

EXAMINATION		NATIONAL SENIOR CERTIFICATE	
GRADE		12	
DATE		MAY/JUNE 2024	
SUBJECT		LIFE SCIENCES	
PAPER		2	
MARK TOTAL		150	
DURATION (HOURS)		2½	
NUMBER OF PAGES		18	



SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE
SUID-AFRIKAANSE KOMPREENSIEWE ASSESSERINGSINSTITUUT

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

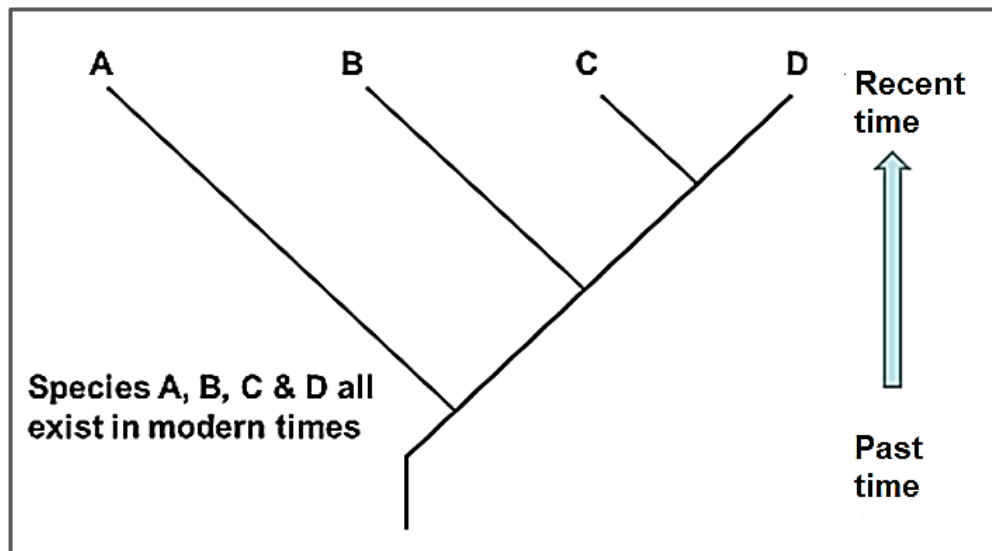
1. Answer **ALL** questions.
2. Write **ALL** the answers in your **ANSWER BOOK**.
3. Start the answers to each question at the top of a **NEW** page.
4. Number the answers according to the numbering system used in the question paper.
5. Present your answers according to the instructions of each question.
6. **ALL** drawings should be done in pencil and labelled 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. You may use non-programmable calculators, protractors and compasses.
10. Write neatly and legibly, **ONLY** in blue ink.

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 1.1.9), for example **1.1.11. D**.

1.1.1 The phylogenetic tree below illustrates the evolution of 4 species.



[Source: www.shmoop.com/studyguides/biology/taxonomy/phylogenetic-trees/]

Study the following statements:

- i) Species A, B and C are extinct.
- ii) Species C and D share a more recent common ancestor than species B and D.
- iii) Species D is most closely related to species A.
- iv) Species D evolved from species C.
- v) Species D will display the most advanced morphological characteristics.

Which of the following combination of statements is true based on the above diagram?

- A. i) and ii)
- B. ii) and v)
- C. i) and iv)
- D. iii) and iv)

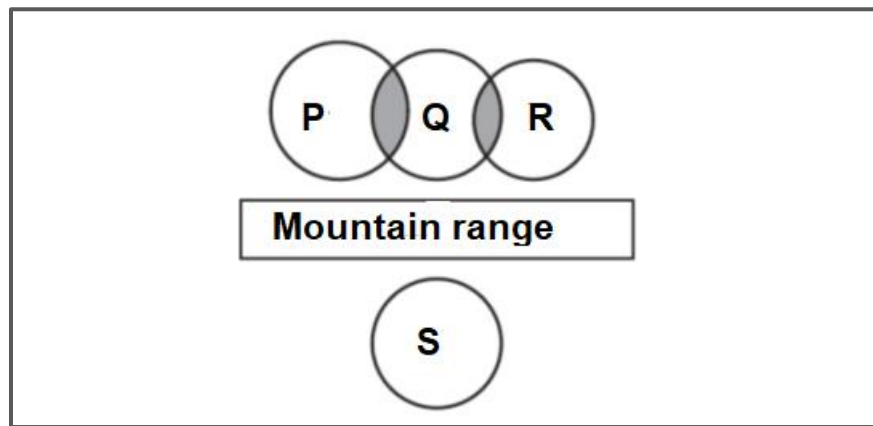
(2)

1.1.2 Boa constrictor snakes have tiny pelvic girdles and leg bones within their bodies. Since these structures are non-functional, they are called:

- A. vestigial.
- B. analogous.
- C. maladaptive.
- D. homologous.

(2)

1.1.3 The diagram below illustrates four populations of animals P, Q, R and S and areas of interbreeding. Interbreeding takes place in the shaded areas.



[Source: N5 Biology Examination May 2015]

The type of speciation that will occur between population S and R is:

- A. Sympatric speciation.
- B. Behavioural isolation.
- C. Allopatric speciation.
- D. Convergent speciation.

(2)

1.1.4 The four children of two parents have all different blood groups of the ABO-range. What are the blood groups of the parents?

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

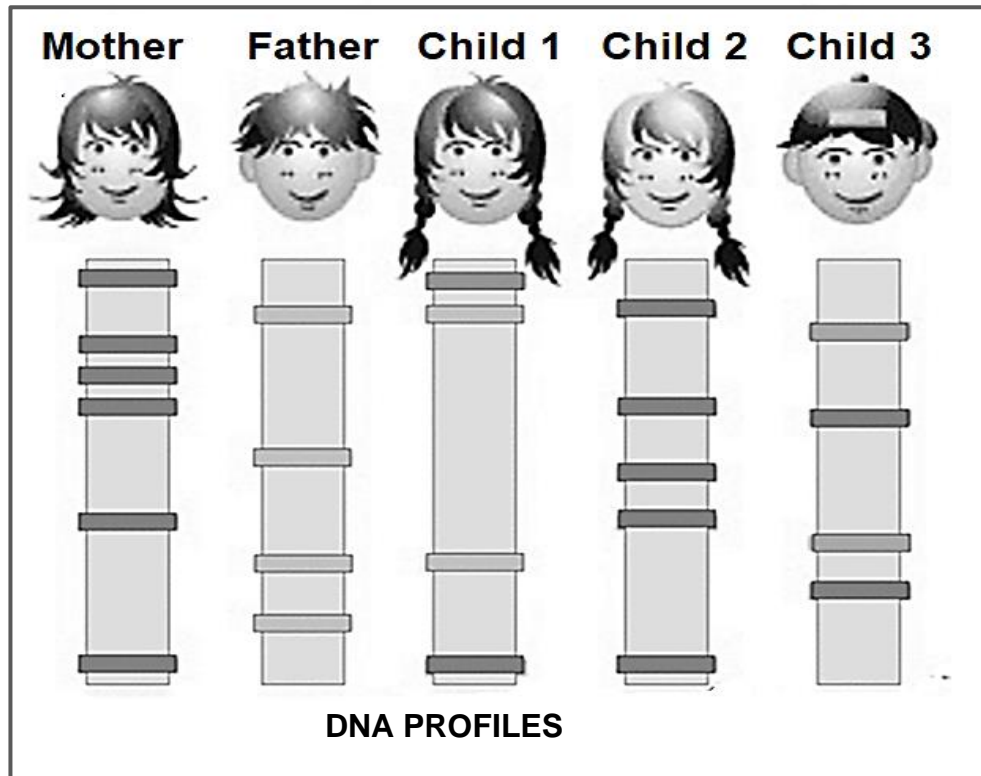
(2)

1.1.5 In a monohybrid cross between two heterozygous pea plants the offspring will yield plants with a genotypic ratio of:

- A. 3:1
- B. 9:3:3:1
- C. 1:1
- D. 1:2:1

(2)

1.1.6 The given diagrams show the DNA profiles of a mother, father and their three children. Study the diagrams and answer the questions that follow.



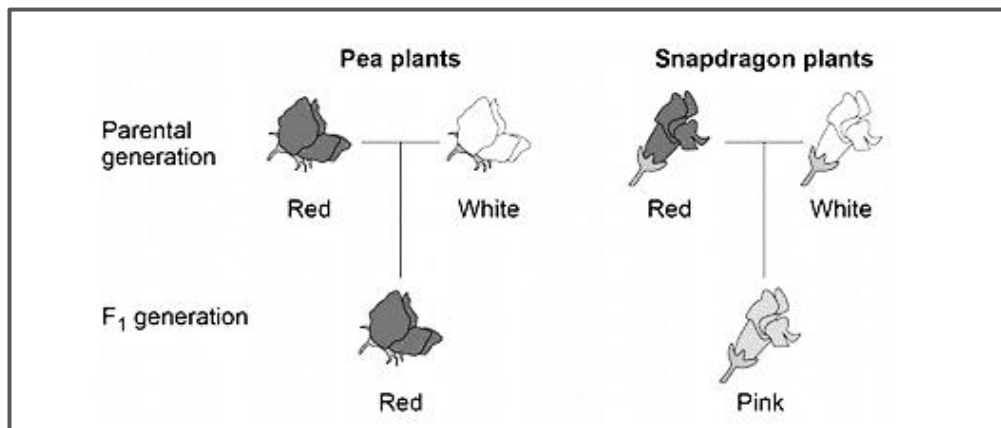
[Source: Adapted from www.pathwayz.org/Tree/Plain/DNA+PROFILING]

Which of the following is the correct conclusion based on the DNA profile

	Child 1	Child 2	Child 3
A	Adopted child	Child of both the mother and father	Not related to the father
B	Only related to the mother	Adopted child	Only related to the father
C	Child of both the mother and father	Only related to the mother	Adopted child
D	Only related to the father	Only related to the mother	Adopted child

(2)

1.1.7 The diagram below illustrates the inheritance of flower colour in two plant species.



[Source: www.thebiologynotes.com; www.slideplayer.com/slide/15540313]

Which row in the table below is correct about the inheritance of flower colour in these plant species?

	Pea plant	Snapdragon plant
A	Co-dominance	Incomplete dominance
B	Complete dominance	Co-dominance
C	Complete dominance	Incomplete dominance
D	Co-dominance	Incomplete dominance

(2)

1.1.8 What percentage of thymine bases are present in a DNA molecule with 2 000 bases if 400 of the bases are cytosine?

- A. 20%
- B. 30%
- C. 40%
- D. 60%

(2)

1.1.9 The type of enzyme that cuts DNA at specific target sequences to isolate a specific gene is a:

- A. restriction enzyme.
- B. ligase enzyme.
- C. polymerase enzyme.
- D. plasmid.

(2)

(9x2) = [18]

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 The syndrome caused by the non-disjunction of chromosome pair 21

1.2.2 The complete set of genetic information in an organism

1.2.3 The type of variation that is the result of polygenic inheritance

1.2.4 The theory that changes accumulate slowly and the evolving population passes through numerous intermediate stages

1.2.5 The physical appearance of an organism resulting from its genotype and the effects of the environment

1.2.6 The point on a chromosome where crossing over takes place

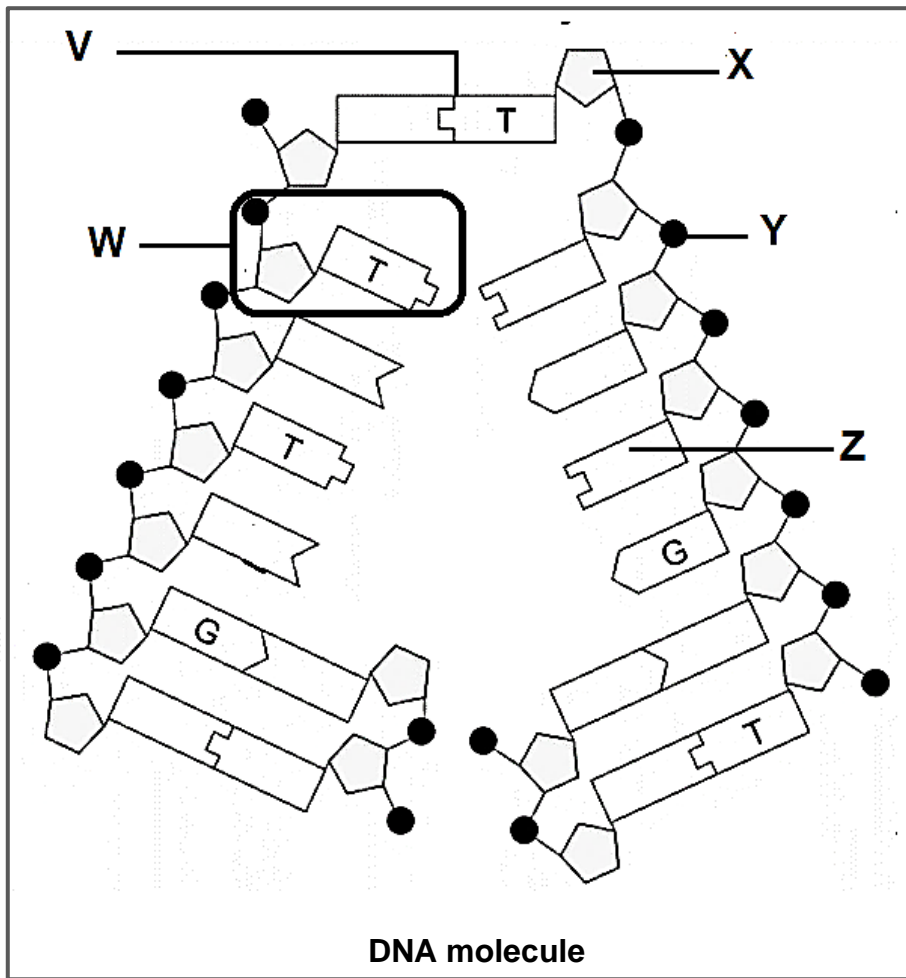
[6]

1.3 Indicate whether each of the descriptions in Column I applies to **A ONLY**, **B ONLY**, **BOTH A and B** or **NONE** of the items in Column II. Only write **A**, **B**, **BOTH** or **NONE** next to the question number.

	COLUMN I	COLUMN II	
1.3.1	Earliest member of the genus <i>Homo</i>	A	<i>Homo naledi</i>
		B	<i>Homo erectus</i>
1.3.2	Karyotype	A	Detect chromosomal abnormalities
		B	Indicate gender
1.3.3	One type of fly mating in February, while a closely related species does not mate until the middle of March	A	Ecological isolation
		B	Temporal isolation
1.3.4	Position of a gene on a chromosome	A	Locus
		B	Allele
1.3.5	Features used by scientists to construct a phylogenetic tree	A	Fossil records
		B	Similarities in DNA sequence

(5x2) = [10]

1.4 The diagram below illustrates a part of a DNA molecule. Study the diagram and answer the questions that follow.











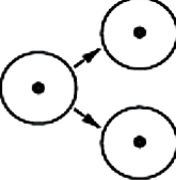









[Source: Adapted from GCSE Biology Paper 2F, June 2020]

- 1.4.1 Identify the process illustrated in the diagram above. (1)
- 1.4.2 Identify the phase of the cell cycle when the process mentioned in Question 1.4.1 will occur. (1)
- 1.4.3 Identify the parts labelled:
 a) **X** (1)
 b) **Y** (1)
- 1.4.4 Identify the type of bond that occurs at **V**. (1)
- 1.4.5 DNA is made up of repeating units. One of the units is labelled **W**. Give the name of this repeating unit. (1)
- 1.4.6 Give the name of the nitrogenous base labelled **Z**. (1)
- 1.4.7 Name TWO functions of DNA in a cell. (2)

1.4.8 The DNA in one human body cell is the length of 6 000 million of the repeating units labelled Z. Each repeating unit is 0,34 nanometres (nm) long. Calculate the length of DNA in the cell in metres. (1 metre = 1×10^{-9} nanometres) (3)

[12]

1.5 Each row in the table below illustrates a sperm cell with its sex chromosome, an ovum and the zygote produced by the fusion of the ovum and sperm cell. Study the diagram and answer the question that follow.

Sperm and its sex chromosome	Ovum	Zygote	Children produced
			a)
			
			b)
			c)
			d)
			

[Source: Adapted from WJEC, Science Higher Tier Biology 1, 24 January 2012]

Use some of the letters from the list below to indicate the children produced by the possible combinations.

Write the letter (A to F) next to question 1.5 a) to d).

List: Possible children produced

A = twins, one boy and one girl

B = identical twin girls

C = twin boys, one with brown eyes the other with blue eyes

D = one boy

E = one girl

F = twin girls, one with red hair and one with black hair

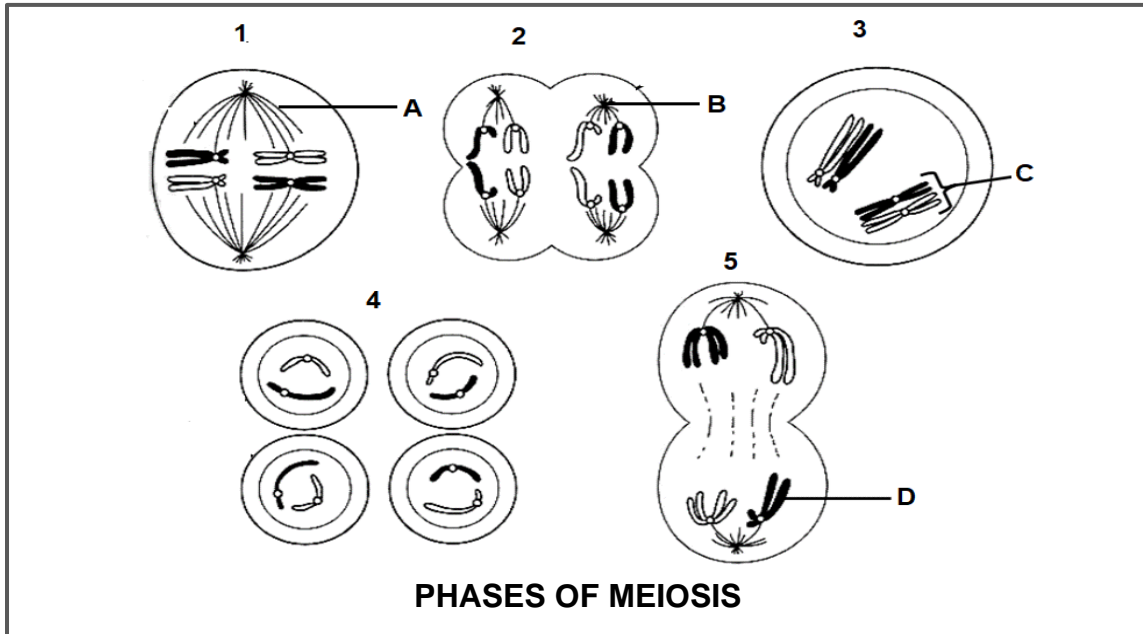
[4]

TOTAL SECTION A: [50]

SECTION B

QUESTION 2

2.1 The diagram below illustrates five phases of meiosis occurring in a fruit fly. Study the diagram and answer the questions that follow.

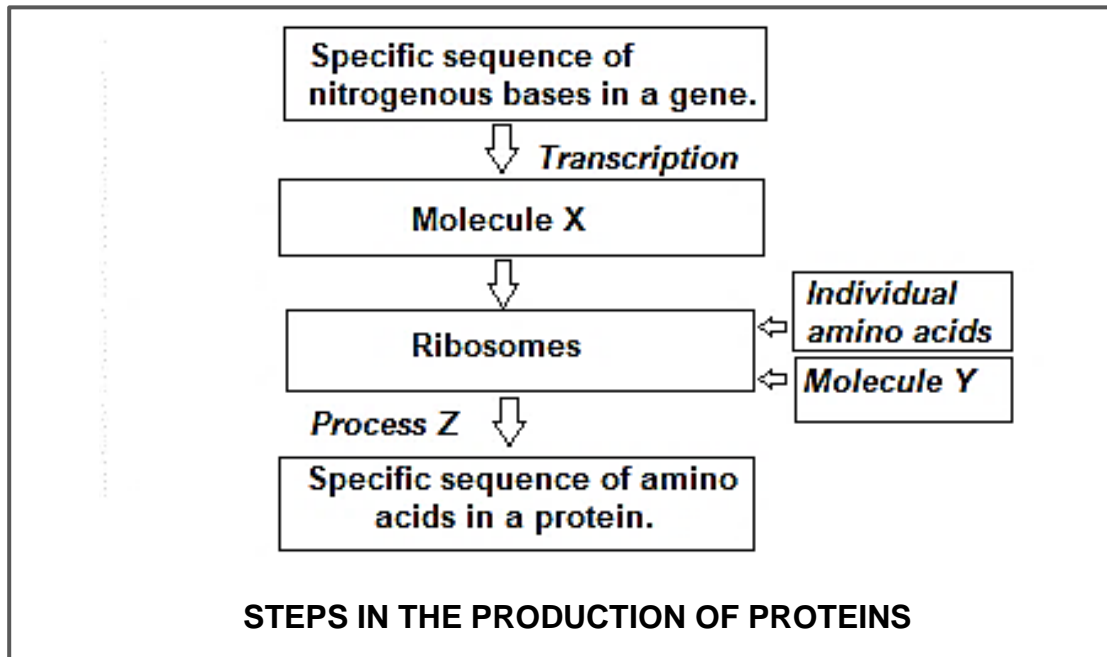


[Source: Adapted from <https://www.shutterstock.com/search/meiosis>]

- 2.1.1 Arrange the phases in the correct sequence. (3)
- 2.1.2 Identify the structures labelled:
- a) **A** (1)
 - b) **B** (1)
 - c) **C** (1)
 - d) **D** (1)
- 2.1.3 Identify the phase labelled **3**. (1)
- 2.1.4 Explain your answer to QUESTION 2.1.3. (2)
- 2.1.5 Explain how the phase labelled **1** increases the genetic variation in the offspring of the fruit fly. (4)
- 2.1.6 Name the diploid chromosome number of the fruit fly. (1)
- 2.1.7 Give the **number** and **name** of the phase that illustrates Mendel's Law of Segregation. (2)

[17]

2.2 The diagram below illustrates some steps in the production of proteins. Study the diagram and answer the questions that follow.



[Source: Adapted from Spot on Life Sciences 2013, J. Avis et. al.]

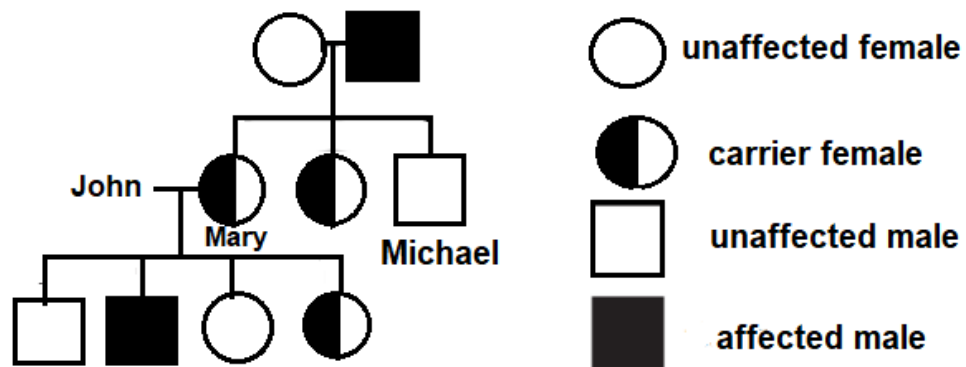
- 2.2.1 Name the organelle in which transcription takes place. (1)
- 2.2.2 Identify the following:
- a) Process Z (1)
 - b) Molecule X (1)
 - c) Molecule Y (1)
- 2.2.3 Give the definition for a *gene*. (2)
- 2.2.4 How many amino acids will be present in the protein produced if molecule X has 282 nitrogenous bases? (1)
- 2.2.5 Name the sequence of three consecutive bases on molecule Y. (1)

[8]

2.3 Read the following information on Duchenne muscular dystrophy and answer the questions that follow.

Duchenne muscular dystrophy (DMD) is one of the most severe forms of inherited muscular dystrophies and is a recessive sex-linked disorder. It is caused by a genetic problem in producing dystrophin, a protein that protects muscle fibres from breaking down when exposed to enzymes. Because the muscle weakness increases gradually over the years, complications eventually develop. The breathing or heart problems usually become more serious for older teenagers or people in their 20s. In the past, most people with DMD did not live beyond their early 20s. Improvements in treatment have meant that life expectancy has increased. At present, average life expectancy for people with DMD is 27 years.

The diagram below illustrates the inheritance of Duchenne muscular dystrophy.



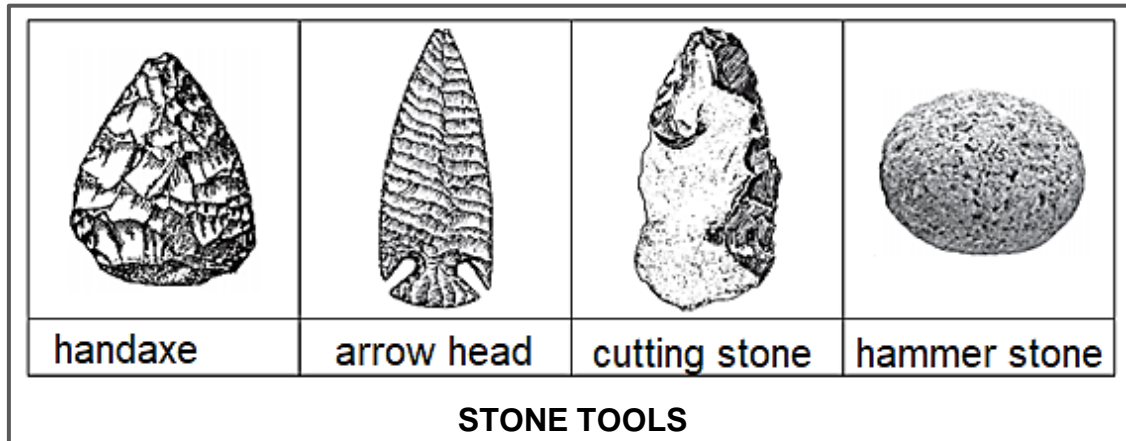
FAMILY TREE OF THE INHERITANCE OF DMD

[Source: <https://patient.info/childrens-health/duchenne-muscular-dystrophy-leaflet>, edited 26 November 2020; Examiner's own data.]

- 2.3.1 Explain why there are fewer females than males that suffer from Duchenne dystrophy. (3)
- 2.3.2 Explain why Michael does not have DMD even though his father suffers from the disease. (2)
- 2.3.3 Use a genetic cross to show the possible genotypes and percentages phenotypes of the offspring produced by **Mary** and **John**. Use the letter **D** for the unaffected allele and the letter **d** for the affected allele. (6)
- 2.3.4 The cells from foetuses can be tested to determine whether they have the genetic mutation responsible for DMD. If they do, the baby is likely to develop DMD at some stage after birth. Explain why expecting parents with a family history of DMD will be advised to perform this pre-natal test. (2)

[13]

2.4 The diagram below illustrates different stone tools that were discovered at different archaeological sites. Study the diagram and answer the questions that follow.



[Sources: Adapted from www.semanticscholar.org/paper/Human-Evolution-and-Human-History]

- 2.4.1 Identify the stone tool that was made most recently. (1)
- 2.4.2 Name TWO physical features that enabled early humans to produce the tool mentioned in QUESTION 2.4.1. (2)
- 2.4.3 Name the type of evidence for human evolution when non-genetic processes of adaptations e.g., development of tool making is used. (1)
- 2.4.4 Explain how the following tools helped the early humans to survive:
- a) cutting stone. (2)
 - b) hammer stone. (2)
- 2.4.5 Mitochondrial DNA can be used as evidence for human evolution. Explain TWO reasons why mitochondrial DNA is used rather than nuclear DNA. (4)

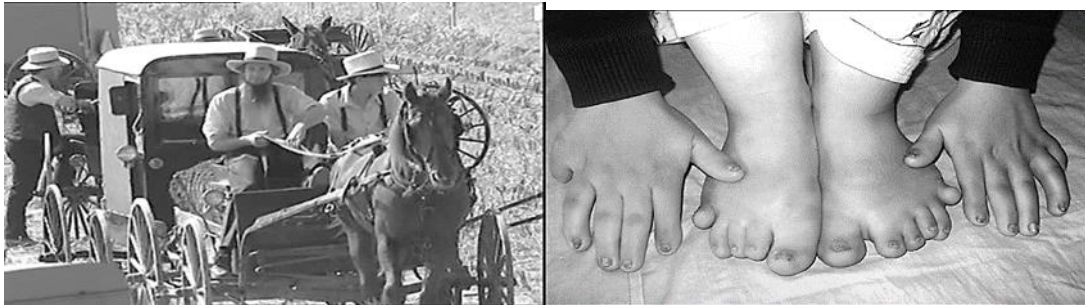
[12]

TOTAL QUESTION 2: [50]

QUESTION 3

3.1 Read the following information on the Amish community and answer the questions that follow.

The Amish is a group of people who live in America. This group was founded by 30 Swiss people, who moved to America many years ago. The Amish do not usually marry people from outside their own group. One of the 30 Swiss founders had a genetic disorder called Ellis-van Creveld (EVC) syndrome. This syndrome is caused by a mutation on chromosome 4 that leads to the production of a protein that has one amino acid missing. People with this disorder have heart defects, are short and have extra fingers and toes. In America today, about 1 in 200 Amish people is born with Ellis-van Creveld syndrome. This disorder is very rare in people in America who are not Amish and in most parts of the world it occurs in 1 in 60 000 to 200 000 new-borns.



Pictures showing the Amish and the extra fingers and toes of an EVC Sufferer

[Source: www.medlineplus.gov/genetics/condition/ellis-van-creveld-syndrome;
www.forgottendiseases.org/assets/EllisVanCreveld.]

- 3.1.1 Give the definition of a *mutation*. (2)
- 3.1.2 Give evidence from the text that Ellis-van Creveld syndrome is an autosomal disorder. (1)
- 3.1.3 Calculate the percentage of Amish children born with Ellis-van Creveld syndrome. (2)
- 3.1.4 The high occurrence of Ellis-van Creveld in the Amish community is due to inbreeding.
 - a) Explain the reason for inbreeding in the Amish community. (2)
 - b) Explain why inbreeding will increase the occurrence of Ellis-van Creveld syndrome. (2)

[9]

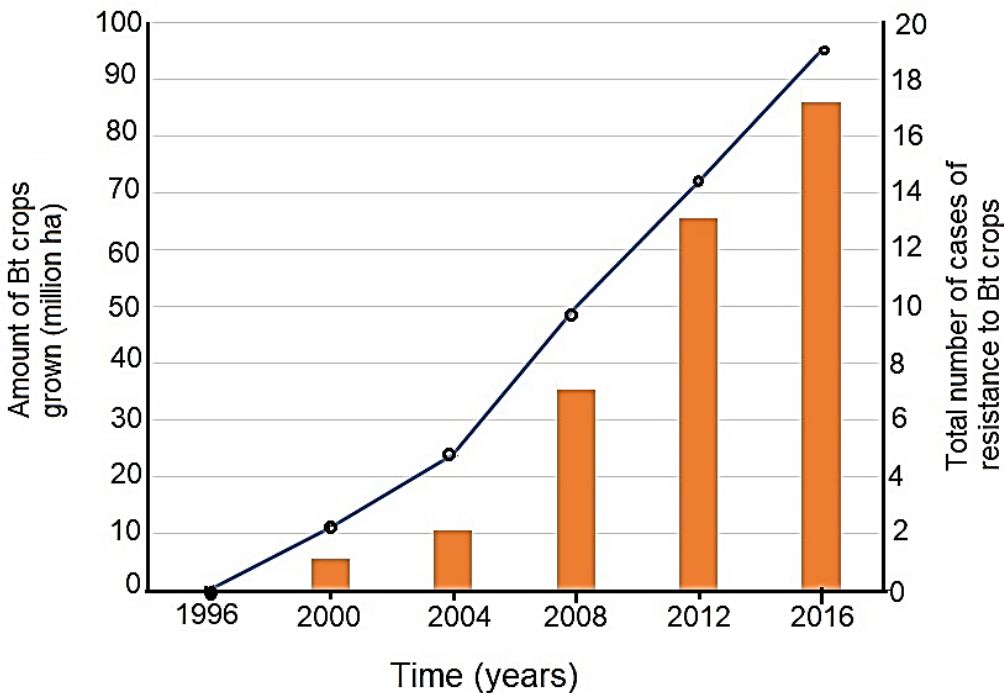
3.2 Read the following information about the evolution of insects to develop resistance and answer the questions that follow.

In 1996 USA farmers were introduced to commercial maize that was genetically engineered with resistance to maize pests. In 2003 another genetically engineered maize was introduced that killed corn rootworm larvae. These genetically engineered maize produce proteins or toxins derived from the soil bacterium, *Bacillus thuringiensis* (Bt), hence the common name "Bt maize". The bacterium secretes specific proteins known as "cry proteins" that are toxic to insects. When an insect feeds on the transgenic plants, the toxic cry protein present in the plants crystallizes the digestive system of insects, eventually leading to its death. However, it has no harmful effects on the human digestive system. Bt crops include potatoes, sweet corn, brinjal, cotton, etc.

But the benefits of Bt crops have been reduced by the evolution of resistance in pests. In the USA several maize pests have developed Bt resistance including the corn earworm and the western corn rootworm. The graph below illustrates the occurrence of Bt resistance.



GRAPH TO ILLUSTRATE THE OCCURANCE OF Bt RESISTANCE



Key
 Line graph: Amount of Bt crops
 Bar graph: Number of cases of resistance

[Source: www.nature.com/articles/nbt.3974: Surge in insect resistance to transgenic crops and prospects for sustainability; www.nature.com/scitable/knowledge/library/use-and-impact-of-bt-maize-46975413/]

3.2.1 Draw a table to illustrate the data from the graph. (6)

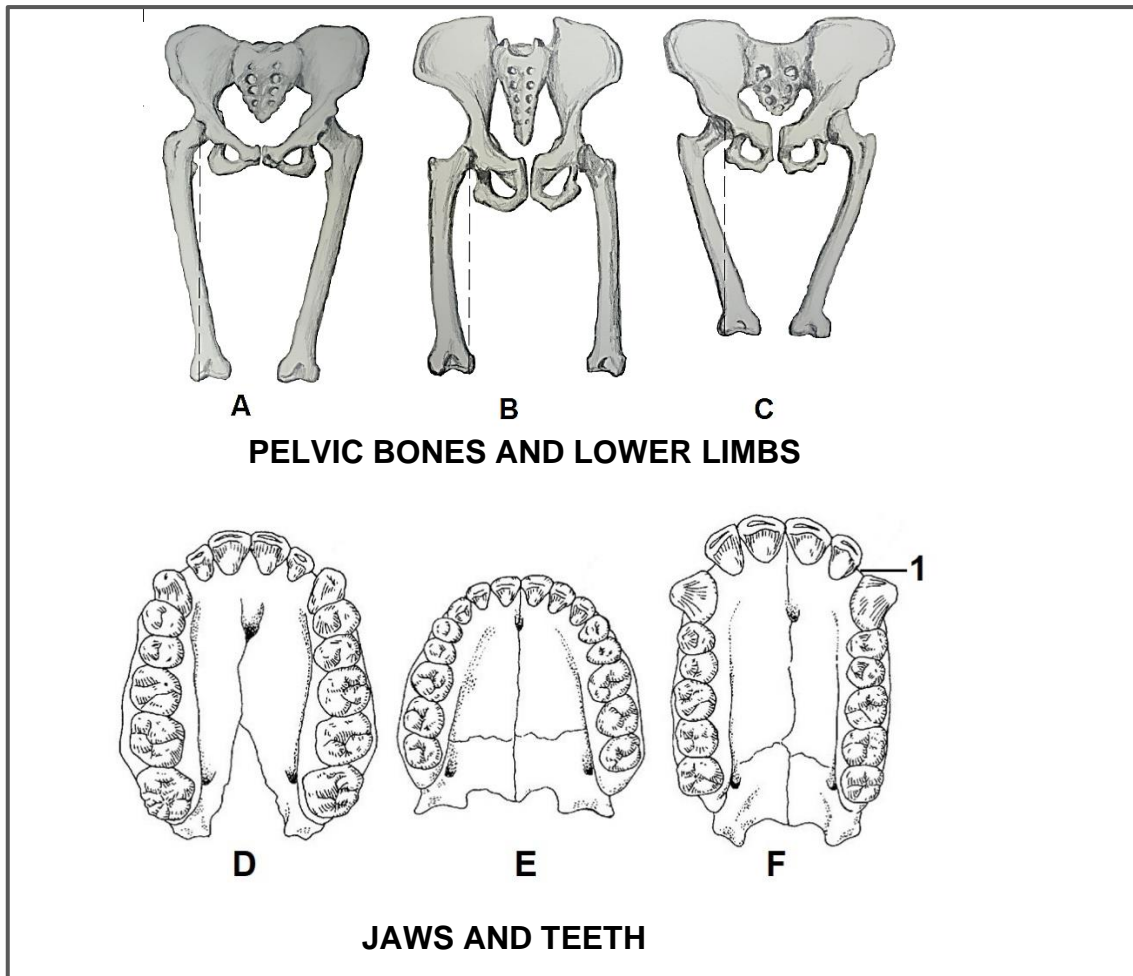
3.2.2 Describe ONE conclusion you can make from the data in the table. (2)

3.2.3 Describe how Darwin's theory can be used to explain the evolution of the pests to become resistant against the toxins produced by the Bt crops. (6)

3.2.4 Explain how the use of GM crops can limit negative effects of farming on the environment. (2)

[16]

3.3 The diagram below illustrates the pelvic bones and upper jaws of different primates. Study the diagrams and answer the questions that follow.



[Sources: www.milnepublishing.geneseo.edu/the-history-of-our-tribe-hominini/; www.researchgate.net/figure/Comparison-of-the-human-and-ape-foot-from-Schultz-]

3.3.1 Identify which one of the pelvic bones and lower limbs (**A to C**) belongs to an animal that is fully quadrupedal. (1)

3.3.2 Give TWO reasons to support your answer to QUESTION 3.3.1. (2)

3.3.3 Name THREE ways how bipedalism assists in the evolution of modern humans. (3)

- 3.3.4 Identify which one of the pelvic bones and lower limbs (**A to C**) belongs to an *Australopithecine*. (1)
- 3.3.5 The structure labelled **1** is an opening between the teeth.
 a) Identify the opening labelled **1**. (1)
 b) Explain why opening **1** occurs in the jaw labelled **F**. (2)
- 3.3.6 Identify the jaw (**D to F**) that belongs to *Homo sapiens*. (1)
- 3.3.7 Give TWO reasons for your answer to QUESTION 3.3.6. (2)


[13]

- 3.4 Read the following information on Candy floss grapes and answer the questions that follow.

Candy Floss grapes

Cotton Candy grapes are a variety of sweet white table grapes whose flavour has been compared to cotton candy. The grapes were developed by horticulturist David Cain. The grapes are produced in California by grower Grapery, which began selling them in 2011.

David attended a trade show in 2001 where researchers from the University of Arkansas were showing grapes. One was a purple Concord grape that tasted sweet like cotton candy but was fragile with tiny seeds. David licensed that grape and began working to improve the size and texture by crossbreeding the grapes with sturdier California grapes. He hand pollinated to cross pollinate millions of grapes to combine the sweet Concord grapes with common grapes in order to make them firmer. Pollen from male grape flowers was extracted and brushed onto the female clusters of the target plant. Over twelve years, a hundred thousand plants were created and grown in test tubes before developing the Cotton Candy variety of grape. The grapes were patented and are widely available at more than twice the price of normal grapes.



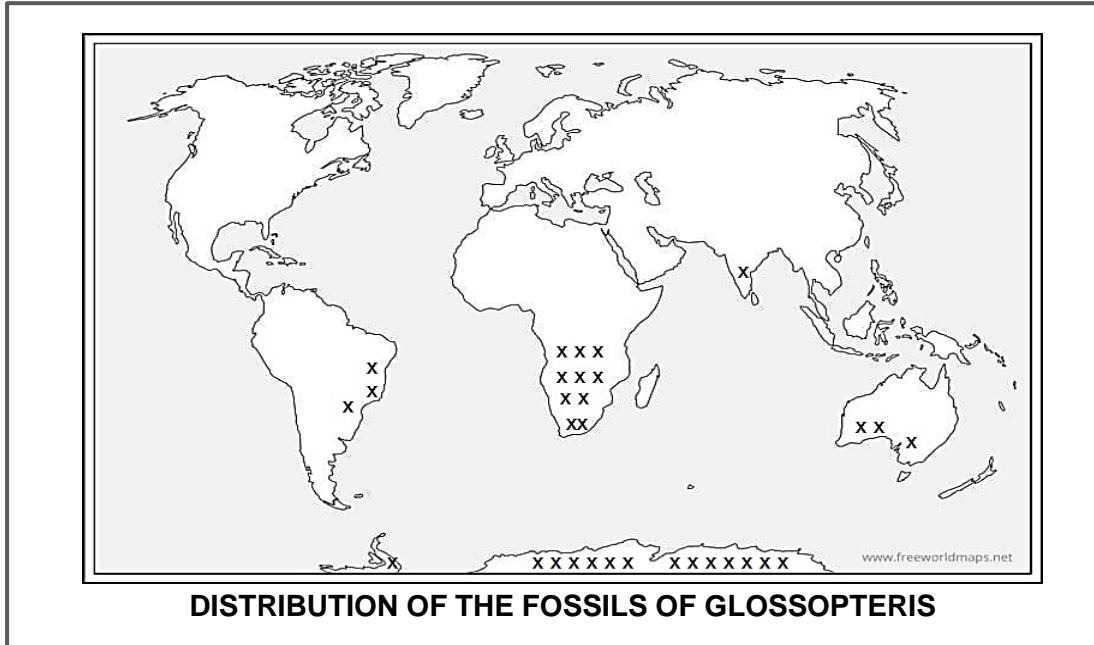
[Source: wikipedia.org/wiki/Cotton_Candy_grapes]

- 3.4.1 Identify the process by which David Cain developed Candy Floss grapes. (1)
- 3.4.2 The process mentioned in Question 3.4.1 differs from the process of genetic engineering. Explain how the process of creating Candy Floss grapes differs from genetic engineering. (2)
- 3.4.3 Explain why scientists today would rather use genetic engineering than the process used by Cain. (2)

3.4.4 Novelty fruit like Candy Floss grapes is very expensive. Do you agree with the development of novelty fruit? Explain ONE reason for your opinion. (2)

[7]

3.5 The diagram below illustrates the distribution of the fossils of *Glossopteris*, an extinct plant species. Study the map and answer the questions that follow.



[Source: Adapted from www://ucmp.berkeley.edu/education/explorations/tours/stories]

3.5.1 Identify the type of evidence for evolution that is illustrated on the map. (1)

3.5.2 Describe how scientists will explain the distribution of *Glossopteris*' fossils over the world. (3)

3.5.3 Name ONE group of organisms that share a common ancestry and of which the current distribution is due to the same phenomenon that caused the distribution of *Glossopteris*. (1)

[5]

TOTAL QUESTION 3: [50]

TOTAL SECTION B: [100]

GRAND TOTAL: [150]