Biodiversity (18.2): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 64 marks · about 77 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 4 · May/June 2019 (42) · Q7(a) · 3 marks

7 (a) Define the term *ecosystem*.

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Question 2 · Paper 4 · May/June 2019 (42) · Q7(b) · 3 marks

(b) State the term used to describe:

the functional role of a species within an ecosystem

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a reproductively isolated group of organisms that interbreed to produce fertile offspring

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physical factors in the environment such as temperature and soil pH.

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[3]

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5 The land area of Italy is composed of forest, grasslands (including agricultural fields), built-up areas (for example towns and cities) and inland water bodies like lakes and rivers.

Table 5.1 shows changes in the area covered by these environments over a fifteen year period.

Table 5.1

environment	area / thousand hectares		
	1990	2000	2005
forest	8791	9564	9951
agricultural fields and towns	20620	19847	19460
inland water bodies	723	723	723
total	30134	30134	30134

(a) (i) Explain why none of the three environments listed in Table 5.1 can be referred to as an ecosystem.

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Question 4 · Paper 4 · October/November 2016 (42) · Q5(a)(ii) · 4 marks

(ii) The increase in area covered by forest in Italy has occurred because farmers have cultivated less of their land or have abandoned their farms altogether.

Describe how this change in land use may affect biodiversity. You should consider the three different levels of biodiversity in your answer.

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Question 5 · Paper 4 · February/March 2023 (42) · Q10(a) · 6 marks

10 (a) The passage in Fig. 10.1 is about biodiversity.

Complete the passage by using the most appropriate scientific terms.

Biodiversity within an area can be assessed at different levels, including the species diversity, genetic diversity and ecological diversity.

Species diversity can be assessed by determining the number of different species and the relative ..... of different species in a given area. From this information, species diversity can be estimated using ..... index of diversity.

Organisms of the same species can show much genetic diversity even though they share the same ..... . This is because they can have different combinations of ..... .

The greater the genetic diversity, the greater the ability of a species to ..... to a changing environment.

Ecological diversity is a measure of the number and range of different ecosystems and ..... within a given area.

Fig. 10.1

[6]

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5 Biodiversity can be considered at three different levels.

Fig. 5.1, Fig. 5.2 and Fig. 5.3 are images that show these three different levels of biodiversity.



Fig. 5.1



Fig. 5.2



Fig. 5.3

(a) Describe the level of biodiversity most clearly visible in each image.

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Question 7 · Paper 4 · May/June 2025 (42) · Q9(a) · 4 marks

9 (a) The biodiversity of an area can be assessed using a variety of sampling methods.

Outline how a frame quadrat could be used to assess the biodiversity of plants in a field.

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Question 8 · Paper 4 · May/June 2017 (42) · Q8(a) · 4 marks

8 An investigation was carried out in a temperate woodland that contained a number of areas with two different types of ground cover vegetation.

- On higher ground where the soil was drier, the dominant ground cover plant was bracken, *Pteridium aquilinum*.
- On lower ground where the soil was wetter, the dominant ground cover plant was bramble, *Rubus fruticosus*.

(a) Describe how the abundance of the two plant species at higher and lower ground sites could be measured.

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Question 9 · Paper 4 · October/November 2021 (42) · Q5(b)(i) · 4 marks

(b) Prairie strips are restored habitat areas planted with native grasses and wildflowers. Prairie strips are usually located between or around the edges of fields of maize or soy bean.

Students in North America wanted to investigate biodiversity along a prairie strip.

(i) Outline how the students could measure the biodiversity of plants and insects along a prairie strip.

plants .....

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insects .....

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[4]

Question 10 · Paper 4 · October/November 2023 (42) · Q10(a) · 4 marks

10 (a) The passage outlines one method of estimating the size of an animal population.

Complete the passage by using the most appropriate scientific terms.

The size of a population of animals can be estimated using the mark-release-recapture method. A sample of animals is captured using a humane (harmless) trap and is counted. The animals are marked using a method that does not harm them. This can be done using a small tag or ..... . The marked animals are released into the area where they were captured. Time is allowed for the marked animals to mix into the population. This period of time must be short so that emigration, immigration, migration or ..... do not occur.

A second sample of animals is then captured and the number of marked and unmarked animals is counted. The population size can be estimated using the ..... Index. For reliability, the method should be ..... .

[4]

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10 The African penguin, *Spheniscus demersus*, lives along the coast of South Africa.

Fig. 10.1 shows two African penguins.



Fig. 10.1

(a) One way of estimating the size of a population of African penguins is to use the mark-release-recapture method.

Suggest **three** assumptions that must be made for the mark-release-recapture method to be valid.

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Question 12 · Paper 4 · October/November 2024 (41) · Q10(d) · 2 marks

(d) A light trap was used to estimate the total size of a population of *B. betularia* in a woodland. On night one, 24 moths were captured. These were marked with a small spot of harmless paint. On night two, 29 moths were captured, and 8 of these showed a spot of paint.

Use the Lincoln index formula provided to calculate the size of the population.

Show your working.

$$N = \frac{n_1 \times n_2}{m_2}$$

Key to symbols:
N = estimate of population size
n_1 = number of individuals captured in first sample
n_2 = number of individuals (both marked and unmarked) captured in second sample
m_2 = number of marked individuals recaptured in second sample

population size = ... [2]

Question 13 · Paper 4 · October/November 2020 (42) · Q8(a) · 5 marks

8 **(a)** Describe a method that could be used to estimate the population size of a mobile animal, such as a brown rat.

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(b) The soft rush plant, *Juncus effusus*, grows in many habitats in Northern Europe. An investigation was carried out to assess whether there was a relationship between the height of soft rush plants and the altitude at which they grow on exposed hillsides.

The mean height of 10 soft rush plants was calculated at each of eight different altitudes.

The results are shown in Table 8.1.

Table 8.1

altitude / m	mean height of soft rush plants / cm
100	85
150	86
200	83
250	79
300	72
350	74
400	68
450	63

The statistical test, Spearman's rank correlation (r_s), was applied to find out if there was a relationship between the altitude and the mean height of the soft rush plants.

(i) The formula for calculating Spearman's rank correlation is:

$$r_s = 1 - \left(\frac{6 \times \Sigma D^2}{n^3 - n}\right)$$

- ΣD^2 is the sum of the differences between the ranks of the two samples
- n is the number of samples.

In this investigation the value of ΣD^2 is 164.

Calculate the value of r_s.

Show your working and write your answer to **two** decimal places.

r_s = ... [2]

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Question 15 · Paper 4 · October/November 2020 (42) · Q8(b)(ii) · 2 marks

(ii) Use your value for r_s to evaluate the relationship between the altitude and the mean height of the soft rush plants.

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(c) Scientists studied the effect of an increase in the number of tourists each year on the number of invasive alien species present in the Galápagos islands.

The scientists recorded the number of invasive alien species present each year in the Galápagos islands over many years. The scientists also recorded the number of tourists visiting the islands each year.

Fig. 5.4 shows a graph of the data for five different years during the study.

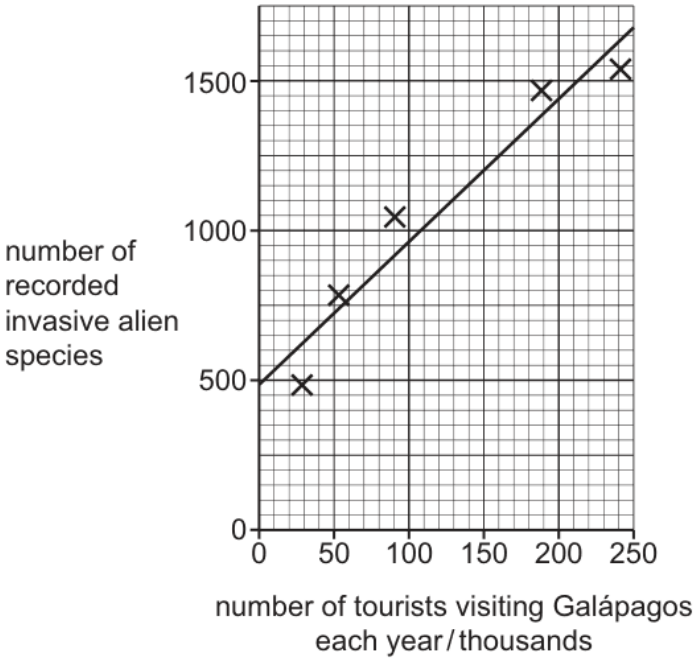


Fig. 5.4

(i) The scientists carried out a Pearson's linear correlation calculation for the data in Fig. 5.4.

The scientists calculated an ***r*** value of 0.930.

The scientists concluded that there is a significant correlation between the number of tourists visiting the Galápagos islands each year and the number of invasive alien species present.

Table 5.1 shows a probability table of critical values for Pearson's linear correlation.

Table 5.1

number of observations	probability level (p)	
	0.05	**0.01**
3	0.997	1.000
4	0.950	0.990
5	0.878	0.959
6	0.811	0.917
7	0.754	0.875

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Question 17 · Paper 4 · October/November 2025 (42) · Q8(c)(i) · 2 marks

(c) The biodiversity of a habitat can be measured by calculating Simpson's index of diversity (*D*).

The formula for Simpson's index of diversity (*D*) is:

$$D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$$

Key to symbols:

n = number of individuals of each type present in the sample

N = the total number of all individuals of all types present in the sample

A survey of shrubs and trees in a temperate woodland was carried out. The results are shown in Table 8.1.

Table 8.1

common name	n	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
maple	807	0.196	0.0384
alder	6	0.001	0.0000
hazel	1856	0.451	.....
hawthorn	82	0.020	0.0004
blackthorn	40	0.010	0.0001
willow	101	0.025	0.0006
birch	78	0.019	0.0004
wild rose	84	0.020	0.0004
oak	1036	0.252	0.0635
dogwood	29	0.007	0.0000
N =	4119	Total =	.....

(i) Complete Table 8.1. [2]

Question 18 · Paper 4 · October/November 2025 (42) · Q8(c)(ii) · 1 mark

(ii) Calculate the value for Simpson's index of diversity (*D*).

D = ...
[1]

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Question 19 · Paper 4 · October/November 2025 (42) · Q8(c)(iii) · 2 marks

(iii) Using your value for *D*, comment on the biodiversity of this temperate woodland.

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(c) (i) Human activity has disturbed the habitat of many populations of spectacled bear, *Tremarctos ornatus*. The spectacled bear feeds on a variety of plant and animal species.

Scientists compared the diversity of the food eaten by two populations of spectacled bear by analysing their faeces. One population lived in an undisturbed habitat and the other population lived in a habitat that had been disturbed by road building.

The scientists analysed the faeces from 60 bears in each population. They identified the species present and the number of individuals of each species in the faeces.

The scientists calculated the diversity of species in the faeces of the two populations using Simpson's Index of Diversity.

The formula for Simpson's Index of Diversity is:

$$D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$$

n = number of individuals of each species present in the sample
N = total number of all individuals of all species

Table 8.1 shows the results and some of the steps for calculating the *D* value for the disturbed population.

Table 8.1

species eaten by bear	number of individuals	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
Gracilinanus aceramarcae	3	0.048	0.002
Oligorizomys sp.	5	0.081	0.007
Hesperomeles cuneata	4	0.065	0.004
Puya atra	28	0.452	0.204
Vaccinium floribundum	2	0.032	0.001
Pernettya prostrata	8	0.129	0.017
Gaultheria hapalotricha	12	.....	.....
total	62		.....

Calculate Simpson's Index of Diversity by completing Table 8.1 in the spaces provided.

Write the value for Simpson's Index of Diversity on the dotted line.

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Question 21 · Paper 4 · May/June 2024 (41) · Q8(c)(ii) · 1 mark

(ii) The scientists calculated a *D* value of 0.833 for the undisturbed population.

Explain what is shown by the difference in the *D* values between the two populations of bear.

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Question 22 · information from earlier in the question

(b) Prairie strips are restored habitat areas planted with native grasses and wildflowers. Prairie strips are usually located between or around the edges of fields of maize or soy bean.

Students in North America wanted to investigate biodiversity along a prairie strip.

Question 22 · Paper 4 · October/November 2021 (42) · Q5(b)(ii) · 2 marks

(ii) Mathematical methods and statistical tests help to summarise and compare biodiversity data.

Name the mathematical method **or** statistical test that the students can use:

to estimate the total biodiversity of a prairie strip

.....

to test whether plant biodiversity is associated with insect biodiversity.

.....

[2]

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Mark schemes

Question 1 · Paper 4 · May/June 2019 (42) · Q7(a) · 3 marks

7(a)	*any* ***three*** *from:*	**3**
	1 functional / self-contained / specific, entity / unit / area ;	
	2 community (of organisms) / all living organisms of all species / all populations of organisms ;	
	3 *ref. to* interactions ;	
	4 abiotic / physical, and, biotic / biological, factors ; **A** living and non-living	
	5 *idea that* linked by, energy flow / mineral cycling / food webs / food chains / nutrient cycle ;	

Question 2 · Paper 4 · May/June 2019 (42) · Q7(b) · 3 marks

7(b)	niche ;	3
	species ;	
	abiotic ;	

Question 3 · Paper 4 · October/November 2016 (42) · Q5(a)(i) · 2 marks

5(a)(i)	ecosystem is, a defined area / self-contained / a functional unit ;	**2**
	idea that Italy consists of multiple, towns and agricultural fields / water bodies / forests ;	

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Question 4 · Paper 4 · October/November 2016 (42) · Q5(a)(ii) · 4 marks

5(a)(ii)	*four from* 1 increase in variety of, habitats / ecosystems ; 2 increase number of species / more complex food web ; 3 increase abundance of organisms within a species ; 4 increase in genetic variation ; 5 *ref. to* succession ;	**4**

Question 5 · Paper 4 · February/March 2023 (42) · Q10(a) · 6 marks

10(a)	abundance / numbers / population (size) ; Simpson's ; genes ; alleles ; adapt / evolve ; habitats / niches ;	**6**

Question 6 · Paper 4 · October/November 2021 (42) · Q5(a) · 3 marks

5(a)	*Fig. 5.1:* species ; *Fig. 5.2:* genetic ; *Fig. 5.3:* habitat / ecosystem ;	**3**

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Question 7 · Paper 4 · May/June 2025 (42) · Q9(a) · 4 marks

9(a)	*any **four** from:* 1 *ref. to* quadrat of, known / same / standard, area / size ; 2 *ref. to* setting out a grid ; 3 random number generator (to produce coordinates) for quadrat placement ; 4 use a key ; 5 count number of species / numbers of individuals of each species / abundance / percentage cover / ACFOR / Braun-Blanquet ; 6 *ref. to* large sample size / repeats ; 7 (use results to calculate) Simpson's Index of Biodiversity / species density ;	**4**

Question 8 · Paper 4 · May/June 2017 (42) · Q8(a) · 4 marks

8(a)	1. random sampling ; 2. (using) random number generator for coordinates ; 3. in both sites ; 4. measure, percentage cover / (Braun-Blanquet / ACFOR) scale cover ; 5. using (square frame) quadrats ; 6. repeat sampling ;	**max 4**

Question 9 · Paper 4 · October/November 2021 (42) · Q5(b)(i) · 4 marks

5(b)(i)	*plants:* 1 quadrats ; 2 transects ; 3 *ref. to* use, ACFOR / Braun-Blanquet **or** estimate percentage cover (of species) count species calculate plus species abundance record species density AW species frequency ; *insects:* 4 pooters / pitfall traps / nets / light traps / sugar traps ; 5 mark-release-recapture ; *accept in either section:* 6 (identification) keys ;	**4**

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Question 10 · Paper 4 · October/November 2023 (42) · Q10(a) · 4 marks

10(a)	1 dye / paint / clipping fur / collar / electronic chip ; 2 death / birth / reproduction ; 3 Lincoln ; 4 repeated / replicated ;	**4**

Question 11 · Paper 4 · May/June 2022 (42) · Q10(a) · 3 marks

10(a)	*any **three** from:* 1 marking, not harmful (described) / cannot be removed (described) ; 2 constant population size ; 3 no, births / deaths (described) **or** no, immigration / emigration / migration ; 4 (sufficient time for) marked individuals to mix with rest of population ; 5 (penguins are) mobile ;	**3**

Question 12 · Paper 4 · October/November 2024 (41) · Q10(d) · 2 marks

10(d)	$(24 \times 29) \div 8$; $= 87$;	**2**

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Question 13 · Paper 4 · October/November 2020 (42) · Q8(a) · 5 marks

8(a)	*any **five** from:*	**5**
	1 mark–release–recapture ;	
	2 capture (sample of) rats **and** count them ;	
	3 *ref. to* humane traps ;	
	4 mark so as to not adversely affect rats **or** describe method of marking such as, tagging / using dyes ;	
	5 return to where they were caught / AW ;	
	6 allow time to mix (with population) / AW ;	
	7 capture second sample ;	
	8 count number caught **and** number marked ;	
	9 population size estimate (M_1) = $\frac{\text{number in first sample } (N_1) \times \text{number in second sample } (N_2)}{\text{number in second sample that are marked } (M_2)}$;	
	10 AVP ; e.g. repeat	

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Question 14 · Paper 4 · October/November 2020 (42) · Q8(b)(i) · 2 marks

8(b)(i)	$r_s = 1 - \left(\frac{6 \times 164}{8^3 - 8}\right)$ **or** $= 1 - \left(\frac{984}{504}\right)$ **or** $= 1 - 1.95$; $r_s = -0.95$;	**2**

Question 15 · Paper 4 · October/November 2020 (42) · Q8(b)(ii) · 2 marks

8(b)(ii)	there is a strong correlation ; negative correlation / as the altitude increases the mean height of the soft rush decreases ;	**2**

Question 16 · Paper 4 · May/June 2025 (41) · Q5(c)(i) · 2 marks

5(c)(i)	*r* / 0.930 / calculated value, is greater than critical value for n = 5 ; at (probability level) 0.05 ;	**2**

Question 17 · Paper 4 · October/November 2025 (42) · Q8(c)(i) · 2 marks

8(c)(i)	0.2034 ; 0.3072 ; *allow **ecf** for mp2 if both incorrect* *allow **ecf** for mp2 if figure correct in both but not to 4dp*	**2**

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Question 18 · Paper 4 · October/November 2025 (42) · Q8(c)(ii) · 1 mark

8(c)(ii)	0.6928 / 0.693 ; *allow* ***ecf*** *for 1 minus their answer to* ***8ci***	**1**

Question 19 · Paper 4 · October/November 2025 (42) · Q8(c)(iii) · 2 marks

8(c)(iii)	(*D*) close(r) to 1 / higher than 0.5 ; (so) high(er) (bio)diversity ;	**2**

Question 20 · Paper 4 · May/June 2024 (41) · Q8(c)(i) · 3 marks

8(c)(i)	*G. hapalotricha* $\frac{n}{N} = 0.194$ **and** $\left(\frac{n}{N}\right)^2 = 0.037$; $\left(\frac{n}{N}\right)^2$ total = 0.272 ; $D = 0.728$;	**3**

Question 21 · Paper 4 · May/June 2024 (41) · Q8(c)(ii) · 1 mark

8(c)(ii)	undisturbed / higher D, has, larger / higher / more, (food), diversity / variation ;	**1**

Question 22 · Paper 4 · October/November 2021 (42) · Q5(b)(ii) · 2 marks

5(b)(ii)	*estimate biodiversity:* Simpson's index (of biodiversity) ; *test relationship:* Pearson's linear correlation coefficient / Spearman's rank correlation ;	**2**

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