basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

LIFE SCIENCES P2

NOVEMBER 2023

MARKS: 150

TIME: 2½ hours

This question paper consists of 15 pages.

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start the answers to EACH question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. Do ALL drawings in pencil and label them in blue or black ink.
7. Draw diagrams, tables or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT necessarily drawn to scale.
9. Do NOT use graph paper.
10. You must use a non-programmable calculator, protractor and a compass, where necessary.
11. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1.1 to 1.1.9) in the ANSWER BOOK, e.g. 1.1.11 D.

1.1.1 The base pairing in DNA was discovered by …

A Watson and Wilkins.
B Franklin and Wilkins.
C Franklin and Crick.
D Crick and Watson.

1.1.2 A gene codes for the production of …

A a chromosome.
B an allele.
C DNA.
D a protein.

1.1.3 Which ONE of the following is a characteristic of stem cells?

A They are easily obtained from any organ.
B They divide by meiosis.
C They are haploid.
D They can be stimulated to form any type of cell needed.

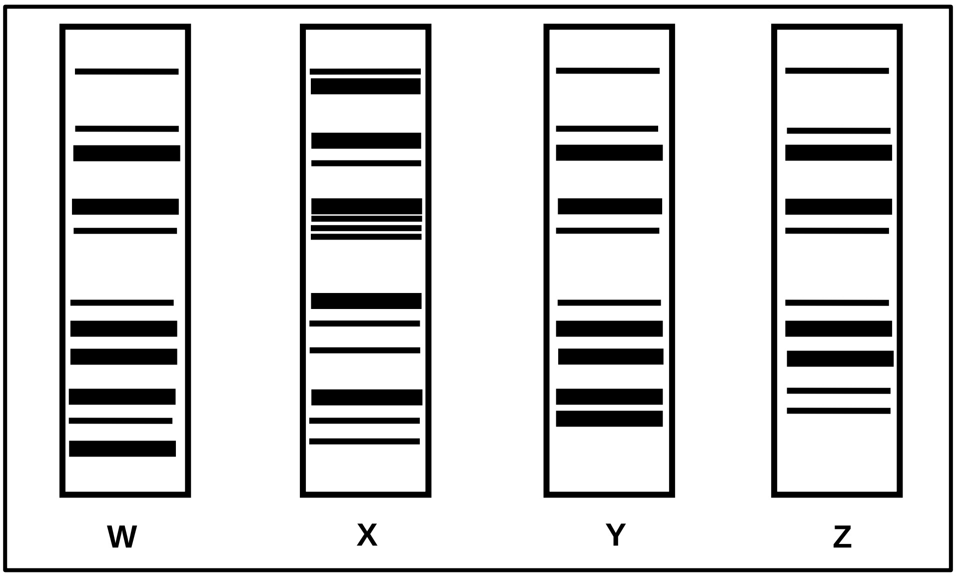
1.1.4 The chances of having a female child in humans is …

A 25%
B 50%
C 75%
D 100%

1.1.5 Which ONE of the following is part of the reason why colour-blindness is more common in males than in females?

A The allele for colour-blindness is recessive and located on the X-chromosome.
B Colour-blind males have two copies of the allele for colour-blindness.
C The allele for colour-blindness is recessive and located on the Y-chromosome.
D Fathers pass the allele of colour-blindness to their sons only.

1.1.6 The DNA profile of four individuals are given below.



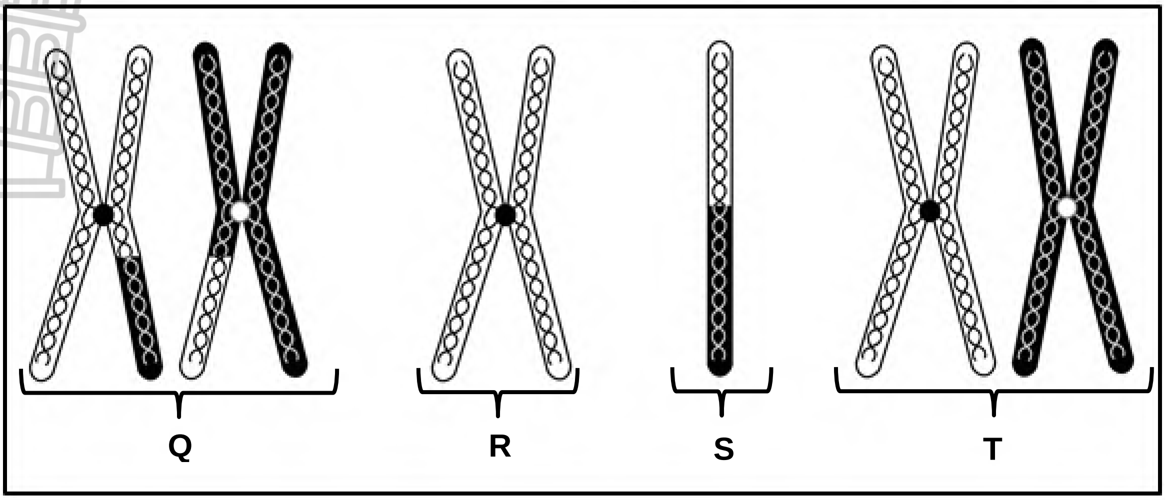
Which individuals are possible members of the same family?

A X and Z only
B X, Y and Z only
C W, Y and Z only
D W, X and Y only

1.1.7 When two plants heterozygous for a characteristic are crossed, the expected ratio is:

	Dominant phenotype		Recessive phenotype
A	3	:	1
B	1	:	3
C	1	:	2
D	1	:	1

1.1.8 The diagram below represents the structure of chromosomes at different stages of meiotic cell division.



Which ONE of the following chromosomes would be found in a cell during late Anaphase II?

A **Q**
B **R**
C **S**
D **T**

1.1.9 The scientist who discovered Little Foot is …

A Lee Berger.
B Raymond Dart.
C Ron Clarke.
D Robert Broom. (9 x 2) **(18)**

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question numbers (1.2.1 to 1.2.10) in the ANSWER BOOK.

1.2.1 The position of a gene on a chromosome

1.2.2 The type of evolution characterised by long periods of little or no change followed by short periods of rapid change

1.2.3 The natural shape of a DNA molecule

1.2.4 The type of bond found between two amino acids

1.2.5 The type of vision shared in primates that allows for depth perception

1.2.6 The type of dominance which results in an intermediate phenotype in the heterozygous condition

1.2.7 The fluid of the nucleus where free nucleotides are found

1.2.8 A tangled mass of chromosomes located within the nucleus

1.2.9 The division of the cytoplasm after a nuclear division

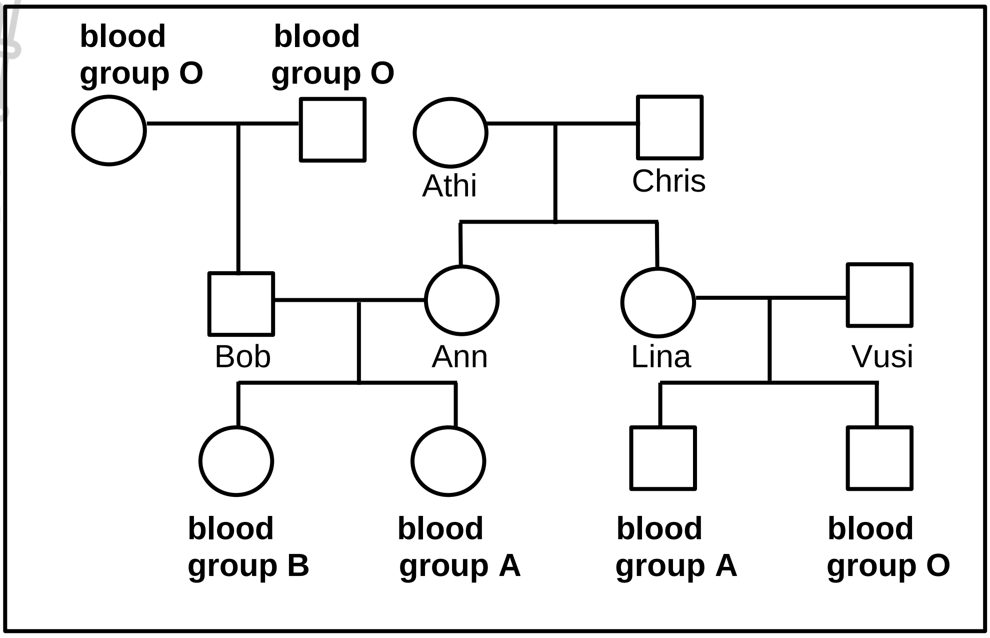
1.2.10 The name for the X and Y sex chromosomes in humans (10 x 1) **(10)**

1.3 Indicate whether each of the descriptions in COLUMN I apply to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B** or **none** next to the question numbers (1.3.1 to 1.3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II
1.3.1	A genetic disorder caused by a chromosomal mutation	A: Haemophilia B: Colour-blindness
1.3.2	The importance of meiosis	A: Formation of gametes B: Halving of the chromosome number
1.3.3	The organelle where DNA is found in plants	A: Mitochondria B: Chloroplast

(3 x 2) **(6)**

1.4 The diagram below shows the inheritance of blood groups in a family.



1.4.1 Name the type of diagram shown. (1)

1.4.2 Give the number of alleles that control blood groups. (1)

1.4.3 How many generations are represented in the diagram? (1)

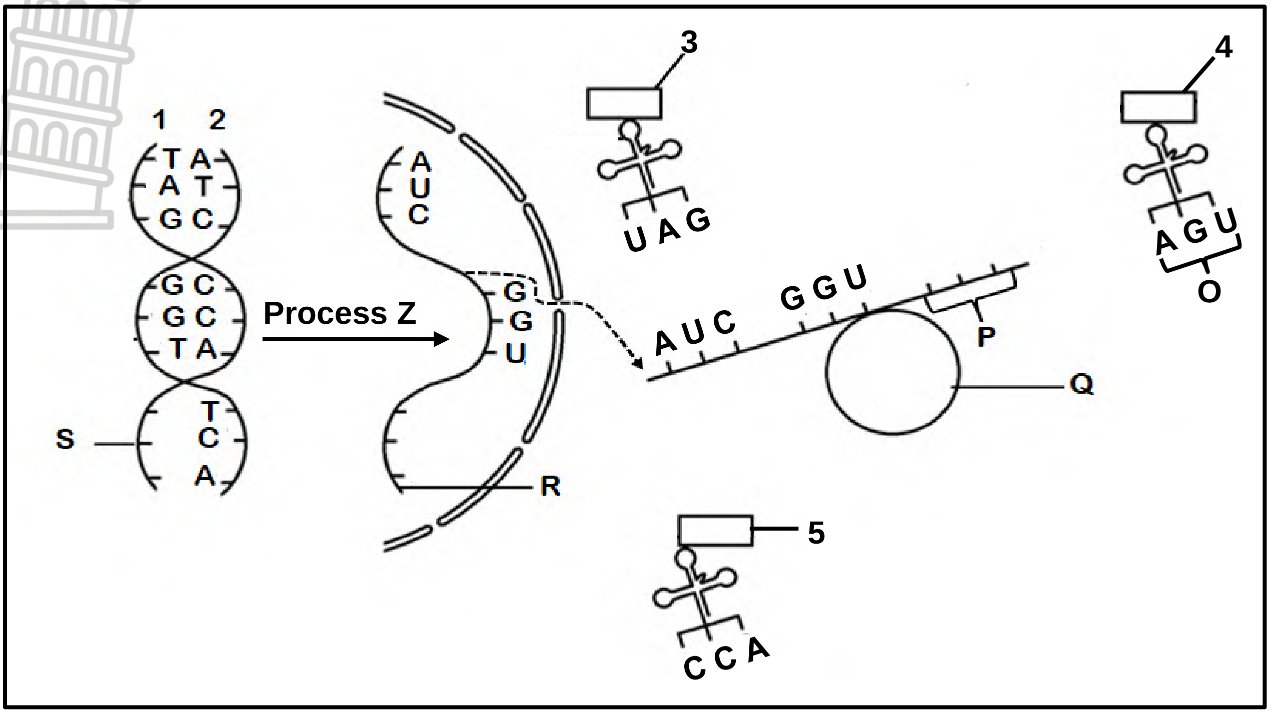
1.4.4 Lina's genotype is $I^A i$.

State ALL the possible genotypes of Vusi. (2)

1.4.5 Give the genotype of Bob. (1)

1.4.6 Give the name of the individual which displays co-dominance. (2)
(8)

1.5 The diagram below is a schematic representation of protein synthesis.



1.5.1 Identify:

(a) Process **Z** (1)

(b) Molecule **R** (1)

(c) Organelle **Q** (1)

1.5.2 Give the collective name of nitrogenous bases **O**. (1)

1.5.3 Determine the sequence of the nitrogenous bases at area **S**. (1)

1.5.4 Which strand (**1** or **2**) was used as a template for the formation of molecule **R**? (1)

1.5.5 Which amino acid (**3**, **4** or **5**) will be brought to area **P**? (1)

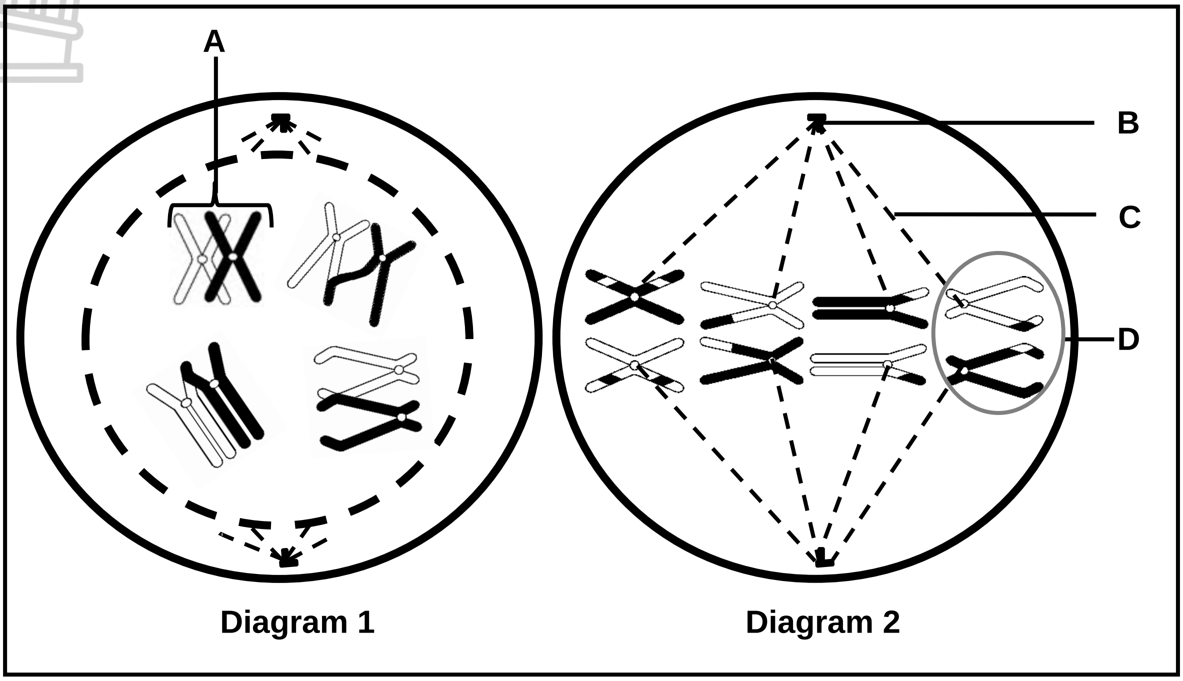
1.5.6 Name the type of sugar that forms part of the structure of molecule **R**. (1)
(8)

TOTAL SECTION A: 50

SECTION B

QUESTION 2

2.1 The diagrams below represent two stages of meiotic cell division.



2.1.1 Name structure:

(a) **B** (1)

(b) **C** (1)

2.1.2 Identify the phase represented in Diagram **1**. (1)

2.1.3 Give THREE reasons for your answer to QUESTION 2.1.2. (3)

2.1.4 Describe the process taking place at **A**. (3)

2.1.5 (a) Identify the phase represented in Diagram **2**. (1)

(b) Describe the difference in the events that take place in the phase mentioned in (a) and the same phase during mitosis. (2)

2.1.6 Describe the results at the end of meiosis if the chromosomes at **D** failed to separate. (3)
(15)

2.2 Describe the process of DNA replication. **(6)**

2.3 Read the information below.

> A gene, VKORC1, codes for a blood-clotting factor in humans. This gene is made up of 163 amino acids.
>
> A mutation occurred that affected amino acid 128 and 139, the sequence CTG changed to CAG and the TAT became TCT. This mutation has been transmitted as an autosomal dominant characteristic through the generations.
>
> The mutation has resulted in resistance to Warfarin drugs in humans. Warfarin is used in the treatment of thrombosis. Thrombosis results in the formation of a blood clot in the artery. Warfarin causes the thinning of blood to break down the blood clot.

2.3.1 Give ONE piece of evidence from the information that shows that the mutation for this gene occurred in the DNA molecule. (1)

2.3.2 How many nitrogenous bases code for the VKORC1 gene? (2)

2.3.3 Describe what is meant by an *autosomal dominant allele*. (3)

2.3.4 The table below shows the amino acids and their corresponding codons.

CODONS	AMINO ACID
GAC	Leu
UCU	Ser
AUA	Try
GUC	Gln
AGA	Arg
ACA	Trp
CAG	Gln
UAU	Phe

Explain:

(a) How the mutation on the VKORC1 gene resulted in resistance to Warfarin in humans (5)

(b) The effect of this mutation on humans with thrombosis (3)
(14)

2.4 Polydactyly is a condition that leads to extra fingers or toes. It is caused by a dominant allele.

A man who is heterozygous for polydactyly has a wife who is not polydactyl.

Using the letters **R** and **r**, do a genetic cross to show the percentage chance that their children will have polydactyly. **(6)**

2.5 In summer squash plants, white fruit colour **(B)** is dominant over yellow fruit colour **(b)**, and round fruit **(D)** is dominant over oval fruit **(d)**.

A summer squash plant that is homozygous for white and round fruit is crossed with a plant that is homozygous for yellow and oval fruit.

2.5.1 State the:

(a) Genotypes of the P_1-parents (2)

(b) Phenotypes of the F_1-generation (2)

2.5.2 Two plants that are heterozygous for both characteristics were crossed.

(a) Give ALL the possible genotypes in the **gametes** that will be formed. (2)

(b) How many plants in the next generation are likely to have yellow and oval fruit? (1)

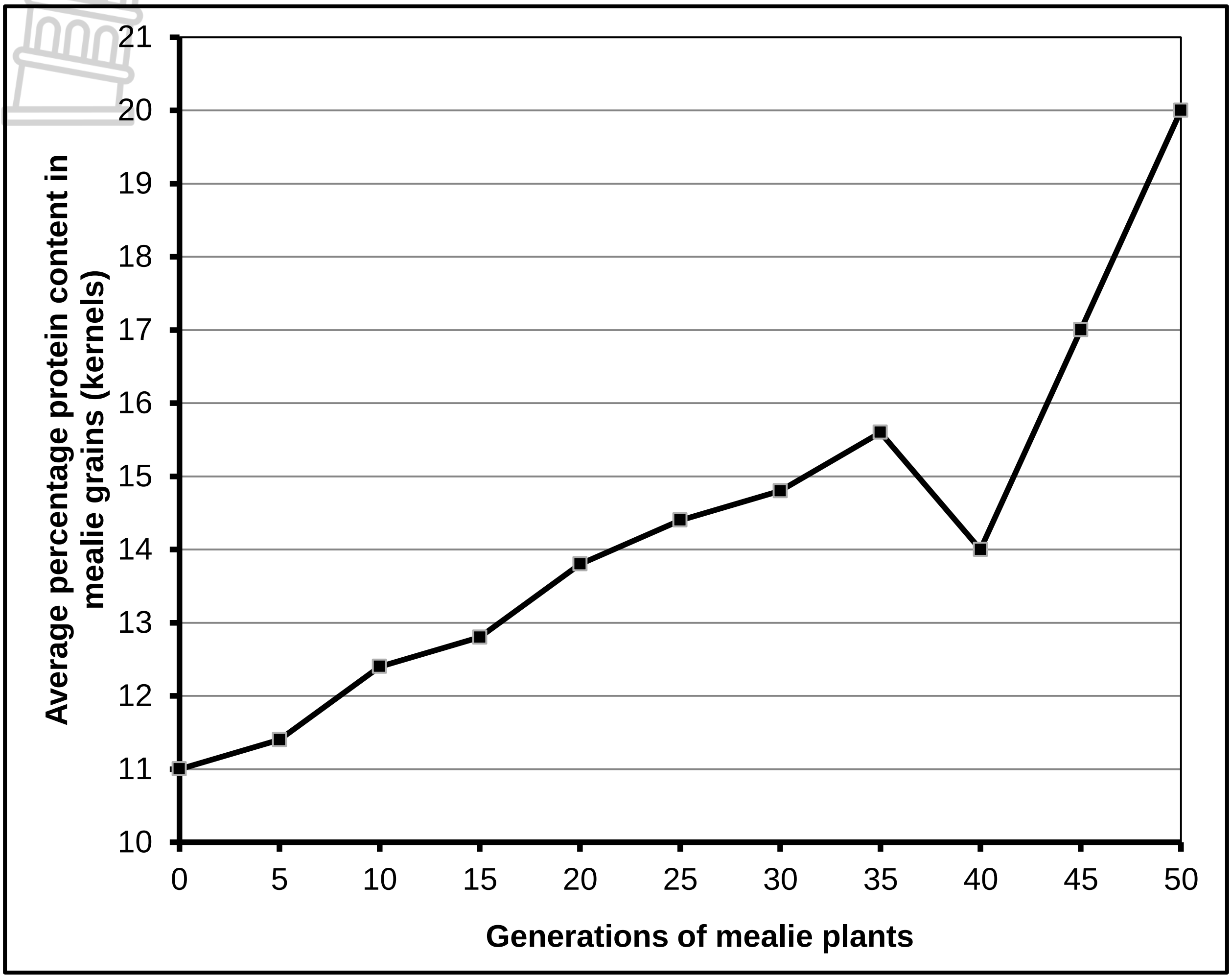
2.5.3 Give the possible genotypes of both parents that must be crossed if a farmer wants summer squash that are white with oval fruit only. (2)

(9)

[50]

QUESTION 3

3.1 The graph below shows the results of artificial selection for protein content in mealie plants over 50 generations.



3.1.1 Describe how this farmer did artificial selection of the mealie plant. (3)

3.1.2 What was the average percentage of the protein content in the mealie grains (kernels) at the 15th generation? (1)

3.1.3 By how many times did the average percentage of the protein content in the mealie grains (kernels) increase between the 40th and 50th generation? Show ALL working. (2)

3.1.4 Describe ONE way in which the process of artificial selection is different from genetic engineering. (2)
(8)

3.2 Describe Darwin's theory of evolution by natural selection. **(7)**

3.3 An investigation was done to determine the relationship between the height of the head and bite force in lizards.

The procedure was as follows:

- The scientists collected 120 lizards with similar characteristics that were around the same reproductive age in different habitats.
- Their body characteristics and DNA were analysed to determine if they belonged to the same species.
- 40 lizards belonged to species **A**, 36 to species **B** and 44 to species **C**.
- Each species was kept in its cage with environmental conditions similar to their habitats.
- The height of the head was measured for each lizard and averages calculated for each species.
- Using a Kistler force, the bite force of each lizard in each species was measured five times and the average calculated for each lizard and each species.

The results are shown in the table below.

Species	**Height of the head (mm)**	**Bite force (N)**
A	10,3	12,4
B	10,7	14,3
C	13,2	20,4

3.3.1 Identify the:

(a) Independent variable (1)

(b) Dependent variable (1)

3.3.2 State TWO factors that were kept constant for this investigation. (2)

3.3.3 Apart from the sample size, state ONE way in which the reliability of the results was ensured for this investigation. (1)

3.3.4 The height of the head was different in each species of lizard.

Name the type of variation displayed by this characteristic. (1)

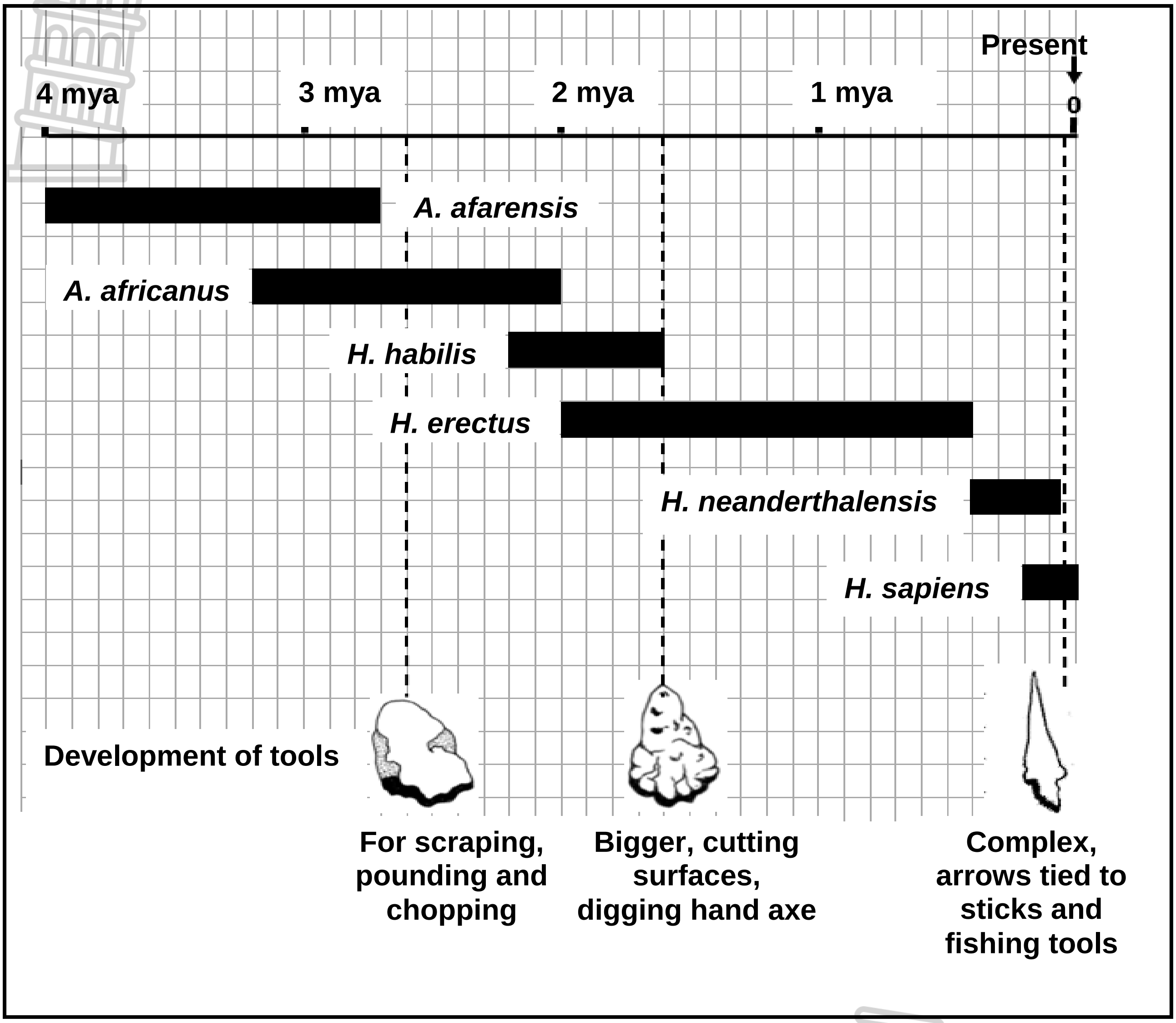
3.3.5 Describe the relationship between the height of the head of the lizards and the bite force. (2)

3.3.6 Which species (**A**, **B** or **C**) would be expected to be feeding mainly on tough fibrous plants? (1)

3.3.7 Explain your answer to QUESTION 3.3.6. (2)

3.3.8 Which species (**A**, **B** or **C**) would be most suited to live in narrow areas between the rocks? (1)
(12)

3.4 The diagram below shows a timeline of different hominid species and the development of tools.



3.4.1 Which species in the diagram above existed/survived for the longest period of time? (1)

3.4.2 Calculate the period (million years) in which the *A. afarensis* and *A. africanus* coexisted. Show ALL working. (2)

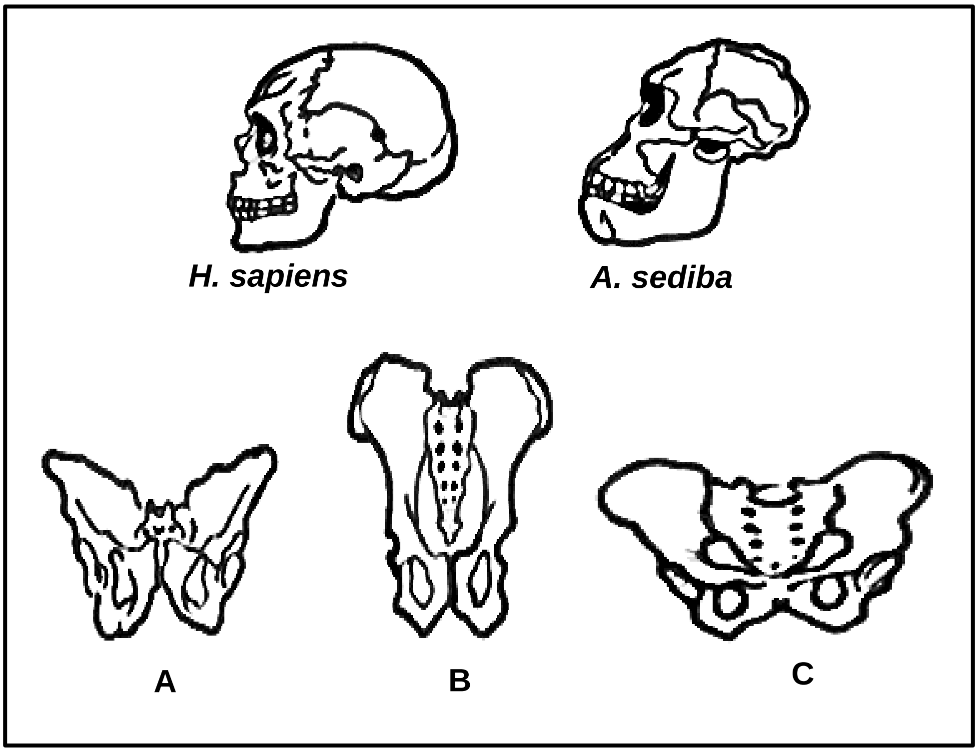
3.4.3 Name the species that was also known as the handyman. (1)

3.4.4 State TWO uses of the tool that was developed 2,6 mya. (2)

3.4.5 Identify TWO species that used the most complex tools. (2)

3.4.6 Explain how the changes in brain size over time relates to the development of tools. (3)
(11)

3.5 The diagrams below show the skulls and pelvises of different hominids.



3.5.1 State the genus name of *A. sediba*. (1)

3.5.2 Describe the shape of the spine of *H. sapiens*. (1)

3.5.3 *A. sediba* is thought to be a transitional species.

State what is meant by a *transitional species*. (2)

3.5.4 Give the LETTER of the pelvis that would be representative of *A. sediba.* (1)

3.5.5 Explain your answer to QUESTION 3.5.4. (2)

3.5.6 Explain the significance of the change in prognathism from *A. sediba* to *H. sapiens*. (5)
(12)
[50]

TOTAL SECTION B: 100
GRAND TOTAL: 150

basic education

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REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

LIFE SCIENCES P2

NOVEMBER 2023

MARKING GUIDELINE

MARKS: 150

These marking guidelines consist of 10 pages.

PRINCIPLES RELATED TO MARKING LIFE SCIENCES

1. **If more information than marks allocated is given**
   Stop marking when maximum marks is reached and put a wavy line and 'max' in the right-hand margin.

2. **If, for example, three reasons are required and five are given**
   Mark the first three irrespective of whether all or some are correct/incorrect.

3. **If whole process is given when only a part of it is required**
   Read all and credit the relevant part.

4. **If comparisons are asked for, but descriptions are given**
   Accept if the differences/similarities are clear.

5. **If tabulation is required, but paragraphs are given**
   Candidates will lose marks for not tabulating.

6. **If diagrams are given with annotations when descriptions are required**
   Candidates will lose marks.

7. **If flow charts are given instead of descriptions**
   Candidates will lose marks.

8. **If sequence is muddled and links do not make sense**
   Where sequence and links are correct, credit. Where sequence and links are incorrect, do not credit. If sequence and links become correct again, resume credit.

9. **Non-recognised abbreviations**
   Accept if first defined in answer. If not defined, do not credit the unrecognised abbreviation, but credit the rest of the answer if correct.

10. **Wrong numbering**
    If answer fits into the correct sequence of questions, but the wrong number is given, it is acceptable.

11. **If language used changes the intended meaning**
    Do not accept.

12. **Spelling errors**
    If recognisable, accept the answer, provided it does not mean something else in Life Sciences or if it is out of context.

13. **If common names are given in terminology**
    Accept, provided it was accepted at the national memo discussion meeting.

14. **If only the letter is asked for, but only the name is given (and vice versa)**
    Do not credit.

15. **If units are not given in measurements**
Candidates will lose marks. Memorandum will allocate marks for units separately.

16. **Be sensitive to the sense of an answer, which may be stated in a different way.**

17. **Caption**
All illustrations (diagrams, graphs, tables, etc.) must have a caption.

18. **Code-switching of official languages (terms and concepts)**
A single word or two that appear(s) in any official language other than the learner's assessment language used to the greatest extent in his/her answers should be credited, if it is correct. A marker that is proficient in the relevant official language should be consulted. This is applicable to all official languages.

19. **Changes to the memorandum**
No changes must be made to the memoranda. The provincial internal moderator must be consulted, who in turn will consult with the national internal moderator (and the Umalusi moderators where necessary).

20. **Official memoranda**
Only memoranda bearing the signatures of the national internal moderator and the Umalusi moderators and distributed by the National Department of Basic Education via the provinces must be used.

SECTION A

QUESTION 1

1.1	1.1.1	D✓✓		
	1.1.2	D✓✓		
	1.1.3	D✓✓		
	1.1.4	B✓✓		
	1.1.5	A✓✓		
	1.1.6	C✓✓		
	1.1.7	A✓✓		
	1.1.8	C✓✓		
	1.1.9	C✓✓	(9 x 2)	**(18)**
1.2	1.2.1	Locus✓		
	1.2.2	Punctuated equilibrium✓		
	1.2.3	Double helix✓		
	1.2.4	Peptide✓bond		
	1.2.5	Stereoscopic✓ / binocular vision		
	1.2.6	Incomplete✓dominance		
	1.2.7	Nucleoplasm✓		
	1.2.8	Chromatin network✓		
	1.2.9	Cytokinesis✓		
	1.2.10	Gonosomes✓	(10 x 1)	**(10)**
1.3	1.3.1	None✓✓		
	1.3.2	Both A and B✓✓		
	1.3.3	Both A and B✓✓	(3 x 2)	**(6)**
1.4	1.4.1	Pedigree✓diagram		(1)
	1.4.2	3✓/Three		(1)
	1.4.3	3✓/Three		(1)
	1.4.4	I^Ai I^Bi ✓✓ ii		(2)
	1.4.5	ii✓		(1)
	1.4.6	Ann✓✓		(2) **(8)**
1.5	1.5.1	(a) Transcription✓		(1)
		(b) mRNA✓/messenger RNA		(1)
		(c) Ribosome✓		(1)
	1.5.2	Anticodon✓		(1)
	1.5.3	AGT✓		(1)
	1.5.4	1✓		(1)
	1.5.5	4✓		(1)
	1.5.6	Ribose✓		(1) **(8)**

TOTAL SECTION A: 50

SECTION B

QUESTION 2

2.1 2.1.1 (a) Centriole✓/centrosome (1)

(b) Spindle fibre✓ (1)

2.1.2 Prophase I✓ (1)

2.1.3
- Pairing of homologous chromosomes is visible✓/ bivalents are visible
- Development of spindle fibres✓
- Crossing over is taking place✓
- Centriole/ centrosome moved to opposite poles✓
- Disintegration of the nuclear membrane✓ Any (3)

(Mark first THREE only)

2.1.4
- Parts of the homologous chromosomes overlap✓ and
- DNA/genetic material is exchanged✓
- at points called chiasmata✓/chiasma (3)

2.1.5 (a) Metaphase I✓ (1)

(b)
- In Metaphase I/Meiosis I chromosomes are arranged in pairs at the equator✓
- In mitosis the chromosomes are arranged singly at the equator✓ (2)

2.1.6
- Four (daughter) cells will be formed✓of which
- two will each have five chromosomes✓ and
- the other two will each have three chromosomes✓ (3)

(15)

2.2
- The (DNA) double helix unwinds✓and
- unzips✓/hydrogen bonds break
- to form two separate strands✓
- Both (DNA) strands serve as templates✓
- to build a complementary (DNA) strand✓/ A pairs with T and C pairs with G
- using free (DNA) nucleotides✓ from the nucleoplasm
- This results in two identical (DNA) molecules✓ Any **(6)**

2.3 2.3.1 The presence of T✓/thymine in the original sequence (1)

2.3.2 489✓✓ (2)

2.3.3
- A form of a gene✓
- that is carried on chromosome 1 to 22✓ and
- is always expressed in the phenotype✓ of an individual
- in the heterozygous✓ condition Any (3)

2.3.4 (a)
- The codon changed from GAC to GUC✓
- resulting in amino acid Leu replaced by Gln✓
- The other codon changed from AUA to AGA✓
- resulting in amino acid Try replaced by Arg✓
- This changed the sequence of amino acids✓
- A different protein was formed✓ Any (5)

(b)
- Harmful✓ effect
- The blood clot is not broken down✓
- Leading to blockage of arteries✓ /oxygen and nutrients are not transported to cells (3)

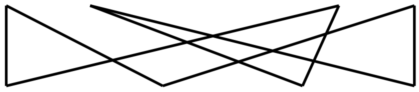
(14)

2.4 **P_1** Phenotype With polydactyly x Without polydactyly✓
Genotype Rr x rr✓

Meiosis

G/gametes R , r x r, r✓

Fertilisation



F_1 Genotype Rr, Rr, rr, rr✓

Phenotype 2 polydactyly ; 2 without polydactyly✓

50✓*% chance of polydactyl child

P_1 and F_1✓
Meiosis and fertilisation✓

***1 compulsory mark** + Any 5

OR

P_1 Phenotype With polydactyly x Without polydactyly✓
Genotype Rr x rr✓

Meiosis

Fertilisation

Gametes	R	r
r	Rr	rr
r	Rr	rr

1 mark for correct gametes
1 mark for correct genotypes

F_1 Phenotype 2 polydactyly ; 2 without polydactyly✓

50✓*% chance of polydactyl child

P_1 and F_1✓
Meiosis and fertilisation✓

***1 compulsory mark** + Any 5 **(6)**

2.5 2.5.1 (a) BBDD✓
bbdd✓ (2)

(b) White, round fruit✓✓ (2)

2.5.2 (a) BD
bD ✓✓
Bd
bd (2)

(b) One✓/1 (1)

2.5.3 BBdd and BBdd✓✓

OR

BBdd and Bbdd✓✓

OR

BBdd and bbdd✓✓ (2)
(9)
[50]

QUESTION 3

3.1 3.1.1
- The farmer interbred✓
- mealie plants with a high protein content✓
- over 50/many generations✓ (3)

3.1.2 12,8✓ % (Accept 12,7 - 12,9%) (1)

3.1.3 $\frac{20✓}{14}$ = 1,43✓ times (2)

3.1.4
- Artificial selection: organisms with a desired characteristic are interbred✓
- Genetic engineering: genes coding for the desired characteristic are inserted into an organism✓ (2)

(Mark first ONE only) **(8)**

3.2
- There is variation amongst the offspring in a population✓
- Some have favourable characteristics and some do not✓
- When there is a change in the environmental conditions✓/there is competition
- organisms with a favourable characteristic survive✓
- whilst organisms with an unfavourable characteristic die✓
- The organisms that survive, reproduce✓
- and pass on the allele for the favourable characteristic to their offspring✓
- The next generation will therefore have a higher proportion of individuals with the favourable characteristic✓ Any **(7)**

3.3 3.3.1 (a) Height of the head✓ (1)

(b) Bite force✓ (1)

3.3.2
- Similar characteristics✓
- (Same) reproductive age✓
- (Same) measuring tool/ for bite force✓/ Kistler force used to measure bite force
- Each species kept in environmental conditions similar to their habitats✓
- Lizards of the same species in each group✓ Any (2)

(Mark first TWO only)

3.3.3 Five measurements of the bite force✓ (1)
(Mark first ONE only)

3.3.4 Continuous✓ variation (1)

3.3.5 Lizards with an increased head height have a stronger bite force✓✓

OR

Lizards with a decreased head height have a weaker bite force✓✓ (2)

3.3.6 C✓ (1)

3.3.7
- Has the strongest bite force✓/20,4 N
- to break down✓ tough fibrous plant material (2)

3.3.8 A✓ (1)
(12)

3.4 3.4.1 *H. erectus*✓ (1)

3.4.2 3,2 – 2,7✓ = 0,5✓ my (2)

3.4.3 *H. habilis*✓ (1)

3.4.4
- Scraping✓
- Pounding✓
- Chopping✓ Any (2)

(Mark first TWO only)

3.4.5
- *H. sapiens*✓
- *H. neanderthalensis*✓ (2)

(Mark first TWO only)

3.4.6
- Increased brain size✓led to
- increased intelligence✓ leading to
- the development of complex tools✓ (3)

(11)

3.5 3.5.1 *Australopithecus*✓ (1)

3.5.2 S✓-shaped spine (1)

3.5.3
- An organism that has intermediate/common characteristics✓
- between two genera✓/species (2)

3.5.4 A✓ (1)

3.5.5
- **A** has a pelvis that is intermediate✓/ transitional between **B** and **C**✓

OR

- **A** has a shorter and wider pelvis than **B**✓ but not as short and wide as **C**✓

OR

- **A** has a longer and narrower pelvis than **C** ✓ but not as long and narrow as **B**✓ (2)

3.5.6
- *A. sediba* was prognathous✓/ more prognathous while
- *H. sapiens* are non-prognathous✓/ less prognathous
- This is due to a smaller jaw✓
- with smaller teeth✓ and
- reduced chewing muscles✓
- caused by a changed diet to eating soft/cooked food✓ (5)

Any

(12)

[50]

TOTAL SECTION B: 100

GRAND TOTAL: 150