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**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

LIFE SCIENCES P1

NOVEMBER 2013

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 answer 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 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 correct 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, for example 1.1.11 D.

1.1.1 The distribution of organisms is known as ...

- A biochemistry.
- B biogeography.
- C archaeology.
- D palaeontology.

1.1.2 Which ONE of the following CORRECTLY describes the cells produced by meiosis?

CELLS PRODUCED BY MEIOSIS		
	Chromosome complement	Genetic composition
A	Haploid	Different
B	Diploid	Identical
C	Diploid	Different
D	Haploid	Identical

1.1.3 Study the following statements:

- (i) Organisms in a population show a great deal of variation.
- (ii) Characteristics are passed on from parents to offspring.
- (iii) If an organism uses an organ frequently it becomes more developed.
- (iv) A large number of offspring are produced, but only few survive.

Which ONE of the following combinations refers to observations upon which Darwin based his theory?

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

1.1.4 Study the following list of molecules:

- (i) Sugar
- (ii) Phosphate
- (iii) Nitrogenous base
- (iv) Amino acid

Which ONE of the following combinations represents components of a nucleotide?

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

1.1.5 Four different phenotypes are possible in the F_1 -generation if the parents' blood types are ...

- A B and B.
- B A and B.
- C O and AB.
- D AB and AB.

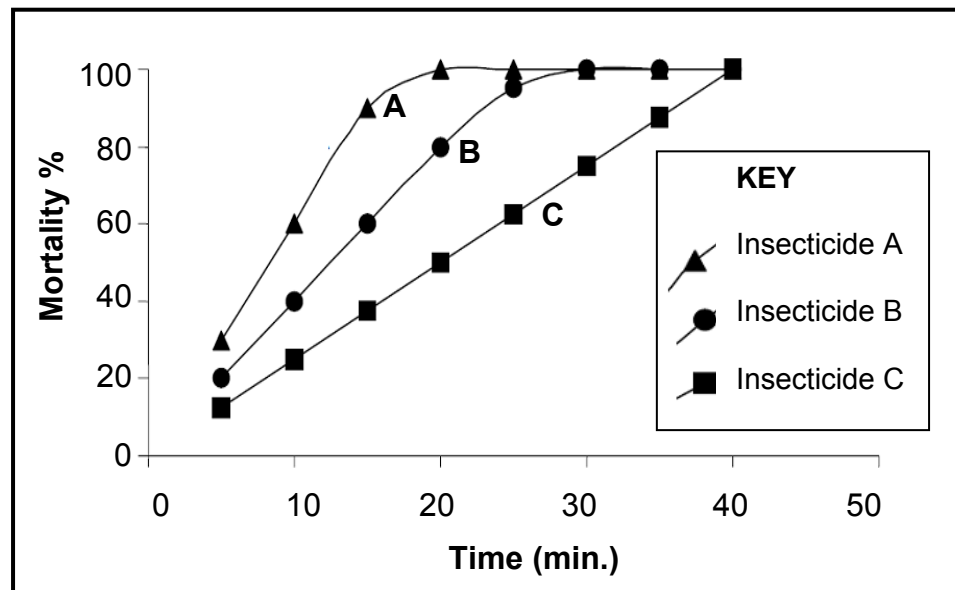
1.1.6 In humans, brown eye colour is dominant over blue eye colour. A mother with blue eyes had two children, a boy with brown eyes and a girl with blue eyes. The eye colour of the father is ...

- A brown, because the allele for brown eye colour is sex-linked.
- B brown, because at least one of the parents must have brown eyes.
- C blue, because at least two other members of the family have blue eyes.
- D blue, because at least one of the parents must be heterozygous for eye colour.

QUESTIONS 1.1.7 TO 1.1.9 ARE BASED ON THE INFORMATION AND GRAPH BELOW.

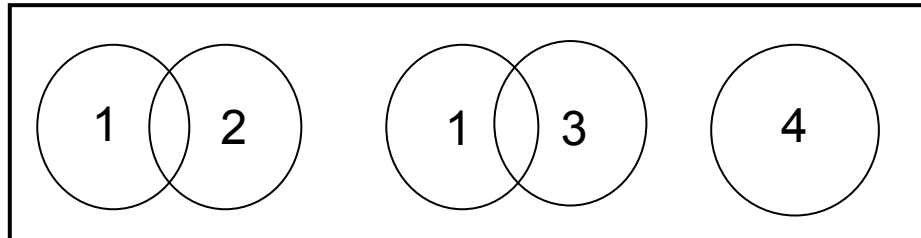
One way to measure the resistance of an insect population to an insecticide is to determine the time taken for the insecticide to kill 90% of the population. This is called the resistance factor (RF).

The graph below shows the results from a resistance investigation in a single population. The same amount of each of three insecticides was used.



- 1.1.7 What is the approximate RF value for insecticide B?
- A 0,5
B 1
C 2
D 24
- 1.1.8 Which ONE of the insecticides has the fastest killing action given that the same quantity of each insecticide was used?
- A Insecticide A
B Insecticide B
C Insecticide C
D All the insecticides were equally fast
- 1.1.9 A general conclusion from the data shown in the graph above, at 30 minutes, is that ...
- A both insecticide B and insecticide C have been 100% effective.
B both insecticide A and insecticide B have been 100% effective.
C both insecticide A and insecticide C have been 100% effective.
D all the insecticides have been 100% effective.

- 1.1.10 Numbers **1**, **2**, **3** and **4** below refer to four populations of frogs. These populations are represented diagrammatically by circles. Overlapping circles show populations that are capable of interbreeding to produce fertile offspring.



It would be reasonable to conclude that ...

- A if populations **2** and **4** were to die out, two different species would remain.
- B populations **1**, **2**, **3** and **4** represent four different species.
- C if population **2** were to die out, two different species would remain.
- D if population **3** were to die out, only one species would remain.

(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 number (1.2.1 to 1.2.8) in the ANSWER BOOK.

- 1.2.1 The triplet of bases found in a tRNA molecule
- 1.2.2 The condition where an organism has more than two complete sets of chromosomes in a cell
- 1.2.3 A genetic disorder characterised by the absence of a blood clotting factor
- 1.2.4 Organisms that have different alleles at a given locus
- 1.2.5 The physical and/or functional expression of a gene
- 1.2.6 An arrangement of black bars representing DNA fragments that can be used to determine whether people are related
- 1.2.7 All the chromosomes found in a cell except the sex chromosomes
- 1.2.8 The biotechnological production of genetically identical offspring

(8)

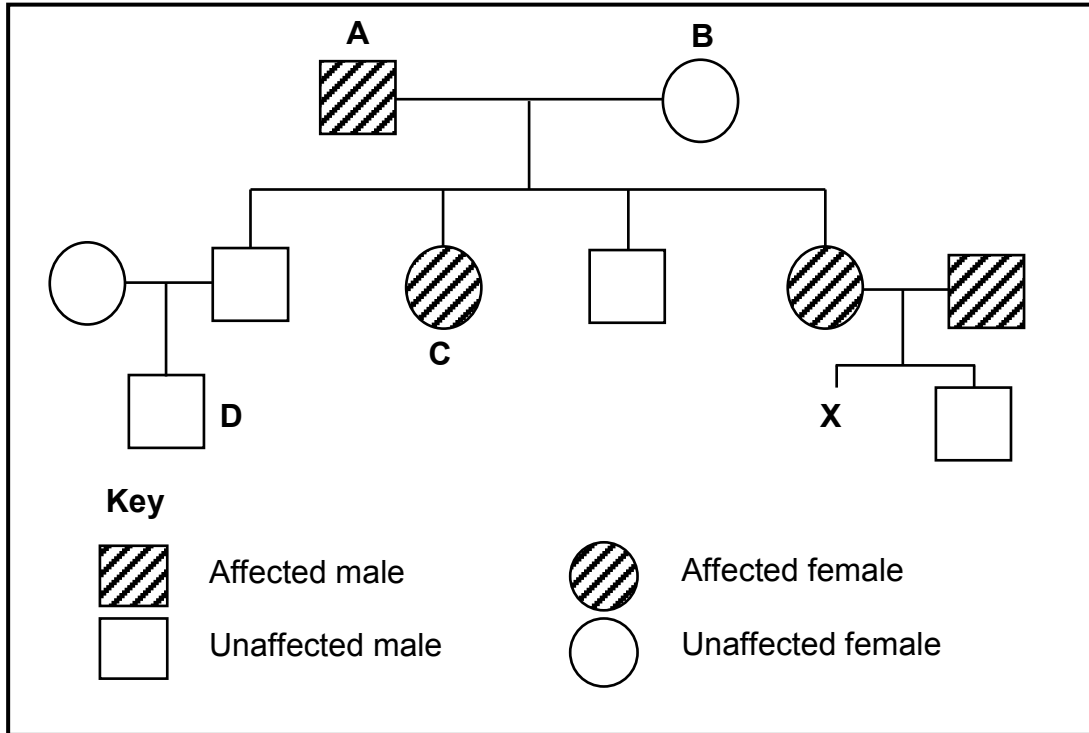
- 1.3 Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B** or **none** next to the question number (1.3.1 to 1.3.8) in the ANSWER BOOK.

COLUMN I		COLUMN II	
1.3.1	A trait such as height in humans that has a range of intermediate phenotypes	A:	Polygenic inheritance
		B:	Codominance
1.3.2	Alternative forms of the same gene in a population	A:	Alleles
		B:	Chromosomes
1.3.3	A type of gene mutation in which adenine is lost/deleted from a DNA base triplet	A:	Frame-shift mutation
		B:	Point mutation
1.3.4	The structure that moves chromosomes/chromatids to the poles during cell division	A:	Centromere
		B:	Spindle
1.3.5	Inheritance of acquired characteristics	A:	Lamarck
		B:	Darwin
1.3.6	Influence(s) the inheritance of blood groups	A:	Multiple alleles
		B:	Codominance
1.3.7	A characteristic that humans share with other primates	A:	Opposable thumb
		B:	Binocular vision
1.3.8	A characteristic that is only expressed when in the homozygous state	A:	Recessive
		B:	Dominant

(8 x 2)

(16)

1.4 A scientist gathered information about the affected and unaffected individuals for a certain genetic disorder. The genetic disorder is caused by a dominant allele. The findings of the scientist are represented in the pedigree diagram below.



1.4.1 Using the letters **R** and **r** to represent the dominant and recessive alleles respectively, state the genotype of individual:

- (a) **A** (1)
- (b) **D** (1)

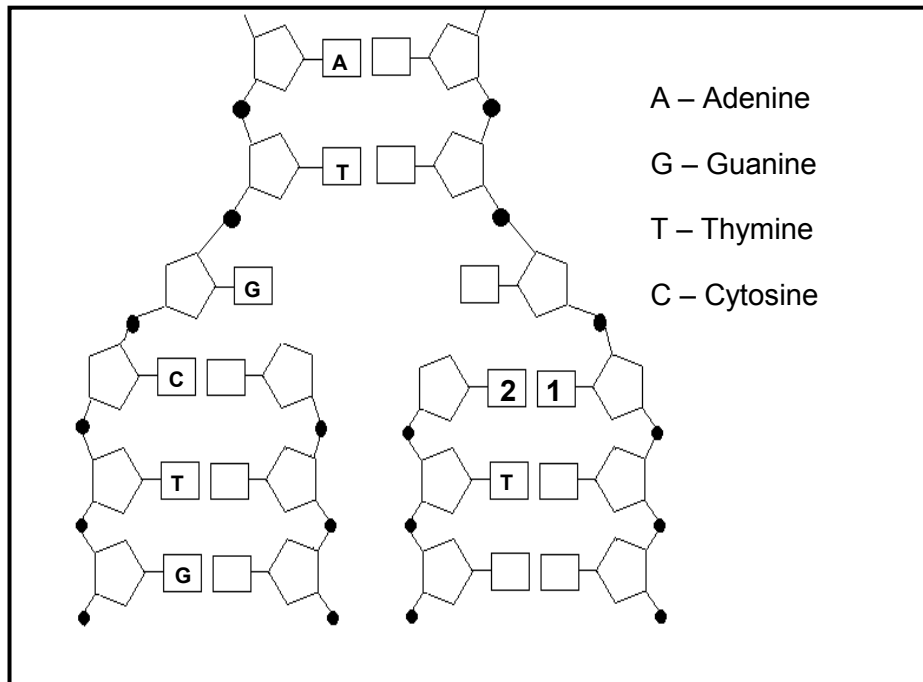
1.4.2 What is the percentage chance of individual **X** having a genetic disorder? (2)

1.4.3 If individual **C** marries an unaffected male, state the possible genotype(s) of their offspring. (2)
(6)

TOTAL SECTION A: 50

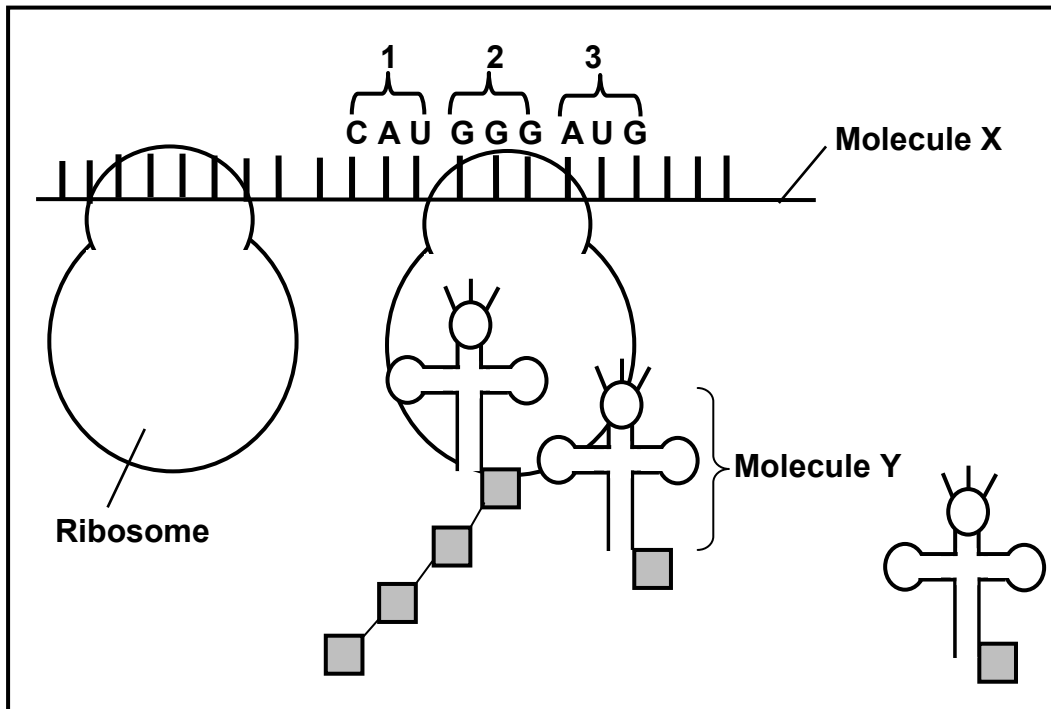
SECTION B**QUESTION 2**

- 2.1 Study the diagram below, which shows a section of a DNA molecule during a process taking place in a cell.



- 2.1.1 Name the process represented in the diagram. (1)
- 2.1.2 When exactly will this process take place in a cell? (1)
- 2.1.3 Give labels for **1** and **2**. (2)
- 2.1.4 State TWO ways in which the structure of RNA differs from the DNA structure shown in the diagram. (2)
- (6)**

2.2 The diagram below shows a part of the process of protein synthesis.



2.2.1 Name the stage of protein synthesis represented in the diagram above. (1)

2.2.2 Identify:

(a) Molecule X (1)

(b) Molecule Y (1)

(c) Structure 1 (1)

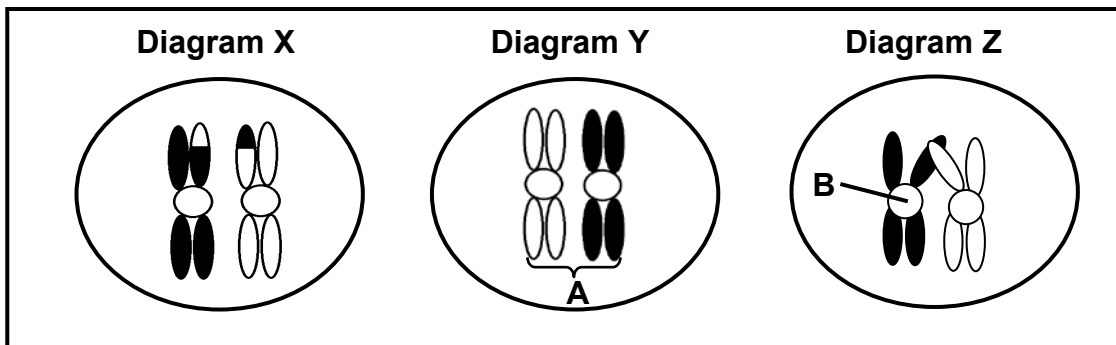
2.2.3 The table below shows the DNA base triplets that code for different amino acids found in human proteins.

AMINO ACID	BASE TRIPLET IN DNA
Leucine	GAA
Proline	GGG
Lycine	TTT
Histidine	GTA
Serine	TCA
Methionine	TAC
Glycine	CCC
Glutamine	GTC

Using the information in the table and the diagram above, write down the sequence of the amino acids that correspond with structures 1, 2 and 3.

(3)
(7)

2.3 The diagrams below show chromosome pair 21 in the nucleus of a cell of the ovary of a woman. The chromosomes are involved in a process that takes place in a phase of meiosis.

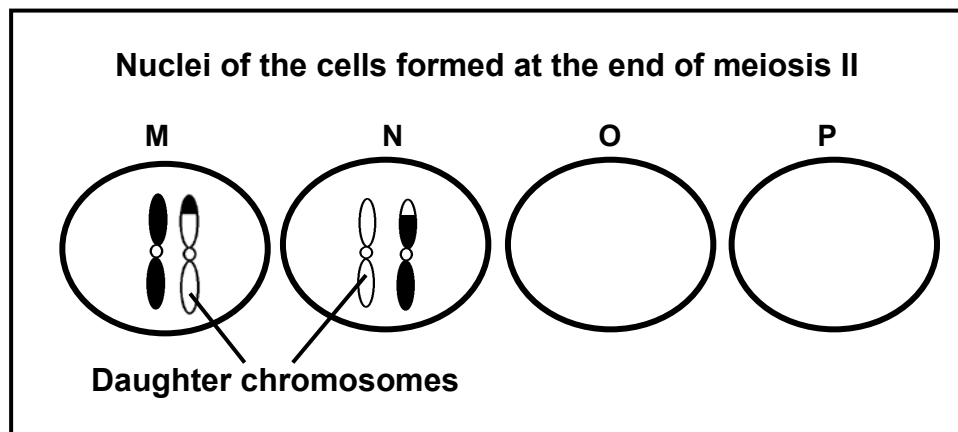


2.3.1 Give labels for **A** and **B**. (2)

2.3.2 Rearrange the letters **X**, **Y** and **Z** to show the correct sequence in which the events take place in this phase. (1)

2.3.3 Explain why the chromosomes in Diagram **X** and Diagram **Y** are different in appearance. (3)

2.3.4 The diagram below shows the nuclei of the four cells that resulted from meiosis involving the chromosomes in Diagram **X** above.



(a) Explain why nuclei **O** and **P** do NOT have chromosomes. (2)

(b) Name and explain the disorder that will result if diagram **M** represents an egg cell that fuses with a normal sperm cell. (3)
(11)

2.4 When flies with grey bodies were crossed with flies with black bodies, all the offspring in the F_1 had grey bodies.

Use the letters **G** and **g** to represent a genetic cross to show the F_2 genotypes and phenotypes if the F_1 were interbred.

(6)
[30]

QUESTION 3

3.1 Read the extract below.

Genetic engineering involves a process whereby a gene is isolated from one organism and transferred into another organism. This gene can become part of the new host's genome. Usually the gene transfer takes place between organisms from different kingdoms.

For example, a gene from a certain bacterium codes for an enzyme that deactivates a herbicide (a weedkiller). This gene is isolated from the bacterium and inserted into the chromosome of a crop plant. The resulting plant will now be herbicide-resistant.

Before the products of genetic engineering can be sold, many tests must be done.

Some seed companies have exclusive rights to sell the seeds that they have genetically engineered. Farmers cannot use seeds harvested from the crops that they have grown. Farmers must buy the seeds from the seed companies every time they want to plant the crop.

[Adapted from *Microbiology and Biotechnology*, 1994]

- 3.1.1 What is meant by the term *genome* referred to in the extract? (1)
- 3.1.2 State ONE way in which the genetic engineering described in the extract differs from selective breeding. (2)
- 3.1.3 Give ONE reason why the products of genetic engineering must undergo many tests before they can be sold. (1)
- 3.1.4 Explain the value of growing herbicide-resistant crops. (3)
- 3.1.5 State THREE advantages of genetic engineering in crop production other than those mentioned in the extract above. (3)
- 3.1.6 Give a reason why seed companies insist that they must have the exclusive rights to the selling of seeds. (2)
- (12)**

- 3.2 Gregor Mendel conducted breeding experiments with pea plants to study the inheritance patterns of four different traits (plant height, seed shape, seed colour and seed coat colour).

For each trait, for example plant height, he crossed homozygous tall plants with homozygous dwarf plants. The offspring obtained in the F₁-generation were then interbred to form the F₂-generation. He did the same for each of the other traits.

The results obtained for the F₂-generation are shown in the table below.

TRAIT	RESULTS OF F ₂ -CROSSING	RATIO
Plant height (Tall or dwarf)	Tall: 787	2,84 : 1
	Dwarf: 277	
Seed shape (Round or wrinkled)	Round: 5 474	X
	Wrinkled: 1 850	
Seed colour (Yellow or green)	Yellow: 6 022	Y
	Green: 2 001	
Seed coat colour (Grey or white)	Grey: 705	3,15 : 1
	White: 224	

[Adapted from *Basic Concepts in Biology*, 3rd edition., C Starr, 1997]

- 3.2.1 What is the expected phenotypic ratio for a trait involving two heterozygous parents? (1)
- 3.2.2 From the results, calculate **X** and **Y**. Also state which trait provided a ratio closest to the expected phenotypic ratio mentioned in QUESTION 3.2.1. Show ALL working. (3)
- 3.2.3 Give a possible reason why the ratio selected in QUESTION 3.2.2 was closest to the theoretical ratio. (2)
- 3.2.4 Using the results, state whether the allele for round seeds or for wrinkled seeds is dominant. (1)
- 3.2.5 State TWO factors that Mendel controlled during these breeding experiments. (2)
- 3.2.6 Write down Mendel's law of segregation. (2)
- 3.3 Describe how allopatric speciation occurs. (7)
- [30]**

TOTAL SECTION B: 60

SECTION C**QUESTION 4**

- 4.1 Although copper is an essential nutrient for the growth of plants, it is toxic and may kill the plants if present in very high amounts.

High amounts of copper in the soil may be a result of ore deposits from old copper mines. Some grass species are tolerant to high levels of copper.

An investigation was carried out to determine the effect of copper on the growth of a species of grass, *Eragrostis sp.*, found near an old copper mine.

- Seeds were collected from plants growing in five sample areas that were 10 metres apart, starting from an old copper mine.
- Forty seeds from each sample area were planted under laboratory conditions in soil containing nutrients for normal growth.
- The seeds were allowed to germinate into seedlings.
- The 40 seedlings from each sample area were divided into two groups (Group 1 and Group 2).
- A dilute copper solution was added to the soil of the Group 1 seedlings.
- Distilled water was added to the soil of the Group 2 seedlings.

After two weeks, the number of seedlings surviving was counted and the average height of the surviving seedlings was measured.

The results are shown in the table below.

Sample area	Distance from the old copper mine where the seeds were collected (m)	Number of seedlings surviving		Average height of surviving seedlings (cm)	
		Group 1	Group 2	Group 1	Group 2
1	10	20	20	3,9	4,0
2	20	20	20	3,8	4,1
3	30	12	20	4,0	4,9
4	40	4	20	3,7	4,8
5	50	2	20	3,8	4,9

[Adapted from *Tropical Grasslands*, Journal Volume 24, 1990]

- 4.1.1 Draw a line graph to represent the results obtained for the number of seedlings surviving in **Group 1**. (7)
- 4.1.2 Identify the dependent variable(s) in the investigation. (2)
- 4.1.3 Identify TWO independent variables in this investigation. (2)

- 4.1.4 In terms of natural selection, explain why seedlings from seeds collected closer to the mine for Group 1 had a high survival rate. (6)
(17)
- 4.2 Describe how a study of the Y-chromosome provides evidence for the 'Out of Africa' hypothesis. (3)
- 4.3 Describe the structural changes to the skull that characterise the evolution of modern humans from their ape-like ancestors, and explain the significance of these changes.
- Content: (17)
Synthesis: (3)
(20)

NOTE: NO marks will be awarded for answers in the form of flow charts or diagrams.

TOTAL SECTION C: 40
GRAND TOTAL: 150