

Answer **all** the questions.

1. Which of the following **best** describes the term *biodiversity*?

- A** the variety of species
- B** the number of individuals of each species
- C** the variety of genes, species and habitats
- D** the variety of genes within a species

Your answer

[1]

2. Q, P, R and S are related species of organisms.

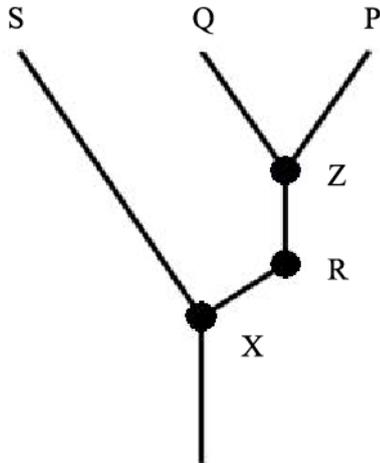
Species X is an extinct recent common ancestor of species Q and R.

X, Q and R all evolved from species P.

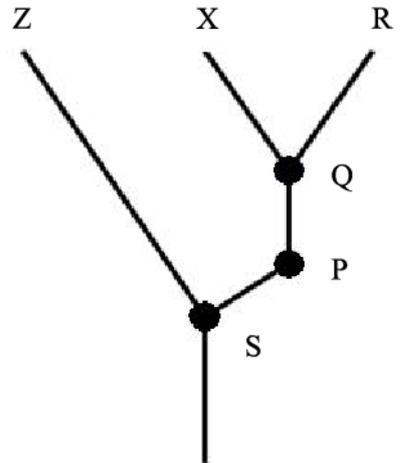
Species S is the least related to the others, with extinct species Z being its most recent phylogenetic link to the other species.

Which of the following phylogenetic trees correctly represents the relationships described above?

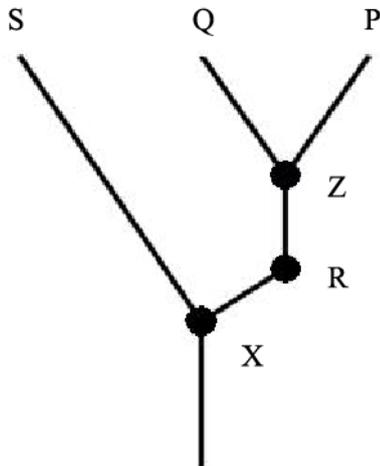
**A**



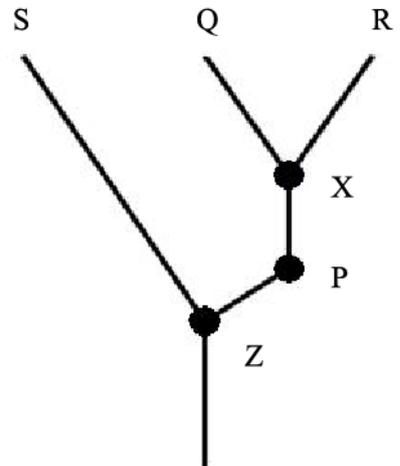
**B**



**C**



**D**



Your answer

[1]

3(a). The cassowary is a large, flightless bird found in the rainforest in parts of Australia. It feeds mainly on fruit. The seeds of the fruit are deposited on the rainforest floor.

(i) The cassowary is known as a *keystone species*. This means it is important for the survival of other species.

Suggest what role the cassowary plays in the survival of other species.

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----- [1]

(ii) The cassowary needs to be conserved for ecological reasons.  
State **two** other reasons for maintaining biodiversity.

1  
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2  
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----- [2]

(b). The mountain gorilla is an endangered species with as few as 880 individuals surviving in the wild. Many of the animals have been 'habituated' to human contact. The health of these animals is monitored and medical assistance is given when necessary. Animals that are not habituated are rarely visited.

(i) Suggest one advantage **and** one disadvantage of keeping some gorilla families that have not been habituated.

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----- [2]

(ii) The gorilla population in one area, Virunga, has been regularly monitored (**Table 24.1**). The data have been collected by indirect methods such as collecting dung samples at nest sites.  
However, DNA analysis of another gorilla population suggests that estimates made by these indirect

methods may be up to 6% inaccurate.

Year	Population in Virunga
1981	254
1989	320
2003	380
2010	480

**Table 24.1**

Calculate the mean annual percentage rate of growth of the gorilla population in Virunga between 1981 and 2010.

Show your working.

Answer ..... % **[2]**

- (iii) In 1993 the Rio Convention on Biodiversity came into force. In 2010, one conservationist commented that the Rio Convention had had a real effect on the gorilla population.

Use the information above to evaluate the effect that the Rio Convention on Biodiversity has had on the gorillas in Virunga.

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**[3]**

4. The table below shows features of the five kingdoms.

Kingdom	Nerves present	Hormones present
Prokaryotae	×	×
Protoctista	×	×
Fungi	×	□
Plantae	×	□
Animalia	□	□

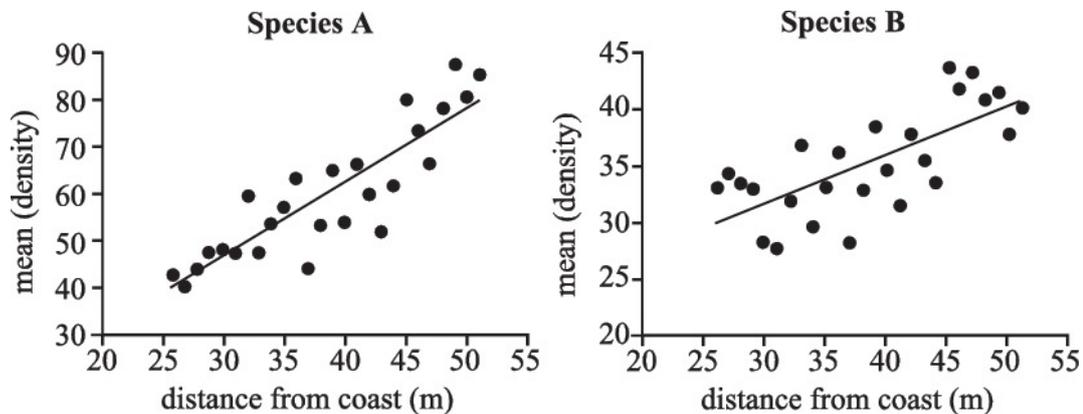
Which of the statements, **A** to **D**, is correct?

- A** only autotrophic organisms require hormones
- B** only heterotrophic organisms need to interact with their environment
- C** only multicellular organisms require hormones
- D** only unicellular organisms require nervous systems

Your answer

[1]

5. The graphs below show the density of two different plant species as proximity to the coast changes.



Which of the following statements correctly describes one aspect of the technique used to collect these data?

- A Quadrats were randomly placed using a random number generator and coordinates.
- B Larger quadrats were required for **species A** because their mean density was higher.
- C A belt transect has been used to allow calculation of density.
- D Abiotic factors were measured at every point of quadrat sampling.

Your answer

[1]

6. Domesticated pigs are descended from *Sus scrofa*, sometimes called the 'wild boar'.

(i) In **Table 17.1**

- number the levels in the correct sequence and
- complete the name column.

Sequence of levels	Level	Name
-----	Order	Artiodactyla
-----	Species	-----
-----	Family	Suidae
1	Kingdom	-----
-----	Genus	-----
-----	Phylum	Chordata
-----	Class	Mammalia

**Table 17.1**

**[4]**

(ii) We now have DNA evidence of how organisms are related to each other. This evidence has helped biologists to construct a second classification viewpoint: the Domain system.

Explain what such developments show about the nature of scientific knowledge.

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**[1]**

- 7(a). A small, permanent pond is the habitat for a climax community of producers (aquatic plants and algae) and consumers (bacteria, protoctista, worms, snails, arthropods and small vertebrates like newts and fish).

Why might ecologists call this a 'climax community'?

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----- [1]

- (b). The protoctist *Paramecium caudatum* is usually between 200 and 300  $\mu\text{m}$  in length. An accurate measurement would help in the correct identification of a specimen from this pond.

What laboratory equipment would you select to make an accurate measurement of the length of *Paramecium caudatum*?

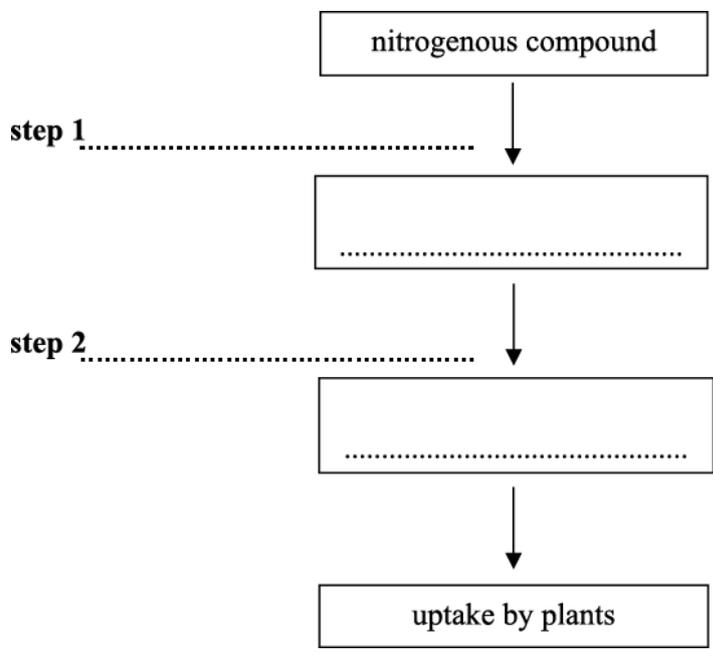
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----- [2]

- (c). An animal fell into the pond. It drowned and decayed. Within a year the biological compounds in its body had been completely recycled.

- (i) What nitrogenous excretory molecule from the decomposers would pass to the next stage of the nitrogen cycle?

----- [1]

- (ii) Complete the flow chart to show what happens to this nitrogenous compound, and name the groups of bacteria involved at steps 1 and 2, as it is converted to a form that plants can take up and use.



[4]



9(a). On a biology field trip, some students carried out a survey of butterfly species in two areas of heathland.

One part of the heathland was used regularly by walkers, while the other had been deliberately fenced off by the National Park Authority in an attempt to promote biodiversity.

**Area 1** was the area accessible to walkers.

**Area 2** was the fenced off area.

On two different mornings in June the students walked along a transect in each area 4 times, at 30 minute intervals, and recorded every butterfly sighting.

The aim of the survey was to compare the biodiversity of butterfly species in the two areas.

Suggest how the procedure could be improved so that a valid comparison could be made.

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**[3]**

(b). The students' results are shown in Table 2.1.

	Area 1	Area 2		
Species of butterfly	Number of individuals ( <i>n</i> )	Number of individuals ( <i>n</i> )		
Grayling	2	5		
Large heath	16	10		
Gatekeeper	9	7		
Green hairstreak	3	5		
Silver-studded blue	0	2		
Small heath	8	11		
<b>Simpsons Index</b>	0.7131			

**Table 2.1**

(i) Identify the area with the higher species **richness** and justify your answer.

Area \_\_\_\_\_

Justification

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[1]

(ii) Identify the area with the higher species **evenness** and justify your answer.

Area \_\_\_\_\_

Justification

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[1]

(iii) Using the formula below, the students calculated Simpsons Index of Diversity in **Area 1** to be 0.7131.

$$D = 1 - (\sum(n/N)^2)$$

Where  $N$  is the total number of individuals of all species.

Simpson's Index of Diversity in **Area 2** is greater than in **Area 1**.

Use the formula to show that this is the case.

You may use the blank spaces in Table 2.1 to assist in your calculations.

Answer \_\_\_\_\_ [4]



10(a). Termites are highly social insects. They are thought to have evolved from earlier forms of insect at least 150 million years ago, in the Jurassic geological period. They are related to cockroaches.

(i) How might scientists a century ago have known that termites evolved in the Jurassic geological period?

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----- [1]

(ii) What new source of evidence might help today's scientists to find out how closely related termites are to cockroaches?

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----- [1]

(b). **Fig. 5.1** shows a termite mound, the nest of approximately one million individuals. The photograph was taken in Queensland Australia, about 3000 kilometres south of the equator.

(i) **Fig. 5.1** shows that the interior of the termite mound is full of interconnecting chambers. At the top of the mound some of these chambers open to the air outside.

Worker termites spend all their time working in brood chambers low in the mound, where eggs and larvae develop.

Explain how carbon dioxide produced in the respiring body cells of worker termites is removed to the air outside the termite mound.

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----- [4]

(ii) In Africa, closer to the equator, the mounds built by some species of termite are blade-shaped, with the long axis pointing North–South. **Fig. 5.2** shows an example of a termite mound in Africa.

Suggest why the African termites need to build mounds in this shape and orientation.

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Fig. 5.1



Fig. 5.2



- 11(a). The Sumatran rhinoceros, *Dicerorhinus sumatrensis*, is a rare member of the family Rhinocerotidae. These rhinoceros are now critically endangered, with only six substantial populations in the wild: four in Sumatra, one in Borneo, and one in the Malay Peninsula.

*D. sumatrensis* lives in rainforests. Their numbers are difficult to determine but they are estimated to number fewer than 100.

Complete the table below, showing the classification of the Sumatran rhinoceros.

Kingdom	-----
Phylum	Chordata
-----	Mammalia
-----	Perissodactyla
Family	Rhinocerotidae
-----	Dicerorhinus
Species	-----

[2]

- (b). The name *Dicerorhinus sumatrensis* is part of the binomial naming system.

State an advantage of using this system rather than using the common name, Sumatran rhinoceros.

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[1]

(c).

(i) Suggest **two** reasons why this species is critically endangered in the wild.

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[2]

(ii) The remaining populations of *D. sumatrensis* are all small and are scattered in isolated areas. These are factors that might speed up the extinction of the species.

Suggest why.

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[2]

(iii) Captive breeding programmes with *D. sumatrensis* have been unsuccessful.

Suggest **one** other way in which zoos can contribute to the conservation of the Sumatran rhinoceros.

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[1]

12. *Nymphaea thermarum* is the world's smallest and most endangered water lily. It was first discovered by scientists in central Africa, in 1987. It has not been seen in the wild since 2008 and is only known to exist in a few botanic gardens.

*N. thermarum* is the only lily that grows in damp mud rather than water.

The site where it was originally discovered has not been directly affected by the activities of humans in the local area.

Suggest why *N. thermarum* is no longer found in the area where it was first discovered.

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[2]

13. The Royal Botanic Gardens also manages the Millennium Seed Bank, which aims to store seeds from one quarter of all plant species.

Give **three** advantages of conserving plant species as seeds and **not** as adult plants.

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3

[3]

14. During the voyage of HMS Beagle, Darwin visited the Galapagos Islands off the coast of South America.

He observed that many of the closely related species showed significant variation.

(i) State the name given to the evolution of a new species.

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[1]

(ii) Suggest why a higher number of species have evolved in the Galapagos Islands, compared with an area of the same size on the South American mainland.

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[1]

15. Fig. 2.1 shows the number of worker bees of *B. pratorum* and *B. terrestris* observed at one location over a year.

Table 2.1 shows some differences in the food collecting behaviour of worker bees of these species.

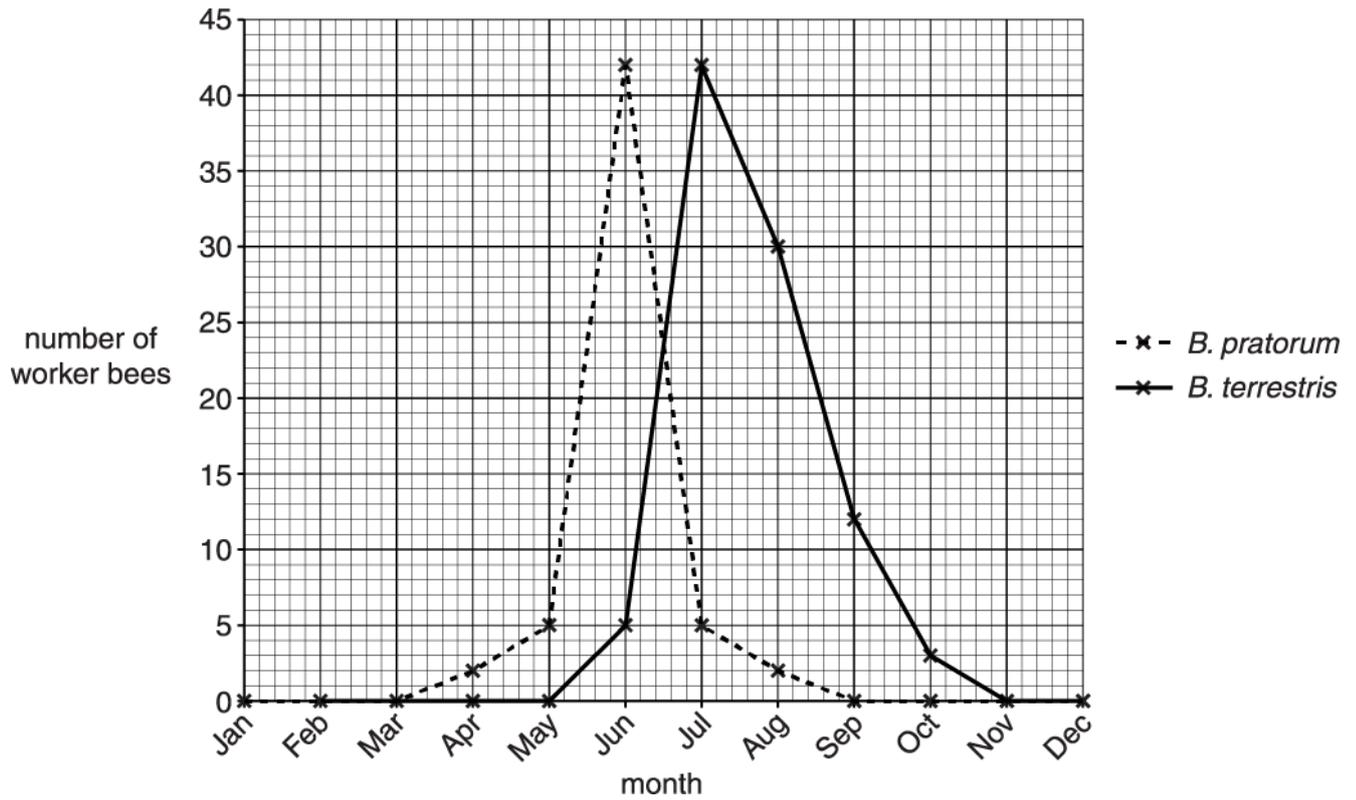


Fig. 2.1

Species of bumble bee	Mean depth of flower visited (mm)	Visits to flowers when nectar only collected (%)	Visits to flowers when pollen only collected (%)	Visits to flowers when both nectar and pollen collected (%)
<i>Bombus pratorum</i>	7.4	23	10	67
<i>Bombus terrestris</i>	6.3	80	11	9

Table 2.1

(i) *B. pratorum* and *B. terrestris* both live in Britain. They can often be found in the same location, as their geographical distributions overlap.

Use Fig. 2.1 and Table 2.1 to evaluate the extent to which the two species may compete.

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16. A batch fermenter is used during the production of beer.

Fig. 5.1(a) and Fig. 5.1(b), show some changes that take place in the fermenter over the first 6 days.

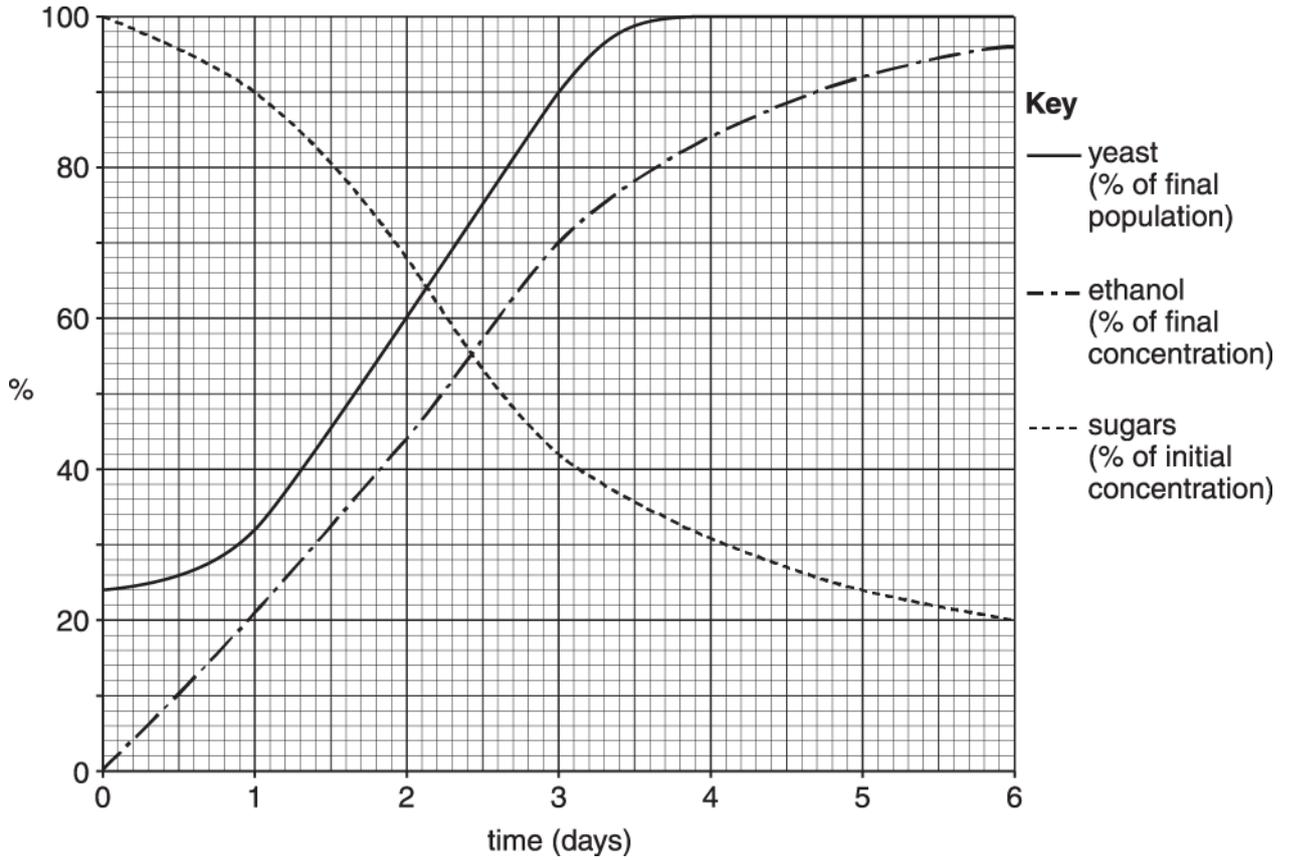


Fig. 5.1(a)



(ii) Fig. 5.1(a) shows that as the sugar concentration decreases the ethanol concentration increases.

Explain this relationship.

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**[3]**

(iii) Using the information from Fig. 5.1(a), explain why ethanol is considered to be a primary metabolite of yeast.

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**[1]**

(iv) Using only the information from Fig. 5.1(a) and Fig. 5.1(b), outline how **two** factors may limit the maximum size of the yeast population.

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**[2]**

**END OF QUESTION PAPER**

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			<b>Total</b>	<b>1</b>	
2			D	1	
			<b>Total</b>	<b>1</b>	
3	a	i	seed dispersal	1	
		ii	(named) economic reason (named) aesthetic reason	2	
	b	i	<i>advantage:</i> exhibit natural behaviour / less likely to catch disease from humans (1)  <i>disadvantage:</i> poaching more likely / could be wiped out by disease / more difficult to count (1)	2	Must give one advantage and one disadvantage.
		ii	3.1 (%) (1)(1)	2	<b>ALLOW</b> one mark if calculation correct but final figure incorrect e.g. $(480 - 254) / 254 \times 100 / 29 =$  <b>ALLOW</b> 3% or 3.07%
		iii	<i>three from</i> no evidence of causal effect (1) the data may be inaccurate as a result of, indirect methods used / unhabituated animals hard to find (1) annual growth rate higher after 1993 (1) 3.2% (per year) before 1993 against 3.8% after 1993 (1) figures may not be accurate due to collection technique (1)	3	
			<b>Total</b>	<b>10</b>	
4			C	1	
			<b>Total</b>	<b>1</b>	
5			C	1	
			<b>Total</b>	<b>1</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																								
6		i	<table border="1"> <thead> <tr> <th>Sequence of Levels □</th> <th>Level</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td>4</td> <td>Order</td> <td>Artiodactyla</td> </tr> <tr> <td>7</td> <td>Species</td> <td><b>scrofa</b> □</td> </tr> <tr> <td>5</td> <td>Family</td> <td>Suidae</td> </tr> <tr> <td>1</td> <td>Kingdom</td> <td><b>Animal(ia)</b> □</td> </tr> <tr> <td>6</td> <td>Genus</td> <td><b>Sus</b> □</td> </tr> <tr> <td>2</td> <td>Phylum</td> <td>Chordata</td> </tr> <tr> <td>3</td> <td>Class</td> <td>Mammalia</td> </tr> </tbody> </table>	Sequence of Levels □	Level	Name	4	Order	Artiodactyla	7	Species	<b>scrofa</b> □	5	Family	Suidae	1	Kingdom	<b>Animal(ia)</b> □	6	Genus	<b>Sus</b> □	2	Phylum	Chordata	3	Class	Mammalia	4	<p><b>One mark</b> for level numbers <b>all</b> correct in Column 1.</p> <p><b>DO NOT ALLOW</b> if scrofa is given capital S.</p> <p><b>ALLOW</b> "Animals"</p> <p><b>DO NOT ALLOW</b> if Sus is given lower-case initial s.</p>
			Sequence of Levels □	Level	Name																								
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			6	Genus	<b>Sus</b> □																								
			2	Phylum	Chordata																								
3	Class	Mammalia																											
	ii	science knowledge / it, advances / improves / grows / AW (1)	1	"Develop" is in the question.																									
<b>Total</b>			<b>5</b>																										
7	a	(pond community is) final / stable / not subject to further succession	1	<b>IGNORE</b> 'permanent', it is in the rubric.																									
	b	light microscope (1) graticule (1)	2																										
	c	i	urea / uric acid	1	<b>ALLOW</b> ammonia, ammonium (ions).																								
		ii	Nitrosomonas (1) nitrite (1) Nitrobacter (1) nitrate (1)	4																									
	<b>Total</b>			<b>8</b>																									

**Mark Scheme**

Question		Answer/Indicative content	Marks	Guidance								
8	a	<table border="1"> <thead> <tr> <th>Deduction</th> <th>Supporting observation(s)</th> </tr> </thead> <tbody> <tr> <td>characteristics are passed on to the next generation</td> <td><b>E</b> (1)</td> </tr> <tr> <td>there is a struggle for existence (1)</td> <td><b>G</b> and <b>H</b></td> </tr> <tr> <td>individuals with beneficial characteristics are among the few who survive</td> <td><b>F</b> and <b>G</b> and <b>H</b> (1)</td> </tr> </tbody> </table>	Deduction	Supporting observation(s)	characteristics are passed on to the next generation	<b>E</b> (1)	there is a struggle for existence (1)	<b>G</b> and <b>H</b>	individuals with beneficial characteristics are among the few who survive	<b>F</b> and <b>G</b> and <b>H</b> (1)	3	
		Deduction	Supporting observation(s)									
		characteristics are passed on to the next generation	<b>E</b> (1)									
		there is a struggle for existence (1)	<b>G</b> and <b>H</b>									
individuals with beneficial characteristics are among the few who survive	<b>F</b> and <b>G</b> and <b>H</b> (1)											
	b	<p><i>biological molecule</i> nucleic acid / (nuclear) DNA / mtDNA / RNA (1)</p> <p><i>idea that</i> in samples from two species sequence similarity in any of the above can imply an evolutionary relationship, difference / divergence in sequence implies evolutionary distance (1)</p> <p><i>biological molecule</i> proteins / polypeptides / cytochrome C / haemoglobin (1)</p> <p><i>idea that</i> in the same protein from two species, amino acid / primary sequence similarity implies evolutionary relationship, difference / divergence in sequence implies evolutionary distance (1)</p>	4	<b>ALLOW</b> named proteins commonly used								
		<b>Total</b>	<b>7</b>									

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
9	a	<p><i>idea of more transects in different parts of area 1 and 2 (1)</i>  <i>(collect at) different, times of day / times of year / weather conditions (1)</i>  <i>method of ensuring that individuals not counted again (1)</i></p> <p><i>(use a method to) capture individuals (1)</i>  <i>(use a method to) correctly identify species (1)</i></p>	3	<p><b>ALLOW</b> example of appropriate method, e.g. (butterfly) net  <b>ALLOW</b> e.g. photograph / use of key</p>
	b	i	1	
		ii	1	<p><b>ALLOW</b> use of figures to exemplify</p>
		iii	4	<p><b>Correct answer given to 4 sig. fig. with no working shown = 4 marks</b></p> <p><b>ALLOW</b> correct answer with different sig. figs  <b>ALLOW</b> correct answer with different sig. figs</p>

Species of butterfly	Area 1		Area 2	
	Number of individuals ( <i>n</i> )	Number of individuals ( <i>n</i> )	<i>n/N</i>	$(n/N)^2$
Grayling	2	5	0.125	0.0156
Large heath	16	10	0.250	0.0625
Gatekeeper	9	7	0.175	0.0306
Green hairstreak	3	5	0.125	0.0156
Silver-studded blue	0	2	0.050	0.0025
Small heath	8	11	0.275	0.0756
		N = 40		<b>0.2024</b>
Simpsons Index	0.7131			<b>0.7976</b>

any successful calculation of  $(n/N)^2$  (1)  
 $(\sum(n/N)^2 \Rightarrow) 0.2024$  (1)  
 $(1-\sum(n/N)^2 \Rightarrow) 0.7976$  (1)  
 answer given to 4 significant figures (1)

## Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
c	<p>For answers marked by levels of response:</p> <p>Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.</p> <p>Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, <b>best</b> describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme.</p> <p>Once the level is located, award the higher or lower mark.</p> <p><b>The higher mark</b> should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.</p> <p><b>The lower mark</b> should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.</p> <p><b>In summary:</b></p> <ul style="list-style-type: none"> <li>• <b>The science content determines the level.</b></li> <li>• <b>The communication statement determines the mark within a level.</b></li> </ul>		

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p><b>Level 3 (5–6 marks)</b>            Full and detailed evaluation of the students' conclusion taking into account the validity of the method used <b>and</b> the implications of the data collected. Learner demonstrates a holistic judgement of the information including evidence for <b>and</b> against the claim. The candidate makes a judgement that there is not enough evidence to support the students' conclusion.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p>	6	<p><b>Indicative scientific points may include...</b></p> <p><b>Evidence to support the conclusion (that fencing increased biodiversity)</b></p> <ul style="list-style-type: none"> <li>• calculated Simpson's Index of Diversity is higher in fenced area</li> <li>• high Simpson's Index means high biodiversity</li> <li>• greater number of species / higher species richness in fenced area</li> <li>• silver-studded blue only occurs in fenced area.</li> </ul>

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p><b>Level 2 (3–4 marks)</b> An evaluation of the students' conclusion taking into account the validity of the method used <b>and / or</b> the implications of the data collected. Learner demonstrates a holistic judgement of the information including evidence for <b>and</b> against the claim. The candidate makes a judgement in line with the argument they have presented.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> <p><b>Level 1 (1–2 marks)</b> An evaluation of the claim is attempted including discussion of either the validity of the method <b>or</b> the implications of the data. The answer includes evidence for <b>or</b> against the claim. A definitive judgement may not be present.</p> <p><i>A basic structure and some relevant information is provided, although a clear line of reasoning may not be present. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i></p> <p><b>0 marks</b> No response or no response worthy of credit.</p>		<p><b>Students' conclusion may be overdrawn because...</b></p> <ul style="list-style-type: none"> <li>• difference in Simpson's Index of Diversity between two areas is small (12%)</li> <li>• range of number of individuals is greater in Area 1 (0–16) than Area 2 (2–11)</li> <li>• higher number of individuals of 'Large heath' and 'Gatekeeper' butterflies sighted in Area 1.</li> <li>• do not know length of time Area 2 has been fenced off.</li> <li>• <i>limitations of method</i> <ul style="list-style-type: none"> <li>◦ samples taken on only two days</li> <li>◦ samples only taken in one season</li> <li>◦ no method to prevent recounting</li> <li>◦ observation at a distance might have led to mis-identification.</li> </ul> </li> </ul>
	<b>Total</b>	<b>15</b>	

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10	a	i	fossils in, known-age / Jurassic, strata / rocks	1	
		ii	DNA / cytochrome c	1	
	b	i	carbon dioxide diffuses down concentration gradient out of the respiring cell (1) carried through body from cell (to tracheoles) by blood passing out via tracheoles / trachea / spiracles (1) respiration generates heat (1) hot gases expand and are less dense so rise up by convection through the mound to vents at mound-top (1)	4	
		ii	<i>shape</i> , large or increased surface area to volume ratio (1)  smallest area exposed to greatest heat (1)	2	Response <b>must</b> be linked to context of avoiding overheating / needing to get rid of heat.
			<b>Total</b>	<b>8</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance								
11	a	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;"><i>Column 1</i></td> <td style="width: 50%; border: none;"><i>Column 2</i></td> </tr> <tr> <td style="border: none;">Class</td> <td style="border: none;">Animalia</td> </tr> <tr> <td style="border: none;">Order</td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;">Genus □</td> <td style="border: none;"><i>sumatrensis</i> □</td> </tr> </table>	<i>Column 1</i>	<i>Column 2</i>	Class	Animalia	Order		Genus □	<i>sumatrensis</i> □	2	<p><i>If additional incorrect answer given, then 0 marks</i> One mark per correct column.</p> <p><b>ACCEPT</b> Animal / phonetic spelling / in lower case</p> <p>'sumatrensis' must be all in lower case <b>DO NOT CREDIT</b> if the 's' is clearly upper case <b>DO NOT CREDIT</b> D. sumatrensis <b>DO NOT CREDIT</b> Sumatran / sumatran</p> <p><b>Examiner's Comments</b></p> <p>In the classification table the categories of taxa were correctly stated by the majority but the actual classification groups within the taxa posed more problematical□ in particular identifying 'Animalia' as the correct kingdom. Eukaryota was a common error. Although many candidates correctly stated the species as 'sumantrensis', very many were not credited the mark because of using a capital letter.</p>
<i>Column 1</i>	<i>Column 2</i>											
Class	Animalia											
Order												
Genus □	<i>sumatrensis</i> □											
	b	<p>universal / recognised worldwide / AW □</p> <p>know which, genus / species, it belongs to □</p> <p><i>idea of</i> different common name for the same organism □</p>	max 1	<p><b>ACCEPT</b> no language barrier</p> <p><b>ACCEPT</b> ref to showing evolutionary relationships (e.g. shows common ancestry)</p> <p><b>Examiner's Comments</b></p> <p>Most candidates stated that the advantage of the binomial naming system is that it is used as a universal language and therefore avoids confusion over different common names for the same organism.</p>								

**Mark Scheme**

Question		Answer/Indicative content	Marks	Guidance
	c i	<p>loss of, (rainforest) habitat / food source <b>or</b> deforestation <input type="checkbox"/></p> <p>hunting / poaching (for horn) <input type="checkbox"/></p> <p>climate change <input type="checkbox"/></p>	max 2	<p><b>IGNORE</b> disease</p> <p><b>ACCEPT</b> loss of (rainforest) ecosystem <b>IGNORE</b> only lives in rainforest</p> <p><b>Examiner's Comments</b></p> <p>'Poaching' or 'hunting' and 'deforestation' were the most common correct reasons given for why the species is critically endangered.</p>
	ii	<p>1 hard to find a mate / may be gender imbalance <input type="checkbox"/></p> <p>2 (inbreeding leading to) low genetic diversity / small gene pool / genetic bottleneck <input type="checkbox"/></p> <p>3 cannot / less likely to, cope with / adapt to, (named) environmental change <input type="checkbox"/></p> <p>4 all wiped out by the same disease <input type="checkbox"/></p> <p>5 more vulnerable to, predators / poachers <input type="checkbox"/></p> <p>6 natural disaster could wipe out, one / some, of the small populations <input type="checkbox"/></p>	max 2	<p>1 <b>ACCEPT</b> few individuals of reproductive maturity</p> <p>2 <b>ACCEPT</b> description</p> <p>3 <b>ACCEPT</b> (population) unable to cope with new selection pressures</p> <p>4 <b>DO NOT CREDIT</b> that they are more susceptible to disease in general</p> <p><b>Examiner's Comments</b></p> <p>Many candidates stated that less reproduction would occur but did not further develop the idea. A smaller gene pool or less genetic variation was often correctly stated but fewer candidates went on to explain how this would speed up extinction in terms of a lack of ability to adapt to environmental change or all being vulnerable to a particular disease. There was a misconception for some candidates in this question, since they discussed problems for small animals as opposed to small populations.</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	<p>education / awareness □</p> <p>support for / promote, conservation projects / research □</p>	max 1	<p><b>IGNORE</b> ref to cloning</p> <p>In the context of educating the general public e.g. information displayed in the zoo or on website / holding education days for schools</p> <p>‘support’ could mean: raise money / provide funds / provide technical support / provide expertise / etc.</p> <p><b>CREDIT</b> in the context of an example e.g. sending people to monitor populations in the wild e.g. supporting the setting up of nature reserve</p> <p><b>IGNORE</b> zoo sets up nature reserves</p> <p><b>Examiner's Comments</b></p> <p>This question proved to be challenging for most candidates who often failed to note from the information in the question that captive breeding programmes with <i>D. sumatrensis</i> have been unsuccessful. It was very common to read in their responses that the zoos could re-introduce the rhinos into the wild, rather than correctly referring to zoos providing funding or support for conservation projects or raising public awareness.</p>
			<b>Total</b>	<b>8</b>	

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
12		<p>global warming;</p> <p><i>example of consequence of climate change</i></p> <p>mud has dried up / mud now too wet / flooding / disease / (new) herbivore / pest;</p>	2	<p><b>ACCEPT</b> climate change <b>IGNORE</b> environmental change</p> <p><b>ACCEPT</b> (new) predator / heavy rainfall / drought <b>IGNORE</b> refs to temperature for this marking point <b>IGNORE</b> competition</p> <p><b>Examiner's Comments</b></p> <p>Both marks were given, more often than not, in this question. Most candidates cited climate change or global warming and many were able to link this to a specific local event, most commonly the drying up of damp mud.</p>
		<b>Total</b>	<b>2</b>	

### Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
13	<p>1 can be collected with minimal damage to (wild), population / habitat / ecosystem;</p> <p>2 take up little space / larger numbers can be stored; <b>ora</b></p> <p>3 can store great(er), genetic / allelic, diversity; <b>ora</b></p> <p>4 low(er) maintenance / manpower costs / AW; <b>ora</b></p> <p>5 easy / cheaper, to transport / AW; <b>ora</b></p> <p>6 <i>idea of remaining viable</i> for long periods; <b>ora</b></p> <p>7 <i>less</i>, susceptible / vulnerable, to, disease / pests / environmental change; <b>ora</b></p> <p>8 <i>idea that</i> prevents fertilisation by undesired pollen;</p>	3 max	<p><b>Mark as prose. Ignore numbered lines.</b></p> <p><b>2 ACCEPT</b> easier to store a large amount</p> <p><b>4 CREDIT</b> 'cheaper' only if supported by an explanation  <b>4 IGNORE</b> easier to keep unqualified  <b>4 ACCEPT</b> less labour-intensive  <b>4 DO NOT CREDIT</b> no maintenance costs</p> <p><b>6 CREDIT</b> description / example – e.g. kept dry so that they do not rot / regular germination and new seed production  <b>6 IGNORE</b> 'last a long time' unqualified  <b>6 ACCEPT</b> 'stay, alive / fertile, for a long time'</p> <p><b>7 ACCEPT</b> the adult plant might have a disease  <b>7 IGNORE</b> prevents</p> <p><b>Examiner's Comments</b></p> <p>This question produced marks in the range 1-3 in roughly equal proportions. All marking points were seen, although it was rarer to see reference to less damage to the wild population or the ability to store greater genetic diversity. Many responses discussed seeds being stored for a long time, but without reference to viability the mark was not awarded. A common answer was that in the future, plants could be easily reintroduced back to into the wild; this was not credited because the same could also be said of conserving adult</p>

### Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					plants.
			<b>Total</b>	<b>3</b>	
14		i	specification;	1	<p><b>Examiner's Comments</b></p> <p>The vast majority of candidates correctly identified speciation as the answer. Variation, adaptation, mutation, and natural selection were also seen.</p>
		ii	<p><i>idea that</i> different islands have different, selection pressures / habitats / environments / vacant niches; <b>ora</b></p> <p><i>idea of</i> isolation; <b>ora</b></p>	1 max	<p><b>CREDIT</b> 'the Galapagos have a wider range of habitats'</p> <p><b>IGNORE</b> islands have different habitat(s) from the mainland</p> <p>e.g. the islands are separated from the mainland / no gene flow / geographic barrier / reproductive barrier</p> <p><b>ACCEPT</b> allopatric (speciation)</p> <p><b>IGNORE</b> sympatric</p> <p><b>IGNORE</b> refs to succession or human habitat destruction on the mainland as the question is about evolution</p> <p><b>Examiner's Comments</b></p> <p>Most candidates were able to get the idea of isolation or more varied selection pressures into their answer. The commonest incorrect answers discussed the influence of humans on the islands.</p>
			<b>Total</b>	<b>2</b>	

**Mark Scheme**

Question	Answer/Indicative content	Marks	Guidance
15	<p>i</p> <p><b>1</b> not much / little / some, competition / niche overlap;</p> <p><i>reasons for little competition</i></p> <p><b>2</b> use / feed on, different sized flowers / different depth of flowers;</p> <p><b>3</b> vary in proportions of pollen <b>and</b> nectar they collect;</p> <p><b>4</b> fly / live / active / feed / visit flowers, at different times;</p> <p><i>reason for competition</i></p> <p><b>5</b> <i>idea that fly / live / active / feed / visit flowers, overlaps there must be competition;</i></p> <p><b>6</b> AVP;</p>	4 max	<p><b>This mark is for a stand alone statement DO NOT CREDIT</b> no competition  <b>IGNORE</b> competition unqualified / inter / intra</p> <p><b>2 CREDIT</b> correct comparative description or use of data            e.g. <i>B. pratorum</i> feed on, bigger / longer / deeper, flowers  <b>or</b>  <i>B. pratorum</i> 7.4(mm) <b>and</b> <i>B. terrestris</i> 6.3(mm)</p> <p><b>3 CREDIT</b> correct description e.g. <i>B. pratorum</i> mostly pollen and nectar <b>and</b> <i>B. terrestris</i> mostly nectar only  <b>or</b> comparison of 2 species using table data  <b>IGNORE</b> 'different amounts' of pollen and nectar</p> <p><b>4 CREDIT</b> correct description of difference e.g. <i>B. pratorum</i> peak in June <b>and</b> <i>B. terrestris</i> in July  <b>or</b>  <i>B. pratorum</i> appear in earlier in the year  <b>or</b> comparison of 2 species using graph data</p> <p><b>5 CREDIT</b> correct description from data e.g. both compete for food between May and September / both collect pollen only from same % flowers</p> <p>6 e.g. use / feed on, different <u>species</u> of flowers</p> <p><b>Examiner's Comments</b></p> <p>Most candidates got the idea that there was some degree of competition, and successfully gained 1 or 2 marks, but generally answers were poorly constructed with many candidates using the space</p>

## Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			<p>available to explain just one or two marking points. For example, many candidates achieved marking point 5, referring to numerous examples of competition in their answer, but only able to achieve one mark. Candidates were good at using data from the graph and table, but often in a vague way - eg. 'peak in the summer months' - and without relating it to the question. Common errors were giving the wrong time scale from x axis, not mentioning both nectar and pollen for mp3 and saying that bees competed as they visited flowers of similar or same depths, or that one species outcompeted the other species of bee.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	ii	<p><b>1</b> <i>idea of</i> isolation / isolating mechanism / barrier;</p> <p><b>2</b> seasonal (difference) / temporal (difference) / males and queens (in different populations) produced in different months / breeding (in different populations) in different months;</p> <p><b>3</b> behavioural (difference) / visit different (types of) flowers / feed at different times / feed on different food types;</p> <p><b>4</b> different flower locations / different (micro)habitats;</p> <p><b>5</b> <i>idea that</i> gene flow restricted / no gene flow (between populations);</p> <p><b>6</b> different adaptations / specialisation / niche partitioning;</p>	3 max	<p><b>2 CREDIT</b> example of seasonal / temporal (e.g. <i>B. pratorum</i> has its peak number of workers in June and <i>B. terrestris</i> in July)</p> <p><b>3 CREDIT</b> 'different mating rituals'</p> <p><b>5 must refer to gene / allele</b></p> <p><b>6 IGNORE</b> speciation (as implied in Q) - can be mistaken for specialisation</p> <p><b>Examiner's Comments</b></p> <p>The majority of candidates scored well on this question. Most recognised the need for isolation / barriers and mentioned seasonal and / or behavioural differences. However, few mentioned the idea of restricted gene flow and specialisation in the two separate populations leading to the evolution of the new species.</p>
		<b>Total</b>	<b>7</b>	

**Mark Scheme**

Question	Answer/Indicative content	Marks	Guidance										
16	<p>i</p> <p><b>1</b> lag phase / slow increase (in, population / number / percentage), at start / initially / day 0 - 1 / during day 1;</p> <p><b>2</b> log phase / exponential increase / rapid increase, day 1 - 3;</p> <p><b>3</b> <u>rate of increase</u>, slows / less steep, days 3 - 4 / during day 3;</p> <p><b>4</b> stationary phase / population levels off / population stays at 100%, at end / finally / remaining days / days 4 - 6;</p> <p><b>5</b> comparative figures quoted with 2 x-y readings;</p>	4 max	<p><b>IGNORE</b> explanations  <b>ACCEPT</b> 'the population grows' or 'it grows' (rather than increase)</p> <p><b>DO NOT CREDIT</b> 'yeast grow(s)'</p> <p><b>1 ACCEPT</b> days 0 – 0.9  <b>ACCEPT</b> lasts 1 day</p> <p><b>2 ACCEPT</b> days 0.9 – 3.5</p> <p><b>3 ACCEPT</b> days 3.3 – 3.6</p> <p><b>4 ACCEPT</b> after day 3.5 – 4</p> <p><b>5</b> Each unit must be quoted at least once</p> <table border="1" data-bbox="983 1003 1501 1196"> <thead> <tr> <th>Time (days)</th> <th>Yeast (% final population)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>24</td> </tr> <tr> <td>1</td> <td>32</td> </tr> <tr> <td>3</td> <td>90</td> </tr> <tr> <td>3.5 - 6</td> <td>100</td> </tr> </tbody> </table> <p><b>Take care to distinguish between an increase in percentage (by either quoting the figures for the days or by calculating the difference) and a percentage increase.</b></p> <p><b>Examiner's Comments</b></p> <p>This question was generally done very well with candidates often gaining 3 out of the 4 available marks. Most candidates knew the terms lag and log phase and could describe the growth occurring there. However many could not accurately quote the days at the beginning and end of each phase. Many also read the values wrongly from the graph or failed to express it correctly i.e. 2 x-y readings, and so failed to gain mp5. Only a very few candidates</p>	Time (days)	Yeast (% final population)	0	24	1	32	3	90	3.5 - 6	100
Time (days)	Yeast (% final population)												
0	24												
1	32												
3	90												
3.5 - 6	100												

**Mark Scheme**

Question		Answer/Indicative content	Marks	Guidance
				gave a comment that the rate of increase slowed down during day 3. A significant number also described the pH, sugar and ethanol changes shown by the graphs, or explained reasons why the growth rate was slow or fast, which gained no credit.
	ii	<p><b>1</b> sugar converted to ethanol;</p> <p><b>2</b> in <u>anaerobic respiration</u>;</p> <p><b>3</b> sugar, undergoes glycolysis / converted to pyruvate;</p> <p><b>4</b> pyruvate, loses carbon dioxide / decarboxylated / forms <u>ethanal</u>;</p> <p><b>5</b> reduced NAD giving hydrogen to ethanal;</p> <p><b>6</b> <i>idea of</i> NAD being, regenerated / recycled, (so) glycolysis continues;</p> <p><b>7</b> correct ref to, pyruvate decarboxylase / ethanol dehydrogenase;</p>	3 max	<p><b>CREDIT</b> glucose / maltose / maltotriose for 'sugar'</p> <p><b>2 IGNORE</b> fermentation</p> <p><b>5 CREDIT</b> NADH<sub>2</sub> / NADH (+H<sup>+</sup>) / red NAD</p> <p><b>Examiner's Comments</b></p> <p>It was pleasing to see that the majority of candidates could relate the decrease in sugar concentration to the fact that the yeast is converting it to ethanol in anaerobic respiration. Good responses went on to describe the steps involved in the conversion of sugar to ethanol to gain full marks.</p>
	iii	<p><i>ethanol is</i> produced in, <b>all</b> yeast growth phases / <b>all</b> of the time</p> <p><b>or</b></p> <p>production of ethanol increases as yeast population increases</p> <p><b>or</b></p> <p><i>idea that</i> ethanol is a normal (metabolic waste) product (of yeast);</p>	1	<p><b>IGNORE</b> ref to ethanol not being a secondary product</p> <p><b>CREDIT</b> 'produced during normal growth'</p> <p><b>CREDIT</b> follows growth curve for yeast</p> <p><b>IGNORE</b> waste unqualified</p> <p><b>Examiner's Comments</b></p> <p>Many candidates successfully gained a mark for stating that ethanol was produced as a normal product of metabolism or that it followed the growth curve of yeast. A common error was to say that ethanol was produced during a specific phase rather than in all growth phases, or that ethanol is needed for growth.</p>

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	iv	<p><b>1</b> sugar <u>concentration</u> falls <b>too</b> low;</p> <p><b>2</b> pH falls <b>too</b> low / conditions become <b>too</b> acidic / decrease in pH causes enzymes to denature;</p> <p><b>3</b> high ethanol <u>concentration</u>, damages / poisons / inhibits, yeast;</p>	2 max	<p><b>1 ACCEPT</b> very low sugar concentration / sugar concentration decreases as used up</p> <p><b>2 ACCEPT</b> very low pH / very acidic <b>DO NOT CREDIT</b> 'falls and rises'</p> <p><b>3 ACCEPT</b> high ethanol <u>concentration</u> kills yeast</p> <p><b>Examiner's Comments</b></p> <p>It was surprising that more candidates did not score 2 marks on this question. Many referred to pH but did not discuss it being too low or refer to denaturing of enzymes, and some thought it would go too high. A number of candidates incorrectly referred to the presence of ethanol as being responsible for pH changes. Only a few referred to sugar concentration going too low, and many just used the term sugar alone or just said it would decrease. The term 'amount' was often used instead of the required more precise term 'concentration'.</p>
		<b>Total</b>	<b>10</b>	