

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(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.

----- [1]

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

1

2

----- [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.

----- [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.

[3]

- 3(a). The invertebrate biodiversity of two different peat bog ecosystems was sampled. Values of Simpson's Diversity Index were calculated for both ecosystems. The results are shown in Table 4.1.

Species	Ecosystem A			Ecosystem B		
	n	n/N	$(n/N)^2$	n	n/N	$(n/N)^2$
<i>G. cottonae</i>	3	0.0361	0.0013	14	0.15	0.0227
<i>G. servulus</i>	1	0.0120	0.0001	12	0.13	0.0166
<i>C. cocksi</i>	4	0.0482	0.0023	20	0.22	0.0462
<i>L. nigrifrons</i>	24	0.2892	0.0836	25	0.27	0.0723
<i>E. cryptarum</i>	33	0.3976	0.1581	22	0.24	0.0560
<i>T. limbata</i>	5	0.0602	0.0036			
<i>S. litorea</i>						
<i>T. rivularis</i>	1	0.0120	0.0001			
<i>S. argus</i>	4	0.0482	0.0023			
$\Sigma =$			0.2607			0.2138
$1 - \Sigma =$			0.7393			0.7862

Table 4.1

- (i) Complete the missing row in Table 4.1 by adding the correct values for *S. litorea*.

[3]

- (ii) What can you conclude about the species evenness and richness of **Ecosystem A** in comparison to **Ecosystem B**?

[2]

- (iii) Scientists planned to sample the biodiversity in another peat bog ecosystem. They identified three different areas within the ecosystem:

- an area of conifer trees (800 m²)
- a marshy area with a high water table (2400 m²)
- a heavily grazed area (3200 m²)

Suggest the sampling strategy that the scientists should use and comment on the number of samples they should collect.

[3]

(b). The genetic diversity of the moss *Polytrichum commune* was analysed in two peat bog ecosystems.

Scientists measured genetic diversity by studying three gene loci. For each gene locus, they calculated the proportion of heterozygotes in each population. These values were used as a measure of genetic diversity.

The scientists sampled 72 individuals from Population A and 48 individuals from Population B.

The results of the genetic analysis are shown in Table 4.2.

	Number of heterozygous individuals		
	Locus 1	Locus 2	Locus 3
Population A	65	69	60
Population B	42	41	40

Table 4.2

Using the data in Table 4.2, suggest which of the two populations of *P. commune* has the greater genetic diversity.

Explain your conclusion **and** show your working.

[2]

4(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.

[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		
Simpsons Index	0.7131			

Table 2.1

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

Area _____

Justification

[1]

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

Area _____

Justification

[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.

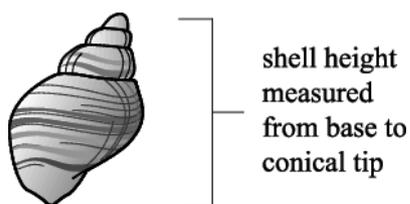
Simpson's Index of Diversity in **Area 2** is greater than in **Area 1**.

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]

5. The effect of wave action on the height of the shells of the dog whelk (*Nucella lapillus*) was investigated by comparing an exposed shore and a sheltered shore.



- A random sampling technique was used to collect 50 shells from an exposed shore.
- The shell height was measured from the base to the conical tip. The whelk was returned to its location.
- The process was repeated for the sheltered shore.
- All the results were recorded in **Table 3.1**.

Location	Height of shell (mm)										Range	Mean	SD
Sheltered shore	26	28	27	26	28	23	28	23	26	28			
	29	29	29	29	29	28	29	29	29	29			
	30	31	30	29	32	29	30	29	30	32			
	33	35	34	32	35	32	34	32	33	35			
	37	39	38	37	39	35	38	36	37	39			
											16	31.3	4.1
Exposed shore	15	17	16	15	23	15	23	16	13	15			
	17	24	18	17	17	14	17	18	16	17			
	19	19	20	24	18	20	19	20	18	20			
	23	14	24	14	21	20	23	17	21	23			
	25	25	28	26	25	27	25	28	25	27			
											15	20.0	4.2

Table 3.1

- (a) The t test can be used to determine the significance of the differences between shell height on the exposed shore and the sheltered shore.
- (i) Calculate the *t* value for the data using the formula:

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

where, $|\bar{x}_1 - \bar{x}_2|$ is the difference in mean values of sample 1 and sample 2

s_1^2 and s_2^2 are the squares of the standard deviations of the samples

n_1 and n_2 are the sample sizes.

Give your answer to **two** decimal places.

Answer_____ [2]

(ii) The null hypothesis is that there is no difference between the means of the two shell populations.

The critical values at 98 degrees of freedom are shown in **Table 3.2**.

Degrees of freedom	$p = 0.10$	$p = 0.05$	$p = 0.01$	$p = 0.001$
98	1.67	2.00	2.64	3.41

Table 3.2

Using the table of critical values, explain whether the student would be able to accept or reject the null hypothesis as a result of the t value you calculated in part (i).

 ----- [1]

(b) The students organised the data from **Table 3.1** into classes.

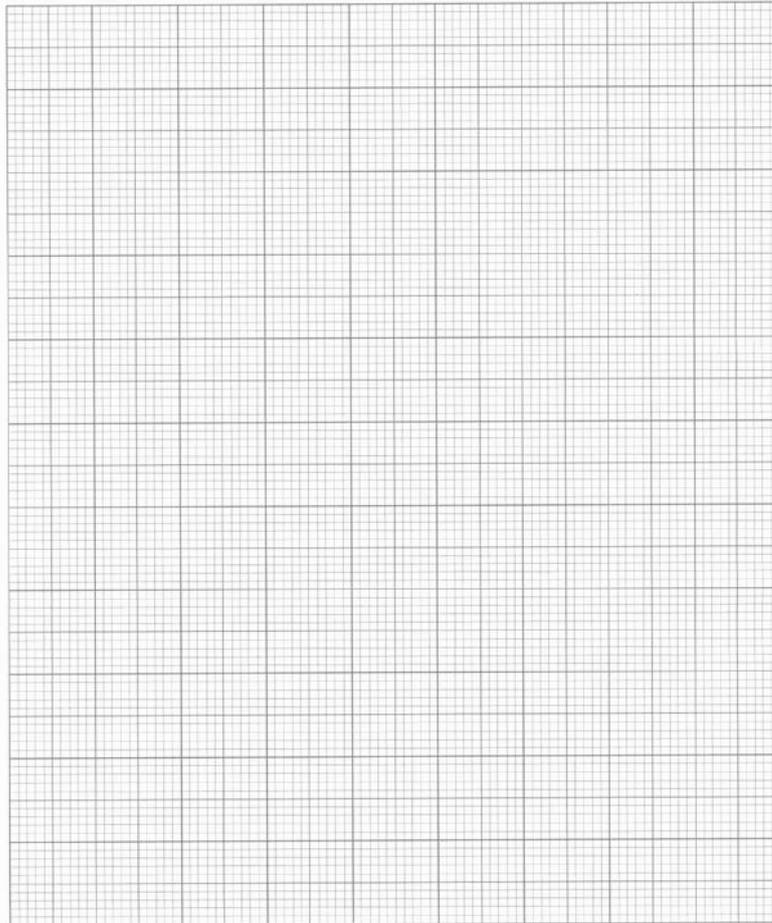
The organised data is shown in **Table 3.3**.

Sheltered shore			Exposed shore		
Height (mm)	Tally	Total	Height (mm)	Tally	Total
23–26	III	5	11–14	IIII	4

27-30	IIII IIII IIII IIII II	22	15-18	IIII II	18
31-34	IIII IIII I	11	19-22	IIII IIII II	12
35-38	IIII IIII	9	23-26	IIII IIII II	12
39-42	IIII	3	27-30	IIII	4

Table 3.3

Plot the most suitable graph of the data given in **Table 3.3**.



[4]

(c) Use the data and graph to discuss any correlation between the height of the whelk shell and the type of shore.

Suggest explanations for your findings.

[3]

(d) Suggest a limitation of the procedure used to gather the data in this experiment and recommend how you could improve this.

[2]

(e) How could the students improve the accuracy of their data?

[1]

(f) Discuss the validity of the conclusions you have made during this experiment.

[3]

6.

Termites such as the species that built the mound in **Fig. 5.1** on the insert can be classed as 'keystone species'.

Use the information given to state one argument that supports this statement and one argument that does not.

[2]

Fig. 5.1



7. DNA fragments can be separated using electrophoresis.

Fig. 3.1 shows the result of electrophoresis of several DNA samples.

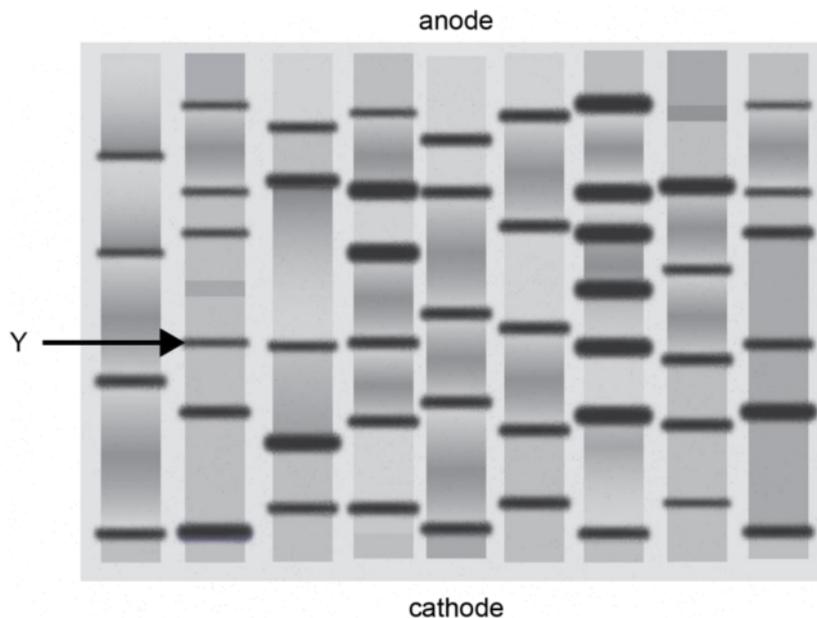


Fig. 3.1

(i) Describe how DNA can be visualised after electrophoresis has been completed.

[2]

(ii) Place a cross (X) on Fig. 3.1 to indicate the position of a fragment of DNA with a mass greater than the DNA band labelled Y.

[1]

8. A student investigated the effect of different sugars on the growth of bacteria.

The student found that the bacteria grew well when provided with glucose, sucrose and fructose, but did not grow well when provided with lactose.

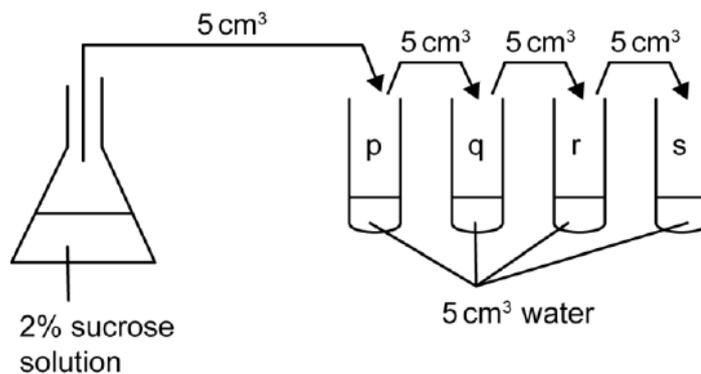
Which statement, **A** to **D**, provides the best explanation for these results?

- A lactose was too large to be absorbed
- B the bacteria could respire only monosaccharides
- C the bacteria did not possess the enzyme to digest lactose
- D the bacteria were inhibited by lactose

Your answer

[1]

9. The diagram shows a serial dilution.



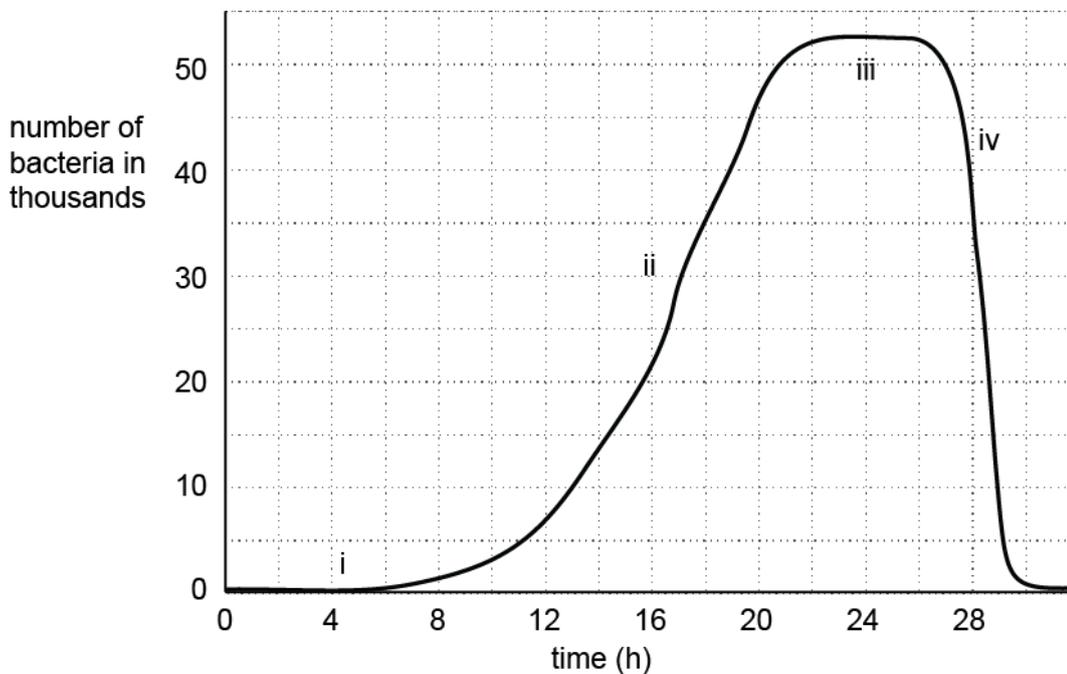
Which of the options, **A** to **D**, shows the correct concentrations of sucrose in tubes p – s?

- A p = 0.2% q = 0.02% r = 0.002% s = 0.0002%
- B p = 1% q = 0.5% r = 0.2% s = 0.1%
- C p = 1% q = 0.5% r = 0.25% s = 0.125%
- D p = 0.2% q = 0.1% r = 0.05% s = 0.025%

Your answer

[1]

10. The graph shows the growth of a population of bacteria in a closed culture.



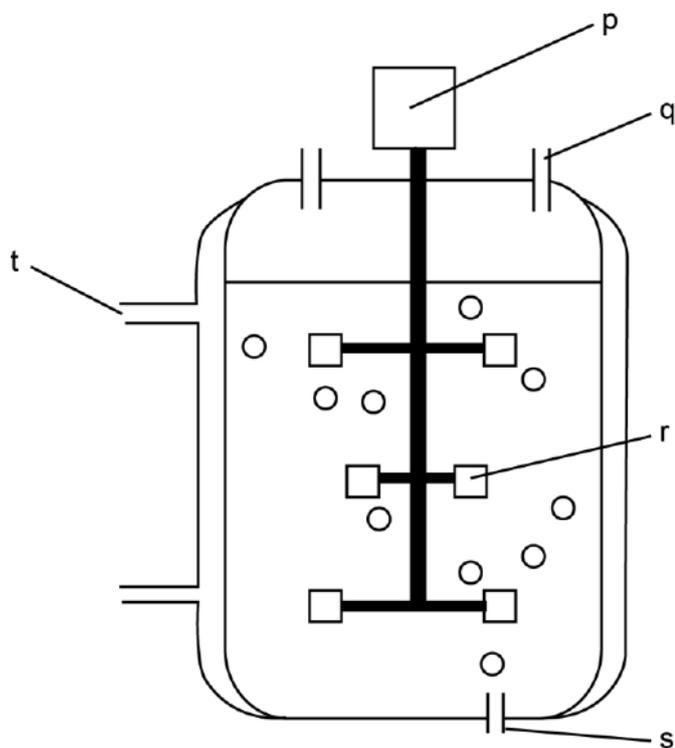
Which of the rows, **A** to **D**, correctly identifies the stages in the growth curve where primary and secondary metabolites are produced?

Row	No metabolites	Mainly primary metabolites	Mainly secondary metabolites
A	i	ii	iii & iv
B	-	i & ii	iii & iv
C	i & iv	ii	iii
D	iv	i & iii	ii

Your answer

[1]

11. The diagram shows a simple fermenter.



Which row, **A** to **D**, correctly identifies the labelled components?

Row	P	q	r	s	t
A	motor	air inlet	stirring paddle	gas outlet	water outlet
B	stirring paddle	gas outlet	nutrient block	air inlet	water inlet
C	motor	gas outlet	stirring paddle	air inlet	water outlet
D	stirring paddle	gas outlet	nutrient block	gas outlet	water inlet

Your answer

[1]

12. In order to sequence the whole genome of an organism it may be necessary to sequence billions of nucleotides. The human genome is approximately 3.2 billion nucleotides long.

Sequencing DNA requires a series of steps.

Place the following steps in the correct sequence. The first and last ones have been done for you.

- A place sections in order by matching overlapping regions
- B cut DNA into sections of varying length
- C sequence short sections of DNA
- D amplify the DNA (create many copies)
- E extract samples of DNA from cells

E ----- A

[2]

The development of high-throughput sequencing techniques has enabled whole genomes to be sequenced more rapidly. Table 17.1 compares a number of DNA sequencing techniques.

Technique	Rate of sequencing (Mb day ⁻¹)	Maximum length of nucleotide chain sequenced	Typical number of errors per 100 000 nucleotides
Sanger (chain termination technique)	6	1000	5
Roche pyrosequencing	750	500	50
SOLiD	5000	50	500
Helicos	5000	32	1000

Table 17.1

13. • Mixtures of proteins can also be separated by electrophoresis.

- Proteins are heated before being placed in the electrophoresis gel.
- The gel contains a substance called SDS, which has a negative charge.
- SDS binds to proteins.

Suggest why proteins are heated before being placed in the electrophoresis gel.

----- [1]

• Suggest why the binding of SDS to proteins is necessary for protein electrophoresis.

----- [2]

14(a). The protein coded for in a gene is 200 amino acids in length. How many errors could be expected in the exons of the sequenced gene when using the least accurate sequencing technique shown in Table 17.1.

Answer_____ [2]

(b). Roche pyrosequencing relies on building a chain of nucleotides against a template. It involves the following steps:

- Nucleotides are washed over the template in a specific order.
- When the correct nucleotide is present it joins the new chain.
- The addition of a nucleotide to the chain releases energy.
- The energy is used to activate a protein called luciferin.
- Light released by luciferin is detected.
- If two identical nucleotides are added together then the intensity of the light emitted is doubled.

Fig. 17.1 shows a readout from a pyrosequencing machine.

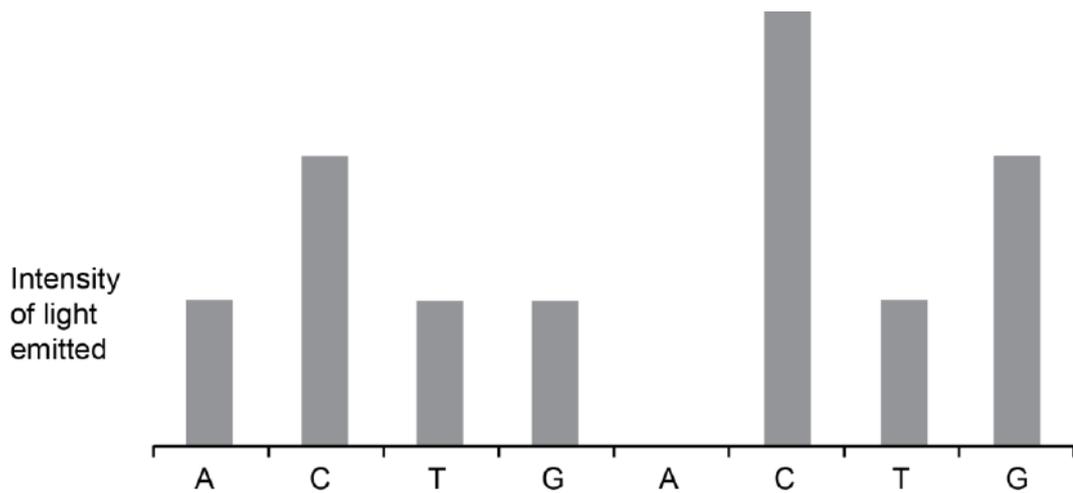


Fig. 17.1

Read off the sequence of bases in the length of DNA.

----- [1]

(c).

- (i) A portion of a gene was sequenced from two members of the same family suspected of having a genetic disease.

The sequences are shown below:

A C G G T A T T G C T A C T T G A A T T A C G T
A C G G T A T T G A G C C T T G A A T T A C G T

What proportion of the sequence is different?

Answer = _____ [2]

- (ii) To identify an allele that causes a genetic disease it must be sequenced accurately so that differences from the healthy allele are clear.

Using the information in **Table 17.1** decide which technique is best to use when sequencing a human gene that causes a genetic disease.

Explain your choice.

----- [2]

- (iii) Suggest how the interdisciplinary field of *bioinformatics* may be useful in determining whether a newly-sequenced allele causes a genetic disease.

----- [2]

(d). DNA profiling uses techniques to separate lengths of DNA to produce a profile that is unique to each individual.

Explain why only selected sections of non-coding DNA are used when profiling a human.

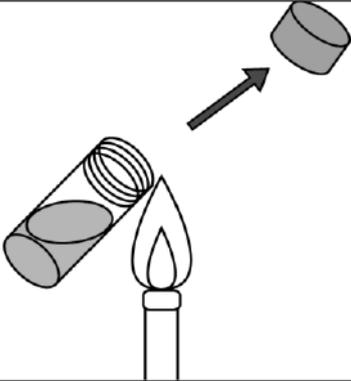
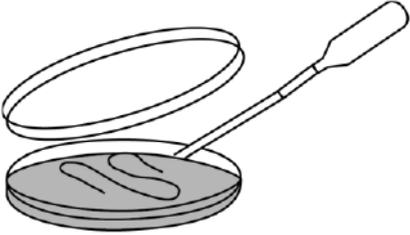
[3]

- 15(a). A student was asked to measure the population density of bacteria in a broth. The student was supplied with a broth culture of the bacterium *Bacillus subtilis*. The teacher suggested that the student should measure the population by transferring a sample of the broth to an agar plate then incubating the plate for 24 hours. The bacterial colonies could then be counted.

The student took certain precautions to avoid contaminating the cultures.

Explain how each precaution shown in the table below helped to avoid contamination.

Write your answers in the spaces provided on the table.

Precaution	Explanation
	
	

[2]

- (b). Microorganisms such as the single-cell fungus *Fusarium* can be cultured to grow food for the human population. In order to scale up cultures of microorganisms scientists use large fermenters. A study was carried out to determine which of two species of *Fusarium* would be better for production of fungal protein.

Fig. 18.1 shows the results of the study.

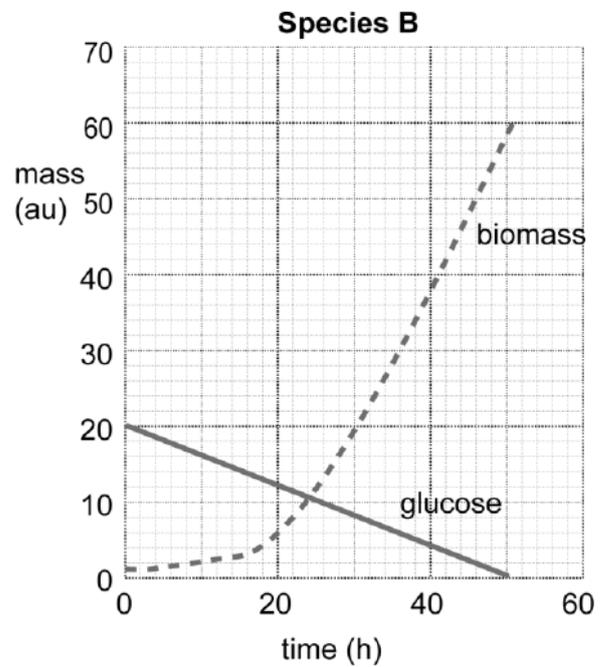
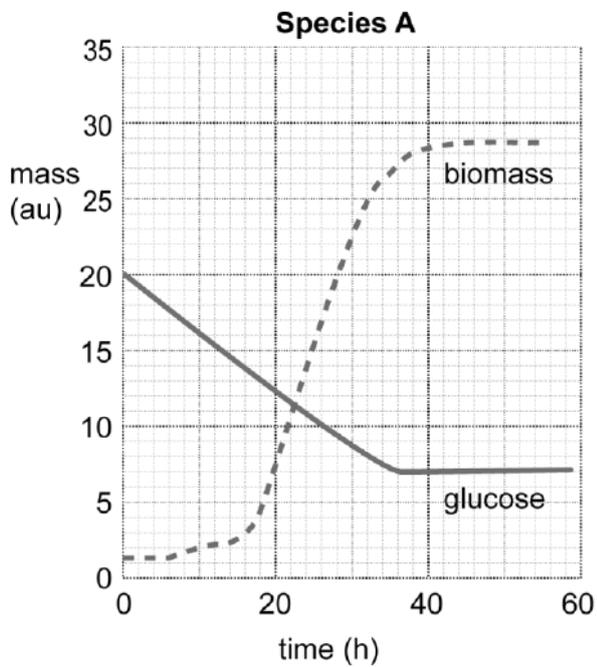


Fig. 18.1

(i) Calculate the percentage of glucose used by species **A**.

Answer = % [2]

(ii) Using the information in Fig. 18.1 suggest which species would be better for use in production of fungal protein for human consumption.

Explain your choice.

[2]

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance						
1			C	1							
			Total	1							
2	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	ALLOW one mark if calculation correct but final figure incorrect e.g. $(480 - 254) / 254 \times 100 / 29 =$ ALLOW 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							
			Total	10							
3	a	i	<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="padding: 2px 10px;">8</td> <td style="padding: 2px 10px;">0.0964</td> <td style="padding: 2px 10px;">0.0093</td> </tr> <tr> <td style="text-align: center; padding: 2px 10px;">(1)</td> <td style="text-align: center; padding: 2px 10px;">(1)</td> <td style="text-align: center; padding: 2px 10px;">(1)</td> </tr> </table>	8	0.0964	0.0093	(1)	(1)	(1)	3	
8	0.0964	0.0093									
(1)	(1)	(1)									
		ii	A has greater richness (1) ORA B has greater evenness (1) ORA	2							
		iii	stratified AND random (within each area) (1) <i>idea that</i> the number of samples within each area should be proportional to their size (1) correct suggestion for the number of samples taken within each area (1)	3	ALLOW description of stratified e.g. 8 in conifer area, 24 in marshy area, 32 in grazed area						

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	A because mean proportion of heterozygotes is higher (1) A = 0.898 AND B = 0.854 (1)	2	ALLOW any correct number of significant figures and percentages
		Total	10	

Mark Scheme

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

Species of butterfly	Area 1		Area 2	
	Number of individuals (n)	Number of individuals (n)	n/N	(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		0.2024
Simpsons Index	0.7131			0.7976

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, best 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>The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.</p> <p>The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.</p> <p>In summary:</p> <ul style="list-style-type: none"> • The science content determines the level. • The communication statement determines the mark within a level. 		

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p>Level 3 (5–6 marks) Full and detailed evaluation of the students' conclusion taking into account the validity of the method used and the implications of the data collected. Learner demonstrates a holistic judgement of the information including evidence for and 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>Indicative scientific points may include...</p> <p>Evidence to support the conclusion (that fencing increased biodiversity)</p> <ul style="list-style-type: none"> • calculated Simpson's Index of Diversity is higher in fenced area • high Simpson's Index means high biodiversity • greater number of species / higher species richness in fenced area • silver-studded blue only occurs in fenced area.

Mark Scheme

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

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5	a	i	$t = 13.61$ (1)(1)	2	<p>ALLOW correct working for 1 mark.</p> $\frac{[31.3 - 20.0]}{50} = 11.3$ $\frac{4.1^2}{50} + \frac{4.2^2}{50} = \frac{16.81}{50} + \frac{17.64}{50} = 0.3362 + 0.3528 = 0.689$ $= 11.3 / \sqrt{0.689}$ $= 11.3 / 0.830 = 13.61$
		ii	probability is highly significant, calculated t value is greater than the critical value at 0.001 / there is a chance (probability) of below 0.001 that the differences in the shell height seen can be due to chance and the null hypothesis can be rejected (1)	1	
	b		<p>histogram correctly plotted for the values (1)</p> <p>two sets of data distinguished by a key or other suitable method to identify them (1)</p> <p>x axis labelled 'height (mm)' and y axis labelled 'number of dog whelks / <i>Nucella lapillus</i> / shells / class' (1)</p> <p>makes good use of the graph paper and both axes are correctly scaled with ascending equidistant intervals (1)</p>	4	<p>DO NOT ALLOW a bar chart or a line graph as neither would represent the data correctly.</p> <p>ALLOW a correlation scattergram.</p> <p>ALLOW '% of the sample' for the y axis if this has been calculated.</p>
	c		<p>three from positive correlation between the height of the whelk shell and the type of the shore (1)</p> <p>correct calculation of the correlation coefficient (1)</p> <p>(histogram / data, indicates that) shore exposure has an impact on height (1)</p> <p><i>Nucella</i> show adaptation to harsher wave action (1)</p> <p>shells measured may not all be exposed to wave action (1)</p>	3	<p>ALLOW correlation is strong or a reference to relationship such as:- taller shell height and sheltered shore or shorter shell height and exposed shore.</p> <p>ALLOW little overlap on the histogram bars.</p> <p>ALLOW the idea that the differences may be due to direct wave action or adaptation.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	d	<p>no detail for the random sampling technique was given / <i>Nucella</i> from the whole population may not have been sampled (1)</p> <p>and</p> <p>use (two) metre tapes to set out a grid and use randomly generated coordinates (1)</p> <p>no measuring instrument specified (1)</p> <p>and</p> <p>use vernier callipers with a precision of more than 0.5 mm (1)</p> <p>incorrect identification of <i>Nucella</i> / several types of shelled molluscs that are similar to <i>Nucella</i> (1)</p> <p>and</p> <p>use a sea shore key to correctly identify the whelk (1)</p> <p>classification of the shore as sheltered or exposed was subjective (1)</p> <p>and</p> <p>use an approved shore classification (such as Ballantine's) (1)</p>	2	Limitation and improvement must be linked for 2 marks.
	e	<p><i>one from</i></p> <p>increase the number of, <i>Nucella</i> used in the data collection / samples (1)</p> <p>replicate / repeat, the entire experiment again (1)</p>	1	<p>ALLOW a value given such as increasing number to 100 from each shore.</p> <p>ALLOW an understanding of the <i>idea</i> that the procedure has only been carried out once for each shore.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	f	<p><i>not valid</i> a small percentage of <i>Nucella</i> sampled and some areas not sampled at all which would lead to skewed data (1)</p> <p>human interpretation of the measurement causes accuracy of the data to be questioned (1)</p> <p>genetic variations or sub species not taken into account (1)</p> <p><i>valid</i> random sampling techniques mean no bias in collection (1)</p> <p>100 <i>Nucella</i> sampled in total (50 in each area) so large sample size (1)</p> <p>precise instructions for consistent measurement of shell height (1)</p>	3	<p>ALLOW reverse arguments made.</p> <p><i>idea that conclusion will be distorted</i></p>
		Total	16	
6		<p><i>argument for</i> important, (N or C) recyclers / saprotrophs (1)</p> <p><i>argument against</i> not a predator (1) large in abundance / biomass (so effect on environment not disproportionate) (1)</p>	2	
		Total	2	
7	i	<p>radioactive, labels / tags (1) fluorescent, labels / tags (1) UV, light / radiation (1) (named) visible stain (1)</p>	2	
	ii	X placed on any fragment below Y (1)	1	X can be placed in any of the 9 lanes, but must be touching a DNA band that is lower in the image (nearer the cathode) than Y
		Total	3	
8		C	1	
		Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9			C	1	
			Total	1	
10			B	1	
			Total	1	
11			C	1	
			Total	1	
12			B, D, C (1)(1)	2	One mark for D after B and one for C after D
			Total	2	
13		i	denature / unfold, protein AND <i>idea of</i> exposes charges or hydrophobic region (1)	1	
		ii	<i>idea that</i> different proteins have different overall charges (1) <i>idea that</i> (binding of) SDS makes all proteins negatively charged (1) <i>idea that</i> proteins will be separated by, mass / length (1) <i>idea that</i> proteins move in the same direction (1)	2	
			Total	3	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance	
14	a	6 (1)(1)	2	Correct response = 2 marks If response incorrect ALLOW one mark for 600 nucleotides / bases ALLOW one mark for idea of one error every 100 nucleotides	
	b	A C C T G C C C T G G	2		
	c	i	1/8 or 0.125 (1)(1)	2	Correct response = 2 marks If response incorrect ALLOW one mark for working e.g. 3/24 ALLOW 12.5%
		ii	Sanger / chain termination technique (1) Only 5 errors per 100 000 nucleotides compared to, 50 in Roche pyrosequencing / 500 in SOLiD / 1000 in Helicos (1)	2	
		iii	base sequence of normal allele and (known) alternatives held (in database) (1) computational analysis allows rapid comparison of sequences with newly sequenced allele (1) amino acid sequence / protein structures, also held (in database) (1) <i>idea of</i> computer modelling of new protein structure from base sequence (1)	2	
	d	in most people, the genome is very similar / most genes the same (1) using coding sequences would not provide unique profiles (1) (parts of) non-coding DNA contains variable numbers of, short tandem repeats / repeating sequences (1)	3		
Total			12		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a		<p><i>flaming the tube</i> causes air to expand and pushes bacteria away so less likely to settle into tube (1)</p> <p>kills bacteria on neck of tube (1)</p> <p><i>holding lid of petri dish over agar plate</i> avoids infection / inoculation with bacteria in the air (1)</p>	2	
	b	i	65 (1)(1)	2	<p>Correct response = two marks.</p> <p>If incorrect response allow one mark for working: $\frac{(20-7)}{20} \times 100$</p>
		ii	<p><i>Species B</i> [no mark]</p> <p>produces more biomass (1)</p> <p>continues to produce biomass at low glucose concentration (1)</p>	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	c	<p><i>Any four from:</i></p> <p>microorganisms grow more quickly and can produce more protein per, hour / day / week (1)</p> <p>microorganisms can be grown on waste material from other processes (1)</p> <p>beef has five times the total fat content of protein produced by microorganisms ORA (1)</p> <p>beef has 20 times the saturated fat content and is more likely to contribute to atherosclerosis / heart disease ORA (1)</p> <p>fungal protein has no cholesterol and is less likely to contribute to, atherosclerosis / heart disease (1)</p> <p>people on a weight reduction diet prefer fungal protein as it has half the energy content of beef (1)</p> <p>AVP (1)</p>	4	<p>ACCEPT reverse argument</p> <p>ACCEPT reverse argument IGNORE 'more' or 'less'</p> <p>ACCEPT reverse argument IGNORE 'more' or 'less'</p> <p>e.g. rearing beef takes up a lot more land</p>
		Total	10	