



**Exampro A-level Biology
(7401/7402)**

Name:

Class:

Investigating diversity QP

Author:

Date:

Time: **70**

Marks: **57**

Comments:

Q1. Ecologists investigated the size of an insect population on a small island. They used a mark-release-recapture method. To mark the insects they used a fluorescent powder. This powder glows bright red when exposed to ultraviolet (UV) light.

(a) The ecologists captured insects from a number of sites on the island. Suggest how they decided where to take their samples.

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(2)

(b) Give **two** assumptions made when using the mark-release-recapture method.

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(2)

(c) Suggest the advantage of using the fluorescent powder in this experiment.

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The ecologists did **not** release any of the insects they captured 1–5 days after release of the marked insects.

The table below shows the ecologists' results.

Days after release	Number of marked insects remaining in population	Number of insects captured	Number of captured insects that were marked
1	1508	524	78

2	1430	421	30
3	1400	418	18
4	1382	284	2
5	1380	232	9

(2)

- (d) Calculate the number of insects on this island 1 day after release of the marked insects.

Show your working.

Answer =

(2)

- (e) The ecologists expected to obtain the same result from their calculations of the number of insects on this island on each day during the period 1–5 days after release. In fact, their estimated number increased after day 1.

During the same period, the number of insects they caught decreased.

The method used by the ecologists might have caused these changes.

Use the information provided to suggest **one** way in which the method used by the ecologists might have caused the increase in their estimates of the size of the insect population.

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(2)

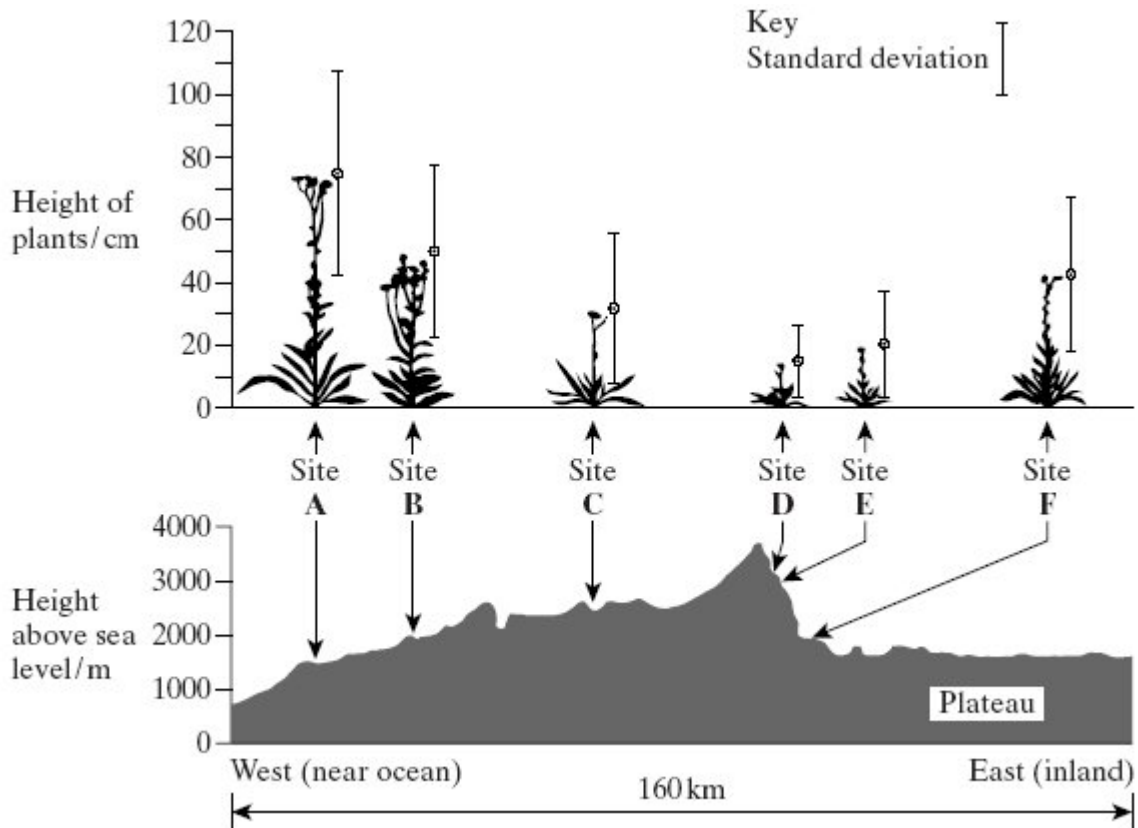
(Total 10 marks)

Q2. Climatic factors, such as temperature and rainfall, vary greatly over short distances

across mountain ranges. In an investigation, populations of the plant, *Achillea lanulosa*, were sampled from several sites on a transect across a mountain range. At each sampling site, seeds were collected at random. Each batch of seeds was germinated and grown to maturity under the same experimental conditions.

The diagram shows

- a profile indicating the position and altitude of the sampling sites
- the mean height of mature plants grown from each sample of seeds
- the standard deviation of heights of the mature plants grown from each sample of seeds.



(a) (i) Give **one** limitation of using a line transect to collect these data.

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(1)

(ii) Suggest how plants should be chosen at each sampling site to avoid bias and to be representative.

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(2)

(b) (i) What information does the bar representing standard deviation give about the plants in a sample?

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(1)

(ii) Describe what the results show about the variation of the height of the plants in relation to altitude.

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(2)

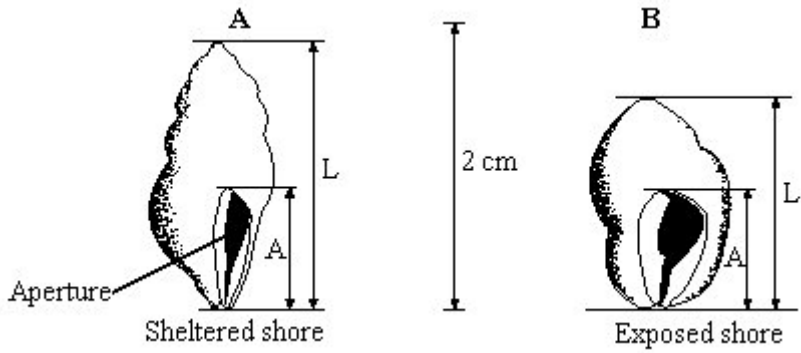
S (iii) There was a significant difference between the mean heights of the plants grown from seeds taken from sites **A** and **D**. Describe the evidence from the information given which shows that this is likely to be due to genetic differences between the two populations.

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(1)

(Total 7 marks)

Q3. The drawings show two dogwhelks taken from two different populations. Dogwhelk **A** came from a sheltered shore and dogwhelk **B** from a shore exposed to heavy wave action. The dogwhelks attach themselves to rocks with a muscular foot which comes out through the aperture. The shell length : aperture length ratios (L/A) were calculated. The mean and standard deviation for each population are shown under the drawings.



mean L/A ratio = 1.91
 standard deviation = 0.19

mean L/A ratio = 1.78
 standard deviation = 0.10

(a) Describe how you would collect a random sample of each population.

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(3)

(b) What do the standard deviations tell you about the two populations of dogwhelks?

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(2)

(c) Suggest how the effect of wave action on the two populations of dogwhelks could result in differences between

(i) the mean L/A ratios;

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(ii) the standard deviations.

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(4)
(Total 9 marks)

Q4. Evolutionary relationships between different primates can be found by comparing their proteins and DNA.

(a) All primates produce a species-specific type of haemoglobin. An antibody against human haemoglobin could be used to compare the evolutionary relationships between different primates. Describe and explain how.

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(3)

(b) Scientists used DNA hybridisation to determine the evolutionary relationships between five species of primate.

The temperature at which a molecule of double-stranded DNA separates into two single strands is the separation temperature.

The scientists recorded the mean separation temperature of DNA in which both strands were from the same species.

The scientists then recorded the mean decrease in separation temperature of DNA in which one of the strands was from another species.

Their results are shown in the table.

Primate	Mean decrease in separation temperature / °C				
	Human	Chimpanzee	Gorilla	Orang-utan	Gibbon
Human					
Chimpanzee	1.7				
Gorilla	2.3	2.3			
Orang-utan	3.6	3.6	3.5		
Gibbon	4.8	4.8	4.7	4.9	

- (i) These data suggest that gibbons are the most distantly related to humans. Explain how.

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(2)

- (ii) There were differences in separation temperature of DNA formed from single-stranded DNA of the **same** species of primate. Suggest why.

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(1)

- (iii) The scientists assumed that the decreases in separation temperatures are directly proportional to the time since the evolutionary lines of these primates separated. Gorillas are thought to have separated from orang-utans 20 million years ago.

Use this information to calculate how long ago the evolutionary lines of humans and chimpanzees separated. Show your working.

..... million years

(2)
(Total 8 marks)

Q5.A student investigated the distribution of plants in a heathland.

The table below shows the number of plants he found in a sample area of 1 m².

Species of plant	Number counted in 1 m ²
Common heather	2
Red fescue	14
Vetch	2
White clover	8

(a) What is the species richness of this sample?

(1)

(b) Calculate the index of diversity of this sample. Show your working.

Use the following formula to calculate the index of diversity.

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

where N is the total number of organisms of all species
and n is the total number of organisms of each species

Index of diversity =

(2)

- (c) Suggest how this student would obtain data to give a more precise value for the index of diversity of this habitat.

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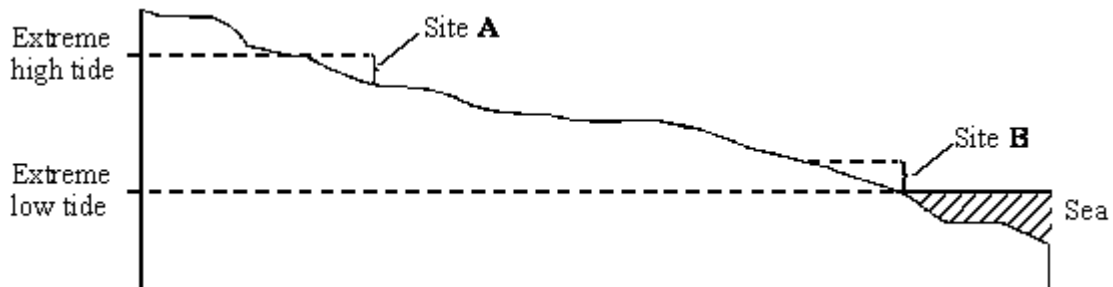
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(2)
(Total 5 marks)

- Q6.** Parts of the sea shore form a very hostile environment for living organisms. Twice each day the incoming and outgoing tides alternately cover the organisms on the sea shore with water and then leave them exposed. The force of the waves could also dislodge any organisms that were not firmly attached.

The diagram shows a section through a rocky shore. Two sites were studied: site **A** was on the upper shore and site **B** on the lower shore.



The table shows the seaweeds that were found growing at sites **A** and **B**.

Site A: upper shore	Mean number per m ²	Site B: lower shore	Mean number per m ²
<i>Ascophyllum nodosum</i>	2	<i>Corallina officinalis</i>	31
<i>Fucus spiralis</i>	10	<i>Fucus serratus</i>	8
<i>Fucus vesiculosus</i>	4	<i>Laminaria digitata</i>	15
<i>Pelvetia canaliculata</i>	6	<i>Laminaria hyperborea</i>	3
		<i>Laminaria saccharina</i>	6
		<i>Laurencia pinnatifida</i>	18
		<i>Palmaria palmata</i>	6
Index of diversity		Index of diversity	4.77

(a) (i) Use the formula $d = \frac{N(N-1)}{\sum n(n-1)}$

where **d** = index of diversity
N = total number of organisms of all species
n = total number of organisms of a particular species

to calculate the index of diversity for the seaweeds growing at site **A**.
Show your working.

Index of diversity at site **A** =

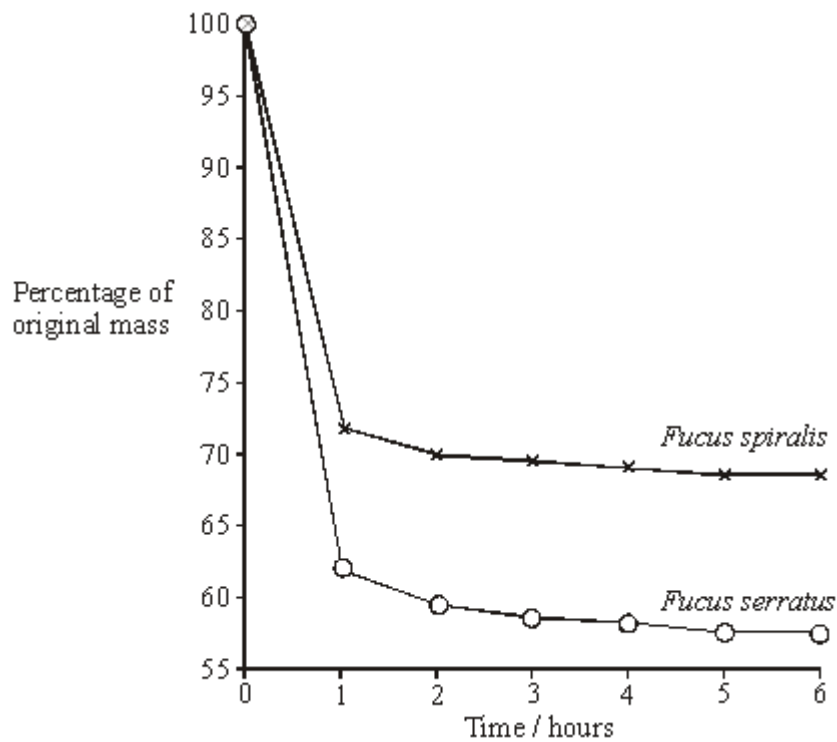
(2)

(ii) Give **one** advantage of calculating the index of diversity rather than just recording the number of species present.

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(1)

(b) Availability of water is one abiotic factor which determines the distribution of seaweeds. The graph shows loss in mass due to water evaporation for two of the seaweed species. The two seaweeds belong to the same genus but one was found only on the upper shore and the other only on the lower shore.



Explain how the results shown in the graph relate to the distribution of these two seaweeds on the sea shore.

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(3)
(Total 6 marks)

Q7. There are wolves in many European countries. Scientists investigated the genetic diversity of these wolves. They collected samples of DNA from the mitochondria of wolves from different countries. For each sample they identified which haplotypes were present in the DNA. A haplotype is a particular sequence of bases on DNA. Mutations can produce

new haplotypes.

Country	Number of wolves sampled	Number of different haplotypes in mitochondrial DNA
Spain	84	3
Portugal	19	2
Italy	101	1
France	7	1
Bulgaria	29	6
Sweden	93	1

The scientists wanted to find out whether one of the haplotypes in the Portuguese wolves was the same as one of those in the Spanish wolves. They used a restriction endonuclease, electrophoresis and a labelled DNA probe.

(a) For what purpose did they use

(i) the restriction endonuclease

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(1)

(ii) electrophoresis?

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(1)

(b) Explain why the labelled DNA probe could be used to find out whether the haplotypes were the same.

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(2)

(c) The scientists analysed the DNA on the Y chromosome and the DNA in the mitochondria of the Swedish wolves. They concluded that the Swedish wolf population descended from one male wolf from Finland and one female wolf from Russia.

(i) Explain why DNA on the Y chromosome helped them to reach this conclusion.

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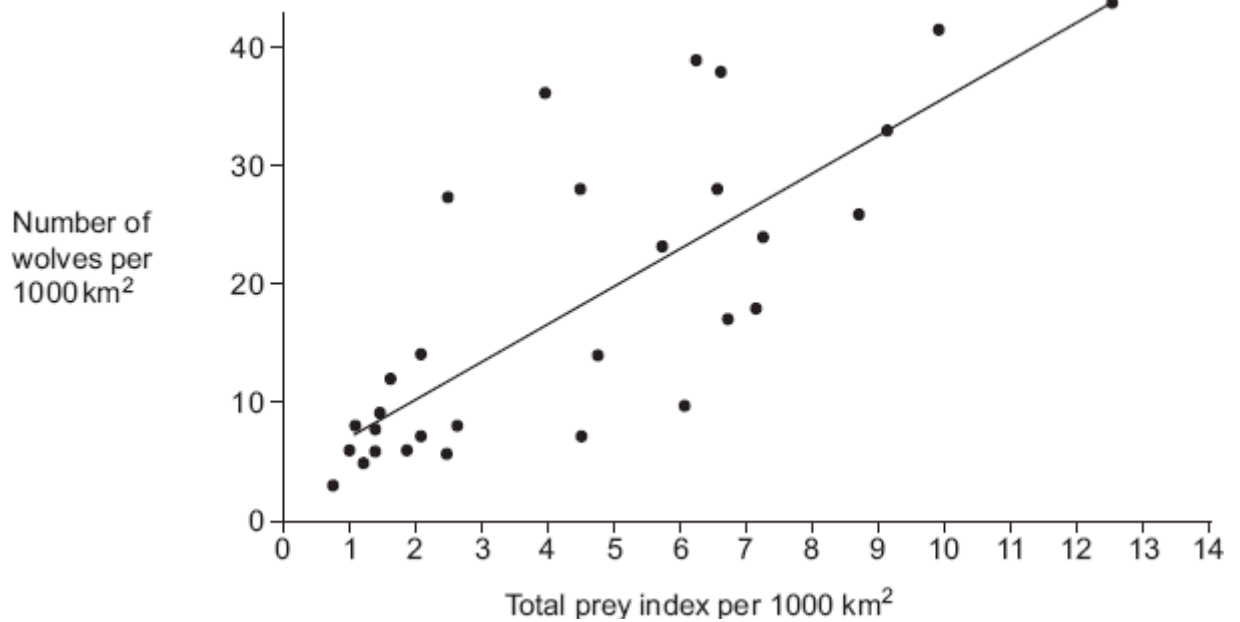
(1)

(ii) Suggest why DNA in the mitochondria helped them to reach this conclusion.

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(1)

Wolves eat different mammals. An ecologist investigated factors that affect wolf numbers in North America. He collected data from different field studies carried out in different places. The graph shows his results.



(d) (i) The wolf numbers are given per unit area. Explain why.

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(2)

- (ii) The ecologist calculated the total prey index for each of the places that had been studied. In order to do this, he gave each prey species a value based on how much food was available to wolves from the prey animal concerned. He called this value the prey index.

The ecologist considered that the prey index gave a better idea of the food available than the prey biomass in kg. Suggest why the prey index gives a better idea of food available.

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(2)

- (e) The ecologist calculated the total prey index by combining the prey indices and the total number of animals of each species present in 1000 km². He plotted this information on the graph. What does the graph suggest about the factors that determine wolf numbers in North America? Explain your answer.

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(2)

(Total 12 marks)