Unit 2

The Variety of Living Organisms

Species & Genetic Diversity

Practice Exam Questions

1.

(a) Heath is a community of plants and animals. A student investigated the species diversity of plants in this community. The table shows her results.

Plant species	Number of plants per m^2
Heath rush	1
Bilberry	1
Sheep's sorrel	5
Ling	2
Bell heather	1
Heath bedstraw	8
Mat-grass	11

(a)   (i)   The index of diversity can be calculated from the formula

$$d = \frac{N(N - 1)}{\Sigma n(n - 1)}$$

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species.

Use this formula to calculate the index of diversity for the plants on the heath. Show your working.

Answer ....
(2 marks)

(a)   (ii)   Explain why it may be more useful to calculate the index of diversity than to record only the number of species present.

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(2 marks)

(b)   The demand for increased food production has led to areas of heath being used to grow wheat. Explain the effect of this on

(b)   (i)   the species diversity of plants

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(2 marks)

(b)   (ii)   the species diversity of animals.

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(2 marks)

2   (a)   A species of seal shows genetic diversity. Explain what is meant by genetic
          diversity.

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          ....
          (1 mark)

2   (b)   In the late 18th century, the population of northern elephant seals was estimated to be
          about 150 000. These seals lived in different colonies in different places. The seals
          were then hunted. By 1910, the total population had fallen to under 100. All these
          seals lived in a single colony on one island. Hunting then stopped. Numbers
          increased and there are now approximately 150 000 seals living in many different
          colonies.

          Use this information to explain

          (i)   what is meant by a genetic bottleneck

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                (2 marks)

          (ii) how you would expect the founder effect to have influenced the genetic
                diversity of northern elephant seals after 1910.

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                (2 marks)

3

(a)   Explain what is meant by genetic diversity.

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                                                                                                (1 mark)

(b)   Apart from genetic factors what other type of factor causes variation within a species?

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                                                                                                (1 mark)

(c)   The spotted owl is a bird. Numbers of spotted owls have decreased over the past
           50 years. Explain how this decrease may affect genetic diversity.

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Costa Rica is a Central American country. It has a high level of species diversity.

(a)   There are over 12 000 species of plants in Costa Rica. Explain how this has resulted in a high species diversity of animals.

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(2 marks)

(b)   The number of species present is one way to measure biodiversity. Explain why an index of diversity may be a more useful measure of biodiversity.

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(2 marks)

(c)   Crops grown in Costa Rica are sprayed with pesticides. Pesticides are substances that kill pests. Scientists think that pollution of water by pesticides has reduced the number of species of frog.

(c) (i)   Frogs lay their eggs in pools of water. These eggs are small. Use this information to explain why frogs' eggs are very likely to be affected by pesticides in the water.

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(2 marks)

(c) (ii)   An increase in temperature leads to evaporation of water. Suggest how evaporation may increase the effect of pesticides on frogs' eggs.

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(1 mark)

An ecologist carried out a survey of butterfly species on the heathland.

The ecologist walked along a marked path on four different days in June. She counted

- the number of butterfly species
- the number of individual butterflies of each species.

The ecologist's results are shown in Table 6.1.

These results can be used to calculate the Simpson's Index of Diversity (D) for butterflies in this heathland using the formula:

$$D = 1 - [\Sigma \, (n/N)^2]$$

where n = number of individuals of a species in the sample
        N = total number of individuals of all species in the sample

(i) Complete the table by filling in the **three** missing values.

Table 6.1

species	n	n/N	(n/N)²
Grayling (*Hipparchia semele*)	3	0.0968	0.09370
Large Heath (*Coenonympha tullia*)	11	....	0.12588
Gatekeeper (*Pyronia tithonus*)	6	0.1935	0.03744
Green Hairstreak (*Callophrys rubi*)	2	0.0645	0.00416
Silver-studded Blue (*Plebeius argus*)	2	0.0645	0.00416
Small Heath (*Coenonympha pamphilus*)	7	0.2258	0.05099
		Sum (Σ)	....
		1 – Σ	D = ...

[3]

(ii) Suggest the implications of a high value of Simpson's Index of Diversity on planning decisions.

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.... **[2]**

Genetic & Species Diversity   Answers and Markscheme

Question 1

(a)(i)	Two marks for correct answer of 4.3; One mark for incorrect answer that clearly shows understanding of $\sum n(n-1)$ /188 as denominator;		2	**Q** An answer of 4 scores 1 mark
(a)(ii)	Measures number of individuals (of each species) and number of species; Some species only present in small numbers;		2	**Q** First marking point can only be awarded if there is a reference to species.
(b)(i)	Reduced as one crop/species grown / other species removed; Use of herbicides/weeding/ploughing; Wheat (better) competitor for named factor e.g. light/nutrients;		2 max	
(b)(ii)	(Reduced) as less variety of food sources; (Reduced) as fewer habitats/niches; (Reduced) by pesticides/chemicals;		2 max	**Q** Answers only referring to 'less food' should not be credited

Question 2

	Difference in DNA/base sequence/alleles/genes;	1	
(i)	Genetic bottleneck linked to low genetic diversity/smaller gene pool; Reference to very low seal population/population in 1910/ under 100 seals/caused by hunting;	2	Must refer to data provided for second mark
(ii)	New colonies formed by small number (of seals)/ small number of founders; Founders have different/fewer alleles/genes / have smaller gene pool;	2	

Question 3

(a)	Difference in DNA/base sequence / difference in alleles/genes/gene pool;	1	Neutral: 'fewer alleles' unless qualified e.g. fewer different alleles.
(b)	Environmental;	1	Accept: Environment
(c)	Reduced (genetic diversity); As fewer different/varied alleles/genes / reduced gene pool; (Genetic) bottleneck;	2 max	Neutral: 'fewer alleles' unless qualified e.g. fewer different alleles.

Question 4

(a)	Greater variety / different foods; More habitats/niches;	2	Answers only referring to 'more food' should not be credited but allow 'more food sources'.
(b)	Also measures number of individuals in a species / different proportions of species; Some species may be present in low/high numbers;	2	First marking point can only be awarded if there is a reference to species.
(c)(i)	Large surface area to volume (ratio); Correct reference to diffusion; (Eggs) cannot move (out of water); Permeable/thin (outer layer);	2 max	
c)(ii)	Concentration (of pesticide) is increased;	1	

Question 5

(i)

species	n	n/N	(n/N)^2	
Grayling (*Hipparchia semele*)				
Large Heath (*Coenonympha tullia*)		<u>0.3548</u>		;
Gatekeeper (*Pyronia tythonus*)				
Green Hairstreak (*Callophrys rubi*)				
Silver-studded Blue (*Plebeius argus*)				
Small Heath (*Coenonympha phamhylus*)				
		Sum (Σ)	0.31633	;
		1 - Σ	D = 0.68367	;

ACCEPT ecf from incorrect answer for Σ (whether decimal places or rounding)

3

(ii)

IGNORE refs to relative robustness of habitat

1 many species present / high species richness / all species evenly represented / high species evenness / high biodiversity ;

1 **ACCEPT** 'types of butterfly' as AW for species
IGNORE 'individuals' or 'organisms'

2 (so) should not be developed / development should be modified / development should be reconsidered / should be conserved / AW ;

2 **DO NOT CREDIT** ref to 'planning' alone (as given in question)
2 **IGNORE** responses that imply uncertainty about the development. e.g. 'could' 'might' 'may'

2

Unit 2 Genetic & Species Diversity