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ST DOMINIC'S SCHOOL FOR GIRLS

GRADE 12 LIFE SCIENCES PRELIMINARY EXAMINATION PAPER 1 2024

Examiner:	M Smith	Date:	30 August 2024
Moderator/s:	C Warrender	Time:	3 Hours
		Marks:	200

Name of student:	
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INSTRUCTIONS TO STUDENTS:

- This question paper consists of 33 pages including this cover.
- There are FOUR questions.
- Answer all questions in the spaces provided.
- There are two lined pages at the end of the exam for corrections to answers.
- Number your answers exactly as the questions are numbered and indicate in your answer that you are using the additional space. (**Do not** "squash" your answer between the printed lines, or in open space near the answer. Marks will be deducted.)
- Write legibly and present your work neatly.
- Use the total marks awarded for each question as an indication of the detail required.

Question	My Mark	Mod. Mark	Possible Mark
1			80
2			40
3			40
4			40
TOTAL			200

Good Luck!

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

[10]

Answer	Column A		Column B
[]	1.1.1 Small evolutionary changes within a species.	A	Biogeography
[]	1.1.2 Lamarck's theory of evolution.	B	Outbreeding
[]	1.1.3 Structures which evolve separately in different lineages but have a similar function.	C	Transitional
[]	1.1.4 Study of where species (both present day and extinct) occur and why.	D	Microevolution
[]	1.1.5 Fossils that have a mixture of traits that show a link between groups of organisms.	E	Palaeontology
[]	1.1.6 Numerous species arising from a single ancestral species.	F	Analogous
[]	1.1.7 Change within a single evolutionary lineage with no branching.	G	Gene flow
[]	1.1.8 Mating of distantly related individuals within a species.	H	Convergent evolution
[]	1.1.9 Study of fossil remains from various species.	I	Acquired Characteristics
[]	1.1.10 The movement of alleles into or out of a population.	J	Genetic drift
		K	Anagenesis
		L	Adaptive radiation
		M	Homologous

- 1.2 Ten multiple choice questions are given below. Choose the most correct alternative in each question and write the letter of the correct answer in the space provided.

[10]

Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5	1.2.6	1.2.7	1.2.8	1.2.9	1.2.10
Answer										

1.2.1. Which of the following is a function of meiosis?

- A. Reduces genetic variation in a species
 - B. Cancels out the doubling effect of fertilization
 - C. Doubles the amount of mitochondrial DNA
 - D. Slows down evolutionary changes in a species
- (1)

1.2.2. Give the correct sequence of events that occur during **METAPHASE 1** and **ANAPHASE 1** of meiosis, respectively:

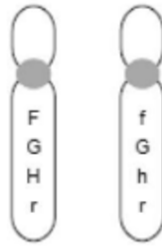
- (i) Homologous chromosomes arrange themselves at the equator.
- (ii) Homologous Chromosomes are pulled to the opposite poles.
- (iii) Spindle fibres shorten.
- (iv) Spindle fibres attach to the centromere.

- A. (i), (ii), (iii) and (iv)
 - B. (i), (ii), (iv) and (iii)
 - C. (i), (iv), (iii) and (ii)
 - D. (iv), (iii), (ii) and (i)
- (1)

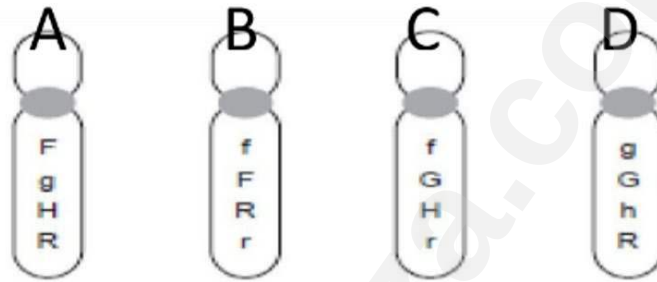
1.2.3. Which statement is NOT true of mitochondrial DNA?

- A. It remains relatively unchanged over long periods of time
 - B. It is inherited through the maternal lineage only
 - C. The more similar the mitochondrial DNA, the more closely related the organisms
 - D. It undergoes crossing over and recombination during meiosis
- (1)

- 1.2.4. A pair of homologous chromosomes involved in normal meiosis in an ovary carries the alleles shown below.



Possible chromosomes in the ova (egg cells) produced would include:



(1)

- 1.2.5. How many mRNA nucleotides code for a protein made up of 120 amino acids?

- A. 360
- B. 40
- C. 30
- D. 120

(1)

- 1.2.6. A DNA molecule contains 800 nucleotides. 20% of these are Adenine bases. Calculate the number of guanine bases in the molecule.



- A. 160
- B. 240
- C. 480
- D. 320

(1)

1.2.7. DNA that has been combined from different biological species.

- A. Non-coding DNA
- B. Recombinant DNA
- C. Coding DNA
- D. mitochondrial DNA

(1)

1.2.8 DNA that is only passed from mother to offspring through the ovum.

- A. Non-coding DNA
- B. Recombinant DNA
- C. Coding DNA
- D. mitochondrial DNA

(1)

1.2.9 Which statement is a correct deduction that can be made from Mendel's work on pea plants?

- A. A blend of parents' traits will be seen in their offspring.
- B. Polygenic inheritance results from more than two alleles.
- C. Genes come in pairs and are inherited as distinct units.
- D. The laws of inheritance are applicable only to plants.

(1)

1.2.10 In pea plant flowers, the colour purple is dominant over the colour white. When Mendel crossed two purple-flowered pea plants, he obtained the following ratio of plants in the offspring:

705 purple flowers : 224 white flowers.

The genotypes of the parents are:

- A. homozygous dominant and heterozygous
- B. both heterozygous
- C. homozygous recessive and heterozygous
- D. homozygous recessive and homozygous dominant

(1)

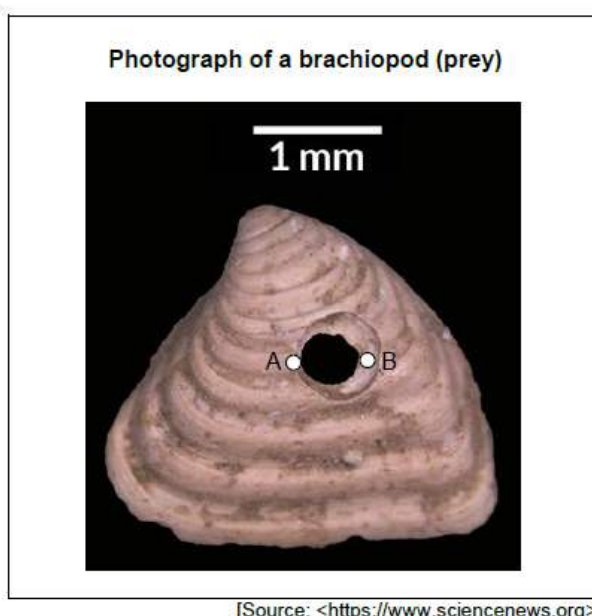
- 1.3. Study the following table and decide whether the statement in column X matches both terms given in column Y, or if only term A matches, only term B matches, or if none match. Record your answer as: Both A and B, only A, only B or None.

[5]

Column X	Column Y	ANSWER
1.3.1. A population parameter that has no effect on a closed population.	A. Mortality B. Emigration	
1.3.2. Lions and cheetah both hunting impala.	A. Interspecific competition B. Intraspecific competition	
1.3.3. A predictable pattern of gradual change in types of species in a community.	A. Primary succession B. Secondary succession	
1.3.4. A density independent factor that limits the size of a population.	A. Predation B. Competition	
1.3.5. An estimate of the resources you need to live your particular lifestyle.	A. Carrying capacity B. Ecological Footprint	

- 1.4 Predators such as moon snails (*Naticarus orientalis*) feed on prey with shells, e.g. brachiopods. Moon snails kill their prey by drilling through their shells. Drilling holes also allows the predator to reach the soft meat of the prey.

The photograph below shows a fossil shell of a brachiopod estimated to be about 4 million years old. The hole made by the predator is clearly seen.

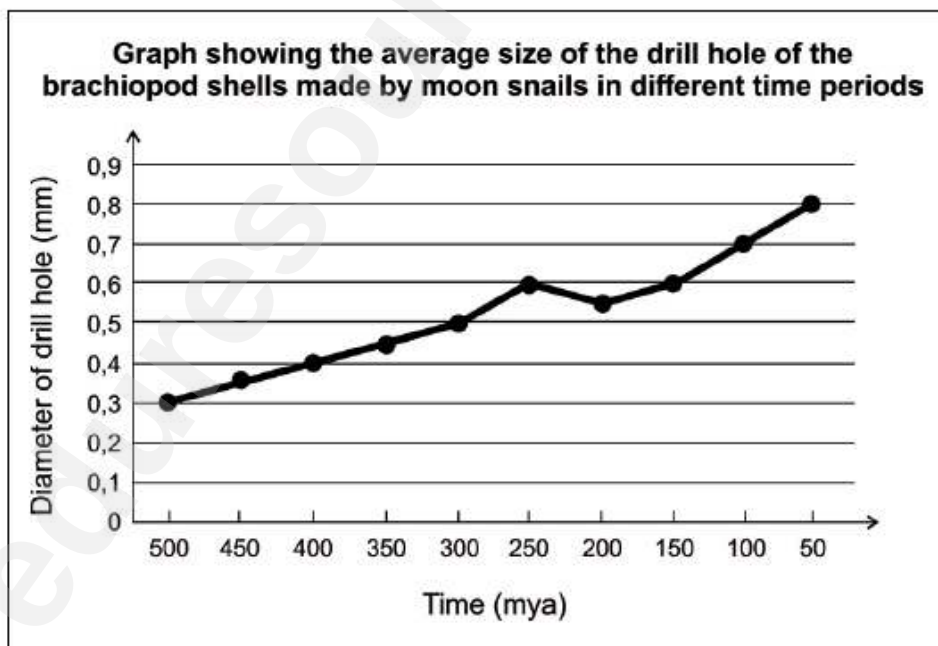


- 1.4.1 Use the scale line to calculate the actual diameter of the drill hole from A to B. (Show all working).



(4)

- 1.4.2 Scientists measured the drill holes made by moon snails in 7 000 brachiopod fossil shells from different time periods. The data was published in a journal. This is shown in the graph below.



[Adapted: <<https://www.sciencenews.org>>]

- (a) Identify the independent variable of this study.

(1)

- (b) What is the average size of the drill hole at 400 million years ago?

(1)

(c) Describe the trend shown by the graph.

_____ (2)

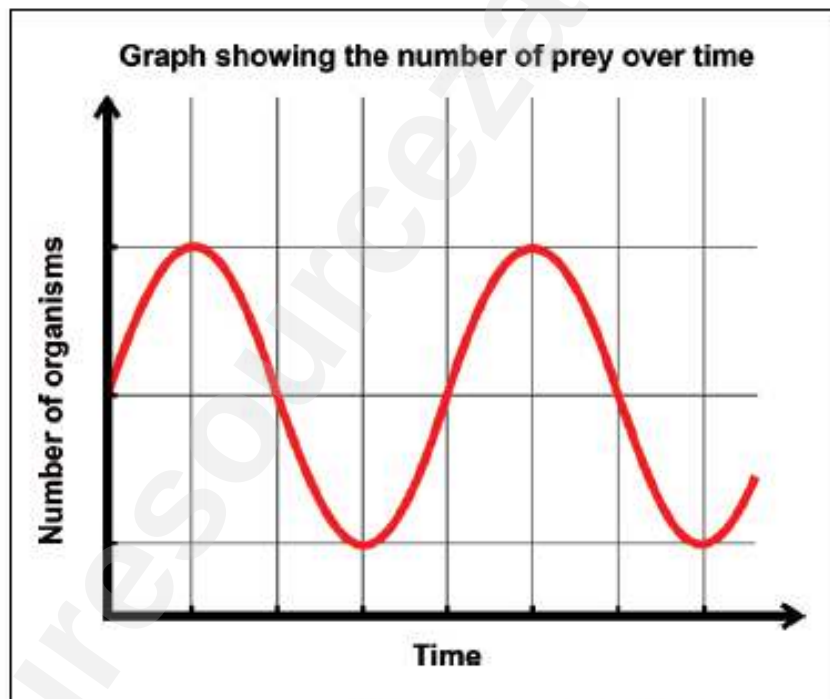
(d) The actual size of the shells of the prey did not change with time. Suggest one physical feature of the shells that may have evolved for protection against predators.

_____ (1)

(e) Give ONE reason why the data collected by the scientists can be regarded as reliable. Explain your answer.

_____ (2)

(f) The graph below shows an incomplete predator-prey relationship. On the graph, draw a line to represent the predators.



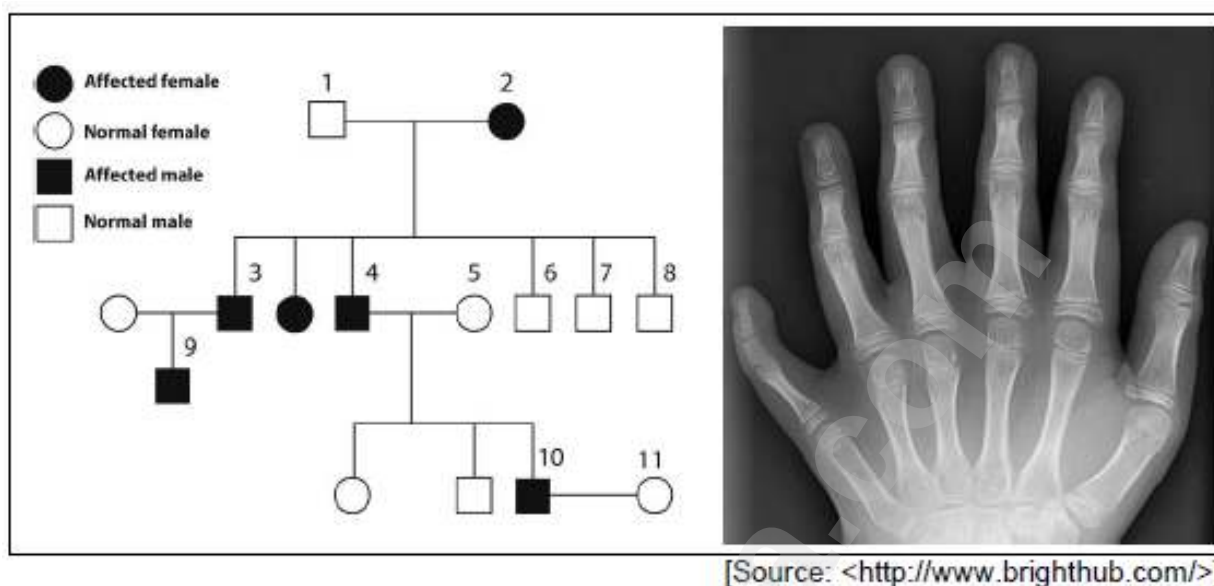
[Source: Lever, P. (2018) Pers.com.]

(2)

[13]

- 1.5 Polydactyly is a medical term used to describe extra fingers on the hands and toes on the feet. It is caused by an **autosomal dominant** gene mutation.

Study the family pedigree below and answer the questions that follow:



(a) Provide a key to express the alleles for normal condition and Polydactyly.

(1)

(b) What is the genotype of the following individuals?

Individual	Genotype
1	
2	
4	

(3)

(c) Explain what is meant by the term "Autosomal dominant gene mutation".

(2)

(d) In the space below, draw a genetic diagram to show the probability that individuals 10 and 11 will have a child with Polydactyly. Use the key chosen in Question 1.5 (a).

Include the following in your answer:

- parental genotypes,
- a genetic cross or Punnet diagram,
- the ratio of the possible genotypes and phenotypes of the offspring.



(7)

1.6 The owner of a factory discovers rat faeces and chewed electric wires in his factory. He suspects that there is a rat problem and so he calls in the pest control technician to determine the extent of the problem. In order to do this, the technician sets a number of traps (which do not harm the rats) in the factory and leaves them for three nights. When he returns, he finds 23 rats in his traps. He applies ear tags to these rats which he then releases. A week later he sets the traps again and this time he traps 29 rats, 11 of which have ear tags.



[Source: <http://bestpestcontrolexterminators.blogspot.co.za/>]



[Source: <https://www.outdooralabama.com/>]

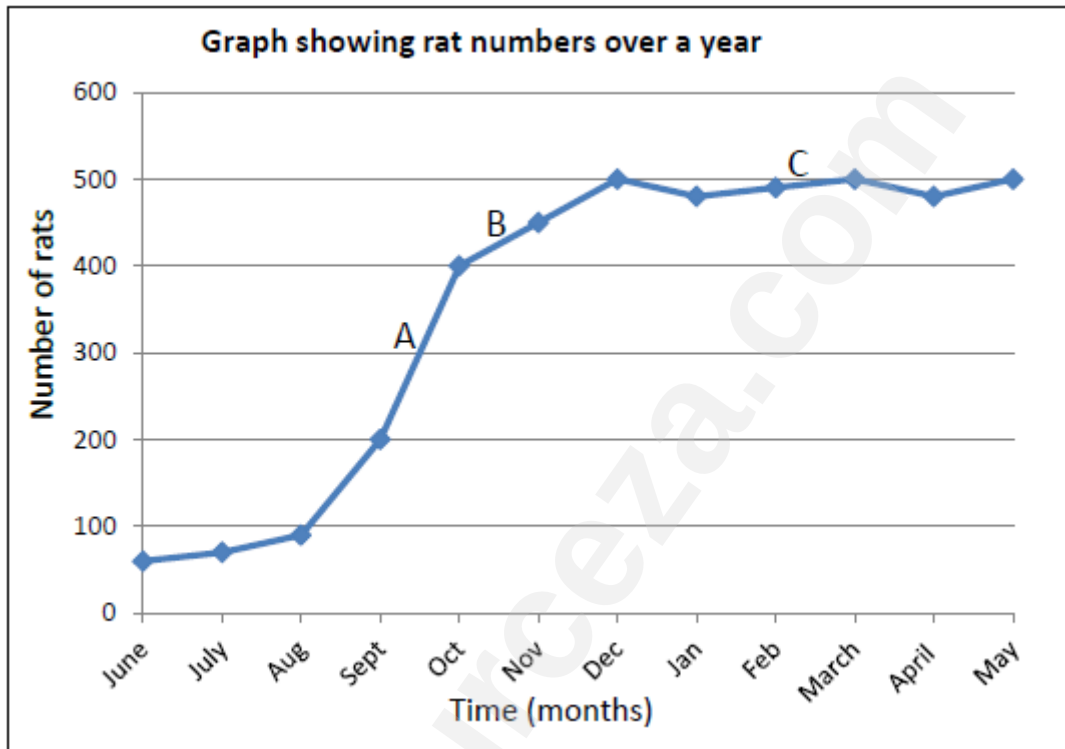
1.6.1 What is the estimate of the total population of rats in the factory? (Show all working).

(4)

1.6.2 List THREE precautions that the technician needed to take when applying the tags.

(3)

- 1.6.3 After the population estimation, the technician decided to set traps every night for 2 weeks to get rid of the rats, but he did not want to hurt the rats, so he found a forest outside of town where he released the rats. Over the next few months, he kept track of the rat numbers in the forest to see how the population was doing. He plotted his results on a graph (shown below).



- (a) Describe and explain the rate of population growth at A and B.

(4)

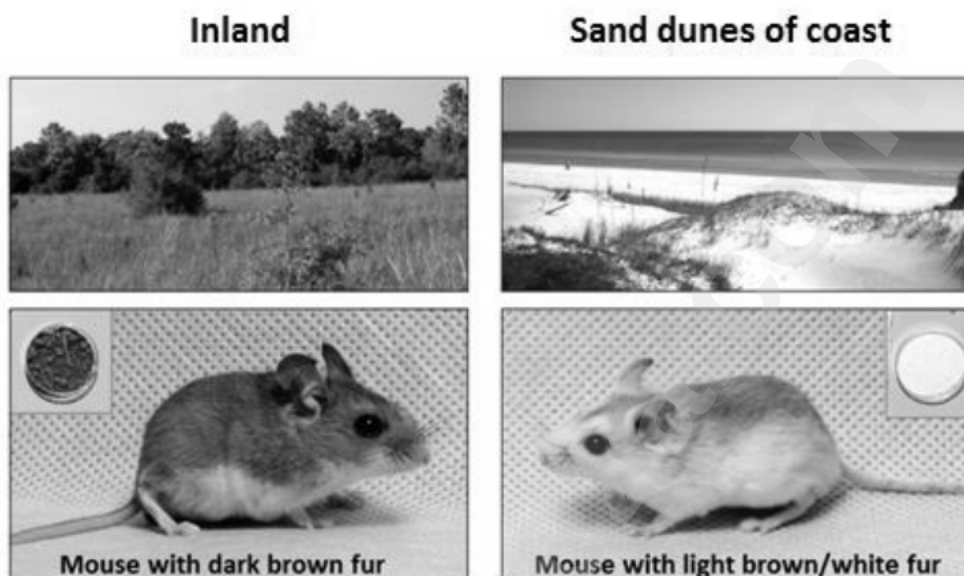
- (b) List THREE density-dependent factors that controlled the rat population at C.

(3)

[14]

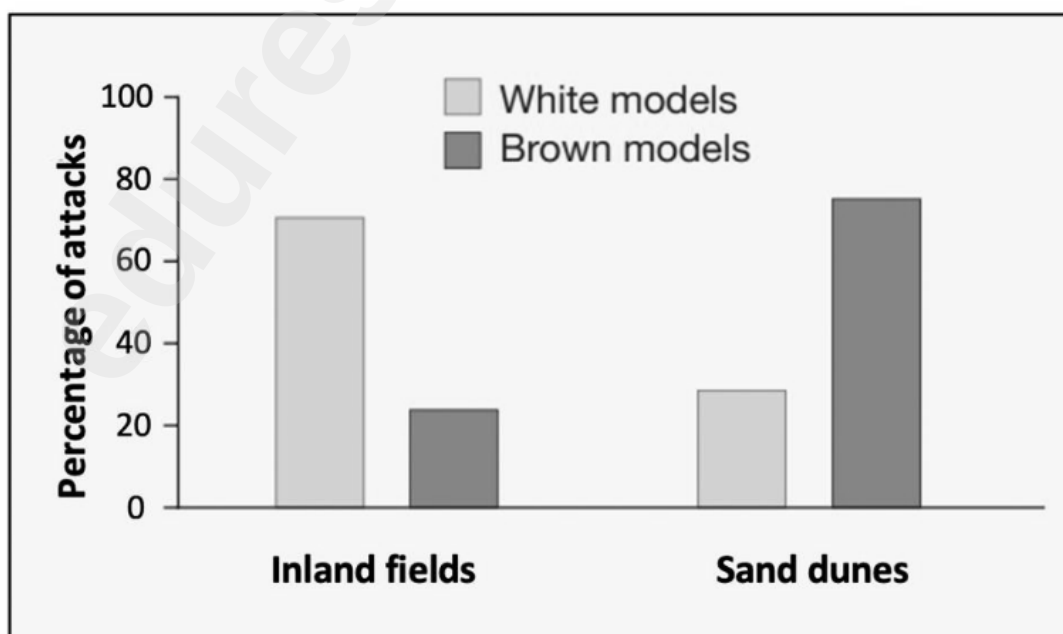
1.7 Read the following information on natural selection in mice and answer the questions that follow.

Researchers have studied aspects of natural selection in fur colour variation in populations of mice of the same species where they occur on the coast and adjacent inland areas. Over the last 60 years, they have noted a change in fur coat colour in the mice populations. Most of the mice living inland have brown fur, while the mice living on the sand dunes of coastal regions have lighter brown or white fur.



Researchers tested a hypothesis that predators drove the natural selection of mouse fur colour. They made plasticine models of white and brown mice. They placed the mice models in fields inland and on sand dunes at the coast. They recorded the percentage of the models that were attacked by predators. The results are shown in Figure 1.4 below.

Figure 1.4: Graph showing percentage of attacks on mouse models inland and on sand dunes on the coast.



[Source: Vignieri, S.N., J.G. Larson, and H. E. Hoekstra. 2010/Evolution 64: 2153–2158; <<https://www.pearson.com>>]

(4)

[illegible]

(5)

- 1.7.3 Complete the table below by selecting the words listed in bold and writing them in the corresponding block in the table.

Slow	Fast	Human
Environment	Decrease in variation	Increase in variation
	Natural selection	Artificial Selection
1. Cause of change		
2. Rate of change		
3. Variation		

(6)

[15]

TOTAL FOR QUESTION 1 = 80

QUESTION 2

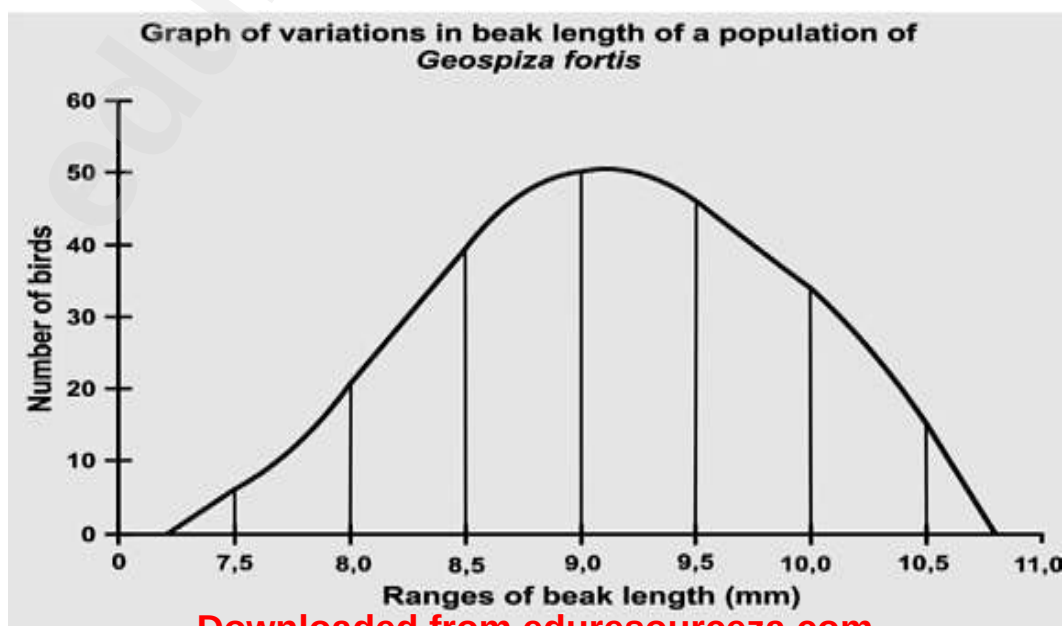
2.1. There are many factors which contribute to the process of evolution of organisms over time. Over the last 30 years scientists have studied many organisms on the Galapagos Islands. One of these, the Medium Ground Finch, *Geospiza fortis* (*G. fortis*), is a bird on one of the smaller islands, Daphne Major. This species of ground finch is a seed eater. During a study over an 18-month period, from June 1976 to the end of 1977, a severe drought occurred on this island. The drought resulted in a shortage of small seeds. When the drought eased in 1978, the Medium Ground Finch population recovered but the average beak size was found to be greater than in 1976.

[Life Sciences Paper 1 Supplementary, 2014]

2.1.1 Explain clearly, using appropriate scientific terminology, how Darwin's theory of evolution through natural selection would account for the change in the average beak size of *G. fortis*.

(4)

The graph below illustrates the variation in beak length in a population of *G. fortis* on the island Daphne Major in 1976.



- 2.1.2 Would beak length be considered an example of a trait displaying continuous or discontinuous variation? Use evidence from the graph to explain your answer.

(2)

- 2.1.3 (a) What was the longest beak length recorded in this sample of *G. fortis*?

(2)

- (b) How many birds had the most common beak length?

(2)

- 2.1.4 Draw a sketch graph showing the variation in beak length of the finches in 1978, after the drought.



(3)

[13]

- 2.2. Zebras and horses can mate to produce an offspring called a zorse (shown below). Zorses are hardy and disease resistant animals but are sterile (unable to produce offspring of their own).

Chromosome number of: Horses: $2n = 64$; Zebra: $2n = 62$

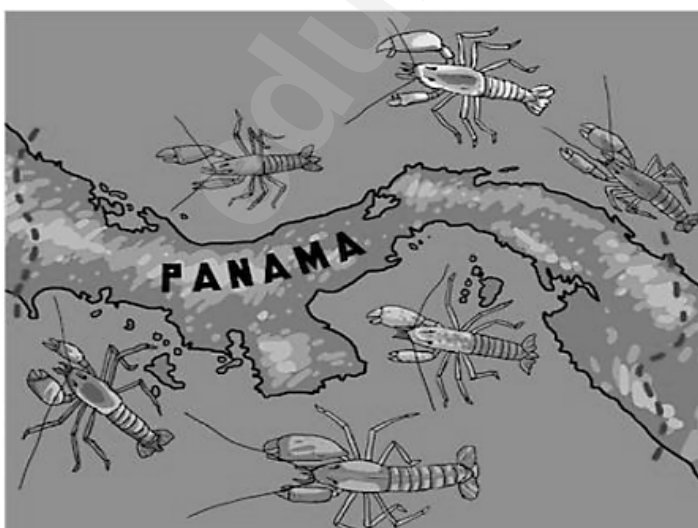


Say whether each of the statements given is TRUE or FALSE. Indicate your answer by ticking in the true or false column in the following table.

Statement	True	False
2.2.1 Zebra and horses are members of the same species.		
2.2.2. Zorses are hybrids.		
2.2.3. Zorses show a high degree of homozygosity in their alleles.		
2.2.4. Zorses have 63 chromosomes in their somatic cells.		
2.2.5. Zorses can form homologous pairs of chromosomes during meiosis.		

[5]

- 2.3. Approximately 3 million years ago, a geological event caused a mass of land to form, joining North and South America. This land mass is known as the Panama Isthmus. It separates the Pacific Ocean from the Atlantic Ocean.



A scientist studying the marine biology of the area found that shrimp on one side of the isthmus appeared very similar to those on the other side, having once been members of the same population. But when she put males and females from different sides of the isthmus together, they snapped aggressively instead of courting and mating.

[Adapted from: <http://www.pbs.org/wgbh/evolution>]

2.3.1. What type of speciation caused the shrimp on either side of the Panama Isthmus to become different species?

_____ (1)

2.3.2. Use a flow chart (with words and arrows) to describe what happened during the speciation of the shrimp in the oceans around Panama.



(6)

2.3.3. (a) When they were placed together, what reproductive isolating mechanism prevented gene flow between the two groups of shrimps?

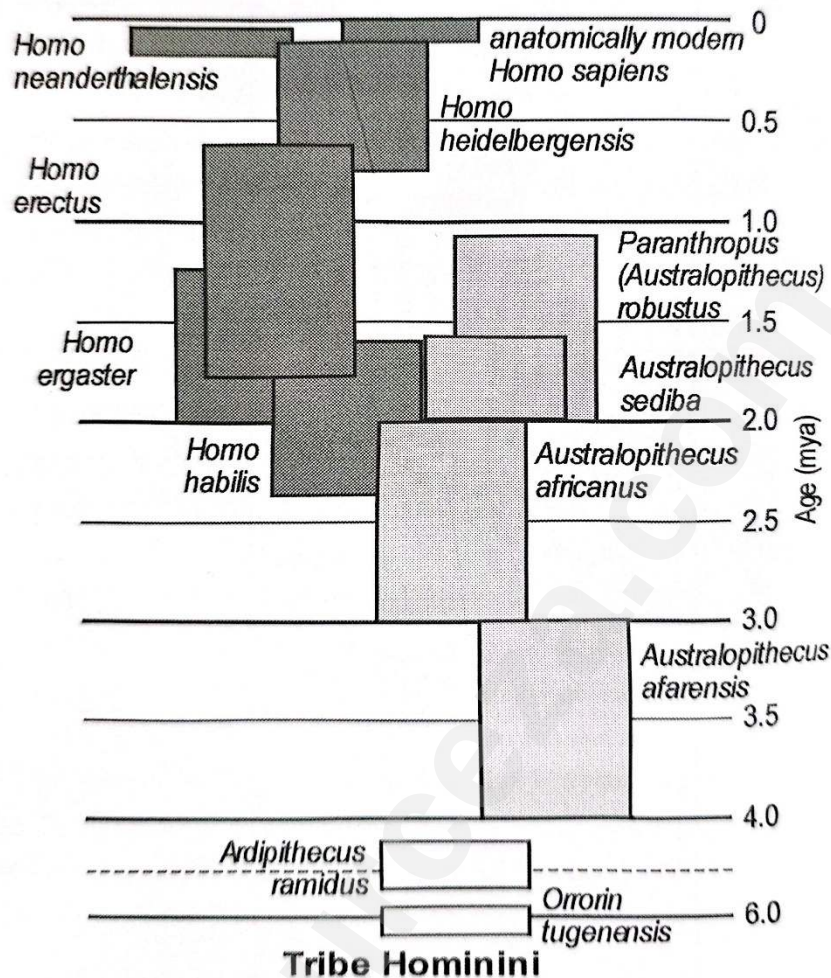
_____ (1)

(b) Give an example of ONE other type of reproductive isolating mechanism that you have studied.

(2)

[10]

2.4. Study the timeline graph below showing a possible representation of human evolution



[Mind Action Series Life Sciences: Grogan and Suter 2017]

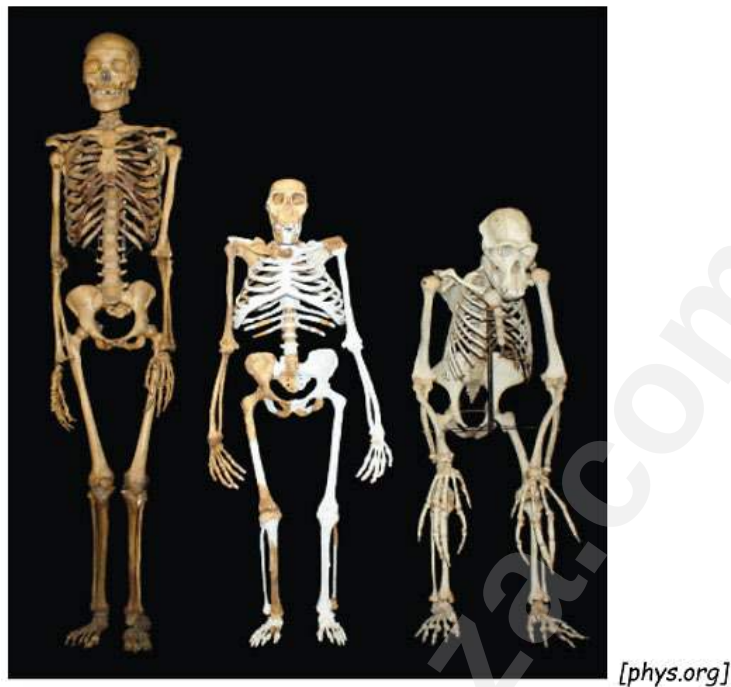
2.4.1. Name the small-brained hominid that existed at the same time as *Australopithecus sediba*.
_____ (1)

2.4.2 Which species in the timeline existed for the longest period of time?
_____ (1)

2.4.3 Of the many types of hominids co-existing in Southern Africa from 2-1.5 mya, only the *Homo* lineage continued. Name two diagnostic features of the genus *Homo* that made it more successful than the other hominids, who eventually became extinct?

(2)

- 2.5. The diagram below compares the skeletons of *Homo sapiens*, *Australopithecus sediba* and a chimpanzee (*Pan troglodytes*).



- 2.5.1 The arms of the Chimpanzee and *Australopithecus* show that they have similar structures and that they are the product of descent from a common ancestor rather than a product of a similar environment. What is the term for structures derived from a common ancestor?

_____ (2)

- 2.5.2 Why are transitional fossils so important when trying to show that evolution occurred?

 _____ (2)

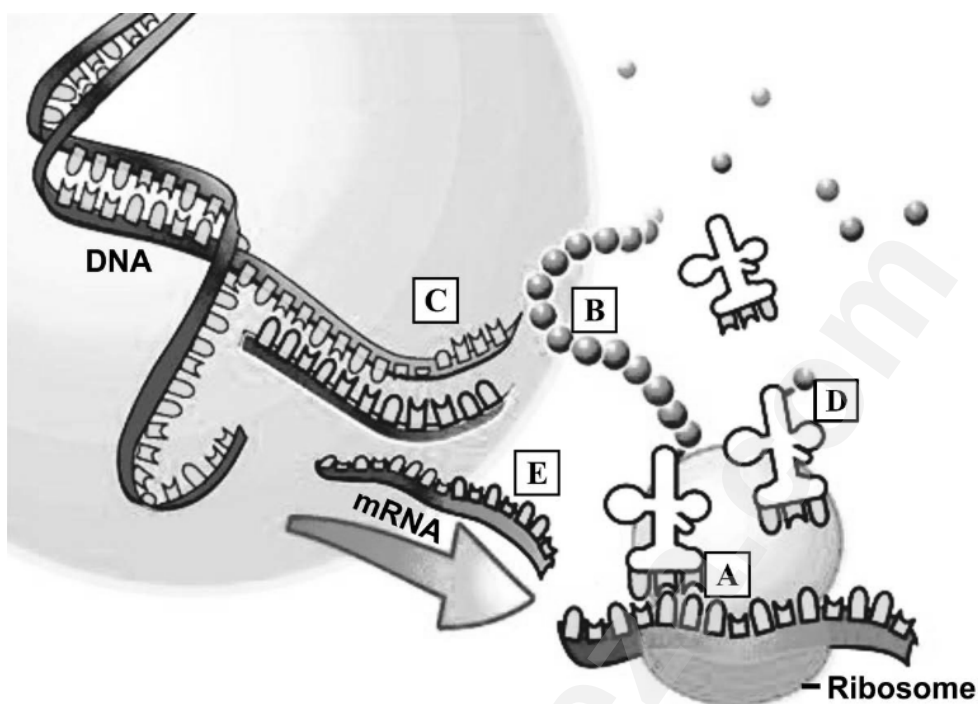
- 2.5.3 The *Australopithecus sediba* reconstruction shows that the hominid was bipedal. Describe two pieces of evidence that a palaeontologist would have used to infer that the organism was bipedal.

 _____ (4)

[8]

QUESTION 3

3.1 Study the diagram below and answer the questions that follow:



[Adapted from: <<http://image.slidesharecdn.com>>]

3.1.1 Name the overall process occurring in the diagram above.

_____ (1)

3.1.2 Give the letter that represents:

(a) transcription _____ (1)

(b) a polypeptide chain _____ (1)

(c) codon–anticodon linkage _____ (1)

3.1.3 Using the letters A–E in the diagram above, place the letters in the correct sequence from start to finish.

_____ (2)

3.1.4 If a particular DNA nucleotide base coding sequence was AGC-CTA-ATG, write the sequence on the corresponding mRNA molecule. (There is no need to draw the nucleotides. Just list the bases in the correct sequence.)

_____ (3)

- 3.2 The Human Genome Project was launched in 1990 and finally completed and published in 2003.

(a) What was the main aim of the Human Genome Project?

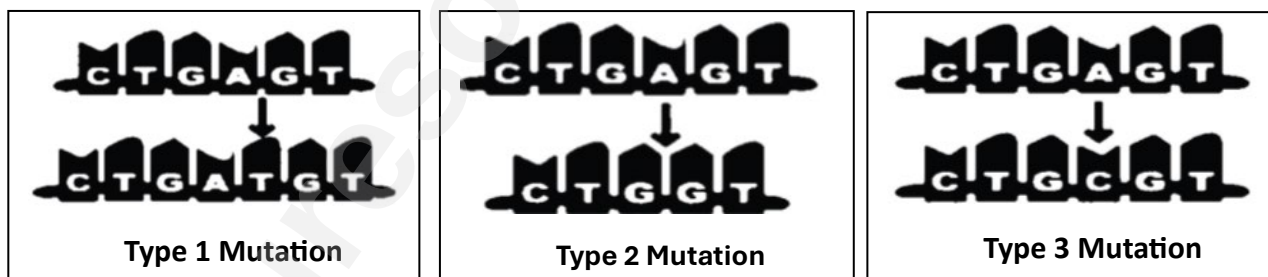
(2)

(b) Discuss TWO ways in which the information gained from the Human Genome Project has been useful to society.

(4)

[6]

- 3.3 A gene mutation is a permanent alteration in the DNA sequence that makes up a gene. Study the diagrams below that show three types of mutations, and answer the questions that follow:



[Adapted from: <<http://image.slidesharecdn.com>>]

- 3.3.1 Name the three specific types of mutation illustrated in the diagrams above. Be sure to link the names to the diagrams, e.g. Type 1 is a ... mutation.

(3)

- 3.3.2 What possible effect would a Type 3 mutation have on the protein coded for if this type of mutation occurred in a coding region of DNA?

(1)

- 3.3.3 The effect of any of these mutations might be neutral, harmful or beneficial. Which ONE of these effects could possibly contribute to speciation? Explain your answer.

(4)

[8]

- 3.4. Read the information below, about genetically modified crops.

Crops such as maize and cotton are genetically modified to produce Bt toxins to protect them against insect pests. When these GM crops first became available it was predicted that insect pests would develop resistance to these toxins. The extent of Bt resistance in insect pest species was surveyed in 2005 and in 2011. The level of resistance in each species was classified according to the highest percentage of resistant individuals recorded in any population anywhere in the world.

Three levels of resistance were identified:

• <1 % • 1– 6 % • >50 %

The results of the surveys are shown in the table below.

year	total number of insect pest species surveyed	number of insect pest species susceptible to Bt toxins	number of insect pest species with reported levels of resistance		
			<1%	1–6%	>50%
2005	9	8	0	0	1
2011	13	4	3	1	5

- 3.4.1. Do the results from the table confirm the prediction that insects would develop a resistance against genetically modified toxins? Explain.

(3)

3.4.2. Briefly describe a procedural inaccuracy with the way this experiment was conducted.

(2)

3.4.3. Genetically modified (GM) crops are a contentious issue worldwide. South Africa has transgenic plants, but other African countries such as Zambia, Egypt, Algeria and Zimbabwe have banned GM crops, especially those that have been used by the United Nations to alleviate the food shortages experienced by these African countries.

Do you agree with the ban that these countries have placed on GM crops? Give two good reasons for your choice.

(4)

[9]

3.5 Use the information below and your own knowledge to answer the following questions.

A new 'cat' database in America is analysing mitochondrial DNA (mtDNA) which is useful in forensics due to two properties:

- It has a high mutation rate making comparisons easier
- Its genes exist in large amounts

It is an extensive database which could be widely used by criminal investigators.

3.5.1 Do you think South Africa should establish a DNA database for cats for forensic or other use? Give TWO well explained reasons for your opinion.

(4)

FUR FROM A FLUFFY WHITE CAT USED IN MURDER TRIAL

Cat fur easily sticks to clothing and many surfaces. The genetic material in cat fur obtained from a crime scene has the potential to link perpetrators, accomplices, witnesses and victims. Police found cat fur on the jacket of Douglas Beamish who was accused of murdering Shirley Duguay. The fur was the only forensic evidence in the case and was genetically linked to the victim's cat, 'Snowball'. It helped to convict Beamish of murder.

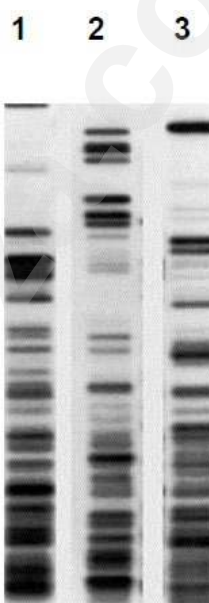
[Adapted: <news.discovery.com>]

A. Genetic profile of fur taken from suspect's jacket

Cat fur on jacket



B. Genetic profiles of 'Snowball' and two other cats in the neighbourhood



[<www.genetec.nlm.gov>]

(Diagrams in A and B not to the same scale)

3.5.2 Which of the cats' profiles, 1, 2 or 3, in B, belongs to 'Snowball'? Give a reason for your choice.

(2)

3.5.3 Why do you think the crime investigators also included samples from the cats in Douglas Beamish's neighbourhood?

(2)

[8]

TOTAL FOR QUESTION 3 = 40

QUESTION 4

4.1.1 Define a population.

(3)

4.1.2 For each of the changes in population size mentioned below, indicate which parameters are responsible for the change.

a) Increase in the size of the population.

(2)

b) Decrease in the size of the population.

(2)

[7]

4.2 State one difference between the following terms.

4.2.1 Density dependent and density independent parameters.

(4)

4.2.2 Mutualism and commensalism.

(4)

[8]

4.3 Read the following passage and then answer the questions that follow:

In 1997, the estimated impala population in the Gomo Nature Reserve was approximately 8000. Large populations of lions and hyenas were present. Between 1997 and 2007 half the lion and hyena populations were eliminated. By 2009, the impala population increased to 80000 and nearly all the grass, shrubs, and young trees were eaten. During the winter of 2009, 80% of the impala population was wiped out. With only 4000 impalas left, the vegetation continued to degenerate for a long time. In 1990 when the Gomo Nature reserve was established, it was estimated that the impala carrying capacity of the reserve was about 20000 impalas.

4.3.1 By referring to the passage, give one example of:

a) intraspecific competition

_____ (1)

b) interspecific competition

_____ (1)

c) predation

_____ (1)

d) a density dependent factor

_____ (1)

4.3.2 Draw a food chain to illustrate the feeding relationship in this area during 1997.

_____ (4)

4.3.3 Why did the impala population continue to decline after 80% had died during the winter of 2009?

_____ (2)

4.3.4 Why did the vegetation continue to deteriorate in spite of the large decrease in the impala population?

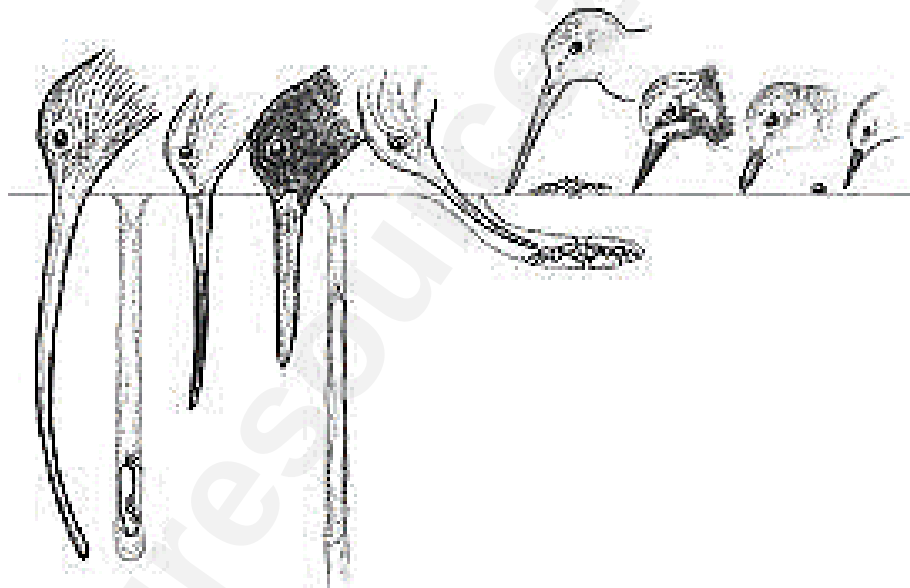
(2)

4.3.5 Explain what is meant by the carrying capacity.

(2)

[14]

4.4. Some sea birds feed on animals found in the mud in estuaries (habitats where rivers enter the sea). The drawing shows the heads of eight species of these birds, that live in the same estuary, and their prey.



4.4.1 Use the information in the drawing to explain how interspecific competition between the birds is reduced.

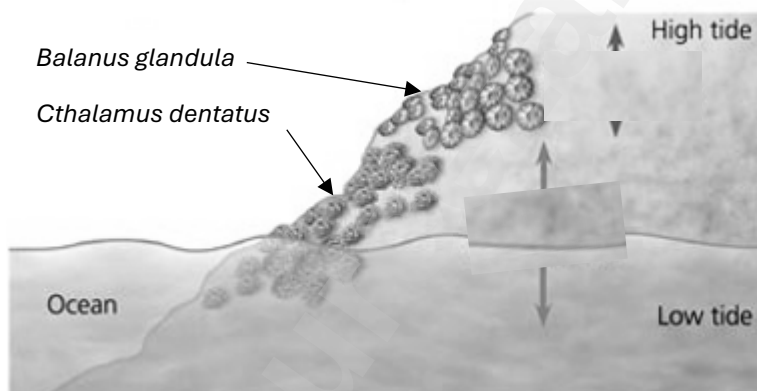
(2)

4.4.2 Identify the outcome from the competition between the birds, illustrated in this example. Explain your answer.

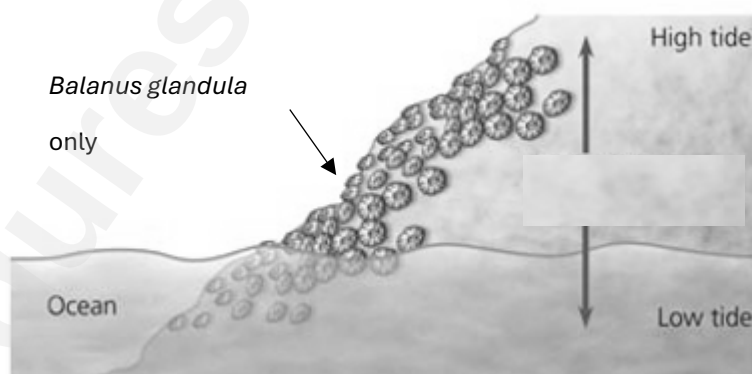
(3)

Barnacles are animals that live on rocky shores. The adults are fixed to the surface of rocks and do not move. The young larvae can swim freely in the sea. As they get older, the larvae settle and attach themselves to a rock surface. Here they develop into adults, which feed on microscopic plants and animals in the sea when the tide is in. *Cthalamus dentatus* is a barnacle that is indigenous to Southern Cape rocky shores in South Africa. An invasive species of barnacle, *Balanus glandula* was introduced to South Africa by ships travelling from Scotland.

Experiment: Ecologist Evadne Skelton from University of Cape Town studied the two barnacle species – *Cthalamus dentatus* and *Balanus glandula*. In nature, *Cthalamus* fails to survive high on the rocks because it is unable to resist desiccation (drying out) during low tides. In contrast *B. glandula* can occupy the drier area. Skelton monitored the distribution and number of barnacles after *B. glandula* had established itself on the rocky shores.



Results: Skelton realised that after two years the *Balanus glandula* not only occupied the high tide zone but also the low tide zone. There was no trace of *Cthalamus dentatus*.



Conclusion: *Balanus* is responsible for forcing *Cthalamus* out of the habitat.

4.5.1 In both species of barnacles few of the larvae which settle become adults. Explain how intraspecific competition is the cause of this.

(2)

(2)

(2)

TOTAL FOR QUESTION 4 = 40

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