basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

LIFE SCIENCES P2

2022

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 to D) next to the question number (1.1.1 to 1.1.10) in the ANSWER BOOK, e.g. 1.1.11 D.

1.1.1 The components of a DNA molecule that provide the code for protein synthesis are the …

A sugars.
B phosphates.
C hydrogen bonds.
D nitrogenous bases.

1.1.2 During which stage of meiosis do spindle fibres begin to form?

A Prophase
B Metaphase
C Anaphase
D Telophase

1.1.3 An individual has Down syndrome. In the karyotype there is an abnormal number of chromosomes at chromosome pair …

A 13.
B 18.
C 21.
D 23.

1.1.4 An individual that has received an identical allele from each parent is described as being …

A homologous.
B dominant.
C homozygous.
D heterozygous.

1.1.5 A plant species has a diploid chromosome number of 12.

Which ONE of the following is the haploid chromosome number for this species?

A 24
B 12
C 6
D 36

1.1.6 Inheritance by *multiple alleles* in genetics refers to …

A two alleles that influence two characteristics.
B more than two alleles that influence one characteristic.
C one allele that influences more than one characteristic.
D more than two alleles that influence two characteristics.

1.1.7 Which ONE of the following is a reproductive isolation mechanism?

A Breeding at the same time of the year
B Infertile offspring
C Plant adaptation to the same pollinators
D Improved fertilisation

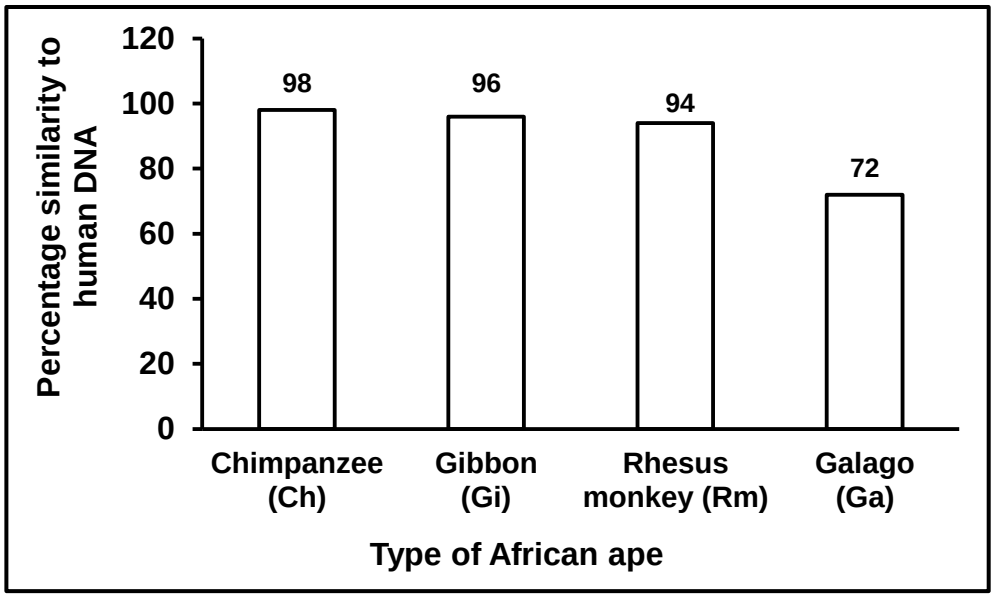
1.1.8 Normal human ova have …

A 22 autosomes and an X chromosome.
B 23 autosomes and an X chromosome.
C 22 autosomes and a Y chromosome.
D 23 autosomes and a Y chromosome.

1.1.9 Which ONE of the following occurs in mitosis but NOT in meiosis?

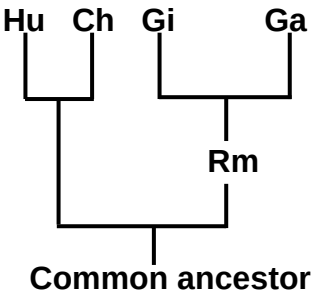
A Two cells are formed at the end of the division
B Crossing over takes place
C Homologous chromosomes arrange at the equator
D Centrioles form at the poles of the cell

1.1.10 The graph below shows the percentage similarity between human (Hu) DNA and the DNA of some species of African apes.

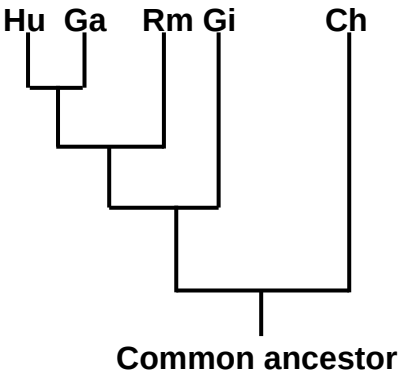


Which ONE of the following phylogenetic trees best represents the information in the graph?

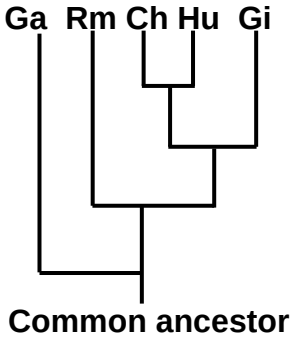
A



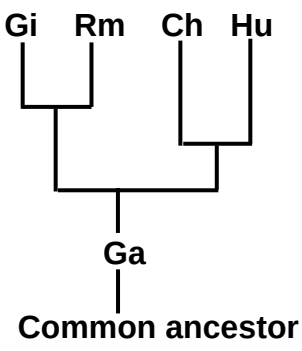
B



C



D



(10 x 2) **(20)**

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 Division of the cytoplasm of a cell during meiosis

1.2.2 The sugar molecule present in a nucleotide of RNA

1.2.3 The position of a gene on a chromosome

1.2.4 The process during which a DNA molecule makes an exact copy of itself

1.2.5 Undifferentiated cells that may be stimulated to develop into any type of body cell

1.2.6 Mendel's principle which states that an organism possesses two factors which separate so that each gamete contains only one of these factors

1.2.7 The evolutionary theory that proposes long periods where species do not change, alternating with short periods where rapid changes occur

1.2.8 A tangled network of DNA and protein located within the nucleus

1.2.9 The natural shape of the DNA molecule

1.2.10 The phase in the cell cycle during which cell growth occurs

(10 x 1) **(10)**

1.3 Indicate whether each of the statements 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 group of similar organisms that occurs in a particular place at a particular time with the ability to interbreed	A: Population B: Species
1.3.2	The manipulation of biological processes to satisfy human needs	A: Biogeography B: Biotechnology
1.3.3	Discovered the structure of the DNA molecule	A: Francis Crick B: James Watson

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

1.4 In tomato plants, tall stems (**T**) are dominant over short stems (**t**) and red fruit (**R**) is dominant over yellow fruit (**r**).

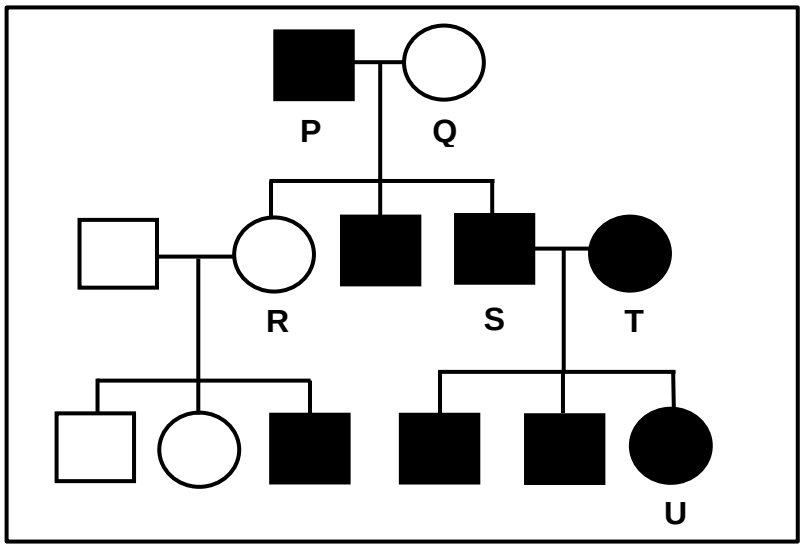
A farmer crosses a homozygous tall, yellow tomato plant with a plant that is heterozygous for both characteristics.

1.4.1 Name this type of genetic cross. (1)

1.4.2 Give the genotype of a homozygous tall, yellow tomato plant. (2)

1.4.3 List the genotypes of ALL the possible gametes for a plant that is heterozygous for both characteristics. (4)
(7)

1.5 Haemophilia is a sex-linked recessive trait **(X^h)**. The pedigree diagram below shows the inheritance of haemophilia in a family.



1.5.1 State what is represented by the squares on a pedigree diagram. (1)

1.5.2 State the number of:

(a) Generations represented in this pedigree diagram (1)

(b) Offspring of individuals **P** and **Q** (1)

1.5.3 Give the:

(a) LETTERS only, of females who have haemophilia (2)

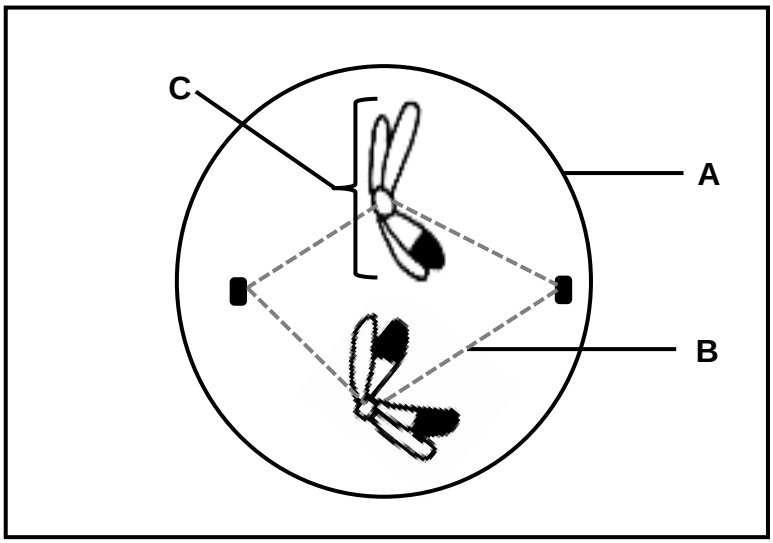
(b) Genotype of individual **R** (2)
(7)

TOTAL SECTION A: [50]

SECTION B

QUESTION 2

2.1 The diagram below represents one cell in a phase of meiosis.



2.1.1 Identify the phase of meiosis shown. (1)

2.1.2 Give ONE observable reason for your answer to QUESTION 2.1.1. (2)

2.1.3 Identify structure:

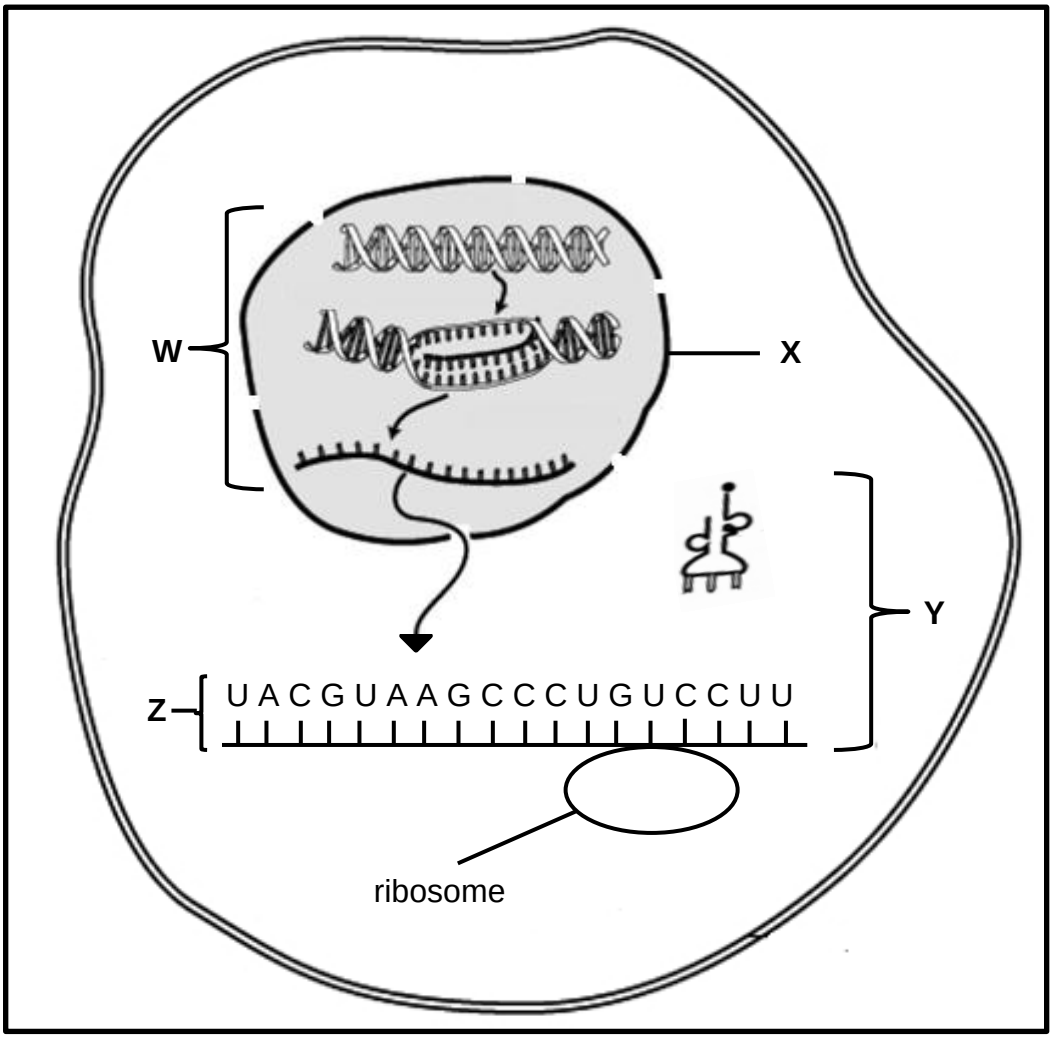
(a) **A** (1)

(b) **B** (1)

2.1.4 Describe the role of part **B** in the movement of chromosomes during meiosis. (2)

2.1.5 Draw a labelled diagram of structure **C** as it would appear in the final phase of this meiotic division. Show the correct shading. (4)
(11)

2.2 The diagram below represents the process of protein synthesis in a cell.



2.2.1 Name the process which occurs at:

(a) **W** (1)

(b) **Y** (1)

2.2.2 Identify:

(a) Organelle **X** (1)

(b) Molecule **Z** (1)

2.2.3 State TWO locations of DNA in a cell, other than in the nucleus. (2)

2.2.4 Describe the process at **W.** (7)

The table below shows some tRNA anticodons with their corresponding amino acids**.**

tRNA ANTICODON	AMINO ACID
CAG	Valine
GAA	Leucine
AUG	Tyrosine
GGA	Proline
UCG	Serine
CAU	Valine

2.2.5 Name the:

(a) DNA base triplet that codes for serine (1)

(b) First TWO amino acids coded for by molecule **Z** in the diagram (the molecule is read from left to right) (2)

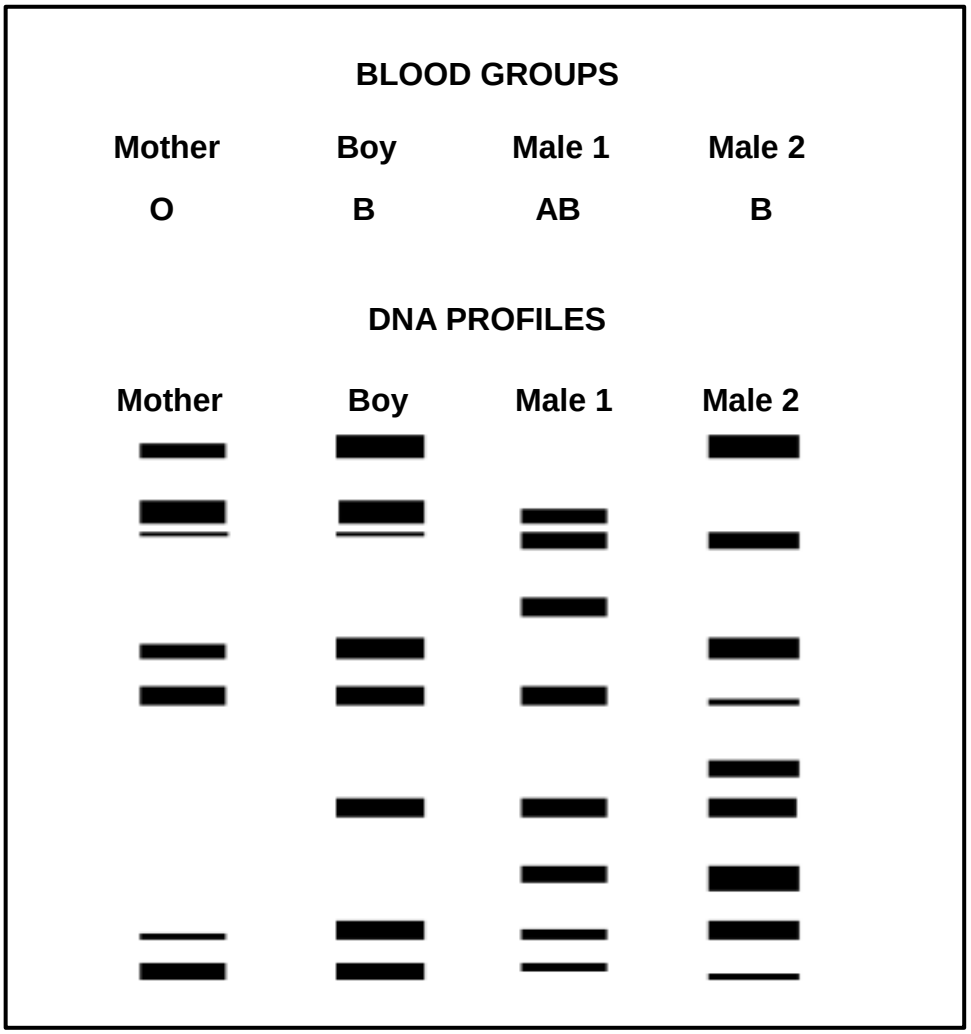
2.2.6 What is the change in the sequence of nitrogenous bases in a DNA molecule called? (1)

2.2.7 The codon CUU (last codon) on molecule **Z** changed to CCU.

Explain the effect it would have on this particular protein molecule. (3)
(20)

2.3 A family wanted to identify the biological father of a boy. The mother of the boy is known. Blood groups and DNA profiles of the mother, the boy and two males were used to determine paternity.

The data below shows the results of the two procedures.



2.3.1 Explain why paternity of the boy could not be established using blood groups only. (5)

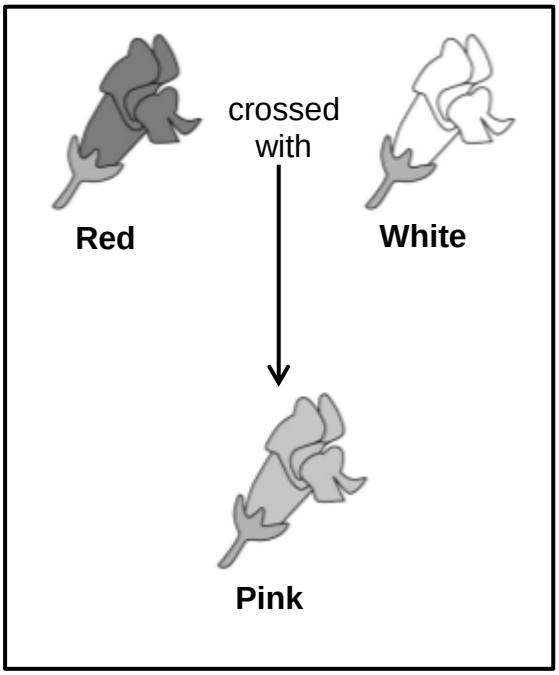
2.3.2 Who is the biological father of the boy according to the DNA profiles? (1)

2.3.3 Explain your answer to QUESTION 2.3.2. (3)

2.3.4 State ONE other use of DNA profiling. (1)
(10)

2.4 The diagram below shows the inheritance of flower colour in snapdragon plants.

The two alleles controlling flower colour are red **(R)** and white **(W)**.



2.4.1 State the type of dominance shown by the snapdragon plants. (1)

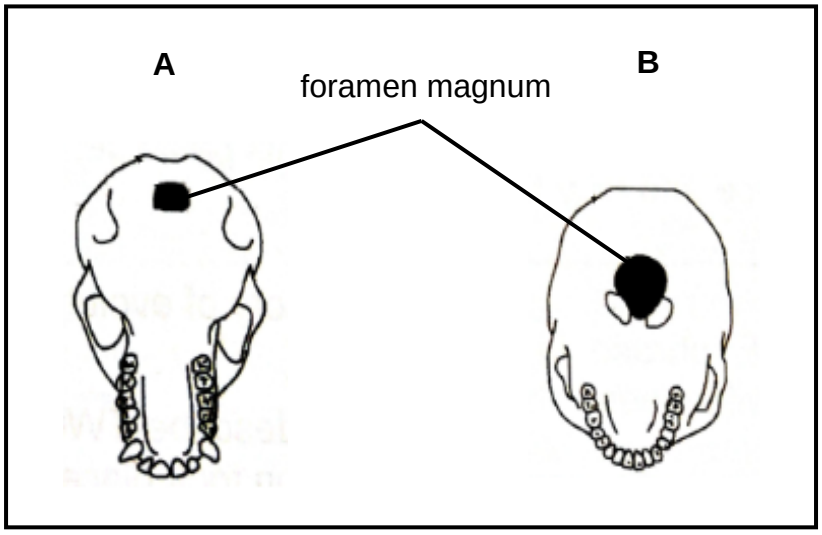
2.4.2 Give a reason for your answer to QUESTION 2.4.1. (2)

2.4.3 A gardener crossed two pink-flowered snapdragon plants.

Use a genetic cross to show the ratio of the expected phenotypes in the offspring. (6)
(9)
[50]

QUESTION 3

3.1 Diagrams **A** and **B** show the ventral (bottom) view of the skulls of two organisms. The diagrams are NOT drawn to scale.



3.1.1 Which diagram represents the skull of a bipedal organism? (1)

3.1.2 Give ONE visible reason for your answer to QUESTION 3.1.1. (2)

3.1.3 Tabulate TWO visible differences between the upper jaws in diagrams **A** and **B** that represent trends in human evolution. (5)

3.1.4 Explain the significance of the shape of the spine that is associated with the skull in diagram **B.** (2)
(10)

3.2 The herbicide glyphosate is used to control weeds in maize fields. The herbicide kills the weeds, but it can also kill the maize plants. It has been found that some weeds developed resistance to glyphosate treatment.

Scientists carried out an investigation to determine the development of glyphosate resistance in the weeds. The weeds were treated with the same concentration of glyphosate each year from 2009 to 2016 and the percentage of glyphosate resistant weeds in the field was recorded every year.

The results are shown in the table below.

YEAR	GLYPHOSATE RESISTANT WEEDS (%)
2009	10
2010	20
2011	32
2012	42
2013	53
2014	58
2015	65
2016	65

3.2.1 Describe the change in glyphosate resistance over the time of the investigation. (3)

3.2.2 Calculate the percentage increase in glyphosate resistant weeds from 2010 to 2015. Show ALL your working. (3)

3.2.3 Scientists isolated the gene for glyphosate resistance from the weeds and used it to genetically modify the maize plants.

Explain the economic benefit of making the maize plants resistant to glyphosate. (3)

3.2.4 Draw a bar graph to illustrate the results of the investigation in the first four years. (6)
(15)

3.3 A population of lizards on an island, Island **A,** were well suited to feed mainly on insects. Scientists moved five adult pairs of this lizard species to a neighbouring island, Island **B**. Here they reproduced and a new population formed. Island **B** has a large supply of plants with tough fibrous leaves and fewer insects. Exposure to this new environment may have caused the lizards to undergo evolution.

Thirty-six years later, scientists returned to Island **B** to conduct further investigations on the lizard population there. They observed that the jaw size of the lizards had increased. Scientists also analysed the stomach content of the lizards and found that it was mainly plant-based. They also confirmed that the two populations still belong to the same species.

3.3.1 Describe how the scientists could confirm that there was a change in jaw size between the lizards of Island **A** and the lizards of Island **B**. (3)

3.3.2 Explain how the larger jaws of the lizards on Island **B** would be structurally suited to eat tough fibrous leaves. (3)

3.3.3 How did the scientists determine that the two populations of lizards on both islands still belong to the same species? (2)

3.3.4 Explain the possible effect that the evolution of the lizards has on biodiversity. (2)

3.3.5 Use Darwin's theory of natural selection to explain the evolution of lizards with larger jaws. (7)
(17)

3.4 The 'Out of Africa' hypothesis is one explanation of the evolution of modern humans.

3.4.1 State the 'Out of Africa' hypothesis. (2)

3.4.2 Name the family to which modern humans belong. (1)

3.4.3 What genetic evidence is used to support the 'Out of Africa' hypothesis? (1)

3.4.4 Describe how fossil evidence is used to support the 'Out of Africa' hypothesis. (4)
(8)
[50]

TOTAL SECTION B: 100
GRAND TOTAL: 150

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SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

LIFE SCIENCES P2

2022

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	D✓✓		
	1.1.2	A✓✓		
	1.1.3	C✓✓		
	1.1.4	C✓✓		
	1.1.5	C✓✓		
	1.1.6	B✓✓		
	1.1.7	B✓✓		
	1.1.8	A✓✓		
	1.1.9	A✓✓		
	1.1.10	C✓✓	(10 x 2)	**(20)**
1.2	1.2.1	Cytokinesis✓		
	1.2.2	Ribose✓		
	1.2.3	Locus✓		
	1.2.4	(DNA) replication✓		
	1.2.5	Stem✓ cells		
	1.2.6	Segregation✓		
	1.2.7	Punctuated equilibrium✓		
	1.2.8	Chromatin✓network		
	1.2.9	Double helix✓		
	1.2.10	Interphase✓	(10 x 1)	**(10)**
1.3	1.3.1	A only✓✓		
	1.3.2	B only✓✓		
	1.3.3	Both A and B✓✓	(3 x 2)	**(6)**
1.4	1.4.1	Dihybrid✓ cross		(1)
	1.4.2	TTrr✓✓		(2)
	1.4.3	TR✓, Tr✓, tR✓, tr✓ **(Mark first FOUR only)**		(4) **(7)**
1.5	1.5.1	Males✓		(1)
	1.5.2	(a) 3✓/Three		(1)
		(b) 3✓/Three		(1)
	1.5.3	(a) T✓ U✓		(2)
		(b) X^HX^h✓✓		(2)
				(7)

TOTAL SECTION A: 50

SECTION B

QUESTION 2

2.1 2.1.1 Metaphase II✓ (1)

2.1.2 Individual chromosomes line up at the equator✓✓ of the cell (2)
(Mark first ONE only)

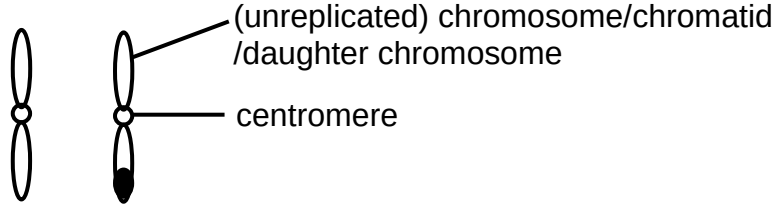
2.1.3 (a) Cell membrane✓ (1)

(b) Spindle fibre✓ (1)

2.1.4
- It contracts✓/shortens
- to pull the chromosomes✓/ daughter chromosomes/chromatids to opposite poles of the cell (2)

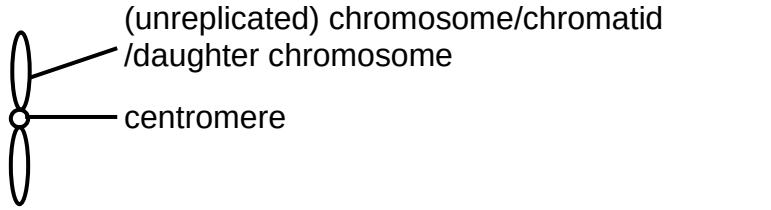
2.1.5

Structure C in the final phase of Meiosis/ Telophase II



OR

Structure C in the final phase of Meiosis/ Telophase II



Guideline for assessing the drawing

CRITERIA	ELABORATION	MARK
Heading (H)	- Structure **C** in the final phase of meiosis/Telophase II	1
Correct drawing (D)	- Daughter chromosome/ unreplicated chromosome/ chromatid/s drawn from structure **C** only	1
Correct shading (S)	- One unshaded - One with a shaded tip } **OR** one unshaded	1
Labels (L)	- Any 1 correct label	1

(4)
(11)

2.2 2.2.1 (a) Transcription✓ (1)
(b) Translation✓ (1)

2.2.2 (a) Nucleus✓ (1)
(b) mRNA✓ (1)

2.2.3 Chloroplasts✓
Mitochondria✓ (2)
(Mark first TWO only)

2.2.4
- The double helix DNA unwinds✓ and
- (the double-stranded DNA) unzips✓/weak hydrogen bonds break
- to form two separate strands✓
- One strand is used as a template✓
- to form mRNA✓
- using free (RNA) nucleotides✓ from the nucleoplasm
- The mRNA is complementary to the DNA✓/ (A-U, G-C)
- mRNA now has the coded message for protein synthesis✓

Any (7)

2.2.5 (a) TCG✓ (1)

(b) Tyrosine✓
Valine✓ **(in this sequence)** (2)
(Mark first TWO only)

2.2.6 Gene mutation✓ (1)

2.2.7
- The anticodon will be GGA✓/not GAA
- The last amino acid would be proline instead of leucine✓
- resulting in a different protein✓/ no protein at all (3)

(20)

2.3 2.3.1
- Either **male 1** or **male 2** could be the father✓ of the boy
- since both males have the I^B allele✓/ **male 1** I^AI^B and **male 2** I^BI^B or I^Bi
- The mother's blood group is O and must have the genotype ii✓/homozygous recessive
- The boy would have inherited the recessive allele/i from the mother✓
- and he would have the genotype I^Bi✓ (5)

2.3.2 Male 2✓ (1)

2.3.3
- Four/some bands of the boy's✓DNA profile
- match with those of the mother's✓ profile
- The remaining bands of the boy match with the bands of male **2**'s✓ DNA profile/fewer bands match with male **1**'s DNA profile (3)

2.3.4
- Tracing missing persons✓
- Identification of genetic disorders✓
- Establishing family relations✓
- Matching tissues for organ transplants✓
- Identifying dead persons✓/criminals/suspects Any (1)

(Mark first ONE only) **(10)**

2.4 2.4.1 Incomplete dominance✓ (1)

2.4.2
- The pink flower colour is an intermediate phenotype✓/ a blend of red and white
- indicating that neither of the alleles is dominant✓ (2)

2.4.3

P_1 /P_2	Phenotype		Pink	x	Pink✓
	Genotype		RW	x	RW✓
Meiosis					
	G/gametes		R, W	x	R, W✓
Fertilisation					
F_1 /F_2	Genotype		RR; RW; RW; WW✓		
	Phenotype		1 Red: 2 Pink: 1 White✓*		

P_1 & F_1✓/
P_2 & F_2
Meiosis and fertilisation✓

OR

P_1 /P_2	Phenotype		Pink	x	Pink✓
	Genotype		RW	x	RW✓

Meiosis

Fertilisation

Gametes	R	W
R	RR	RW
W	RW	WW

1 mark for correct gametes
1 mark for correct genotypes

F_1 /F_2	Phenotype	1 Red: 2 Pink: 1 White✓*

P_1 & F_1✓/
P_2 & F_2
Meiosis and fertilisation✓

(6)

1*** compulsory** + Any 5 **(9)**

[50]

QUESTION 3

3.1 3.1.1 B✓ (1)

3.1.2 - The foramen magnum is in a more forward position✓✓ (2)
(Mark first ONE only)

3.1.3

	A		B
1	Larger canines✓/teeth	1	Smaller canines✓/teeth
2	Jaws with teeth in a rectangular/U shape✓	2	Jaws with teeth on a gentle/round curve✓
3	More protruding jaw✓/ prognathous	3	Less protruding jaw✓/non-prognathous
4	Diastema present✓	4	No diastema✓

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

3.1.4
- The spine is S-shaped✓*****
- to support upper body weight✓
- for shock absorption✓
- for flexibility✓ 1***** compulsory + Any 1 (2)

(10)

3.2 3.2.1
- Glyphosate resistance increased✓
- from 2009 to 2015✓
- and remained constant in 2016✓ (3)

3.2.2 $\left.\frac{45}{20}\right\}$ ✓ x 100✓ **OR** $\left.\frac{65 - 20}{20}\right\}$ ✓ x 100✓

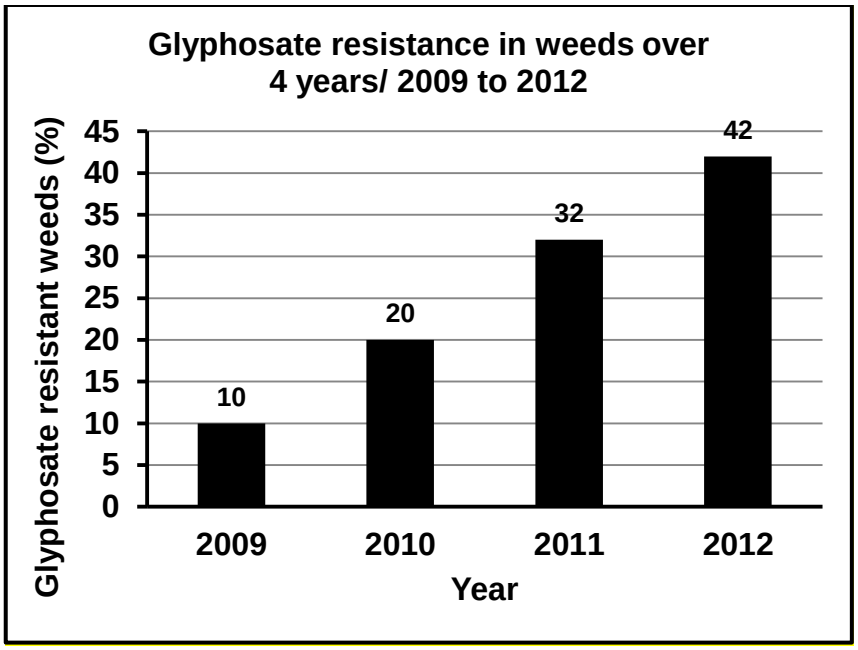
= 225✓% (3)

3.2.3
- The glyphosate will not kill the maize✓
- A greater yield✓ of maize
- means greater profit✓

OR

- Application of the glyphosate does not have to be selective✓
- This will save on labour✓/time/costs which
- means greater profit✓ (3)

3.2.4



Guideline for assessing the graph

CRITERIA	ELABORATION	MARK
Correct type of graph (T)	Bar graph drawn	1
Caption of graph (C)	Both variables included	1
Axes labels (L)	X- and Y-axis correctly labelled with units	1
Scale for X- and Y-axis (S)	- Equal space and width of bars for X-axis and - Correct scale for Y-axis	1
Plotting of co-ordinates (P)	- 1 to 3 co-ordinates plotted correctly - The 4 required co-ordinates plotted correctly	1 2

(6)
(15)

3.3 3.3.1
- They measured the jaw size of lizards on both islands✓ and
- determined the average jaw size for each population✓
- They compared the difference✓ between the two (3)

3.3.2
- A larger jaw allows for better muscle attachment✓/more teeth /larger teeth
- Thereby increasing the bite force✓/ability
- to break down✓the fibrous plant material (3)

3.3.3
- They allowed the lizards of the two islands to mate✓
- and determined that they were able to interbreed✓ and
- give rise to fertile offspring✓ Any (2)

3.3.4
- Biodiversity remains the same✓/there is no effect
- because the number of species remains the same✓/a new species has not been formed

OR

- Biodiversity decreases✓
- because some species of plants eaten on Island **B** could become extinct✓ (2)

3.3.5
- There is variation in the size of the lizards' jaws✓
- Some have small jaws and others have large jaws✓
- Due to the larger supply of (fibrous) plants✓/fewer insects
- those with smaller jaws will be unable to feed✓
- and die✓
- The lizards with the larger jaws will have more food✓
- and survive✓
- to reproduce✓
- The allele for larger jaws will be passed on to the offspring✓
- The next generation will have a higher proportion of lizards with larger jaws✓ Any (7)

(17)

3.4 3.4.1
- (Modern) humans originated in Africa✓ and
- then migrated to other continents✓ (2)

3.4.2 Hominidae✓ (1)

3.4.3 Mitochondrial DNA✓ (1)

3.4.4
- Fossils of *Ardipithecus* were found in Africa <u>only</u>✓
- Fossils of *Australopithecus* were found in Africa <u>only</u>✓
- Fossils of *Homo habilis* were found in Africa <u>only</u>✓
- The <u>oldest</u> fossils of *Homo erectus* were found in Africa✓
- The <u>oldest</u> fossils of *Homo sapiens* were found in Africa✓

Any (4)

(8)

[50]

TOTAL SECTION B: 100
GRAND TOTAL: 150