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TOTAL MARKS

NATIONAL SENIOR CERTIFICATE EXAMINATION
 NOVEMBER 2024

LIFE SCIENCES: PAPER I

EXAMINATION NUMBER

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Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 40 pages. Please check that your question paper is complete.
2. Read the questions carefully.
3. **Answer ALL the questions on the question paper in the spaces provided and hand it in at the end of the examination. Remember to write your examination number in the space above.**
4. Use the total marks that can be awarded and the space provided for each question as an indication of the detail required.
5. It is in your own interest to write legibly and to present your work neatly.
6. Two blank pages (pages 38–39) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the number of your answer should you use this extra space. There is a spare copy of graph paper on page 40.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

	Q1	Q2	Q3	Q4	Total
Mark					
Marker Initial					
Moderated Mark					
Moderator Initial					
Question Total	80	40	40	40	200
Re-mark					
Initial					
Code					

QUESTION 1

- 1.1 Select the term in Column B that best matches the description in Column A. Write the letter of the term in the space provided between the brackets. Each letter may be used only once.

COLUMN A	COLUMN B
[] The individuals within a colony of social animals that perform a specialised role.	A Limiting factor
[] The type of competition between individuals of the same species.	B Ecological footprint
[] A measure of how dependent humans are on natural resources.	C Immigration
[] The role an organism plays in a community.	D Castes
[] The maximum population size of a species that can be sustained in a specific environment.	E Mortality
[] A resource that is in short supply.	F Census
[] A method of directly counting all individuals in a population.	G Interspecific
[] The movement of individuals into a population.	H Emigration
[] The type of competition between individuals of different species.	I Carrying capacity
[] A measure of the number of deaths in a population.	J Ecological niche
	K Intraspecific

(10)

1.2 Six multiple-choice questions follow. Choose the most correct option for each question and write the letter of your choice in the space provided in the table below.

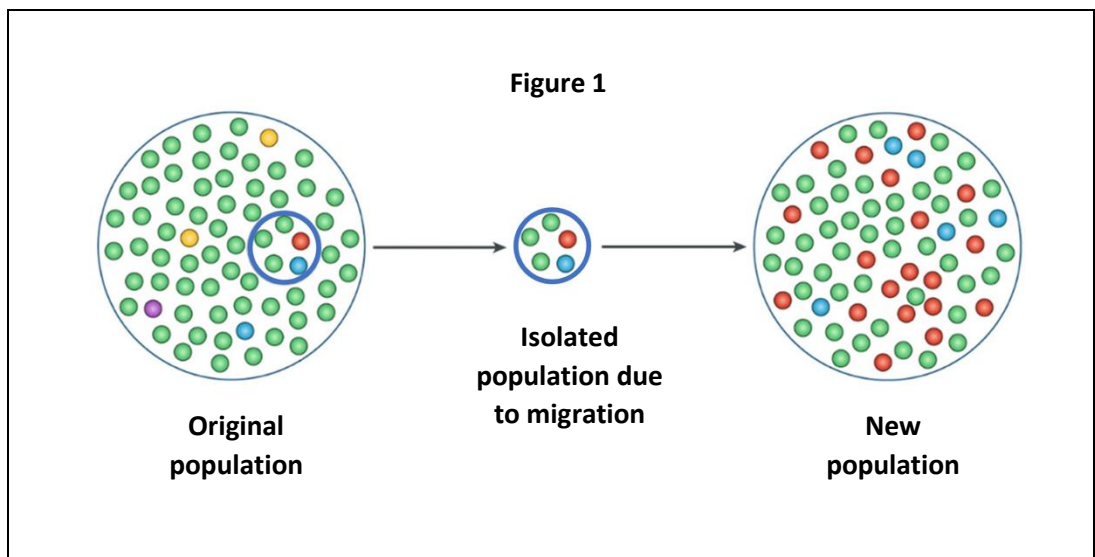
Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5	1.2.6
Answer						

1.2.1 Which concept describes evolution occurring at a slow, constant rate?

- A Macroevolution
- B Natural selection
- C Punctuated equilibrium
- D Gradualism

(1)

1.2.2 The following question is based on Figure 1 below.



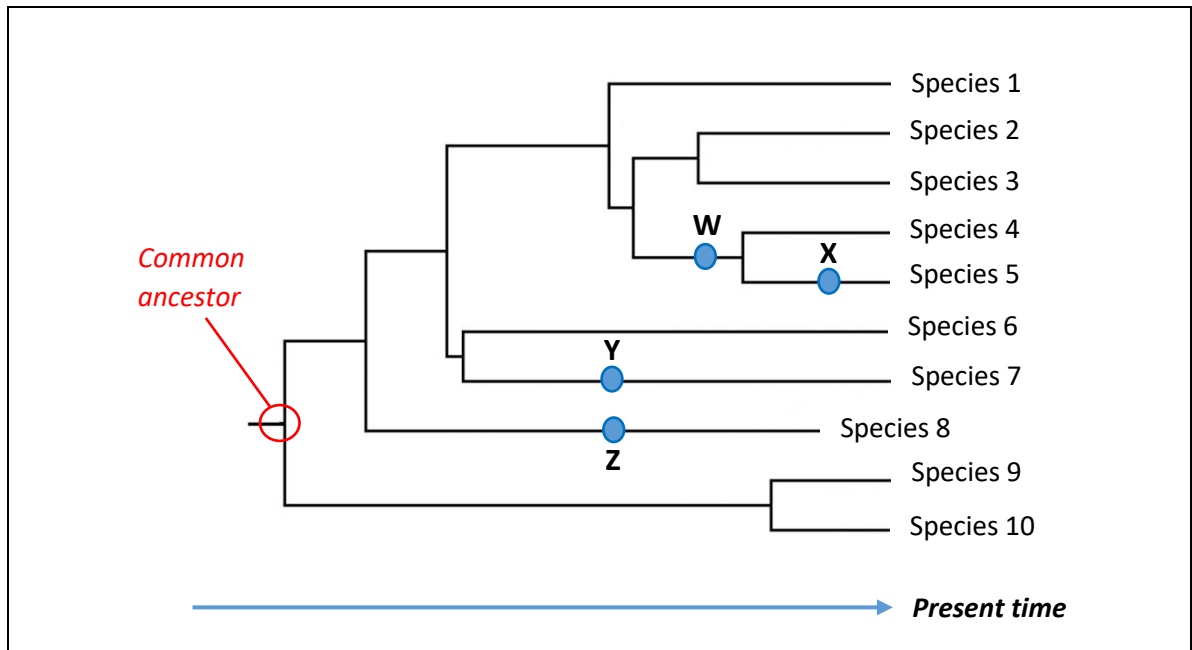
[Adapted: <<https://pbs.twimg.com/media/ErdN9LNxcAAYDeX.jpg:large>>]

Which option correctly describes the process shown in Figure 1?

- A Outbreeding
- B Microevolution
- C Founder effect
- D Convergent Evolution

(1)

Questions 1.2.3 to 1.2.5 are based on the phylogenetic tree below. The different species are represented by numbers.



[Image: <Examiner's own>]

1.2.3 Which statement is TRUE regarding species 8?

- A Species 8 evolved after species 9.
 - B Species 8 is extinct.
 - C Species 8 is the closest relative to species 4.
 - D Species 9 and 10 evolved from species 8.
- (1)

1.2.4 A new species (species 11) has been discovered. The evidence indicates the following:

- Species 11 is closely related to species 7.
- Species 11 evolved at the same time as species 1.

At which point would scientists place species 11 on the phylogenetic tree?

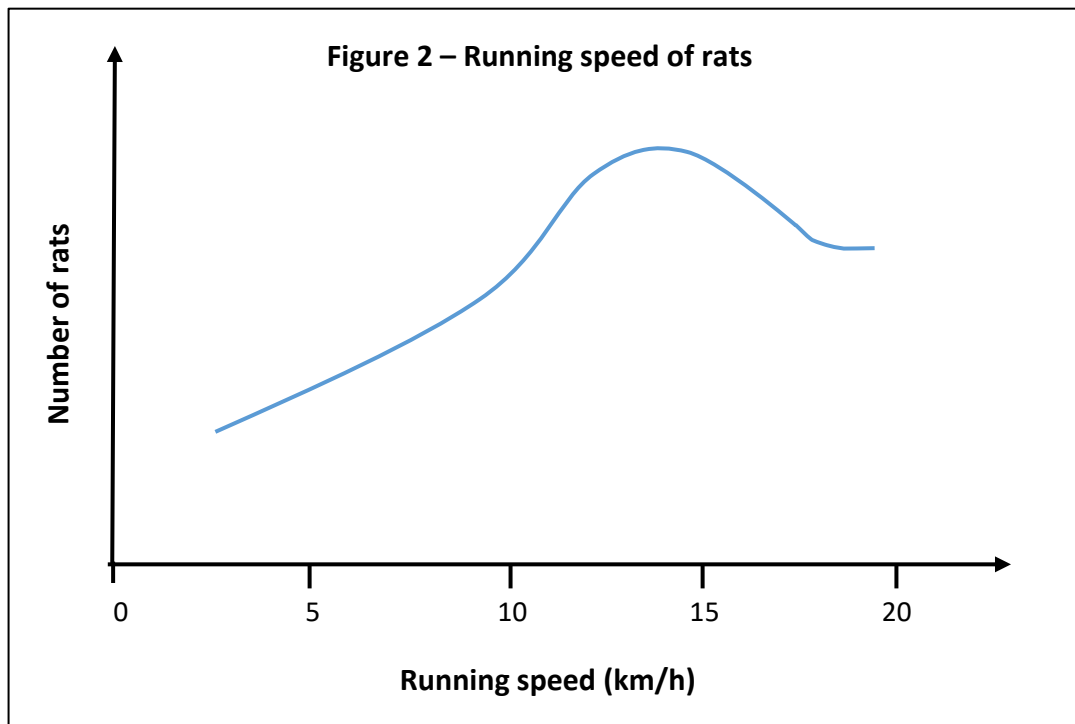
- A W
 - B X
 - C Y
 - D Z
- (2)

1.2.5 Which statement best describes a relationship between the common ancestor and species 1 to 10 in the phylogenetic tree?

- A The common ancestor is most closely related to species 9 and species 10.
- B Species 1 to 10 will have exactly the same DNA as the common ancestor.
- C Species 8, 9 and 10 were the first species to evolve from the common ancestor.
- D The common ancestor will have segments of DNA that are also present in species 1 to 10.

(2)

1.2.6 Variations in the running speed of a rat population are represented in Figure 2 below. The highest running speed of a top predator of the rats is 10 km/h.



[Image: <Examiner's own]

Which statement describes the **rats** with running speeds of 12 km/h and higher?

- A These individuals are more likely to survive, reproduce and increase the number of rats with fast running speeds in the population.
- B These individuals are fast because the predator caused them to acquire mutations that increase running speed.
- C These individuals represent a very small number in the population.
- D These individuals only produce offspring with running speeds lower than 12 km/h.

(2)

1.3 1.3.1 Study the following table that consists of rows with a statement in the first column and TWO items (numbered 1 and 2) in the second column. Decide which item(s) relate to the statement. Write down your choice in the space provided in the Answer column, using the following codes:


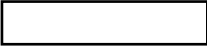

- 1** Only item 1 relates to the statement.
- 2** Only item 2 relates to the statement.
- Both** Both items 1 and 2 relate to the statement.
- None** Neither item 1 nor item 2 relates to the statement.

Statement	Item	Answer
A genotype that increases genetic variation.	1. Heterozygous 2. Homozygous	
A single set of chromosomes in a cell.	1. Haploid 2. Diploid	
Possessing more than two complete sets of chromosomes.	1. Hybrid vigour 2. Polygenic	
Scientist(s) that discovered the shape of the DNA molecule.	1. Gregor Mendel 2. James Watson	
Vector used to deliver genetic material into an organism.	1. Plasmid 2. Virus	

(5)

1.3.2 Use the key provided to draw a diagram of a single unit (monomer) of DNA in the space below. Label all parts.

Key:

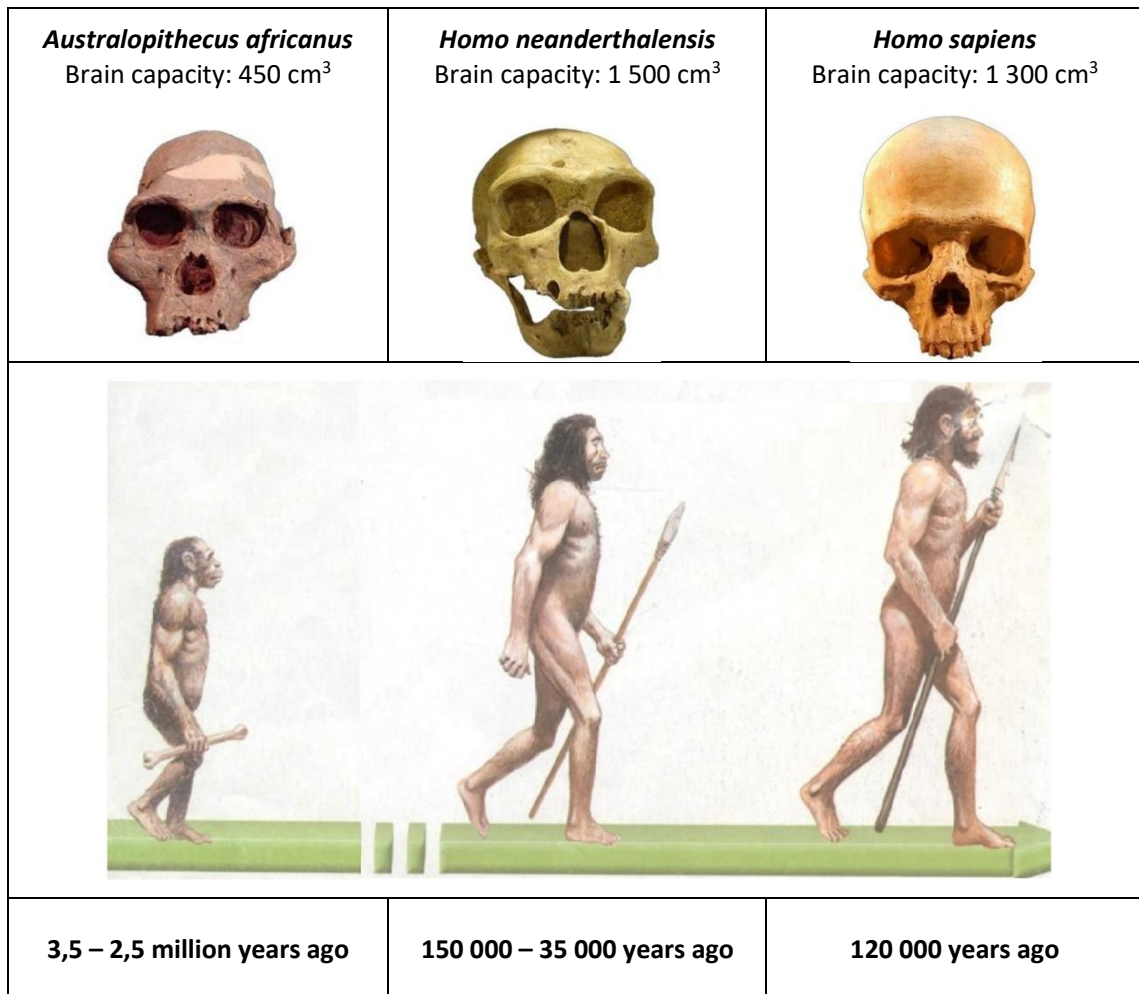
Name of molecule	Sugar	Nitrogenous base	Phosphate
Shape of molecule			

- Provide a heading to name the DNA monomer.
- Provide the name of a nitrogenous base found only in DNA in your diagram.

(3)

1.4 Study the infographic (Figure 3) below on hominids and answer the questions that follow. Note: The skulls are not to scale.

Figure 3 – Image of three hominids and their skulls



[Adapted: <<https://i.pinimg.com/originals/2d/5a/25/2d5a25149906b3b503de0d4fe5681ed4.jpg>> and <https://msjoconnor.weebly.com/uploads/2/3/9/1/23919811/d3ii._humanevolution.pdf>]

1.4.1 The statements in the table below refer to the infographic. For each statement decide whether:

- A** The statement is supported by the information.
- B** The statement is contradicted by the information.
- C** The statement is neither supported nor contradicted by the information.

	Statement	A, B or C
(a)	<i>Australopithecus africanus</i> has longer arms than legs.	
(b)	<i>Homo neanderthalensis</i> had the ability for language communication.	
(c)	<i>Homo neanderthalensis</i> and <i>Homo sapiens</i> did not exist at the same time.	

(3)

1.5 1.5.1 Consider the list below of various cultural developments in hominid evolution:

- A** Used only simple stone tools.
- B** Wore clothing and made ornamental/symbolic objects.
- C** Complex language.
- D** First to use and control fire for cooking and hunting.

Fill in the following table by writing TWO letters of correct cultural developments that apply to each of the hominid species in the table. Each letter may only be used ONCE.

Hominid name	Letters
<i>Homo sapiens</i>	
<i>Homo erectus</i>	

(4)

1.5.2 Why was the use and control of fire an important step in hominid cultural evolution?

(4)

1.6 Read the information in the textbox below on the population of South Africa and then use it to answer the questions that follow.

Facts about the population of South Africa

- Population in 2023: **60 710 077**.
- South Africa's population is equivalent to **0,75%** of the world's population.
- The fertility rate in 1960 was **6,16**.
- The fertility rate in 2023 was **2,32**.
- The fertility rate in 2050 is forecasted to be **1,93**.

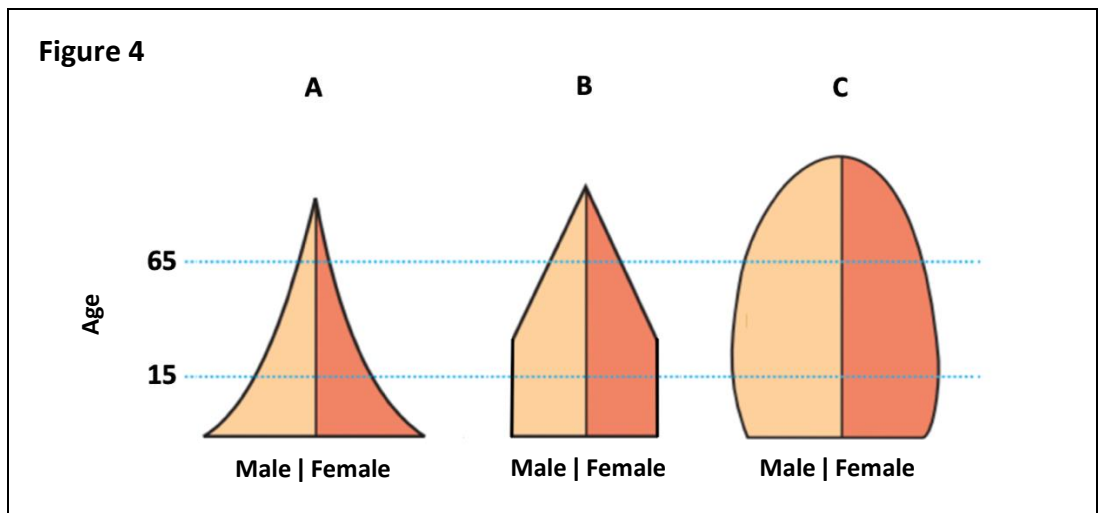
The fertility rate is defined as the number of live births per 1000 women in the total population in one year.

[Source: <<https://www.worldometers.info/world-population/south-africa-population/>>]

1.6.1 Using the information provided, calculate the total world population. Show all working.

(2)

1.6.2 Consider the examples of three types of population pyramids shown in Figure 4 below:



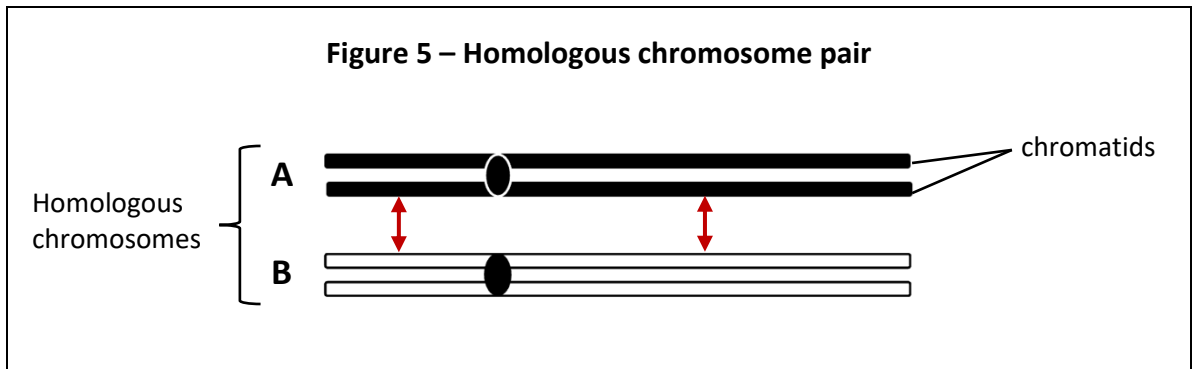
[Adapted: <https://vediphlie-aws.s3.ap-south-1.amazonaws.com/Types_of_Pyramid_b2a72f710a.PNG>]

Write the letter of the population pyramid in the table below (A, B, or C) that most accurately represents the population of South Africa in 2050 and 1960.

Year	A, B, or C
2050	
1960	

(2)

1.7 Figure 5 below shows a diagram of a homologous chromosome pair. Refer to it and your own knowledge to answer the questions that follow.



[Source: <Examiner's own>]

1.7.1 Name two types of molecules that make up the structure of a chromosome.

(2)

1.7.2 List TWO criteria needed for two chromosomes to be considered an 'homologous chromosome pair'.

(2)

1.7.3 Name the process that occurs to form an identical chromatid of a chromosome.

(1)

1.7.4 The red arrows shown in Figure 5 indicate the points where crossing over will occur.

(a) Why is the process of crossing over important?

(1)

- (b) Draw the resultant homologous chromosome pair AFTER crossing over, as shown in Figure 5, has taken place. (No heading required.)

(4)

- (c) Construct a flow chart to describe the sequence of events that occur in the chromosome pair after crossing over is completed to the end of meiosis I only. (No drawings required.)

(5)

1.8 Read the information below and answer the questions that follow.

During meiosis, errors can occur that change the chromosome number in cells. This can lead to chromosomal abnormalities, such as Down's syndrome. Down's syndrome is a result of an extra number 21 chromosome. This additional chromosome 21 causes delays in physical and intellectual development in affected individuals.

In 1983, the life expectancy for people born with Down's syndrome was 25 years. Today, the life expectancy is 55 years.

Table 1 – Incidence of Down's syndrome in the world

Category	Incidence of Down's syndrome
More Developed Countries	1 in 1000 live births
Less Developed Countries	1 in 650 live births
South Africa	Approximately 1 in 500 live births

[Source: <<https://www.downsyndrome.org.za/facts-about-down-syndrome/>>]

[Adapted: <<https://www.westerncape.gov.za/general-publication/learn-more-about-down-syndrome/>>]

1.8.1 Give one reason why the life expectancy for people with Down's syndrome may have increased.

(1)

1.8.2 Suggest one way in which a person with Down's syndrome would be affected negatively in society.

(1)

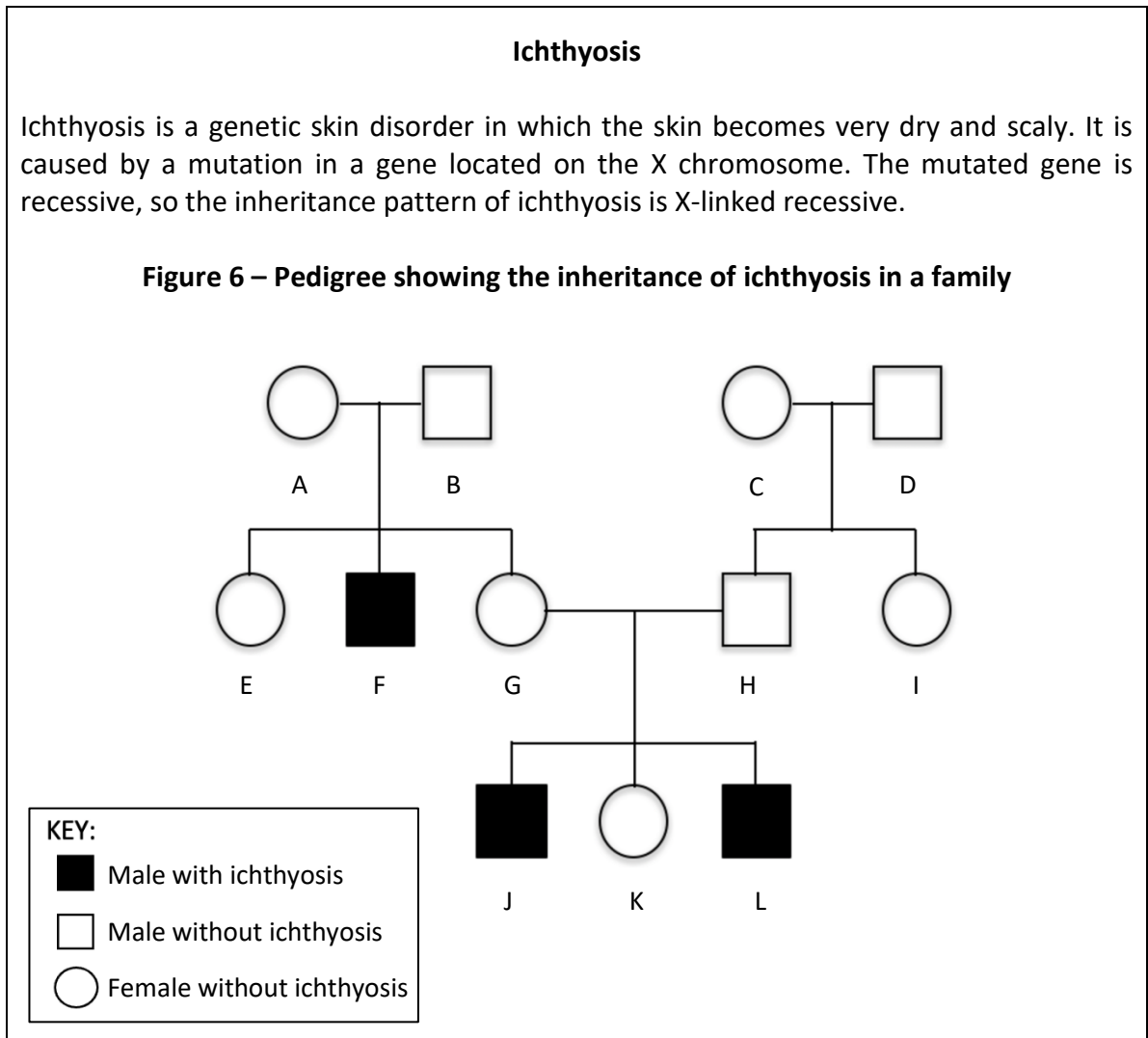
1.8.3 (a) Why would the South African health authorities be concerned about the data in Table 1?

(1)

(b) Suggest one way this data affects the lives of people in South Africa that are impacted by Down's syndrome.

(1)

1.9 Read the information below and study Figure 6. Use this information and your own knowledge to answer the questions that follow.



[Adapted: <<https://rarediseases.org/rare-diseases/ichthyosis-x-linked/>>]
 [Image adapted from: <<https://community.gep.wustl.edu/fragilex/image/pedigree.png>>]

1.9.1 Which type of chromosome listed below has the locus for the gene causing ichthyosis? Write the correct **number** in the box provided.

1	Autosome
2	Gonosome

(1)

1.9.2 Where are chromosomes located in a cell?

(1)

1.9.3 Complete the genetic cross below between individuals G and H from the pedigree chart (Figure 6).

Use the following key:

X^A – Normal

X^a – Mutation for ichthyosis

Phenotype of Parent G: _____

Phenotype of Parent H: _____

Genotypes: Parent G × Parent H:

Punnett diagram:

<i>Gametes</i>	↓	→		

(6)

1.9.4 What is the probability of parents G and H having a child with ichthyosis?

(1)

1.9.5 Explain why individual F in Figure 6 cannot pass ichthyosis on to any male children.

(3)

1.9.6 Individual A in Figure 6 is termed a 'carrier' of the ichthyosis gene. What is meant by the term 'carrier' in this example?

(2)

[80]

QUESTION 2

2.1 Consider the names listed below of the four scientists whose ideas have contributed to evolutionary theory:

- Jean Baptiste Lamarck
- Alfred Wallace
- Charles Darwin
- Erasmus Darwin

2.1.1 Write the name of the person that best matches the role that their idea contributed in the development of the theory of evolution in the table below.

	Role in development of evolutionary theory	Name of contributor
(a)	The scientist that first described that species changed over time and that all species share a common ancestor.	
(b)	The scientist's research on the geographic distribution of animals in Southeast Asia provided critical support and contribution for the theory of natural selection.	
(c)	The scientist who described that species evolve due to the mechanism of natural selection after his studies on the Galápagos Islands.	
(d)	The scientist that suggested that organisms can pass traits onto their offspring that are acquired during their lifetime.	

(4)

2.1.2 The ideas that these scientists presented were not well received by society and the scientific community at that time. Suggest why the following groups would have responded negatively to the ideas presented by these scientists:

(a) society

(2)

(b) the scientific community

(2)



2.2 Read the information below and use it and your own knowledge to answer the questions that follow.

The spotted hyena is a large carnivore that lives in Africa. Spotted hyena are social animals that live and hunt in groups.

Impalas are medium sized antelope. They are herbivores and they live in large groups known as a herd. They roam the savannah and woodlands of eastern and southern Africa. The impala is hunted and eaten by the spotted hyena.

Study the data in Table 2 below which shows the numbers of spotted hyena and impala in a small protected private game reserve in South Africa.

Table 2

Time (year)	Number of animals	
	Spotted hyena 	Impala 
2010	11	16
2012	14	58
2013	20	60
2015	20	50
2016	11	56
2018	17	48
2019	17	46

[Table: Examiner's own hypothetical data]

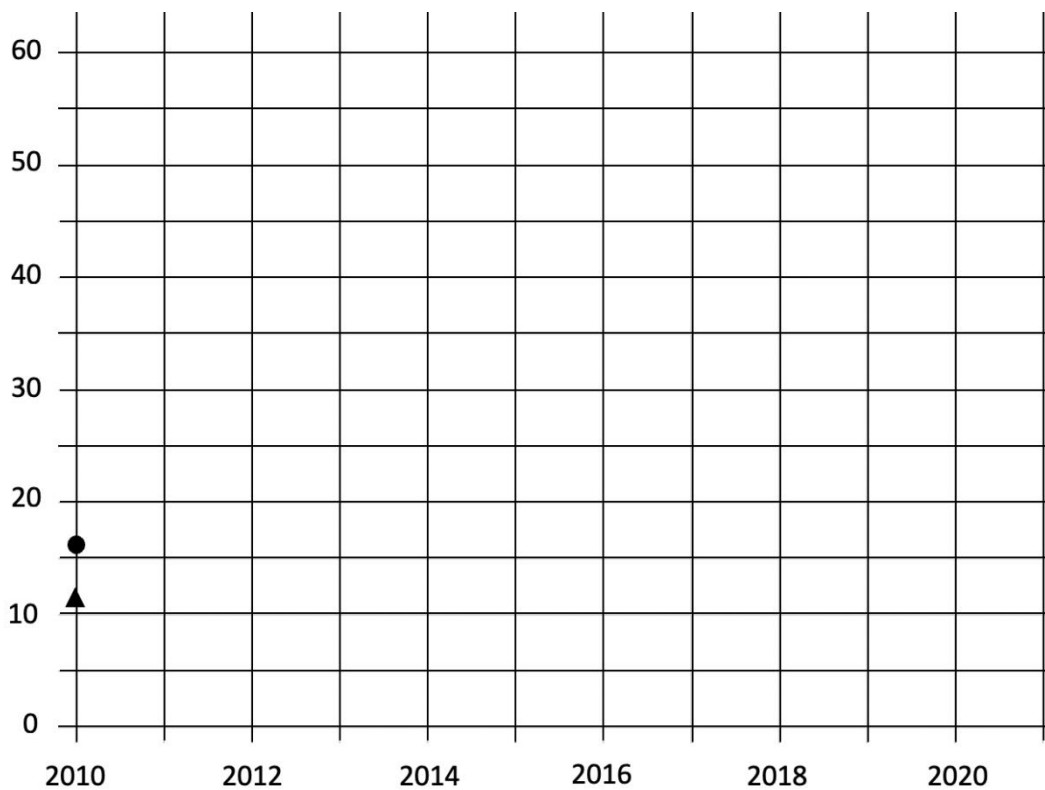
[Images: <https://upload.wikimedia.org/wikipedia/commons/b/be/Grazing_Impala_%28200668815%29.jpeg> and <https://images.rawpixel.com/image_800.jpg>]

2.2.1 Complete the graph below by using data from Table 2.

Include the following:

- Plot the remaining data points.
- Add the labels for the axes.
- Complete the key in the space provided.
- Provide a suitable heading.

<p>Key:</p>



(7)

2.2.2 Name the relationship that exists between the impala and spotted hyena that is shown in the graph.

(1)

2.2.3 From the plotted graph, give the number of impalas in the game reserve in 2011.

(1)

2.2.4 Describe a strategy that a herd of impala may use to avoid predation.

(2)

2.2.5 Why is it necessary for a country to have protected areas such as game reserves?

(2)

2.2.6 In the small game reserve there is potential for inbreeding to occur within the hyena population.

(a) What is meant by the term *inbreeding*?

(2)

(b) Describe the disadvantages of inbreeding.

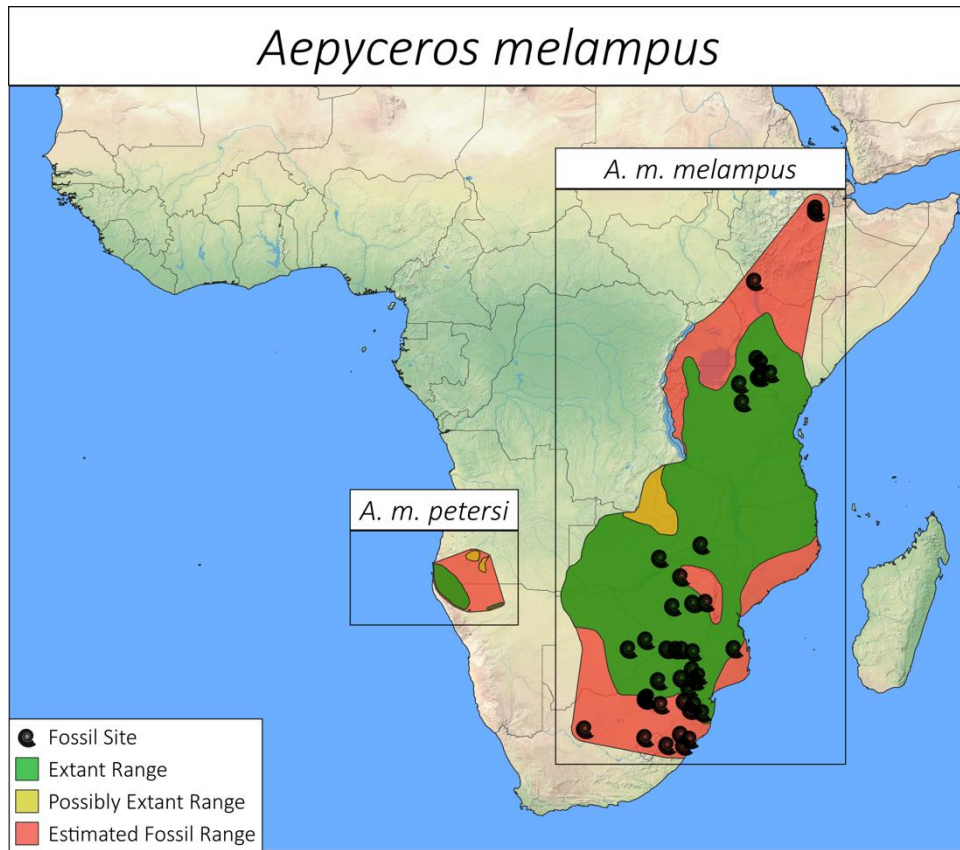
(4)

2.3 Read the information below and answer the questions that follow.

There are two distinct groups (subspecies) of impala — the black-faced impala (*Aepyceros melampus petersi*) and the common impala (*Aepyceros melampus melampus*). Black-faced impala have darker fur (particularly around the face) and are larger than common impala. Impalas of both subspecies have a total of 60 chromosomes ($2n = 60$).

Historically, black-faced impala occurs as an isolated population in southwest Africa, more than 900 kilometres west of the common impala range. Due to the small herd size of black-faced impala, common impala have been introduced from South Africa into the black-faced impala herds on Namibian game farms to help increase population size. These farms, with both black-faced impala and common impala, have reported breeding occurring between individuals from these two groups in the mixed herds.

Figure 7 – Map of Africa showing distribution of the two groups of impalas



***Subspecies:** a group within a species that has become either physically and/or genetically different from the rest of the group but are still similar enough to interbreed

***Extant:** still in existence; surviving

[Adapted: <<https://academic.oup.com/jhered/article/97/2/119/2187572>> and http://the-eis.com/elibrary/sites/default/files/downloads/literature/Are%20black_faced%20and%20common%20impala%20interbreeding%20in%20Etosha%20National%20Park.pdf and <<http://placentation.ucsd.edu/impala.html>>]

[Image: <https://images.squarespace-cdn.com/content/v1/5fbbf5363c8e8724072a6bc2/1629808056059-1JOOX9TTRJJQZSMYUP01/Aepyceros_melampus.png>]

2.3.3 Figure 7 indicates that there are many fossil sites of impala ancestors.

(a) How does the fossil record support the theory of evolution?

(2)

(b) List any THREE other lines of evidence that supports the theory of evolution.

(3)

[40]

QUESTION 3

3.1 Read the information below and answer the questions that follow.

Sea Anemones

Sea anemones are:

- predatory marine invertebrate animals
- soft bodied animals that attach to a hard surface such as rocks
- mostly stationary (but can detach from the rock surface and move if required).

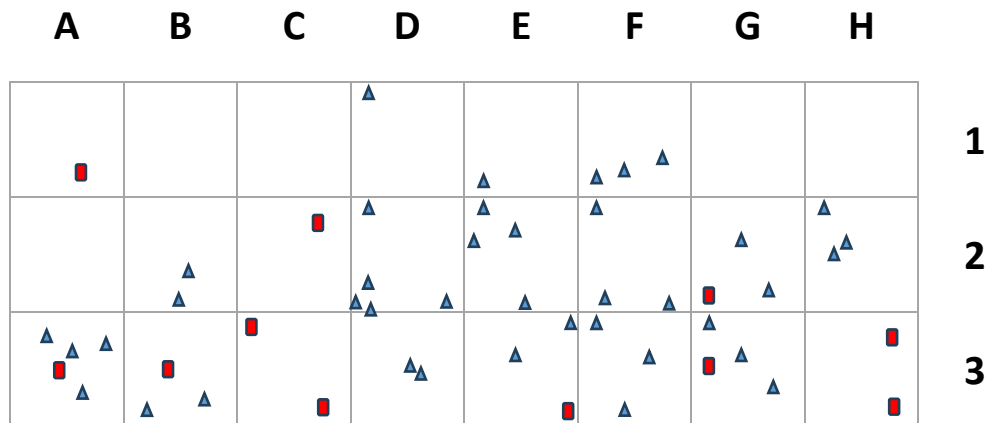


Figure 8 – Sea anemone attached to a rock

Two anemone species (X and Y) live in the rocky shores of a marine protected area. Species X and species Y feed off plankton and the larvae of other fish.

The quadrat method is used to estimate the size of these two sea anemone populations in the marine protected area. The total area is 2 400 m² (80 m × 30 m). The area was sectioned off into a grid pattern as seen in Figure 9 below. Each square in the grid pattern is considered a 'quadrat' and has an area of 100 m².

Figure 9 – Area that was sampled to determine sea anemone population size



Key:
 Species X: ▲
 Species Y: ■

[Adapted: <<https://www.aquarium.co.za/news/7-cool-anemone-facts-you-may-not-know>>]

[Figure 8: <https://upload.wikimedia.org/wikipedia/commons/f/fb/A_bright_pink_sea_anemone_-_panoramio.jpg>]

[Figure 9: <Examiner's own>]

3.1.1 Why is sea anemone species X considered a 'population' in this context?

(3)

3.1.2 Why is the quadrat method suitable to estimate the population size of sea anemones?

(3)

3.1.3 A biologist placed the letters A to H, and numbers 1 to 3 in separate containers. She asked her colleague to select a letter followed by a number from the containers. This was done three times. The selected quadrats were: B3, E2 and G3.

Refer to Figure 9.

(a) Would you consider the selection of the quadrats to be random? Explain your decision.

(2)

(b) What is the **average** number of species X for only the selected quadrats? (Quadrats B3; E2; G3)

(1)

- (c) Use the average number calculated in Question 3.1.3 (b) to determine the estimated population size for species X. Show all working.

(2)

- (d) The actual number of species X in the total area is 40. Evaluate the accuracy of the quadrat method compared to the direct count of species X. Give a reason for your opinion.

(3)

- 3.1.4 (a) State TWO density dependent factors for which individuals of species X would compete.

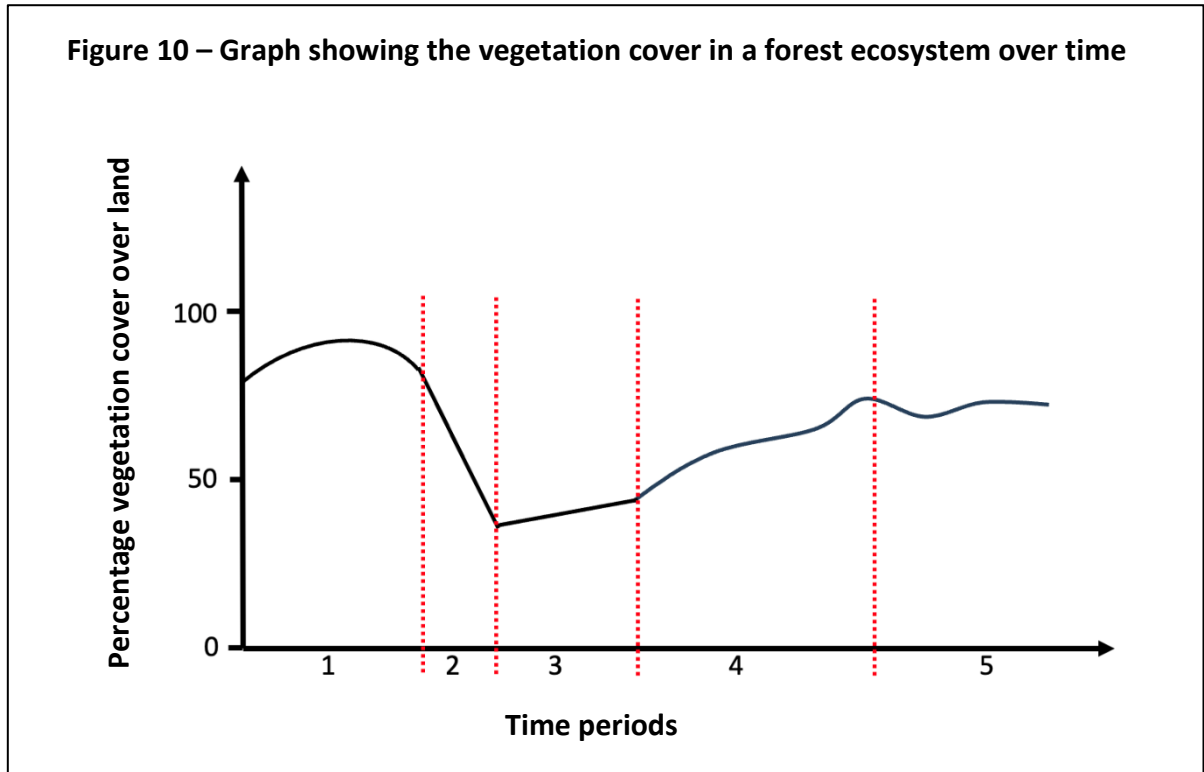
(2)

- (b) Although the sea anemone species X and Y compete with one another for resources, both species have healthy stable populations. Explain how they are able to coexist.

(2)

3.2 Illegal logging is the harvest, transportation, purchase or sale of timber (wood) against the laws of a country. It is prevalent in countries with tropical rainforests that have large well-established, mature trees.

Figure 10 below represents ecological succession after illegal logging took place in an indigenous forest ecosystem in a country. Note: the time axis is not to scale.



[Adapted: <https://www.researchgate.net/figure/Old-field-succession-on-Piedmont-and-four-stage-forest-succession-model-and-hypothesized_fig4_221912131>]

3.2.1 What is meant by the term *forest ecosystem*?

(2)

3.2.2 The ecosystem was disturbed by illegal logging. During which numbered time period in Figure 10 did this disturbance occur?

(1)

3.2.3 The authorities of a country planted various tree seedlings and sowed seeds on the land area where there had been illegal logging activities. This was done to promote the forest ecosystem to return to a normal/healthy condition after the disturbance of illegal logging.

(a) Would this strategy by the authorities be considered primary or secondary ecological succession? Give a reason for your answer.

(2)

(b) In which time period (1, 2, 3, 4 or 5) on the graph would the most number of pioneer organisms be present after the disturbance of illegal logging?

(2)

3.2.4 Why is it ethically correct for governments of countries to make it illegal to cut down trees in indigenous forests?

(3)

3.3 Read the information in the textbox below.

DNA analysis and forensic science can be used to fight environmental crimes – like illegal logging and the illegal timber trade in the same way that they have helped to solve serious crimes.

A few DNA sequences located in the genome of each forest tree species, can distinguish individual trees from one another. Such sequences are called DNA markers. DNA techniques to produce a DNA profile from a small sample rely on the polymerase chain reaction (PCR).

[Adapted: <<https://www.doublehelixtracking.com/news/providing-access-more-tools-help>>]

[Adapted: <https://www.researchgate.net/publication/259829353_Application_of_DNA_markers_against_illegal_logging_as_a_new_tool_for_the_Forest_Guard_Service>]

3.3.1 For each statement provided in the table below, give a term used in the textbox that best describes the statement.

Statement	Term
A nucleic acid.	
An enzyme used in PCR.	
An organism's complete set of genes.	

(3)

3.3.2 Why is PCR used in the process of producing a DNA profile?

(2)

3.3.3 Consider this statement from the text:

'DNA sequences located in the genome of each forest tree species, can distinguish individual trees from one another.'

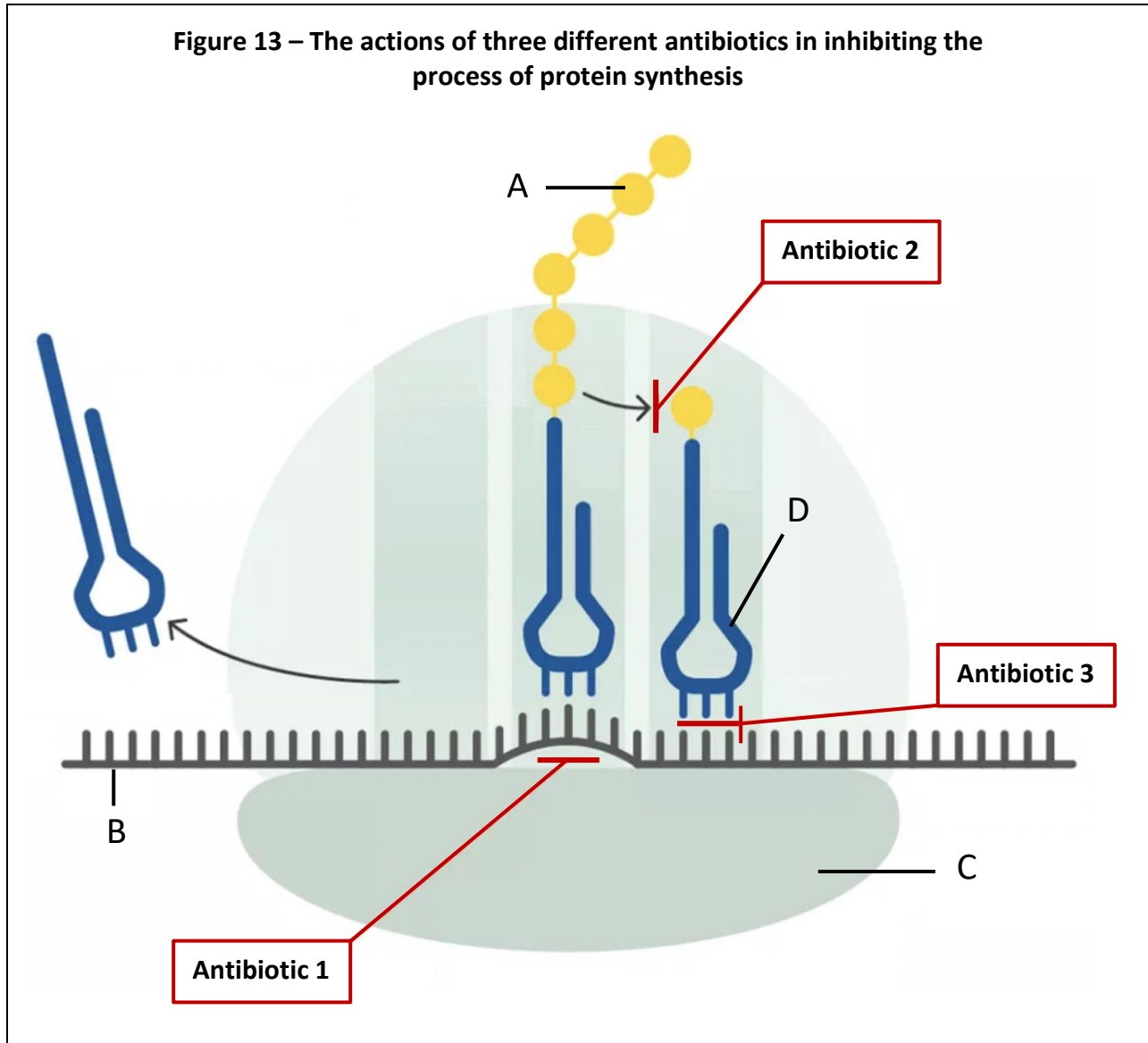
Explain what this statement means.

(3)

[40]

QUESTION 4

4.1 Figure 13 below shows where three different types of antibiotics (1, 2 and 3) may interfere in the process of protein synthesis in bacterial cells. Study Figure 13 and use it and your own knowledge to answer the questions that follow.



[Adapted: <<https://www.biomol.com/resources/biomol-blog/how-do-antibiotics-affect-protein-synthesis>>]

4.1.1 Identify the following structures shown in Figure 13:

(a) D: _____ (1)

(b) A: _____ (1)

(c) C: _____ (1)

4.2 Read the information below and use it and your own knowledge to answer the questions that follow.

Tuberculosis (TB) is a disease caused by bacteria that attack and damage the lungs. TB is a serious public health issue and is the leading cause of death in South Africa. About 450 000 people develop the disease every year. Most cases of TB respond well to the standard treatment of antibiotic medications. But failure in completing the course of antibiotics by TB patients has led to the development of multi-drug resistant TB (MDR-TB) and extreme drug resistant TB (XDR-TB).

Scientists have identified a wide range of mutations in various genes in the TB bacterial genome that are associated with resistance to the TB antibiotic medications. An example of a mutated section of a DNA sequence is shown in Figure 14 below that causes antibiotic resistance.

Figure 14 – DNA sequences in the genome of TB causing bacteria

Normal DNA sequence	T	A	C	G	A	C	A	G	C
Mutated DNA sequence	T	A	C	G	A	C	C	G	C

[Adapted: <<https://copenhagenconsensus.com/publication/south-africa-perspective-tuberculosis>> ; <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9062869>>]

4.2.1 Mutations are associated with the development of antibiotic resistance.

(a) State one factor that can cause a mutation.

_____ (1)

(b) (i) Name the type of mutation in Figure 14.

_____ (1)

(ii) Why would the mutated sequence in Figure 14 not change the length of the protein produced?

 _____ (1)

(c) Is this an example of a lethal, neutral or beneficial mutation for the species of bacteria causing TB? Explain your answer.

 _____ (2)

- 4.2.2 (a) Complete the table below to show the mRNA sequence that would be transcribed from the normal DNA sequence.

Normal DNA sequence	T A C G A C A G C
mRNA sequence	

(3)

- (b) The total length for the mRNA sequence is 1824 bases. How many amino acids will there be in the protein? Show all working.

(2)

- 4.2.3 Use the mRNA codon table below to answer the question that follows.

		Second letter in codon					
		U	C	A	G		
First letter in codon	U	UUU Phe UUC UUA Leu UUG	UCU Ser UCC UCA UCG	UAU Tyr UAC UAA STOP UAG STOP	UGU Cys UGC UGA STOP UGG Trp	U C A G	
	C	CUU Leu CUC CUA CUG	CCU Pro CCC CCA CCG	CAU His CAC CAA Gln CAG	CGU Arg CGC CGA CGG	U C A G	
	A	AUU Ile AUC AUA AUG Met	ACU Thr ACC ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G	
	G	GUU Val GUC GUA GUG	GCU Ala GCC GCA GCG	GAU Asp GAC GAA Glu GAG	GGU Gly GGC GGA GGG	U C A G	
						Third letter in codon	

[Source: <<https://xaktly.com/Images/Biology/GeneticCode/GeneticCode.png>>]

- (a) State the amino acid coded for in the normal DNA sequence AGC.

(1)

- (b) State the changed amino acid coded for by the mutated DNA sequence CGC.

(1)

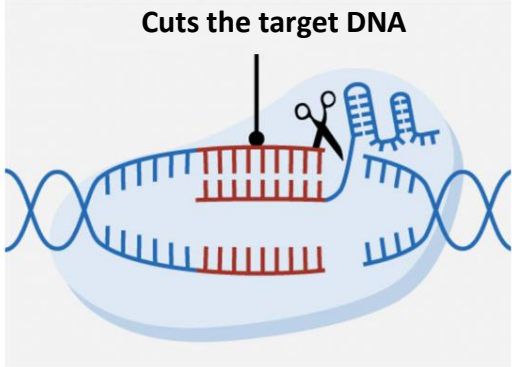
4.3 Read the information below and use it and your own knowledge to answer the following questions.

CRISPR is a revolutionary genetic engineering technique that has the potential to combat the rise in antibiotic resistant bacterial populations.

CRISPR is used as a gene-editing tool, or a pair of 'molecular scissors' to cut and edit the DNA in the cells of plants and animals, including humans.

The CRISPR system can recognise any short DNA sequence in plant and animal cells, cut it out, and can insert a new one.

Scientists are actively involved in researching its application in treating diseases.



[Adapted: <<https://pubs.acs.org/doi/10.1021/acsinfecdis.2c00649#:~:text=The%20CRISPR%20Cas%20strategy%20can,of%20plasmids%20encoding%20antibiotic%20resistance>> and <<https://www.dst.gov.za/index.php/media-room/latest-news/3036-demystifying-crispr-gene-editing>>]

4.3.1 What is meant by the term *genetic engineering*?

(2)

4.3.2 Name an enzyme/group of enzymes used in genetic engineering that 'cuts the target DNA'.

(1)

4.3.3 State two similarities between the processes of CRISPR and artificial selection.

(2)

4.3.4 Name an example of artificial selection that you studied and state the feature that was changed in your chosen example.

(2)

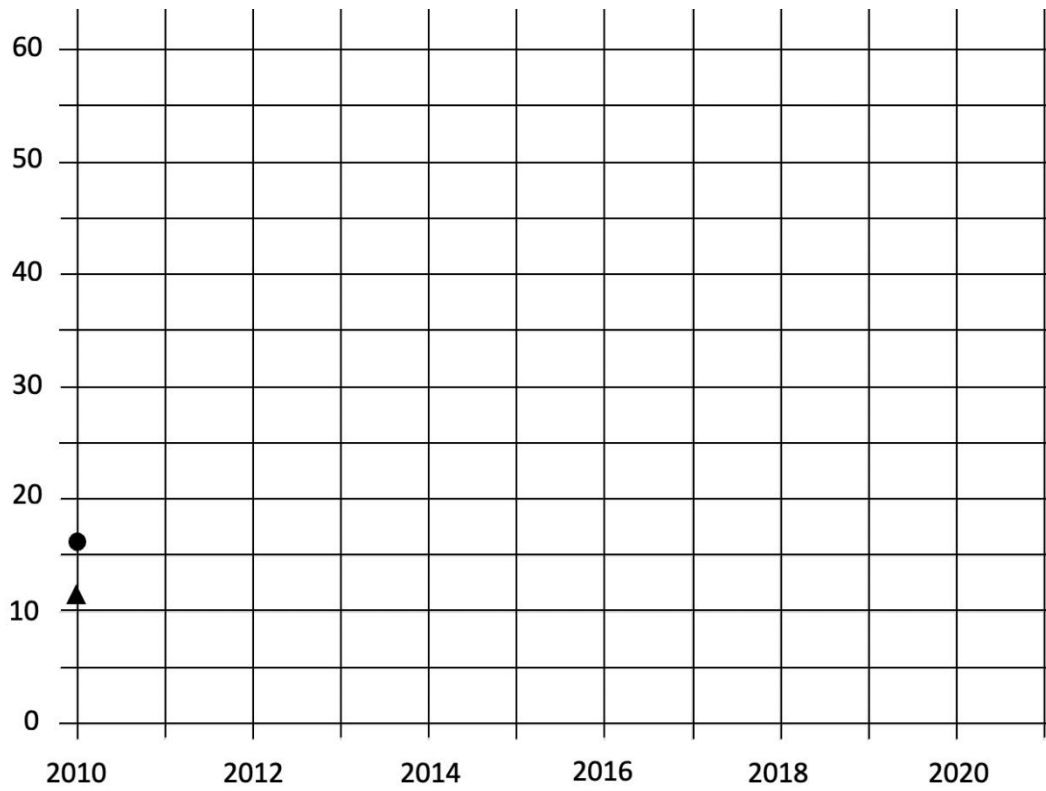
4.3.5 Why is it important that scientists research the use of CRISPR thoroughly before it becomes an accepted treatment for diseases in humans?

(2)

[40]

Total: 200 marks

QUESTION 2.2.1



(7)