

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

# BIOLOGY



## EXAM QUESTION PACK

TOPIC 3: CLASSIFICATION AND BIODIVERSITY  
NATURAL SELECTION

SCORE

**/157**

PERCENTAGE

**%**

**STEMUP**

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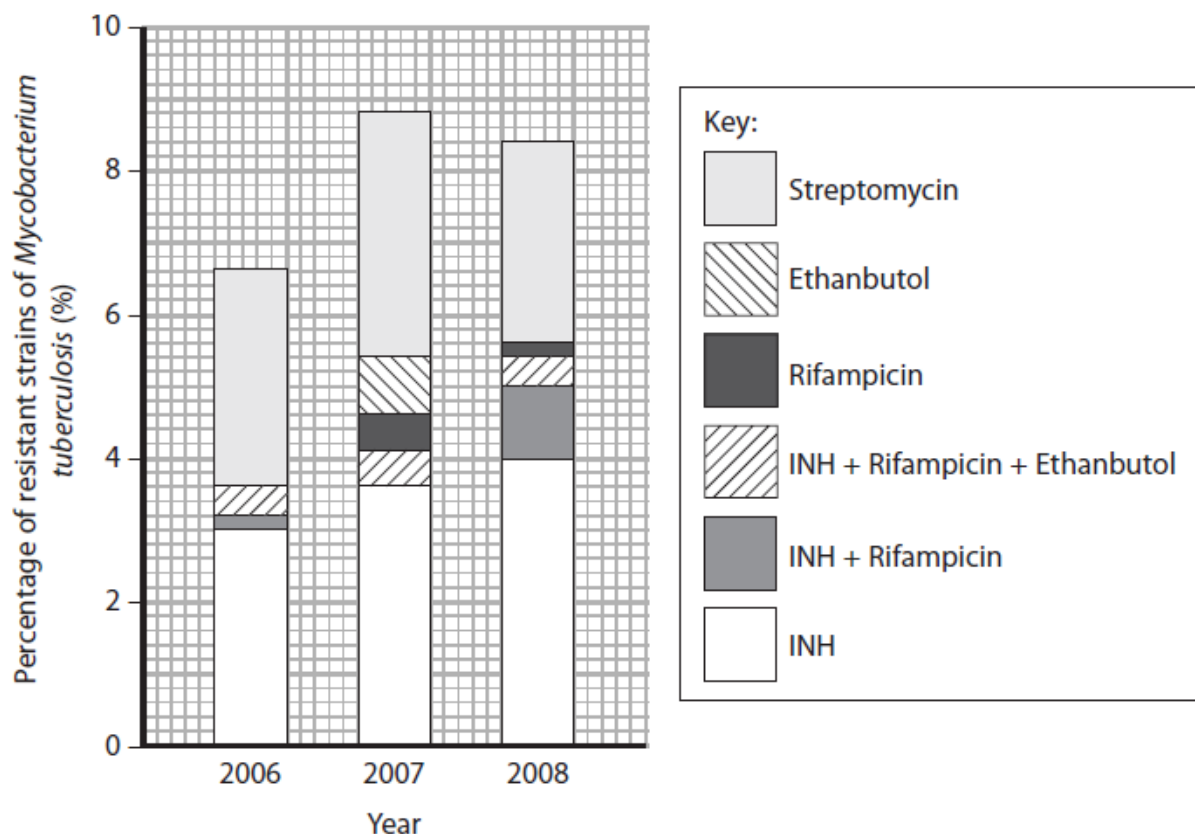
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Q1.

Treating *Mycobacterium tuberculosis* infections can be a problem, as the bacteria are resistant to many antibiotics.

There are many strains of *Mycobacterium tuberculosis*. Different strains are resistant to different antibiotics or combinations of antibiotics.

The chart below shows the percentage of resistant strains of *Mycobacterium tuberculosis* to six different antibiotics, or combinations of antibiotics, in 2006, 2007 and 2008.



(i) Using the information in the graph, compare the types of antibiotics and combinations of antibiotics that the *Mycobacterium tuberculosis* are resistant to in 2006 with 2007.

(3)

(ii) The percentage of strains of *Mycobacterium tuberculosis* resistant to the antibiotic INH has increased during these three years.

Suggest how natural selection could have resulted in this increase.

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(iii) Suggest how hospitals could prevent an increase in the percentage of strains of *Mycobacterium tuberculosis* resistant to antibiotics.

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Q2.

There are drugs that can be taken to reduce the reproduction of HIV.

Explain why a patient is usually given several different drugs at the same time.

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**(Total for question = 2 marks)**

Q3.

Skin flora include bacteria that live on the skin.

Different parts of the body have different types of bacteria present.

Skin flora are beneficial as they inhibit the growth of pathogenic bacteria on the skin.

Skin flora compete for nutrients and space or secrete toxic chemicals.

The following are types of bacteria found in the female genital tract:

- *Escherichia coli*
- *Klebsiella species*
- *Lactobacillus species*
- *Staphylococcus species*.

(i) Describe how these types of bacteria present in the female genital tract could be identified.

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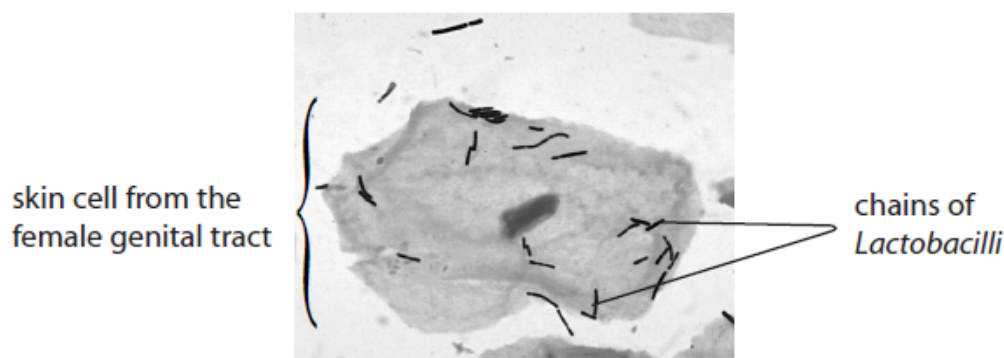
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(ii) The photograph shows *Lactobacilli* on a skin cell from the female genital tract.



Source: © Janice Carr Content Providers (s): CDC/Dr. Mike Miller

*Lactobacilli* metabolise glycogen into lactic acid.

Explain how *Lactobacilli* inhibit the growth of pathogenic bacteria in the female genital tract.

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**(Total for question = 7 marks)**

Q4.

The photograph shows a wombat, an animal that lives in dry parts of Australia.



Source: © Blue Gum Pictures/Alamy Stock Photo

Wombats are herbivores, feeding on grasses, leaves and bark. Wombats also dig in the soil for roots.

They have behavioural and physiological adaptations to survive periods of severe drought.

The effect of drought on the health of wild wombats was investigated.

Changes in body mass, body condition and the chemical constituents of stomach contents and faeces were recorded.

These changes were related to the changes in the quality and quantity of the food of wombats.

The table shows some of the measurements made in this investigation.

| Measurement                                               | Before drought | 10 months into drought | 14 months into drought | 2 months after rain |
|-----------------------------------------------------------|----------------|------------------------|------------------------|---------------------|
| Body condition index                                      | .....          | 0.86                   | 0.76                   | 0.85                |
| Body mass / kg                                            | 26.4           | 25.1                   | 21.2                   | 25.2                |
| Organic matter in stomach / g kg <sup>-1</sup> dry matter | 946            | 732                    | 704                    | 822                 |
| Mineral ion content in stomach                            | low            | high                   | high                   | low                 |
| Moisture content of faeces / g kg <sup>-1</sup> wet mass  | 815            | 603                    | 522                    | 748                 |

(i) The body condition was expressed as a body condition index (BCI).

The BCI can be calculated using the formula

$$\text{BCI} = \frac{\text{body mass of wombat}}{\text{mass-for-length of wombat (Y)}}$$

The mass-for-length (Y) of a wombat can be calculated using the formula

$$Y = (\text{body length} \times 0.73) - 34.5$$

A wombat before the drought had a body length of 86.4 cm and a mass of 26.4 kg.

Calculate the BCI of this wombat.

(2)

Answer .....

\*(ii) Analyse the data to explain the results of this investigation.

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(Total for question = 8 marks)

Q5.

When a mouse is put in a new environment, it will move around to find a safe place to live.

This is called exploratory behaviour.

A student investigated exploratory behaviour by putting a mouse into a large box.

The bottom of the box was marked into squares. There were four corner squares (C), two middle squares (M) and six side squares (S).

The marked bottom of the box is shown in the diagram.

|   |   |   |   |
|---|---|---|---|
| C | S | S | C |
| S | M | M | S |
| C | S | S | C |

The mouse moved about on the bottom of the box. The square occupied by the mouse was recorded every 10 seconds for 10 minutes.

The table shows the results of this investigation.

| Total number of times square occupied by the mouse |               |             |
|----------------------------------------------------|---------------|-------------|
| Corner square                                      | Middle square | Side square |
| 42                                                 | 6             | 12          |

The student tested the null hypothesis that mice show no significant preference for corner, middle or side squares.

(i) Calculate the Chi squared value using the formula shown.

(2)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Answer .....

(ii) The table shows some critical values of Chi squared at different degrees of freedom.

| Degrees of freedom | <i>p</i> value |       |       |       |        |
|--------------------|----------------|-------|-------|-------|--------|
|                    | 0.900          | 0.500 | 0.100 | 0.050 | 0.010  |
| 1                  | 0.016          | 0.455 | 2.706 | 3.841 | 6.635  |
| 2                  | 0.211          | 1.386 | 4.605 | 5.991 | 9.210  |
| 3                  | 0.584          | 2.366 | 6.251 | 7.815 | 11.345 |
| 4                  | 1.064          | 3.357 | 7.779 | 9.488 | 13.277 |

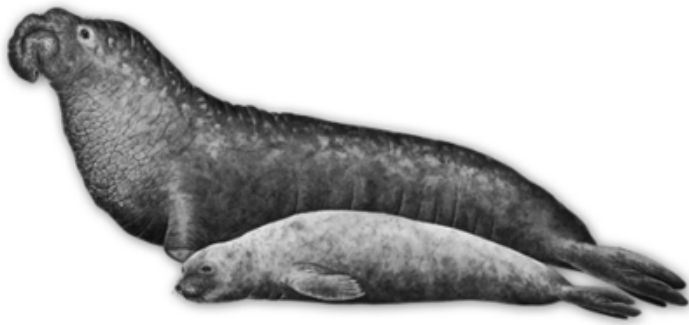
Use your calculated Chi squared value and this table to comment on the conclusion the student should make about the null hypothesis.

(4)

(Total for question = 6 marks)

Q6.

The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

Northern elephant seals are able to dive to great depths and hold their breath for up to two hours.

The tables show data for four diving mammals.

| Species                | Maximum time holding breath / min | Maximum diving depth / m | Mass of animal / kg |
|------------------------|-----------------------------------|--------------------------|---------------------|
| bottlenose dolphin     | 5                                 | 20                       | 200                 |
| harbour seal           | 17                                | 19                       | 24                  |
| Weddell seal           | 82                                | 400                      | 400                 |
| Northern elephant seal | 119                               | 437                      | 400                 |

| Species                | Volume of oxygen in body / $\text{cm}^3 \text{ kg}^{-1}$ | Concentration of haemoglobin in blood / $\text{g dm}^{-3}$ | Total blood volume / $\text{cm}^3 \text{ kg}^{-1}$ | Percentage of stored oxygen in different body tissues |       |        |
|------------------------|----------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------|-------|--------|
|                        |                                                          |                                                            |                                                    | lungs                                                 | blood | muscle |
| bottlenose dolphin     | 36                                                       | 14                                                         | 71                                                 | 34                                                    | 27    | 39     |
| harbour seal           | 57                                                       | 21                                                         | 132                                                | 13                                                    | 54    | 33     |
| Weddell seal           | 87                                                       | 210                                                        | 173                                                | 5                                                     | 66    | 29     |
| Northern elephant seal | 97                                                       | 216                                                        | 207                                                | 4                                                     | 71    | 25     |

(i) Calculate the total mass of haemoglobin in a Northern elephant seal.

(3)

Answer .....

\* (ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

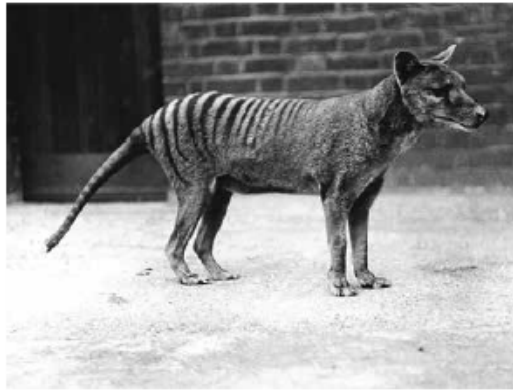
This image shows a full page of a document template designed for handwritten notes or answers. It features approximately 20 evenly spaced horizontal dashed lines across the entire width of the page, providing a guide for letter height while leaving space for individual characters and words. The background is plain white, and there are no margins, headers, or footers present.

**(Total for question = 9 marks)**

Q7.

The photographs below show three mammals.

Tasmanian wolf (*Thylacinus cynocephalus*)



© The Zoological Society

Grey wolf (*Canis lupus*)



(Source: [http://www.animalgalleries.org/Large-Land-Mammals/Wolf/Grey+Wolf+Mexican\\_Wolf\\_065+Canis+Lupus.jpg.php](http://www.animalgalleries.org/Large-Land-Mammals/Wolf/Grey+Wolf+Mexican_Wolf_065+Canis+Lupus.jpg.php))

Dunnart (*Sminthopsis crassicaudata*)



5 cm

(Source: [apscience.org.au](http://apscience.org.au))

The evolutionary relationships between these three mammals were investigated. The DNA base sequence of part of the gene for 12S ribosomal RNA from each mammal was analysed.

|                |                                   |
|----------------|-----------------------------------|
| Tasmanian wolf | CCTGGCCTTACTGTTAATTCTTATTAGACCTAC |
| Grey wolf      | CCTAGCCTTCCTATTAGTTTTTAGTAGACTTAC |
| Dunnart        | CCTAGCCTTACTGTTAATTTTATTAGACCTAC  |

(a) Explain which two of these mammals are most closely related in their evolutionary history.

(2)

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(b) The Tasmanian wolf is a marsupial mammal. In marsupials, the young are born in a tiny, immature form and move into a pouch on the abdomen of the mother to develop further.

The grey wolf is a placental mammal. The fetus develops inside the uterus and the larger young are born in a more mature form.

The ancestors of Tasmanian wolves and grey wolves once shared similar habitats.

Explain why grey wolves and their close relatives are now found in many parts of the world but Tasmanian wolves only survived on isolated islands.

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**(Total for question = 5 marks)**

Q8.

\* The photograph shows a tawny owl. These owls live in areas close to the Arctic Circle.



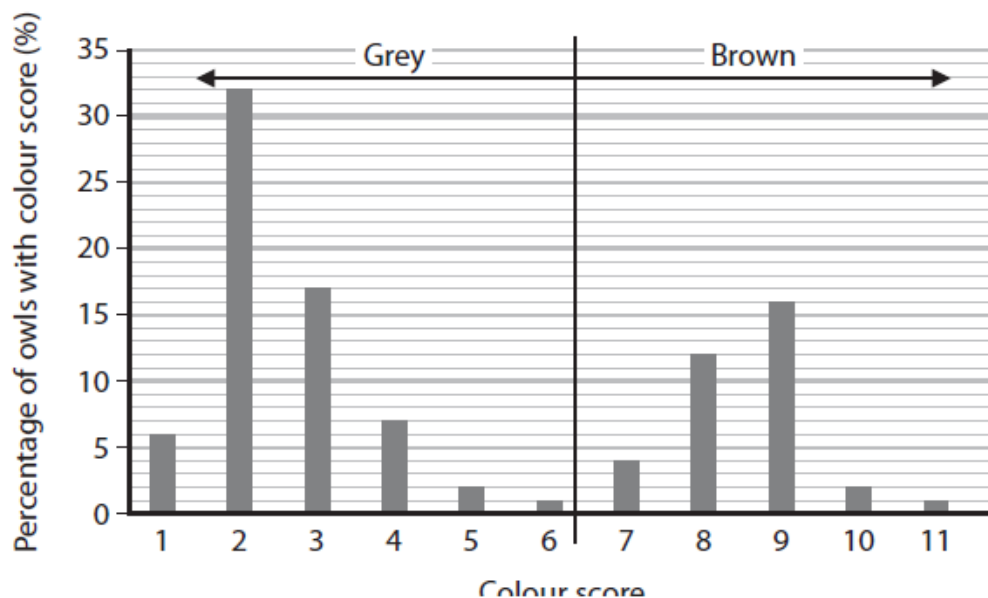
(Source: © LINDA WRIGHT/SCIENCE PHOTO LIBRARY)

Scientists investigated the feather colours of a population of tawny owls. Feather colours of the owls were scored on a scale of 1 to 11, according to how grey or brown they were.

Grey feathered owls were given a score between 6 and 1, with 1 being the most grey.

Brown feathered owls were given a score between 7 and 11, with 11 being the most brown.

The graph shows the percentages of owls in the population with each of the colour scores.



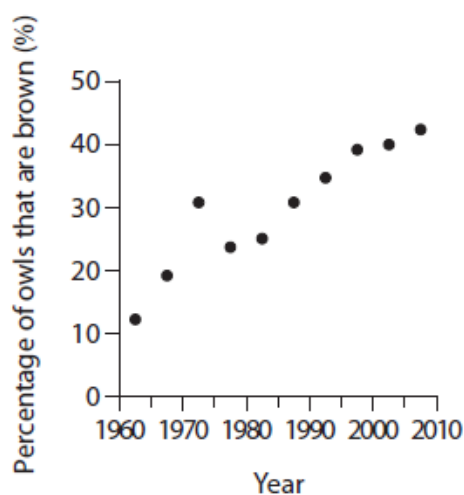
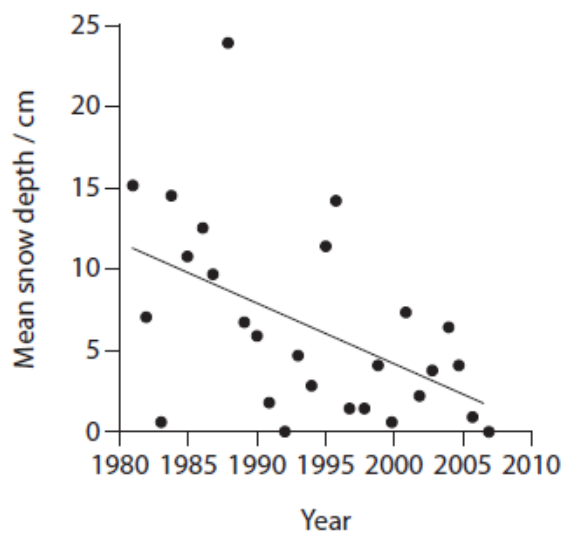
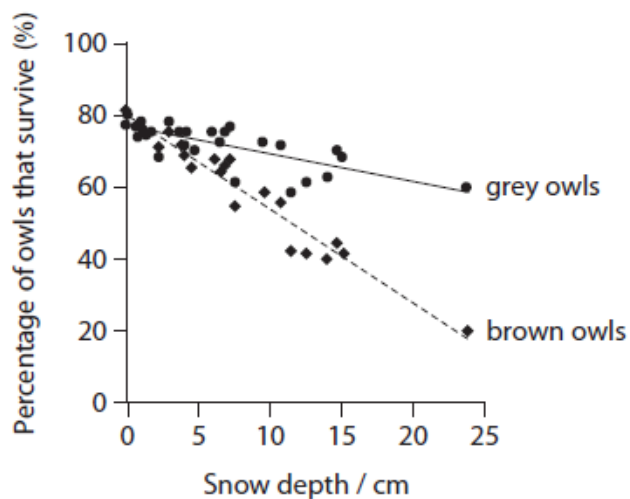
The scientists investigated the effect of climate change on the frequencies of these two alleles for feather colour in populations of tawny owls.

The percentage survival rates of both colours of owl were measured when there were different depths of snow.

The mean depth of snow was recorded each year between 1980 and 2007.

The percentage of owls that were coloured brown between 1960 and 2007 was also recorded.

The graphs show the results.



The scientists concluded that increased greenhouse gases from human activity are resulting in an increase in the frequency of the brown allele.

Analyse the data to evaluate this conclusion.

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**(Total for question = 6 marks)**

Q9.

The island of Lanzarote is near the African coast and has a desert climate.

The photograph shows the edge of a lava flow from a volcano that erupted on this island about 200 hundred years ago.

In the foreground is an area that was not covered by the lava flow.

Over a long period of time, the lava will change to look like the climax community seen in the foreground.



King Juba's spurge, *Euphorbia regis-jubae*, is a plant that occupies a niche in the climax community.

Explain the niche occupied by King Juba's spurge.

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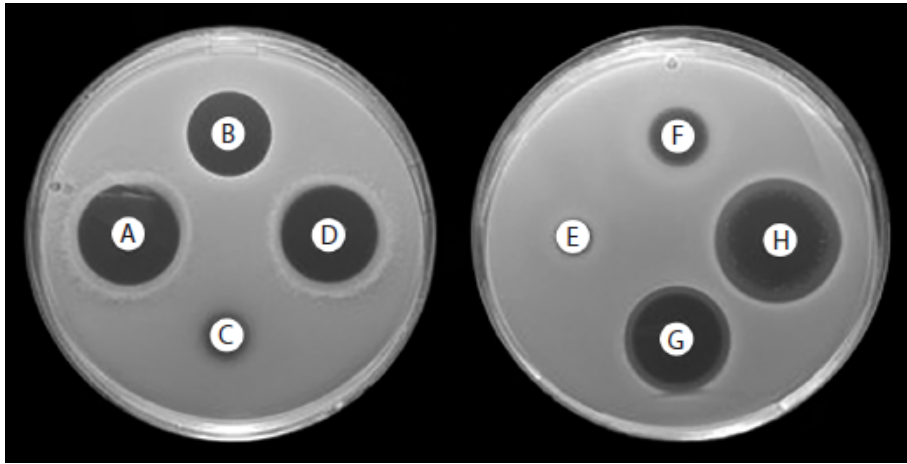
Q10.

A student read that more than half of raw chickens on sale in supermarkets are contaminated with bacteria from the genus *Campylobacter*.

Some species of *Campylobacter* cause food poisoning in humans.

The student carried out an experiment to test the effectiveness of various antibiotics against *Campylobacter*.

The photograph shows the student's agar plates at the end of the experiment.



The white circles labelled A-H are filter paper discs. These discs were soaked in different antibiotics then placed on the surface of the agar.

The student concluded that fresh chickens should be sprayed with antibiotic H before being packaged for sale in supermarkets.

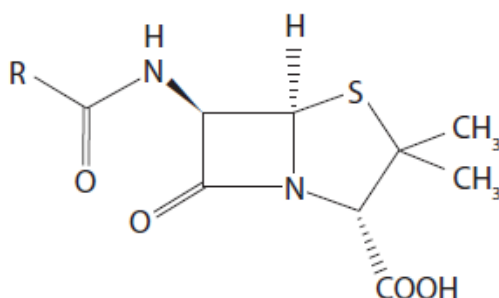
Evaluate the student's conclusion.

[illegible]

Q11.

Tetracycline and penicillin are two antibiotics that are commonly used to treat bacterial infections.

The diagram shows the structure of penicillin.



In 2013, an Australian scientist said that 'evolution was winning the antibiotics arms race'.

Comment on the statement made by this scientist.

(5)

Q12.

Malaria is caused by *Plasmodium*, a pathogenic microorganism.

Vaccination is one of many methods being used to control malaria.

In a study, the effectiveness of a vaccine for malaria was tested.

The following method was used:

- samples of *Plasmodium* were exposed to radiation and used to make a vaccine
- two groups of people, A and B, were given different doses of the vaccine
- a third group of people, C, was used as a control
- one month after vaccination, all three groups of people were exposed to mosquitoes known to contain live *Plasmodium*
- the number of people in each group with malaria was recorded.

The results are shown in the table.

| Group | Treatment with the vaccine | Number of people in each group | Number of people with malaria |
|-------|----------------------------|--------------------------------|-------------------------------|
| A     | low dose                   | 17                             | 16                            |
| B     | high dose                  | 6                              | 0                             |
| C     | control                    | 12                             | 11                            |

Anti-malarial drugs can be used to protect people from malaria.

These drugs are not always effective because *Plasmodium* develop resistance.

Explain how drug-resistant *Plasmodium* may evolve.

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(Total for question = 3 marks)

Q13.

Antibiotics have been developed to control bacterial infections.

(a) Name **one** bacterium which causes symptoms of infection by producing exotoxins.

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(b) Explain how an antibiotic has a bacteriostatic effect on bacteria.

(2)

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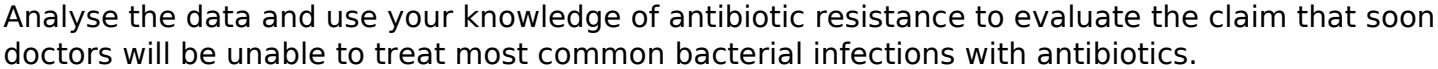
\*(c) Bacterial resistance to common antibiotics is an increasingly serious problem facing doctors treating a wide range of infections.

The graph below shows the percentage of resistant bacteria in patients being treated with antibiotics for *Streptococcus pneumoniae* infections.

Group A had never been given antibiotics.

Group B had been previously treated with other antibiotics.

Group C had been previously treated with the named antibiotic.

[illegible]

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**(Total for question = 12 marks)**

Q14.

Sickle cell anaemia is caused by a mutation in the  $\beta$ -globin gene which codes for part of haemoglobin.

The diagram shows the first 10 amino acids in this part of haemoglobin, in a healthy person and in a person with sickle cell anaemia.

**Healthy person:**

val – his – leu – thr – pro – glu – glu – lys – ser – ala

**Person with sickle cell anaemia:**

val – his – leu – thr – pro – val – glu – lys – ser – ala

The allele that leads to sickle cell anaemia is known as HbS.

From 1990 to 1996, all newborn infants in California were screened for the presence of the HbS allele.

The data in the table show the ratio of individuals with and without the HbS allele, in various ethnic groups.

| Ethnic group     | HbS allele : no HbS allele |
|------------------|----------------------------|
| African American | 1:14                       |
| Asian            | 1:1336                     |
| Caucasian        | 1:625                      |
| Hispanic         | 1:183                      |
| Middle Eastern   | 1:360                      |
| Native American  | 1:176                      |

A chi squared test was used to analyse the raw data.

The null hypothesis was: "There is no difference between the frequency of the HbS allele in

African Americans and in all other ethnic groups combined."

The calculated value of chi squared was 450 615.

The table shows some critical values for the chi squared distribution, with one degree of freedom.

|                       |       |       |       |       |       |
|-----------------------|-------|-------|-------|-------|-------|
| probability, <i>p</i> | 0.005 | 0.010 | 0.025 | 0.050 | 0.100 |
| critical value        | 7.879 | 6.635 | 5.024 | 3.841 | 2.706 |

Malaria is a major cause of death in Africa.

Assess the effect that this might have on the frequency of the HbS allele in African populations.

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Q15.

The photograph shows an insect fossilised in amber resin.



(Source: Bjoern Wylezich. 123rf.com/PAL)

Scientists have classified another fossilised insect found in amber resin as a new species of mosquito, *Priscoculex burmanicus*.

This mosquito is anatomically very similar to modern species of mosquito.

Mosquito populations are often controlled using pesticides that inhibit the enzyme acetylcholinesterase.

Long-term use of pesticides often leads to the development of resistance in these mosquitoes.

The ace-1 gene codes for the enzyme acetylcholinesterase.

The ace-1<sup>r</sup> allele is a recessive form of this gene that gives resistance to pesticides.

The changes in the numbers of resistant and non-resistant mosquitoes in an area of farmland where pesticides were used in 2007 was investigated.

The use of the pesticides was stopped in 2016.

The table shows the results of this investigation.

| Mosquito type | Number of mosquitoes |      |      |
|---------------|----------------------|------|------|
|               | 2005                 | 2015 | 2018 |
| resistant     | 125                  | 5250 | 4120 |
| non-resistant | 8755                 | 1250 | 3950 |

(i) Calculate the number of heterozygous mosquitoes in 2015.

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

(3)

Answer .....

(ii) Explain why the changes in the numbers of the resistant and non-resistant mosquitoes, from 2005 to 2018, are related to the function of the ace-1 gene.

(4)

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

**(Total for question = 7 marks)**

Q16.

When a mouse is put in a new environment, it will move around to find a safe place to live.

This is called exploratory behaviour.

A student investigated exploratory behaviour by putting a mouse into a large box.

The bottom of the box was marked into squares. There were four corner squares (C), two middle squares (M) and six side squares (S).

The marked bottom of the box is shown in the diagram.

|   |   |   |   |
|---|---|---|---|
| C | S | S | C |
| S | M | M | S |
| C | S | S | C |

The mouse moved about on the bottom of the box. The square occupied by the mouse was recorded every 10 seconds for 10 minutes.

The table shows the results of this investigation.

| Total number of times square occupied by the mouse |               |             |
|----------------------------------------------------|---------------|-------------|
| Corner square                                      | Middle square | Side square |
| 42                                                 | 6             | 12          |

The student tested the null hypothesis that mice show no significant preference for corner, middle or side squares.

The method used by the student had limitations.

Justify how the student could modify the investigation to address these limitations.

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(Total for question = 3 marks)

The photograph shows a stonechat, *Saxicola dacotiae*.

The species breeds only on the island of Fuerteventura.



Explain how this species of stonechat may have evolved on the island of Fuerteventura.

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Q18.

**Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.**

The photograph shows an insect fossilised in amber resin.



(Source: Bjoern Wylezich. 123rf.com/PAL)

Scientists have classified another fossilised insect found in amber resin as a new species of mosquito, *Priscoculex burmanicus*.

This mosquito is anatomically very similar to modern species of mosquito.

(i) Which of these processes produces new species without geographically separating populations?

(1)

- ☐ **A** allopatric speciation
- ☐ **B** genetic speciation
- ☐ **C** stabilising speciation
- ☐ **D** sympatric speciation

(ii) *Priscoculex burmanicus* became extinct about 100 million years ago.

State why it was difficult for scientists to decide if this insect belonged to a different species from modern mosquitoes.

(1)

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(iii) State how scientists would have reached agreement on classifying this mosquito.

(1)

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(iv) Complete the classification table for *Priscoculex burmanicus*.

| Taxon   | Name        |
|---------|-------------|
| Domain  | Eukarya     |
| Kingdom | Animalia    |
|         | Arthropoda  |
|         | Diptera     |
| Order   | Culicidae   |
| Family  | Anophelinae |
| Genus   |             |
| Species |             |

**(Total for question = 5 marks)**

Q19.

A student carried out an investigation to test the hypothesis that the surface area to mass ratio of leaves is affected by the amount of light they receive.

A nettle plant growing in sunlight and a second nettle plant growing in shade in a wood were selected.

The surface area and mass of several leaves were measured and the surface area to mass ratio was calculated. The table below shows the results.

| Leaf | Surface area to mass ratio / $\text{cm}^2 \text{g}^{-1}$ |                               |
|------|----------------------------------------------------------|-------------------------------|
|      | Nettle plant growing in sunlight                         | Nettle plant growing in shade |
| 1    | 114.5                                                    | 118.9                         |
| 2    | 114.0                                                    | 117.8                         |
| 3    | 115.2                                                    | 118.1                         |

(a) Explain how the data shows how nettle plant leaves grown in the shade are adapted to growing in low light intensities.

(3)

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(b) The student was told that his method was not valid and that some biotic and abiotic variables may not be controlled.

Give five ways in which the student could modify the investigation to address these concerns.

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(Total for question = 8 marks)

The polar bear, *Ursus maritimus*, preys on seals and fish. Polar bears are adapted to live in cold Arctic regions.



Polar bear  
Magnification  $\times 0.04$

A recent study has shown that all polar bears are descended from populations that diverged from the Irish brown bear, *Ursus arctos*, approximately 120 000 years ago.

In this study, DNA from modern polar bears, the remains of historic polar bears and the remains of Irish brown bears was analysed.

(a) The first part of the study involved the amplification of DNA to give large enough samples for analysis.

(i) Describe how small samples of DNA can be amplified.

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(ii) Name **one** technique that could be used to analyse the amplified DNA samples.

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(b) Suggest how the scientists who conducted the study had their results accepted by other scientists.

(2)

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(c) Suggest how each of the following may have contributed towards the divergence of polar bears and Irish brown bears into two separate species.

(i) Separation of the Arctic and Irish regions by sea

(2)

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(ii) Genetic mutation

(2)

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**(Total for question = 11 marks)**

Q21.

Macroalgae and microalgae are photosynthetic organisms.

Seaweeds are macroalgae that live attached to rock in coastal areas.

Some seaweeds are green, some are brown and some are red.

The colour of seaweeds depends on the photosynthetic pigments contained in their cells.

Green seaweeds contain chlorophyll, brown seaweeds contain chlorophyll and fucoxanthin and red seaweeds contain chlorophyll and phycoerythrin.

(i) Explain why these seaweeds have different absorption spectra and action spectra.

(3)

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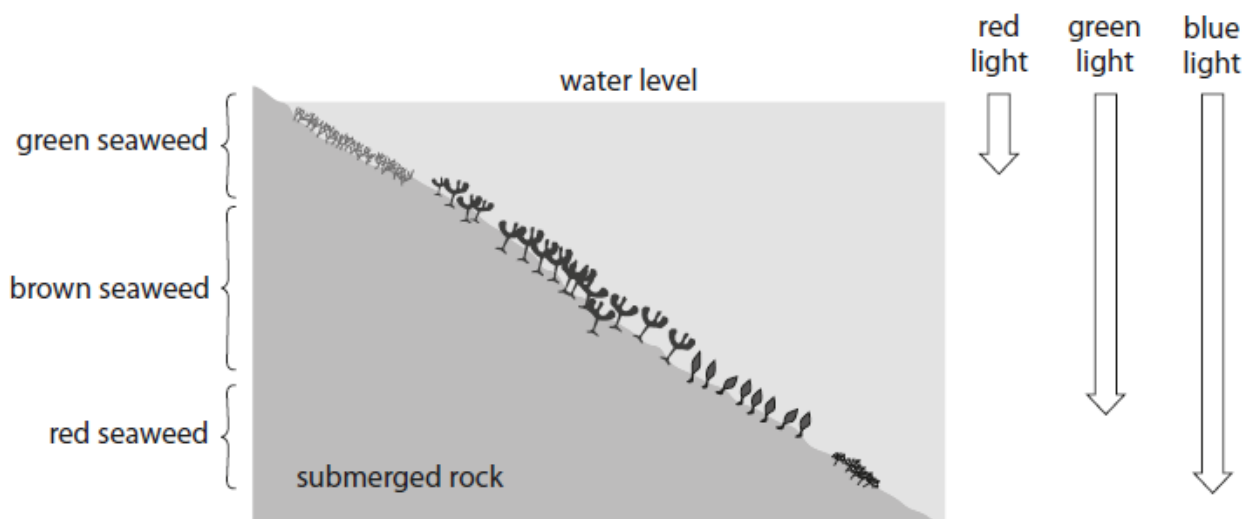
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(ii) The diagram shows the position that these seaweeds occupy on submerged rock and the depth to which different wavelengths of light penetrate into the water.



Explain why the seaweeds occupy different positions on the submerged rock.

(3)

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**(Total for question = 6 marks)**

Q22.

*Fritillaria delavayi* is a small plant (height 7 cm), that grows on rocky slopes on mountains in China.

The image shows *Fritillaria delavayi*.



For at least 2 000 years, this plant has been collected and used in Chinese medicine. It is not known to be eaten by animals.

In less accessible regions, where few humans go, the plants are bright green with bright yellow flowers.

In locations where bulbs are collected in high numbers, most plants have greyish-brown leaves and flowers.

Scientists believe that the greyish-brown plants are the same species as the brightly-coloured plants.

Explain why most of the plants in areas where bulbs are collected in high numbers have greyish-brown leaves and flowers.

**(4)**

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**(Total for question = 4 marks)**

Q23. The group of birds, known as warblers, contains many species which are very similar in external appearance.

Two of these species, the chiffchaff, *Phylloscopus collybita*, and the willow warbler, *Phylloscopus trochilus*, are so similar that many experts can identify them only by listening to their individually-characteristic songs.  
These songs are used during breeding to mark territory and attract mates.

The photographs below show these two warblers.



Chiffchaff



Willow warbler

Magnification × 0.75

- (a) Although chiffchaffs and willow warblers are often found at the same time in the same woodlands, they do not interbreed.
- (i) Suggest why successful interbreeding between chiffchaffs and willow warblers would make some scientists doubt their classification as separate species.

(3)

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- (ii) Suggest reasons why the two species do not interbreed.

(3)

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- (b) Records show that very little change in the appearance of chiffchaffs and willow warblers has occurred during the last two hundred years.

Suggest why the rate of change in the appearance of these two species is relatively slow.

(3)

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(Total for Question = 9 marks)

Q24. The group of birds, known as warblers, contains many species which are very similar in external appearance.

The chiffchaff, *Phylloscopus collybita*, and the willow warbler, *Phylloscopus trochilus* are two species of warbler.

These warblers are so similar that many experts can identify them only by listening to their characteristic songs. Their songs are used during breeding to mark territory and attract mates.

The photographs below show these two warblers.



Chiffchaff



Willow warbler

Magnification  $\times 0.75$

(a) Explain the meaning of the term **species**.

(1)

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(b) Suggest how these two types of warbler became separate species.

(4)

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(c) Suggest why these two species of warbler are so similar in external appearance.

(3)

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**(Total for Question = 8 marks)**

Q25.

Frogs are ectothermic animals. This means that their body temperature will vary as the environmental temperature varies.

(a) Explain why body temperature affects the rate of development of animals.

(3)

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(b) Several species of the frog genus, *Rana*, can be found in North America. Many of these species inhabit areas within a range of latitudes from the colder north to the warmer south.

The table below shows data for four of these species, *R. clamitans*, *R. palustris*, *R. pipiens* and *R. sylvatica*.

| Species             | Body temperature of frog / °C       |                              |                                 |                                     |
|---------------------|-------------------------------------|------------------------------|---------------------------------|-------------------------------------|
|                     | Lower lethal, below which frog dies | Minimum to start development | Maximum to complete development | Upper lethal, above which frog dies |
| <i>R. clamitans</i> | 10.0                                | 11.0                         | 35.0                            | 37.0                                |
| <i>R. palustris</i> | 5.0                                 | 7.0                          | 30.0                            | 31.0                                |
| <i>R. pipiens</i>   | 3.0                                 | 6.0                          | 28.0                            | 30.0                                |
| <i>R. sylvatica</i> | 0.0                                 | 2.0                          | 24.0                            | 25.0                                |

Using the information, suggest why the lower and upper lethal temperatures limit the range of latitudes inhabited by each species of frog.

(2)

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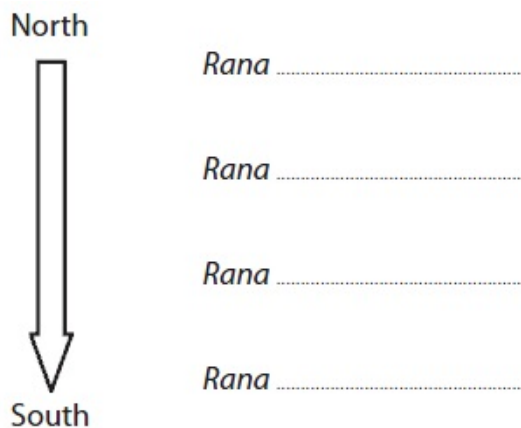
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(c) Complete the species names in the diagram below to show the most likely distribution of

*Rana* from north to south.

(2)



(d) Populations of the different species overlap on the boundaries of each latitude range.

Suggest why interbreeding does not take place between these populations.

(3)

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(e) Suggest how global warming may affect the distribution of these species of *Rana* in North America.

(3)

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(Total for question = 13 marks)

## **Mark Scheme**

Q1.

| <b>Question Number</b> | <b>Answer</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Additional Guidance</b>                                                                                                                                                                                                                                                                                                                                                                                            | <b>Mark</b> |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>(i)</b>             | <ol style="list-style-type: none"><li>1. idea that bacteria are resistant to fewer {antibiotics / antibiotic combinations} (in 2006 than 2007) ;</li><li>2. in both years there are resistant strains to {streptomycin / INH + rifampicin + ethambutol / INH } ;</li><li>3. idea that there are resistant strains to INH + rifampicin in 2006 but not in 2007 ;</li><li>4. idea that there are resistant strains to {ethambutol / rifampicin} in 2007 but not in 2006 ;</li></ol> | <p><b>ACCEPT</b> clear abbreviations to the names of the antibiotics throughout</p> <p><b>1 ACCEPT</b> a description e.g. new resistances, resistant to 4 in 2006 and 5 in 2007</p> <p><b>3 ACCEPT</b> idea that {resistance decreased to zero / no longer resistant}</p> <p><b>4 ACCEPT</b> idea of resistance developing<br/><b>NB</b> development of new resistances to {ethambutol / rifampicin} = Mp 1 and 4</p> | <b>(3)</b>  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Additional Guidance                                                                                                      | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|
| (ii)            | <ol style="list-style-type: none"> <li>1. bacteria have a mutation in {DNA / gene / eq } ;</li> <li>2. idea that the {presence / usage of} {antibiotic (INH) / INH} acts as a selection pressure ;</li> <li>3. idea that the allele (for resistance) is passed on ;</li> <li>4. idea that bacteria {divide by asexual reproduction / divide by binary fission / produce clones / eq} ;</li> <li>5. idea of increasing the allele frequency ;</li> </ol> | <p><b>3 NOT</b> gene</p> <p><b>4 ACCEPT</b><br/>divide by mitosis / conjugation / transduction / transformation / eq</p> |      |

| Question Number | Answer                                                                                                               | Additional Guidance | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------|---------------------|------------|
|                 | 6. idea that the more resistant bacteria there are, the more likely new strains will acquire the (resistance) gene ; |                     | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                               | Additional Guidance                                                                                                                                                                                                                                             | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| (iii)           | <ol style="list-style-type: none"> <li>reference to codes of {practice / conduct / eq } ;</li> <li>idea that appropriate {antibiotics / named example} should be given to patients ;</li> <li>idea of {educating patients about taking antibiotics / taking the full course of antibiotics ;</li> <li>credit another appropriate procedure e.g. hand washing, screening ;</li> </ol> | <p><b>1 ACCEPT</b> named policy /code<br/><b>NB</b> Mp5 is for named practice</p> <p><b>2 ACCEPT</b> not giving antibiotics if not necessary / not using antibiotics for prophylactic treatment / using narrow spectrum antibiotics / rotate antibiotic use</p> | <b>(2)</b> |

Q2.

| Question Number | Acceptable Answer                                                                                                                                                                            | Additional guidance | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
|                 | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>HIV mutates (1)</li> <li>resistance to one drug but not to {all / others} (1)</li> </ul> |                     | <b>(2)</b> |

Q3.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                           | Additional Guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (i)             | <p>A description that makes reference to four of the following:</p> <ul style="list-style-type: none"> <li>sample taken from the female genital tract (1)</li> <li>bacteria grown on {selective / indicator} media (1)</li> <li>bacteria grown on media containing different types of antibiotics (1)</li> <li>use of {antibodies / DNA profiling} (1)</li> <li>using {Gram staining / cell shape / colony shape / colony colour} (1)</li> </ul> |                     | (4)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Additional Guidance            | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------|
| (ii)            | <p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>because they grow on the skin cells preventing pathogenic bacteria from doing so (1)</li> <li>because they use the glycogen so less {glucose / energy / glycogen} available for the pathogenic bacteria (1)</li> <li>because they produce lactic acid which inhibits the growth of pathogenic bacteria (1)</li> <li>because the low pH denatures the enzymes of the pathogenic bacteria (1)</li> </ul> | <p>ACCEPT below optimum pH</p> | (3)  |

Q4.

| Question Number | Answer                                                                                                                   | Additional Guidance                                                                                                                                                      | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (i)             | <ul style="list-style-type: none"> <li>Y calculated (1)</li> <li>body condition index calculated to 2 dps (1)</li> </ul> | <p><u>Example of calculation:</u></p> <p><math>Y = 0.73 \times 86.4 - 34.5 = 28.572</math></p> <p><math>26.4 \div 28.572 = 0.92</math><br/>ecf from calculation of Y</p> | (2)  |

| Question Number | Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * (ii)          | <p>Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><u>Indicative content</u></p> <ul style="list-style-type: none"> <li>• decrease in body mass (D)</li> <li>• therefore decrease in condition index (D / E)</li> <li>• because less nutritious plant material available (E)</li> <li>• decrease in organic matter in stomach (D)</li> <li>• because less plant material available (E)</li> <li>• increase in mineral ion content (D)</li> <li>• because more foraging for roots (E)</li> <li>• and therefore soil is consumed (E)</li> <li>• less water in faeces (D)</li> <li>• as plant material does not contain as much water (E)</li> </ul> |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <ul style="list-style-type: none"> <li>• therefore wombat had to conserve water (E)</li> <li>• 2 months after drought measurements start returning back to normal (D)</li> <li>• as quality and quantity of plant material increases (E)</li> </ul> <p><b>Level 1 :</b></p> <p>1 mark = 1 description (1 D)<br/> 2 marks = 2 descriptions (2 D) or 1 description and 1 explanation (D + E)</p> <p><b>Level 2 :</b></p> <p>3 marks = 3 descriptions that include what happens after rain (3D + D) or 2 descriptions and 1 explanations (2D +1E)<br/> 4 marks = 2 descriptions and 2 explanations (2D +2E)</p> <p><b>Level 3 :</b></p> <p>5 marks = 3 descriptions and 3 explanations (3D +3E)<br/> 6 marks = 4 descriptions and 4 explanations that include an explanation of why mineral content in stomach is higher (4D + 4E)</p> |
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| Level | Marks |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0     | No awardable content                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1     | 1-2   | Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.<br><br>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.                                                                                                                                                                                                  |
| 2     | 3-4   | Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented.<br><br>Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures).<br><br>The explanation shows some linkages and lines of reasoning with some structure.                                                         |
| 3     | 5-6   | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented.<br><br>Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures).<br><br>The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured. |

Q5.

| Question Number | Answer                                                                                                               | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                  | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (i)             | <ul style="list-style-type: none"> <li>deduce expected values (1)</li> <li>calculation of Chi squared (1)</li> </ul> | <p><u>Example of calculation</u></p> <p>C: <math>(42 - 20)^2 \div 20 = 24.2</math> and</p> <p>M: <math>(6 - 10)^2 \div 10 = 1.6</math> and</p> <p>S: <math>(12 - 30)^2 \div 30 = 10.8</math></p> <p>Chi squared value = 36.6</p> <p>Correct answer gains full marks, with no working shown</p> <p><b>ACCEPT</b> one mark in working for expected values of 20, 10 and 30 or 37.2</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Additional Guidance                                                                                    | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------|
| (ii)            | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>reject {null hypothesis / <math>H_0</math>} significant difference between observed and expected results (1)</li> <li>because calculated value is greater than the critical value at <math>\{p = 0.05 / p = 0.01\}</math> / because calculated value is greater than 5.991 / 9.210 (1)</li> <li>uses 2 degrees of freedom / 5.991 / 9.210 (1)</li> <li>concludes mice show preference for corner squares (1)</li> </ul> | <p><b>ACCEPT</b> converse for all Mps if answer in (i) produces a calculated value less than 5.991</p> | (4)  |

Q6.

| Question Number | Answer                                                                                                                                                                                                                                                                           | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (i)             | <ul style="list-style-type: none"> <li>total blood volume in one seal (1)</li> <li>conversion of <math>\text{g dm}^{-3}</math> to <math>\text{g cm}^{-3}</math> (1)</li> <li>total mass of haemoglobin (concentration of haemoglobin x volume of blood in a seal) (1)</li> </ul> | <p><u>Example of calculation:</u></p> <p><math>400 \times 207 = 82800 \text{ cm}^3</math></p> <p><b>Accept</b> calculation of total haemoglobin per <math>\text{cm}^3 \text{ kg}^{-1}</math> blood:<br/> <math>207 \times 216 = 44712</math></p> <p><b>Accept</b> calculation of concentration of haemoglobin in one seal:<br/> <math>216 \times 400 = 86400</math></p> <p><math>216 \div 1000 = 0.216 \text{ g cm}^{-3}</math></p> <p><math>0.216 \times 82800 = 17885 \text{ g}</math></p> <p>Correct answer with no working gains full marks</p> <p><b>Accept</b> for two marks a correct answer with no units / wrong units</p> <p><b>Accept</b> for three marks:<br/> 17884.8 g / 17880 g / 17890 g / 17900 / 18000 g / 17.8848 kg / 17.885 kg / 17.89 kg / 17.9 kg / 18 kg</p> | (3)  |

| Question Number | Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (ii) *          | <p>Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><u>A: Depth and diving:</u></p> <ul style="list-style-type: none"> <li>• positive correlation between maximum depth and maximum time holding breath</li> <li>• weak positive correlation between mass of animal and depth</li> <li>• weak correlation between maximum time holding breath and mass of mammal</li> <li>• because diving deeper requires larger oxygen storage as can't breathe underwater</li> <li>• aerobic respiration requires oxygen to release energy</li> </ul> <p><u>B: Blood and muscle:</u></p> <ul style="list-style-type: none"> <li>• positive correlation between volume of oxygen in body and maximum depth</li> <li>• positive correlation between concentration of haemoglobin in blood and maximum depth</li> <li>• no correlation between oxygen stored in muscle and maximum depth</li> <li>• all the mammals must possess myoglobin acting as an oxygen store in muscle</li> <li>• bottlenose dolphin and harbour seal have more oxygen stored in lungs / Weddell seal and Northern elephant seal have less oxygen stored in lungs</li> <li>• oxygen stored in lungs results in more buoyancy so deeper diving mammals have less stored in lungs</li> <li>• combined effect of high blood volume and haemoglobin concentration results in very high blood oxygen storage</li> <li>• more oxygen stored in blood so higher haemoglobin concentration and blood volume in animals that dive deeper</li> <li>• all have similar proportions of oxygen stored in muscle</li> </ul> <p><u>Quantitative analysis</u></p> <ul style="list-style-type: none"> <li>• Q1: quoting of data to support explanation</li> <li>• Q2: manipulation of data to support explanation, for example, determining total haemoglobin concentrations in mammals.</li> </ul> |

| Level | Marks |                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | 0     | No awardable content                                                                                                                                                                                                                                                                                                                                                                               |
| 1     | 1-2   | <p>Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.</p> <p>The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.</p> <p><b>Level 1: Description of some patterns from at least one of A or B</b></p>                                         |
| 2     | 3-4   | <p>Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts.</p> <p>The discussion shows some linkages and lines of scientific reasoning with some structure.</p> <p><b>Level 2: Description of patterns with explanation from at least one of A or B</b></p>                                                                           |
| 3     | 5-6   | <p>Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.</p> <p>The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p> <p><b>Level 3: Detailed description and explanation of patterns from both A and B with quantitative analysis (Q)</b></p> |

Q7.

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                    | Additional guidance                                                                                                                                                                                                             | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(a)</b>      | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• Tasmanian wolf and Dunnart more closely related (1)</li> <li>• because there are fewer base differences between Dunnart and the Tasmanian wolf than between the grey wolf and Tasmanian wolf (1)</li> </ul> | <p>For answers relating to grey wolf and Dunnart</p> <p>Base differences quantified {only 2 differences between Tasmanian wolf and Dunnart but 5 between grey wolf and Dunnart, and 7 between grey wolf and Tasmanian wolf}</p> | <b>(2)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Additional guidance | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| <b>(b)</b>      | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• placental mammal/grey wolf has more successful reproduction than marsupial mammal/ Tasmanian wolf (1)</li> <li>• because young are born more {developed/mature}marsupial offspring very small so less likely to survive (1)</li> <li>• therefore grey wolves outcompete Tasmanian wolves unless Tasmanian wolves are geographically isolated (1)</li> </ul> |                     | <b>(3)</b> |

Q8.

| Question Number | Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *               | <p>Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> <li>with increasing snow depth, there is higher survival of grey owls / fewer brown owls survive / more grey owls D</li> <li>snow depth has decreased over time D</li> <li>the percentage of brown owls has increased over time / percentage of grey owls has decreased D</li> </ul> <p>For</p> <ul style="list-style-type: none"> <li>with less snow, more ground is visible / uncovered / more twigs and trees visible E</li> <li>with less snow, grey owls more obvious (to predators / prey) / less camouflaged E</li> <li>with less snow, natural selection would favour brown owls / more brown (advantageous) alleles passed on / fewer grey alleles passed on / brown owls outcompete grey owls E</li> <li>enhanced greenhouse effect due to carbon dioxide emissions reflecting radiation back / absorbing radiation (causing melting) E</li> </ul> <p>Against</p> <ul style="list-style-type: none"> <li>no direct measure of greenhouse gas / temperature / fossil fuel emissions A</li> <li>graphs show correlations not causal links A</li> <li>data for owl survival with snow depth is scattered / gaps in data / weak correlation A</li> <li>data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A</li> <li>other factors (named factors) could be affecting the owl population A</li> <li>reduced snow may not be due to greenhouse gas release A</li> </ul> |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <ul style="list-style-type: none"> <li>data for owl survival with snow depth is scattered / gaps in data / weak correlation A</li> <li>data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A</li> <li>other factors (named factors) could be affecting the owl population A</li> <li>reduced snow may not be due to greenhouse gas release A</li> </ul> |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Level 0</b> | <b>Marks</b> | <b>No awardable content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Level 1</b> | 1-2<br>(1-3) | <p>Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made</p> <p>1 mark : any 1 from D, E, A</p> <p>2 marks : any 2 from D, E, A</p>                                                                                                                                     |
| <b>Level 2</b> | 3-4<br>(4-6) | <p>A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.</p> <p>D and, E OR A</p> <p>3 marks : at least 3 points. Any combination of D, plus E, or A</p> <p>4 marks : at least 4 points. Any combination of D, plus E, or A</p>                              |
| <b>Level 3</b> | 5-6<br>(7-9) | <p>A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.</p> <p>D, E, AND A</p> <p>5 marks : at least 5 points. Must have combination of D, E, and A</p> <p>6 marks : at least 6 points. Must have combination of D, E, and A</p> |

Q9.

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Additional Guidance | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
|                 | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li><i>Euphorbia regis-jubiae</i> is a producer (1)<br/>therefore provides { food / energy } for other organisms (herbivores / primary consumers / decomposers)</li> <li>{ presence of roots / organic material } (1)<br/>holds soil structure together / increases nutrients</li> <li>therefore it provides { shelter / (micro) habitat } (1)<br/>for other organisms to establish themselves</li> </ul> |                     | <b>(3)</b> |

Q10.

| Question Number | Acceptable Answer                                                                                                                                                                                                                                  | Additional Guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
|                 | <p>An answer that makes reference to the following:</p> <p><u>Evaluation</u></p> <ul style="list-style-type: none"> <li>judgment clearly stated (1) and supported by an argument</li> </ul> <p>AND at least one from each argument for 4 marks</p> |                     |      |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |     |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----|
|  | <p><u>For</u></p> <ul style="list-style-type: none"> <li>antibiotic H is the most effective therefore spraying might help to reduce food poisoning (1)</li> <li>which could prevent wider spread of infection or contamination of other products (1)</li> </ul> <p><u>Against</u></p> <ul style="list-style-type: none"> <li>bacteria may be inside the chicken so unaffected by spraying (1)</li> <li>possibility of promoting antibiotic resistance / effects on gut flora of consumers (1)</li> <li>experimental results may not be {valid due to molecular size and diffusion / reliable due to lack of replicates} (1)</li> <li>experiment used harmless strain of <i>Campylobacter</i> so results may not apply to { pathogenic strain / other bacteria that also cause food poisoning } (1)</li> </ul> |  | (5) |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----|

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Additional guidance | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
|                 | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• mutation rates in bacteria are very high because bacteria divide frequently (1)</li> <li>• resistant bacteria have a selective advantage (1)</li> <li>• rapid asexual reproduction causes large numbers of antibiotic-resistant bacteria (1)</li> <li>• therefore there is a need for new antibiotics that bacteria are not resistant to (1)</li> <li>• this is a slow process because research and testing takes time (1)</li> </ul> |                     | <b>(5)</b> |

Q12.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                         | Additional Guidance                                                                                        | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------|
|                 | <p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>• {random / chance} mutations (1)</li> <li>• produce {proteins / enzymes} that make the drug ineffective (1)</li> <li>• therefore resistant organisms pass on allele (1)</li> <li>• drug is the selection pressure (1)</li> </ul> | <p><b>DO NOT ACCEPT</b> if mutation caused by drug</p> <p><b>DO NOT ACCEPT</b> pass on mutation / gene</p> | <b>(3)</b> |

Q13.

| Question Number | Correct Answer             | Additional guidance | Mark       |
|-----------------|----------------------------|---------------------|------------|
| <b>(a)</b>      | <i>Staphylococcus</i> spp. |                     | <b>(1)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                     | Additional guidance                                                                   | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------------|
| <b>(b)</b>      | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>the number of living bacteria does not increase (1)</li> <li>because cell division is prevented (1)</li> </ul> | Accept more sophisticated answers that give details of how cell division is prevented | <b>(2)</b> |

| Question Number | Indicative content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>*(c)</b>     | <p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>Candidates are expected to reach a decision/conclusion on whether the development of bacterial resistance is so serious and rapid that antibiotics will become ineffective in the treatment of the majority of bacterial infections.</p> <ul style="list-style-type: none"> <li>Prior use of antibiotics increases the percentage of resistant bacteria, supported by quantitative data</li> <li>Prior use of the named antibiotic has the greatest effect, supported by quantitative data</li> <li>Increasing use of antibiotics increases selection pressures so more resistant strains</li> <li>Shows understanding that resistance mechanisms are inherited by sexual means and lateral gene transfer, e.g. via plasmids and this means they can spread rapidly and in some cases across species</li> <li>Bacteria have high reproduction rates and mutations more likely within a short time</li> <li>Understands current methods used to limit increase in resistant strains such as strict controls on antibiotic prescribing, problems of ensuring patients complete course of treatment when symptoms disappear, limit use of antibiotics in animal husbandry etc.</li> <li>Comments on difficulties of developing new drugs</li> <li>Methods of preventing spread of resistant strains especially hospital infection</li> <li>Movement of humans means that transfer of resistant strains will spread to new hosts more easily</li> </ul> |

| Level          | Mark | Descriptor                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | 0    | No rewardable material                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Level 1</b> | 1-3  | Provides little or no reference to a range of scientific ideas, processes, techniques and procedures.<br><br>Scientific argument may be attempted, but fails to link biological concepts and/or ideas in order to support decision/conclusion.<br>Limited attempt to address the question.                                                                                                                                                       |
| <b>Level 2</b> | 4-6  | Scientific reasoning occasionally supported through the linkage of a range of scientific ideas, processes, techniques and procedures.<br><br>Scientific argument is partially developed. Attempts to synthesise and integrate relevant knowledge with linkages to biological concepts and/or ideas, leading to a notional scientific argument or decision/conclusion based on evidence.                                                          |
| <b>Level 3</b> | 7-9  | Scientific reasoning supported throughout by sustained linkage of a range of scientific ideas, processes, techniques or procedures.<br><br>Scientific argument is well developed and logical. Demonstrating throughout the skills of synthesising and integrating relevant knowledge with consistent linkages to biological concepts and/or ideas, leading to nuanced and balanced scientific argument or decision/conclusion based on evidence. |

Q14.

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Additional Guidance | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
|                 | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• { selective pressure against / loss of } sickle cell alleles due to effects of sickle cell anaemia (1)</li> <li>• heterozygote advantage due to protection against malaria increases { HbS frequency / number of heterozygotes } (1)</li> <li>• heterozygote advantage increases with increased prevalence of malaria (1)</li> <li>• HbS frequency depends on whether malaria or sickle cell disease represents a greater risk to survival (1)</li> </ul> |                     | <b>(4)</b> |

Q15.

| Question Number | Answer                                                                                                                                                                                                                                                                | Additional Guidance                                                                                                                                                                                                             | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (i)             | <p>A calculation that makes reference to:</p> <ul style="list-style-type: none"> <li>• correct calculation to find q (1)</li> <li>• correct calculation to find p (1)</li> <li>• correct calculation to find <math>2pq</math> and number of mosquitoes (1)</li> </ul> | <p><math>q = 0.899...</math> <b>Allow</b> any dpp<br/> <math>= 0.101...</math> <b>Allow</b> any dp</p> <p><b>Allow</b> ecf for mp2 and mp3</p> <p>1183 = three marks</p> <p>Correct answer with no working gains full marks</p> | 3    |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                              | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (ii)            | <p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> <li>• The frequency of the resistance allele increased in 2015 (1)</li> <li>• because the (resistant) acetylcholinesterase enzyme is not affected by the pesticide / enzyme still works (1)</li> <li>• acetylcholine is still broken down in synapses (1)</li> <li>• the mosquitoes survive and breed (1)</li> <li>• the resistance allele carries a cost as it is reduced when no pesticide is used / after 2015 (1)</li> </ul> | <p><b>Allow</b> Number of resistant mosquitoes increases in 2015<br/> <b>Allow</b> converse</p> <p><b>Allow</b> converse</p> <p><b>Allow</b> converse</p> <p><b>Allow</b> resistant mosquitoes are at a selective advantage</p> <p><b>Allow</b> lost by genetic drift / non-resistant mosquitoes out compete resistant ones after pesticide use stops<br/> <b>Allow</b> no selective pressure to retain the resistant allele</p> | 4    |

Q16.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                  | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
|                 | <p>An answer that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>• use more mice as one mouse might behave as an anomaly / mice behave differently (1)</li> <li>• control {temperature / light} because it affects preference (1)</li> <li>• control {sex / age / species} as they affect behaviour (1)</li> <li>• clean before using other mice so scent removed (1)</li> </ul> | (3)  |

Q17.

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Additional Guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
|                 | An explanation that makes reference to five of the following:                                                                                                                                                                                                                                                                                                                                                                                                           |                     | (5)  |
|                 | <ul style="list-style-type: none"> <li>• geographical isolation between Fuerteventura and mainland birds (1)</li> <li>• birds exposed to different selection pressures (1)</li> <li>• variation between individuals (1)</li> <li>• therefore increased survival / reproduction of individuals with advantageous { alleles / genes } (1)</li> <li>• increasing frequency of (these) alleles (1)</li> <li>• reproductive isolation / allopatric speciation (1)</li> </ul> |                     |      |

Q18.

| Question Number | Answer                                                                                                                                                                                                                                       | Additional Guidance | Mark     |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------|
| (i)             | D sympatric speciation<br><br>A is incorrect because allopatric speciation requires geographical separation<br>B is incorrect because genetic speciation is the wrong term<br>C is incorrect because stabilising selection is the wrong term |                     | <b>1</b> |
| (ii)            | <i>An answer that makes reference to:</i> <ul style="list-style-type: none"> <li>• have not seen if they can breed and produce fertile offspring with modern mosquitoes (1)</li> </ul>                                                       |                     | <b>1</b> |
| (iii)           | <i>An answer that makes reference to:</i> <ul style="list-style-type: none"> <li>• peer review / published in journals / conferences (1)</li> </ul>                                                                                          |                     | <b>1</b> |
| (iv)            | <ul style="list-style-type: none"> <li>• Phylum and class (1)</li> <li>• <i>Prisoculex</i> and <i>burmanicus</i> (1)</li> </ul>                                                                                                              |                     | <b>2</b> |

Q19.

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                | Additional guidance | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| <b>(a)</b>      | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>the shaded leaves have a larger surface area to mass ratio and are therefore bigger and thinner than leaves in the sun (1)</li> <li>bigger allows more {chloroplasts / chlorophyll} for absorption of light (1)</li> <li>thinner allows shorter diffusion path for entry of carbon dioxide (1)</li> </ul> |                     | <b>(3)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Additional guidance | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| <b>(b)</b>      | <p>An explanation that makes reference to five of the following:</p> <ul style="list-style-type: none"> <li>growing nettles in {pots / eq} to ensure soil pH / {mineral/ named mineral} content in pots is the same (1)</li> <li>{measure / control} the {light intensity / duration} for both treatments to ensure light intensities are different (1)</li> <li>watering regime is the same in both treatments to ensure same potential for leaf growth (1)</li> <li>use {groups of pots / measure more leaves} so that data collected is reliable (1)</li> <li>use genetically identical nettles in each treatment as some genes may affect growth (1)</li> <li>make sure that all pathogens / consumers are prevented from access as they can reduce growth (1)</li> </ul> |                     | <b>(5)</b> |

Q20.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                       | Additional guidance                      | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|------------|
| (a)(i)          | <ol style="list-style-type: none"> <li>reference to {polymerase chain reaction / PCR} ;</li> <li>polymerase (enzyme) {added / eq };</li> <li>idea of need for primers and nucleotides ;</li> <li>{90-98} (°C) → {50-65} (°C) → {70-75} (°C) ;</li> <li>idea that cycle needs to be repeated {several times / to make several copies of DNA / eq};</li> </ol> | <b>1. Accept</b> as a ref to PCR machine | <b>(4)</b> |

| Question Number | Answer                                                       | Additional guidance                                                                 | Mark       |
|-----------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------|------------|
| <b>(a)(ii)</b>  | (DNA) {profiling / fingerprinting / (gel) electrophoresis} ; | <b>Ignore</b> Southern blotting, PCR<br><b>Accept</b> DNA profile / DNA fingerprint | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                    | Additional guidance                                     | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------------|
| <b>(b)</b>      | 1. idea of work appearing in a (Scientific) journal or being presented at a conference ;<br><br>2. idea that validity or reliability is considered ;<br><br>3. by other scientists / ref to peer review ; | <b>1. Accept</b> publishing a paper, scientific meeting | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                         | Additional guidance                                                                                                                           | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(i)          | 1. reference to different {conditions / environments /eq} (in each region) ;<br><br>2. idea of different selection pressures ;<br><br>3. idea of {restricted gene flow / separate gene pools} ;<br><br>4. reference to reproductive isolation; | <b>1. Accept</b> appropriate named factor e.g. temperature<br><br><br><br><br><br><br><br><br><br><b>3. Ignore</b> different allele frequency | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                           | Additional guidance                                                                                  | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------|
| <b>(c)(ii)</b>  | <ol style="list-style-type: none"> <li>idea of different {alleles/ gene pool} ;</li> <li>idea that this leads to {new / different} phenotypes ;</li> <li>idea of new {allele / gene} can be {advantage / disadvantage} ;</li> <li>reference to (advantageous) {(mutated) gene / (new) allele} passed onto offspring ;</li> </ol> | <p><b>1. Ignore</b> allele frequency</p> <p><b>2. Accept</b> traits / characteristics / features</p> | <b>(2)</b> |

Q21.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Additional Guidance                                                                                                                        | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(i)</b>      | <p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>each pigment will absorb different wavelengths (of light) (1)</li> <li>each pigment will absorb different amounts of light at each wavelength (1)</li> <li>action spectrum is different because the seaweeds are absorbing different wavelengths of light (1)</li> <li>the rate of photosynthesis will therefore be different at each wavelength(1)</li> </ul> | <p><b>ACCEPT</b> each pigment will reflect different wavelength (of light) description of which colour light is {reflected / absorbed}</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Additional Guidance       | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------|
| (ii)            | <p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>green seaweeds found in shallow water as they {cannot absorb the green light / can absorb the red light} (1)</li> <li>{brown / red} seaweeds can absorb {green / blue / other} wavelengths of light so are positioned further down as these wavelengths can penetrate further (1)</li> <li>seaweeds positioned so that they can absorb light for {photosynthesis / light-dependent reactions / photolysis} (1)</li> <li>seaweeds positioned to avoid competition with the other types of seaweed (1)</li> </ul> | ALLOW plants for seaweeds | (3)  |

Q22.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                 | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                | Mark    |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
|                 | <p>An explanation that includes four of the following:</p> <ul style="list-style-type: none"> <li>collection acts as a selection pressure (1)</li> <li>(random) mutation (in gene) for pigment / colour (1)</li> <li>greyish brown plants are less likely to be {collected / found} as harder to see (1)</li> <li>more likely to reproduce, passing on new <b>allele</b> (1)</li> <li><b>allele</b> frequency increases (1)</li> </ul> | <p>Accept collection of plants results in natural selection</p> <p>Accept genetic variation for colour exists (in population)</p> <p>Accept greyish brown plants {better camouflaged / blend in} so not picked <b>piece together</b></p> <p>Accept converse</p> <p>Accept more likely to pass on allele to offspring</p> <p>Accept converse</p> <p>Accept allele increases in gene pool</p> <p>Accept converse</p> | Exp (4) |

Q23.

| Question Number | Answer                                                                                                                                                                                                                                        | Additional Guidance                                                                                                                                                                   | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(i)          | <ol style="list-style-type: none"> <li>1. (successful interbreeding) produces offspring;</li> <li>2. (same species produce) fertile (offspring);</li> <li>3. credit reason why offspring of different species might be infertile ;</li> </ol> | <p><b>Accept</b> converse throughout</p> <p><b>Ignore</b> viable</p> <p>eg genetic incompatibility, different number of chromosomes, poor quality gametes , low number of gametes</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                               | Additional Guidance | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(ii)         | <ol style="list-style-type: none"> <li>1. reference to reproductive isolation ;</li> <li>2. different breeding times;</li> <li>3. do not recognise {courtship displays / songs / eq} ;</li> <li>4. physically incompatible eg genitalia ;</li> </ol> |                     | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Additional Guidance                                                                                                                                                        | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)             | <ol style="list-style-type: none"> <li>1. idea that the two species share the same habitat ;</li> <li>2. idea that the two species experience the same environmental conditions ;</li> <li>3. (therefore) the same selection pressures ;</li> <li>4. idea that they are both well-adapted (to their environment) ;</li> <li>5. idea that no mutations have happened that {improve / change} their {phenotypes / survival};</li> <li>6. {no / few} changes in allele frequency / gene pool is stable ;</li> <li>7. idea that there has been very little change in environment (over the years) ;</li> </ol> | <p><b>Accept</b> similar</p> <p><b>NB</b> this needs to be in the context of both species being subjected to the same selection pressures</p> <p><b>Accept</b> similar</p> | (3)  |

Q24.

| Question Number | Answer                                                      | Additional Guidance                                           | Mark |
|-----------------|-------------------------------------------------------------|---------------------------------------------------------------|------|
| (a)             | idea of organisms that breed to produce fertile offspring ; | <b>Ignore</b> reproductively isolated<br><b>Ignore</b> viable | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                     | Additional Guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (b)             | 1. idea of geographical isolation ;<br><br>2. idea of different {environmental conditions / habitats / eq} ;<br><br>3. reference to different selection pressures ;<br><br>4. idea that mutation resulted in {adaptation / increased survival} ;<br><br>5. idea of {decrease in gene flow / different alleles} ;<br><br>6. ref to reproductive isolation ;<br><br>7. credit suitable example e.g. different songs, incompatible genitals ; |                     | (4)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                   | Additional Guidance                                                                          | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| (c)             | 1. idea of descending from common ancestor ;<br><br>2. idea of living in similar habitats ;<br><br>3. idea of similar (environmental) {conditions / factors} ;<br><br>4. idea of similar selection pressures ;<br><br>5. idea that both well-adapted ;<br><br>6. idea that mutations have not changed appearance ;<br><br>7. idea of similar gene pool ; | <b>Accept</b> same for similar throughout<br><br><b>2. Accept</b> place / environment / area | (3)  |

Q25.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Additional guidance                                                                                                                                                                  | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(a)</b>      | <ol style="list-style-type: none"> <li>reference to increase in {metabolic rate / enzyme activity / eq} as temperature rises ;</li> <li>reference to increase in {kinetic / eq} energy of molecules (as temperature rises) / eq ;</li> <li>reference to increase in {enzyme-substrate complexes / energy of collisions / eq} (as temperature rises) ;</li> <li>idea of {inactivation at lower temperatures/ denaturation at higher temperatures} of enzymes ;</li> <li>idea that temperature affects {differentiation / growth /division / eq} ;</li> </ol> | <p><b>1. Accept</b> converse argument for mp 1 – 3</p> <p><b>2. Accept</b> movement</p> <p><b>4.Accept</b> the idea that enzyme-substrate complexes cannot be made if denaturing</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                         | Additional guidance | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| <b>(b)</b>      | <ol style="list-style-type: none"> <li>idea that temperature affects {survival / development / growth / metabolism / cell division / eq} ;</li> <li>idea that enzymes affect {development / growth / metabolism / cell division/ eq} ;</li> <li>idea that temperature affects enzymes ;</li> <li>idea that different frogs have different enzymes ;</li> </ol> |                     | <b>(2)</b> |

| Question Number | Answer                                                                            | Additional guidance                    | Mark       |
|-----------------|-----------------------------------------------------------------------------------|----------------------------------------|------------|
| <b>(c)</b>      | <i>sylvatica,</i><br><i>pipiens,</i><br><i>palustris,</i><br><i>clamitans</i> ; ; | if order correct but reversed = 1 mark | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Additional guidance                                         | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------|
| <b>(d)</b>      | <ol style="list-style-type: none"> <li>1. idea that different species are reproductively isolated ;</li> <li>2. idea of different breeding {times / seasons / eq} ;</li> <li>3. idea of different {breeding / courtship / eq} {behaviour / rituals / displays / colour / songs / croaks / eq} ;</li> <li>4. idea that population at {northerly / southerly} limit of range may not develop (to adulthood) ;</li> <li>5. idea that breeding between different species results in infertile offspring ;</li> </ol> | <b>3. Accept</b> idea of incompatible {genitalia / gametes} | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Additional guidance            | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------------|
| <b>(e)</b>      | <ol style="list-style-type: none"> <li>1. idea that global warming will increase the temperature (at the latitudes) ;</li> <li>2. idea that temperatures (at these latitudes) may become too high for any of the species ;</li> <li>3. idea that new temperature may be above the maximum to complete development or above the upper lethal limit ;</li> <li>4. idea that species move {north / to cooler regions / eq} ;</li> <li>5. ref to change in {food source / predators / competition / eq} ;</li> </ol> | <b>2.Accept</b> become extinct | <b>(3)</b> |