2024 NATIONAL SENIOR CERTIFICATE (NSC)
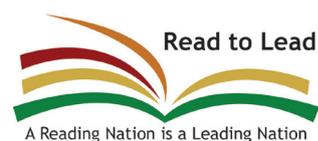
DIAGNOSTIC REPORT

BOOK 1

Empowering Education Through Solidarity, Championing Equality, and Building a Sustainable Future Together.

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

MTN

Read to Lead
A Reading Nation is a Leading Nation

NDP 2030

CHAPTER 8

LIFE SCIENCES

The following report should be read in conjunction with the Life Sciences question papers of the November 2024 NSC examinations.

8.1   PERFORMANCE TRENDS (2020–2024)

The number of candidates who sat for the Life Sciences examination in 2024 decreased by 4 302 compared to that of 2023.

There was a pleasing improvement in the pass rate this year. Candidates who passed at the 30% level improved from 75,6% in 2023 to 80,8% in 2024. There was a significant improvement in the pass rate at the 40% level over the past two years from 52,3% to 61,2%.
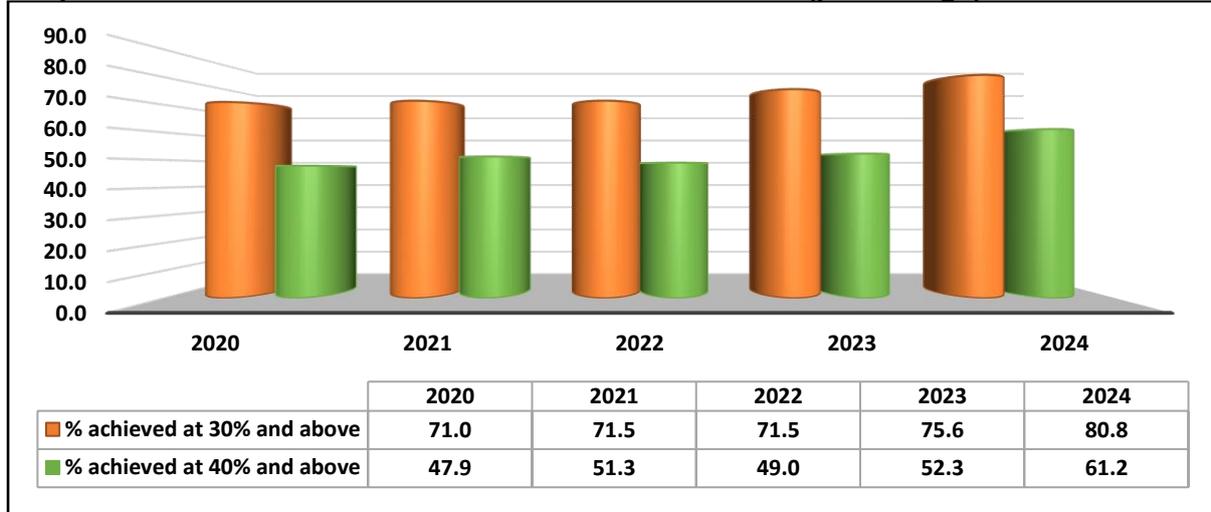
The percentage of distinctions (80% and over) increased from 2,3% in 2023 to 4,0% in 2024.   Given the size of the 2024 cohort, this converts to an increase in the total number of distinctions from 8 718 to 14 989.

The various commendable support programmes employed by teachers, subject advisors and provincial education departments were continued in 2024. The resourcefulness and diligence of the above-average candidates also contributed to the overall improvement in the subject.
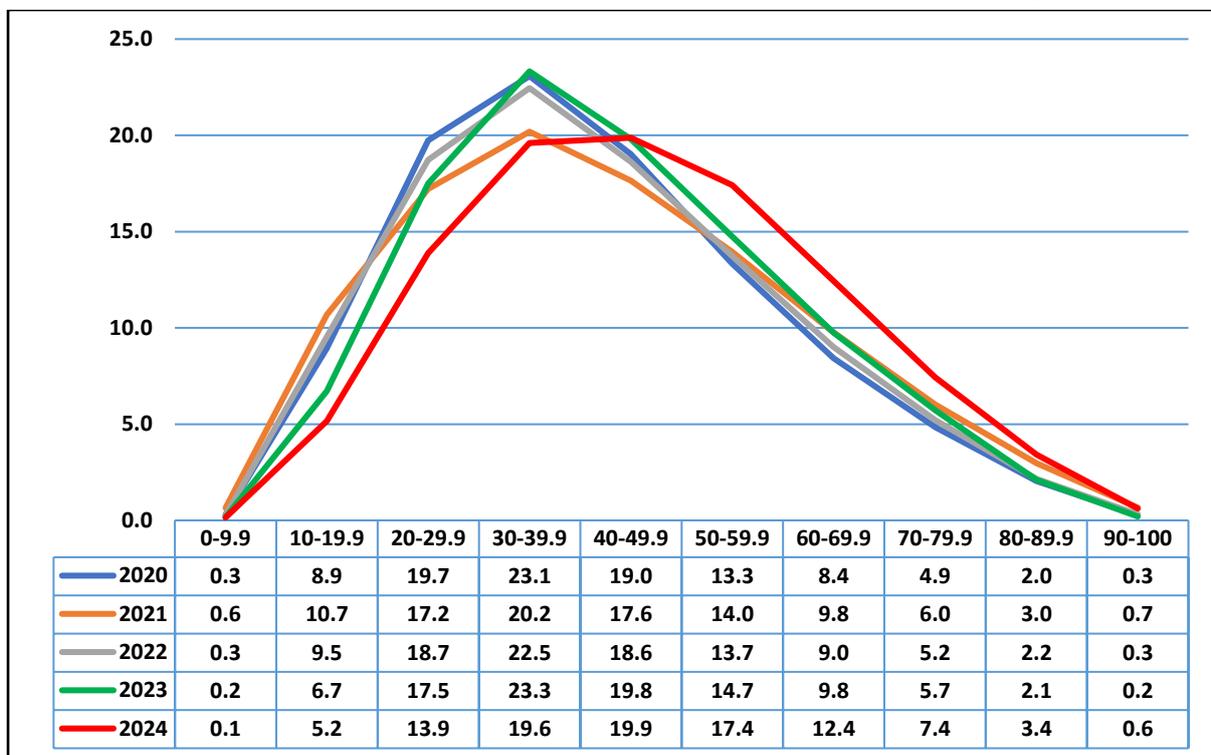
Table 8.1.1 Overall achievement rates in Life Sciences

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
2020	319 228	226 700	71,0	153 028	47,9
2021	384 216	274 584	71,5	197 017	51,3
2022	399 007	285 217	71,5	195 620	49,0
2023	379 024	286 708	75,6	198 309	52,3
2024	374 722	302 793	80,8	229 361	61,2

Graph 8.1.1   Overall achievement rates in Life Sciences (percentage)

	2020	2021	2022	2023	2024
🟧 % achieved at 30% and above	71.0	71.5	71.5	75.6	80.8
🟩 % achieved at 40% and above	47.9	51.3	49.0	52.3	61.2

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
2020	0.3	8.9	19.7	23.1	19.0	13.3	8.4	4.9	2.0	0.3
2021	0.6	10.7	17.2	20.2	17.6	14.0	9.8	6.0	3.0	0.7
2022	0.3	9.5	18.7	22.5	18.6	13.7	9.0	5.2	2.2	0.3
2023	0.2	6.7	17.5	23.3	19.8	14.7	9.8	5.7	2.1	0.2
2024	0.1	5.2	13.9	19.6	19.9	17.4	12.4	7.4	3.4	0.6

General comments on Paper 1 and Paper 2

Teachers need to ensure that candidates have basic mathematical skills by providing them with enough practice during the FET Phase. These skills should be assessed from Grade 10 to guarantee a better understanding of mathematical applications by Grade 12. Candidates should also be discouraged from using the term 'directly proportional' as this is not credited in Life Sciences. Candidates need to describe the relationship by explaining the changes (increase/decrease) that take place.

An attempt must be made to improve learners' handwriting as many candidates have an illegible handwriting which makes marking difficult. Teachers need to apply for concessions for these candidates as their poor handwriting is a disadvantage to them.

In both Papers 1 and 2, candidates are expected to read short passages on different topics and then apply their knowledge on the given topic. Candidates faced a challenge in synthesising relevant details from the text provided. This meant that they could not form a coherent paragraph, which reflected their understanding, from the information given. Teachers need to expose learners to these types of questions from Grade 10 to Grade 12 to enable them to read and extract relevant information, apply knowledge and articulate precise responses. Learners must be taught not to be intimidated by these questions and should practise active reading and comprehension skills.

It is important for learners to improve their conceptual understanding of key biological processes, as these underpin their ability to answer higher-order questions. Teachers should reinforce foundational concepts through diverse teaching methods and encourage active participation.

## 8.2   OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 1

General comments

(a)   Many candidates performed very well in Q1 as it consisted mainly of level A and B questions. Most of the learners attempted to answer all questions. Very few questions were left unanswered.

(b)   A number of candidates disregarded the importance of correct spelling. If the incorrect spelling changed the meaning of the response, candidates lost marks, for example:
   - *Ureter* instead of *urethra* Q1.4.1(a)
   - *Epidermis* instead of *epididymis* Q1.4.1(b)
   - *Syrup* instead of *stirrup* Q1.2.4
   - *Ciliary* instead of *circular muscles* Q3.2.3.

(c)   Poor performance is still evident in questions based on scientific investigations, despite the support provided in the diagnostic reports of previous years. More scientific investigation questions must be included during informal and formal assessments, as well as during revision sessions. Practical application through understanding is important to include in all teaching.

(d)   Many candidates did not know how to calculate a *percentage increase*, even though a detailed summary of the different types of calculations was given in the diagnostic report of 2023.

(e)   As indicated in previous reports, the sections on *reproductive strategies* and *plant responses to the environment* were poorly answered. These are relatively short topics, and it appeared as if some teachers merely glossed over them. It is important to concentrate on these two topics, as they are a compulsory inclusion in the paper for 8 and 13 marks respectively.

## 8.3   DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 1

Based on the item analysis, the weakest performance by candidates was recorded in the sub questions on the *eye (cataracts and long-sightedness)*, *homeostasis (scientific investigation)* and *plant responses to the environment (scientific investigation)*.

The following graph is based on data from a random sample of candidates' scripts. 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 performance per question in Paper 1
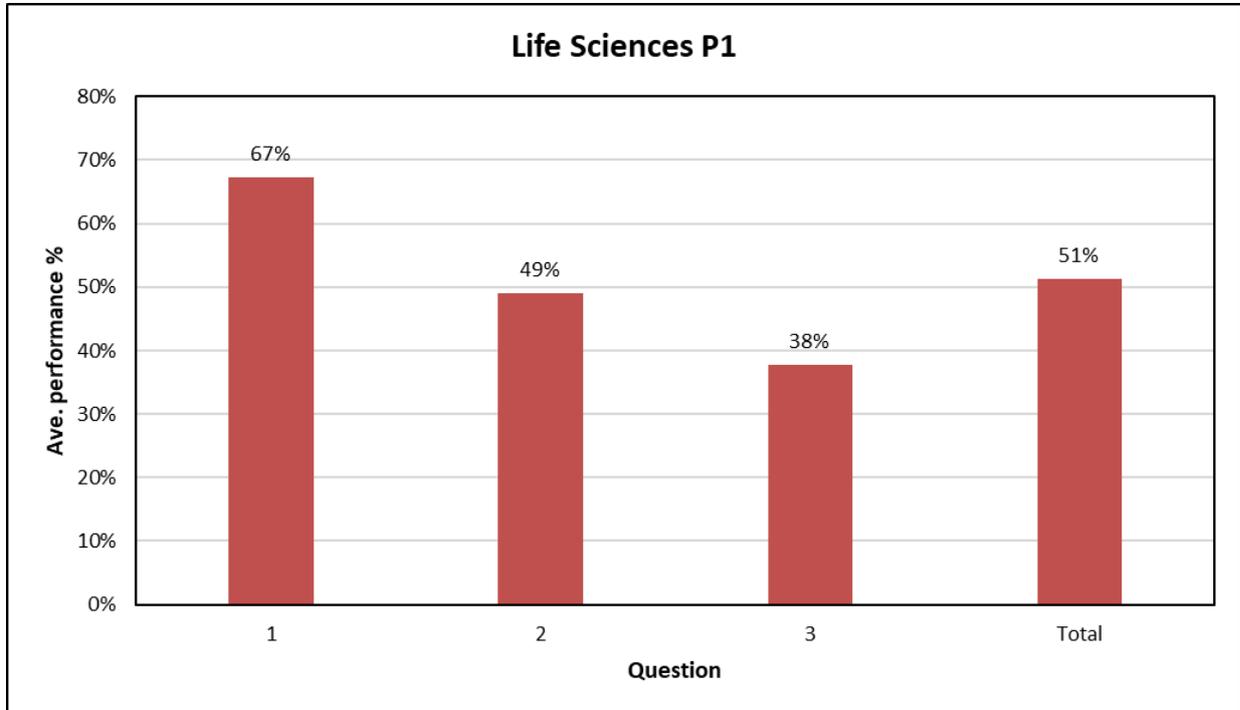
Q	Topics
1	Multiple choice, Terminology, Matching items, Male reproductive system, Homeostasis (endocrine glands and skin)
2	Female reproductive system, Menstrual cycle, Cataracts, Long-sightedness and Neurons.
3	Reproductive strategies, Eye (pupillary mechanism), Scientific investigation on insulin and blood glucose levels, Homeostatic control of thyroxin (negative feedback) and Scientific investigation on the effect of auxins.

Graph 8.3.2 Average performance per subquestion in Paper 1

Life Sciences P1
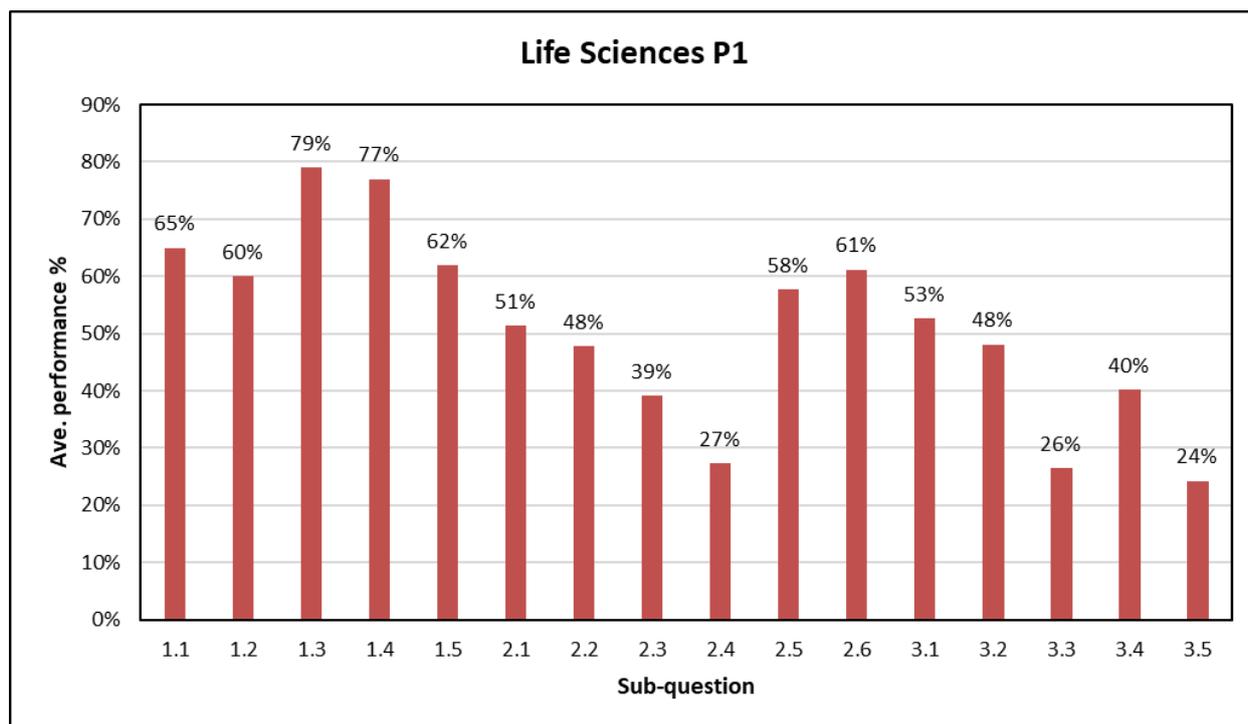
Subq	Topic	Subq	Topic
1.1	Multiple-choice question	2.4	Long-sightedness
1.2	Terminology	2.5	Neurons – types
1.3	Matching items	2.6	Neurons – analysis of data
1.4	Male reproductive system	3.1	Reproductive strategies
1.5	Homeostasis (endocrine glands and skin)	3.2	Eye (pupillary mechanism)
2.1	Female reproductive system	3.3	Scientific investigation on insulin and blood glucose levels
2.2	Menstrual cycle	3.4	Homeostatic control of thyroxin (negative feedback
2.3	Cataracts	3.5	Scientific investigation – plant responses on auxin

8.4 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE CHOICE, TERMINOLOGY, MATCHING ITEMS, MALE REPRODUCTIVE SYSTEM, HOMEOSTASIS (ENDOCRINE GLANDS AND SKIN)

Common errors and misconceptions

(a) As indicated in previous reports, some candidates did not read nor follow the instructions as stated in the questions, e.g., they chose more than one option in the MCQs.

- In Q1.1 candidates performed well except for Q1.1.10 where they had to apply their knowledge. They were not familiar with the pathway of the nerve impulses for balance. Some candidates did not know which part of the brain was involved in balance and gave the answer as C (cerebrum), instead of B (cerebellum).

(b) As spelling continues to be a problem, the following points in Q1.2 mentioned in previous reports are still valid. Candidates:
- Wrote *umbilical artery/vein* instead of *umbilical cord* in Q1.2.1; *peripheral* nervous system instead of *autonomic* nervous system in Q1.2.2, some also wrote ANS which is not a biological term and was not credited; provided *maculae* as a response, instead of *cristae* or gave both answers in Q1.2.3.
- It was also evident that the individual bones of the ossicles in Q1.2.4 had not been well taught. Also, in Q1.2.5 *geotropism* was the only correct answer for a growth reaction in response to gravity. Some candidates wrote positive/negative geotropism which was not credited. Knowledge of the basic functions of plant hormones in Q1.2.7 was also lacking.

(c) Some candidates only provided the letter or the name of the part in Q1.4.1. A few candidates could not spell *urethra* and were not able to differentiate between the *epididymis* and *vas deferens*.

(d) In Q1.5 some candidates had difficulty in:
- Q1.5.1 – differentiating between exocrine and endocrine glands;
- Q1.5.2 – linking both the sweat glands and the blood vessels to thermoregulation and incorrectly identified the hypothalamus, which was not one of the structures labelled on the diagram.
- Q1.5.3 – (a) identifying the hormone and in (b) giving the target organ responsible for water regulation. They referred to the renal tubules and cortex instead.

QUESTION 2:   FEMALE   REPRODUCTIVE   SYSTEM,   MENSTRUAL   CYCLE, CATARACTS, LONG-SIGHTEDNESS AND NEURONS.

Common errors and misconceptions

(a) In Q2.1, which was based on female reproductive system, candidates lost marks because they:
- Incorrectly identified the structure as the *Graafian follicle* instead of the *ovary* in Q2.1.1 (b);
- Stated in Q2.1.2 that there were 'many sperm' in the fallopian tube although there were only a few sperm drawn in the diagram – the correct reason was that *'the sperm were in the fallopian tube/close to the ovum'*;
- Left out key words when explaining *oogenesis* in Q2.1.3. The following were common errors:
  - 'Cells in the ovary undergo mitosis' instead of 'diploid cells in the ovary undergo mitosis.'
  - 'One follicle enlarges and undergoes meiosis' instead of 'one cell in the follicle' undergoes meiosis.
  - 'To produce an ovum' instead of 'one of the four cells produced forms a haploid ovum'.
- Could not present their responses in a cause-and-effect way in Q2.1.4. and often gave the effect of the strategy without the cause. They also confused the concepts 'increasing chances of fertilisation' in Q2.1.2 (b) with 'reproductive success' in Q2.1.4.

(b)   Some candidates performed well in Q2.2. However, many candidates lost marks in:
- Q2.2.2 because they could not explain why FSH increased from day 24, but rather explained the function of FSH. FSH increased because the levels of progesterone decreased and therefore, the production of FSH by the pituitary gland was no longer inhibited.
- Q2.2.4 because they were unable to calculate a percentage increase. This was highlighted in the November 2023 Diagnostic Report.
- Q2.2.5 by stating that the *progesterone* stays constant, instead of mentioning that it remains high, or it will increase.
- Q2.2.6 because they could not explain what caused the increase in progesterone from day 20, when a female is pregnant. They explained the function of progesterone in a pregnant female. Some candidates did not link the *corpus luteum not degenerating* to *an increase in progesterone*. Also, that the *developing placenta* caused an *increase in progesterone*.

(c)   In Q2.3.2 candidates had difficulty using the information in the passage and instead gave a generic description of what cataracts were. Some answered the whole question using quotes from the text without adding their own explanation, while others did not use the text at all. Candidates were required to extract the quote that 'protein structures in the eye start to disintegrate and clump together' and then explain how this would lead to vision loss. They also did not know that if the lens becomes cloudy, light cannot pass through to the retina. They instead incorrectly stated that 'light cannot enter the eye'. Some candidates did not score full marks, because they left out the part which referred to 'stimuli will not be converted into impulses.'

(d)   Q2.4 was poorly answered. In Q2.4.1 most candidates referred to the lens instead of how the eyeball affected vision. In Q2.4.2 they had difficulty explaining why the convex lenses helped to improve vision. Convex lenses cause light to be refracted *more,* thereby causing the image to fall on the retina.

(e)   Many candidates performed well in Q2.5. In Q2.5.1 some still referred to the type of neuron as *multipolar*, instead of a *motor neuron.* In Q2.5.2 and Q2.5.3 they referred to outgrowths instead of *dendrites.* In Q2.5.5 some candidates referred to the disorder as *Alzheimer's disease* instead of *Multiple sclerosis.*

(f)   Poor performance in Q2.6 can be attributed to the fact that candidates did not understand what was expected of them. In Q2.6.2(a) some candidates provided numerical comparisons, e.g. myelinated neurons have an impulse speed of x m/s while unmyelinated neurons have y m/s instead of describing the general trend. In Q2.6.2(b) candidates still gave the trend in the graph instead of the relationship between axon diameter and impulse speed. A number of candidates still referred to direct proportionality, as was mentioned previously.

QUESTION 3: REPRODUCTIVE STRATEGIES, EYE (PUPILLARY MECHANISM), SCIENTIFIC INVESTIGATION ON INSULIN AND BLOOD GLUCOSE LEVELS, HOMEOSTATIC CONTROL OF THYROXIN (NEGATIVE FEEDBACK) AND SCIENTIFIC INVESTIGATION ON THE EFFECT OF AUXINS.

Common errors and misconceptions

(a)   Many learners performed well in Q3.1. Some candidates:
- Did not read the instruction to quote from the passage and gave a definition of *oviparous* in Q3.1.1;

- Referred to advantages for embryos/foetus instead of gametes in Q3.1.2;
- Confused *altricial* development with *precocial* development in Q3.1.3; and
- Found it difficult to make the connection between the amount of yolk in the egg and the degree of development of the chick in Q3.1.4. They did not relate the fact that birds that have altricial development have very little yolk in their eggs. This meant that the chick's incubation period would be short because there would not be enough nutrition and they would therefore not be fully developed when born.

(b)   Q3.2 was well answered. Some candidates gave a generic description of a *reflex action* without mentioning light as the stimulus in Q3.2.2. In Q3.2.3 a number of candidates referred to *ciliary muscles* instead of *circular muscles*. Candidates gave both mechanisms in dim light and bright ligh in which case only the first answer was marked.

(c)   Many candidates performed poorly in Q3.3. They lost marks because:
- In Q3.3.1 they provided generic responses and failed to link the function of the control to the investigation;
- In Q3.3.2 they could not describe how insulin decreased blood glucose levels; they described the mechanism of insulin production by the pancreas, without linking it to the absorption and conversion of glucose by the cells/ liver/ muscles;
- They did not understand how to use the data to explain the answer in Q3.3.4. Many candidates simply compared Y to the normal limits and their answers were not specific: they failed to state the times at which glucose was within normal limits.

(d)   In Q3.4.1 some candidates quoted from the stem above the diagram and gave the answer as *homeostasis* instead of *negative feedback mechanism*. They read the negative feedback diagram in Q3.4.3 incorrectly. They had to follow the lines and the arrows to understand the flow of hormones between the two glands. Q3.4.4 was poorly answered. Candidates had difficulty explaining and interpreting the questions on how a decreased metabolic rate reduced cellular respiration causing less glucose use and more storage. Candidates referred to nutrients as food/calories.

(e)   Q3.5 showed the lowest performance in the paper because:
- Most candidates wrote the *effect of auxin as the independent variable* in response to Q3.5.1(a). This was incorrect as the effect of auxin is in fact the growth of the lateral branches. In Q3.5.1(b) candidates described how the variables were controlled (dividing the species into three groups, keeping the plants in darkness for 72 hours) rather than what the variables were (light exposure, duration in darkness and plant species). Candidates wrote about phototropism, yet the plants were kept in darkness for 72 hours. They wrote what they had learnt and struggled to apply their knowledge to a new scenario.
- Many candidates wrote 'no growth' in response to Q3.5.2(b). This was incorrect. There would be no upward growth but there would still be growth of lateral branches.
- Candidates were required to answer that each group would have had four plants which made it a sufficient sample size to be reliable in Q3.5.3. Many candidates referred to 12 plants, but the three groups of plants were treated differently, therefore this was an incorrect answer. (Their response did not follow from the stem.)
- Candidates wrote about *phototropism* instead of applying their knowledge to the context given in Q3.5.4. Many candidates could not link the agar- containing auxins with the auxins ability to diffuse through the agar. They could identify the function of auxins in the role of growth but not how this growth was brought about through cell division/mitosis/cell elongation/cell growth.

Suggestions for improvement on teaching content and concepts for P1

(a)   As elaborated in previous diagnostic reports, Paper 1 is about the physiology of humans; therefore, diagrams of different structures/organs are an integral part of this paper. The structures/organs are best taught using annotated diagrams. Diagrams without labels should be given to learners to identify the parts and their functions.

(b)   The use of the *2021 Examination Guidelines* is a vital teaching tool that should be consulted when teaching. The *Examination Guidelines* contain some explanations for concepts that are meant to guide teachers as to the depth of understanding candidates require e.g., *oogenesis*, *spermatogenesis*. These concepts should be taught as per the guidelines and not as they are presented in some textbooks. The same applies for other terminology e.g. *goitre* – learners refer to Grave's disease, which is incorrect.

(c)   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. Consult the *2021 Examination Guidelines* for the correct terminology to teach and assess.

(d)   Teachers need to emphasise instructions to questions, especially in Q1.2 where the correct biological term is required. Learners should avoid abbreviations and acronyms of terms in response to this question, as these will not be credited.

(e)   Teachers should emphasise the importance of focusing on visible or structural factors when addressing questions about the female reproductive system. By focusing on the specific structures, learners will understand the biological processes more clearly.

(f)   Teachers need to use diagrams when explaining ovulation to show learners that the ovum is released from the ovary into the Fallopian tubes. This will prevent learners from identifying the ovary as the *Graafian follicle*. Learners must be sensitised to the fact that the diagrams they encounter in the examination may differ slightly from the ones they encounter in the classroom.

(g)   Learners should be encouraged to read questions with proper understanding. In Q2.2.3 candidates were instructed to use data from the table to explain their answers. They could not refer to the glucose level as normal for Y, without specifying the times as well. Learners need to learn how to use the data from graphs and tables as evidence, in their explanations.

(h)   Teachers should teach in the format:
       (i)   What is the structure?
       (ii)   What is its function?
       (iii) How is the function affected when the structure is damaged?

(i)   Teachers need to emphasise that a reflex action is a rapid, involuntary action in response to a stimulus.

(j)   Teaching should be differentiated to accommodate all cognitive levels.

(k)   Teachers must place more emphasis on scientific investigations and their design. Learners should be taught the value of each design element and how it contributes to a valid investigation.

(l) Wherever possible, investigations involving plant responses to the environment should be done. If not, then learners must be exposed to the practical design of these experiments through worksheets, notes, slides, and past examination papers. More attention should be paid to the types of variables (*dependent, independent* and *controlled*), the implementation of reliability, accuracy and validity, as well as the controls.

(m) A number of Afrikaans terms have become obsolete, and teachers and learners should be discouraged from using them. This has often been mentioned in previous reports.

Afrikaans words that should not be used in teaching

CORRECT TERM	TERMS NOT TO USE
Fallopius-buis	Eierleier
Goiter	Kropgeswel
Vas deferens	Spermbuis
Akson en dendriete	Uitloper(s)
Epididimus	Bytestis
Diabetes	Suikersiekte
Tiroïedklier	Skildklier
Timpanium	Oordrom
Koglea	Slakkehuis

(n) Scientific skills must be emphasised from Grade 10. This will strengthen critical thinking and problem-solving skills.

(o) The idea of increased glucose absorption and utilisation during respiration must become a bigger focus area when presenting this content in the classroom. This can start in Grade 11. In general, teachers must emphasise that hormones inhibit or stimulate a response in an *effector/target organ* and do not perform that response themselves.

(p) When teaching *homeostasis* and the *endocrine system,* emphasis must be placed on the words 'more'/'less' (whichever one is applicable) as well as changes that may occur in the blood, body or skin.

(q) Learners must be exposed to various types of questions with the different verbs (*explain*, *discuss* and *describe*). Questions focusing on c*ause* and *effect* must also be dealt with properly in class.

(r) Learners must not just study past marking guidelines, as the context of the question can change. Instead, teachers must ensure that learners have a sound understanding of the knowledge that they have to apply to different situations. Teachers should not just teach content but stimulate learners' cognitive skills.

(s) Learners must be taught to read the questions properly and be specific in answering them.

(t) Feedback after formal assessment is very important for candidates to know where and how mistakes were made.

## 8.5   OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 2

General comments

(a)   Wherever there was a higher difficulty level in the question paper, it was either due to stimulus difficulty or response difficulty. Candidates appeared to have been more comfortable with content than before, but were missing the mark when they had to provide the specific responses required to answer a question successfully and completely.
This may be because they did not:
- Read the stem of the question;
- Pay attention to the instructional verb of each question;
- Apply their knowledge to a specific context or scenario;
- Present their responses in the expected scientific notation;
- Base their responses on the data, diagram, texts or graphs provided;
- Read or follow the instructions of each question/sub-question;
- Pay attention to correct spelling.

(b)   Skills associated with designing and interpreting a scientific investigation appeared to be underdeveloped. The investigation question tested candidates' ability to analyse and evaluate procedures and data. They were also expected to pre-empt the planning steps of the investigation. All these questions required higher order cognitive skills; the average candidate found these questions challenging.

(b)   Candidates generally fared well in questions that required brief responses but struggled to articulate accurate responses for questions that required extended writing, e.g. Q2.1.2; Q2.3.3; Q2.4.3; Q3.1.2; Q3.4.2 and Q3.5.3.

(d)   Producing a drawing that detailed the processes and products of meiosis proved to be problematic. Candidates did not understand the process of meiosis. This topic is studied regularly, however, candidates struggled to apply their knowledge.

(e)   There is a notable and encouraging improvement in graph drawing skills. Candidates, however, still struggle to formulate a comprehensive caption for the title of their graphs.

(g)   There are sections of the content that are poorly understood by candidates. These are topics that feature later in the Annual Teaching Plan and are generally glossed over by teachers. The section on *evolution*, in particular *human evolution*, is a casualty of this. Furthermore, many teachers struggle with understanding *evolution,* and this was evident from the poor performance of the candidates.

(h)   The following topics in Paper 2 also appeared not to have been taught well, either due to lack of teacher development or due to infrequency of testing in previous examinations:
- Genetic engineering;
- Phylogenetic trees;
- Scientists and their discoveries; and
- The Out-of-Africa hypothesis.

8.6   DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 2

Based on the item analysis, the weakest performance by candidates was recorded in the subquestions on *Genetic engineering*, *Human Evolution* and *Natural selection*.

The following graph is based on data from a random sample of candidates' scripts. 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 performance per question in Paper 2
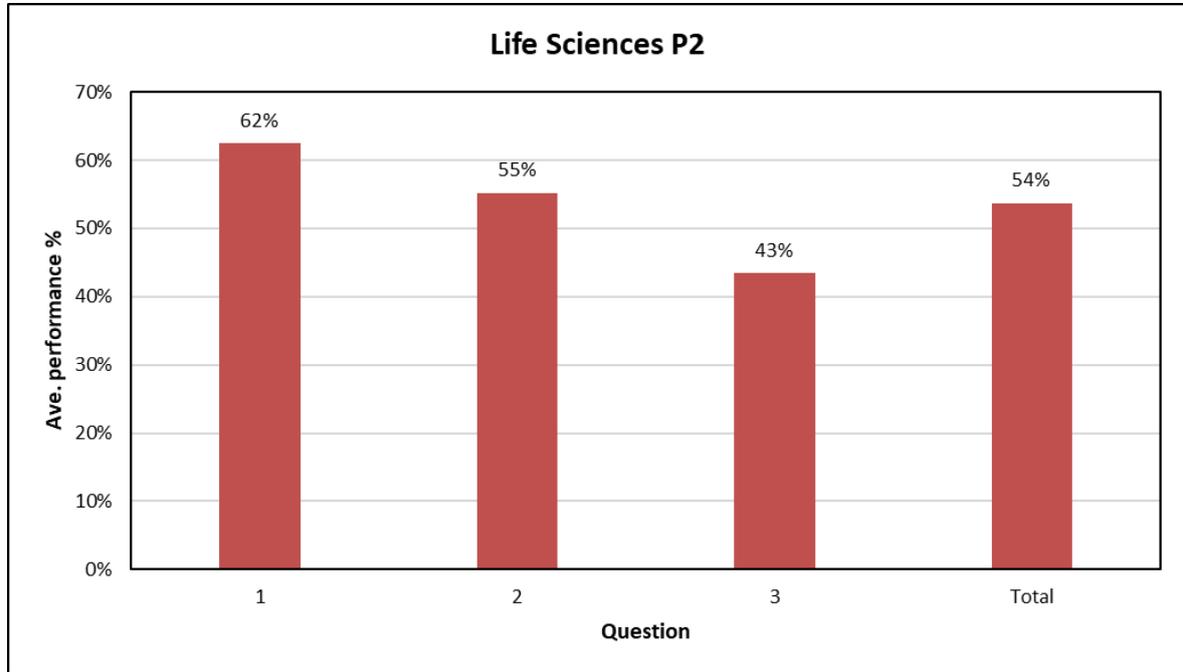
Q	Topics
1	Multiple choice, Terminology, Matching items, DNA replication, Dihybrid cross
2	Protein synthesis, meiosis, inheritance of blood groups, pedigree diagram and sex-linked monohybrid cross
3	Genetic engineering, phylogenetic tree, scientific investigation – evolution/genetics, human evolution, natural selection

Graph 8.6.2 Average performance per subquestion in Paper 2

Life Sciences P2
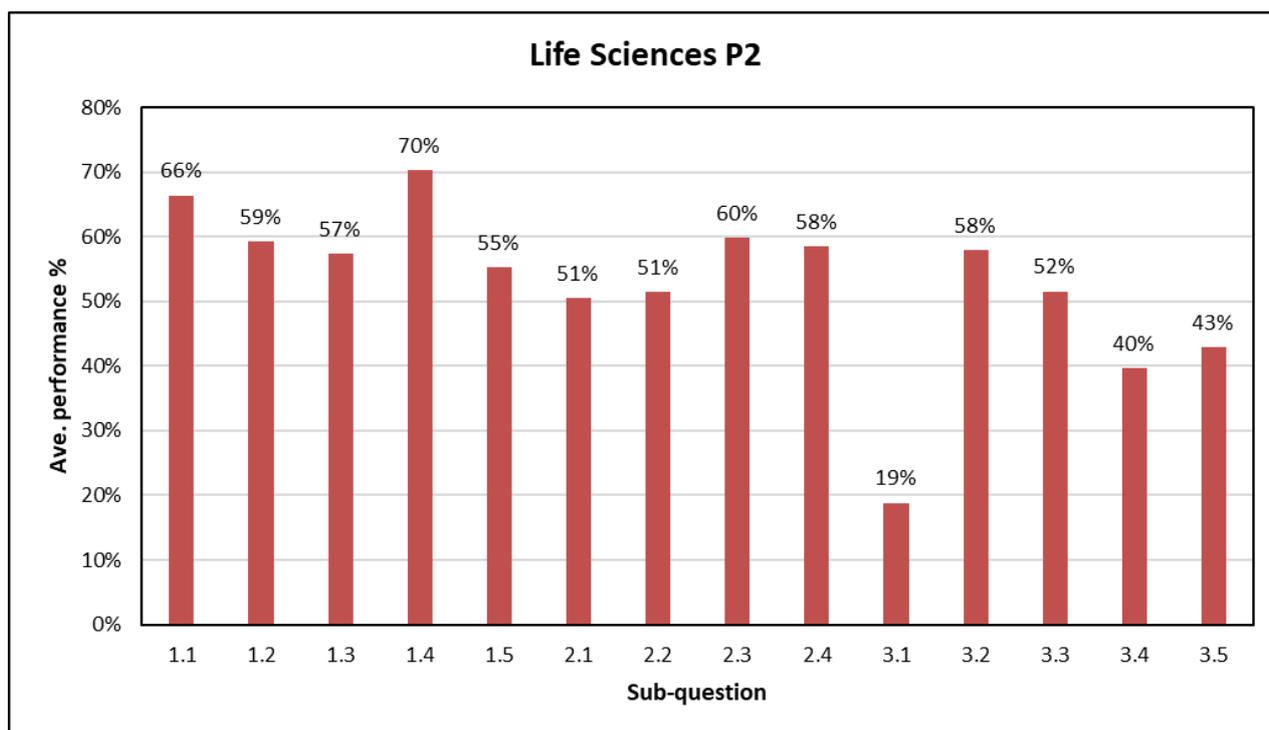
Subq	Topic	Subq	Topic
1.1	Multiple-choice question	2.3	Inheritance of blood groups
1.2	Terminology	2.4	Pedigree diagram and sex-linked monohybrid cross
1.3	Matching items question	3.1	Genetic engineering
1.4	DNA Replication	3.2	Phylogenetic tree
1.5	Dihybrid cross	3.3	Scientific investigation – Evolution/genetics
2.1	Protein synthesis	3.4	Human Evolution
2.2	Meiosis	3.5	Natural selection

8.7 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1:   MULTIPLE-CHOICE, TERMINOLOGY, MATCHING ITEMS, PEDIGREE DIAGRAM, PROTEIN SYNTHESIS

Common errors and misconceptions

(a)   Most candidates performed well In Q1.1, except in Q1.1.5, Q1.1.8 and Q1.1.9.
   - In Q1.1.5 many candidates saw the word 'gradual' and immediately went to the option '*punctuated equilibrium*' since it's definition also included the word 'gradual';
   - In Q 1.1.8, most candidates confused the processes and products of *mitosis* and *meiosis*;
   - In Q1.1.9 a number of candidates did not know the South African scientists and the fossils that each one discovered.

(b)   In Q1.2 some candidates lost marks because they:
- Did not give the correct and complete biologically accepted abbreviation in Q 1.2.1 and Q1.2.4 for *DNA* and *tRNA*;
- Confused the term *aneuploidy* with *haploid* in Q1.2.2. The word 'condition' in the question may have led candidates to believe that a disorder was being referred to;
- Still confused the terms *centriole, centrosome, chromosome and centromere* in Q1.2.3;
- Used the terms '*DNA profile*' and '*DNA profiling*' interchangeably in Q1.2.5; whereas one referred to an image and the other referred to a process;
- Confused the terms *species* and *population* in Q1.2.7; this was due to the similarity in their definitions;
- Failed to indicate whether the phase they had identified in Q1.2.8 occurred in *meiosis I* or *meiosis II*

(c)   Most candidates performed well in Q1.3. Some candidates struggled with the history of the discovery of DNA in Q1.3.2, even though the scientists involved are specifically named in the *Examination Guidelines* (pg. 7), as well as the *CAPS* document. The controversy regarding the *earlier* recognition of the scientists might have stumped the candidates. In Q1.3.3 many candidates chose the incorrect option as they were not familiar with the term *karyokinesis* in cell division.

(d)   Q1.4 was one of the better answered questions in the paper. In Q1.4.2(b) some candidates named the individual components of the labelled structure instead of the 'collective' term that was asked for. A few candidates identified the phase in Q1.4.3 as *interphase I* or *interphase II*, however, *interphase* does not occur separately in *meiosis I* and *meiosis II;*

(e)   Some candidates listed the dominant *alleles* in Q1.5.2, instead of listing the dominant *characteristics*. Furthermore, candidates only listed the colours red and black instead of giving the full description of the characteristic, viz. 'red spots and black eyes'. When presenting the genotypes in Q1.5.3(a), candidates lost marks for the incorrect presentation of the *alleles*, e.g. *ReRe* instead of *RRee*. In Q1.5.3(c) candidates were unable to formulate the '*genotype of the gametes' (re)* in a dihybrid cross and gave the *genotype of somatic cells (rree)* instead.

QUESTION 2:   PROTEIN SYNTHESIS, MEIOSIS, INHERITANCE OF BLOOD GROUPS, SEX-LINKED GENETIC CROSS

Common errors and misconceptions

(a)   A few subquestions in Q2.1 proved to be challenging for candidates because:
- Some candidates could not identify the process represented by the diagram and described *DNA replication* instead of *transcription* in Q2.1.2. This description is given in the *Examination Guidelines* and was of a lower cognitive demand. Candidates lost marks for omitting important information such as DNA *double helix, RNA nucleotides* and that only one strand was used as a template;
- Many candidates lost marks in Q2.1.4, as they gave the *complementary base sequence* for strand 1, instead of that for strand 2 (where *triplet Z* occurs);
- In Q2.1.5 many candidates were unable to interpret the *codon* table and its relation to the diagram. The first and last *amino acids* in the sequence were requested, however, candidates did not refer to the stem of the question which indicated that the sequence of bases should be read from left to right. This

question required multi-step application and was pitched at a higher cognitive level.

(b)   Q2.2 depended heavily on the correct application of biological terminology. Most candidates lost marks for using the terms incorrectly as follows:
- Identified the phase incorrectly or simply writing '*anaphase*', instead of a*naphase II* in Q2.2.1;
- Used the terms *chromosomes, chromatids, centromeres* and *centrioles* incorrectly in Q2.2.2. and not making the distinction that *homologous chromosome pairs* separate in *anaphase I* and a single *chromosome* separates in *anaphase II.*
- Wrote *'centromere'* instead of *'centriole'* or *'centrosome'* in response to Q2.2.3(a) and 'springle', 'spingle' or 'sprindle' instead of *'spindle'* as an answer to Q2.2.3(b)*;*
- Used colloquial terms like 'side' or 'ends' instead of referring to the *'poles'* of a cell.
- In Q 2.2.5 candidates were unable to work out the number of *chromosomes*, their arrangement and genetic configuration in order to successfully produce the correct drawing. Many candidates re-drew the diagram from the question paper and included labels they were mandated to exclude.

(c)   Q2.3.3 was poorly answered by many candidates who referred to the inheritance of a *blood group* rather than to the inheritance of an *allele* and described a *dominant blood group*, rather than a *dominant allele*. Candidates failed to describe the inheritance of *alleles* from both parents and also used the incorrect notation for the *alleles* and lost marks for this.

(d)   Candidates performed very well in Q2.3.4. Most candidates scored full marks for the drawing of the graph. However, some learners lost marks for unequal spacing between bars and the incorrect use of a scale on the Y-axis. Many candidates also lost marks for an incomplete caption.

(e)   Q2.4 showed varied candidate performance across the sub-questions. Many candidates lost marks in Q2.4.3 and Q2.4.4.
- In Q2.4.3 candidates were unable to explain how the presence of *recessive alleles* on the *gonosomes* of males and females would result in the inheritance of the disorder. Most of them only stated the type of *gonosomes* found in males and females. They failed to state that males only needed one *recessive allele* to have the disorder while females needed two *recessive alleles*. Candidates were also unable to explain the inheritance of the disorder in terms of the masking of the *recessive allele;*
- In Q2.4.4 candidates lost marks for the incorrect wording of the *phenotype* – they did not include the gender and gave an incorrect representation of the *genotype.* Some candidates still used the term 'fusion' instead of 'fertilisation' incorrectly, despite this being reported in the diagnostic report of 2023. Also, the *P2* and *F2* generations were not indicated by most candidates.

QUESTION 3: GENETIC ENGINEERING, PHYLOGENETIC TREE, SCIENTIFIC INVESTIGATION (EVOLUTION/GENETICS), HUMAN EVOLUTION NATURAL SELECTION

Common errors and misconceptions

(a)   Q3.1 ranked as the lowest scoring question in the paper. Most candidates lacked a fundamental understanding of the basic steps involved in *genetic modification*. A specific scenario of *Bt corn* was given, however, most candidates confused this with

DNA recombinant technology that is used to mass produce products like insulin. Candidates who had some understanding of genetic engineering described how the Bt toxin was mass produced by bacteria. Q3.1. was of a higher cognitive demand and gauging from candidates' responses, this was clearly a question that separated the level 7 candidate from the rest.

(b)   Q3.2 required the interpretation of a *phylogenetic tree*. This topic is taught from Grade 10 to Grade 12. Some candidates displayed a clear lack of understanding that species that shared the *most recent common ancestor* were the most closely related. Most candidates who lost marks in this question could not correctly interpret a *phylogenetic tree* and identified *Orangutans* as the species most closely related to *Old-world monkeys* in Q3.2.2 and Q3.2.3. They did not trace the lines of origin back to *gibbons* and instead chose the species that was indicated next to *Old-world monkeys* on the diagram. Candidates fared much better in Q3.2.5. However, the expression of a few technical criteria caused their responses to be incorrect.
These included:
- Writing long arms instead of long *upper* arms;
- Referring to other body parts, when the question specifically required differences in the upper limbs;
- Discussing the significance of *bipedalism;* and
- Providing incomplete descriptions, e.g. '5 fingers', instead of '5 fingers per limb', or simply saying 'nails', rather than specifying 'have nails instead of claws'.

(c)   The scientific investigation questions in Q3.3 was of a high cognitive demand. Most candidates struggled with the analysis and evaluation of the procedure and their results. The challenges faced in each sub-question are listed below.
- Many candidates lost a mark in Q3.3.1 for writing the independent variable as the 'influence' of the type of milk. The '*influence* of the type of milk' is the 'height of the children' which is in fact, the dependent variable. Some candidates incorrectly took the headings of the table to describe the variables.
- In Q3.3.3 candidates did not differentiate between planning steps and the procedure and merely copied the first bullet of the procedure as their response.
- The poor performance of candidates, in response to Q3.3.4 and Q3.3.5 confirmed that most candidates did not grasp the concept of evaluating the validity of an investigation.
- In Q3.3.6 candidates lost marks because they provided generic responses to how reliability could be improved, such as 'increase sample size,' without applying it to the context of the investigation.
- Candidates were asked to provide a conclusion for the investigation in Q3.3.7. Many candidates did so unsuccessfully as they provided an analysis of the results, rather than linking the results to the aim of the investigation. Depending on how the results are presented, an analysis of results may sometimes provide the conclusion, but this is not always the case. Candidates must read and comprehend the context of each investigation and not apply generalised rules.

(d)   Q3.4 was set at a lower cognitive level, but still caused candidates to lose marks because they:
- Did not correctly describe the role of fossils in supporting the '*Out of Africa'* hypothesis in Q3.4.1 and Q3.4.2. Key words such as 'oldest' and 'only' were either omitted or used incorrectly in the descriptions. Some candidates referred to evidence for human evolution rather than evidence for the '*Out-of-Africa hypothesis*'.
- Listed the differences between the *Homo erectus* and *Homo sapiens* outside of the ones mentioned in the passage in Q3.4.3. They also did not align the

differences per row in the table e.g., they listed brain size in the first column and compared it to brow ridges in the second column.

- Incorrectly described the position of the *foramen magnum* as being 'in the middle' or 'central' rather than 'in a more forward position'.

(e)   Candidates' inability to read with comprehension was clearly evident in their responses to Q3.5.3. Many candidates lost marks because they:

- Gave a generic response to describe *natural selection* rather than applying it to the given scenario;
- Used the terms '*favourable and unfavourable characteristics'* without qualifying them in the context of the question;
- Could not identify the characteristic in wolves that was the source of variation and incorrectly identified the variation as '*resistance to radiation'* rather than *'immunity to cancer'*;
- Referred to evolution of the '*species*' rather than to evolution of the '*population*';
- Omitted to mention that the *allele* for *immunity to cancer* was passed on to offspring and instead incorrectly stated that the *characteristic of immunity to cancer* was passed on;
- Incorrectly stated that the wolf *population* would now have the characteristic of immunity instead of stating that the next generation had a *higher proportion* of wolves with immunity.

Suggestions for improvement on teaching content and concepts for P2

(a)   A significant number of marks in Paper 2 are allocated to the topic of *meiosis.* The list below provides a few tips on how the teaching of this topic can be improved.

- Before commencing with content delivery of *meiosis*, teachers must do a thorough revision and baseline testing of learners' knowledge of *mitosis* (Grade 10). Once the section on *meiosis* is taught, teachers must then highlight the similarities and differences between
   o *meiosis* and *mitosis*;
   o *meiosis I* and *meiosis II;*
   o *meiosis II and mitosis.*
- When describing the behaviour of *chromosomes* during *meiosis*, learners must be specific as to whether they are referring to a *homologous pair* of chromosomes or to a single *chromosome.*
- It should be pointed out to learners that *interphase* is a phase between *meiotic divisions,* and it is therefore incorrect to refer to *interphase I and interphase II.* However, all other phases of meiosis that need to be identified, must be followed by the number I or II;
- Learners must be given classwork and homework exercises that enable them to use features of a meiosis diagram to identify the specific phases and be able to identify the preceding or following phases;
- Teachers must allow learners to practise the drawing of *chromosomes* and *chromatids* using shading to show the effects of *crossing over* and *independent assortment.*

(b)   The differentiation between the scientists responsible for the discovery of *DNA* and those responsible for the discovery of key *fossils* was raised in the *Diagnostic Report* of 2023. Reference should be made to this document on the following link:

https://www.education.gov.za/LinkClick.aspx?fileticket=X4BWNU0gxUU%3d&tabid=92&portalid=0&mid=4359

The following issues were also reported on in the *Diagnostic Report* of 2023, but continued to be a challenge in the 2024 examination:
- The correct genetic notation for blood groups;
- The steps in DNA replication;
- The genotypes of gametes in a dihybrid cross;
- Knowledge that natural selection occurs in a population and not in a species;
- Characteristics in natural selection are 'favourable' and not 'desirable';
- Providing generic responses in questions on *validity* and *reliability* in scientific investigations;
- The names of scientists and the fossils that they discovered.

(c)   Learners should be given a list of the correct convention of writing:
- Abbreviations for the nucleic acids e.g., DNA, RNA, mRNA and tRNA;
- The genotypes of the different blood groups as in the table below:

Phenotype (Blood group)	Genotype
A	Homozygous - (I^AI^A) Heterozygous - (I^Ai)
B	Homozygous - (I^BI^B) Heterozygous - (I^Bi)
AB	Heterozygous - (I^AI^B)
O	Homozygous - (ii)

(d)   Learners need to understand the concept of the DNA *double helix* in order to fully comprehend the beginning stages of *replication* and *transcription*. The term 'double helix' means that DNA has two 'strands', which are twisted into a spiral configuration, hence the separate points of 'the DNA molecule unwinds' and then 'unzips through the breaking of the hydrogen bonds'.

(e)   Learners must engage in activities that allow them to distinguish between the following similar-sounding terms:
- chromosome
- centrosome
- centromere
- centriole
- chromatin
- chromatid

These terms are especially relevant to 'biological terminology' and 'match the columns' activities.

(f)   It must be noted that all descriptions of cellular processes and structures refer to *eukaryotic* cells, unless otherwise stated, e.g. in *recombinant DNA technology* or the development of *resistance in viruses and bacteria*.

(g)   Teachers must assist learners to create a list of definitions that distinguishes between the following terms:
- *species* and *population;*
- *DNA* and *RNA;*
- *DNA profile* and *DNA profiling;*
- *karyokinesis* and *cytokinesis;*
- *DNA replication* and *transcription;*
- *transcription* and *translation;*

- *monohybrid* and *dihybrid;*
- *phenotype* and *genotype;*
- *alleles* and *characteristics;*
- *codon* and *anticodon.*

(h)   Learners must be instructed on the correct convention of writing the genotypes for a dihybrid cross and teachers must emphasise that:
- The alleles for a particular characteristic have to be written together, e.g., RRee and NOT ReRe;
- There should be no space or 'X' between the alleles for the two characteristics, e.g. *RRee* and not *RR ee*, as the latter may imply two different genotypes.

(i)   When teaching a dihybrid cross in genetics, teachers must emphasise the difference between the genotype of an individual or somatic cell and the genotype of a gamete. The table below summarises the *genotypes* assigned in a *Dihybrid cross.*

GENOTYPE OF …	NUMBER OF ALLELES	EXAMPLE
Individuals	Have two alleles for each characteristic	RRee
Gametes	Have one allele for each characteristic	Re

(j)   When conducting internal assessments, teachers must insist that learners give full descriptions for *phenotypes*, indicating the characteristic as well, e.g. 'Red spots and black eyes' and not just 'red and black'.

(k)   Teachers need to expose learners to a diversity of diagrams representing *protein synthesis,* so they are comfortable with all the different approaches. Also, both *codon* and *anticodon* tables must be practised on.

(l)   Learners are competent at doing genetic crosses to establish the possible *phenotypes* in offspring, but struggle to articulate the inheritance pattern when asked for an explanation. Teachers must provide opportunities for this in SBA tasks and tests. The following general criteria may be followed, depending on the context:
- Establish the phenotype of the offspring;
- Formulate the genotype of the offspring;
- Give the phenotype and genotype of each parent; and
- Indicate which allele was inherited from each parent.

(m)   The teaching of biotechnology appears to pose a challenge. Genetic modification as a topic is poorly understood. Learners can be assisted in understanding the process, if it is broken down as follows:
- The desirable characteristic/product, e.g. production of the Bt toxin;
- The source of the gene responsible for the desired characteristic, e.g. the bacterium;
- Where the gene is transferred to, e.g. the maize plant;
- The effect of the gene in the second organism; and
- The resultant product, e.g. insect resistant plant.

(n)   The successful interpretation of phylogenetic trees can only be mastered through practice and teachers need to provide as many examples, formats and opportunities for learners to do so. The following features, inter alia, need to be emphasised:
- Species that occur in present time;
- Points of extinction of species;
- Species that exist during the same period;

- The difference between a common ancestor and the most recent common ancestor and that species that have a more recent common ancestor are more closely related.

(o)   The section on evolution comprises 36% (54 marks) in Paper 2. Evolution, in particular human evolution, is taught towards the end of the academic year and as such is often glossed over. This may explain the lower performance in Q3.

Teachers must ensure that sufficient time and effort is placed on the delivery of this content to prepare the learners adequately. The question on the Out-of-Africa hypothesis was pitched at a lower cognitive level, yet candidates could not achieve maximum marks.

Some teachers encourage the studying of the content from the *Examination Guidelines*, rather than ensuring that the learners understand the content. This causes learners to fumble when they cannot recall correctly, or a different context is presented.

Teachers could also use mnemonics to enable the recall of the evolutionary sequence of fossils, e.g. 'hes' for *habilis, erectus and sapiens* representing the 'Homo' genera.

Since many learners are visual or spatial learners, a valuable strategy to understanding the use of fossil evidence for the Out-of-Africa hypothesis would be to use a map of the continents, showing which fossils occurred on which continents. Using the image and the relative ages of the fossils, they must explain to learners *how* and *why* scientists made the deductions they did. If learners understand the logic, their recall will be more effective.

The diagrammatic representation shown below is only an example and teachers must produce their own images.

Diagrammatic representation of the Out-of-Africa Hypothesis
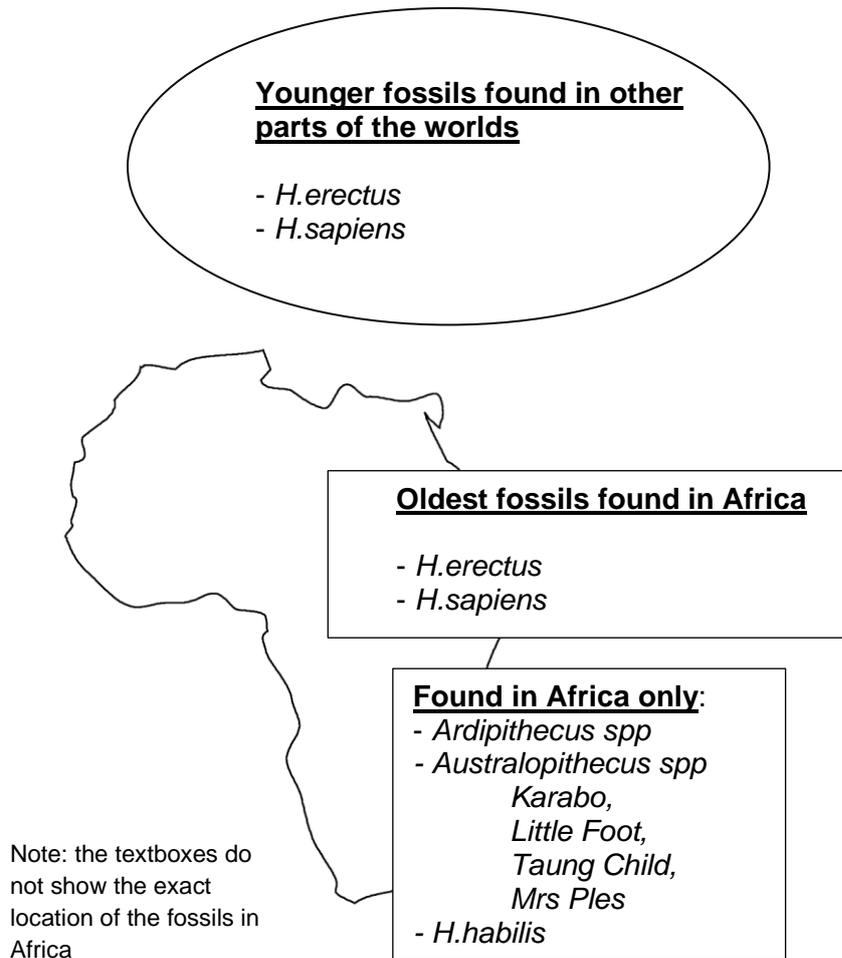
(p)   Learners seem to have a good overview of the dynamics of natural selection, but struggle to identify the details specific to the scenario given. Teachers must present learners with as many different scenarios as possible and ensure that they are able to identify:

- The population concerned, e.g. the wolves;
- The variation that occurs within the population, e.g. mutation/immunity to cancer;
- The favourable characteristic, e.g. mutation/immunity to cancer;
- The unfavourable characteristic, e.g. no mutation/immunity to cancer;
- The selection pressure/change in the environment, e.g. high radiation;
- The allele that is passed on (not the characteristic);
- The higher proportion of which variant in the next generation, e.g. those with the mutation/immunity to cancer.

General suggestions for improvement for Paper 1 and Paper 2

(a)   The *CAPS* document, *Examination Guidelines* and *ATP*s provide the framework for content delivery. Teachers must use their discretion and the information in approved textbooks to determine the aspects that are crucial to the understanding of content, e.g. none of the aforementioned documents mentions the term *karyokinesis*, yet it is crucial to the understanding of meiosis that this term be utilised. Similarly, the exact

anatomical structures in the nervous system are not mentioned, but knowledge of these structures is crucial to the understanding of the content.

(b)   Life Sciences is a science subject and therefore the correct representation and notations are important, e.g. tRNA is the accepted abbreviation for transfer RNA and not TRNA. Genotypes and genetic crosses have to be given with the correct scientific representation. Full phenotypic descriptions must be given. The descriptions given in the key to a pedigree diagram must be used to indicate the phenotypes when requested.

(c)   Many of the errors and misconceptions that presented themselves in candidate responses in the November 2024 examinations have been highlighted in previous Diagnostic Reports. This indicates that this document is not being used as a remedial tool. The past reports may be accessed using the link below:

        https://www.education.gov.za/?fileticket=4JVOD_6ncds%3D&tabid=92&portalid=0&mid=4359

(d)   There is clear evidence that many learners have been effectively taught and that they have learnt the necessary material, however, due to stimulus difficulty and response difficulty, they are unable to obtain the maximum marks per question. Learners must be taught not only to reproduce what they recall of the content, but to ensure that their responses accurately answer the questions asked. An example of this is from Paper 1 where candidates were able to describe the features of the *uterus*, but not its suitability for *implantation*.

(e)   Learners must be made aware that data response questions require them to use the data, extract, texts, diagrams or scenarios provided, to answer the questions. They should consider the context and not provide generic responses.

(f)   Scientific investigations are a pivotal assessment tool for higher-order questions and are present in both Papers 1 and 2. Learners who are able to master the typical questions based on a scientific investigation will definitely perform well in Life Sciences. The questions that are asked generally require candidates to:
        • Identify the independent variable;
        • Identify the dependent variable;
        • Identify the controlled variables;
        • Define a control;
        • Express the need for a control;
        • State the aim of the investigation;
        • List the planning steps for the investigation;
        • Suggest how to improve the validity of the investigation;
        • Suggest how the reliability of the results can be improved;
        • State a conclusion;
        • Evaluate the procedure.

        Learners must ensure that they do not give generic responses but respond to the specific procedure and data provided. Candidates may be asked, for example, how to improve the reliability, or how the scientists improved that reliability. In the latter case, they must indicate how the reliability for *each group* was improved. Reference can be made to previous diagnostic reports that give the specific descriptions of the requirements mentioned above.

(g)   Learners must master the skill of drawing graphs as this may be assessed in one or both papers. The criteria for assessing the different types of graphs may be accessed from the official national Marking Guidelines and given to learners for self-assessment of the graphs that they have drawn. The one area that learners struggle with is the graph caption/heading. Headings in a graph must mention both variables and any other specific details of the data provided. The term 'versus' (or vs) should not appear in the graph caption.

(h)   It is clear that learners do not understand how to interpret a graph, or the data given in a tabular form. They are proficient at reading off values but are unable to identify and explain trends. When describing the trend in a graph, learners must begin with the independent variable and see how its values affect the dependent variable. Learners must understand that they should not describe the data as being directly proportional or indirectly proportional. This is not accepted as a description, since direct proportion means an increase or decrease at a constant rate, which is rarely the case with biological data.

(i)   Learners should be provided with the relevant sections of the official *2021 Examination Guidelines* before a particular topic is taught. Too often, learners are presenting information that is outside the scope of the curriculum and examinable content which may not specifically be the required response. Learners can also use the *Examination Guidelines* as a tick list to guide their studies.

(j)   The format of internal and provincial examinations as well as the criteria in the Marking Guidelines should follow the format and layout of the national examination from Grade 10 onwards. This will familiarise learners on how to present their responses for multiple choice questions, biological terminology etc., as well as sensitise them on how these concepts are marked.

(k)   Internal and provincial assessments must include questions of higher cognitive levels, as prescribed in the *CAPS*. They should also include questions that require extended writing and articulation of responses.

(l)   Biological terminology is crucial to the general understanding of *all* the questions in Life Sciences, and not just for Q1.2. In order to consolidate biological terminology, the approach should be:
 • First provide the description and the learner must give the term; and
 • Next, provide the term and allow the learners to give the associated description.

(m)   The instructional verbs in a question determine the depth of the expected response. When candidates are asked to 'describe', then reasons may not always be required, however, when they are asked to 'explain', then reasons must be provided. Learners must be taught to underline the instructional verb, so that they are alerted to the required response.

(n)   Learners must be encouraged not to express their responses in a negative form, e.g. *'use the data to explain which group has healthy individuals',* candidates responded with an explanation for which group had the unhealthy individuals*.*

(o)   Subject advisors should facilitate the administration of topic tests to ensure the tempo and completion of the relevant sections. These may be extracted from previous examination papers and used as informal assessments.

(p)   The following topics are often neglected and not given the necessary attention:
- Reproduction in vertebrates;
- Plant responses to the environment;
- Genetic engineering (biotechnology, stem cell research, cloning);
- Human evolution.

These topics have to be assessed in every national examination and should be emphasised in the classroom. Teachers and subject advisors must plan effectively so that these topics are covered and reinforced thoroughly.