basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS

LIFE SCIENCES P2

2023

MARKS: 150

TIME: 2½ hours

This question paper consists of 14 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. 1.1.10 D.

1.1.1 According to Lamarck's theory for evolution, …

A acquired characteristics are not inherited.
B organisms evolve because they adapt to their environment.
C there is variation amongst offspring.
D environmental changes have no influence on species diversity.

1.1.2 The genotype for a specific characteristic …

A contains two chromosomes.
B is the physical appearance of an individual.
C is the composition of a gene pair.
D is represented by one allele.

1.1.3 After the discovery of a fossil, scientists classified it as an African ape because it had a …

A large cranium, a prognathous jaw and large canines.
B small cranium, a non-prognathous jaw and large canines.
C small cranium, a prognathous jaw and large canines.
D large cranium, a prognathous jaw and small canines.

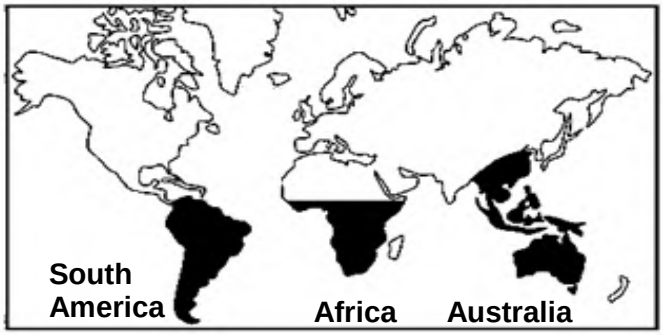
1.1.4 The statements below describe the steps in the process of cloning an animal.

(i) The embryo is implanted into the uterus of an adult female for development.
(ii) The nucleus from a somatic cell of the donor is extracted.
(iii) The nucleus from the somatic cell is inserted into the ovum.
(iv) The nucleus from the ovum of another individual is removed.
(v) The ovum with the new nucleus is given an electric shock to stimulate cell division and the formation of the embryo.

Which combination shows the CORRECT order of the steps?

A (ii)→ (iv)→ (iii)→ (v)→ (i)
B (ii)→ (iii)→ (iv)→ (v)→ (i)
C (i)→ (ii)→ (iii)→ (iv)→ (v)
D (ii)→ (iv)→ (v)→ (iii)→ (i)

1.1.5 Shrubs of the family Proteaceae (e.g. Waratahs and proteas) can be found in Australia, South America, Indo-China and parts of Africa as shown on the map below.

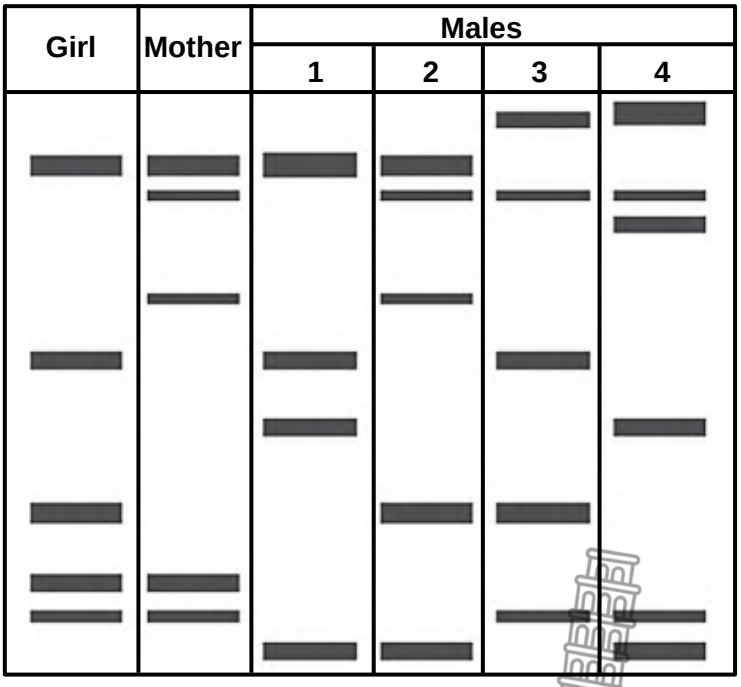


It is hypothesised that all continents were once one large continent called Pangaea and that they separated due to continental drift.

This is evidence that the family Proteaceae …

A all belong to the same species.
B are equally distributed on all continents.
C became extinct when Pangaea separated.
D arose from a common ancestor when Pangaea separated.

1.1.6 The diagram below shows the DNA profiles of a girl, her mother and four males.



Which male is the girl's biological father?

A 1
B 2
C 3
D 4

1.1.7 The following are characteristics of a group of animals:

(i) Able to interbreed
(ii) Occupy the same habitat
(iii) Produce infertile offspring
(iv) Belong to the same species

Which combination CORRECTLY represents a *population*?

A (i), (ii), (iii) and (iv)
B Only (i), (ii) and (iv)
C Only (i), (ii) and (iii)
D Only (i) and (iv)

1.1.8 During Anaphase II of meiosis, the two chromatids of a chromosome are pulled apart, each moving towards opposite poles at a rate of 1 micrometre per second.

The distance, in micrometres, between the chromatids after 20 seconds is …

A 10.
B 20.
C 30.
D 40.

1.1.9 Which ONE of the following indicates the type of variation for each of the human characteristics given?

	Height	Skin colour	Ear lobe types
A	discontinuous	continuous	discontinuous
B	continuous	continuous	discontinuous
C	discontinuous	discontinuous	continuous
D	discontinuous	continuous	continuous

(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 1.2.7) in the ANSWER BOOK.

1.2.1 The type of inheritance which produces an intermediate phenotype

1.2.2 The point where adjacent chromatids overlap during crossing over

1.2.3 The process whereby information is copied from DNA to RNA in the nucleus of a cell

1.2.4 The sugar found in a DNA molecule

1.2.5 The bond that occurs between nitrogenous bases in a DNA molecule

1.2.6 The manipulation of an organism's genes to obtain a desired characteristic

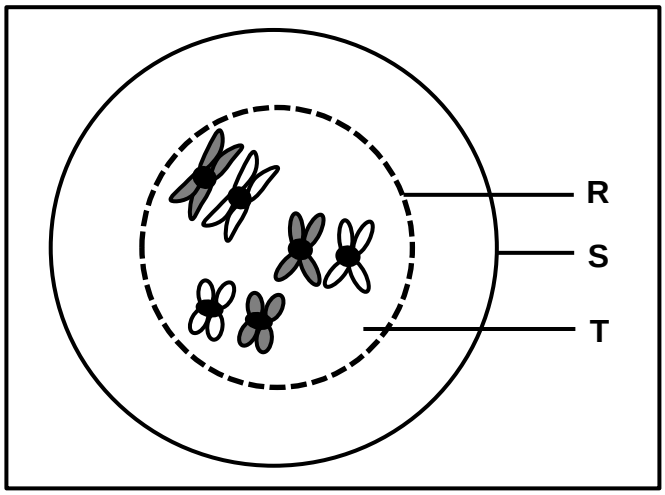
1.2.7 The representation showing the arrangement of a diploid set of chromosomes (7 x 1) **(7)**

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	Source of variation in a species	A: random mating B: random fertilisation
1.3.2	An organism possesses two factors which separate so that each gamete contains only one of these factors	A: law of dominance B: principle of independent assortment
1.3.3	Reproductive isolating mechanism in species	A: breeding in the same season of the year B: infertile offspring

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

1.4 The diagram below represents a cell in an early stage of meiosis.



1.4.1 Give the:

(a) Phase of meiosis represented (1)

(b) Number of chromatids shown (1)

(c) Number of homologous chromosome pairs (1)

1.4.2 Identify structure:

(a) **R** (1)

(b) **S** (1)

(c) **T** (1)

1.4.3 Name TWO organs in an animal where meiosis occurs. (2)
(8)

1.5 The brinjal plant carries edible fruit. Scientists have been studying the inheritance of two genes, one for stem texture and the other for fruit shape.

The stems can be smooth **(N)** or prickly (**n)**, while the fruit shape can be round **(R)** or elongated **(r)**.

1.5.1 Name the type of cross that studies two characteristics. (1)

1.5.2 State the:

(a) Dominant characteristic for stem texture (1)

(b) Recessive characteristic for fruit shape (1)

1.5.3 Give the:

(a) Genotype of a plant with a prickly stem and elongated fruit (2)

(b) Phenotype of a plant with the genotype NnRR (2)
(7)

1.6 The table below shows information on selected hominid fossils.

Common name of the fossil	Species	Fossil site	Scientists responsible for discovery
P	*Australopithecus sediba*	Malapa Cave in the Cradle of Humankind	**Q**
Taung Child	**R**	Sterkfontein Caves	**S**

1.6.1 Name fossil **P**. (1)

1.6.2 Identify the species at **R**. (1)

1.6.3 Give the name of the scientist at:

(a) **Q** (1)

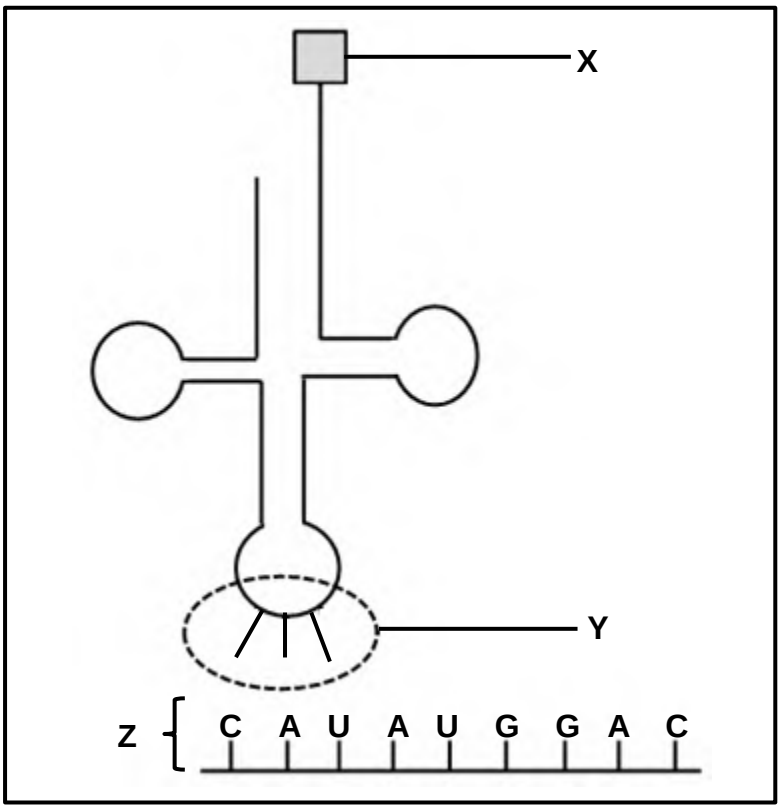
(b) **S** (1)
(4)

TOTAL SECTION A: 50

SECTION B

QUESTION 2

2.1 The diagram below represents a process that occurs during protein synthesis.



2.1.1 Identify molecule:

(a) **X** (1)

(b) **Z** (1)

2.1.2 Give the nitrogenous base sequence of:

(a) The DNA base triplet complementary to the middle codon on molecule **Z** (2)

(b) **Y** (1)

2.1.3 Name and describe the process shown in the diagram during the formation of a protein. (7)
(12)

2.2 The table below shows the codons that code for some amino acids.

mRNA codon	Amino acid
AUG	methionine
CAU	histidine
CUA	leucine
GUA	valine
GAC	aspartic acid
GAG	glutamic acid
GAU	aspartic acid

A mutation caused a DNA base triplet to change from CTG to CTA.

Describe the effect of this mutation on the protein formed. **(4)**

2.3 Tabulate TWO differences between *DNA* and *RNA nucleotides*. **(5)**

2.4 Down syndrome is the result of an individual having an extra copy of chromosome 21.

Two genetic variations that can cause Down syndrome are:

- Trisomy 21
  All the somatic cells in an individual have three copies of chromosome 21 due to an abnormal process that occurs during gamete production.

- Mosaic Down syndrome
  The individual has only some cells with an extra copy of chromosome 21 which is caused by an abnormal process during cell division after fertilisation.

2.4.1 Name the:

(a) Type of mutation that leads to Trisomy 21 (1)

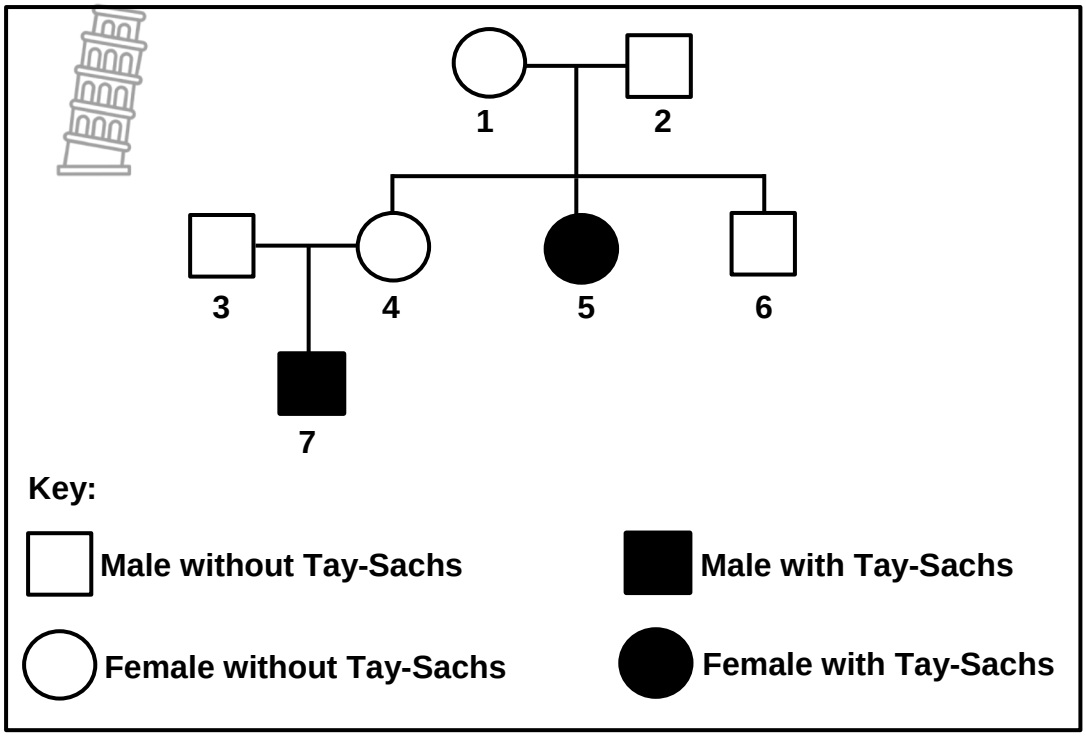
(b) Abnormal process during gamete production that leads to three copies of chromosome 21 (1)

(c) Type of cell division that occurs after fertilisation (1)

2.4.2 Describe how the process in QUESTION 2.4.1(b) leads to Trisomy 21. (5)

2.4.3 Describe TWO differences between *Trisomy 21* and *Mosaic Down syndrome*. (4)
(12)

2.5 The diagram below shows the inheritance of Tay-Sachs, a rare disease which leads to the destruction of neurons. It is inherited as an autosomal disorder, controlled by two alleles, **(T)** and **(t)**.



2.5.1 Describe what is meant by an *autosomal disorder*. (2)

2.5.2 How many sons do individuals **1** and **2** have? (1)

2.5.3 Using individuals **3**, **4** and **7**, explain why it can be concluded that Tay-Sachs disease is controlled by a recessive allele. (5)

2.5.4 Individuals **1** and **2** can produce children with three possible genotypes.

List ALL the genotypes that have a 25% chance of being produced. (2)
(10)

2.6 In humans, haemophilia is caused by a recessive allele on the X-chromosome ($\mathbf{X^h}$).

A woman, who is heterozygous for haemophilia, marries a man with haemophilia.

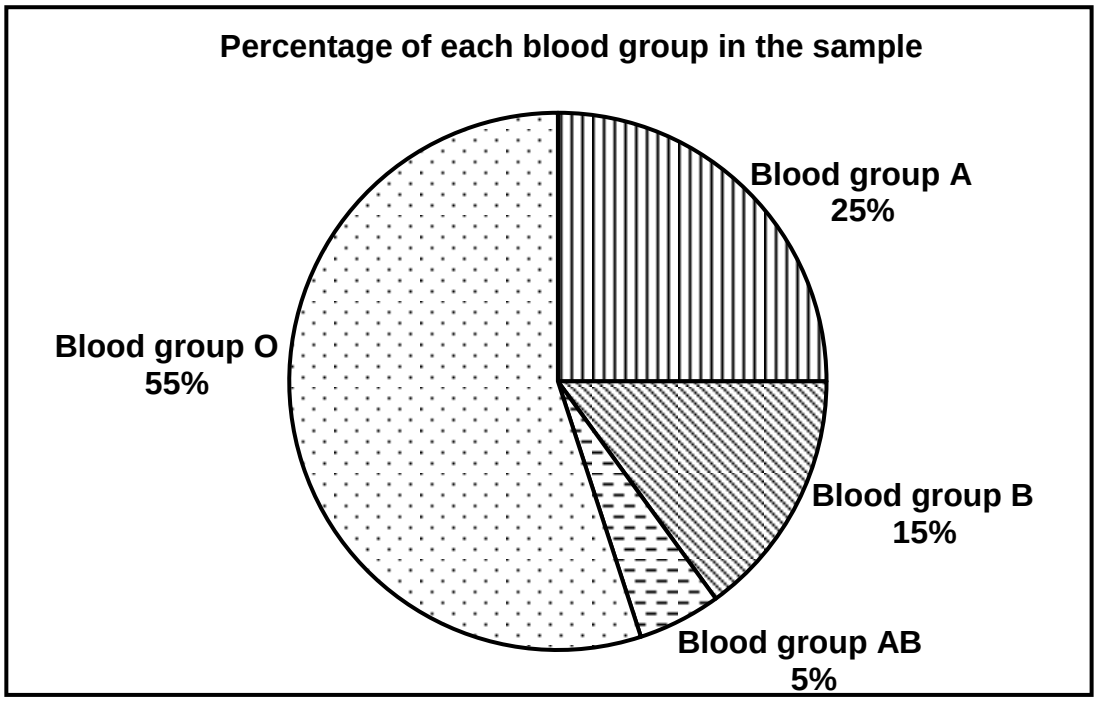
Use a genetic cross to show the percentage chance of the couple having a *daughter* who is homozygous for normal blood clotting. **(7)**
[50]

QUESTION 3

3.1 Learners conducted an investigation to determine which blood group was the most common in their community.

They collected information about the blood groups of 200 blood donors in each of the three blood donor clinics in their community. They did not include first-time donors in the investigation.

The pie chart below shows the results of the investigation.



3.1.1 State the aim of the investigation. (2)

3.1.2 Answer the following questions:

(a) State THREE planning steps to consider when conducting this investigation. (3)

(b) State ONE way in which the learners ensured the reliability of the results. (1)

(c) Give ONE reason why they did not include first-time donors. (1)

3.1.3 Calculate the number of participants that had blood group **B**. Show ALL workings. (3)

3.1.4 Name the blood group which:

(a) Has only recessive alleles in the genotype (1)

(b) Is a result of co-dominance (1)

3.1.5 Give ALL the possible genotypes of the blood group represented by 25% of the donors. (2)
(14)

3.2 Dogs have been selected and bred over many years to produce approximately 340 different dog breeds. They have been bred for certain characteristics desirable to humans.

An analysis of 736 base pairs of the cytochrome-b gene showed that grey wolves are the only direct ancestor to present-day dog breeds. All dog breeds belong to the species *Canis familiaris*.

The table below shows some dog breeds and their desirable characteristics.

Grey wolf	Dog breeds	Characteristics
	 **Poodle**	Intelligent
	 **Pug**	Loving, affectionate and playful
	 **Saint Bernard**	Outgoing and adventurous
	 **Rhodesian ridgeback**	Strong, athletic and fast

3.2.1 Name the process whereby the different breeds of dogs were produced. (1)

3.2.2 Describe how humans carried out the process named in QUESTION 3.2.1. (3)

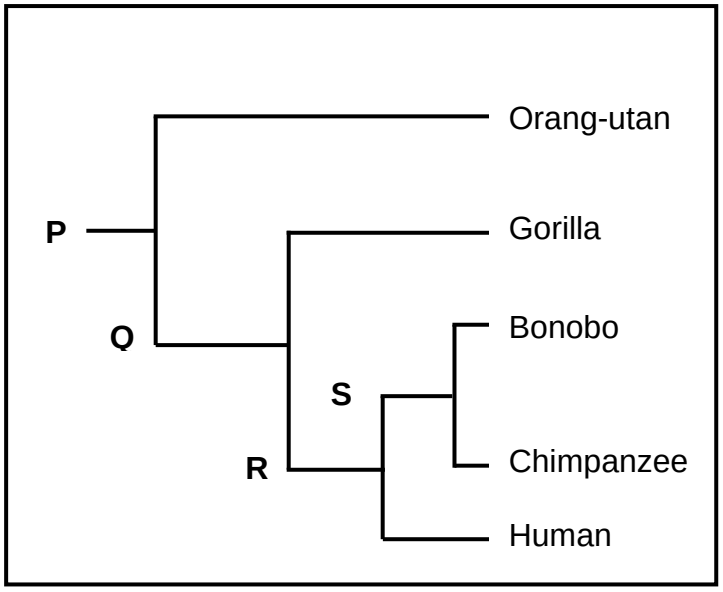
3.2.3 Explain how it can be confirmed that all these dog breeds belong to the same species. (2)

3.2.4 Explain which of the dog breeds shown would best be used for hunting. (2)

3.2.5 Explain how present-day dog breeds may be disadvantaged in relation to their common ancestor. (3)
(11)

3.3 Describe the process of *speciation* through geographic isolation. **(7)**

3.4 The diagram below represents the evolution of the family Hominidae.



3.4.1 Name the type of diagram represented above. (1)

3.4.2 Give the LETTER of the organism which:

(a) Is the common ancestor of all hominids (1)

(b) Shares the most recent common ancestor with the gorilla (1)

3.4.3 Name TWO organisms that:

(a) Have **S** as a common ancestor (2)

(b) Are quadrupedal (2)

3.4.4 Describe THREE anatomical features of the skeleton of a quadrupedal hominid. (3)
(10)

3.5 Fossil evidence is used to support the 'Out-of-Africa' hypothesis.

3.5.1 State the 'Out-of-Africa' hypothesis. (2)

3.5.2 Describe how fossil evidence is used to support the 'Out-of-Africa' hypothesis. (6)
(8)
[50]

TOTAL SECTION B: 100
GRAND TOTAL: 150

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SENIOR CERTIFICATE EXAMINATIONS/
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LIFE SCIENCES P2

2023

MARKING GUIDELINES

MARKS: 150

These marking guidelines consist of 11 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	B✓✓		
	1.1.2	C✓✓		
	1.1.3	C✓✓		
	1.1.4	A✓✓		
	1.1.5	D✓✓		
	1.1.6	C✓✓		
	1.1.7	B✓✓		
	1.1.8	D✓✓		
	1.1.9	B✓✓	(9 x 2)	**(18)**
1.2	1.2.1	Incomplete dominance✓		
	1.2.2	Chiasma✓/chiasmata		
	1.2.3	Transcription✓		
	1.2.4	Deoxyribose✓		
	1.2.5	Hydrogen✓ (bond)		
	1.2.6	Genetic engineering✓		
	1.2.7	Karyotype✓	(7 x 1)	**(7)**
1.3	1.3.1	Both A and B✓✓		
	1.3.2	None✓✓		
	1.3.3	B only✓✓	(3 x 2)	**(6)**
1.4	1.4.1	(a) Prophase I✓		(1)
		(b) Twelve✓/12		(1)
		(c) Three✓/3		(1)
	1.4.2	(a) Nuclear membrane✓		(1)
		(b) Cell membrane✓/plasmalemma/plasma membrane		(1)
		(c) Nucleoplasm✓		(1)
	1.4.3	- Testes✓		(1)
		- Ovaries✓		(1)
		(Mark first TWO only)		**(8)**

	1.5.1		Dihybrid✓ cross	(1)
	1.5.2	(a)	Smooth✓ stem	(1)
		(b)	Elongated✓ fruit	(1)
	1.5.3	(a)	nnrr✓✓/nrnr/ rrnn	(2)
		(b)	Smooth stem round fruit✓✓	(2) **(7)**
1.6	1.6.1		Karabo✓	(1)
	1.6.2		*Australopithecus africanus*✓	(1)
	1.6.3	(a)	(Lee) Berger✓	(1)
		(b)	(Raymond) Dart✓	(1) **(4)**

TOTAL SECTION A: 50

SECTION B

QUESTION 2

2.1 2.1.1 (a) Amino acid✓ (1)

(b) mRNA✓ (1)

2.1.2 (a) TAC✓✓ (2)

(b) GUA✓ (1)

2.1.3 Translation✓*
- Each tRNA carries a specific amino acid✓
- When the anticodon on the tRNA✓/GUA
- matches the codon on the mRNA✓/CAU
- then tRNA brings the required amino acid to the ribosome✓
- Amino acids become attached to each other by peptide bonds✓
- to form the required protein✓ **1* compulsory +** 6 (7)

(12)

2.2
- Codon GAC✓ (on the mRNA)
- changed to GAU✓
- Both these codons code for the same amino acid✓/Aspartic acid
- therefore there will be no effect✓ on the protein formed **(4)**

2.3

DNA	RNA
Has deoxyribose✓ sugar	Has ribose✓ sugar
Has thymine✓/nitrogenous base T	Has uracil✓/nitrogenous base U

(Mark first TWO only) Table 1 + (2 x 2) **(5)**

2.4 2.4.1 (a) Chromosomal✓mutation (1)

(b) Non-disjunction✓ (1)

(c) Mitosis✓ (1)

2.4.2
- The chromosome pair/chromatids failed to separate✓
- at position 21✓
- during anaphase✓(I or II)
- resulting in one daughter cell having an extra chromosome✓/ 24 chromosomes
- Fusion of a gamete with 24 chromosomes✓
- and a normal gamete✓/gamete with 23 chromosomes
- results in a zygote with 47 chromosomes✓/extra chromosome at position 21 Any (5)

2.4.3 - In Trisomy 21 there is an extra chromosome/three copies of chromosome 21 in each somatic cell✓
In Mosaic Down syndrome there is an extra chromosome only in some cells✓
- Trisomy 21 occurs during meiosis✓/before fertilisation
Mosaic Down syndrome occurs during mitosis✓/after fertilisation (2 x 2) (4)
(Mark first TWO only)

(12)

2.5 2.5.1 - The disorder is controlled by alleles✓/genes that
- are located on the autosomes✓ (2)

2.5.2 - One✓/1 (1)

2.5.3 - Individuals 3 and 4 are both without Tay-Sachs disease✓
- The child has Tay-Sachs✓/Individual 7 has Tay-Sachs
- which is only expressed in the phenotype in a homozygous condition✓
- Each parent must carry a recessive allele✓/be heterozygous
- The child has two recessive alleles✓
- One was received from each parent✓

OR

- Individuals 3 and 4 are both without Tay-Sachs disease✓
- If it was caused by a dominant allele✓
- then individual 3 or 4 would *have* Tay Sachs✓
- and still have a child with Tay-Sachs✓/individual 7 has Tay-Sachs
- who could be heterozygous✓ Any (5)

2.5.4 TT✓
tt✓ (2)
(10)

2.6

P_1	Phenotype	Woman without haemophilia	x	Man with haemophilia✓
	Genotype	X^HX^h	x	X^hY✓
Meiosis				
	G/gametes	X^H, X^h	x	X^h, Y✓
Fertilisation				
F_1	Genotype	X^HX^h, X^HY, X^hX^h, X^hY✓		
	Phenotype	1 daughter without haemophilia, 1 daughter with haemophilia, 1 son without haemophilia, 1 son with haemophilia✓		
		0%✓*chance of a daughter homozygous for normal blood clotting		

P_1 and F_1✓
Meiosis and fertilisation✓

***1 compulsory mark** + any 6

OR

P_1	Phenotype	Woman without haemophilia	x	Man with haemophilia✓
	Genotype	X^HX^h	x	X^hY✓

Meiosis

Fertilisation

Gametes	X^H	X^h
X^h	X^HX^h	X^hX^h
Y	X^HY	X^hY

1 mark for correct gametes
1 mark for correct genotypes

F_1	Phenotype	1 daughter without haemophilia, 1 daughter with haemophilia, 1 son without haemophilia, 1 son with haemophilia✓
		0%✓* chance of a daughter homozygous for normal blood clotting

P_1 and F_1✓
Meiosis and fertilisation✓

***1 compulsory mark**+ any 6 **(7)**

[50]

QUESTION 3

3.1 3.1.1 To determine which blood group was the most common in their community✓✓ (2)

3.1.2 (a)
- Obtain permission from the school✓/clinic to conduct the investigation
- Decide on the sample size✓
- Decide on the method for recording results✓
- Decide on time✓/date to collect data from the clinic (3)

(Mark first THREE only)

(b)
- Sampled 3✓/all blood donor clinics in the community
- 200 donors per clinic sampled✓/600 donors Any (1)

(Mark first ONE only)

(c) First time donors' blood groups are not known yet✓/ not in the database (1)

3.1.3 $\frac{15}{100}$ ✓x 600✓= 90✓ participants (3)

3.1.4 (a) (Blood group) O✓ (1)

(b) (Blood group) AB✓ (1)

3.1.5 $I^A I^A$ ✓
I^A i✓ (2)
(14)

3.2 3.2.1 Artificial selection✓/selective breeding (1)

3.2.2
- They chose dogs with desirable traits✓
- and interbred✓ them to
- produce offspring with these traits✓ (3)

3.2.3
- Allow them to interbreed with each other✓
- and see whether they produce fertile offspring✓

OR

- Analysis of DNA✓
- to check for matching sequences✓ (2)

3.2.4
- Rhodesian ridgeback✓
- is strong, athletic and fast✓
- is able to catch the prey✓ Any (2)

3.2.5
- Due to reduction in gene pool✓/variation
- they will not be able to hunt✓/find shelter/defend themselves
- as well as wolves are able to✓
- therefore unable to survive in the wild✓

(3)
(11)

3.3
- If a population of a single species becomes separated by a geographical barrier✓ (sea, river, mountain, lake)
- then the population splits into two✓
- There is now no gene flow between the two populations✓
- Since each population may be exposed to different environmental conditions✓/the selection pressure may be different
- natural selection occurs independently in each of the two populations✓
- such that the individuals of the two populations become (very) different✓ from each other
- genotypically and phenotypically✓
- Even if the two populations were to mix again✓
- they will not be able to interbreed✓
- The two populations are now different species✓

Any **(7)**

3.4 3.4.1 Phylogenetic tree✓/cladogram (1)

3.4.2 (a) P✓ (1)

(b) R✓ (1)

3.4.3 (a) Bonobo✓
Chimpanzee✓ (2)
(Mark first TWO only)

(b) Orang-utan✓
Gorilla✓
Bonobo✓
Chimpanzee✓ Any (2)
(Mark first TWO only)

3.4.4
- Foramen magnum at a more backward position✓
- C-shaped spine✓
- Pelvis long and narrow✓

(3)
(**Mark first THREE only)**

(10)

3.5 3.5.1 (Modern) humans originated in Africa✓ and migrated to other parts of the world✓ (2)

3.5.2
- Fossils of *Ardipithecus* were found in Africa only✓
- Fossils of *Australopithecus* were found in Africa only✓
- Fossils of *Homo habilis* were found in Africa only✓
- The oldest fossils of *Homo erectus* were found in Africa✓while the younger fossils of *Homo erectus* were found in other parts of the world✓
- The oldest fossils of *Homo sapiens* were found in Africa✓while
- the younger fossils of *Homo sapiens* were found in other parts of the world✓ Any (6)

(8)
[50]

TOTAL SECTION B: 100
GRAND TOTAL: 150