can be laid on their backs do not become entangled and survive
The organisms that survive, reproduce	Those with horns that can be laid back will reproduce
They will pass on the desirable characteristic to their offspring	The gene for horns that can be laid on their backs will be passed on to the next generation
Over many generations, the proportion of individuals with the desirable characteristic, increases	Over many generations, the proportion of animals that are able to lay their horns on their backs, increases

(i) The concepts of selective breeding/artificial selection and genetic engineering should be dealt with in more detail with learners to effectively bring out the similarities and differences between them.

(j) Teachers should deliberately teach learners how to answer questions requiring an explanation. For example, if asked to explain two reasons why people may be against genetic engineering, each answer should consist of a statement followed by an elaboration/reason. An example is provided below where the elaboration is shown in italics.

- The long-term effects of genetic engineering on the environment are not known ✓ *so it could lead to health problems in the future* ✓
- It is morally wrong to engage in genetic engineering ✓
- *since it is interfering with nature* ✓

The ticks included in the above answers also indicate how the marks are distributed separately for the statement and the elaboration/reason.

QUESTION 3 NUCLEIC ACIDS, GENETICS, SCIENTIFIC INVESTIGATION

Common errors and misconceptions

(a) Poor performance in Q3.1 despite answers being accessible in the text provided, indicates that candidates experienced difficulty in comprehending and interpreting textual information.

(b) In Q3.2.1, some candidates did not receive credit for *functional differences* between DNA and RNA since the question specifically asked for *structural differences*.

(c) In Q3.3.2, in particular, many candidates were not able to arrive successfully at the percentage of the males that were affected. Most candidates used the fraction instead of when calculating the percentage. This indicates that they expressed the number of males that were affected as a proportion of all the individuals in the diagram (12) rather than just the number of males (7).

(d) Performance was poor in Q3.3.3. Some candidates wrote generally on sex-linked disorders without addressing the question in particular. Other candidates gave an answer that matched a related question in a past exam paper but which was not relevant to the question in this paper.

(e) In Q3.4.2, many candidates were not able to differentiate between the *dependent* and *independent variable*.

(f) Many candidates were not able to correctly determine the percentage increase in the weight of the chickens in Q3.4.3.

(g) In Q3.4.5, some candidates confused *reliability* with *validity* and, therefore, included as answers, factors that improve reliability.

Suggestions for improvement

(a) Teachers should provide multiple opportunities for learners to interpret textual and other information. Special attention should be given to strategies that would assist learners in identifying the key information in the text so that it could be used as clues in the answering of the questions.

(b) There are differences between DNA and RNA based on their location, their structure and their function. Learners should be taught how to distinguish among these and to be aware of what is required by the question.

(c) Teachers should teach learners the steps involved in determining percentages as it relates to a pedigree diagram. In Q3.2.2, for example, the following steps were required:

- Read the key provided and apply it to the given data;
- Count the number of males that are affected (3 in this example);
- Count the number of males in the pedigree diagram (7 in this example);
- Express this in a form of a fraction (in this example);
- Multiply by 100 to get a percentage as follows:

(d) Teachers should advise learners not to use answers directly from the memoranda of past exam papers as the requirement of the question might not be the same. It is therefore important to analyse the question and adapt the information that one has available to suit the question asked.

(e) Teachers should clearly differentiate among the three types of variables as follows:

Controlled/fixed variable – refers to the factors that should be kept constant so that the results of an investigation can be considered valid.

Independent variable – refers to the factor that is being investigated. This factor is usually manipulated by the investigator either at the start of or during the course of the investigation. The independent variable appears on the X-axis of a graph.

Dependent variable – refers to the effect of the independent variable. This effect is usually measured in some way and appears on the Y-axis of a graph.

(f) Teachers should teach learners the steps involved in determining percentage increase/decrease. In Q3.4.3, for example, the following steps apply:

- Determine the difference in the weight of the chickens between day 8 and day 45 (which is 2500-500 = 2000)
- Divide the difference by the original number on day 8 (which is 2000/500)
- Multiply by 100 to obtain a percentage as follows:

(g) 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.

What is reliability?

- The idea behind reliability is that any significant results of an investigation must be more than a once-off finding and be repeatable.
- Other researchers must be able to perform exactly the same investigation, under the same conditions, and generate the same results.
- This would reinforce the findings of the investigation and ensure that the wider scientific community accepts the hypothesis.
- For questions that require learners to state how the reliability of the investigation could have been improved, the following answers may apply depending on the nature of the investigation:
  - Repeat the investigation;
  - Take many readings and use the average;
  - Select a sample randomly;
  - Increase the sample size; and
  - Increase the period of the investigation.

What is validity?

- Validity questions how the investigation was carried out. It is important to be sure that all the factors/ variables have been controlled/fixed except the variable/factor being tested.
- In questions that require learners to suggest some factors that might have decreased the validity of an investigation, learners should identify some factors/variables that were not fixed/controlled when carrying out the investigation.

QUESTION 4 PROTEIN SYNTHESIS

Common errors and misconceptions

(a) Although this question was generally well answered, candidates sometimes lost marks or did not receive credit because they:

- Wrote on DNA replication instead of protein synthesis thus losing the synthesis mark for relevance;
- Confused the events of transcription with that of translation thus losing the synthesis mark for logical sequence;
- Confused the role of mRNA and that of tRNA;
- Used the terms *codon* and *anticodon* with the wrong RNA molecule;
- Described various aspects of mutations without relating it to protein synthesis thus losing the synthesis mark for relevance;
- Provided information on genetic disorders caused by mutations which is not relevant to the question thus losing the synthesis mark for relevance; and
- Described protein synthesis but ommitted to describe the effect of mutations thus losing the synthesis mark for comprehensiveness.

Suggestions for improvement

(a) Teachers should offer more opportunities for learners to write answers in paragraph and essay formats. The logical sequence of an account on protein synthesis should have the steps in the process in the correct order, for example:

- Transcription should be described before translation;
- The role of the nucleic acids should appear in the order of their involvement i.e. DNA followed by mRNA and then tRNA; and
- The effect of mutations should be included after the process of protein synthesis has been described.

(b) The process of protein synthesis should be taught to learners using appropriate diagrams.

(c) Teachers must make use of the *Mind the Gap* Study Guide to assist learners in the use of mind maps in the planning of an essay.

(d) 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. The following mark allocation for synthesis applies to Q4 in this paper.

Criterion	Relevance (R)	Logical sequence (L)	Comprehensive (C)
Generally	All information provided is relevant to the question.	Ideas are arranged in a logical/cause-effect sequence.	All aspects required by the essay have been sufficiently addressed.
In this essay in Q4	Only information relevant to the description of protein synthesis and the effects of mutation on the process is given. There is no irrelevant information.	The description of protein synthesis and the effects of mutation on the process given are logical and sequential.	Essay includes at least: - **5** correct points in the description of transcription - **5** correct points in the description of translation - **2** correct points on the effects of mutation
Mark	1	1	1

(e) 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.

(f) Subject advisors should workshop teachers on the application of the criteria for synthesis. This can be done by giving different teachers the same sample script to mark and 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.