AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.4.7 INVESTIGATING DIVERSITY

SCORE	PERCENTAGE
/ 491	%

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Q1.

(a) Compare and contrast the DNA in eukaryotic cells with the DNA in prokaryotic cells.

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(5)

(b) Haemoglobins are chemically similar molecules found in many different species.

Differences in the primary structure of haemoglobin molecules can provide evidence of phylogenetic (evolutionary) relationships between species.

Explain how.

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(5)

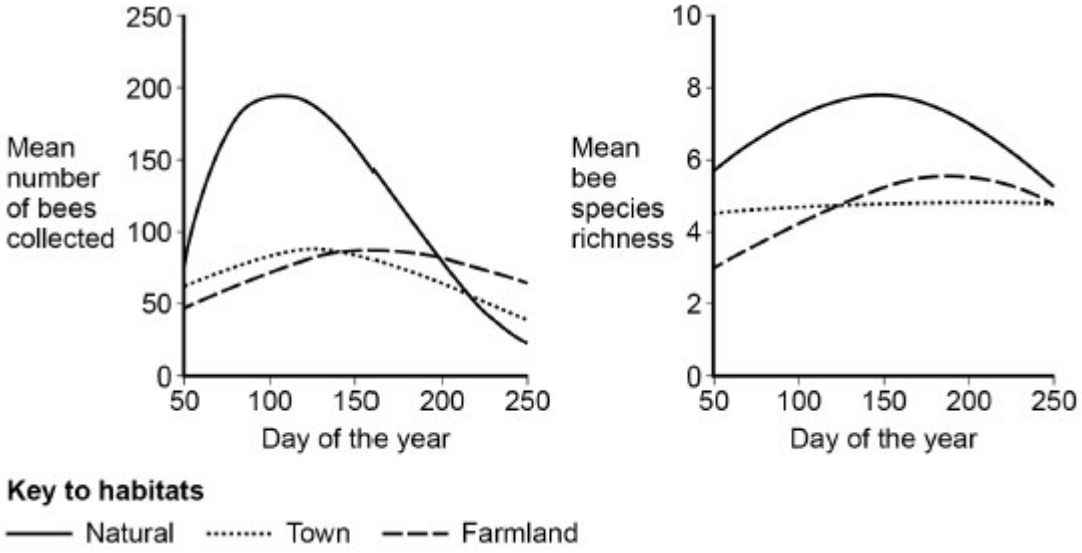
(Total 10 marks)

Q2.

Bees are flying insects that feed on nectar made in flowers. There are many different species of bee.

Scientists investigated how biodiversity of bees varied in three different habitats during a year. They collected bees from eight sites of each habitat four times per year for three years.

The scientists' results are shown below in the graphs in the form they presented them.



(a) What is meant by 'species richness'?

_____

_____

_____

_____

_____

_____

_____

(1)

(b) From the data in the graphs, a student made the following conclusions.

1. The natural habitat is most favourable for bees.
2. The town is the least favourable for bees.

Do the data in the graphs support these conclusions? Explain your answer.

1. The natural habitat is most favourable for bees.

_____

_____

_____

2. The town is the least favourable for bees.

(4)

(c) The scientists collected bees using a method that was ethical and allowed them to identify accurately the species to which each belonged.

In each case, suggest **one** consideration the scientists had taken into account to make sure their method

1. was ethical.

2. allowed them to identify accurately the species to which each belonged.

(2)

(d) Suggest and explain **two** ways in which the scientists could have improved the method used for data collection in this investigation.

1. _____

2. _____

(2)

(e) Three of the bee species collected in the farmland areas were *Peponapis pruinosa*, *Andrena chlorogaster* and *Andrena piperi*.

What do these names suggest about the evolutionary relationships between these bee species? Explain your answer.

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(2)

(Total 11 marks)

Q3.

A student investigated the effect of three types of disinfectant on the growth of *Lactobacillus* bacteria.

During the investigation, the student:

- boiled the agar before pouring the agar plates
- transferred 0.5 cm^3 of a diluted liquid culture of *Lactobacillus* onto each agar plate
- left some agar plates as controls
- added to other agar plates different concentrations of the disinfectants as shown in the table in part (a).

After 2 days, she counted the number of colonies of bacteria on each agar plate.

(a) Explain the purpose of:

boiling the agar _____

_____

_____

_____

transferring the same volume of liquid culture onto each agar plate.

_____

_____

_____

_____

(2)

The three disinfectants used by the student were Lysol, propan-2-ol and ammonia.

The table shows the student's results.

Concentration of disinfectant / arbitrary units	Number of colonies of bacteria		
	Lysol	Propan-2-ol	Ammonia
0	300	300	300
5	0	290	300
10	0	195	295
15	0	0	275
20	0	0	240

The liquid culture the student transferred was diluted by 1 in 10 000 (10^{-4}).

(b) Use information in this question to calculate how many bacteria were present in 1 cm^3 of undiluted liquid culture.

Answer = _____

(2)

(c) The student concluded that the minimum concentration of propan-2-ol needed to stop the growth of *Lactobacillus* was 15 units. This conclusion is incorrect.

Describe how you could obtain a more accurate estimate of the minimum concentration of propan-2-ol needed to stop the growth of this species of bacterium.

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(2)

(Total 6 marks)

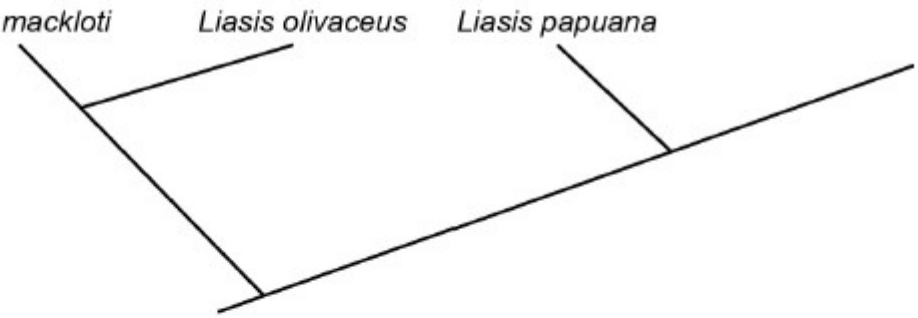
Q4.

The diagram shows two different ways of classifying the same three species of snake.

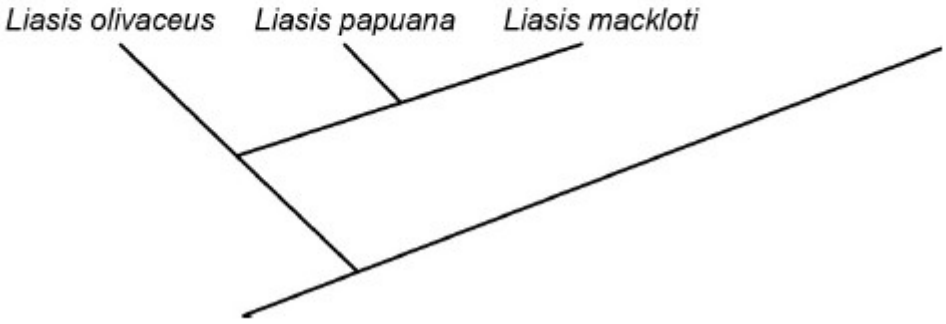
- Classification **X** is based on the frequency of observable characteristics
- Classification **Y** is based on other comparisons of genetic characteristics.

All three species of snake belong to the Python family.

Classification **X**



Classification **Y**



(a) What do these classifications suggest about the evolutionary relationships between these species of snake?

Classification **X** _____

_____

_____

_____

Classification **Y** _____

_____

_____

_____

(2)

(b) Complete the table below to show the missing names of the taxa when classifying these snakes.

Taxon (hierarchical order)	**Name**
	Eukaryote
	Animal
	Chordata
	Reptilia

	Squamata
Family	Python

(1)

(c) There is a debate about the name of one of these species of snake. Some scientists name it *Liasis papuana* and other scientists name it *Apodora papuana*.

Give the name of the taxon about which the scientists disagree.

_____

_____

(1)

(d) State **three** comparisons of genetic diversity that the scientists used in order to generate Classification **Y**.

1. _____

_____

_____

2. _____

_____

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3. _____

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(3)

(Total 7 marks)

Q5.

(a) Contrast how an optical microscope and a transmission electron microscope work **and** contrast the limitations of their use when studying cells.

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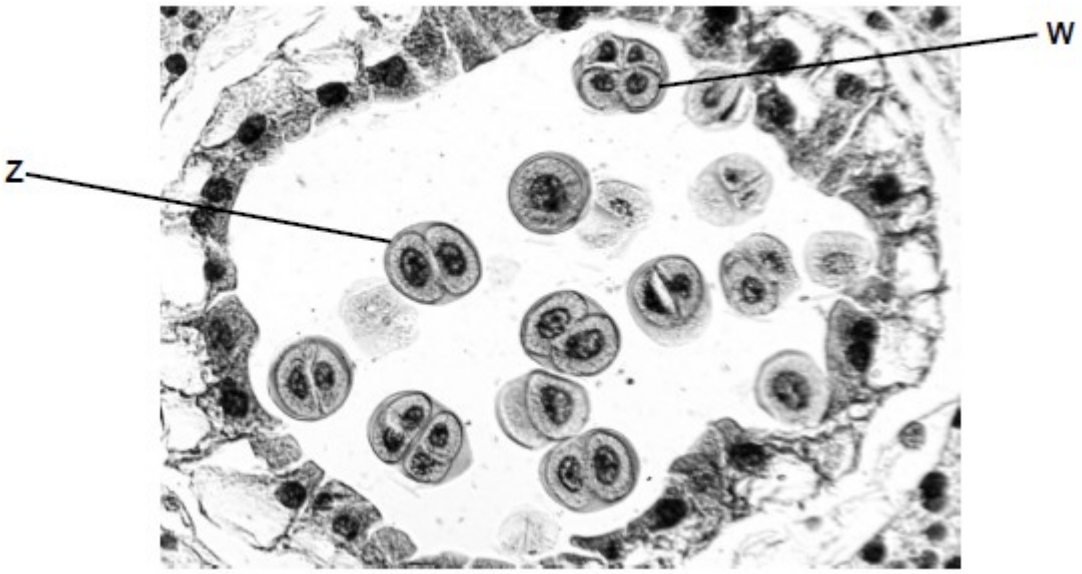
_____

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(6)

(b) The diagram shows an image from an optical microscope of meiosis occurring in a flower bud of a flowering plant. **W** and **Z** are undergoing meiosis.



Explain the appearance of **W** and **Z**.

_____

_____

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(4)

(c) An environmental scientist investigated a possible relationship between air pollution and the size of seeds produced by one species of tree.

He was provided with a very large number of seeds collected from a population of trees in the centre of a city and also a very large number of seeds collected from a

population of trees in the countryside.

Describe how he should collect and process data from these seeds to investigate whether there is a difference in seed size between these two populations of trees.

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(5)

(Total 15 marks)

Q6.

The UK government pays farmers to leave grassy strips around the edges of fields of crops. These grassy strips contain a variety of plant species. Leaving the strips is an attempt to encourage biodiversity of animals.

(a) Give **two** reasons why the grassy strips increase the biodiversity of animals.

1. _____

2. _____

(2)

A group of scientists investigated the effect of grassy strips on the biodiversity of soil animals.

- They divided a field into plots measuring 25 m × 5 m, with a 5-metre-wide grassy strip of land between each plot.
- Each year, they planted wheat in each of the plots.
- In the fifth year, they removed samples of soil from each plot where wheat was growing and from the grassy strips around them.
- They sorted each soil sample by hand for 40 minutes to collect the soil animals within the sample.

(b) The scientists decided to collect animals from the soil samples for 40 minutes.

Suggest how the scientists decided that 40 minutes was an appropriate time.

_____

_____

_____

_____

_____

(2)

(c) The table below shows how the scientists published their results. They calculated mean values and two times the standard deviation (SD) of the mean.

Two standard deviations above and below the mean includes 95.4% of the data.

Group of animals	**Mean number of animals per m^2 (± 2 × SD)**		**Mean number of species per m^2 (± 2 × SD)**	
	Soil under wheat crop	**Soil under grassy strips**	**Soil under wheat crop**	**Soil under grassy strips**
Beetles	41.2 (± 6.4)	80.1 (± 10.1)	10.0 (± 1.6)	17.3 (± 1.0)
Centipedes	18.4 (± 3.6)	13.5 (± 1.0)	1.8 (± 0.3)	2.1 (± 0.2)
Earthworms	244.5 (± 27.1)	281.2 (± 39.4)	3.8 (± 0.3)	5.1 (± 0.2)
Millipedes	38.4 (± 12.2)	36.2 (± 2.9)	3.5 (± 0.3)	3.2 (± 0.2)
Woodlice	0.0	73.9 (± 8.5)	0.0	2.8 (± 0.2)

It would **not** be possible to calculate an index of diversity from the results in the table.

Explain why.

_____

_____

_____

(1)

A summary of this research was published in a farming magazine. The journalist concluded that creating grassy strips around fields had little effect on the diversity of soil animals.

Do you agree with this conclusion?

Use evidence from the table to justify your answer.

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(4)

(Total 9 marks)

Q7.

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 m^2.

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.

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

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.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

Q8.

Species richness and an index of diversity can be used to measure biodiversity within a community.

(a) What is the difference between these two measures of biodiversity?

_____

_____

(1)

Scientists investigated the biodiversity of butterflies in a rainforest. Their investigation lasted several months.

The scientists set one canopy trap and one understorey trap at five sites.

- The canopy traps were set among the leaves of the trees 16–27 m above ground level.
- The understorey traps were set under trees at 1.0–1.5 m above ground level.

The scientists recorded the number of each species of butterfly caught in the traps. The table below summarises their results.

Species of butterfly	Mean number of butterflies		P value
	In canopy	In understorey	
Prepona laertes	15	0	< 0.001
Archaeoprepona demophon	14	37	< 0.001
Zaretis itys	25	11	> 0.05
Memphis arachne	89	23	< 0.001
Memphis offa	21	3	< 0.001
Memphis xenocles	32	8	< 0.001

(b) The traps in the canopy were set at 16–27 m above ground level. Suggest why there was such great variation in the height of the traps.

_____

_____

(1)

(c) By how many times is the species diversity in the canopy greater than in the understorey? Show your working.

Use the following formula to calculate species 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.*

Answer = _____

(3)

(d) The scientists carried out a statistical test to see if the difference in the distribution of each species between the canopy and understorey was due to chance. The P values obtained are shown in the table.

Explain what the results of these statistical tests show.

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q9.

Table 1 shows how a bird called the bluethroat (*Luscinia svecica*) is classified by biologists.

Table 1

Taxon	Name of taxon
Domain	Eukaryota
	Animalia

	Chordata
	Aves
	Passeriformes
	Muscicapidae
Genus	
Species	

(a) Complete **Table 1** by filling the seven blank spaces with the correct terms.

(2)

A group of scientists investigated genetic diversity in different species of bird. For each species, the scientists:

- collected feathers from a large number of birds
- extracted DNA from cells attached to each feather
- analysed the samples of DNA to find genetic diversity.

Table 2 summarises their results.

Table 2

Species of bird	**Number of genes examined**	**Number of genes examined that showed genetic diversity**
Willow flycatcher	708	197
House finch	269	80
Bluethroat	232	81

(b) In this investigation, what is meant by **genetic diversity?**

_____

_____

(1)

(c) The scientists concluded that the bluethroat showed greater genetic diversity than the willow flycatcher. Explain why they reached this conclusion. Use calculations to support your answer.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q10.

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.

_____

_____

_____

_____

(2)

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

1. _____

_____

2. _____

_____

(2)

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

_____

_____

_____

_____

(2)

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

(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.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q11.

(a) Human papilloma virus (HPV) is the main cause of cervical cancer. A vaccine has been developed to protect girls and women from HPV.

Describe how giving this vaccine leads to production of antibody against HPV.

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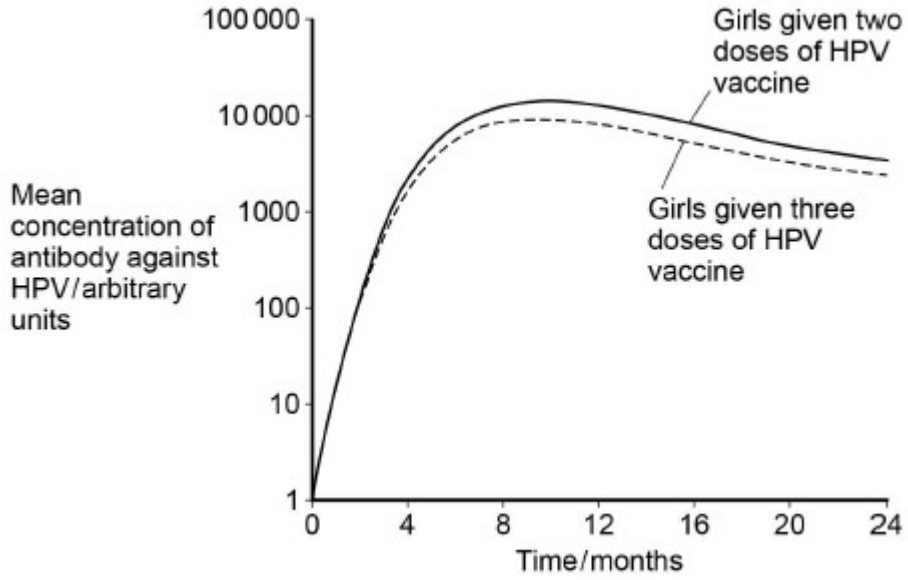
(4)

(b) Doctors investigated whether it was better to give two or three doses of the HPV vaccine. They determined the mean concentration of antibody against HPV in blood samples from girls who were given either two or three doses of the vaccine.

- Girls given two doses received an initial vaccination, followed by a second at 6 months.
- Girls given three doses received an initial vaccination, followed by a second at 1 month and a third at 6 months.

The doctors measured the concentration of antibody each month.

The results are shown below.



What do these results suggest about whether it is better to give two or three doses of the vaccine? Give reasons for your answer.

_____

_____

_____

_____

_____

(2)

(c) The doctors carried out a statistical test to determine whether the antibody concentrations were significantly different in girls given two doses of the vaccine, compared with those given three doses. They determined the mean concentrations of antibody 9 months after the first dose of vaccine.

What statistical test should the doctors have used? Give the reason for your choice.

Test _____

Reason _____

_____

(1)

(d) There is genetic diversity within HPV.

Give **two** ways doctors could use base sequences to compare different types of HPV.

1. _____

_____

2. _____

_____

(2)

(Total 9 marks)

Q12.

Scientists investigated the effect of different types of animal farming on the diversity and number of dung beetles. They determined the number of dung beetle species and their total number on intensive (**I**), rough grazing (**R**) and organic (**O**) farms.

Figure 1 and **Figure 2** show some of their results.

Figure 1

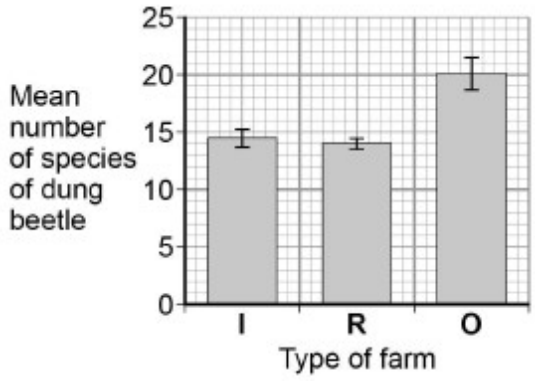
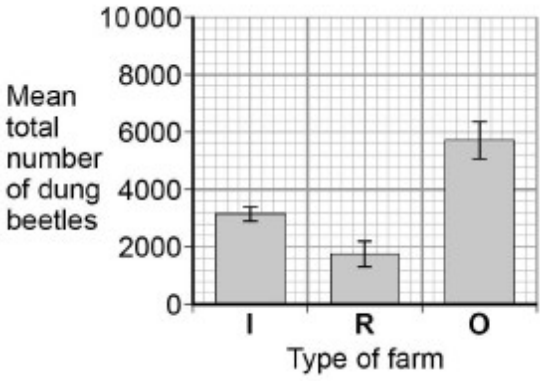


Figure 2



Key: I Standard deviation

(a) What is the mean species richness for dung beetles on the rough grazing farms?

_____

(1)

(b) In addition to the information provided in **Figures 1** and **2**, what other measurement is required to calculate an index of diversity for dung beetles?

_____

_____

(1)

(c) Explain what the standard deviations suggest about the difference in mean total number of dung beetles between the different types of farm.

_____

_____

_____

_____

_____

(2)

(d) The scientists placed traps to collect the dung beetles at sites chosen at random.

Explain the importance of the sites being chosen at random.

_____

_____

(1)

(e) On the intensive farms, the farmers had removed hedges to increase land for grazing. This resulted in a decrease in the diversity of birds on these farms.

Explain why the removal of hedges caused a decrease in the diversity of birds.

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(3)

(Total 8 marks)

Q13.

(a) Explain what is meant by a

(i) phylogenetic group

_____

_____

(1)

(ii) species.

_____

_____

_____

_____

(2)

The classification of tigers and clouded leopards is shown in **Table 1**.

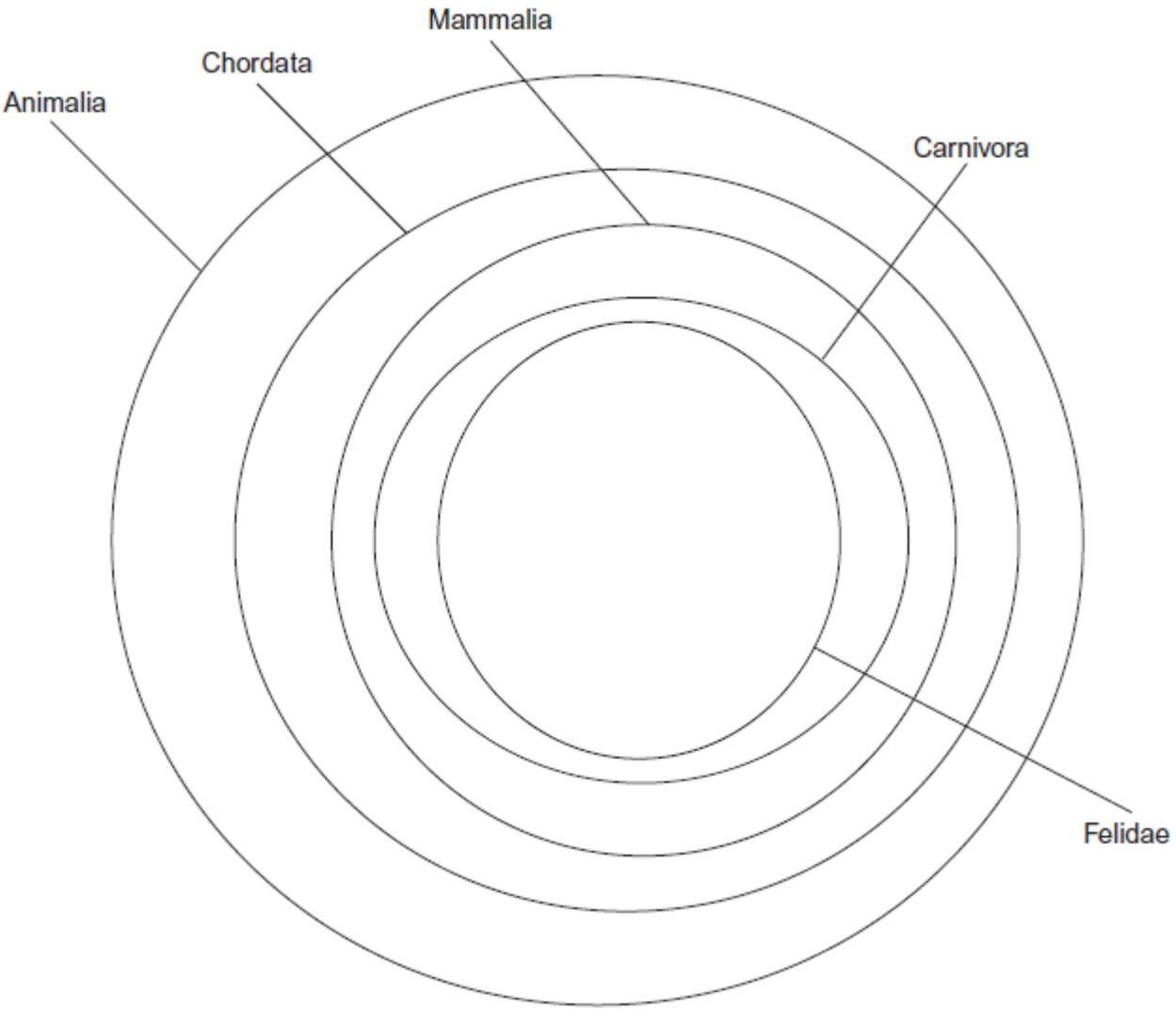
Table 1

Taxonomic group	**Tiger**	**Clouded Leopard**
Kingdom	Animalia	Animalia
	Chordata	Chordata
	Mammalia	Mammalia
Order	Carnivora	Carnivora
	Felidae	Felidae
	Panthera	Neofelis
Species	Tigris	Nebulosa

(b) Complete **Table 1** by adding the **four** other taxonomic groups to which the tiger and clouded leopard belong.

(1)

The circles in the diagram represent the hierarchy of taxonomic groups for the classification shown in **Table 1**.



(c) Draw additional circles on the diagram and label them to include all the information about the tiger and clouded leopard shown in **Table 1**.

(2)

Table 2 shows part of the nucleotide sequence in a gene in populations of tigers living in different parts of the world.

Table 2

Siberian tiger	G C A C C G T
South China tiger	A C G C C G C
Sumatran tiger	A C G C C G C

(d) Explain what the information in **Table 2** suggests about the phylogenetic relationships between these tigers.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q14.

(a) What is meant by species diversity?

_____

_____

_____

(1)

(b) Give **two** pieces of information needed to calculate an index of diversity for a community.

1. _____

2. _____

(2)

(c) A scientist investigated the effect sewage entering a river had on the distribution of organisms living in the river. Where sewage entered the river, he found a high density of organisms but a low index of diversity.

Suggest how sewage entering the river could explain the scientist's findings.

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(2)

(d) A second scientist repeated the investigation of the first scientist at the same place. The second scientist obtained a high index of diversity.

(i) Explain how the second set of results affects the ability of the scientists to make any conclusions about the effect of sewage on the index of diversity.

_____

_____

_____

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(2)

(ii) Suggest the additional steps that should be taken by the scientists before they are able to make any conclusions about the effect of sewage entering this river.

_____

_____

_____

(1)

(Total 8 marks)

Q15.

Scientists investigated the presence of bacteria resistant to the antibiotic neomycin in turkeys, chickens and the farmers who kept the turkeys and chickens. They looked for *Escherichia coli* (*E. coli*) resistant to neomycin. At 46 farms, the scientists obtained samples of bacteria from faeces of turkeys, turkey farmers, chickens and chicken farmers. The turkey farmers very often used turkey food containing neomycin. The chicken farmers did not use chicken food containing neomycin very often.

The bacteria were grown on nutrient agar in cultures. The nutrient agar contained neomycin. Any resistant bacteria grew and divided to form visible colonies.

The results are shown in the table

Samples taken from	**Percentage of samples of faeces containing *E. coli* resistant to neomycin**
Turkeys	81
Turkeys farmers	57
Chickens	24
Chicken farmers	8

(a) Suggest **two** hypotheses the scientists were testing in this investigation.

Hypothesis 1 _____

_____

_____

Hypothesis 2 _____

_____

_____

(2)

(b) (i) Describe what the results in the table show.

_____

_____

_____

_____

_____

(2)

(ii) Suggest and explain **one** reason for the observed differences in percentage of neomycin-resistant *E. coli* in turkeys and chickens.

_____

_____

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_____

(2)

(c) The scientists followed strict safety guidelines when collecting samples of faeces. Apart from the risk of contamination from *E. coli* this was especially important when collecting samples from humans.

Explain why.

_____

_____

_____

(1)

(d) Use the information provided to identify and explain **one** way in which the scientists increased the reliability of their method.

_____

_____

_____

_____

_____

(2)

(e) Suggest how the scientists could use DNA to investigate whether the neomycin-

resistant bacteria in farmers were identical to the strain of bacteria in the birds they kept.

(2)

(f) At one time, most animal feeds contained antibiotics that increased the rate of animal growth. In the UK, fewer animal feeds now contain antibiotics.

Suggest reasons why.

(4)

(Total 15 marks)

Q16.

There are nine subspecies of giraffe. These subspecies evolved when populations of giraffe were separated for long time periods. Each subspecies has distinct coloured skin markings. Some biologists have suggested that up to six of these subspecies should be classified as different species.

(a) Explain how different subspecies of giraffe may have evolved from a common ancestor.
Use information from the passage in your answer.

_____

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_____

(5)

(b) Biologists compared the mitochondrial DNA of the different subspecies of giraffe. They used the results from comparing this DNA to conclude that six of the nine subspecies are separate species.

Suggest how they came to this conclusion.

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(2)

(Total 7 marks)

Q17.

(a) What **two** measurements are needed to calculate an index of diversity?

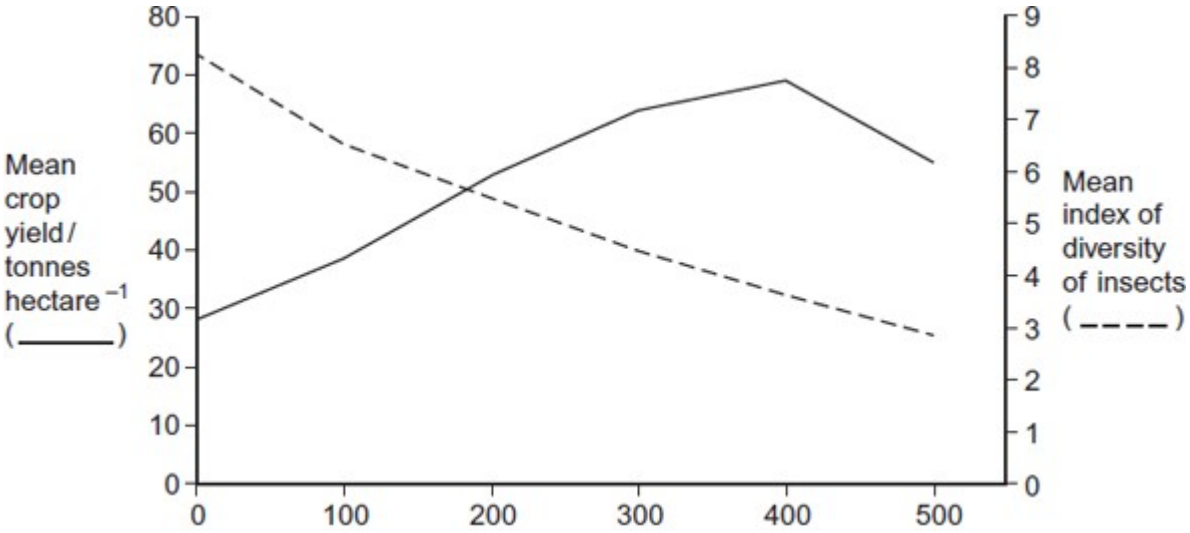
1. _____

2. _____

(2)

(b) A herbicide is a chemical used to kill weeds. Ecologists investigated the effect of a herbicide on crop yield and the diversity of insects. They sprayed different fields with the same volume of different concentrations of the herbicide. At harvest, the ecologists determined the mean crop yield and the mean index of diversity of insects for fields that had received the same concentration of the herbicide.

The figure below shows their results.



(i) Some fields acted as controls. They were sprayed with a solution that did not contain the herbicide. Explain the purpose of these control fields.

_____

_____

_____

(1)

(ii) Suggest an explanation for the relationship between the concentration of herbicide and the mean crop yield.

_____

_____

_____

_____

(2)

(iii) Explain the relationship between the concentration of herbicide and the mean index of diversity of insects.

_____

_____

_____

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(3)

(Total 8 marks)

Q18.

Farmland previously used for growing crops was left for 30 years and developed into woodland. During this period, ecologists recorded an increase in the diversity of birds in the area.

(a) Name the process that resulted in the development of woodland from farmland.

_____

(1)

(b) Explain the increase in the diversity of birds as the woodland developed.

_____

_____

_____

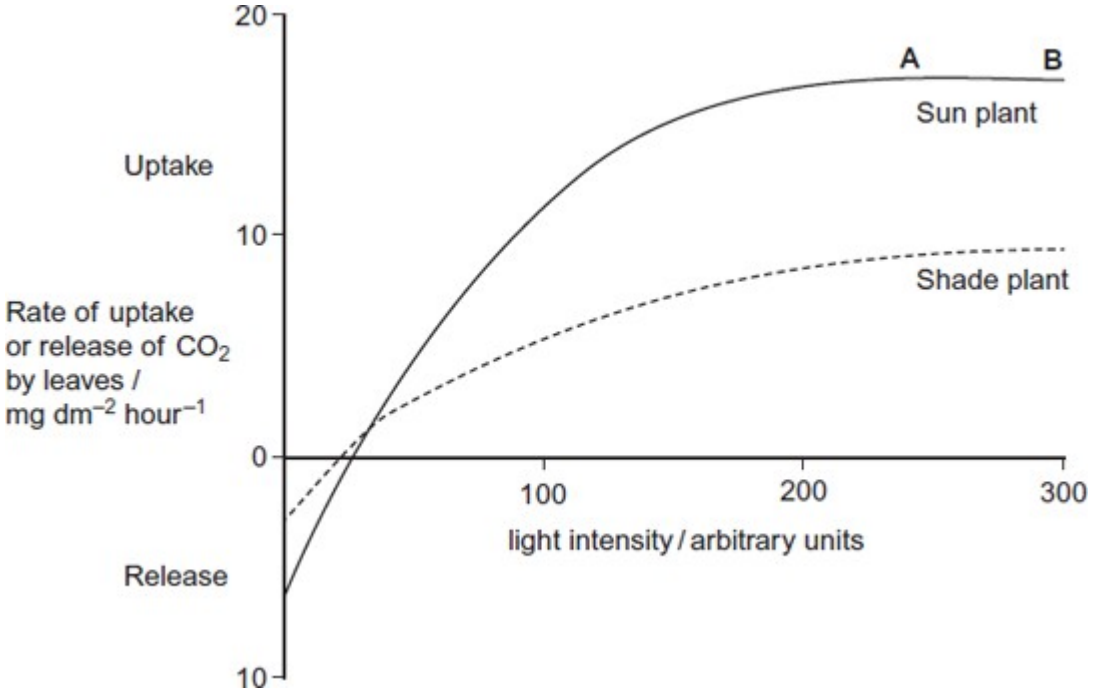
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(3)

(c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in the figure below.



(i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on the figure.

1. _____

2. _____

(1)

(ii) Explain why CO_2 uptake is a measure of net productivity.

_____

_____

(1)

(iii) Use the information in the figure to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

_____

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_____

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(2)

(Total 8 marks)

Q19.

During the light-independent reaction of photosynthesis, carbon dioxide is converted into organic substances. Describe how.

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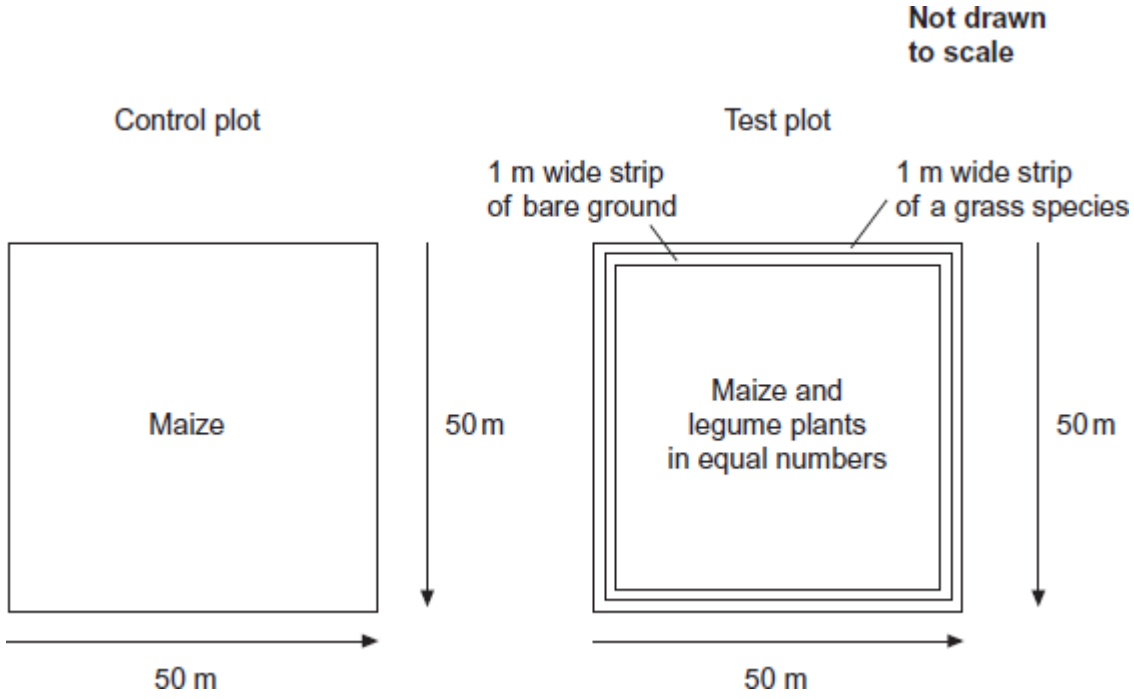
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(Total 6 marks)

Q20.

Stemborers are insect pests that feed on maize plants. Scientists investigated the effect of **push-pull** stimuli on the control of these pests.

For this investigation, the scientists divided a large field into plots measuring 50 m × 50 m. They then designated each plot as a control plot or a test plot. The following figure shows what they planted in each type of plot.



The legumes planted with the maize drive stemborers away.
The grass species attracts stemborers.

The table below shows the scientists' results.

Plots	**Mean percentage damage to maize plants**	**Mean maize grain yield / tonnes per hectare (± standard deviation)**	**Mean production costs per farmer / $ per hectare (± standard deviation)**	**Mean total income for farmer / $ per hectare (± standard deviation)**
Control	29.6	1.5 (±0.2)	250 (±0.7)	329 (±5.9)
Test	6.7	3.7 (±0.3)	278 (±1.1)	679 (±10.2)

(a) In the test plot of land, identify the push stimulus and the pull stimulus.

Push stimulus _____

Pull stimulus _____

(1)

(b) When measuring the mean percentage damage to maize plants, 60 plants from each test plot were selected at random and examined.
Describe how the maize plants could be selected at random.

_____

_____

_____

_____

_____

_____

(3)

(c) In the test plot, bare ground was left between the maize and the grass species.
Suggest an explanation why.

_____

_____

_____

_____

_____

(2)

(d) The legume plants have nodules containing nitrogen-fixing bacteria on their roots.
Explain how nitrogen-fixing bacteria could increase the growth of the maize.

_____

_____

_____

_____

_____

(2)

(e) A year after this investigation, the government of one country decided that their farmers should use these **push-pull** stimuli.
How do these data support this decision?

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks)

Q21.

Organisms can be classified using a hierarchy of phylogenetic groups.

(a) Explain what is meant by:

(i) a hierarchy

_____

_____

_____

_____

_____

(2)

(ii) a phylogenetic group.

_____

_____

_____

(1)

(b) Cytochrome c is a protein involved in respiration. Scientists determined the amino acid sequence of human cytochrome c. They then:

- determined the amino acid sequences in cytochrome c from five other animals
- compared these amino acid sequences with that of human cytochrome c
- recorded the number of differences in the amino acid sequence compared with human cytochrome c.

The table shows their results.

Animal	Number of differences in the amino acid sequence compared with human cytochrome c
A	1
B	12
C	12
D	15
E	21

(i) Explain how these results suggest that animal **A** is the most closely related to

humans.

_____

_____

_____

_____

_____

(2)

(ii) A student who looked at these results concluded that animals **B** and **C** are more closely related to each other than to any of the other animals.

Suggest **one** reason why this might **not** be a valid conclusion.

_____

_____

_____

(1)

(iii) Cytochrome c is more useful than haemoglobin for studying how closely related different organisms are. Suggest **one** reason why.

_____

_____

_____

(1)

(Total 7 marks)

Q22.

Malaria is a disease caused by a parasite. Scientists investigated the effect of malaria on competition between two species of *Anolis* lizard on a small Caribbean island. They sampled both populations by collecting lizards from a large number of sites on the island.

(a) (i) Explain the importance of collecting lizards from a large number of sites.

_____

_____

_____

(1)

(ii) Describe **one** method the scientists could have used to ensure that the sites were chosen without bias.

_____

_____

_____

_____

_____

(2)

(iii) The population number of both species of lizard varied at different times of the year. Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

The scientists investigated the percentage of lizards of both species that were infected with malaria at different sites on the island. They collected samples of both lizards at intervals of 3 months for 1 year. They also recorded the elevation (height above sea level) of each site. Some of their results are shown in the table.

Site	**Elevation of collection site / metres**	**Total number of *A. gingivinus* collected in one year**	**Percentage of *A. gingivinus* infected with malaria**	**Total number of *A. wattsi* collected in one year**	**Percentage of *A. wattsi* infected with malaria**
1	10	13	0	0	0
2	80	30	0	0	0
3	120	35	23	3	0
4	200	40	30	7	0
5	300	52	46	12	0
6	315	35	31	13	1
7	370	155	37	79	2
8	414	124	44	68	4

(b) When analysing their results, the scientists used the percentage of lizards infected at each site, rather than the number of lizards infected. Explain why.

_____

_____

_____

_____

_____

(2)

(c) A preliminary study suggested that malarial infections were more common at higher elevations. Use the information provided to evaluate this suggestion.

_____

_____

_____

_____

_____

(2)

(d) (i) As a result of this investigation, the scientists concluded that the presence of malaria provided a competitive advantage to *A. wattsi.* Use the information provided to explain how they reached this conclusion.

_____

_____

_____

_____

_____

(2)

(ii) The malarial parasite of *Anolis* lizards destroys both red and white blood cells.Suggest how an increase in the percentage of *A. gingivinus* infected with malaria could result in *A.wattsi* having a competitive advantage.

_____

_____

_____

_____

_____

(2)

(iii) The scientists carried out a statistical test to determine whether the correlation between the number of *A. wattsi* collected and the percentage of *A. gingivinus* infected was significant. They obtained a value for P of < 0.01.

Use the terms **probability** and **chance** to help explain what this means.

_____

_____

_____

_____

_____

(2)

(Total 15 marks)

Q23.

Hummingbirds belong to the order Apodiformes. One genus in this order is *Topaza*.

(a) (i) Name **one** other taxonomic group to which all members of the Apodiformes belong.

_____

(1)

(ii) Name the taxonomic group between order and genus.

_____

(1)

The crimson topaz and the fiery topaz are hummingbirds.

Biologists investigated whether the crimson topaz and the fiery topaz are different species of hummingbird, or different forms of the same species.

They caught large numbers of each type of hummingbird. For each bird they

- recorded its sex
- recorded its mass
- recorded the colour of its throat feathers
- took a sample of a blood protein.

The table shows some of their results.

	Crimson topaz		**Fiery topaz**	
	Male	**Female**	**Male**	**Female**
Mean mass / g (± standard deviation)	13.6 (±1.9)	10.8 (±1.3)	14.2 (±1.6)	11.6 (±0.63)
Colour of throat feathers	Green	Grey edges	Yellowish green	No grey edges

(b) Explain how the standard deviation helps in the interpretation of these data.

_____

_____

_____

_____

_____

(2)

(c) The biologists analysed the amino acid sequences of the blood protein samples from these hummingbirds.

Explain how these sequences could provide evidence as to whether the crimson topaz and the fiery topaz are different species.

_____

_____

_____

_____

_____

(2)

(Total 6 marks)

Q24.

Scientists investigated the species of insects found in a wood and in a nearby wheat field. The scientists collected insects by placing traps at sites chosen at random both in the wood and in the wheat field.

The table shows the data collected in the wood and in the wheat field.

Species of insect	Number of organisms of each species	
	Wood	Wheat field
Bird-cherry oat aphid	0	216
Beech aphid	563	0
Large white butterfly	20	0
Lacewing	12	3
7-spot ladybird	36	0
2-spot ladybird	9	1
Total number of organisms of all species	640	220

(a) The scientists collected insects at sites chosen at random. Explain the importance of the sites being chosen at random.

_____

_____

_____

(1)

(b) (i) Use the formula

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

to calculate the index of diversity for the insects caught in the wood, where

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

Show your working.

Answer _____

(2)

(ii) Without carrying out any further calculations, estimate whether the index of diversity for the wheat field would be higher or lower than the index of diversity for the wood.

Explain how you arrived at your answer.

_____

_____

_____

_____

_____

(2)

(c) A journalist concluded that this investigation showed that farming reduces species diversity.
Evaluate this conclusion.

_____

_____

_____

_____

_____

(2)

(d) Farmers were offered grants by the government to plant hedges around their fields. Explain the effect planting hedges could have on the index of diversity for animals.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

Q25.

A student investigated the rate of respiration of yeast cells. He set up a conical flask with a suspension of yeast in some apple juice. He took samples of the mixture at different times and found the number of yeast cells.

His results are recorded in the table below.

Time from start of investigation/days	Mean number of yeast cells ($\times 10^6$) per cm^3
3	7.413
4	8.912
8	16.595
9	19.952
10	23.442
11	23.703

(a) The student set up a suspension of yeast in apple juice. Apple juice contains all the nutrients that yeast requires for growth. Name **two** types of nutrients present in the apple juice that are essential for the growth and reproduction of yeast cells.

1. _____

2. _____

(2)

(b) The student counted the yeast cells in a sample of the suspension.
Give **one** precaution the student should have taken to make sure he obtained a representative sample. Explain how this precaution would result in a representative sample.

_____

_____

_____

_____

_____

(2)

(c) Calculate the percentage increase of yeast cells between day 3 and day 4. *Show your working.*

Answer _____

(2)

(d) The increase in the number of yeast cells was less between days 10 and 11 than it was between days 3 and 4.
Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

Q26.

(a) Scientists can use protein structure to investigate the evolutionary relationships between different species. Explain why.

_____

_____

_____

_____

_____

(2)

(b) Comparing the base sequence of genes provides more evolutionary information than comparing the structure of proteins. Explain why.

_____

_____

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_____

_____

(2)

(Total 4 marks)

Q27.

(a) A student investigated the diversity of plants at several sites on a golf course. At each site she took a large number of random samples.

(i) Explain the importance of taking a large number of samples at each site.

_____

_____

_____

(1)

(ii) Explain the importance of taking samples at random.

_____

_____

_____

(1)

The student collected data from one part of the golf course and calculated an index of diversity.

The table shows her data.

Species	**Number of plants per m^2**
Sheep's fescue	11
Creeping buttercup	6
Clover	5
Dandelion	2
Sheep's sorrel	1
Lady's bedstraw	7
Stemless thistle	4

The index of diversity can be calculated from 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 each species

(b) Use the formula to calculate the index of diversity for the plants on this part of the golf course. Show your working.

Answer _____

(2)

(c) The golf course was surrounded by undeveloped grassland from which it had been produced.
The golf course had

- some areas of very short grass which was cut frequently
- some areas of longer grass which was cut less frequently
- some areas of long grass and shrubs which were never cut.

The index of diversity for the insects on the golf course was higher than that for the surrounding undeveloped grassland.

Explain the effect of developing this golf course on the index of diversity of insects.

_____

_____

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(3)

(Total 7 marks)

Q28.

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)

(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.

_____

_____

_____

_____

_____

(2)

(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.

(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.

_____

_____

_____

_____

_____

(2)

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

_____

_____

(1)

(Total 7 marks)

Q29.

The Harvest Index is the percentage of dry biomass that is harvested and used.

Barley is a cereal. It is grown for its grain. Researchers collected data to calculate the Harvest Index of barley growing in a small field. They obtained their measurements from

quadrats at different places in the field. Their results are shown in the following table.

Quadrat number	Dry biomass of barley plants / g m^{-2}	Dry biomass of barley grain harvested / g m^{-2}
1	80	42
2	75	37
3	82	41
4	93	39

(a) Use the data for quadrat number **4** in the table to calculate the Harvest Index for barley. Show your working.

Harvest Index = _____

(2)

(b) Plant breeders are trying to produce barley plants with shorter stems.
Explain how this would increase the Harvest Index.

_____

_____

(1)

(c) The values for the biomass of the barley plants are different in each quadrat.
Suggest an explanation for this difference.

_____

_____

_____

_____

_____

(2)

(d) The researchers measured the dry biomass of the barley plants and the barley grain.
What is the advantage of using dry biomass for these measurements?

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q30.

Herbicides are substances that kill weeds. Three farmers wanted to know which herbicide to use to control weeds in fields of barley. They chose eleven fields of barley and used a different herbicide in each field. Four weeks later they collected, counted and weighed the weeds in each field. Their results are shown in **Figure 1** and **Figure 2**.

Figure 1

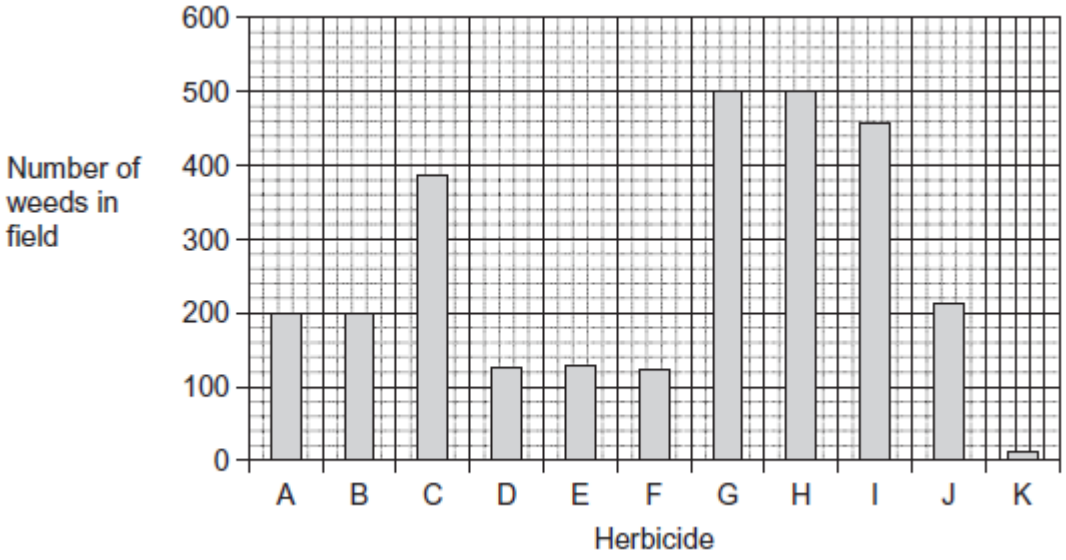
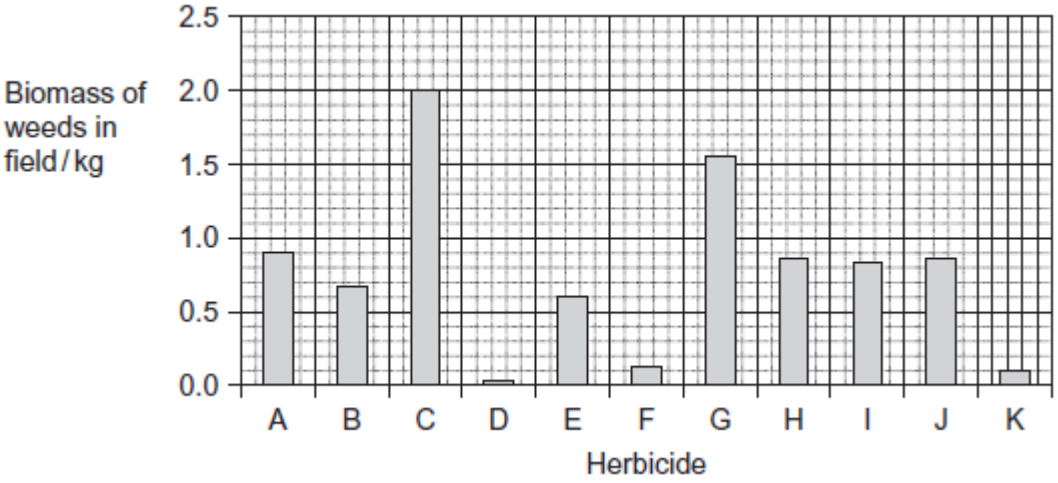


Figure 2



(a) Describe the difference in biomass of **each** of the weed plants in fields treated with herbicides **G** and **H**. Explain how you arrived at your answer.

_____

_____

_____

_____

_____

(2)

(b) The farmers decided that **K** would be the best herbicide to use.
Explain why herbicide **K** would give a higher crop yield.

_____

_____

_____

_____

_____

(2)

(c) The farmers carried out their investigation during the summer.
Suggest **one** advantage and **one** disadvantage of carrying out this investigation during the summer.

Advantage _____

_____

Disadvantage_____

_____

(2)

(d) One of the farmers told a local newspaper reporter of their findings. The newspaper published an article with the following headline: “Local farmers show scientists the way to bigger crop yields.” Was this headline justified? Explain your answer.

_____

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(5)

(Total 11 marks)

Q31.

The body markings of cheetahs vary, in particular the pattern of bands on their tails. Cheetahs are solitary animals but the young stay with their mother until they are between 14 and 18 months old.

Scientists investigated the banding pattern on the tails of cheetahs living in the wild.

- They drove a car alongside a walking cheetah and used binoculars to study the tail pattern.
- They gave each cheetah a banding pattern score based on the width of the dark and light bands on the end of the tail.
- They scored the width of the bands on the right and left side of the tail using a 5 point scale of width.

A typical pattern on the right side of one cheetah's tail is shown in **Figure 1**.

Figure 1

Band number 1 2 3 4 5 6 7



Band width score 3 1 1 4 3 3 3

The scientists collected data from each cheetah on four separate occasions. **Figure 2** shows the data for one of the cheetahs.

Figure 2

Side of tail	**Mean band width score (± standard deviation)**						
	Band 1	**Band 2**	**Band 3**	**Band 4**	**Band 5**	**Band 6**	**Band 7**
Right	3.00 (± 0.82)	1.00 (± 0.00)	1.00 (± 0.00)	3.75 (± 0.50)	2.75 (± 0.50)	3.00 (± 0.00)	3.00 (± 0.00)
Left	3.75 (± 0.50)	3.25 (± 0.50)	2.00 (± 0.50)	3.00 (± 0.00)	2.00 (± 0.00)	2.50 (± 0.50)	3.00 (± 0.50)

(a) The scientists only used data from cheetahs which were fully grown. Suggest why.

_____

_____

(1)

(b) The scientists estimated the width of the bands on the same cheetah on four

separate occasions. They did not always get the same score.

(i) Give **two** pieces of evidence from **Figure 2** which show that the scientists sometimes obtained different scores for the same band.

1. _____

_____

2. _____

_____

(2)

(ii) The method the scientists used resulted in them getting different scores for the same band. Suggest why.

_____

_____

(1)

(c) What is the evidence from **Figure 2** that the dark and light bands do **not** form rings of equal width around the tail?

_____

_____

(1)

(d) The scientists found the difference in banding pattern between

- offspring in the same family
- cheetahs chosen randomly.

Explain how scientists could use this information to show that some variation in tail banding was genetic.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q32.

(a) What information is required to calculate an index of diversity for a particular community?

_____

_____

_____

(1)

(b) Farmers clear tropical forest and grow crops instead. Explain how this causes the diversity of insects in the area to decrease.

_____

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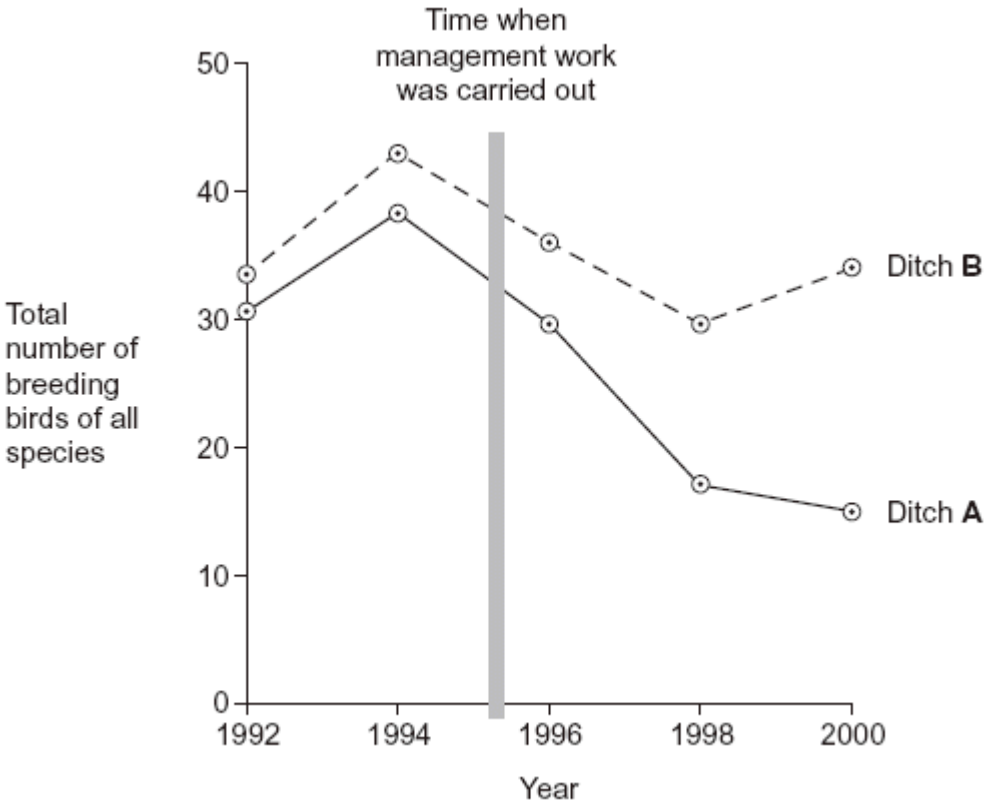
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(3)

Farmers manage the ditches that drain water from their fields. If they do not, the ditches will become blocked by plants. Biologists investigated the effects of two different ways of managing ditches on farmland birds.

- Ditch **A** was cleared of plants on both banks
- Ditch **B** was cleared of plants on one bank.

The graph shows the number of breeding birds of all species along the two ditches, before and after management.



(c) (i) The points on the graph have been joined with straight lines rather than with a smooth curve. Explain why they have been joined with straight lines.

_____

_____

_____

(1)

(ii) It would have been useful to have had a control ditch in this investigation. Explain why.

_____

_____

_____

(1)

(d) A farmer who wanted to increase the diversity of birds on his land read about this investigation.

He concluded that clearing the plants from one bank would not decrease diversity as much as clearing the plants from both banks. Evaluate this conclusion.

_____

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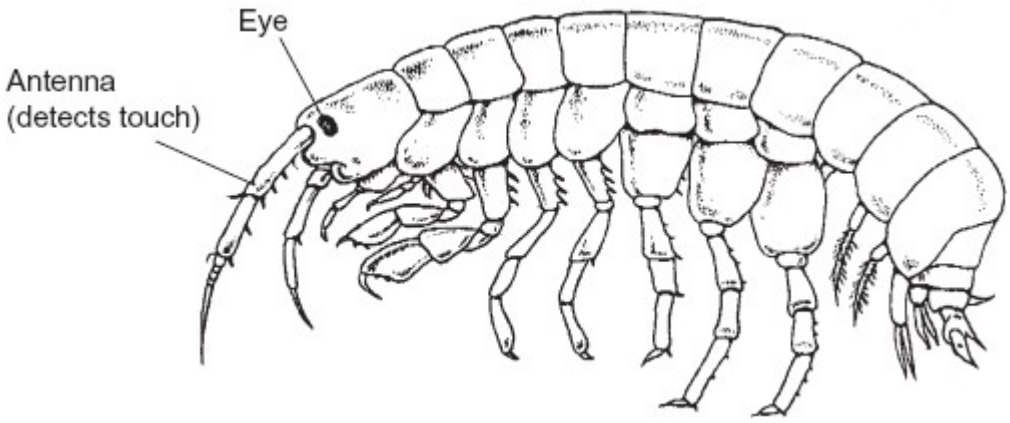
(3)

(Total 9 marks)

Q33.

Figure 1 shows a fresh-water shrimp.

Figure 1



Biologists collected shrimps from a stream inside a cave and from the same stream when it was in the open.

They measured the maximum diameter of each shrimp's eye. They also measured the length of its antenna. From these measurements they calculated the mean values for each site. **Figure 2** shows their results.

Figure 2

	Shrimps from the stream	
	Inside the cave	In the open
Mean diameter of eye /mm	0.09	0.24
Mean length of antenna /mm	8.46	5.81

(a) The biologists measured the maximum diameter of each shrimp's eye.

Explain why they measured the **maximum** diameter.

_____

_____

_____

(1)

(b) A scientist working many years earlier suggested that animals which live in caves had similar adaptations. These adaptations included

- smaller eyes
- greater use of sense organs such as those involved in detecting touch.

(i) Do the data in **Figure 2** support this scientist's suggestion? Explain your answer.

_____

_____

_____

_____

_____

(2)

(ii) The data in **Figure 2** are mean values. Explain how standard deviations of these cmean values would help you to interpret the data in **Figure 2**.

_____

_____

_____

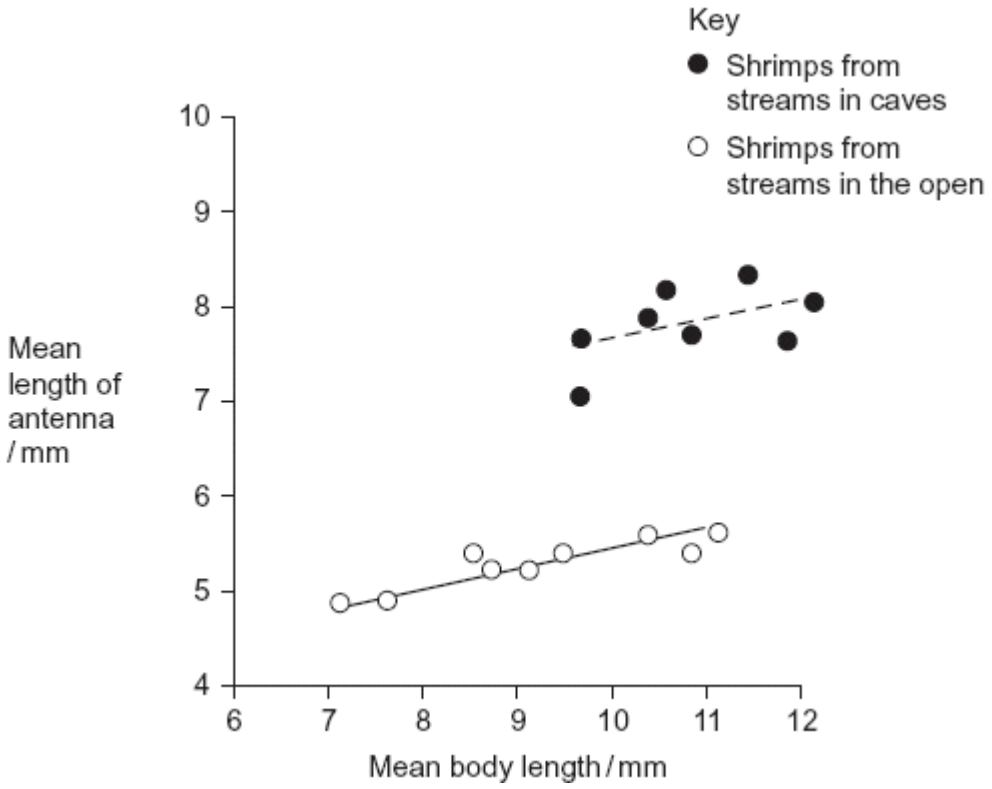
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(2)

(c) The biologists investigated shrimps living in other streams. They measured the length of the antennae of these shrimps. They also measured their body length. **Figure 3** shows the mean antenna length plotted against mean body length for each site.

Figure 3



(i) What does the information in the graph suggest about the body lengths of shrimps living in caves and living in the open?

_____

_____

_____

_____

_____

(2)

(ii) Do the data in the graph support the conclusion that shrimps with longer bodies have longer antennae? Give the reason for your answer.

_____

_____

_____

(1)

Other biologists investigated the genetic diversity of these shrimps. **Figure 4** shows some of the data they collected.

Figure 4

Gene	Allele	Percentage of shrimps with this allele in steam	
		Inside a cave	In the open
PGI	**A**	0.9	2.5
	B	0.0	3.3
	C	98.2	66.4
	D	0.9	6.6
	E	0.0	21.3
ACO2	**J**	0.0	5.6
	K	0.0	76.7
	L	100.0	17.8

(d) The biologists concluded that the shrimps in the open had a higher genetic diversity than those in the cave. Explain how the data in **Figure 4** support this conclusion.

_____

_____

_____

(1)

(e) The percentage of shrimps with allele **L** in the cave is different from the percentage of shrimps with allele **L** in the open. Use your knowledge of the founder effect to suggest a reason for this difference.

_____

_____

_____

_____

_____

_____

(3)

(f) The biologists who studied these shrimps wanted to know if the shrimps living in the cave were the same species as those living in the open. They used breeding experiments to investigate this.

(i) Describe how the biologists should carry out these breeding experiments.

_____

_____

_____

_____

(ii) The results of breeding experiments would help the biologists to decide whether the shrimps were the same species. Explain how.

_____

_____

(3)

(Total 15 marks)

Q34.

Cytochrome c is a protein found in all eukaryotes. In humans it consists of 102 amino acids. Biologists have compared the amino acid sequence in some other species with that in humans. The table shows amino acids 9 to 13 in the amino acid sequences of cytochrome c from four species.

	Amino acid in this position in cytochrome c				
Species	9	10	11	12	13
Human	Ile	Phe	Ile	Met	Lys
Chicken	Ile	Phe	Val	Gln	Lys
Dogfish	Val	Phe	Val	Gln	Lys
Chimpanzee	Ile	Phe	Ile	Met	Lys

(a) What do the results suggest about the relationship between humans and the other three species?

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_____

(2)

(b) Suggest **one** advantage of using cytochrome c to determine relationships between species.

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(1)

(c) Comparing the base sequence of a gene provides more information than comparing the amino acid sequence for which the gene codes. Explain why.

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(2)

(Total 5 marks)

Q35.

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

_____

_____

(1)

(ii) electrophoresis?

_____

_____

(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)

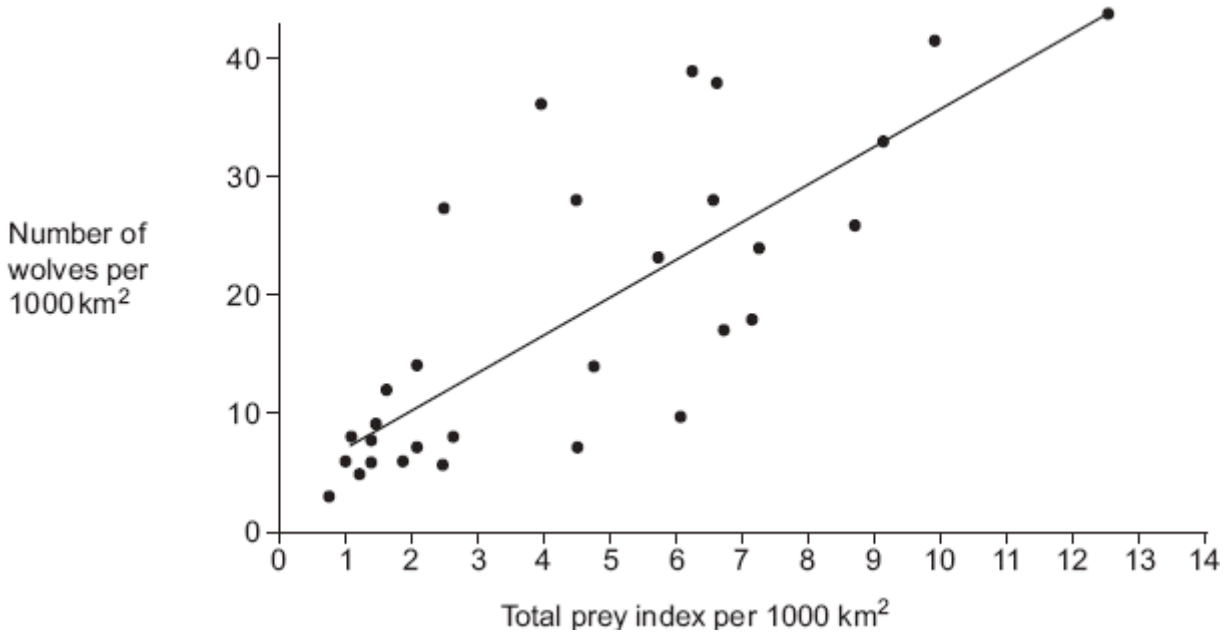
(ii) Suggest why DNA in the mitochondria helped them to reach this conclusion.

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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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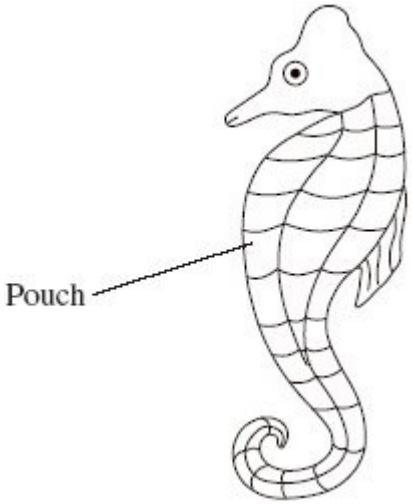
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(2)

(Total 12 marks)

Q36.

The diagram shows a seahorse. A seahorse is a fish. Mating in seahorses begins with courtship behaviour. After this, the female transfers her unfertilised eggs to the male's pouch. Most male fish fertilise eggs that have been released into the sea. However, a male seahorse fertilises the eggs while they are inside his pouch. The fertilised eggs stay in the pouch where they develop into young seahorses.



(a) Give **two** ways in which courtship behaviour increases the probability of successful mating.

1. _____

_____

2. _____

_____

(2)

(b) Give **one** way in which reproduction in seahorses increases the probability of

(i) fertilisation

_____

_____

(1)

(ii) survival of young seahorses.

_____

_____

(1)

Scientists investigated the effect of total body length on the selection of a mate in one Australian species of seahorse. The scientists used head length as a measure of total body length.

(c) (i) Use the diagram to suggest why the scientists measured head length rather than total body length.

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(1)

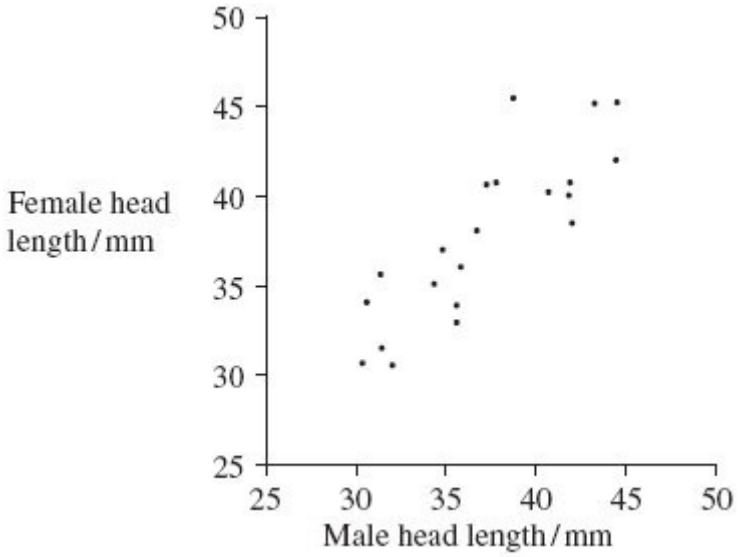
(ii) Suggest why the scientists were able to use head length as a measure of total body length.

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(1)

The scientists measured the head lengths of the female and male of a number of pairs. The results are shown in the graph.



(d) The scientists concluded that total body length affects the selection of a mate. Explain how the results support this conclusion.

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_____

(1)

(e) A female with a head length of 50 mm selected a mate. Explain how you could use the graph to predict the total head length of the mate selected.

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(2)

(f) Scientists studied two species of North American seahorse. They thought that these two species are closely related. Describe how comparisons of biological molecules in these two species could be used to find out if they are closely related.

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(6)

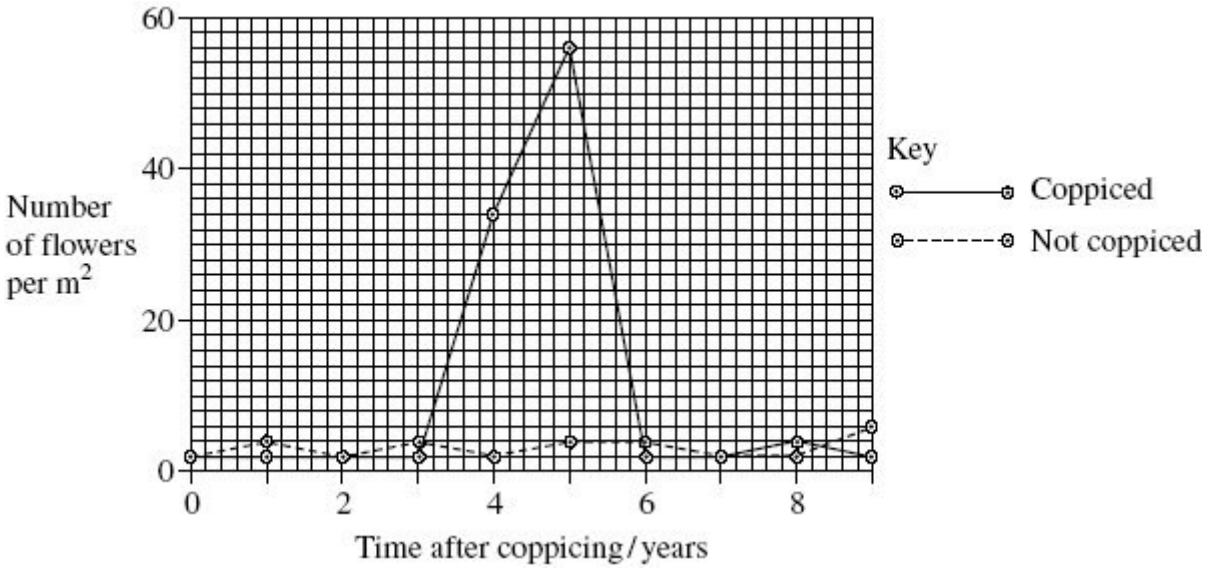
(Total 15 marks)

Q37.

Woods can be coppiced to provide a continuous supply of useful logs and poles. Coppicing involves cutting down some trees in a wood to leave stumps. New shoots grow from the stumps. After about 15 years, these trees can be coppiced again.

Because coppicing produces a wood with patches of light and shade, the diversity of plants and animals in a coppiced wood is high.

Ecologists investigated the effect of coppicing on the flowering of wild daffodils growing in a wood in Cumbria. Some areas of the wood were coppiced and some areas were not. The graph shows some results from this investigation.



(a) You could collect data for the coppiced plots by using quadrats.

(i) Describe how you would place the quadrats at random.

_____

_____

_____

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(2)

(ii) Describe how you would decide the number of quadrats to use in order to collect representative data.

_____

_____

_____

_____

(2)

(b) Members of the public visit this wood to see wild daffodils in flower. Explain how the information in the graph could help the owners to manage the wood so that there were many wild daffodils in flower every year.

_____

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(2)

(c) The ecologists analysed the relationship between the number of daffodils in flower in the whole wood and data collected from a nearby weather station for the previous year.

They used the Spearman rank correlation test. The table shows their results.

Month	Climatic factor	Correlation coefficient	Statistical significance
July	Total rainfall	+ 0.65	significant
August	Total rainfall	+ 0.74	significant
July	Monthly mean temperature	– 0.78	significant
August	Monthly mean temperature	– 0.65	significant

The ecologists concluded that a wet, cool summer produces good flowering the following spring. Do you support this conclusion? Use the data in the table to explain your answer.

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(2)

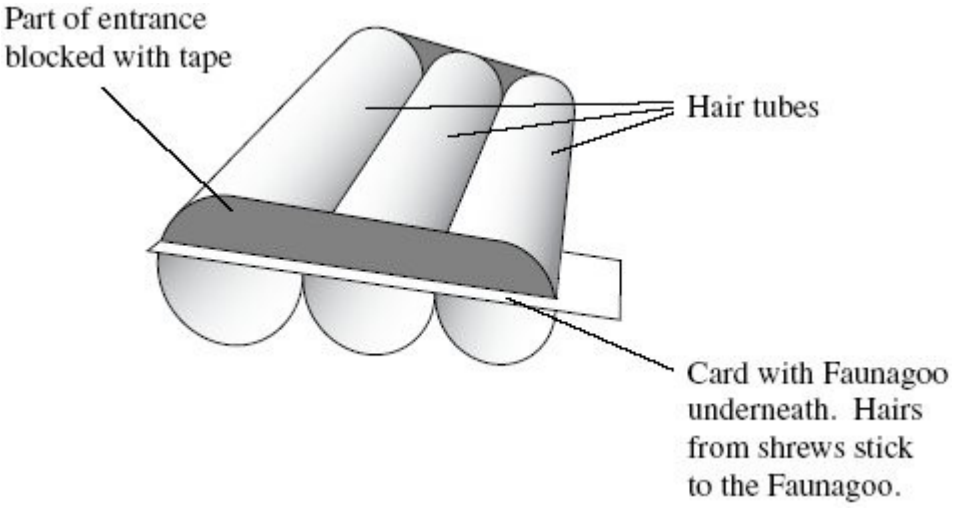
(Total 8 marks)

Q38.

Shrews are small mammals. Three species of shrew live in mainland Britain. The table shows some features of these shrews.

Species	Mean body mass / g	Mean length of head and body / mm	Food
Common shrew	10	79	Mainly insects and other small invertebrates
Pygmy shrew	5	58	
Water shrew	13	85	

A team of biologists investigated a method of estimating the abundance of shrews. They used plastic tubes, called hair tubes. Some of the hairs from a shrew that enters one of these tubes stick to glue in the tube. These hairs can be used to identify the species of shrew. The diagram shows a set of these hair tubes.



(a) (i) Faunagoo is a glue that remains sticky after wetting and drying. Explain the advantage of using Faunagoo in these hair tubes.

_____

_____

(1)

(ii) The diagram shows that the biologists partly blocked the entrances to the tubes with tape. Suggest why they partly blocked the entrances.

_____

_____

(1)

(b) The biologists needed to find a way of distinguishing between the hairs of the three species of shrew. They collected hairs from shrews of each species. For each species, they selected hairs at random and made different measurements.

Explain why the biologists selected the hairs at random.

_____

_____

(1)

(c) Repeatable measurements are measurements of the same feature that are very similar.

In this investigation, each measurement was made by two observers. This helped the team to check the repeatability of these measurements.

(i) Explain why it was important to check the repeatability of the measurements.

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(2)

(ii) You could use a scatter diagram to check the repeatability of measurements made by two observers. Describe how.

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(2)

(d) The biologists used hair tubes to find the abundance of shrews along the edges of some fields. They also used traps that caught shrews without harming them. They selected areas where all three species of shrew were present.

- They put sets of hair tubes at 5 m intervals along the edges of the fields. They inspected the tubes one week later and recorded the number of sets of tubes that contained shrew hairs. They called this the hair tube index.
- At each site where they used hair tubes, they set traps immediately after using the hair tubes. They recorded the number of different shrews caught in these traps.

(i) The research team found the hair tube index. Explain why they could not use the hair tubes to find the total number of shrews present.

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_____

(1)

(ii) The research team set the traps immediately after using the hair tubes. Explain why setting the traps immediately after using the hair tubes would make comparisons between the two methods more reliable.

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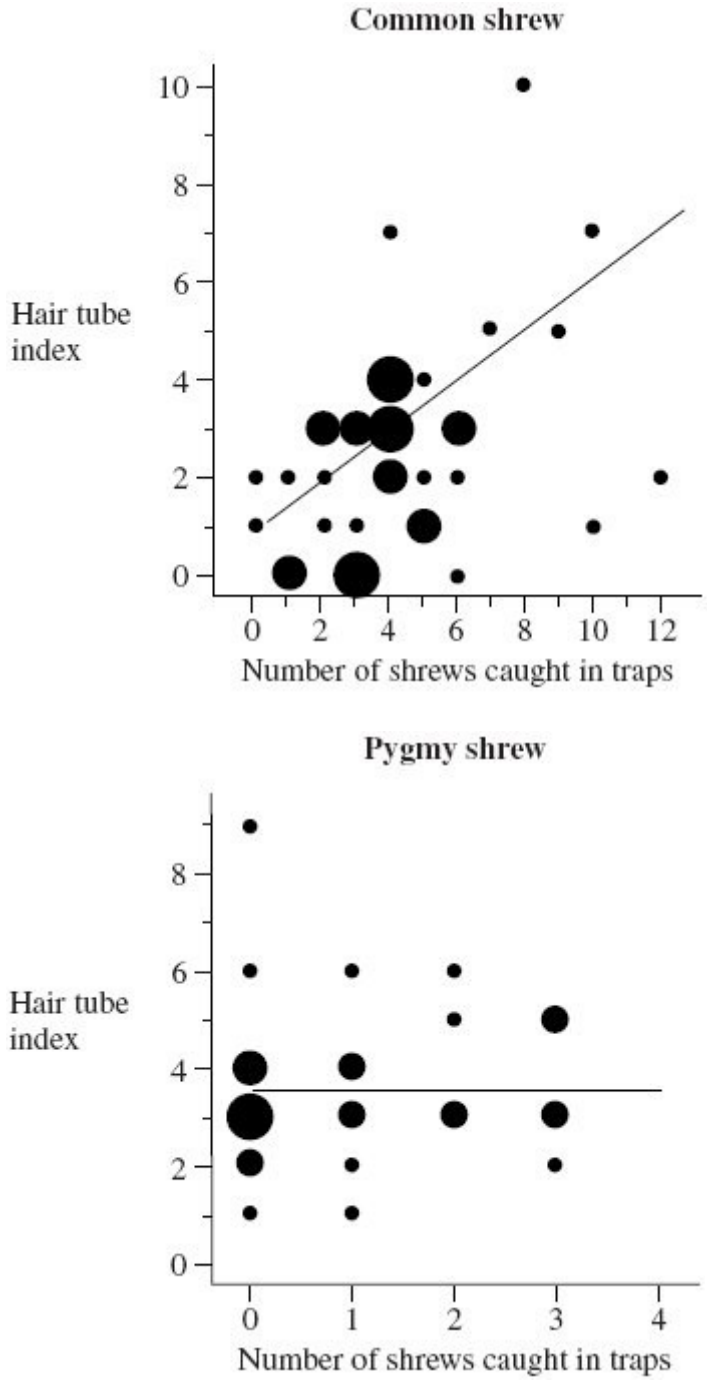
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(2)

The graphs are types of scatter diagram called bubble plots. They show hair tube index plotted against the number of shrews caught in traps. The area of the bubble is

proportional to the number of records plotted.



(e) Explain why a statistical test was necessary in analysing the results for the common shrew. Use the terms chance and probability in your answer.

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(2)

(f) (i) The biologists concluded that hair tubes were a reliable way of measuring the abundance of common shrews. Give evidence from the graph to support this conclusion.

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(1)

(ii) Use information in this question to evaluate the use of hair tubes as a way of measuring the abundance of pygmy shrews.

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(2)

(Total 15 marks)

Q39.

(a) A fish uses its gills to absorb oxygen from water. Explain how the gills of a fish are adapted for efficient gas exchange.

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(6)

Mackerel live in the surface waters of the sea. Toadfish live on the seabed in deep water.

(b) The concentration of oxygen is higher in the surface waters than it is in water close

to the seabed. Suggest why.

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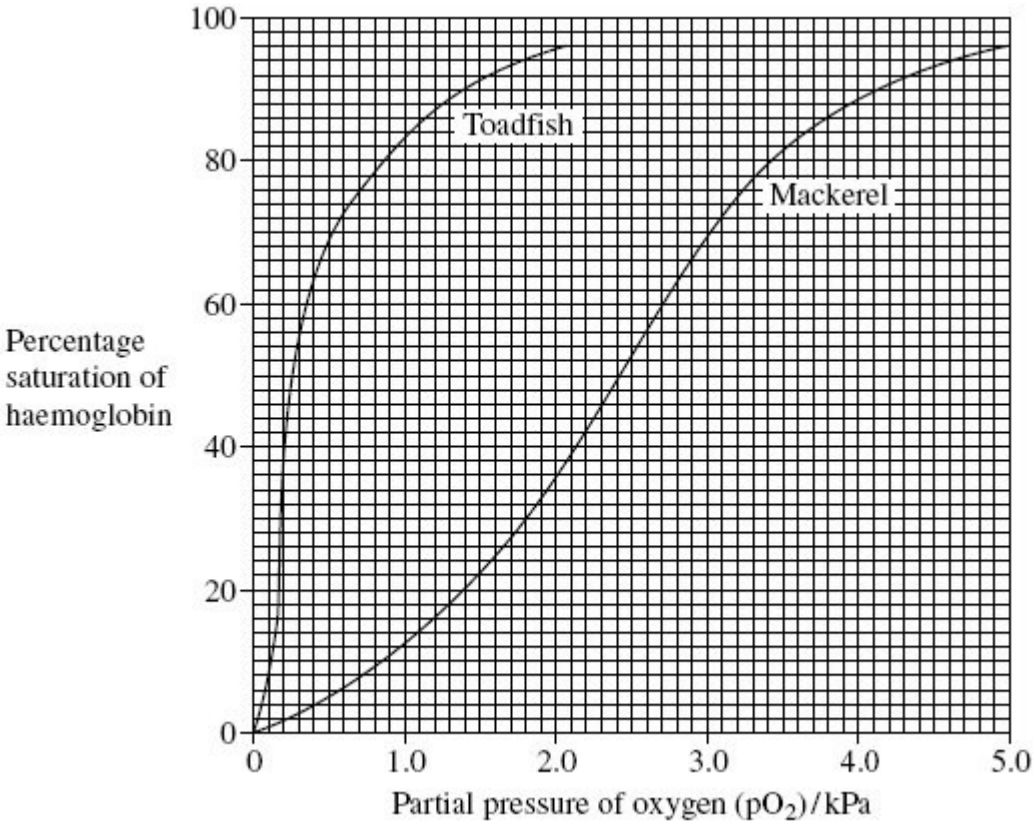
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(2)

(c) The graph shows oxygen dissociation curves for toadfish haemoglobin and for mackerel haemoglobin.



Explain how the shape of the curve for toadfish haemoglobin is related to where the toadfish is normally found.

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_____

(2)

(d) Scientists analysed the sequence of amino acids in one polypeptide chain in the haemoglobin of four different species of ape. The only difference they found affected the amino acids at three positions in the polypeptide chain. Their results are shown in the table. The letters are abbreviations for particular amino acids.

Species	Position 87	Position 104	Position 125
Chimpanzee	T	R	P
Bonobo	T	R	P
Gorilla	T	K	P
Orang utan	K	R	Q

What information do the data in the table suggest about the relationships between the chimpanzee, the bonobo and the gorilla? Explain your answer.

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(2)

(Total 12 marks)

Q40.

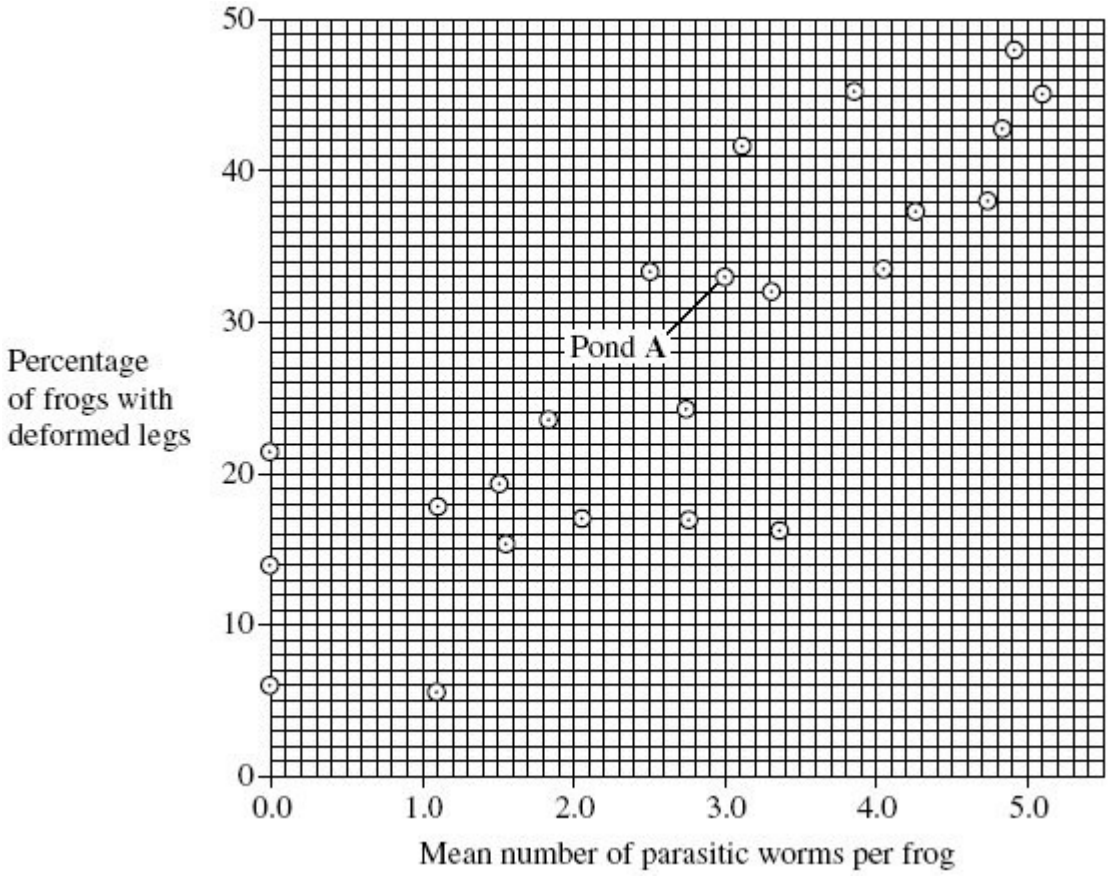
(a) In the USA, members of the public found many frogs with deformed legs. Scientists investigated this. They collected samples of the frogs. They wanted to get reliable data. Give **one** feature of the sample, other than a large sample size, that would help to make sure that their data were reliable.

_____

_____

(1)

The team of scientists then investigated frogs in ponds. The team measured many different factors and then analysed their results. The graph shows the relationship between the percentage of frogs with deformed legs and the mean number of parasitic worms found in the frogs.



(b) The scientists collected a sample of three frogs from pond **A**. What was the total number of parastic worms found in these three frogs?

(1)

(c) One scientist suggested that the parasites caused the deformed legs found in frogs.

Does the graph support this suggestion? Explain your answer.

(4)

(d) The scientists wrote a paper. In their discussion they wrote that they found very few ponds that were free from human influence. The few that they did find were only in mountainous areas.

The scientists could not draw any reliable conclusions about whether human influence contributed to the frogs' deformed legs. Explain why each of the following meant that they could not draw reliable conclusions.

(i) There were very few ponds free from human influence.

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_____

(1)

(ii) The ponds free from human influence were found only in mountainous areas.

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(2)

In a second investigation, another research team investigated deformed legs in frogs in a different way.

- They chose six ponds, all of which contained parasitic worms. Three of the ponds were close to fields and received agricultural run-off from these fields. The other three ponds did not receive agricultural run-off.
- They built two cages in each of the six ponds. One cage in each pond allowed parasitic worms to enter and one cage did not.
- They put frogs that were not infected with parasitic worms into all twelve cages.

The table shows the results of this second investigation.

	Percentage of frogs with deformed limbs					
	Ponds with agricultural run-off			Ponds with no agricultural run-off		
Pond number	1	2	3	4	5	6
Cage with mean mesh diameter of 500 μm	22	27	24	3	4	7
Cage with mean mesh diameter of 75 μm	0	0	0	0	0	0

(e) One of the boxes in the table has been shaded. Describe the information given in the shaded box.

_____

_____

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_____

(2)

(f) What conclusions can you draw from the data in the table about the factors causing deformed leg in frogs? Explain your answer.

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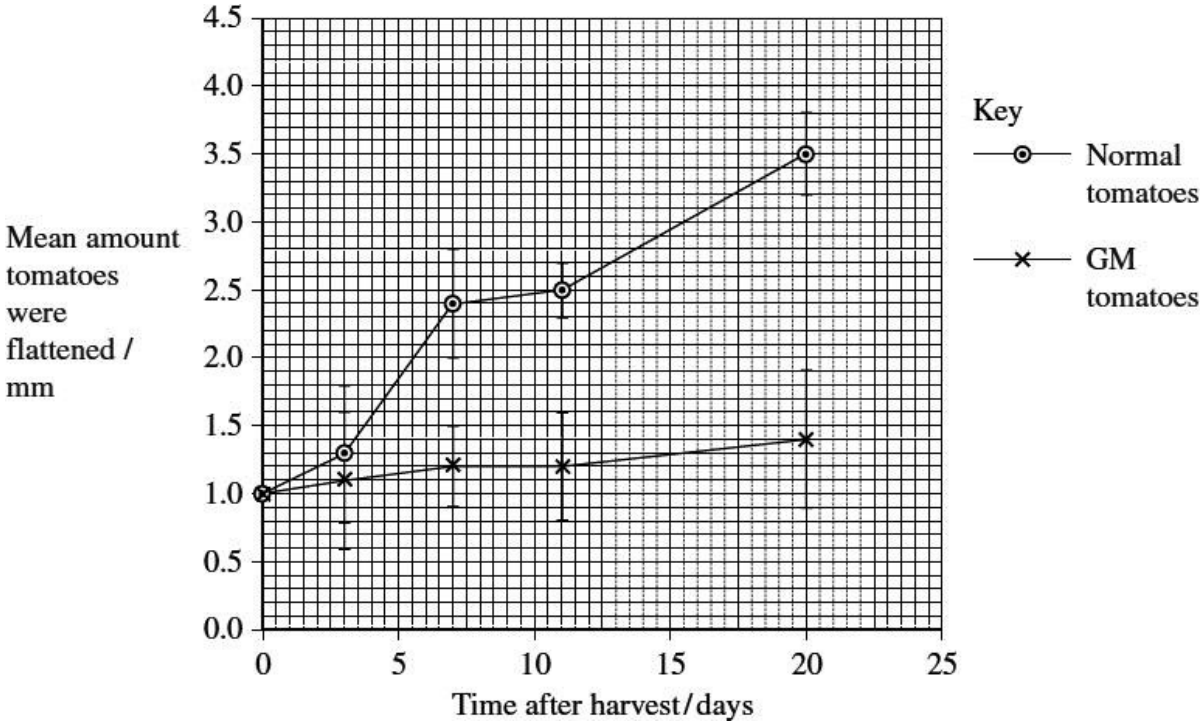
(4)

(Total 15 marks)

Q41.

Tomatoes become softer as they ripen. This is due partly to the breakdown of pectin by the enzyme pectinase. Scientists have produced a genetically modified variety of tomato plant (GM tomato) that produces tomatoes that ripen more slowly. The DNA of the GM tomato plant has been altered so it does not produce pectinase.

Scientists tested the ripeness of normal and GM tomatoes. They placed a 500 g mass on top of tomatoes at different times after they were harvested. The scientists measured the amount the tomatoes flattened. The following figure shows the results. The error bars represent standard deviation.



(a) The scientists used tomatoes of the same size in the technique described above to measure ripeness. Explain why.

_____

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(2)

(b) What do the standard deviation bars suggest about the difference in ripeness of the two varieties of tomato at 7 days? Explain your answer.

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(2)

(Total 4 marks)

Q42.

Biologists studied the process of succession in an area of wasteland over a period of ten years. They calculated the index of diversity of the area every year. After three years, the index of diversity was 1.6. After ten years, it had risen to 4.3.

(a) What information concerning the organisms present in the area is suggested by the increase in the index of diversity?

_____

_____

_____

_____

(2)

(b) The increase in the index of diversity is one indication that a biological succession is taking place in the area. Describe those features of a succession that would bring about an increase in the index of diversity.

_____

_____

_____

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_____

(3)

(Total 5 marks)

Q43.

Deforestation often involves clearing large areas of forest for use as agricultural land.

(a) Deforestation reduces the diversity index of an area cleared in this way. Explain why.

_____

_____

_____

_____

(2)

(b) Because the forest soil is often nutrient-poor, nitrogen-containing fertilisers may be applied to ensure good crop yields. Use your knowledge of the nitrogen cycle to explain the potential benefit of applying a fertiliser containing ammonium nitrate rather than one containing potassium nitrate.

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(3)

(Total 5 marks)

Q44.

Mayflies are insects which lay their eggs in streams and rivers. The nymphs which hatch from the eggs live in the water for several years.

Mayfly nymphs were collected by disturbing the gravel of a stream bed. A net placed immediately downstream caught any animals which were washed out of the gravel. Eight samples were collected from shallow, fast-flowing parts of the stream and eight from deeper, slow-flowing parts. Nymphs from two different families of mayfly were found. The results are given in the table.

	Family Caenidae		**Family Baetidae**	
	Shallow water	**Deep water**	**Shallow water**	**Deep water**
Mean number of nymphs	2.38	12.88	24.50	6.00
Standard deviation	1.51	7.92	6.72	1.51

(a) Describe how you would have collected the samples in order to ensure they were representative of the habitats being investigated and could be compared with each other.

_____

_____

_____

_____

_____

_____

(3)

(b) Which **one** of the four samples showed the greatest variation within the sample? Give evidence from the table for your answer.

_____

_____

(1)

(c) The two families of mayfly nymph occupy different ecological niches.

(i) What is meant by the term *ecological niche*?

_____

_____

(1)

(ii) Describe the evidence in the table which suggests that the two families of mayflies occupy different ecological niches.

_____

_____

(1)

(iii) Explain the advantage to these two families of mayflies of occupying different ecological niches.

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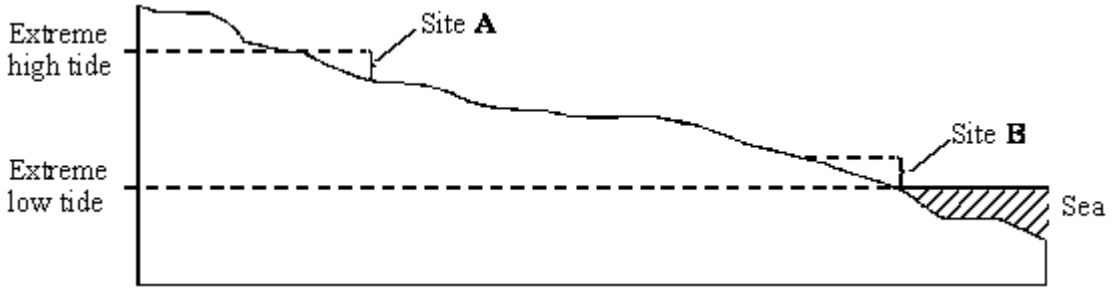
(2)

(Total 8 marks)

Q45.

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
Ascophyllum nodosum	2	*Corallina officinalis*	31
Fucus spiralis	10	*Fucus serratus*	8
Fucus vesiculosus	4	*Laminaria digitata*	15
Pelvetia canaliculata	6	*Laminaria hyperborea*	3
		Laminaria saccharina	6

		Laurencia pinnatifida *Palmaria palmata*	18 6
Index of diversity		Index of diversity	4.77

(a) (i) Use 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 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)

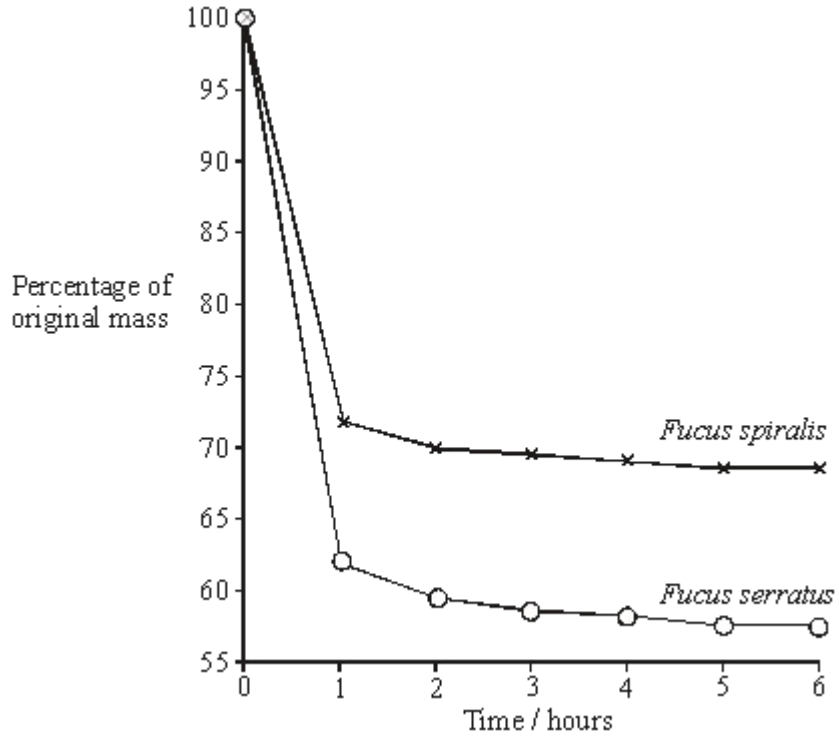
(ii) Give **one** advantage of calculating the index of diversity rather than just recording the number of species present.

_____

_____

(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.

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q46.

When coal is mined by open-cast mining, the top layer of soil is first scraped off and stored in a large heap. Once mining has finished, the area can be reclaimed. Soil from this store is then spread back over the surface.

Some of the bacteria living in the soil store respire aerobically and some respire anaerobically. **Table 1** shows the numbers of aerobic and anaerobic bacteria found at different depths in a soil store.

Depth / cm	**Mean number of bacteria per gram of soil (× 10^7)**			
	Aerobic bacteria		Anaerobic bacteria	
	after 1 month	after 6 months	after 1 month	after 6 months
0	12.0	12.1	0.6	0.8

50	10.4	8.6	0.8	1.3
100	10.1	6.1	0.7	4.1
150	10.0	3.2	0.7	7.9
200	11.6	0.8	0.7	8.4
250	11.9	0.7	0.8	8.8
300	11.0	0.8	0.6	9.1

Table 1

(a) Some of the soil used to determine bacterial numbers was collected from the surface of the soil store. Describe how you would ensure that this soil was collected at random.

_____

_____

_____

_____

(2)

(b) (i) Describe how the numbers of aerobic bacteria after 6 months change with depth.

_____

_____

_____

_____

(2)

(ii) Explain the difference in the numbers of aerobic bacteria at a depth of 300 cm between 1 and 6 months.

_____

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(2)

(c) Explain how the changes in bacterial numbers which take place at 150 cm illustrate the process of succession.

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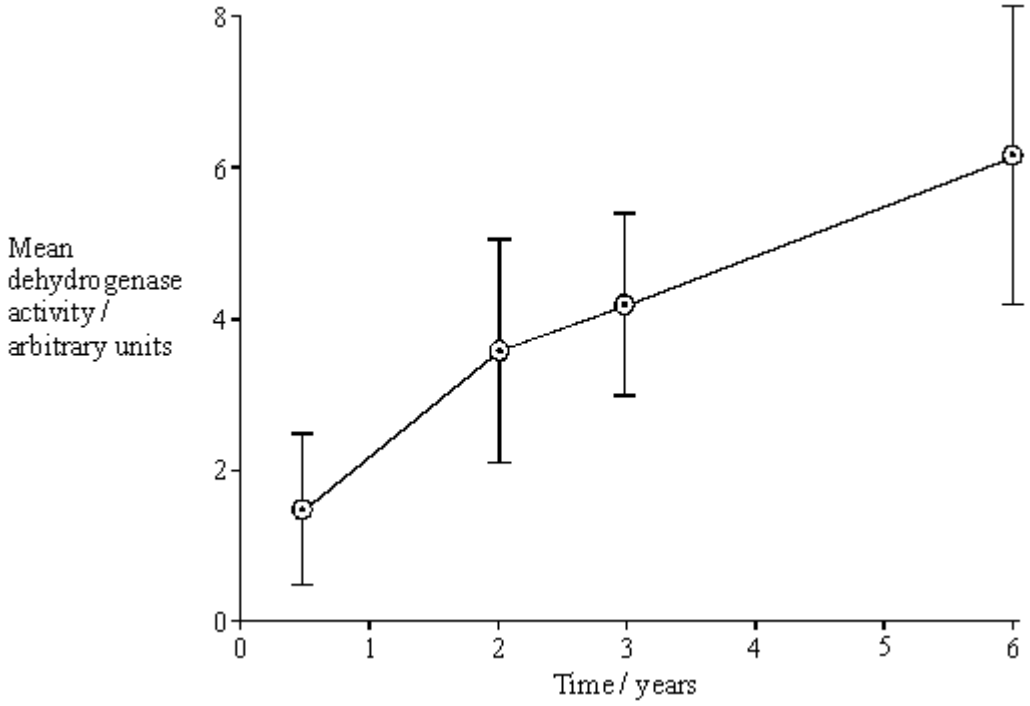
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(3)

Dehydrogenase is an enzyme involved in aerobic respiration. Dehydrogenase activity in a soil sample can be used as a measure of the activity of aerobic bacteria. The graph shows the mean dehydrogenase activity of soil samples taken from the same depth in a soil store at different times. The bars on the graph represent two standard errors above and below the mean.



(d) (i) From what depth in the soil store would you expect these soil samples to have been taken? Use information from **Table 1** to explain your answer.

_____

_____

_____

_____

(2)

(ii) How would you expect dehydrogenase activity to vary with depth after 6 months?

Use information from **Table 1** to explain your answer.

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(3)

(e) What do the error bars tell you about the difference between the mean dehydrogenase activity at 6 months and 3 years? Explain your answer in terms of probability and chance.

_____

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(3)

(f) **Table 2** shows the dehydrogenase activity and the number of aerobic bacteria present in some soil samples.

Dehydrogenase activity / arbitrary units	Number of aerobic bacteria per gram of soil ($\times 10^7$)
13.1	12.0
9.2	8.7
5.5	6.5
3.0	4.6
2.2	2.7
0.4	0.6

Table 2

A sample of soil was found to have dehydrogenase activity of 8.7 arbitrary units. Explain how you would use the data in **Table 2** to predict the likely number of aerobic bacteria in 1 g of this soil sample.

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(3)

(Total 20 marks)

Q47.

(a) The cheetah, *Acinonyx jubatus*, and other cat species belong to the family Felidae. Complete the table to show the classification of the cheetah.

Kingdom	Animalia
	Chordata
	Mammalia
	Carnivora
Family	Felidae
Genus	

(2)

(b) This system of classification is described as hierarchical. Explain what is meant by a hierarchical classification.

_____

_____

(1)

(c) Despite differences in form, leopards, tigers and lions are classified as different species of the same genus. Cheetahs, although similar in form to leopards, are classified in a different genus.

(i) Describe **one** way by which different species may be distinguished.

_____

_____

(1)

(ii) Suggest **two** other sources of evidence which scientists may have used to classify cheetahs and leopards in different genera.

1. _____

_____

2. _____

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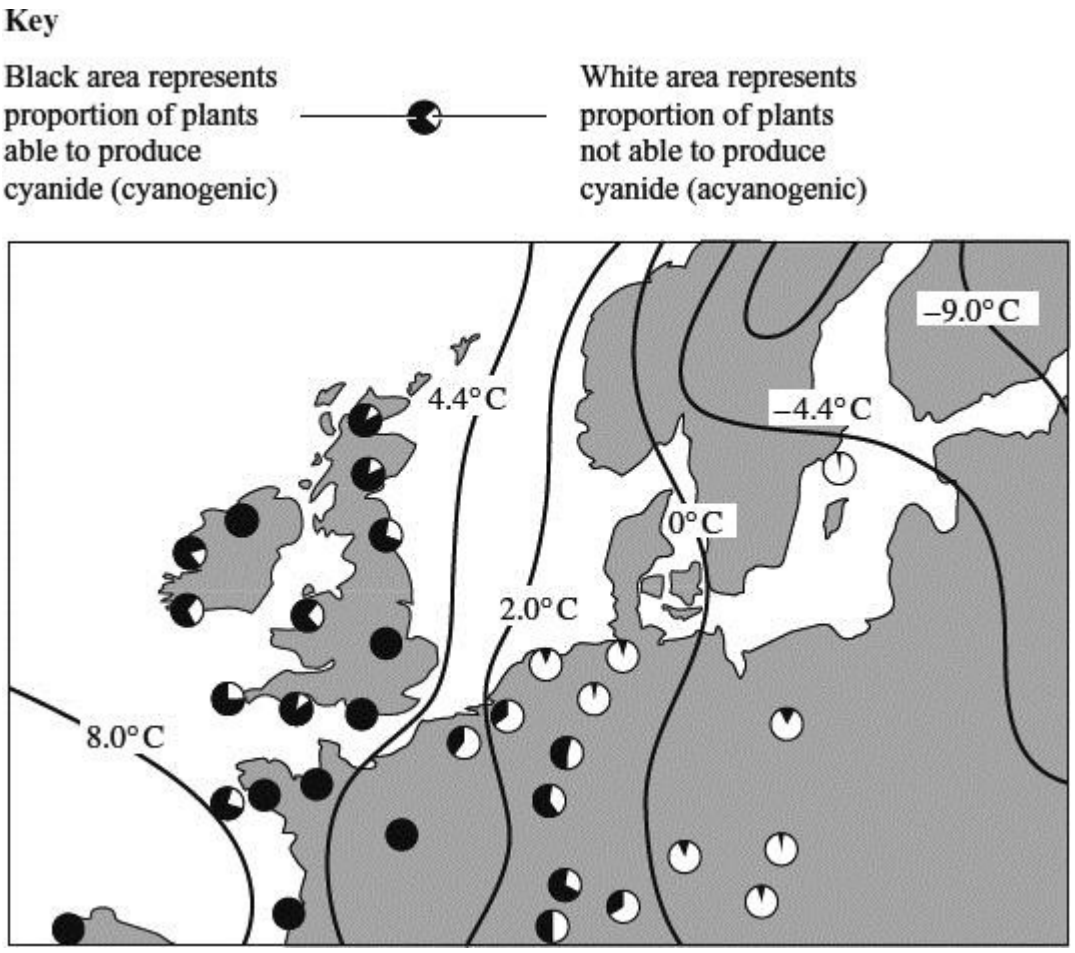
(2)

(Total 6 marks)

Q48.

Clover plants have leaves all through the year. Some clover plants have leaves that produce poisonous hydrogen cyanide gas when damaged. These cyanogenic plants are less likely to be eaten by snails. However, the leaves of these plants can be damaged by frost, resulting in the production of enough hydrogen cyanide to kill the plants. Acyanogenic plants do not produce hydrogen cyanide. This characteristic is genetically controlled.

The map shows the proportions of the two types of plant in populations of clover from different areas in Europe. It also shows isotherms, lines joining places with the same mean January temperature.



(a) Explain how different proportions of cyanogenic plants may have evolved in populations in different parts of Europe.

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(4)

(b) Differences in cyanide production may affect the total number of clover plants growing in different areas. Describe how you would use quadrats in an investigation to determine whether or not there is a difference in the number of clover plants in two large areas of equal size.

_____

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(4)

(Total 8 marks)

Q49.

Lake Malawi in East Africa contains around 400 different species of cichlids which are small, brightly coloured fish. All these species have evolved from a common ancestor.

(a) Describe **one** way in which scientists could find out whether cichlids from two different populations belong to the same species.

_____

_____

_____

_____

(2)

(b) During the last 700 000 years there have been long periods when the water level was much lower and Lake Malawi split up into many smaller lakes. Explain how speciation of the cichlids may have occurred following the formation of separate, smaller lakes.

_____

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_____

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(4)

(c) Many species of cichlids are similar in size and, apart from their colour, in appearance. Suggest how the variety of colour patterns displayed by these cichlids may help to maintain the fish as separate species.

_____

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_____

(2)

(Total 8 marks)

Q50.

(a) Explain the principles which biologists use to classify organisms into groups.

_____

_____

_____

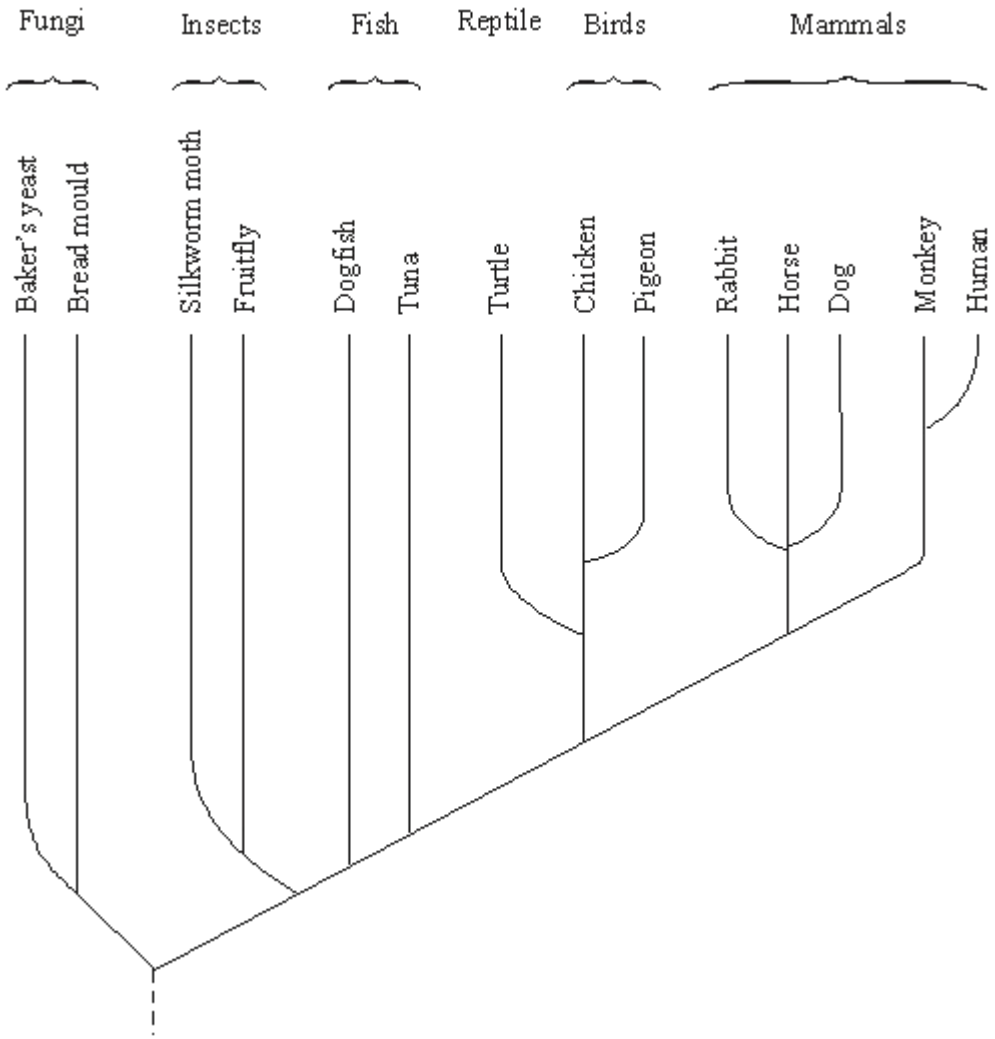
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(3)

Cytochrome c is a protein with about 100 amino acids and is present in all eukaryotic organisms. It has the same three-dimensional shape in all species, but only 30 of the amino acids are the same in all species. The amino acid sequence of cytochrome c has been used to construct the phylogenetic tree shown below.



(b) Name the kingdoms represented in this phylogenetic tree.

_____

(1)

(c) What does the phylogenetic tree show about the evolutionary relationship between fungi and insects?

_____

_____

_____

_____

(2)

(d) Suggest how information on amino acid sequences is used to construct a phylogenetic tree.

_____

_____

_____

_____

(2)

(e) Suggest **one** advantage and **one** disadvantage of using cytochrome c to construct a phylogenetic tree.

Advantage

_____

_____

Disadvantage

_____

_____

(2)

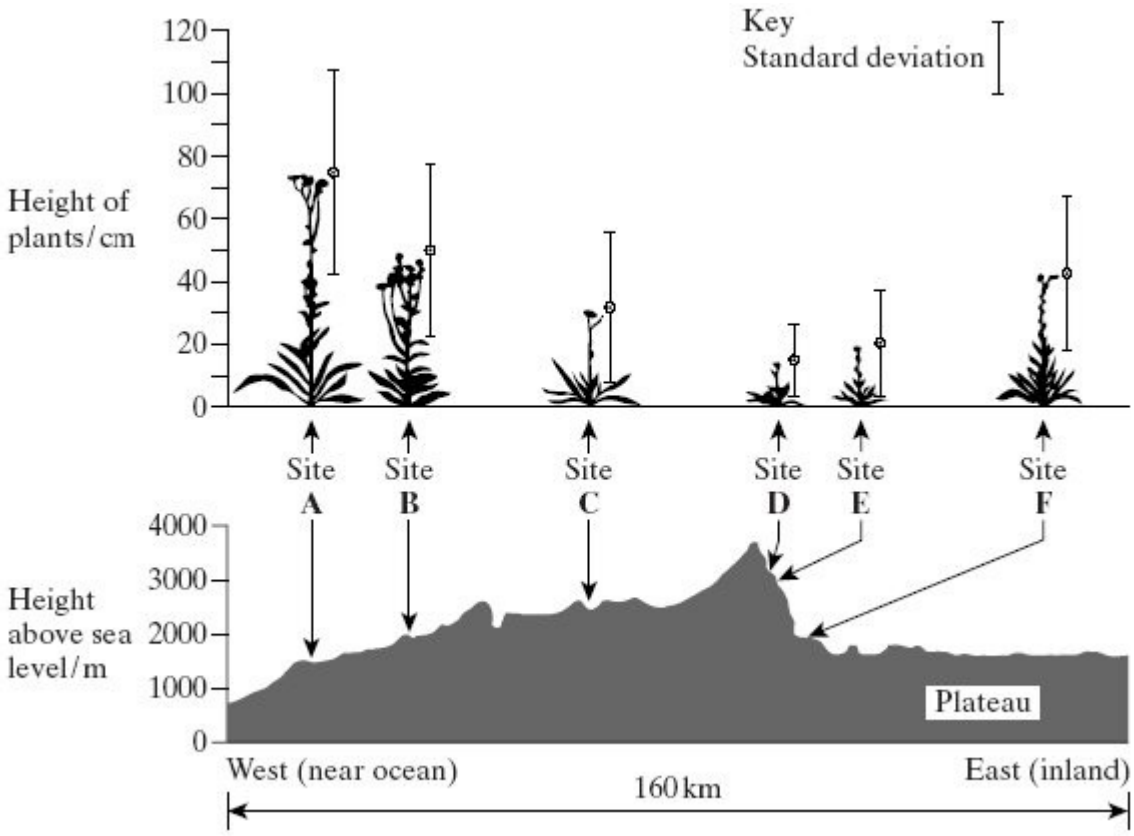
(Total 10 marks)

Q51.

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.

_____

_____

(1)

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

_____

_____

_____

_____

(2)

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

_____

_____

(1)

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

_____

_____

_____

_____

(2)

(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.

_____

_____

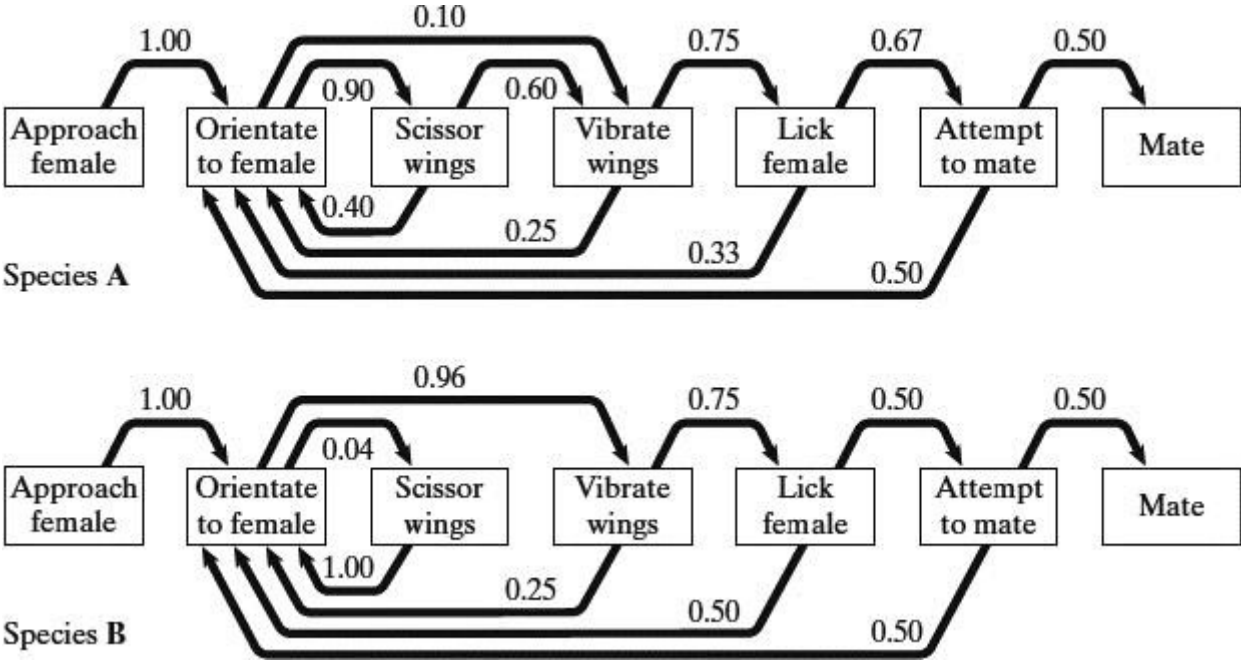
(1)

(Total 7 marks)

Q52.

Courtship and mating in fruitflies can occur equally well in the light or dark.

The diagrams show the courtship sequence of males from two closely related species of fruitfly (species **A** and species **B**). The numbers show the probability of one courtship element following from another.



(a) Once a male of species **A** has orientated to the female, what is the probability that he will perform each courtship element once only and then attempt to mate? Show your working.

Probability _____

(2)

(b) Suggest how the courtship sequences provide evidence to support the claim that the two species are

(i) closely related;

_____

_____

(1)

(ii) separate species.

_____

_____

(1)

(c) During courtship, vibration of the wings creates a sound. The sound is different in the two species of fruitfly. Explain how this prevents mating between members of different species.

_____

_____

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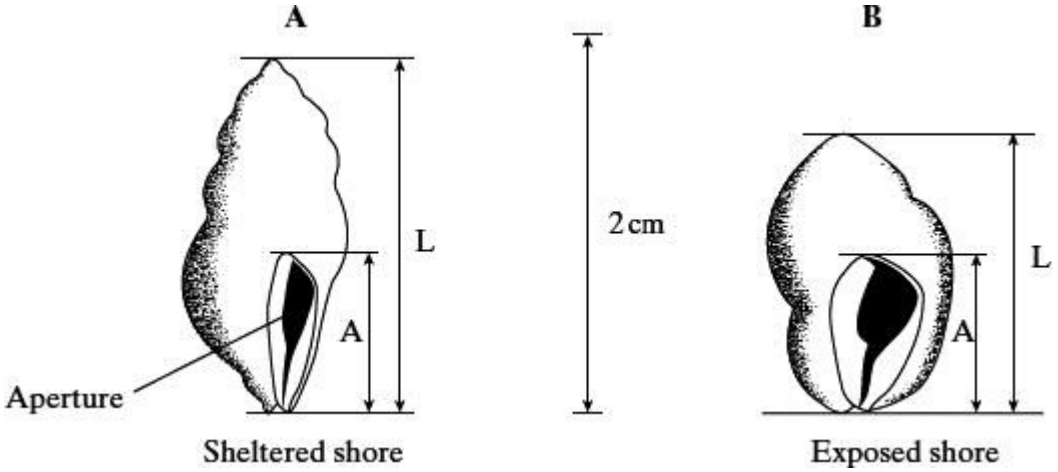
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(2)

(Total 6 marks)

Q53.

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	mean L/A ratio = 1.78
standard deviation = 0.19	standard deviation = 0.10

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

_____

_____

_____

_____

_____

_____

(3)

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

_____

_____

_____

_____

(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;

_____

_____

_____

_____

(ii) the standard deviations.

_____

_____

_____

_____

(4)

(Total 9 marks)

Q54.

This question should be written in continuous prose, where appropriate.

Quality of Written Communication will be assessed in these answers.

(a) Use your knowledge of classification to arrange *class*, *phylum*, *genus* and *family* in order of decreasing number of species.

largest number of species | | | smallest number of species

_____ _____ _____ _____

(1)

(b) Cytochrome c is a protein involved in one of the reactions of aerobic respiration in a mitochondrion. The molecular structure of cytochrome c from different species has been analysed. More similarities are present in the structure of cytochrome c in closely related species than in distantly related species.

(i) Explain what is meant when two species are described as being *closely related*.

_____

_____

(1)

(ii) A difference in the molecular structure of cytochrome c may arise in a small population that becomes geographically isolated. Explain how the difference may arise and how it may spread in the population.

_____

_____

_____

_____

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_____

(4)

(Total 6 marks)

Q55.

In an investigation, the population density of plants in a regularly cut lawn was compared with that in a lawn which was only cut occasionally. The table shows the results.

Species	Mean population density / number of plants per m^2		Result of statistical test value of p
	Regularly cut lawn	Occasionally cut lawn	

Daisy	36.0	18.6	< 0.02
Dandelion	10.8	3.4	< 0.05
Field buttercup	1.2	10.0	< 0.01
Ribwort plantain	4.3	2.8	> 0.5
Greater plantain	0.9	1.5	> 0.5

(a) Describe a practical technique which you could use to find the mean population density of daisies on a lawn.

_____

_____

_____

_____

_____

_____

(3)

(b) Give the null hypothesis for the statistical test on the population density of daisies.

_____

_____

(1)

(c) What conclusions can be drawn from the results of this investigation?

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q56.

The vegetation on a large heap of waste from an old mine was investigated. The table

shows the results of the measurements of certain factors in 1m^2 frame quadrats placed on the south-facing slope.

Quadrat	Angle of slope / °	Vegetation cover / %	Moisture content of soil / %	pH of soil
1	45	60	17.2	5.6
2	30	70	14.6	4.2
3	25	68	20.3	5.2
4	12	100	23.5	7.1
5	7	85	21.0	5.4
6	1	100	21.2	6.8

(a) Which of the factors measured are abiotic?

_____

(1)

(b) Describe how the investigators could obtain the value for vegetation cover in each quadrat.

_____

_____

_____

_____

(2)

(c) The correlation between vegetation cover and soil moisture content was tested statistically. These two factors were found to be positively correlated, and $p < 0.05$. Explain what this result means.

_____

_____

_____

_____

(2)

(d) At first the waste heap had no plants growing on it. Some of the first plants to colonise it were small herbaceous plants. Explain **one** way in which colonisation by herbaceous plants could change the physical environment.

_____

_____

_____

_____

(2)

(Total 7 marks)