

PEARSON EDEXCEL IAL BIOLOGY • YBI11

# BIOLOGY



**EXAM QUESTION PACK**

**UNIT 2: PLANT STRUCTURE AND FUNCTION, BIODIVERSITY AND CONSERVATION**

**SCORE**

**/310**

**PERCENTAGE**

**%**

**STEMUP**

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Q1.

The photograph shows a Venus fly trap (*Dionaea muscipula*), a plant native to North and South Carolina in the United States.



This plant is found in nitrogen and phosphorus poor environments, such as a bog. The plant catches and digests insects and spiders and absorbs compounds containing nitrogen.

(a) Explain why the Venus fly trap needs compounds containing nitrogen.

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(b) The Venus fly trap secretes extracellular enzymes that digest the insects and spiders it catches.

Describe the role of the Golgi apparatus in forming these extracellular enzymes.

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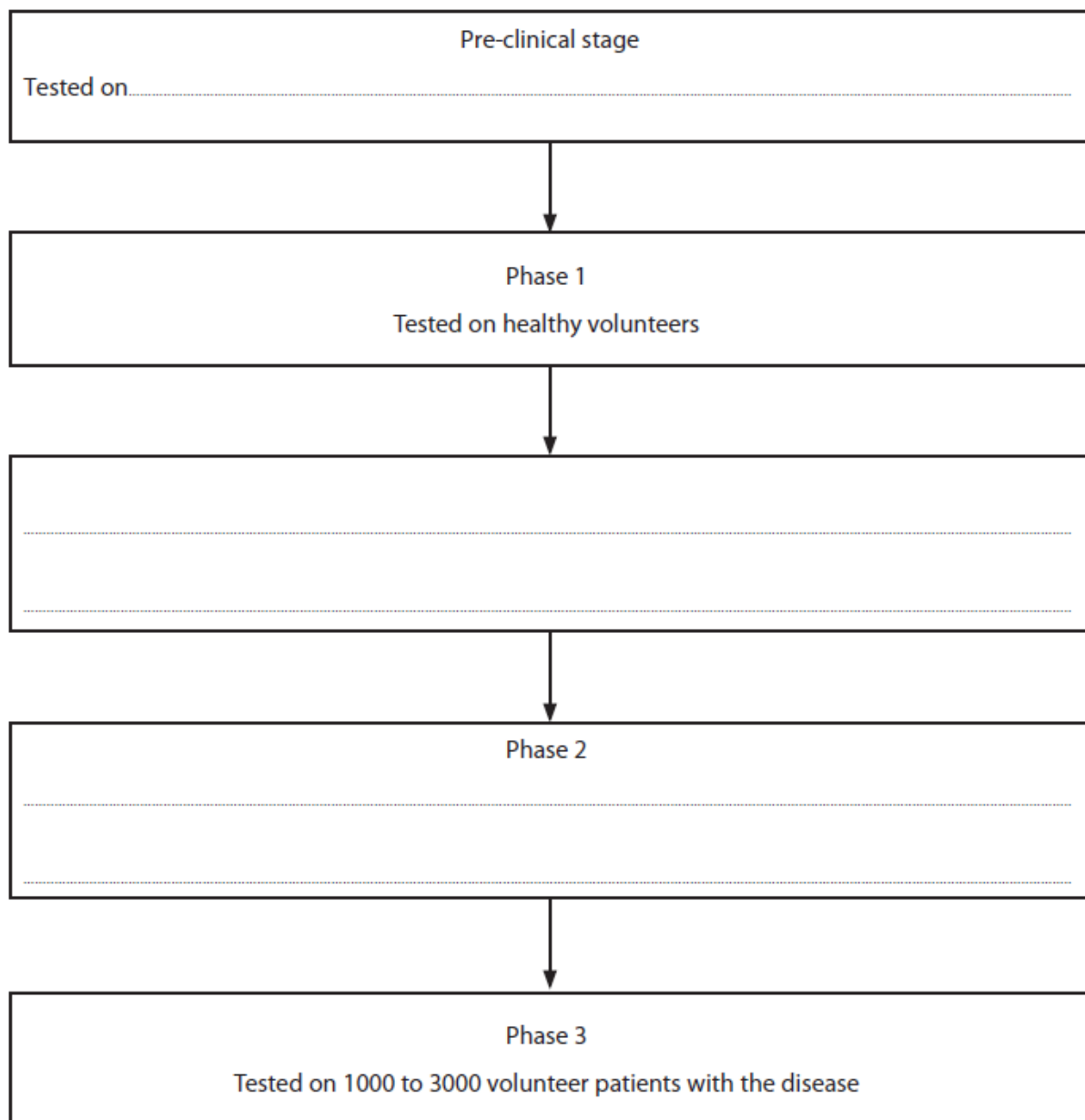
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(c) Extracts from Venus fly trap plants are used in some alternative medicines as a treatment for HIV and some cancers.

Complete the diagram to show how an extract could be tested as part of the initial stages of a drug trial.

(3)



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

Q2.

Beavers were hunted to extinction in Scotland in the 16th century.

In mainland Europe, populations of beavers have become isolated from each other.

In 2009, 11 beavers were reintroduced to Scotland from Norway.

Beavers are adapted to live on land and in water. They can cut down trees. They gnaw branches from trees, which they use to build dams.

The photograph shows two beavers and a pond that has been created due to a beaver dam.



(a) Explain how the reintroduction of beavers resulted in a change in the biodiversity in Scotland.

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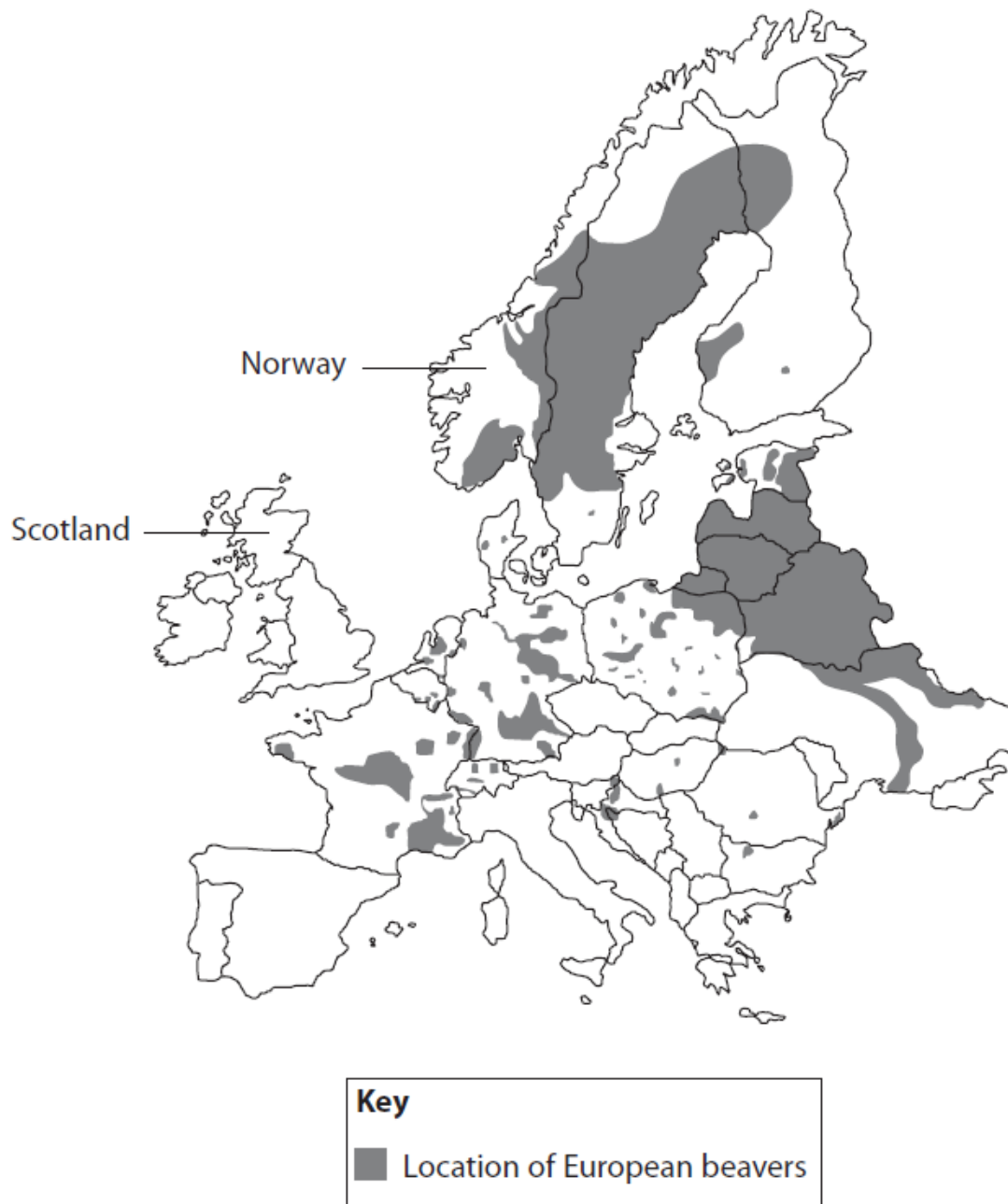
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\*(b) Some scientists were concerned that the low numbers of beavers reintroduced into Scotland from Norway could affect the genetic diversity of the population in Scotland. The scientists proposed two solutions to this concern:

- to introduce more beavers from Norway
- to introduce beavers from several different European locations.

The map shows locations of European beavers before they were reintroduced to Scotland.



Discuss the solutions, proposed by these scientists, to overcome the concern of introducing only 11 beavers into Scotland from Norway.

Use the information in the map to support your answer.

(6)

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Q3.

There are 18 species of puffer fish found in the Maldives.

The photograph shows one of these species, *Canthigaster valenti*.



© kaschibo/Shutterstock

Magnification  $\times 0.5$

(a) The markings on the skin of *Canthigaster valenti* are warnings to predators. It also protects itself from predators by producing poisons and by inflating its body.

Which row of the table describes these types of adaptations?

(1)

|                            | Markings on the skin | Production of poison | Inflating the body |
|----------------------------|----------------------|----------------------|--------------------|
| <input type="checkbox"/> A | anatomical           | behavioural          | physiological      |
| <input type="checkbox"/> B | anatomical           | physiological        | behavioural        |
| <input type="checkbox"/> C | physiological        | anatomical           | behavioural        |
| <input type="checkbox"/> D | physiological        | behavioural          | anatomical         |

(b) Another fish found in the Maldives is *Paraluteres prionurus*.

This fish is not poisonous. It grows to about 10 cm in length.

The photograph shows *Paraluteres prionurus*.



Source: <http://www.underwaterkwaj.com/uw-misc/file/Paraluteres-prionurus.htm>

Explain how the appearance of *Paraluteres prionurus* shows it is adapted to its habitat.

(3)

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(c) Explain why *Canthigaster valenti* and *Paraluteres prionurus* are unable to reproduce with each other.

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(Total for question = 6 marks)

Q4.

The Galapagos Islands are located off the west coast of South America.

The biodiversity on these islands has changed over the past 40 years due to human activity.

One of these islands is called Santa Cruz.

(a) The population of Santa Cruz increases by approximately 6.4% per year.

The majority of the population, 85%, live in urban areas.

The population of Santa Cruz living in urban areas in 2020 was 17 000.

Predict the total population of Santa Cruz in 2025.

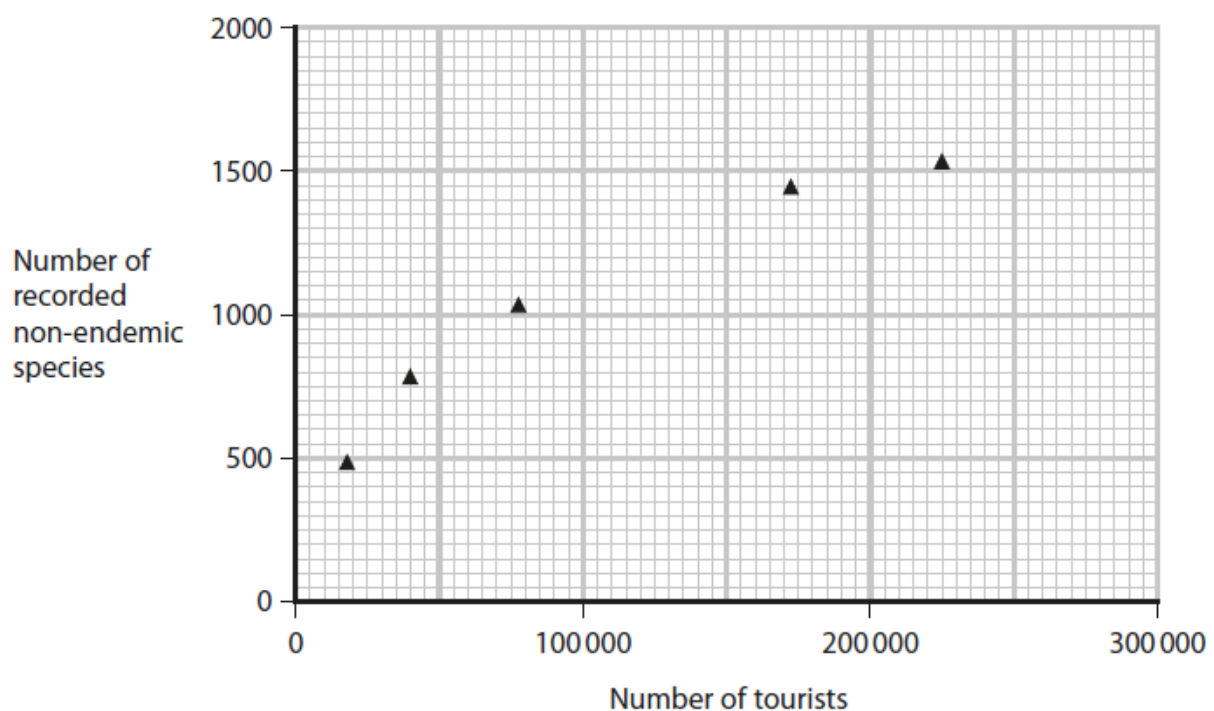
Assume that the rate of increase stays constant.

(3)

Answer .....

(b) Non-endemic species have been introduced to the Galapagos Islands.

The graph shows the number of tourists to all the islands and the number of recorded non-endemic species.



<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0184379>

State the relationship shown in the graph.

(1)

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(c) The wild blackberry was introduced to Santa Cruz in 1970 and has since spread over much of the island.

This has resulted in the reduction of the native endemic forest.

In 1960, the number of species in an area of the native forest was measured.

The table shows these results.

| Species | Number of individuals (n) | (n – 1) | n(n – 1)    |
|---------|---------------------------|---------|-------------|
| A       | 21                        | 20      |             |
| B       | 2                         | 1       | 2           |
| C       | 4                         | 3       | 12          |
| D       | 13                        | 12      |             |
| E       | 54                        | 53      |             |
| F       | 15                        | 14      | 210         |
| G       | 6                         | 5       | 30          |
| H       | 32                        | 31      |             |
|         | Total (N) =               |         | Σn(n – 1) = |

(i) Calculate the index of diversity (D) for this area of the forest using the formula

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

Use the table to help you.  
Give your answer to **one** decimal place.

(3)

Answer .....

(ii) Explain why the spread of the wild blackberry affects the biodiversity of the island.

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

Q5.

Many female organisms produce egg cells containing cortical granules.

(a) Explain how cortical granules ensure that the egg cell is diploid after fertilisation.

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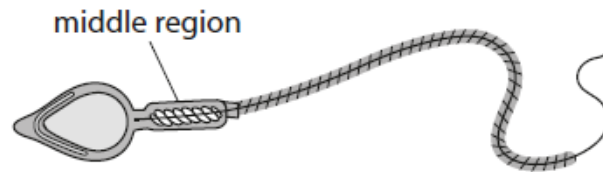
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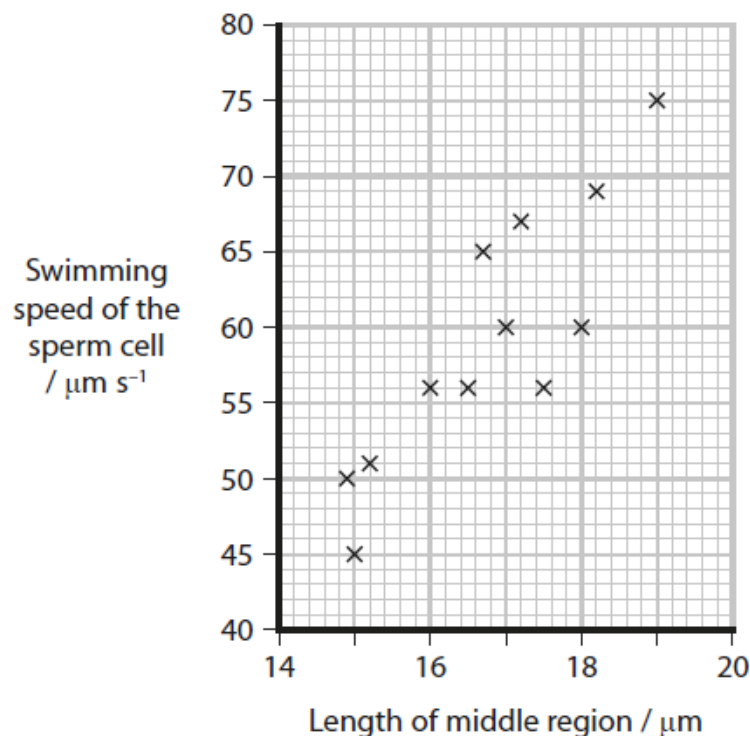
\*(b) Organisms have evolved different mating strategies such as:

- Some male animals have sperm cells with longer middle regions, as shown in the diagram.



The females of these species produce multiple egg cells and mate with many males in a short period of time.

The graph shows the effect of the length of the middle region on the swimming speed of the sperm cell.



- Some male animals, such as the zebra longwing butterfly, produce spermatophores that remain inside the reproductive system of the female after mating.

The spermatophore contains sperm cells and nutrients for the female. The spermatophore also releases chemicals that reduce the attractiveness of this female butterfly to other males.

- Some female animals, such as the eastern box turtle, mate with numerous males and then store the sperm for a number of years. This allows fertilised egg cells to be laid even

when the female has not mated in that year.

Comment on the effect that these three mating strategies would have on the reproductive success of the males and females, and the genetic diversity of the offspring.

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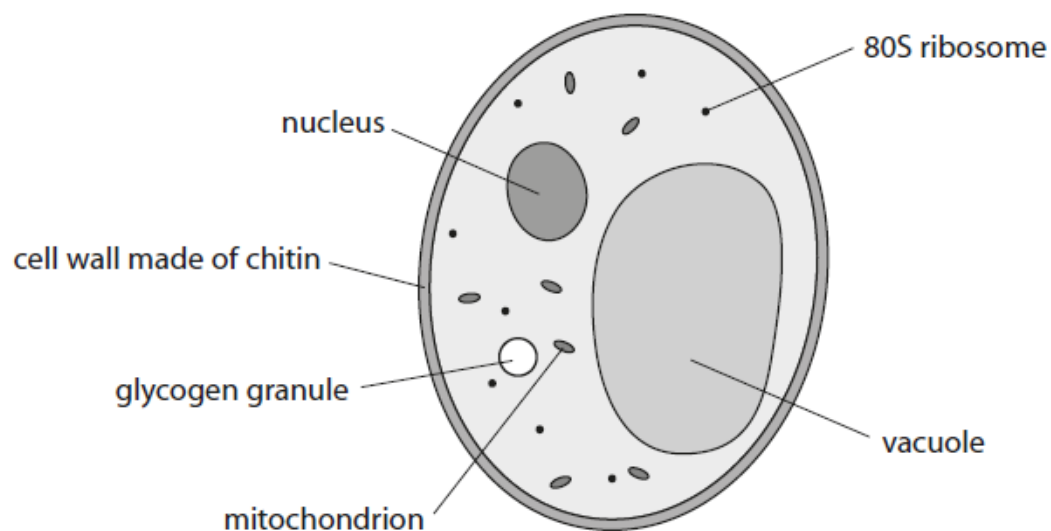
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**(Total for question = 10 marks)**

Q6.

Some fungi infect plants and affect the expression of the plant genes.

(a) A student drew and labelled a fungal cell.



Compare and contrast the structure of this fungal cell and a plant cell.

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(b) The photograph shows dandelion, a species of grass.



© blickwinkel / Alamy Stock Photo

The fungus *Epichloë festucae* lives within dandelion for part of its life cycle.

The fungus influenced the expression of certain genes in the plant cells.

- There was reduced expression of some genes involved in DNA synthesis.
- There was reduced expression of some genes involved with the synthesis of phospholipids, starch and sucrose.

(i) Explain the effect of this fungal infection on the growth of the plant.

(4)

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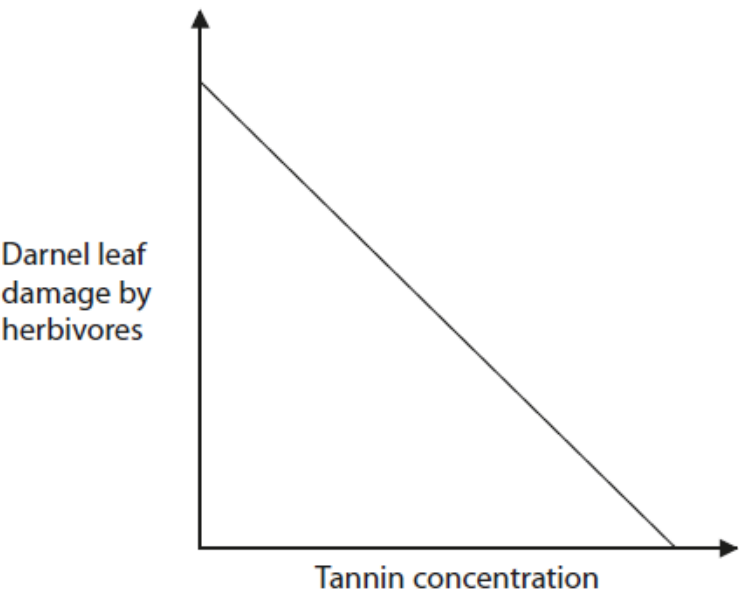
\*(ii) The fungus and the plant both benefit from this relationship.

The fungus absorbs nutrients from the plant.

The expression of certain genes in the plant cells is increased when infected with the fungus.

These genes are involved in the synthesis of tannin and flavonoids.

The graph shows the relationship between tannin concentration and the degree of darnel leaf damage by herbivores (grazing animals).



The table shows the antimicrobial effect of different concentrations of flavonoids on cultures of the bacterium *Pseudomonas aeruginosa*. This bacterium causes disease in plants.

| Flavonoid concentration<br>/ $\mu\text{g cm}^{-3}$ | Diameter of inhibition zone<br>/ mm |
|----------------------------------------------------|-------------------------------------|
| 500                                                | 7.0                                 |
| 666                                                | 8.0                                 |
| 1000                                               | 9.0                                 |

The fungus increases the expression of the genes involved in the synthesis of tannin and flavonoids.

Discuss the advantages and disadvantages of this for the fungus and for the infected plants.

(6)

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(iii) The bacterium *Pseudomonas aeruginosa* causes lung infections in humans.  
Describe how a drug containing flavonoids could be tested in a stage II drug trial.

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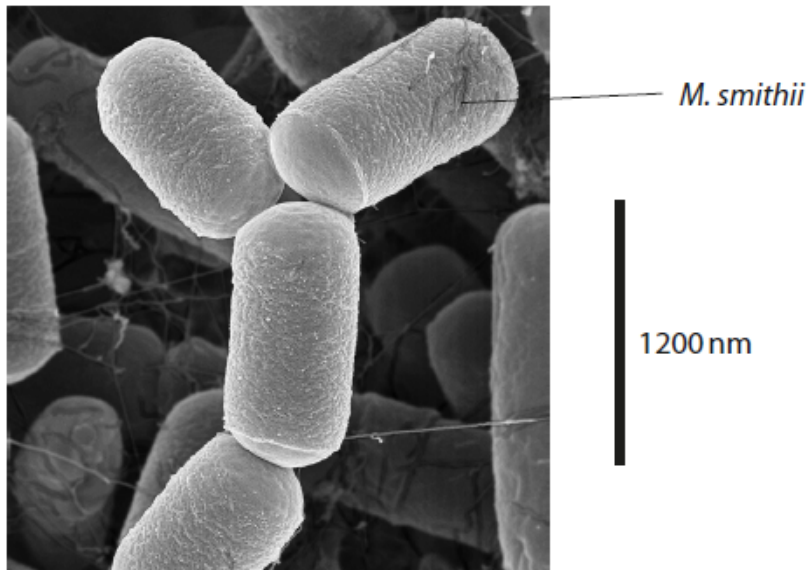
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Q7.

*Methanobrevibacter smithii* (*M. smithii*) is a single-celled microorganism found in the human intestine.

The photograph shows *M. smithii*.



(© DENNIS KUNKEL MICROSCOPY / SCIENCE PHOTO LIBRARY)

(a) (i) Calculate the magnification of this photograph.

Give your answer in standard form to two significant figures.

(2)

Answer .....

(ii) Explain which type of microscope was used to take this photograph.

(2)

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(b) Scientists classified this microorganism as a species in the domain Archaea.

(i) Describe the information the scientists would have used to classify *M. smithii* into the Archaea domain.

(2)

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(ii) Scientists have identified a similar microorganism in the human mouth.

This microorganism is called *Methanobrevibacter oralis* (*M. oralis*).

Explain how the scientists could confirm that *M. smithii* and *M. oralis* are different species of Archaea.

(3)

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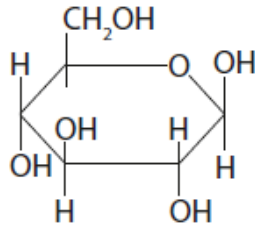
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(Total for question = 9 marks)

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 ☒ .

Plants contain many types of molecule.

(a) (i) Which molecule is shown in the diagram?



(1)

☐ **A**  $\alpha$ -glucose

☐ **B**  $\beta$ -glucose

☐ **C** starch

☐ **D** sucrose

(ii) Which is a feature of cellulose molecules?

(1)

☐ **A** contain peptide bonds

☐ **B** contain  $\alpha$ -glucose molecules

☐ **C** form microfibrils

☐ **D** are soluble

(iii) Which molecule contains magnesium ions?

(1)

☐ **A** calcium pectate

☐ **B** chlorophyll

☐ **C** DNA

☐ **D** starch

(b) Plants contain tissues that have different functions.

(i) Name **one** tissue that gives the plant support and is also involved in the transport of water through the plant.

(1)

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(ii) Name **one** fibre that gives the plant support but is **not** involved in the transport of water through the plant.

(1)

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

Q9.

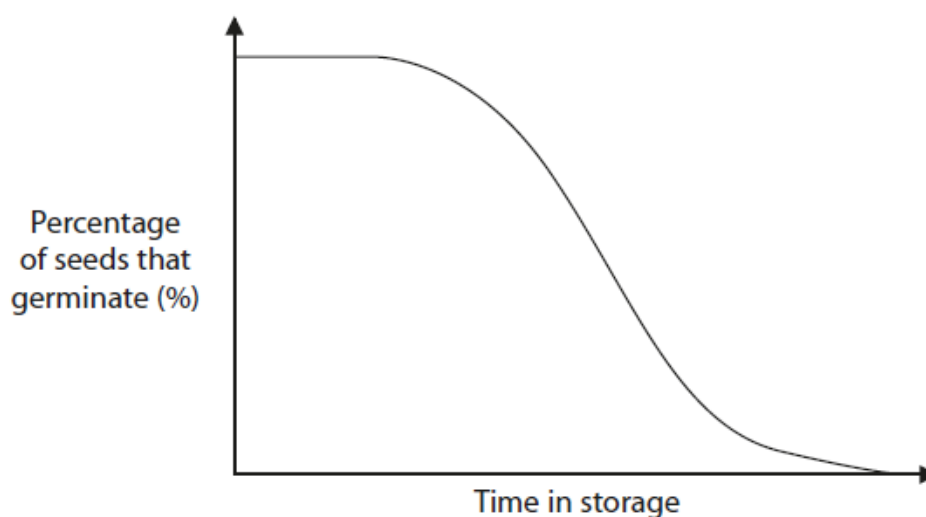
Seed banks are used to store seeds from a wide variety of plants. Some plants are a sustainable source of bioplastics.

(a) The Germplasm Bank of Wild Species is the largest seed bank for wild species of plants in Asia.

Seeds from 8 500 species have been collected and stored.

Seeds were dried before being stored at temperatures below 0 °C.

The effect of length of time in storage on seed germination is shown in the graph.



(i) Describe the effect of length of time in storage on the germination of these seeds.

(2)

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(ii) Two of the methods used in seed banks are:

- store seeds from many different plants of the same species, instead of many seeds from just one plant
- regularly germinate samples of the stored seeds, allowing them to grow into adult plants.

Explain the advantages of these methods.

(4)

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(b) The photograph shows bioplastic straws and cutlery, produced from the seeds of avocados.



© Facinadora / Alamy Stock Photo

(i) In 2018, a company in Mexico produced 130 000 kg of bioplastic cutlery and straws per month.

40% of the products were straws.

Calculate the mass of cutlery produced per year by this company.

Give your answer to **two** significant figures.

(2)

Answer .....

(ii) The use of these plant-based products is more sustainable than the use of cutlery and straws made from oil-based plastic.

Explain what is meant by the term sustainable, with reference to the cutlery produced from the seeds of avocados.

(2)

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**(Total for question = 10 marks)**

Q10.

Boards used for chopping fruit and vegetables can be made from wood or oil-based plastics.

The photograph shows some chopping boards.



(Source: © Dorling Kindersley Ltd/Alamy Stock Photo)

(a) (i) Bacteria can grow on the surfaces of chopping boards.

Explain the conditions that would result in the greatest bacterial growth on the surface of a chopping board.

(3)

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(ii) Explain why boards made from oil-based plastics are not considered sustainable.

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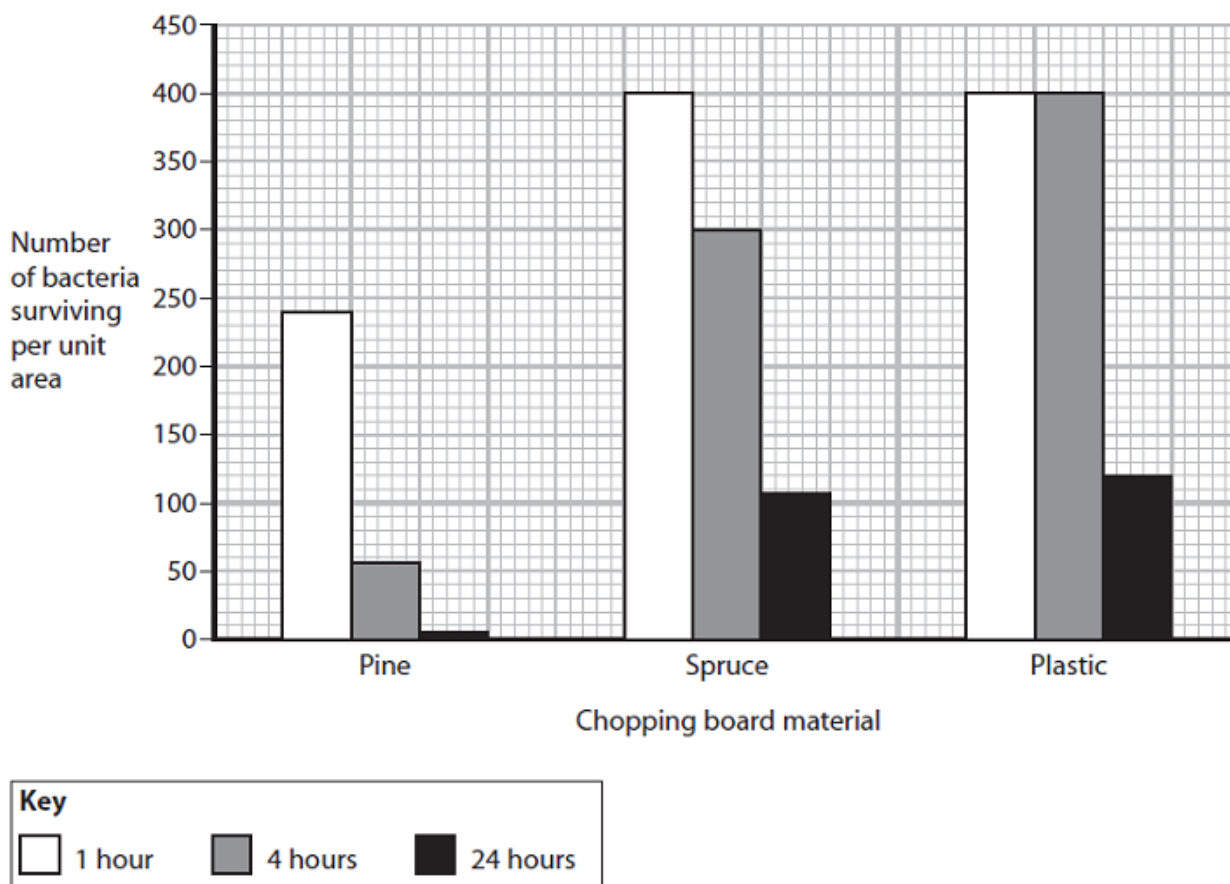
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(b) The number of bacteria surviving on boards made from different materials was investigated.

Identical bacterial cultures were placed on boards made of pine wood, spruce wood and plastic. The graph shows the number of bacteria surviving after bacteria were placed on the boards and kept in the same conditions.



(i) Comment on the results of this investigation.

(3)

(ii) Suggest **one** reason for the difference in bacterial survival on the pine chopping board and on the plastic chopping board.

(1)

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

Q11.

The photograph shows a river and mangrove trees in Bhitarkanika National Park in India.



(Source: © Mariano Gaspar/Shutterstock)

(a) (i) The biodiversity of this area of Bhitarkanika National Park could be measured by calculating species richness.

Which of the following describes species richness in Bhitarkanika National Park?

**(1)**

- ☐ **A** the number of animal species
- ☐ **B** the number of plant species
- ☐ **C** the number of organisms in each of the species
- ☐ **D** the number of species

(ii) Describe **one** other way in which the biodiversity of this area of Bhitarkanika National Park could be measured.

**(2)**

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(b) Saltwater crocodiles are found in the rivers in this area.

The numbers of this endangered species have decreased over the past 40 years.

Explain the possible causes of this decrease.

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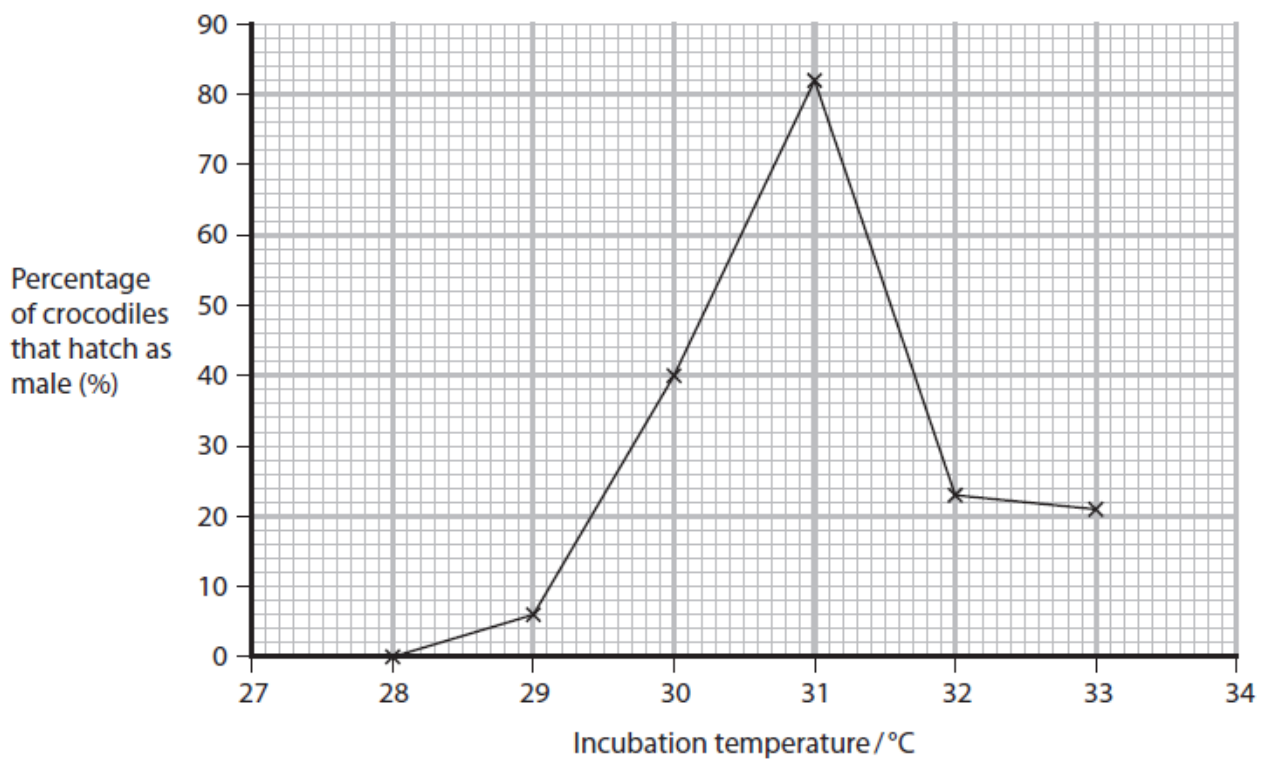
(c) Scientists are involved in conservation projects to increase the numbers of endangered saltwater crocodiles, without causing a reduction in the genetic diversity of future populations.

One project involves collecting the eggs from nests in different parts of Bhitarkanika National Park. The eggs are incubated at a suitable temperature.

The incubation temperature influences the sex of the developing crocodiles.

The crocodiles are released into the park when they have hatched.

The graph shows the effect of temperature on the percentage of crocodiles that hatch as male.



(i) Calculate the number of female crocodiles that would develop from 350 eggs incubated at 32 °C.

(2)

Answer .....

(ii) Explain how this project could increase the number of crocodiles rapidly, without reducing the genetic diversity of future populations in Bhitarkanika National Park.

Use the information in the graph to support your answer.

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**(Total for question = 14 marks)**

Q12.

The use of plant products can contribute to sustainability.

(a) Fruits from calabash plants are used to make bowls.

The photograph shows a bowl made from a Nigerian calabash fruit.



(Source: © Irene Abdou / Alamy Stock Photo)

(i) A spherical calabash fruit was cut in half to make two bowls.

Each bowl had a radius of 25 cm.

Calculate the volume of one bowl to the nearest whole number.

Use the formula: volume of a sphere =  $\frac{4}{3}\pi r^3$

(2)

Answer ..... cm<sup>3</sup>

(ii) Explain why bowls made from calabash fruits are a sustainable resource.

(2)

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(b) Fibres from the stems of the calabash plants have many uses. Some of these fibres are formed from phloem, sclerenchyma and xylem.

(i) How many of the following statements about sclerenchyma fibres are correct?

(1)

- they provide support to the plant
- they are used to translocate organic solutes
- they are used to transport water and mineral ions

- ☐ **A** none
- ☐ **B** one
- ☐ **C** two
- ☐ **D** three

(ii) Compare and contrast the structures of phloem sieve tubes and xylem vessels.

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

Q13.

The scientist Carl Woese proposed the three-domain system of classification.

The photograph shows *Haemanthus albiflos*, a flowering plant native to South Africa.



(Source: © COULANGES/Shutterstock)

(a) (i) Which of the following is the domain for this plant?

**(1)**

- ☐ **A** Archaea
- ☐ **B** Bacteria
- ☐ **C** Eukarya
- ☐ **D** Prokaryota

(ii) Describe the evidence that Carl Woese used to support his system of classification.

**(2)**

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(b) A pollen grain can germinate on the stigma of a flower.

After germination, a pollen tube grows through the style.

Explain the function of a pollen tube in the fertilisation of flowering plants.

(3)

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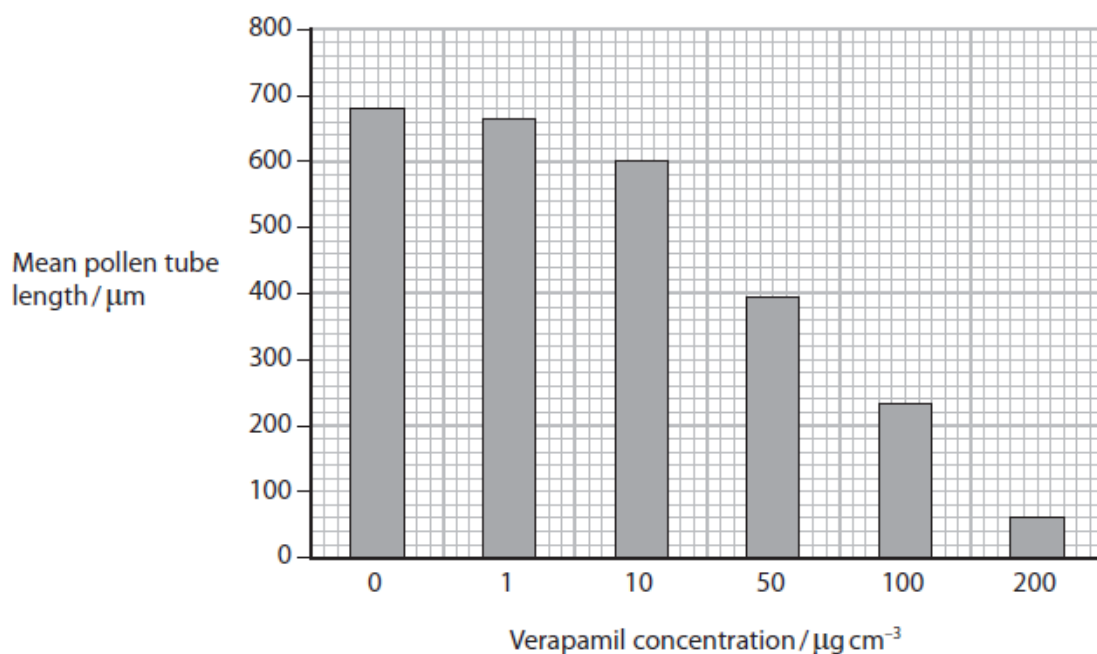
(c) Verapamil is a substance that inhibits the uptake of calcium ions by the pollen tube.

An investigation was carried out to study the effect of Verapamil on the growth of pollen tubes.

Each pollen sample was exposed to a different concentration of Verapamil solution.

The lengths of the pollen tubes in each sample were measured after one hour.

The graph shows the mean length of the pollen tubes after one hour in each concentration of Verapamil.



(i) Determine the effect of Verapamil concentration on the growth of pollen tubes.

(2)

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(ii) Explain why Verapamil can reduce the strength of cell walls.

(3)

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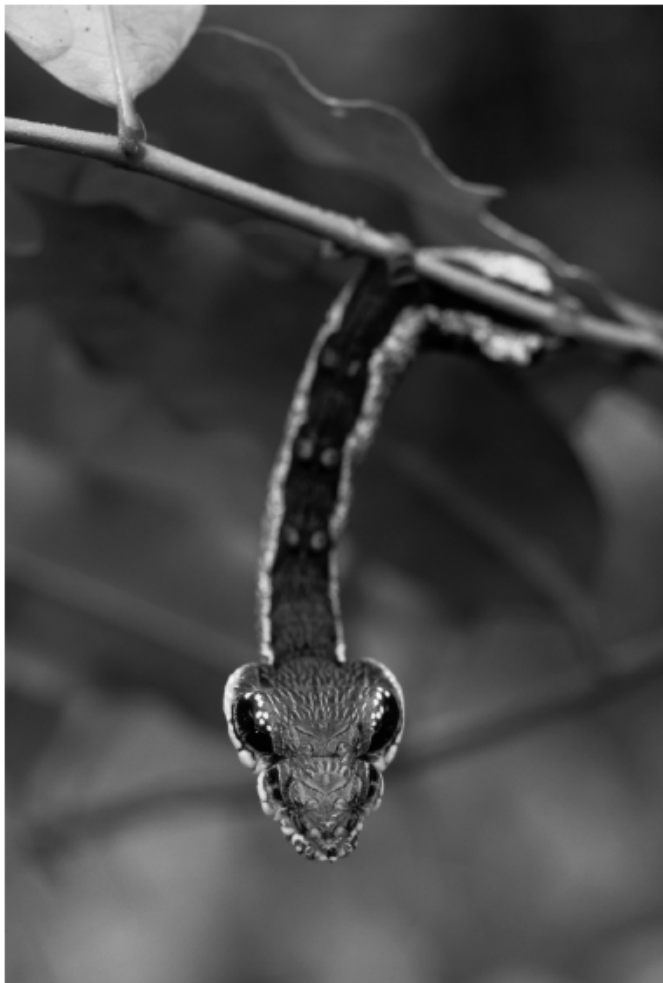
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Q14.

The photograph shows the caterpillar of a moth from Costa Rica.

The caterpillar looks like a pit viper snake. It will try to strike potential predators.



(Source: © Avalon/Photoshot License / Alamy Stock Photo)

(a) This caterpillar is adapted to its niche.

Complete the table to show the type of adaptations shown by this caterpillar.

(2)

| Feature                             | Type of adaptation |
|-------------------------------------|--------------------|
| looks like a pit viper snake        | .....              |
| tries to strike potential predators | .....              |

(b) The photograph shows an organelle that can be found in caterpillar cells, as seen using a microscope.



(Source: © Science History Images / Alamy Stock Photo)

Magnification  $\times 72\,500$

(i) State the type of microscope used to view this organelle.

(1)

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(ii) Describe the function of this organelle.

(3)

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(c) Rough endoplasmic reticulum is another organelle found in caterpillar cells.

Draw a labelled diagram of rough endoplasmic reticulum.

(3)

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

Q15.

All organisms contain one or more cells.

(a) (i) In which of the following is a cell membrane present?

(1)

- ☐ **A** animal cells only
- ☐ **B** animal and plant cells only
- ☐ **C** plant and prokaryotic cells only
- ☐ **D** animal, plant and prokaryotic cells

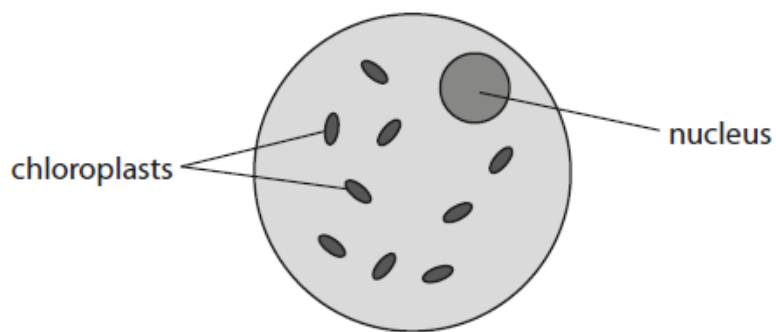
(ii) In which of the following is a cell wall present?

(1)

- ☐ **A** plant cells only
- ☐ **B** animal and plant cells only
- ☐ **C** plant and prokaryotic cells only
- ☐ **D** animal, plant and prokaryotic cells

(b) Sailor's eyeball (*Valonia ventricosa*) is a single-celled, spherical organism.

The diagram shows one of these cells.



(i) The diameter of this cell is 25  $\mu\text{m}$ .

Calculate the magnification of the diagram.

(2)

Answer .....

(ii) This cell contains chloroplasts.

State the function of these chloroplasts.

(1)

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(iii) This cell is not a prokaryotic cell as it contains chloroplasts.

Give **one** other reason why this organism is not a prokaryotic cell.

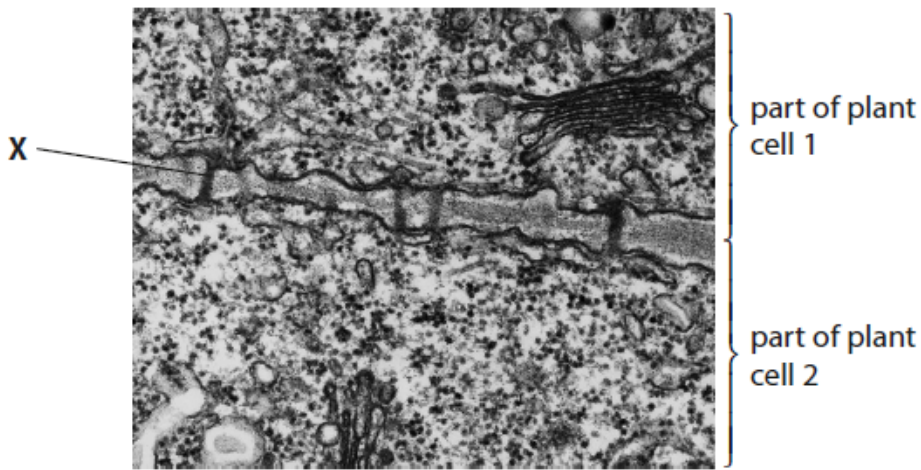
(1)

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(c) The photograph shows part of two adjoining plant cells, as seen using an electron microscope.



(Source: © biophoto associates/Getty Images)

(i) Name the part labelled **X**.

(1)

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(ii) Explain the function of the part labelled **X**.

(2)

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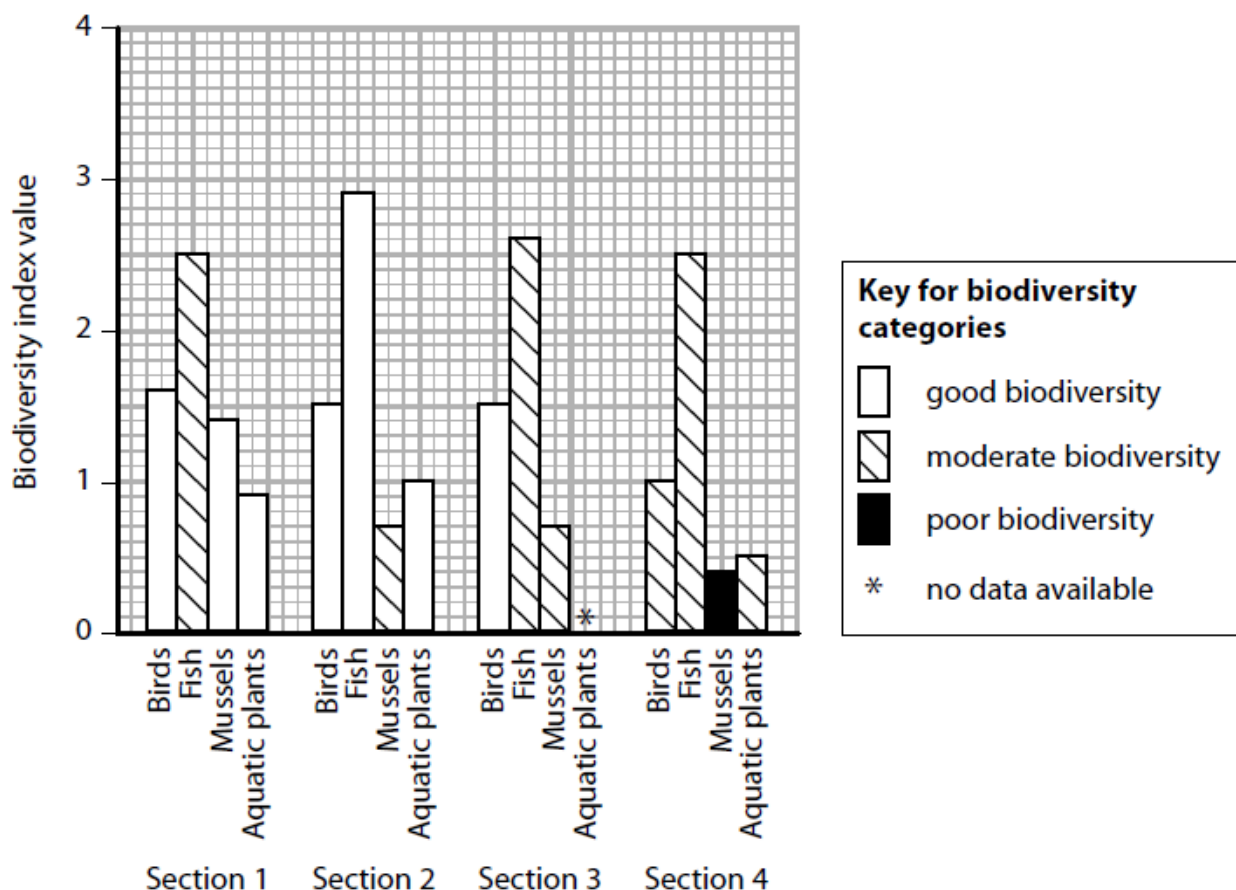
**(Total for question = 9 marks)**

Q16.

The biodiversity of four groups of organisms – birds, fish, mussels and aquatic plants – was studied along four sections of the Rideau River in Canada.

A biodiversity index value was calculated for each group of organisms.

The graph shows the results of this study.



The biodiversity index value can be used to compare biodiversity within one group of organisms.

The biodiversity categories (good, moderate and poor) can be used to compare biodiversity between different groups of organisms.

(a) Which statement describes biodiversity?

(1)

- ☐ **A** species richness of only the endemic species within a habitat
- ☐ **B** species richness of all the species within a habitat
- ☐ **C** the role of only the endemic species within a habitat
- ☐ **D** the role of all the species within a habitat

\*(b) Describe the changes in biodiversity along the Rideau River. Use the information in the graph to support your answer.

(6)

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(c) In Section 1, birds have a biodiversity index value of 1.6 and fish have a biodiversity index value of 2.5.

Suggest why the fish are considered to have a moderate biodiversity and the birds have a good biodiversity, but the biodiversity index value of the fish is greater.

(2)

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(d) No data were available for aquatic plants in Section 3.

A student collected some data in Section 3 to calculate a biodiversity index value.

The equation that the student used is:

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

The data are shown in a table prepared by the student.

| Species of aquatic plant | Number of aquatic plants counted | (n – 1) | n(n – 1) |
|--------------------------|----------------------------------|---------|----------|
| Coontail                 | 8                                |         |          |
| Tape grass               | 6                                |         |          |
| Common waterweed         | 3                                |         |          |
| Northern water milfoil   | 2                                |         |          |
| Star duckweed            | 9                                |         |          |
| White water lily         | 2                                |         |          |
| Water stargrass          | 2                                |         |          |
| Eurasian water milfoil   | 6                                |         |          |
| Curly pondweed           | 5                                |         |          |
| European frogbit         | 2                                |         |          |
| Flowering rush           | 3                                |         |          |

(i) Complete the table.

(1)

(ii) Calculate the biodiversity index value for the aquatic plants in Section 3 of this river.

(3)

Answer .....

**(Total for question = 13 marks)**

Q17.

Stomach ulcers are sores that develop in the lining of the stomach.

The mucus produced by the stomach prevents bacteria from reaching the lining of the stomach.

Stomach ulcers can be caused by infection with the bacterium *Helicobacter pylori*.

These bacteria reproduce in the stomach as it provides all the conditions required for the growth of bacteria.

(a) Explain the conditions needed for the growth of bacteria.

(4)

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(b) The plant *Cibotium barometz* is native to several countries in East Asia.

The photograph shows hairs on the surface of this plant.



(Source: © Mauro Rodrigues/123RF)

Extracts from the hairs on this plant have antimicrobial properties.

An investigation compared the use of this extract and the drug omeprazole to treat stomach ulcers in rats.

The mass of mucus and the area of ulcer were measured in five groups of rats.

The table shows the treatments and the results of this investigation.

| Group                                   | Treatment / mg kg <sup>-1</sup> | Mean mass of mucus / g | Mean area of ulcer / mm <sup>2</sup> |
|-----------------------------------------|---------------------------------|------------------------|--------------------------------------|
| Control rats with no ulcer              | 0.00                            | 2.28                   | 0.00                                 |
| Control rats with ulcer                 | 0.00                            | 0.75                   | 802.71                               |
| Rats with ulcer treated with omeprazole | 20.00                           | 1.92                   | 95.71                                |
| Rats with ulcer treated with extract    | 125.00                          | 1.87                   | 202.80                               |
| Rats with ulcer treated with extract    | 500.00                          | 2.17                   | 172.80                               |

(Source: adapted from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5244617/>)

(i) Calculate the percentage decrease in the mean areas of ulcer of the rats treated with omeprazole compared with the control rats with ulcer.

(2)

Answer ..... %

\*(ii) Explain the results of this investigation.

Use all the information in Question 6 to support your answer.

(6)

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

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 ☐ .**

A coral reef is an underwater ecosystem.

The photograph shows a coral reef in the Caribbean.



(Source: © Belize / Alamy Stock Photo)

A photosynthetic bacterium found on these coral reefs produces a chemical called curacin A.

This chemical has been found to be effective against some colon and kidney cancers.

(a) Large quantities of this organism need to be grown in a culture medium in order to extract enough curacin A.

The culture is kept at the optimum temperature for the growth of this bacterium.

Suggest **two** other conditions that would be needed for maximum growth of this bacterium.

1 .....

2 .....

(b) Scientists conduct experiments to determine the effectiveness and safety of new drugs.

(i) Which of the following scientists tested the effectiveness of digitalis soup?

(1)

☐ **A** Adolf Fick

☐ **B** Matthew Meselson and Franklin Stahl

☐ **C** Godfrey Hardy and Wilhelm Weinberg

☐ **D** William Withering

(ii) Curacin A is being developed as a drug to treat some colon and kidney cancers in humans.

Suggest how a suitable dose for cancer treatment would be determined in human trials.

(2)

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(iii) Describe how a double-blind clinical trial would be performed with this cancer drug.

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(Total for question = 9 marks)

Q19.

The five stages of cancer are used to describe the size and spread of a cancer in a human body.

(a) The mitotic index of a tissue can be used to determine the stage of cancer.

A higher mitotic index is usually linked to a later stage of cancer.

The mitotic index is calculated using the formula

$$\text{Mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}} \times 100$$

Tests were performed on three patients, P, Q and R, who had cancer.

The table shows the number of cells that were counted in each stage of the cell cycle per mm<sup>2</sup> of tissue, taken from the same organ in each patient.

| Patient | Interphase | Prophase | Metaphase | Anaphase | Telophase |
|---------|------------|----------|-----------|----------|-----------|
| P       | 16         | 1        | 3         | 0        | 0         |
| Q       | 14         | 2        | 1         | 1        | 2         |
| R       | 11         | 2        | 2         | 3        | 2         |

(i) State what is meant by the term **tissue**.

(1)

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(ii) Using the data in the table, determine the stages of cancer in patients P and R.

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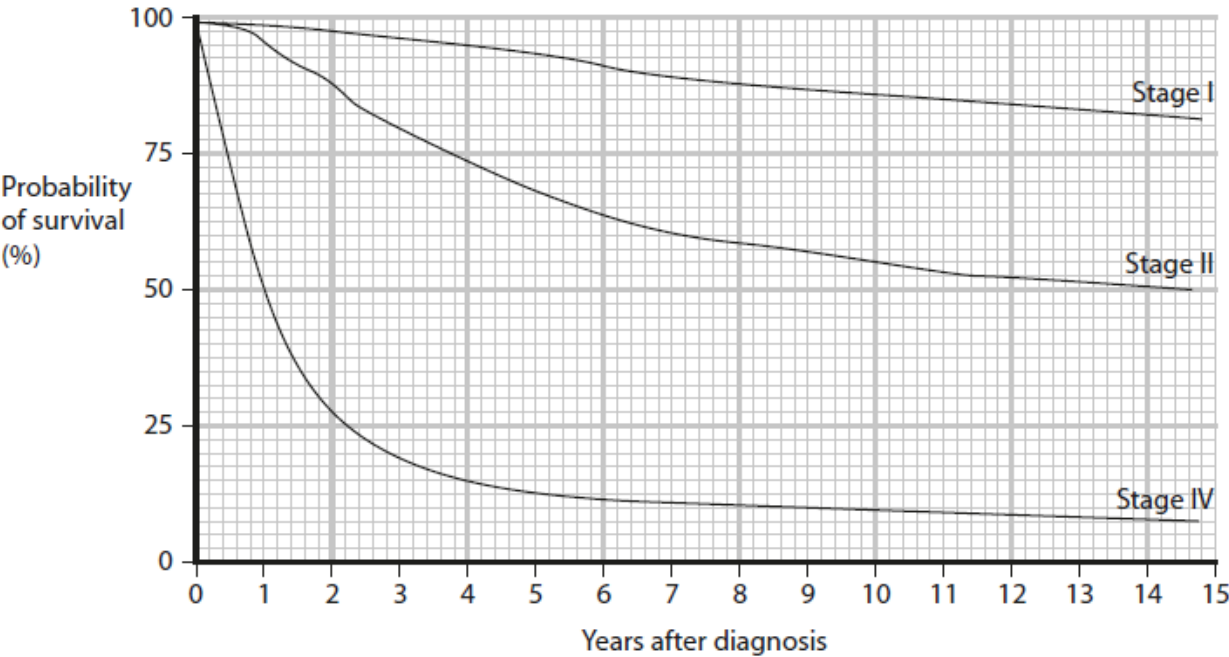
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(b) The graph shows the probability of survival for different stages of a cancer, after diagnosis.



(Source: [http://www.mmmp.org/MMMP/import.mmmp?page=tnm\\_staging.mmmp](http://www.mmmp.org/MMMP/import.mmmp?page=tnm_staging.mmmp))

Compare and contrast the probabilities of survival for the different stages of this cancer, as shown by the graph.

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(c) Anticancer drugs have to undergo double-blind trials before they are used to treat patients.  
Describe how a placebo is used in a double-blind trial.

(2)

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

Q20.

The photograph shows a Baird's tapir.



Source: <https://www.biolib.cz/IMG/GAL/171566.jpg>

(a) Baird's tapir is endemic to countries in Central America.

State what is meant by the term **endemic**.

(1)

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(b) Baird's tapir is classified as endangered.

In 2006, it was estimated that there were 5500 Baird's tapirs. This number had fallen to 3000 in 2016.

(i) Calculate the percentage decrease in the number of Baird's tapirs from 2006 to 2016.

(2)

Answer ..... %

(ii) Explain how human activity, other than hunting, could have caused this decrease in the number of Baird's tapirs.

(3)

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(c) Preservation of sperm collected from Baird's tapir may help captive breeding programmes.

Scientists investigated the effect of freezing on sperm from Baird's tapir.

The sperm were frozen and then thawed.

The results of this investigation are shown in the table.

| Sperm                  | Percentage of sperm capable of moving (%) | Ability of sperm to swim in a straight line / a.u. | Percentage of sperm with an undamaged acrosome (%) |
|------------------------|-------------------------------------------|----------------------------------------------------|----------------------------------------------------|
| Freshly collected      | 63                                        | 3.5                                                | 80                                                 |
| Frozen and then thawed | 38                                        | 2.5                                                | 48                                                 |

(i) Describe how each of these effects of freezing could be determined.

(3)

(ii) Explain how freezing sperm could affect the success of captive breeding programmes.

(4)

(Total for question = 13 marks)

Q21.

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 Ulin tree (*Eusideroxylon zwageri*), is native to Brunei, Indonesia and the Philippines.

The photograph shows an Ulin tree.



(Source: © Pacific Imagica / Alamy Stock Photo)

(a) This species of tree is endangered and the export of wood from these trees is forbidden from some countries.

Suggest **three** reasons why this species of tree is endangered.

(3)

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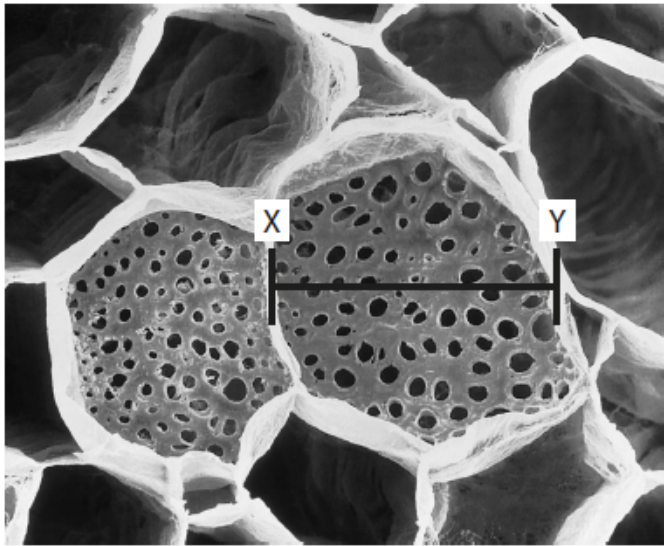
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(b) Trees, and other plants, contain phloem vessels and sclerenchyma fibres.

The photograph shows sieve plates in the phloem of a plant.



(Source: © Science Photo Library / Alamy Stock Photo)

magnification  $\times 200$

(i) Calculate the width of the phloem vessel along the line XY in micrometres.

Give your answer in standard form.

(3)

Answer .....  $\mu\text{m}$

(ii) Describe the role of phloem.

(2)

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(iii) How many of the following statements about mature sclerenchyma fibres are correct?

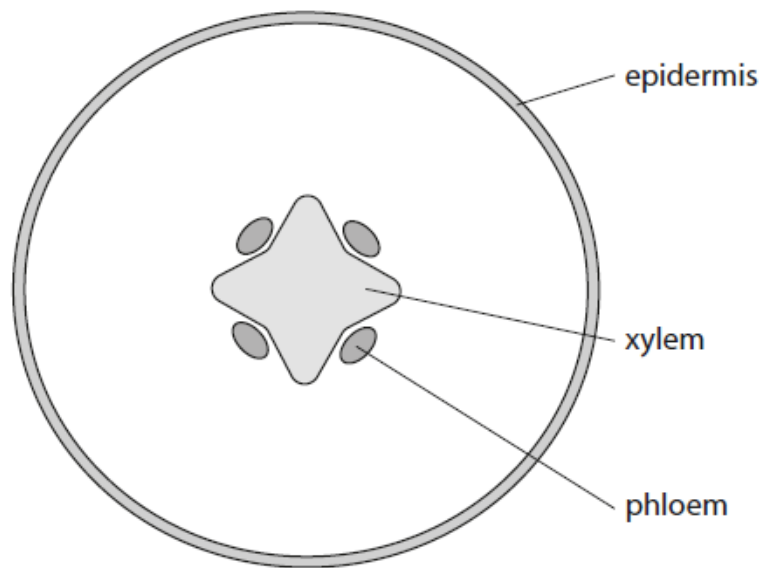
- they contain cellulose microfibrils

- they contain pits
- they contain cytoplasm

(1)

- ☐ **A** none
- ☐ **B** one
- ☐ **C** two
- ☐ **D** three

(c) The roots of plants contain phloem and xylem vessels, as shown in the diagram.



Give **three** differences between the distribution of phloem and xylem in the root compared with their distribution in the stem.

(3)

- 1 .....
- .....
- .....
- 2 .....
- .....
- .....
- 3 .....
- .....
- .....

Q22.

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 Hood Island giant tortoise (*Chelonoidis hoodensis*) is only found on one of the Galapagos Islands.

The photograph shows two Hood Island giant tortoises fighting over territory.



(Source: © Minden Pictures / Alamy Stock Photo)

(a) Which of the following is a term that would be used to describe the fact that this species of giant tortoise is found only on the Galapagos Islands?

(1)

- ☒ **A** diversity
- ☒ **B** endemic
- ☐ **C** isolation
- ☐ **D** linkage

(b) The Hood Island giant tortoise has adaptations to its environment.

Two features are:

- long neck
- shell that arches above the neck.

When there is a dispute over territory, the tortoises use these features to make themselves look as large as possible.

(i) Complete the table to show the type of adaptations shown by this tortoise.

(3)

| Feature                                     | Type of adaptation |
|---------------------------------------------|--------------------|
| long neck                                   |                    |
| shell that arches above neck                |                    |
| making themselves look as large as possible |                    |

(ii) Suggest one selection pressure that results in the development of one of these features.

(1)

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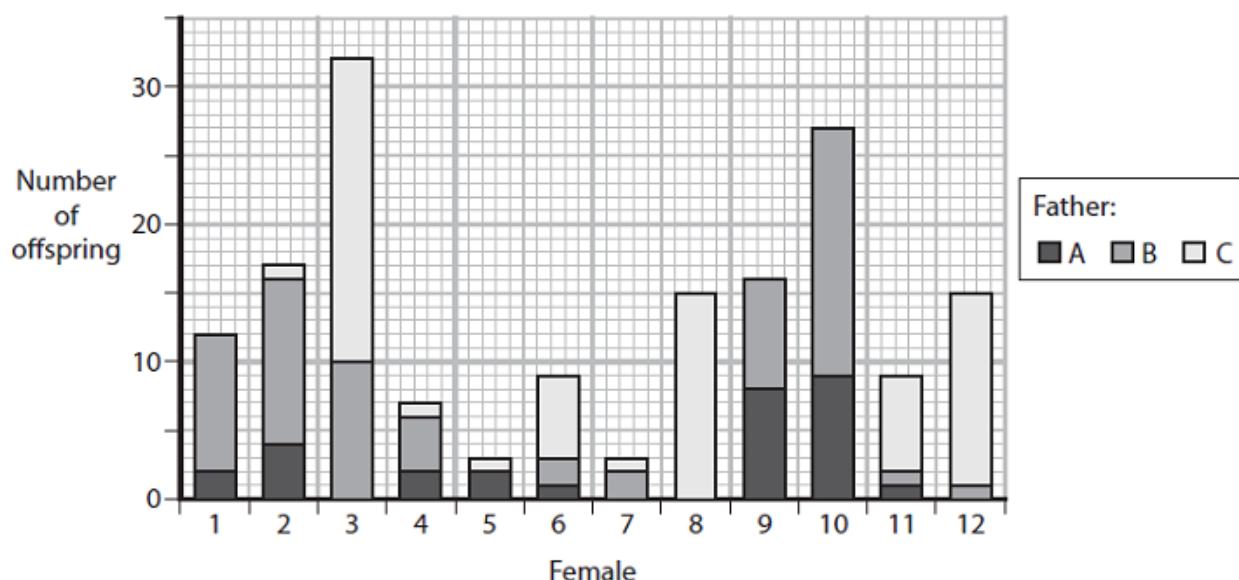
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(c) In 1963, there were only three males and 12 females of *C. hoodensis* left in the wild.

These 15 tortoises were used in a breeding programme.

The diagram shows the number of offspring from each female tortoise and the fathers of these offspring.



(i) Calculate the percentage of female 10's offspring that were fathered by male B.

(1)

Answer ..... %

(ii) The wild population of *C. hoodensis* is now 1800 individuals.

Calculate the percentage increase in the wild population of *C. hoodensis* tortoises.

Give your answer to **one** decimal place.

(2)

Answer ..... %

(iii) A zoo tested its captive-bred giant tortoise and determined that it was a *C. hoodensis* tortoise.

Explain how the zoo determined that its giant tortoise was a *C. hoodensis* tortoise.

(3)

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(d) Scientists thought that a recessive allele was changing in frequency in the tortoise population.

Explain how the change in frequency of this allele could be determined.

(2)

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**(Total for question = 13 marks)**

Q23.

The photograph shows a Madagascan pygmy kingfisher (*Ceyx madagascariensis*).



(Source: © Nature Picture Library/Alamy Stock Photo)

This kingfisher is endemic to forests in Madagascar.

The diet of this kingfisher is mainly frogs and insects.

(a) (i) State what is meant by the term **endemic** with reference to this kingfisher.

(1)

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(ii) State the domain in which this kingfisher is classified.

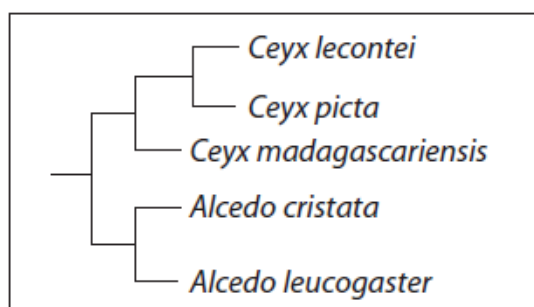
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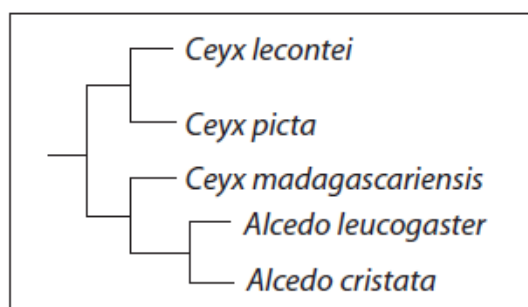
(b) A scientist recently collected new data about the classification of kingfishers, using molecular evidence.

The data were used to propose the reclassification of some kingfishers, including *Ceyx madagascariensis*.

The diagrams show an old classification and the proposed reclassification of five species of kingfishers.



Old classification



Proposed reclassification

(i) Using the proposed reclassification, explain which species of kingfisher are most closely related to *Ceyx madagascariensis*.

(2)

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(ii) Explain how molecular evidence led to the reclassification of species and how the scientific community would have reviewed the evidence before it was accepted.

Use the information in the photograph and the diagrams to support your answer.

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**(Total for question = 10 marks)**

Q24.

The photograph shows a strawberry poison dart frog.



(Source: © Dirk Ercken. Shutterstock (PAL))

The strawberry poison dart frog is found in parts of Nicaragua, Costa Rica and Panama only. This frog has several features that are adaptations to its environment.

Three of these features are:

- bright red skin with black spots
- production of a powerful poison that can cause paralysis
- adhesive discs at the end of each toe.

(a) Which of the following is a term used to describe the fact that this frog is found only in these countries?

(1)

- ☐ **A** diversity
- ☐ **B** endemic
- ☐ **C** polygenic
- ☐ **D** specific

(b) Complete the table to show the type of adaptations shown by this frog.

(3)

| Feature                          | Type of adaptation |
|----------------------------------|--------------------|
| bright red skin with black spots |                    |
| production of poison             |                    |
| adhesive discs on toes           |                    |

(c) Suggest the advantages for the frog of these features.

(2)

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(d) Suggest how natural selection could have given rise to frogs that can produce poison

[illegible]

**(Total for question = 10 marks)**

Q25.

All living organisms are made of cells.

Eukaryotic cells and prokaryotic cells have some features in common and some differences.

(a) (i) Which cells have a cell wall?

(1)

- ☐ **A** plant cells only
- ☐ **B** animal cells and prokaryotic cells
- ☐ **C** plant cells and prokaryotic cells
- ☐ **D** animal cells, plant cells and prokaryotic cells

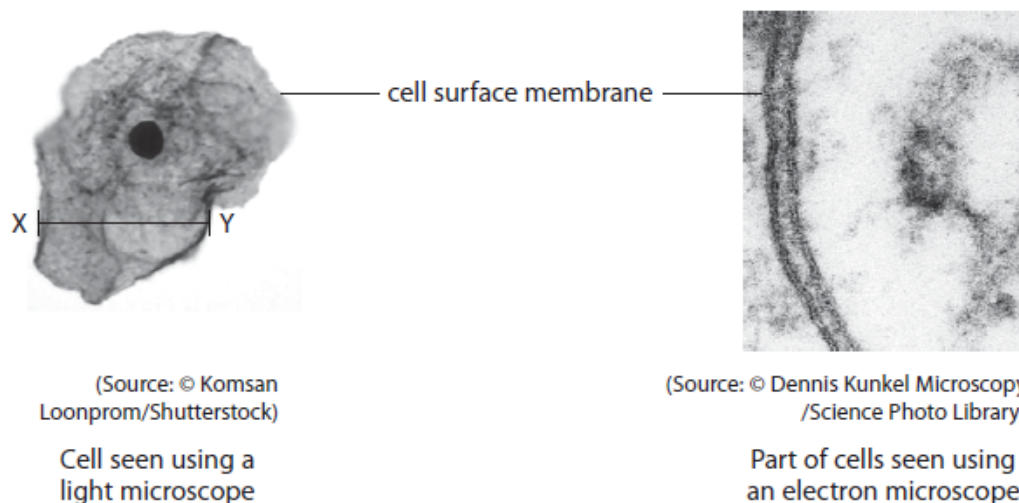
(ii) Eukaryotic cells contain a nucleus.

Draw a labelled diagram of a nucleus, as seen using an electron microscope.

(4)

(b) The photographs show a cell as seen using a light microscope and part of two cells using an electron microscope.

The bilayer structure of the cell surface membrane can be seen only with an electron microscope.



(i) Explain why the bilayer structure of the cell surface membrane could not be seen using a light microscope.

(2)

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(ii) The light microscope magnified the cell 200 times.

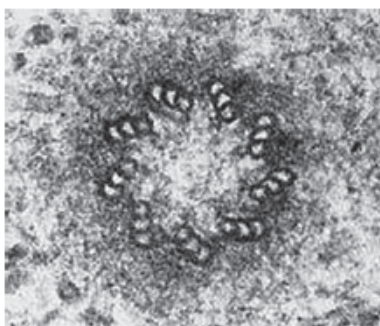
Calculate the actual width of this cell by measuring the line XY.

Give your answer in  $\mu\text{m}$ .

(3)

Answer .....  $\mu\text{m}$

(iii) The photograph shows an organelle that can be found in a eukaryotic cell, as seen using an electron microscope.



Describe the function of this organelle.

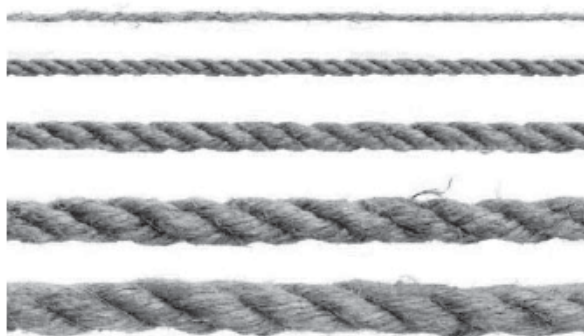
(2)

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

Some plant fibres have a high tensile strength.

The photograph shows ropes made using fibres from the stems and leaves of hemp plants.



Sclerenchyma fibres and xylem vessels are found in plant fibres.

(a) Both sclerenchyma fibres and xylem vessels contain lignin.

(i) How many of the following statements are correct?

- Lignin adds strength to the cell membranes.
- Lignin gives waterproofing properties.
- Lignin can form spiral shapes.

(1)

- ☐ **A** none
- ☐ **B** one
- ☐ **C** two
- ☐ **D** three

(ii) Give **one** similarity, other than the presence of lignin, and **one** difference in the structures of sclerenchyma fibres and xylem vessels.

(2)

Similarity

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Difference

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(b) Scientists have suggested that plant-based plastics should be used instead of oil-based plastics.

Hemp has been used to make some of these plant-based plastics.

Explain why hemp fibres are a sustainable resource.

(2)

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(c) Biofuels, produced from crop plants, are a sustainable resource.

Biofuels include bioethanol and biodiesel.

Bioethanol is produced from hemp and from sugar beet. Biodiesel is produced from rapeseed oil and from soybean oil.

(i) The table shows information about the global production of bioethanol.

| Year | Global production of bioethanol $\times 10^6 \text{ dm}^3$ |
|------|------------------------------------------------------------|
| 2000 | 17 000                                                     |
| 2011 | 84 600                                                     |

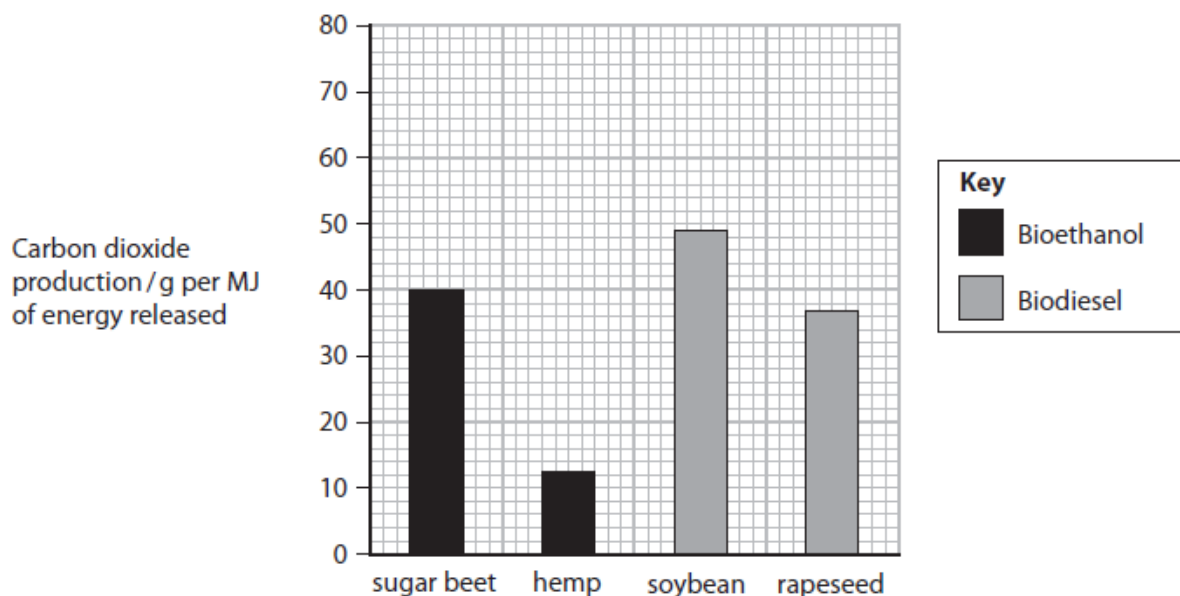
Determine what the global bioethanol production will be in 2020.

Assume the mean rate of increase stays constant.

(3)

Answer .....

\* (ii) The use of biofuels produces carbon dioxide. The graph shows the production of carbon dioxide using biofuels from four crop plants.



The table gives information about the level of water, fertilisers and pesticides needed for crop plants to grow.

| Crop plant | Level of resources used in production of biofuels |               |            |
|------------|---------------------------------------------------|---------------|------------|
|            | Water                                             | Fertilisers   | Pesticides |
| Hemp       | Medium to low                                     | Low           | Low        |
| Rapeseed   | High                                              | Medium        | Medium     |
| Soybean    | High                                              | Low to medium | Medium     |
| Sugar beet | Medium to low                                     | High          | Medium     |

Explain the advantages and disadvantages of using these crop plants as a sustainable resource to produce biofuels.

Use the information in the question to support your answer.

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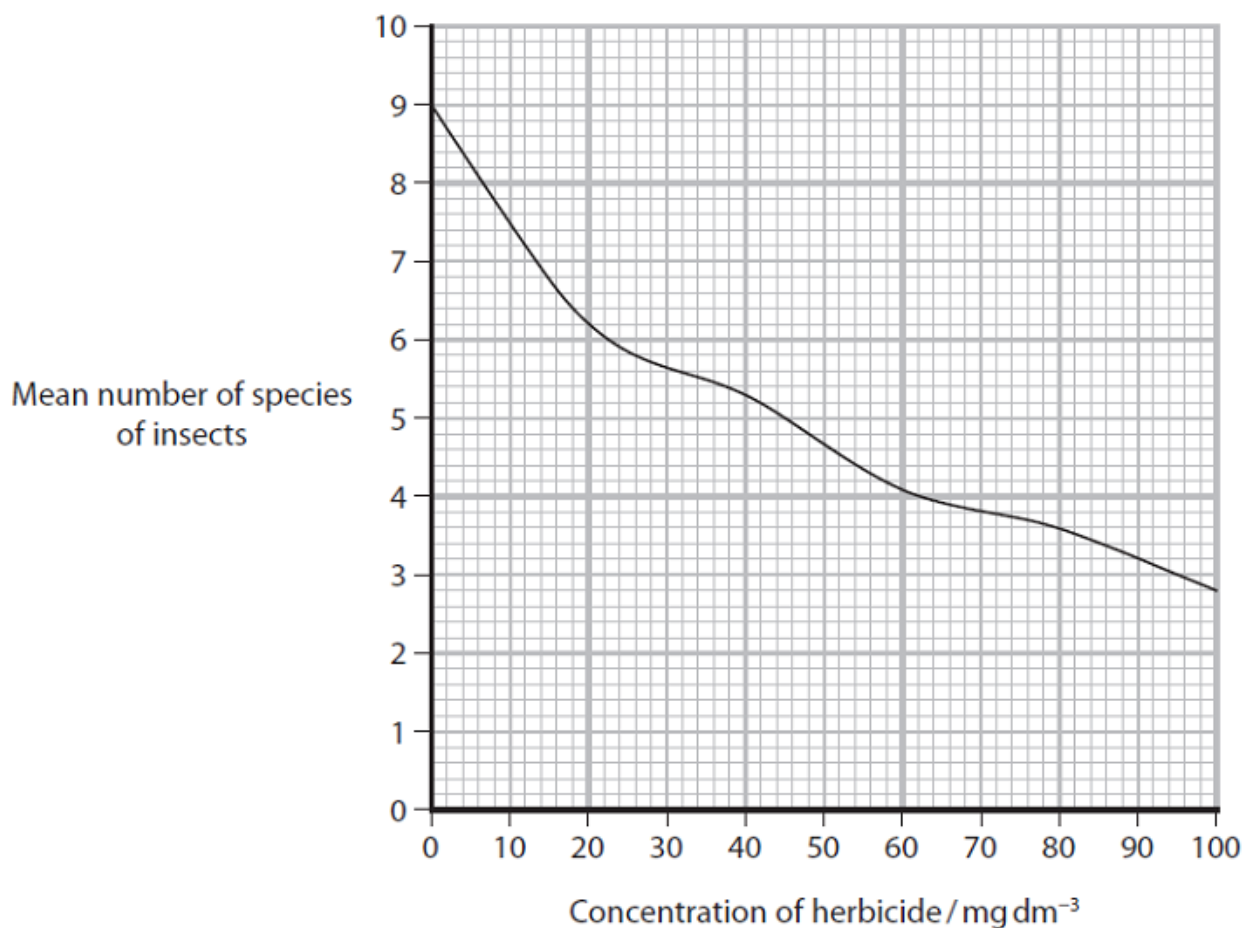
Q27.

Farmers sometimes spray herbicides on their fields. Herbicides kill plants that the farmer does not want to grow.

The effect of the concentration of herbicide on the number of species of insects in three fields was investigated.

The mean number of species for the three fields was calculated.

The graph shows the results of this investigation.



(a) State what is meant by the term species.

(1)

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(b) Explain the relationship between the concentration of herbicide and the mean number of species of insects in the three fields.

Use the information in the graph to support your answer.

(4)

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

Q28.

Elk are one of the largest species of deer. The photograph shows three elk grazing in Yellowstone National Park.

They prefer to feed on young tree shoots, such as aspen and cottonwoods, rather than grass.



(Source: ©Westend61 GmbH/Alamy Stock Photo)

(a) Wolves were introduced into Yellowstone National Park in 1995.

Wolves are predators of elk.

Before the introduction of wolves, elk grazed undisturbed, eating all the young tree shoots in the forest and riverside habitats.

The table shows how the percentage of young shoots eaten by the elk changed after the introduction of wolves.

| Year | Percentage of young tree shoots eaten by elk (%) |                   |
|------|--------------------------------------------------|-------------------|
|      | Forest habitat                                   | Riverside habitat |
| 1996 | 100                                              | 100               |
| 1998 | 100                                              | 100               |
| 2000 | 100                                              | 92                |
| 2002 | 90                                               | 81                |
| 2004 | 86                                               | 45                |
| 2006 | 63                                               | 11                |
| 2010 | 19                                               | 2                 |

Explain why the percentage of young tree shoots eaten by the elk changed after the introduction of wolves.

(3)

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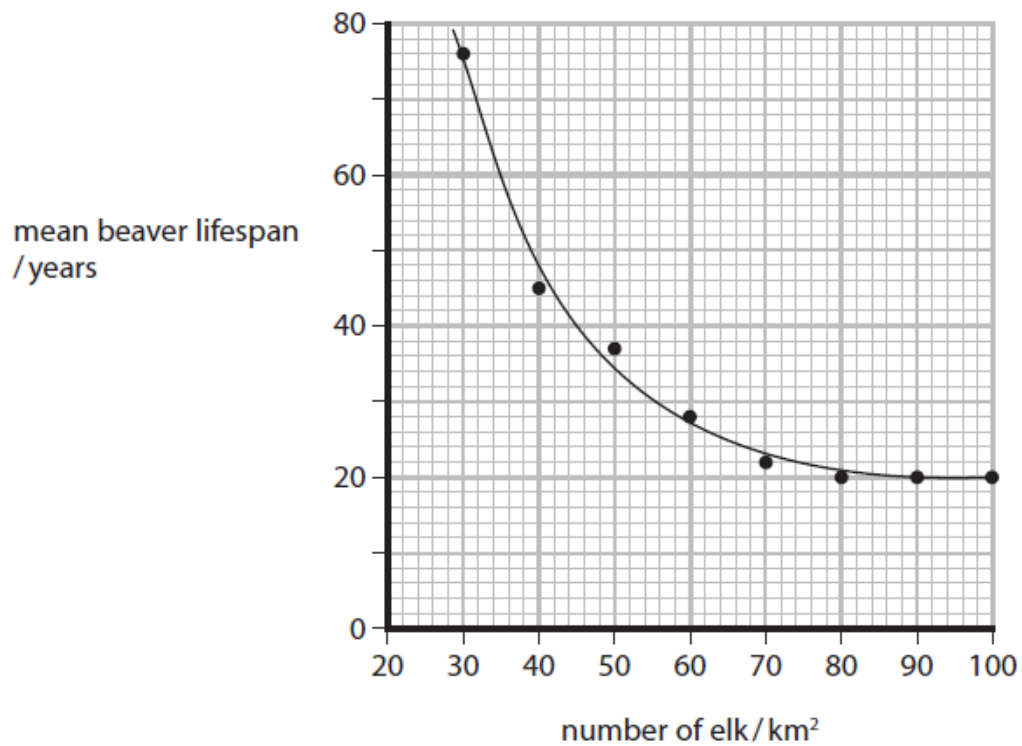
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(b) The photograph shows a beaver.



(Source: © Ian MacNicol/Getty Images)

The graph shows the mean beaver lifespan in areas with different numbers of elk per km<sup>2</sup>.



Describe the relationship shown in the graph.

(3)

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(c) Scientists investigated the effect of the introduction of wolves on the biodiversity of Yellowstone National Park.

(i) Suggest what information the scientists would need to collect in order to calculate species richness in a habitat in Yellowstone National Park.

(2)

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(ii) Write a formula that could be used to determine the biodiversity of a habitat in Yellowstone National Park.

(1)

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\* (d) Beavers and elk eat the shoots of young trees.

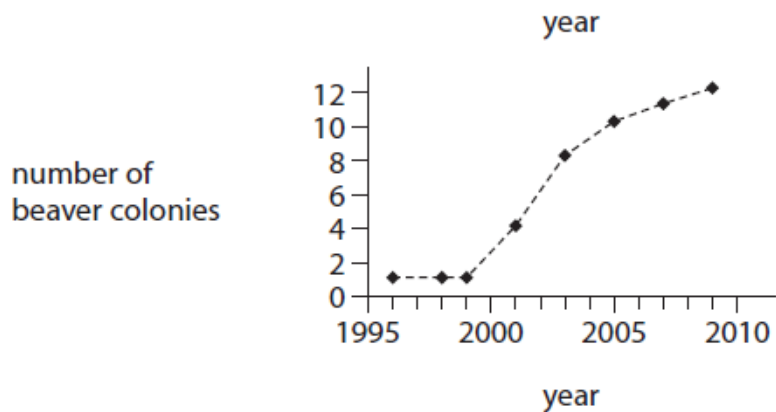
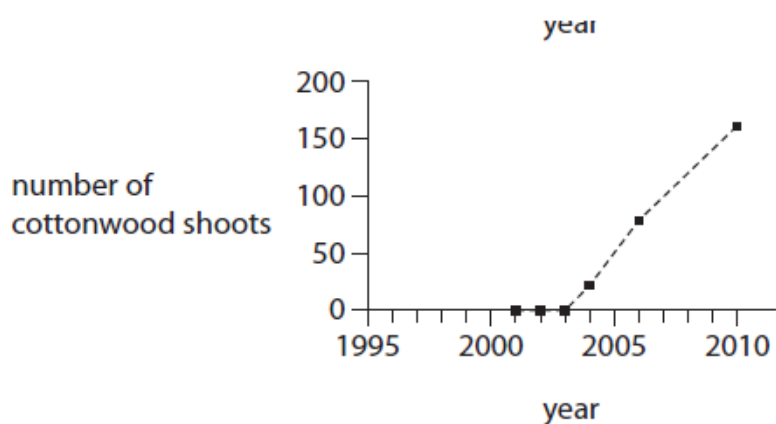
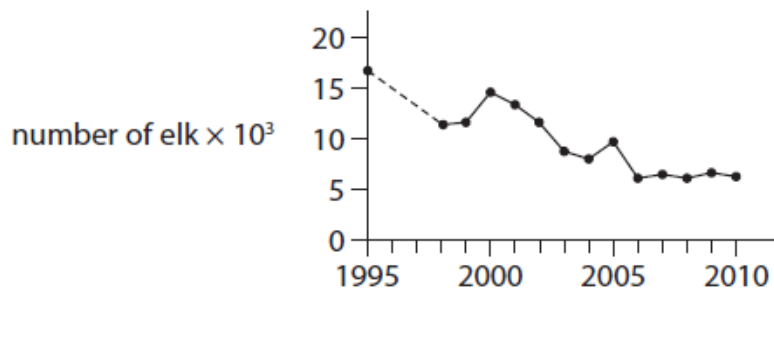
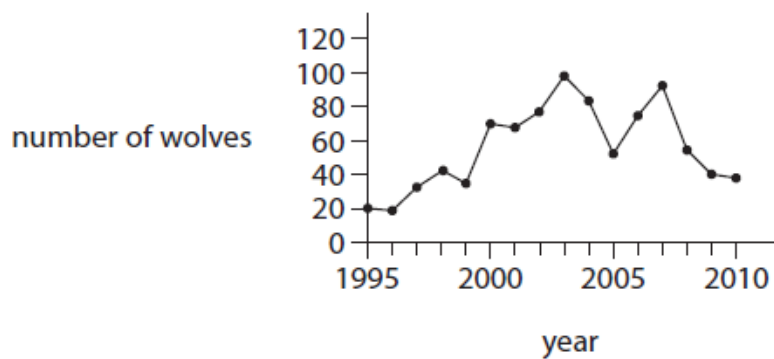
Beavers use older trees to build dams in the rivers, which create new habitats, such as ponds.

Beavers live in colonies of up to 8 individuals.

After the introduction of the wolves, scientists recorded the number of wolves, elk and beaver colonies for 15 years.

They also recorded the number of young cottonwood shoots that were taller than 5 cm.

The graphs show the data collected by these scientists.



Discuss the effect of the introduction of wolves on the biodiversity of Yellowstone National Park.  
Use all the information in the question to support your answer.

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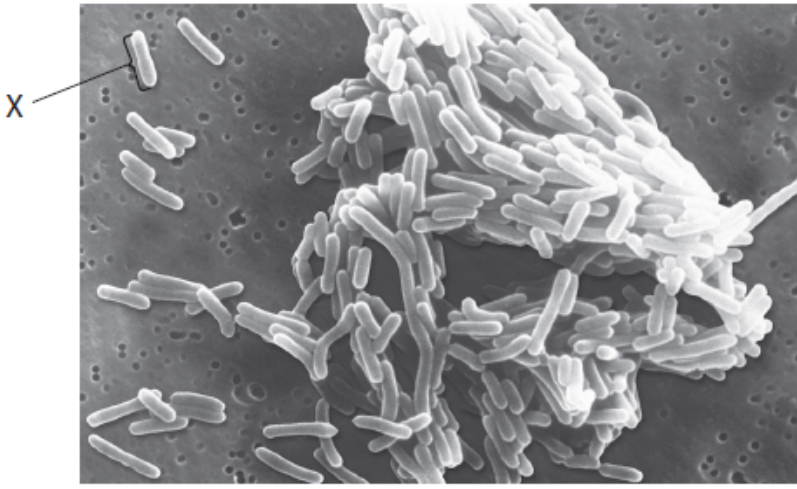
**(Total for question = 15 marks)**

Q29.

**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 ☐.**

*Listeria monocytogenes* is a bacterium that contaminates food and causes the disease listeriosis.

The photograph shows a colony of these bacteria, as seen using an electron microscope.



(Source: © BSIP SA / Alamy Stock Photo)

(a) The bacterium labelled X on the photograph is  $0.5\text{ }\mu\text{m}$  in length.

(i) Calculate the magnification of this image.

(1)

Answer .....

(ii) State why a light microscope cannot be used to view these bacteria.

(1)

.....

.....

.....

(b) The photograph shows a bottle of oil extracted from the plant oregano. This plant is native to Mediterranean and western Asian countries.



(Source: © Frank Hecker / Alamy Stock Photo)

Oregano oil contains antimicrobial substances.

This oil can be used in the production of plastic used to package food.

Explain why this packaging may be chosen over traditional oil-based plastic packaging.

(2)

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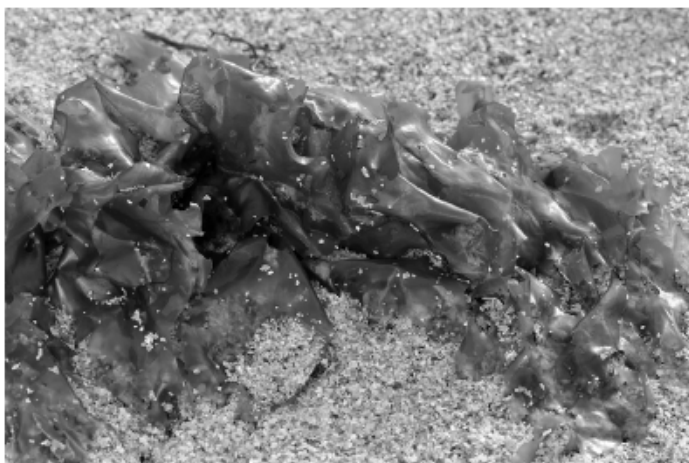
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(c) The photograph shows green algae called sea lettuce (*Ulva lactuca*).



(Source: © Arterra Picture Library / Alamy Stock Photo)

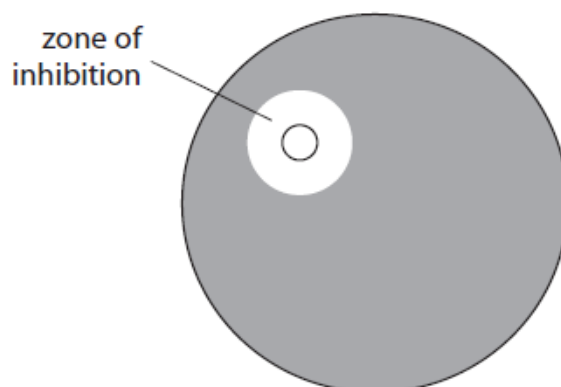
Sea lettuce contains chemicals called fucoxanthins that have antimicrobial properties.

The antimicrobial properties of these chemicals were investigated.

Discs containing fucoxanthin chemical were placed onto four agar plates each seeded with a different type of bacteria.

These plates were then incubated for 24 hours at 25 °C and the zone of inhibition measured.

The diagram shows the zone of inhibition.



The table shows the results of this investigation.

| Type of bacteria        | Mean diameter of the zone of inhibition / mm | Range / mm |
|-------------------------|----------------------------------------------|------------|
| <i>E. coli</i>          | 10.2                                         | $\pm 0.72$ |
| <i>S. aureus</i>        | 11.1                                         | $\pm 0.63$ |
| <i>L. monocytogenes</i> | 6.0                                          | $\pm 0.41$ |
| <i>P. aeruginosa</i>    | 7.5                                          | $\pm 0.55$ |

(i) Which type of bacteria was least affected by fucoxanthin?

(1)

- ☐ **A** *E. coli*
- ☐ **B** *S. aureus*
- ☐

**C** *L. monocytogenes*

☒ **D** *P. aeruginosa*

(ii) The table shows the mean and the range of the diameter of the zone of inhibition for each type of bacteria.

Calculate the maximum difference in the diameter of the largest and smallest zones of inhibition.

**(1)**

Answer ..... mm

(d) Drugs containing these chemicals must be tested for safety before they can be approved and used to treat humans.

Three-phase testing can be used to check for the safety and effectiveness of these chemicals.

Describe the roles of phase I and phase II.

**(3)**

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

Q30.

**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 ☒ .**

Brazil is the largest producer of sugarcane.

The photograph shows sugarcane plants growing in Brazil.



(Source: © jeep2499/Shutterstock)

(a) Products from sugarcane, such as starch and cellulose, are used to make bioplastic.

(i) How many of the following statements about **starch** are correct?

- contains  $\alpha$ -glucose and  $\beta$ -glucose molecules
- contains amylose and amylopectin
- stored in the tonoplast

(1)

☐ **A** none

☐ **B** one

☐ **C** two

☐ **D** three

(ii) How many of the following statements about a **cellulose** molecule are correct?

- contains  $\alpha$ -glucose and  $\beta$ -glucose molecules
- contains 1,4 glycosidic bonds
- forms hydrogen bonds with other cellulose molecules

(1)

☐ **A** none

☐ **B** one

☐ **C** two

☐ **D** three

(b) Bioplastic bags made from sugarcane take up to six months to decompose.

Bacteria secrete enzymes onto the bags during the process of decomposition.

(i) Name **two** structures found in bacterial cells that are involved in the synthesis of these enzymes.

(1)

1 .....

2 .....

(ii) Decomposition of bioplastic bags occurs faster if there is increased bacterial growth.

Explain the conditions needed for increased bacterial growth.

(3)

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

## **Mark Scheme**

Q1.

| Question Number | Answer                                                                                                                                                                                                    | Additional guidance                                                                                                                                                                                                                                                   | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | An answer that makes reference to the following: <ul style="list-style-type: none"><li>named nitrogen containing compound synthesised (1)</li><li>credit role of this compound in the plant (1)</li></ul> | e.g. amino acids / proteins / nucleic acids / ATP / NADP<br><br>e.g. {Proteins/ (peptide) hormones} are needed for {growth / repair} / DNA is needed for protein synthesis<br>Ignore amino acids needed to form proteins<br>Ignore nucleotides needed to form DNA/RNA | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                         | Additional guidance                                                                  | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------|
| (b)             | <p>A description that makes reference to two of the following:</p> <ul style="list-style-type: none"> <li>• modification of protein (into enzyme) (1)</li> <li>• enzyme(s) packaged into (secretory) vesicles (1)</li> <li>• enzyme(s) leave cell by exocytosis (1)</li> </ul> | Accept vesicles fuse with cell (surface) membrane and release enzyme(s) outside cell | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                   | Additional guidance                                                                                                                                                                                          | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)             | <pre> graph TD     A[Tested on human cells / animals] --&gt; B[Phase 1<br/>Tested on healthy volunteers]     B --&gt; C[Results reviewed (by independent scientists)]     C --&gt; D[Phase 2<br/>Tested on small group of volunteer patients with the disease / HIV / cancer(s)]     D --&gt; E[Phase 3<br/>Tested on 1000 to 3000 volunteer patients with the disease]           </pre> | <p>Accept identification of side effects<br/>Ignore identification of appropriate dosage</p> <p>Accept tested on 100-500 volunteer patients with {disease / HIV/ cancer}<br/>Ignore patients unqualified</p> | (3)  |

Q2.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                                                                                                                                                          | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• introduction of new (beaver) species increased the {species richness / biodiversity} (1)</li> <li>• reduction in (plant) biodiversity due to trees being cut down / reduction in (animal) biodiversity as {habitat / food} reduced (by the trees being cut down) (1)</li> <li>• (increase in biodiversity) due to {pond being created / new habitat / increased space (due to trees being cut down)} (1)</li> <li>• (increase in biodiversity) due to new food source (1)</li> </ul> | <p>Accept number of {species/ organisms} for biodiversity</p> <p>Ignore genetic diversity</p> <p>Accept reduction in animal biodiversity due to {competition with / predation from} beavers</p> <p>Accept plant or beaver as food source</p> | (4)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> <li>genetic diversity identified as the variety of alleles in the population</li> <li>only small numbers of introduced beavers could reduce the genetic diversity</li> <li>loss of alleles from population</li> <li>increased homozygosity</li> <li>introducing more Norwegian beavers could increase genetic diversity</li> <li>but could have same alleles so no effect on genetic diversity</li> <li>introducing beavers from different European locations could increase genetic diversity</li> <li>could be many different alleles in wider populations of European beavers</li> <li>however the map shows many geographically isolated populations</li> <li>these small populations could also have low genetic diversity</li> <li>reproductive isolation could have occurred</li> <li>preventing introduced beavers mating with Scottish beavers</li> </ul> <p style="text-align: right;">(6)</p> |

|         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                                |
|---------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 0 | 0   | No awardable content                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                    |
| Level 1 | 1-2 | <p>Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.</p> <p>Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures.</p> <p>The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.</p> | <p>Discussion of at least one solution and the impact on genetic diversity</p> <p>1 solution = 1 mark</p> <p>2 solutions = 2 marks</p>                                                                                                                             |
| Level 2 | 3-4 | <p>Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts.</p> <p>Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures.</p> <p>The discussion shows some linkages and lines of scientific reasoning with some structure.</p>                                          | <p>Discussion of both solutions and their impact on genetic diversity</p> <p>plus</p> <p>consideration of effect of geographically isolated populations on genetic diversity 1 mark (accept description e.g. scattered populations)</p> <p>plus alleles 1 mark</p> |

|         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                       |
|---------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Level 3 | 5-6 | <p>Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.</p> <p>Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures.</p> <p>The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p> | <p>all level 2 content</p> <p>plus<br/>reproductive isolation one mark</p> <p>plus<br/>inbreeding / heterozygosity index one mark</p> |
|---------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|

| Question Number | Answer                                                                                                                                                                                                                 | Additional guidance                                                                                                                                                                                                                           | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)             | <p>A calculation showing the following steps:</p> <ul style="list-style-type: none"> <li>• value for q (1)</li> <li>• value for p (1)</li> <li>• calculation of correct percentage for <math>p^2</math> (1)</li> </ul> | <p><u>Example of calculation</u></p> <p>Accept values for either p or q:</p> <p><math>\sqrt{0.09} / 0.3</math></p> <p><math>(1 - 0.3) / 0.7</math></p> <p><math>p^2 = 49\%</math></p> <p>Correct answer with no working scores full marks</p> | (3)  |

Q3.

| Question number | Answer                                   | Mark |
|-----------------|------------------------------------------|------|
| (a)             | B anatomical, physiological, behavioural | (1)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                               | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)             | <p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> <li>• mimics the <i>Canthigaster valenti</i> by having similar markings (1)</li> <li>• mimics the <i>Canthigaster valenti</i> by having similar {size / shape} (1)</li> <li>• therefore it still deters predators even though it does not produce poison (1)</li> </ul> | (3)  |

| Question number | Answer                                                                                                                                                                                                         | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)             | <p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> <li>• because they are different species (1)</li> <li>• therefore cannot produce fertile offspring (1)</li> </ul> | (2)  |

Q4.

| Question Number | Answer                                                                                                                                                                                                                                                    | Additional guidance                                                                                                                                                                                                                                                       | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>• total population of Santa Cruz in 2020 calculated (1)</li> <li>• total population of Santa Cruz in 2025 calculated (1)</li> <li>• population given to whole number (1)</li> </ul> | <p><u>Example of calculation</u></p> $(17000 \div 85) \times 100 = 20\,000$ $20\,000 \times 1.064^5 = 27\,273.3 / 27\,273.328 / 27\,273.33$ <p>{27 273 / 27 000}</p> <p>Correct answer with no working scores full marks ecf applies</p> <p>{26400 / 26000} = 2 marks</p> | (3)  |

| Question Number | Answer                                                                                                                                                          | Additional guidance                                                                                | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------|
| (b)             | <ul style="list-style-type: none"> <li>• positive correlation between the number of recorded nonendemic species and the number of tourists increased</li> </ul> | <p>ACCEPT number of recorded non endemic species increased as the number of tourists increased</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                 | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Mark               |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------------|-------|--------|---|----|----|-----|---|---|---|---|---|---|---|----|---|----|----|-----|---|----|----|------|---|----|----|-----|---|---|---|----|---|----|----|-----|--|---------------|--|--------------------|-----|
| (c)(i)          | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>• <math>N(N-1)</math> correctly calculated (1)</li> <li>• <math>\sum n(n-1)</math> correctly calculated (1)</li> <li>• correct substitution to obtain D to 1 d.p. (1)</li> </ul> | <p><u>Example of calculation</u></p> <p><math>(147 \times 146) = 21462</math></p> <p>4684</p> <p>4.6</p> <p>(4.58 = 2 marks)</p> <table border="1"> <thead> <tr> <th>Species</th><th>Number of individuals (n)</th><th>(n-1)</th><th>n(n-1)</th></tr> </thead> <tbody> <tr><td>A</td><td>21</td><td>20</td><td>420</td></tr> <tr><td>B</td><td>2</td><td>1</td><td>2</td></tr> <tr><td>C</td><td>4</td><td>3</td><td>12</td></tr> <tr><td>D</td><td>13</td><td>12</td><td>156</td></tr> <tr><td>E</td><td>54</td><td>53</td><td>2862</td></tr> <tr><td>F</td><td>15</td><td>14</td><td>210</td></tr> <tr><td>G</td><td>6</td><td>5</td><td>30</td></tr> <tr><td>H</td><td>32</td><td>31</td><td>992</td></tr> <tr> <td></td><td>Total (N)=147</td><td></td><td><math>\sum n(n-1)=4684</math></td></tr> </tbody> </table> <p>Correct answer with no working scores full marks<br/>ECF applied</p> | Species            | Number of individuals (n) | (n-1) | n(n-1) | A | 21 | 20 | 420 | B | 2 | 1 | 2 | C | 4 | 3 | 12 | D | 13 | 12 | 156 | E | 54 | 53 | 2862 | F | 15 | 14 | 210 | G | 6 | 5 | 30 | H | 32 | 31 | 992 |  | Total (N)=147 |  | $\sum n(n-1)=4684$ | (3) |
| Species         | Number of individuals (n)                                                                                                                                                                                                                              | (n-1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | n(n-1)             |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| A               | 21                                                                                                                                                                                                                                                     | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 420                |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| B               | 2                                                                                                                                                                                                                                                      | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2                  |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| C               | 4                                                                                                                                                                                                                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 12                 |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| D               | 13                                                                                                                                                                                                                                                     | 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 156                |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| E               | 54                                                                                                                                                                                                                                                     | 53                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2862               |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| F               | 15                                                                                                                                                                                                                                                     | 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 210                |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| G               | 6                                                                                                                                                                                                                                                      | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 30                 |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
| H               | 32                                                                                                                                                                                                                                                     | 31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 992                |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |
|                 | Total (N)=147                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $\sum n(n-1)=4684$ |                           |       |        |   |    |    |     |   |   |   |   |   |   |   |    |   |    |    |     |   |    |    |      |   |    |    |     |   |   |   |    |   |    |    |     |  |               |  |                    |     |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                      | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(ii)         | <p>An answer that includes five of the following points:</p> <ul style="list-style-type: none"> <li>• reduction in biodiversity (1)</li> <li>• as forest is habitat for many species of plants (1)</li> <li>• (because) populations will decrease because loss of forest will result in {reduced habitat for animals / reduced food} / increased competition between (animal) species (1)</li> <li>• causing reduction in species richness (1)</li> <li>• (because) loss of forest will result in reduction of genetic diversity (1)</li> <li>• (due to) reproduction in {smaller / isolated} populations (1)</li> </ul> | <p>Accept possible increase in species that have blackberry as part of food chain</p> <p>Accept reduction in forest habitat (for many species unqualified) / blackberry {outcompetes (the forest) plants / introduces disease}</p> <p>Accept animals not adapted to feed on blackberry / blackberry is poisonous to the animals</p> <p>Accept descriptions of what animals would compete for e.g. nesting sites</p> <p>Accept reduction in gene pool</p> | (5)  |

Q5.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Additional guidance        | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------|
| (a)             | <p>An explanation that includes four of the following points:</p> <ul style="list-style-type: none"><li>• cortical granules are released (from the egg cell) (1)</li><li>• cortical granules fuse with the {zona pellucida / egg cell membrane} (1)</li><li>• cortical granules release {chemicals / enzymes / proteins} to cause the hardening of zona pellucida (1)</li><li>• prevents more than one sperm (cell) entering the egg cell (1)</li><li>• egg cell and sperm nuclei are haploid and they fuse (during fertilisation) (1)</li></ul> | ACCEPT prevents polyspermy | (4)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * (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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><u>length of middle region</u></p> <ul style="list-style-type: none"> <li>increased length of mid region size increases swimming speed (I)</li> <li>due to more mitochondria supplying more {energy/ ATP} to move the flagella (I)</li> <li>increased chance of that male's sperm {reaching the egg cell(s) first / fertilising the egg cell(s)} / reproductive success for that male} (R)</li> <li>selection pressure / males with alleles for longer mid sections will have an advantage over other males (R)</li> <li>more offspring will {have the same father/ inherit same alleles} (G)</li> <li>leading to possible reduction in genetic diversity (G)</li> <li>many males and many egg cells could lead to an increased genetic diversity of offspring (G)</li> </ul> <p><u>spermatophore</u></p> <ul style="list-style-type: none"> <li>spermatophore contains sperm cells for fertilisation of egg (I)</li> <li>nutrients will be used by female to produce {egg cells with more nutrients / more egg cells} (R)</li> <li>{chemicals / pheromones} reduce chances of other males mating with the female (R)</li> <li>increased chance of that male's sperm {reaching the egg cells(s) first / fertilising the egg cell(s)} / reproductive success for that male} (R)</li> <li>more offspring will {have the same father/ inherit same alleles} (G)</li> <li>leading to possible reduction in genetic diversity (G)</li> </ul> <p><u>storage of sperm</u></p> <ul style="list-style-type: none"> <li>{fertilised eggs / offspring} can be produced in absence of a mate (I)</li> <li>increased reproductive success for {that female / males that mated} (R)</li> <li>increased chance that offspring will {have different father/ inherit different alleles} (G)</li> <li>leading to possible increase in genetic diversity (G)</li> <li>not mating with (new) males every year could reduce genetic diversity (G)</li> </ul> <p style="text-align: right;">(6)</p> |

|         |     |                                                                                                                                                            | Additional guidance                                                                                                                                                                                                                                                                                                       |
|---------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 0 | 0   | No awardable content                                                                                                                                       |                                                                                                                                                                                                                                                                                                                           |
| Level 1 | 1-2 | Limited number of the most important or relevant scientific factors from the data/information provided are synthesised.<br><br>No judgement is made.       | 1 mark – either R or G for one mating strategy<br>2 marks – either R+G for one mating strategy<br>OR<br>either R or G for two mating strategies<br><br>OR<br><br>1 mark - basic information (I) given<br>2 marks - basic information (I) given + 1 or 2 x {R or G}                                                        |
| Level 2 | 3-4 | Some of the most important or relevant scientific factors from the data/information provided are synthesised.<br><br>A limited accurate judgement is made. | 3 marks – 3 x (R or G) considered<br>4 marks = 4 x (R or G) considered                                                                                                                                                                                                                                                    |
| Level 3 | 5-6 | Most of the important or relevant scientific factors from the data/information provided are synthesised.<br><br>A detailed and accurate judgement is made. | 5 marks = either reproductive success for all strategies considered plus genetic diversity of two strategies considered OR genetic diversity for all strategies considered plus reproductive success of two strategies considered<br><br>6 marks genetic diversity and reproductive success considered for all strategies |

Q6.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Additional guidance                                                                                                                                                                                                                                                 | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | <p>An answer that includes at least one similarity and one difference:</p> <p>similarities:</p> <ul style="list-style-type: none"> <li>both contain membrane bound organelles (1)</li> <li>both contain a {cell membrane / cell wall} (1)</li> </ul> <p>max 2 differences:</p> <ul style="list-style-type: none"> <li>plant cell wall is composed of cellulose whereas a fungal cellwall is composed of chitin (1)</li> <li>fungal cells contain glycogen granules whereas plant cells contain {starch grains / amyloplasts} (1)</li> <li>plant cells contain {chloroplasts / plasmodesmata /tonoplast} whereas fungal cells do not (1)</li> </ul> | <p>ACCEPT named organelle(s) e.g. nucleus,mitochondria, 80S ribosomes etc</p> <p>ACCEPT both contain DNA associated with histones (1)</p> <p>ACCEPT fungal cells contain lysosomes whereas plant cells do not / plant vacuole may be larger than fungal vacuole</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Additional guidance                                                                                                                                                                                                                                                    | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(i)          | <p>An explanation that makes reference to four of the following points:</p> <ul style="list-style-type: none"> <li>reduction in growth (1)</li> </ul> <p>and any three from:</p> <ul style="list-style-type: none"> <li>due to reduced {cell division / mitosis} (1)</li> <li>reduced gene expression will cause reduction in {enzyme/ protein} production (1)</li> <li>reduced phospholipids which are needed for (growth of) {cell /organelle} membranes (in daughter cells) (1)</li> <li>reduced transport of sucrose (around the plant) in the phloem /reduced sucrose available for other plant cells (1)</li> </ul> | <p>ACCEPT reduced DNA synthesis results in fewer cells in S phase / not enough DNA produced for mitosis to occur</p> <p>ACCEPT named enzyme e.g. DNA polymerase</p> <p>ACCEPT correct examples of sucrose use by plant e.g. reduced {respiration / ATP production}</p> | (4)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * (b)(ii)       | <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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><u>Description of data</u></p> <ul style="list-style-type: none"> <li>infection with fungus results in increased {tannin/ flavonoid} production</li> <li>increasing the concentration of tannin reduces the leaf damage from herbivores</li> <li>negative correlation / linear decrease</li> <li>increasing the concentration of flavonoids increases the diameter of inhibition zone</li> <li>doubling the concentration of flavonoids increases the diameter of inhibition zone by 28.6%</li> </ul> <p><u>Plant</u></p> <ul style="list-style-type: none"> <li>explanation of how tannins reduce leaf damage e.g. herbivores don't like the taste / toxic / poisonous therefore less likely to eat the plant (A)</li> <li>more leaves for photosynthesis and therefore increased growth (A)</li> <li>explanation of what the diameter of inhibition zone shows = link to bactericidal/ bacteriostatic effect of flavonoids (A)</li> <li>reduced plant infections (A)</li> <li>link to why reduced herbivory and reduced plant infection benefits the infected plant e.g. fewer resources goes into growing new leaves and more can go into sexual reproduction (A)</li> <li>disadvantage for plant – increased fungal growth (D)</li> <li>more resources required {to produce tannins / for gene expression} instead of being used for {growth / sexualreproduction} (D)</li> </ul> <p><u>Fungus</u></p> <ul style="list-style-type: none"> <li>link to why reduced herbivory benefits the fungus e.g. reduced competition for plant resources from herbivores, more plant resources available to fungus (A)</li> <li>link to why reduced plant infection benefits the fungus e.g. reduced competition for plant resources from {bacteria / other fungi} (A)</li> <li>reduced resources for fungus from plant as more used to synthesise tannins / flavonoids (D)</li> </ul> |

|         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                           |
|---------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |     | <ul style="list-style-type: none"> <li>the fungus might only be able to {influence / live in / complete life cycle in} dandelion plants (D)</li> </ul>                                                                                                                                                                                                                                                                         | (6)                                                                                                                                                                                                                                                                                                       |
|         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                                                                       |
| Level 0 | 0   | No awardable content                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                           |
| Level 1 | 1-2 | <p>Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.</p> <p>Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures.</p> <p>The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.</p> | Information from one section                                                                                                                                                                                                                                                                              |
| Level 2 | 3-4 | <p>Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts.</p> <p>Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures.</p> <p>The discussion shows some linkages and lines of scientific reasoning with some structure.</p>                                          | <p>level one content plus consideration of advantage(s) and / or disadvantage(s)</p> <p>5 marks = L1 + one from {FA / FD / PA / PD}</p> <p>6 marks = L1 + two from {FA / FD / PA / PD}</p> <p>FA = fungal advantage<br/>FD = fungal disadvantage<br/>PA = plant advantage<br/>PD = plant disadvantage</p> |

|         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                              |
|---------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 3 | 5-6 | <p>Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.</p> <p>Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures.</p> <p>The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p> | <p>Information from three sections applied to the given context showing a good understanding of the advantages and disadvantages to the infected plant and to the fungus</p> <p>7 marks = L2 + three from {FA / FD / PA / PD}</p> <p>6 marks – all four of {FA / FD / PA / PD} discussed</p> |
|---------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Question Number | Answer                                                                                                                                                                                                                                                               | Additional guidance                                                                                                                              | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(iii)        | <p>A description that includes reference to the following points:</p> <ul style="list-style-type: none"> <li>(flavonoid drug) tested on small numbers of patients with {<i>P. aeruginosa</i> / lung infection} (1)</li> <li>use of double-blind trial (1)</li> </ul> | <p>ACCEPT tested on {100 to 500} of patients with {<i>P. aeruginosa</i> / lung infection}</p> <p>ACCEPT placebo / established drug treatment</p> | (2)  |

Q7.

| Question Number | Answer                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                               | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(i)          | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>conversion of actual length of scale into nm (1)</li> <li>actual length divided by the given length (answer given to 2 significant figures and in standard form) (1)</li> </ul> | <p><u>Example of calculation:</u></p> <p>30mm = 30 000 000 nm</p> <p>30 000 000 ÷ 1200 = <math>2.5 \times 10^4</math></p> <p>accept +/- 1mm for length of bar</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                      | Additional guidance                                                                                                                                                           | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(ii)         | <p>An explanation that makes reference to two of the following points:</p> <ul style="list-style-type: none"> <li>electron microscope (1)</li> <li>due to high magnification (1)</li> </ul> | <p>ecf from 2(a)(i) applies</p> <p>Accept high resolution</p> <p>Accept converse for light microscope</p> <p>Accept 3D image if qualified as scanning electron microscope</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                              | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (b)(i)          | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>presence of {(peptidoglycan) cell wall / circular chromosome(s) / DNA associated with histones / 70S ribosomes / RNA polymerase} (1)</li> <li>absence of {nucleus / membrane bound organelles} (1)</li> </ul> | Accept ether bonds  | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                       | Additional guidance                                                                                                                                                                                  | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(ii)         | <p>An explanation that makes reference to three of the following points:</p> <ul style="list-style-type: none"> <li>(analysis of) molecular evidence (1)</li> <li>to identify similarities and differences in biological molecules / comparison of biological molecules (1)</li> <li>(analysis of) phenotype (1)</li> <li>to identify similarities and differences between the two microorganisms (phenotype) (1)</li> </ul> | <p>e.g. DNA, mRNA, proteins, enzymes</p> <p>e.g. cell structure / anatomical features, grow in different {habitats/ conditions}</p> <p>e.g. named similarities and differences in cell structure</p> | (3)  |

Q8.

| Question Number | Answer                                                                                                                                                                                                                                                                                                               | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(i)          | <p>The only correct answer is B <math>\beta</math>-glucose</p> <p><i>A is not correct because the molecule is <math>\beta</math>-glucose</i></p> <p><i>C is not correct because the molecule is <math>\beta</math>-glucose</i></p> <p><i>D is not correct because the molecule is <math>\beta</math>-glucose</i></p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                            | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(ii)         | <p>The only correct answer is C form microfibrils</p> <p><i>A is not correct because cellulose forms microfibrils</i></p> <p><i>B is not correct because cellulose forms microfibrils</i></p> <p><i>D is not correct because cellulose forms microfibrils</i></p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                          | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(iii)        | <p>The only correct answer is B chlorophyll</p> <p><i>A is not correct because magnesium is not a component of calcium pectate</i></p> <p><i>C is not correct because magnesium is not a component of DNA</i></p> <p><i>D is not correct because magnesium is not a component of starch</i></p> | (1)  |

| Question Number | Answer                                                  | Additional guidance | Mark |
|-----------------|---------------------------------------------------------|---------------------|------|
| (b)(i)          | <ul style="list-style-type: none"> <li>xylem</li> </ul> |                     | (1)  |

| Question Number | Answer                                                         | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------|---------------------|------|
| (b)(ii)         | <ul style="list-style-type: none"> <li>sclerenchyma</li> </ul> | Accept tracheids    | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                             | Additional guidance | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(i)          | <p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>the germination of the seeds remains {high/ constant} for an initial period of time (1)</li> <li>(after this) the germination of the seeds (rapidly) {decreases / reduces} with increased time in storage (1)</li> </ul> |                     | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Additional guidance                                                                                                                                                                                                                                                                  | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(ii)         | <p>An explanation that makes reference to four of the following points:</p> <ul style="list-style-type: none"> <li>(many different plants result in) increased genetic diversity of the seeds stored (1)</li> <li>because more (seeds from different) {individuals/ plants} increases the probability of having {more alleles / different genotypes / heterozygotes} (1)</li> <li>adult plants allow {pollination / sexual reproduction} to occur (1)</li> <li>to produce new seeds (for storage) (1)</li> <li>to replace those seeds stored for a long time (1)</li> </ul> | <p>Accept reduces chance of seeds from (mainly) {homozygous recessive / diseased} plants</p> <p>Accept to produce seeds which are genetically different (from parent plants)</p> <p>Accept to increase the {viability of stored seeds / percentage of seeds that will germinate}</p> | (4)  |

| Question Number | Answer                                                                                                                                                                                                          | Additional guidance                                                                                                                                                                                                                                      | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(i)          | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>mass of cutlery per month calculated (1)</li> <li>mass of cutlery per year calculated to two significant figures with unit (1)</li> </ul> | <p><u>Example of calculation</u></p> <p><math>(130000 \div 100) \times 60 = 78000 \text{ (kg)}</math></p> <p><math>(78000 \times 12) = 940000 \text{ kg} / 9.4 \times 10^5 \text{ kg}</math></p> <p>Correct answer with no working scores full marks</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                               | Additional guidance                                                                                                                                  | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(ii)</b>  | <p>An answer that includes the following points:</p> <ul style="list-style-type: none"> <li>• more (cutlery) can (constantly) be made from avocado seeds(1)</li> <li>• as avocados are {continually being grown / can be grown by future generations} (1)</li> </ul> | <p>Accept carbon neutral / lower carbon emissions (than oil-based plastic production) / biodegradable Accept as avocado seeds are waste products</p> | <b>(2)</b> |

Q10.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                               | Additional guidance                                                                                                                                                                                                                                                                                                    | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(a)(i)</b>   | <p>An explanation that includes three of the following points:</p> <ul style="list-style-type: none"> <li>• oxygen for (aerobic) respiration (1)</li> <li>• glucose for {respiration / ATP production} / amino acids for protein synthesis (1)</li> <li>• optimum temperature for {enzyme / metabolic} reaction (1)</li> <li>• water for {hydrolysis reactions / solvent} (1)</li> <li>• optimum pH for {enzyme / metabolic} reaction (1)</li> </ul> | <p>accept lack of oxygen for survival of obligate anaerobes</p> <p>accept lipids for synthesis of cell membranes</p> <p>accept suitable stated temperature for {faster/optimum} enzyme activity</p> <p>accept to prevent dehydration</p> <p>accept suitable stated pH for {faster/optimum} enzyme rate of reaction</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                    | Additional guidance                                                                                                                                                          | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(a)(ii)</b>  | <p>An explanation that makes reference to two of the following points:</p> <ul style="list-style-type: none"> <li>• oil-based plastic is non-renewable (1)</li> <li>• oil-based plastic {takes a long time to decompose / isn't biodegradable} (1)</li> <li>• contributes to increased carbon dioxide (in atmosphere) / not carbon neutral (1)</li> </ul> | <p>accept (oil is a) finite resource / may run out / may not always be available for future generations</p> <p>accept contributes to {global warming/ greenhouse effect}</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                      | Additional guidance                                                                                                                                                                                                                                                                                    | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(i)</b>   | <p>An answer that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>bacterial survival decreases over time (on all three boards) (1)</li> <li>bacterial survival is lowest on pine chopping board (1)</li> <li>no change in number of bacteria surviving on plastic during first 4 hours (1)</li> </ul> | <p>accept converse for plastic</p> <p>accept only significant difference between spruce and plastic is at 4 hours / only slight difference between spruce and plastic at 24 hours</p> <p>accept same survival for {spruce/plastic} after 1 hour</p> <p>e.g. no reference to repeats, no error bars</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                  | Additional guidance                                                                                                             | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(ii)</b>  | <p>An answer that includes one of the following points:</p> <ul style="list-style-type: none"> <li>pine boards have antimicrobial properties (1)</li> <li>pine chopping boards have a pH outside of bacterial optimum pH (1)</li> </ul> | <p>accept pine boards contain chemicals which kill bacteria</p> <p>accept converse for plastic ignore temperature and water</p> | <b>(1)</b> |

Q11.

| Question Number | Answer                                                                                                                                                                                                                                                                         | Additional guidance | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------|
| <b>(a)(i)</b>   | <p>The only correct answer is D the number of species</p> <p><i>A is not correct because it refers to more than just animals</i></p> <p><i>B is not correct because it refers to more than just plants</i></p> <p><i>C is not correct because that is species evenness</i></p> |                     | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                            | Additional guidance                                                                                           | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------|
| <b>(a)(ii)</b>  | <p>A description that includes two of the following points:</p> <ul style="list-style-type: none"> <li>determining the genetic {diversity / variation} (of a species) (1)</li> <li>by the number of different alleles present (1)</li> <li>by calculating the heterozygosity index (1)</li> </ul> | <p>Mark their first method</p> <p>ignore allele frequency<br/>ignore genes</p> <p>Accept correct equation</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                                                 | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)</b>      | <p>An explanation that includes three of the following points:</p> <ul style="list-style-type: none"> <li>deforestation (of mangroves) causing habitat loss (1)</li> <li>reduction in food due to {deforestation (of mangroves) / competition with other species / overfishing} (1)</li> <li>{pollution / change in salinity} of river making it unsuitable habitat (for the crocodile) (1)</li> <li>{disease / hunting} (causing death of crocodiles) (1)</li> </ul> | <p>ignore water levels</p> <p>Accept reduction in food due to pollution of river</p> <p>Accept pollution killed {crocodiles / caused migration of crocodile}</p> <p>Accept fewer mates due to lower population / {gender imbalance / fewer eggs hatching} due to global warming</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                     | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(c)(i)</b>   | <p>A calculation that shows the following steps:</p> <ul style="list-style-type: none"> <li>calculation of percentage of females (1)</li> <li>calculation of number that would develop (1)</li> </ul> | <p>Example of calculation:</p> <p><math>100 - 23 = 77</math><br/> <math>(350 \div 100) \times 77 = 269 / 270</math><br/> Do not accept a decimal answer<br/> Correct answer with no working shown scores full marks</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| * (c)(ii)       | <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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> <li>• numbers will increase faster if there are more females hatching</li> <li>• as more females to lay eggs</li> <li>• more eggs increases likelihood of more offspring hatching</li> <li>• 31°C not selected as there are significantly more males hatching than females / 82:18</li> <li>• more females develop at 29/30/32/33°C</li> <li>• too few males develop at 29°C</li> <li>• future offspring would only inherit these alleles</li> <li>• reduction in genetic diversity of a population could occur when there are small numbers of one of the sexes</li> <li>• as offspring would only inherit these few alleles</li> <li>• increased number of homozygotes for these few alleles / reduction in heterozygosity index of population over time</li> <li>• reference to competition for mates</li> <li>• more males develop at 30/32/33°C than 29°C</li> <li>• too few males hatching could reduce genetic diversity of offspring</li> <li>• therefore reduced probability of reduction in genetic diversity of future population</li> <li>• eggs taken from nests throughout National Park are likely to contain different alleles</li> <li>• analyse genetic makeup of individuals</li> <li>• use this analysis to choose individuals for breeding programme / prevent inbreeding</li> <li>• use of stud books</li> </ul> | <p style="text-align: right;"><b>(6)</b><br/><b>Expert</b></p> |

|         |     |                                                                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                                                                                                                                                                                                                                                                 |
|---------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 0 | 0   | No awardable content                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                     |
| Level 1 | 1-2 | <p>An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information.</p> <p>The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.</p>       | <p>A temperature selected with an attempt to explain why</p> <p>OR</p> <p>basic recognition of male:female ratio = 1 mark<br/>attempt at explanation of need for acceptable male:female ratio (e.g. more females than males would increase population faster) = 2 marks</p> <p>basic comments linked to genetic diversity (not linked to graph)</p> |
| Level 2 | 3-4 | <p>An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning, with some structure.</p>                                                                            | <p>Level 1 content plus supported reasoning of selection of {30/32/33} °C to address idea of increase population quickly e.g. consideration of appropriate male:female ratio (depth of answer determines mark)</p> <p>OR</p> <p>explanation linked to way(s) in which genetic diversity could be maintained (depth of answer determines mark)</p>   |
| Level 3 | 5-6 | <p>An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.</p> | <p>All level 2 content plus Supported reasoning of selection of {30/32/33}°C plus linked to maintaining genetic diversity (depth of answer determines mark)</p>                                                                                                                                                                                     |

Q12.

| Question Number | Answer                                                                                                                                                                                            | Additional guidance                                                                                                                                                        | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(i)          | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>• calculation of volume of sphere (1)</li> <li>• calculation of volume of hemisphere to nearest whole number (1)</li> </ul> | <p><u>Example of calculation:</u></p> <p>answer between 65416.67 to 65476.19</p> <p>whole number answer between 32708 to 32738</p> <p>Correct answer scores full marks</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                      | Additional guidance                   | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|------------|
| <b>(a)(ii)</b>  | <p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> <li>• (because) calabash fruits are renewable / more can be grown / will not run out / available to future generations (1)</li> <li>• biodegradable / can be broken down by decomposers (1)</li> <li>• carbon neutral (1)</li> </ul> | ignore produces less greenhouse gases | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                           | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(i)</b>   | <p>The only correct answer is B one</p> <p><i>A is not correct because they provide support to the plant</i></p> <p><i>B is not correct because they are not involved in transporting substances</i></p> <p><i>C is not correct because they are not involved in transporting substances</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Additional guidance                                                                                                                                                                                                                                                                                 | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(ii)</b>  | <p>An answer that makes reference to four of the following:</p> <p>Similarities:</p> <ul style="list-style-type: none"> <li>• both (fibres) contain cellulose (in the cell wall) (1)</li> <li>• both have tubular structures (1)</li> <li>• both do not contain a nucleus (1)</li> </ul> <p>Differences (max 3):</p> <ul style="list-style-type: none"> <li>• phloem (sieve tubes) have {sieve plates / (perforated) end walls} whereas xylem (vessels) have no {end walls / sieve plates} (1)</li> <li>• phloem (sieve tubes) {contain cytoplasm / are not hollow} whereas xylem (vessels) {do not contain cytoplasm / are hollow} (1)</li> <li>• phloem (sieve tubes) contain no {lignin / secondary thickening} whereas xylem contain {lignin / secondary thickening} (1)</li> </ul> | <p>ACCEPT piecing together from adjacent sentences</p> <p>ACCEPT both have a cell wall</p> <p>ignore organelles</p> <p>ACCEPT phloem (sieve tubes) contain living cells whereas xylem (vessels) contain dead cells</p> <p>ACCEPT phloem cell walls are thinner than xylem cell walls / converse</p> | <b>(4)</b> |

|  |                                                                                                         |                                                                                               |  |
|--|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--|
|  | <ul style="list-style-type: none"> <li>phloem have plasmodesmata whereas xylem have pits (1)</li> </ul> | ACCEPT xylem have pits whereas phloem do not / phloem have plasmodesmata whereas xylem do not |  |
|--|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--|

Q13.

| Question Number | Answer                                                                                                                                                                                                                                                                          | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(i)          | <p>The only correct answer is C Eukarya</p> <p><i>A is incorrect because plants are found in the domain Eukarya</i></p> <p><i>B is incorrect because plants are found in the domain Eukarya</i></p> <p><i>D is incorrect because plants are found in the domain Eukarya</i></p> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                         | Additional guidance                                                                                                                                                                                                                                                     | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(ii)         | <p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> <li>(evidence from) molecular phylogeny (1)</li> <li>identification of (similarities / differences) in (DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components) (1)</li> </ul> | <p>Accept comparing (DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components)</p> <p>Ignore (looking at / analysing) the (DNA / RNA / proteins / enzymes / ribosomes / membrane components / cell wall components / genetic makeup)</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Additional guidance                                                                                                                                                                                                                                                            | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)             | <p>An explanation that includes three of the following points:</p> <ul style="list-style-type: none"> <li>(tube) grows (through style) to (ovary / ovule / egg cell) / transports the (male nuclei / generative nucleus / male gametes) to (ovary / ovule / egg cell) (1)</li> <li>(and secretes) digestive enzymes used to aid growth of tube (to ovule) (1)</li> <li>(therefore) male nuclei can fuse with (egg cell (nucleus) / polar nuclei) (1)</li> </ul> | <p>Ignore micropyle</p> <p>Accept forms pathway to reach (ovary / ovule / egg cell)</p> <p>Accept enzymes digest through the style</p> <p>Accept fertilisation occurs to form (zygote / endosperm)</p> <p>Accept double fertilisation occurs / zygote and endosperm formed</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                          | Additional guidance         | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------|
| (c)(i)          | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>as the Verapamil concentration increases the length of the pollen tube decreases (1)</li> <li>credit a correct manipulated mathematical statement (1)</li> </ul> | Accept negative correlation | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                               | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                 | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(II)         | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• lower concentration of calcium ions (in the cells) (1)</li> <li>• fewer {pectin / calcium pectate} molecules formed (1)</li> <li>• therefore increased flexibility of {microfibrils / cellulose} (due to fewer {pectin / calcium pectate} molecules) (1)</li> </ul> | <p>Accept no calcium ions present (in the cells)</p> <p>Accept calcium (ions) needed to produce {pectin / calcium pectate}</p> <p>Accept {calcium pectate / pectin} (are needed to) hold {microfibrils / cellulose} together (in a matrix)</p> <p>Accept {microfibrils / cellulose} are not held together by {calcium pectate / pectin}</p> <p>Accept calcium pectate helps middle lamella to hold adjacent cell walls together</p> | (3)  |

Q14.

| Question Number | Answer                                                                                | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------|---------------------|------|
| (a)             | <ul style="list-style-type: none"> <li>• anatomical</li> <li>• behavioural</li> </ul> |                     | (2)  |

| Question Number | Answer                | Additional guidance | Mark |
|-----------------|-----------------------|---------------------|------|
| (b)(i)          | electron (microscope) |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                  | Additional guidance                                                                                                                                                                                                                                               | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(ii)         | <p>A description that includes the following points:</p> <ul style="list-style-type: none"> <li>• aerobic respiration (1)</li> <li>• produce ATP (1)</li> <li>• for cell metabolism / named cell process (1)</li> </ul> | <p>Accept {Krebs / citric acid} cycle / oxidative phosphorylation</p> <p>accept cell {reactions / processes} / named process e.g. mitosis, protein synthesis, muscle contraction, active transport etc</p> <p>accept contains ribosomes for protein synthesis</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                      | Additional guidance                    | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------|
| (c)             | <p>An answer showing:</p> <ul style="list-style-type: none"> <li>at least two tubules with ribosomes on surface (1)</li> <li>{cisternae / membrane} labelled (1)</li> <li>ribosomes labelled (1)</li> </ul> | Accept tubules<br>ignore cell membrane | (3)  |

Q15.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                              | Additional guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(i)          | <p>The only correct answer is D animal, plant and prokaryotic cells</p> <p><i>A is not correct because all three cell types contain a cell membrane</i></p> <p><i>B is not correct because all three cell types contain a cell membrane</i></p> <p><i>C is not correct because all three cell types contain a cell membrane</i></p> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                          | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(ii)         | <p>The only correct answer is C plant and prokaryotic cells only</p> <p><i>A is not correct because prokaryotic cells contain a cell wall</i></p> <p><i>B is not correct because animal cells do not contain a cell wall</i></p> <p><i>D is not correct because animal cells do not contain a cell wall</i></p> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                       | Additional guidance                                                                                                                                                                                          | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(i)</b>   | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>cell diameter measured and converted into micrometres (1)</li> <li>diameter divided by 25 with no units (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>25 converted to mm</li> <li>diameter divided by 0.025 with no units</li> </ul> | <p><u>Example of calculation:</u></p> <p>42mm=42000 µm</p> <p>42000 ÷ 25 = x1680</p> <p>ecf for ±1mm and incorrect conversions</p> <p>Correct answer with no units and with no working scores full marks</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                        | Additional guidance                                                                                      | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(ii)</b>  | <p>An answer that includes one of the following points:</p> <ul style="list-style-type: none"> <li>(site of) photosynthesis / converts light energy to {chemical energy / ATP} (1)</li> </ul> | <p>ACCEPT formation of correct named product of photosynthesis e.g. glucose</p> <p>ignore makes food</p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                             | Additional guidance                                                                             | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------|
| <b>(b)(iii)</b> | <p>An answer that includes the following point:</p> <ul style="list-style-type: none"> <li>this organism has a nucleus / prokaryotic cells do not contain a nucleus (1)</li> </ul> | <p>DO NOT ACCEPT cell membrane / cytoplasm</p> <p>ignore contains membrane bound organelles</p> | <b>(1)</b> |

| Question Number | Answer                                                                            | Additional guidance | Mark       |
|-----------------|-----------------------------------------------------------------------------------|---------------------|------------|
| <b>(c)(i)</b>   | <ul style="list-style-type: none"> <li>plasmodesma / plasmodesmata (1)</li> </ul> |                     | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                        | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(c)(ii)</b>  | <p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> <li>communication between / connects (connected) cells (1)</li> <li>therefore signalling substances pass through {symplast / cytoplasm} / cytoplasmic streaming / transport of suitable named molecules e.g. minerals, water, glucose, amino acids, proteins, RNA (1)</li> </ul> | <p>allow ECF for pits, cell wall and middle lamella only pits</p> <ul style="list-style-type: none"> <li>communication between / connects (connected) cells</li> <li>therefore transport of suitable named molecules</li> </ul> <p>cell wall</p> <ul style="list-style-type: none"> <li>(sieve like network made of) cellulose fibres support the cell</li> <li>therefore helps retain rigid structure / prevent cell lysis</li> </ul> <p>middle lamella</p> <ul style="list-style-type: none"> <li>joins (adjacent) cell (walls) together</li> <li>therefore increases {strength / stability} of {plant / cell (wall)}</li> </ul> | <b>(2)</b> |

Q16.

| Question number | Answer                                                 | Mark |
|-----------------|--------------------------------------------------------|------|
| (a)             | B species richness of all the species within a habitat | (1)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><b>Indicative content</b></p> <ul style="list-style-type: none"> <li>• good diversity for birds in all sections except Section 4, which decreases to moderate</li> <li>• good diversity for birds is very similar in Sections 1, 2 and 3</li> <li>• moderate diversity for fish in Section 1, which increases in Section 2 but then decreases again in Sections 3 and 4</li> <li>• moderate diversity is very similar in the three sections</li> <li>• good diversity for aquatic plants in Sections 1 and 2, which has decreased by Section 4</li> <li>• good biodiversity for mussels in stretch 1, decreasing to moderate biodiversity in stretch 2 and poor diversity in stretch 4</li> <li>• no overall trends as you move down the river</li> </ul> | (6)  |

| Level | Marks | Descriptor                                                                                                                                                                                                                                                        |
|-------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | 0     | No awardable content.                                                                                                                                                                                                                                             |
| 1     | 1-2   | <p>Demonstrates isolated elements of biological knowledge related to the given context with generalised comments made.</p> <p>The description will contain basic information with some attempt made to link knowledge and understanding to the given context.</p> |
| 2     | 3-4   | <p>Demonstrates adequate knowledge by selecting and applying some relevant biological facts/concepts to provide the description being presented.</p> <p>The description shows some linkages and lines of reasoning with some structure.</p>                       |
| 3     | 5-6   | <p>Demonstrates comprehensive knowledge by selecting and applying relevant knowledge of biological facts/concepts to provide the description being presented.</p> <p>The description is clear, coherent and logically structured.</p>                             |

| Question number | Answer                                                                                                                                                                                                                                                 | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)             | <p>An answer that includes the following points:</p> <ul style="list-style-type: none"> <li>• there are more species of fish than birds (1)</li> <li>• therefore a value of 2.5 has a relatively lower biodiversity than a value of 1.6 (1)</li> </ul> | (2)  |

| Question number          | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Mark                     |                                  |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|----------------------------------|-------|--------|----------|---|---|----|------------|---|---|----|------------------|---|---|---|------------------------|---|---|---|---------------|---|---|----|------------------|---|---|---|------------------|---|---|---|------------------------|---|---|----|----------------|---|---|----|------------------|---|---|---|----------------|---|---|---|-----|
| (d)(i)                   | <table><tr><th>Species of aquatic plant</th><th>Number of aquatic plants counted</th><th>(n-1)</th><th>n(n-1)</th></tr><tr><td>Coontail</td><td>8</td><td>7</td><td>56</td></tr><tr><td>Tape grass</td><td>6</td><td>5</td><td>30</td></tr><tr><td>Common waterweed</td><td>3</td><td>2</td><td>6</td></tr><tr><td>Northern water milfoil</td><td>2</td><td>1</td><td>2</td></tr><tr><td>Star duckweed</td><td>9</td><td>8</td><td>72</td></tr><tr><td>White water lily</td><td>2</td><td>1</td><td>2</td></tr><tr><td>Water star-grass</td><td>2</td><td>1</td><td>2</td></tr><tr><td>Eurasian water milfoil</td><td>6</td><td>5</td><td>30</td></tr><tr><td>Curly pondweed</td><td>5</td><td>4</td><td>20</td></tr><tr><td>European frogbit</td><td>2</td><td>1</td><td>2</td></tr><tr><td>Flowering rush</td><td>3</td><td>2</td><td>6</td></tr></table> | Species of aquatic plant | Number of aquatic plants counted | (n-1) | n(n-1) | Coontail | 8 | 7 | 56 | Tape grass | 6 | 5 | 30 | Common waterweed | 3 | 2 | 6 | Northern water milfoil | 2 | 1 | 2 | Star duckweed | 9 | 8 | 72 | White water lily | 2 | 1 | 2 | Water star-grass | 2 | 1 | 2 | Eurasian water milfoil | 6 | 5 | 30 | Curly pondweed | 5 | 4 | 20 | European frogbit | 2 | 1 | 2 | Flowering rush | 3 | 2 | 6 | (1) |
| Species of aquatic plant | Number of aquatic plants counted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | (n-1)                    | n(n-1)                           |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Coontail                 | 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 7                        | 56                               |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Tape grass               | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 5                        | 30                               |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Common waterweed         | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2                        | 6                                |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Northern water milfoil   | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                        | 2                                |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Star duckweed            | 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 8                        | 72                               |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| White water lily         | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                        | 2                                |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Water star-grass         | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                        | 2                                |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Eurasian water milfoil   | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 5                        | 30                               |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Curly pondweed           | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 4                        | 20                               |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| European frogbit         | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                        | 2                                |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |
| Flowering rush           | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2                        | 6                                |       |        |          |   |   |    |            |   |   |    |                  |   |   |   |                        |   |   |   |               |   |   |    |                  |   |   |   |                  |   |   |   |                        |   |   |    |                |   |   |    |                  |   |   |   |                |   |   |   |     |

| Question number | Answer                                                                                                                                                                                                           | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (d)(ii)         | <ul style="list-style-type: none"> <li>• <math>\sum n(n-1)</math> is 228 (1)</li> <li>• value for <math>N(N-1)</math> is <math>(11 \times 10) = 110</math> (1)</li> <li>• diversity index is 0.48 (1)</li> </ul> | (3)  |

Q17.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Additional guidance                                                                                                                                                                                                                                                                                                                                                           | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | <p>An explanation that includes four of the following points:</p> <ul style="list-style-type: none"> <li>• water for {hydrolysis reactions / form cytoplasm / solvent / hydration} (1)</li> <li>• (some bacteria require) oxygen for (aerobic) respiration (1)</li> <li>• (suitable/optimum) temperature for {enzyme-controlled / metabolic} reactions to occur (at suitable rate) (1)</li> <li>• (suitable/optimum) pH for {enzyme-controlled / metabolic} reactions to occur (at suitable rate) (1)</li> <li>• named organic molecule and an explanation of why that organic molecule is needed (1)</li> </ul> | <p>ACCEPT (some anaerobic bacteria require) no oxygen for anaerobic respiration</p> <p>ACCEPT (suitable) temperature so enzymes do not denature</p> <p>ACCEPT (suitable) pH so enzymes do not denature</p> <p>e.g. glucose for respiration / lipids to provide fatty acid chains for new cell membrane / proteins to provide amino acids for {protein synthesis / growth}</p> | (4)  |

| Question Number | Answer                                                                                                                                                                                                      | Additional guidance                                                                                                                                                                                                                            | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(i)          | <p>A calculation showing the following steps:</p> <ul style="list-style-type: none"> <li>• calculation of difference in mean area of ulcer (1)</li> <li>• calculation of percentage decrease (1)</li> </ul> | <p><u>Example of calculation</u></p> <p><math>(802.71 - 95.71) = 707</math></p> <p><math>\frac{(802.71 - 95.71)}{802.71} \times 100 = 88 / 88.077 / 88.08 / 88.1 (\%)</math></p> <p>Correct answer with no working shown scores full marks</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| (b)(ii)         | <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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><u>Description of data in table</u></p> <ul style="list-style-type: none"> <li>• mass of mucus</li> <li>• ulcer area</li> </ul> <p><u>Conclusions and Explanations</u></p> <ul style="list-style-type: none"> <li>• omeprazole was most effective treatment /none of the extracts were as effective as omeprazole at reducing ulcer area / all treatments resulted in {reduction of ulcer area / increased mass of mucus}</li> <li>• correlation between mucus mass and ulcer area (apart from omeprazole)</li> <li>• bacteria damage stomach lining causing ulcers</li> <li>• suggestion that {omeprazole / extract} increases mucus production</li> <li>• high mucus content prevents bacteria {reaching / damaging} stomach lining</li> <li>• explanation of how mucus production links to ulcer area</li> <li>• high mucus content prevents acid contents damaging stomach lining</li> </ul> <p><u>Sustained</u></p> <ul style="list-style-type: none"> <li>• link to biological process resulting in increased mucus production</li> <li>• {omeprazole / extract} causes the {stomach lining / goblet cells} increases mucus production</li> <li>• suggestion that {omeprazole / extract} reduces acidity of stomach making it less suitable for <i>H. pylori</i></li> <li>• antimicrobial properties of {omeprazole / extract} reducing {number / reproduction} of bacteria</li> <li>• therefore {slow population growth / reduced population of bacteria} results in {reduced damage to stomach lining / smaller ulcer area}</li> </ul> | (6) |

|         |     |                                                                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                                                                                                    |
|---------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 0 | 0   | No awardable content                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                        |
| Level 1 | 1-2 | <p>An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information.</p> <p>The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.</p>       | <p>Either</p> <p>Description of:<br/>mass of mucus data<br/>and/or<br/>ulcer area data</p> <p>OR</p> <p>description of one<br/>and/or<br/>conclusion / explanation of one data set</p> |
| Level 2 | 3-4 | <p>An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning, with some structure.</p>                                                                            | <p>description of both data plus:<br/>explanation of mass of mucus / ulcer area<br/>and/or<br/>simple conclusion of most effective treatment</p>                                       |
| Level 3 | 5-6 | <p>An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.</p> | <p>all level 2 plus:<br/>a detailed explanation using sustained application. The detail of sustained application determines the mark in this level.</p>                                |

Q18.

| Question Number | Answer                                                                                                                                                                                          | Additional guidance                                                                                                                                                                                                              | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | <p>An answer that includes two of the following points:</p> <ul style="list-style-type: none"> <li>minerals (1)</li> <li>(suitable) pH (1)</li> <li>(suitable) light (intensity) (1)</li> </ul> | <p>ACCEPT named mineral e.g. phosphate, nitrates<br/>ACCEPT oxygen, nitrogen, carbon dioxide, water<br/>ignore nutrients / moisture / predation / glucose / temperature</p> <p>ACCEPT suitable wavelength of light /sunlight</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                 | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(i)</b>   | <p>The only correct answer is D William Withering</p> <p><i>A is not correct because Withering tested his digitalis soup</i></p> <p><i>B is not correct because Withering tested his digitalis soup</i></p> <p><i>C is not correct because Withering tested his digitalis soup</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                    | Additional guidance                                                    | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------|
| <b>(b)(ii)</b>  | <p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> <li>patients given a range of {doses / concentrations} / doses increase in concentration (throughout the investigation) (1)</li> <li>(to allow selection of) lowest effective concentration / highest dose that can be tolerated without serious side effects (1)</li> </ul> | ACCEPT (selection of) dose that is effective with minimal side effects | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                                                                                                                             | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(iii)</b> | <p>A description that includes the following points:</p> <ul style="list-style-type: none"> <li>(selection of) patients with (colon / kidney) <b>cancer</b> (1)</li> <li>{half / one group} given {curacin A / (this) cancer drug} and {half / one group} given current (best) drug (1)</li> <li>neither doctor nor patient knows which treatment has been given (1)</li> <li>analysis of data to see if curacin A is more effective than the {current best drug / placebo} (1)</li> </ul> | <p>ignore ref to stage of trial</p> <p>ACCEPT placebo / sugar pill</p> <p>ACCEPT analysis to see if there is a {significant difference/improvement} between those who took the drug compared to the placebo</p> | <b>(4)</b> |

Q19.

| Question Number | Answer                                                                                                                                                                                 | Additional guidance                                       | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------|
| <b>(a)(i)</b>   | <p>An answer that includes the following point:</p> <ul style="list-style-type: none"> <li>group of (similar) cells (working together to) perform a (specific) function (1)</li> </ul> | ACCEPT cells with similar {structure / function / origin} | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                | Additional guidance                                                                                                                        | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(a)(ii)</b>  | <p>An answer that includes the following points:</p> <ul style="list-style-type: none"> <li>patient P has a mitotic index of 20 (1)</li> <li>patient R has a mitotic index of 45 (1)</li> <li>correct order of cancer stage identified (1)</li> </ul> | <p>e.g. P has an earlier stage of cancer (than R), R has a more advanced stage of cancer<br/>ACCEPT ecf from calculated MI for P and R</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Additional guidance                                                          | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------|
| <b>(b)</b>      | <p>An answer that includes at least one similarity and one difference:</p> <p>similarity:</p> <ul style="list-style-type: none"> <li>the survival probability decreases over time (for all three stages) (1)</li> </ul> <p>differences:</p> <ul style="list-style-type: none"> <li>stage I has the highest survival probability for all years whereas stage IV has the lowest probability for all years (1)</li> <li>stage IV has the {fastest/steeper} decrease (in survival probability) / stage I has the slowest decrease (in survival probability) (1)</li> </ul> | <p>ACCEPT correct order of survival probability for a point on the graph</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                      | Additional guidance                                                                                                                                                 | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(c)</b>      | <p>A description that includes the following points:</p> <ul style="list-style-type: none"> <li>correct description of a placebo being given to one group (and the other group receiving (anticancer) drug) (1)</li> <li>neither the patient nor the doctor knows whether the patient is receiving (the drug or) the placebo (1)</li> </ul> | <p>ACCEPT description of a placebo e.g. has no active ingredient / already known drug / sugar pill / dummy drug</p> <p>ACCEPT scientist / researcher for doctor</p> | <b>(2)</b> |

| Question number | Answer                                                                                       | Mark |
|-----------------|----------------------------------------------------------------------------------------------|------|
| (a)             | <ul style="list-style-type: none"> <li>{restricted / native} to a particular area</li> </ul> | (1)  |

| Question number | Answer                                                                                                                                                                                        | Additional guidance | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (b)(i)          | <ul style="list-style-type: none"> <li>subtraction (1)</li> <li>percentage (1)</li> </ul> <p>Example of calculation:</p> $5\,500 - 3\,000 / 2\,500$ $(2\,500 \div 5\,500) \times 100 = 45.45$ | Accept 45.5 and 45  | (2)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                         | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(ii)         | <p>An explanation that includes three of the following points:</p> <ul style="list-style-type: none"> <li>because of habitat destruction there is no food (1)</li> <li>because of habitat destruction there is no shelter (1)</li> <li>fragmentation of habitat makes it harder to find a mate (1)</li> <li>therefore, there is a decrease in genetic diversity (1)</li> </ul> | (3)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                              | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(i)          | <p>A description that includes the following points:</p> <ul style="list-style-type: none"> <li>sperm observed under a microscope to assess {motility / ability to swim in a straight line} (1)</li> <li>use of {stains / microscope} to observe the integrity of the acrosome (1)</li> <li>comparisons need to be made to freshly collected sperm so that effects can be calculated (1)</li> </ul> | (3)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(ii)         | <p>An explanation that includes any four of the following points:</p> <ul style="list-style-type: none"> <li>because sperm can be frozen from different males to increase genetic diversity (1)</li> <li>because frozen sperm will always be available if numbers of Baird's tapir decrease too far (1)</li> <li>can freeze sperm so that they are available when females come in to season (1)</li> <li>freezing could reduce the number of successful fertilisations because of poor viability (1)</li> <li>more sperm would need to be used as viability is low, reducing stocks (1)</li> </ul> | (4)  |

Q21.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                          | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | <p>An answer that includes three of the following points:</p> <ul style="list-style-type: none"> <li>deforestation / loss of habitat (1)</li> <li>increased grazing (of forest) (1)</li> <li>reduced number of new trees (1)</li> <li>disease (that has killed the trees) (1)</li> <li>reduced genetic diversity (1)</li> </ul> | <p>ACCEPT loss of trees due to natural events e.g. landslides / tsunamis / fire / poor soil quality</p> <p>ACCEPT new grazing species</p> <p>e.g. reduced {pollination / reproduction / pollinators} / tree doesn't flower often / reduced enzyme activity due to {changing temperatures / drought} / few trees producing seeds / {air pollution / global warming / climate change}</p> <p>e.g. fungal disease</p> <p>ACCEPT reproduce asexually so no variation</p> | (3)  |

| Question Number | Answer                                                                                                                                                                      | Additional guidance                                                                                                                                                                                                                                                                                                               | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(i)          | <ul style="list-style-type: none"> <li>correct line measurement and conversion (1)</li> <li>correct calculation (1)</li> <li>correct answer in standard form (1)</li> </ul> | <p>ACCEPT <math>\pm 1\text{mm}</math></p> <p><u>Example of calculation:</u><br/> <math>38\,000\mu\text{m}</math><br/> <math>(38\,000 \div 200) = 190\,(\mu\text{m})</math><br/> <math>1.9 \times 10^2\,(\mu\text{m})</math><br/>           ecf applies<br/>           Correct answer with no workings shown scores full marks</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                              | Additional guidance                                                                             | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------|
| (b)(ii)         | <p>An answer that includes the following points:</p> <ul style="list-style-type: none"> <li>{transport/ translocation} of {sucrose / amino acids} (1)</li> <li>from {source / site of production / leaves} to {sink / site of use / site of storage} (1)</li> </ul> | <p>ACCEPT products of photosynthesis / lipids / hormones / mRNA / sugars<br/>ignore glucose</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                       | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(iii)        | <p>The only correct answer is C two</p> <p><i>A is not correct because all the statements are correct apart from, they do not contain cytoplasm</i></p> <p><i>B is not correct because all the statements are correct apart from, they do not contain cytoplasm</i></p> <p><i>D is not correct because they do not contain cytoplasm</i></p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)             | <p>An answer that includes three of the following points:</p> <ul style="list-style-type: none"> <li>the edge of the xylem is closer to the {outside of the structure / epidermis} (than the phloem) in the root / the phloem is closer to the {outside of the structure / epidermis} than the xylem in the stem (1)</li> <li>xylem and phloem are contained in (separate vascular) bundles in the stem (1)</li> <li>more equal phloem:xylem in stem (whereas 4:1 in root)</li> <li>(xylem and phloem / (vascular) bundles) are arranged in {outer part of / a circular pattern in} stem (1)</li> </ul> | <p>ACCEPT xylem and phloem are separated by cambium in stem ignore sclerenchyma/parenchyma<br/>ACCEPT xylem and phloem together make an oval shape</p> <p>ignore {sizes/number unqualified} of {xylem/phloem}</p> <p>ACCEPT both xylem and phloem are closer to epidermis in stem<br/>ACCEPT (xylem and phloem/ (vascular) bundles) are arranged in all areas of stem (in monocots)<br/>ACCEPT vascular tissue in one area in the root whereas in several areas in the stem<br/>ACCEPT labelled diagram showing the distribution in the stem</p> | (3)  |

Q22.

| Question Number | Answer                                                                                                                                                                                                                             | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)             | <p>The only correct answer is B endemic</p> <p><i>A is not correct because the answer is endemic</i></p> <p><i>C is not correct because the answer is endemic</i></p> <p><i>D is not correct because the answer is endemic</i></p> | (1)  |

| Question Number | Answer                                                                                                                                                                          | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (b)(i)          | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• anatomical (1)</li> <li>• anatomical (1)</li> <li>• behavioural (1)</li> </ul> |                     | (3)  |

| Question Number | Answer                                                                                                                                                                                                                  | Additional guidance                                                                                 | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------|
| (b)(ii)         | <p>An answer that makes reference to one of the following points:</p> <ul style="list-style-type: none"> <li>• competition for a {mate / territory} (1)</li> <li>• competition for food / height of food (1)</li> </ul> | <p>ignore mutation<br/>ACCEPT predators</p> <p>e.g. more food sources<br/>above height of shell</p> | (1)  |

| Question Number | Answer                                                                                                                              | Additional guidance                                                                                         | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|------|
| (c)(i)          | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>• calculation of percentage using correct data (1)</li> </ul> | <p><u>Example of calculation:</u></p> <p><math>(18 \div 27) \times 100 = 66.67\% / 66.7\% / 67\%</math></p> | (1)  |

| Question Number | Answer                                                                                                                                                                                            | Additional guidance                                                                                                                 | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(ii)         | <p>A calculation in which:</p> <ul style="list-style-type: none"> <li>• calculation of increase in population (1)</li> <li>• calculation of percentage increase using correct data (1)</li> </ul> | <p><u>Example of calculation:</u></p> <p><math>1800 - 15 = 1785</math></p> <p><math>(1785 \div 1800) \times 100 = 99.2\%</math></p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(iii)        | <p>An explanation that makes reference to three of the following points:</p> <ul style="list-style-type: none"> <li>analysis of molecular evidence (of the zoo tortoise) (1)</li> <li>comparison (of molecular evidence) to a <i>C. hoodensis</i> tortoise (to see how similar the sequences are) (1)</li> <li>comparison of {phenotype / anatomy/physiology} to a <i>C. hoodensis</i> tortoise (1)</li> <li>breeding the tortoise with a <i>C. hoodensis</i> tortoise to see if <b>fertile</b> offspring are produced (1)</li> </ul> | <p>e.g. DNA / RNA / proteins<br/>ACCEPT molecular phylogeny</p> <p>ACCEPT comparison of bands (from gel electrophoresis) with <i>C. hoodensis</i> tortoise</p> <p>ACCEPT identification of features {exclusive/similar} to <i>C. hoodensis</i></p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                               | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (d)             | <p>An explanation that makes reference to two of the following points:</p> <ul style="list-style-type: none"> <li>DNA analysis to identify different alleles (1)</li> <li>use of Hardy-Weinberg equation / <math>p^2+2pq+q^2</math> (1)</li> <li>(in order to) compare (recessive) allele frequency in previous generation(s) with current generation (1)</li> </ul> |                     | (2)  |

Q23.

| Question Number | Answer                                                                                                                           | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(i)          | <ul style="list-style-type: none"> <li>the (Madagascan pygmy) kingfisher is found only in (forests in) Madagascar (1)</li> </ul> |                     | (1)  |

| Question Number | Answer                                                                    | Additional guidance | Mark |
|-----------------|---------------------------------------------------------------------------|---------------------|------|
| (a)(ii)         | <ul style="list-style-type: none"> <li>Eukarya / Eukaryote (1)</li> </ul> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                | Additional guidance                                                                                                                                      | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(i)          | <p>An answer that includes the following points:</p> <ul style="list-style-type: none"> <li>• <i>Alcedo leucogaster</i> and <i>Alcedo cristata</i> (1)</li> <li>• because they share (the most) recent common ancestor (1)</li> </ul> | <p>Accept they share most similarities in their {DNA / named biological molecule}<br/>Accept converse for <i>Ceyx lecontei</i> and <i>Ceyx picta</i></p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |               |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| (b)(ii)         | <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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> <li>• classification definitions historically based on similarities and differences in phenotype</li> <li>• some examples of phenotypes used for previous classification, e.g. beak shape, bird size, diet, habitat</li> <li>• previous classification had <i>Ceyx madagascariensis</i> as more closely related to other <i>Ceyx</i> kingfishers</li> <li>• more recent classification based on molecular evidence / molecular phylogeny</li> <li>• similarities and differences in mRNA / DNA / amino acid sequences identified</li> <li>• explanation of how they are compared</li> <li>• fewer differences means they are more closely related / have more recent common ancestor</li> <li>• reference to closer together on evolutionary tree</li> <li>• proposed classification had <i>Ceyx madagascariensis</i> as more closely related to <i>Alcedo</i> (<i>leucogaster</i> and / or <i>cristata</i>)</li> <li>• scientist proposing a reclassification</li> <li>• published in scientific journal</li> <li>• reference to peer review (of molecular evidence)</li> <li>• repetition of experiments by other scientists (to see if same data are collected)</li> <li>• extend the analysis e.g. look for similarities / differences in more genes</li> <li>• analysis of data to see if same conclusions can be reached / more research</li> <li>• statistical analysis</li> </ul> | (6)<br>Expert |

|         |     |                                                                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                                                                                                                                                         |
|---------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 0 | 0   | No awardable content                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                             |
| Level 1 | 1-2 | <p>An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information.</p> <p>The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.</p>       | 1 mark – information from one section<br>2 marks – information from two sections                                                                                                                                                            |
| Level 2 | 3-4 | <p>An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning, with some structure.</p>                                                                            | 3 marks – information from three sections<br>4 marks – information from four sections                                                                                                                                                       |
| Level 3 | 5-6 | <p>An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.</p> | 5 marks – information from five sections<br>6 marks – Information from all six sections applied to the given context showing a good understanding of the review process leading to an accepted reclassification by the scientific community |

Q24.

| Question Number | Answer                                                                                                                                                                                                                                    | Additional guidance | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)             | <p>The correct answer is B endemic</p> <p><i>A is incorrect because the correct term is endemic</i></p> <p><i>C is incorrect because the correct term is endemic</i></p> <p><i>D is incorrect because the correct term is endemic</i></p> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                   | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (b)             | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• anatomical (adaptation) (1)</li> <li>• physiological (adaptation) (1)</li> <li>• anatomical (adaptation) (1)</li> </ul> |                     | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                                           | Additional guidance                                                                                                      | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|
| (c)             | <p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>{poison / skin colour/ spots} deters predators / reduce risk of predation (1)</li> <li>adhesive discs allow the frog to (climb / cling to) surfaces (to find food) (1)</li> </ul> | <p>Accept reduce risk of being eaten / protects frog from predators<br/>Ignore camouflage</p> <p>e.g. trees / leaves</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Additional guidance                                                                                                                     | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------|
| (d)             | <p>An answer that makes reference to four of the following:</p> <ul style="list-style-type: none"> <li>(genetic) mutation(s) occurred (1)</li> <li>(new) <b>allele</b> coding for poison production (1)</li> <li>(which then) conferred a selective advantage / (those with poison) more likely to (survive and reproduce / pass alleles to offspring) (1)</li> <li>(therefore) increasing <b>allele</b> frequency (1)</li> <li>(resulting in) new species of frog with the ability to produce poison evolved (1)</li> </ul> | <p>Ignore genes</p> <p>Accept those without the {mutation / poison / advantageous allele} were less likely to survive and reproduce</p> | (4)  |

Q25.

| Question Number | Answer                                                                                                                                                                                                                                                                                                 | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(I)          | <p>The only correct answer is C plant cells and prokaryotic cells</p> <p><i>A is incorrect because prokaryotic cells also have a cell wall</i></p> <p><i>B is incorrect because animal cells do not have a cell wall</i></p> <p><i>D is incorrect because animal cells do not have a cell wall</i></p> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Additional guidance                                                                                                                 | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(II)         | <p><b>Drawing (2):</b></p> <ul style="list-style-type: none"> <li>{double (nuclear) membrane / nuclear envelope} obvious</li> <li>nuclear pores shown and (1 or more) nucleoli present</li> </ul> <p><b>Labels (max 2):</b></p> <ul style="list-style-type: none"> <li>(nuclear) envelope / <u>double</u> membrane / {inner / outer} (nuclear) membrane</li> <li>(nuclear) pore</li> <li>nucleolus</li> <li>correct reference to chromatin / nucleoplasm</li> </ul> | <p>if one incorrect label, max of 1 label mark<br/>if two incorrect labels then no label marks can be awarded</p> <p>Ignore DNA</p> | (4)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                              | Additional guidance                                                                                        | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------|
| (b)(I)          | <p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> <li>the two {layers (of the membrane) / membranes} are very close together / there is a very small distance between the {two layers / membranes} (1)</li> <li>therefore, the <b>resolution</b> of a light microscope is not high enough (1)</li> </ul> | <p>Accept the bilayer structure is very close together</p> <p>Ignore the bilayer is too {small / thin}</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)(II)         | <p>A calculation showing the following steps:</p> <ul style="list-style-type: none"> <li>length of XY measured correctly +/- 1mm (1)</li> <li>calculation of actual size (1)</li> <li>correct answer given in <math>\mu\text{m}</math> (1)</li> </ul> | <p>Mark the answer on answer line first</p> <p><u>Example of calculation</u></p> <p>26 mm / 2.6 cm</p> <p><math>26 \div 200 = 0.13 \text{ (mm)}</math></p> <p><math>= 130 \text{ (}\mu\text{m)}</math></p> <p>Correct answer scores full marks</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                               | Additional guidance           | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------|
| (b)(III)        | <p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> <li>form spindle (fibres / poles) in (prophase / mitosis / meiosis / cell division) (1)</li> <li>to separate {chromosomes/ chromatids} (1)</li> </ul> | Ignore DNA / genetic material | (2)  |

Q26.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                 | Additional guidance | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(I)          | <p>The correct answer is C two</p> <p><i>A is incorrect because lignin gives waterproofing properties and can form spiral shapes</i></p> <p><i>B is incorrect because lignin gives waterproofing properties and can form spiral shapes</i></p> <p><i>D is incorrect because lignin does not add strength to the cell membranes</i></p> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                   | Additional guidance                                                                                                                                                                                                                    | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (a)(II)         | <p>Similarity (1)</p> <ul style="list-style-type: none"> <li>both contain {cellulose / pits / dead cells / secondary walls}</li> <li>both {are hollow / do not contain cytoplasm}</li> </ul> <p>Difference (1)</p> <ul style="list-style-type: none"> <li>sclerenchyma contain end walls whereas xylem do not</li> </ul> | <p>Ignore cell walls unqualified</p> <p>Ignore no nucleus</p> <p>Accept sclerenchyma are {pointed/closed} at each end whereas xylem are {not / open at each end}</p> <p>Accept xylem contain tracheids whereas sclerenchyma do not</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                       | Additional guidance | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (b)             | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• hemp is renewable / more can be grown / will not run out (1)</li> <li>• available to future generations (1)</li> </ul> |                     | (2)  |

| Question Number | Answer                                                                                                                                                                                                           | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                     | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(i)          | <ul style="list-style-type: none"> <li>• calculation of mean yearly increase (1)</li> <li>• calculation of total volume in 2020 (1)</li> <li>• correct answer for total volume in 2020 with units (1)</li> </ul> | <p>Example of calculation<br/> <math>(84,600,000,000 - 17,000,000,000) \div 11 = 6145454545.45</math></p> <p><math>(6145454545.45 \times 20) = 1229090909 + 17,000,000,000 = 1.39 \times 10^{11} / 1.4 \times 10^{11} / 139909 \times 10^6</math></p> <p><math>= 1.39 \times 10^{11} \text{ dm}^3 / 1.4 \times 10^{11} \text{ dm}^3 / 139909 \times 10^6 \text{ dm}^3</math></p> <p>Correct answer with no working gains full marks</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * (c)(ii)       | <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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• indication of sustainability in the context of biofuel production e.g. more plants can be grown, renewable</li> <li>• available for future generations</li> <li>• consideration of carbon neutral or removal of carbon dioxide from atmosphere (by photosynthesis) as plant is growing</li> <li>• consideration of lower carbon emissions than fossil fuels</li> <li>• linkage to greenhouse effect / global warming</li> <li>• some biofuels require limited resources</li> <li>• hemp produces the least carbon dioxide emissions of all fuels</li> <li>• hemp and sugar beet require the least water</li> <li>• hemp and soybean require fewer fertilisers</li> <li>• hemp requires fewer fertilisers</li> <li>• hemp requires fewest resources</li> <li>• consideration of reduced water requirements for producing biofuels than food production</li> <li>• hemp requires fewest resources so lowest production costs</li> <li>• bioethanols require fewer resources so lower production costs</li> </ul> <p><b>Disadvantages</b></p> <ul style="list-style-type: none"> <li>• rapeseed and soybean production require high levels of water</li> <li>• rapeseed and sugar beet production require high levels of fertilisers</li> <li>• rapeseed, soybean and sugar beet production require high levels of pesticides</li> <li>• rapeseed requires highest level of resources</li> <li>• consideration of effect of fertilisers on ecosystem</li> <li>• consideration of effect of pesticides on ecosystem</li> <li>• disadvantage of reduced land available for food production</li> <li>• disadvantage of reduced water available for food production</li> <li>• disadvantage of reduced water available for population</li> <li>• cost of providing resources</li> <li>• biodiesels require more resources so higher production costs</li> </ul> <p>• supported conclusion of which bioethanol fuel would be most sustainable</p> |

(6)

|         |     |                                                                                                                                                                                                                                                                                                                                           | Additional guidance                                                                                                                                                                                                                                            |
|---------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 0 | 0   | No awardable content                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                |
| Level 1 | 1-2 | Limited scientific judgement made with a few strengths / weaknesses identified.<br><br>A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgment being made.                                                                             | simple description of trends shown in the graph / table linked to basic advantages or disadvantages = lower mark<br><br>simple description of trends shown in the graph / table linked to basic advantages AND disadvantages = higher mark                     |
| Level 2 | 3-4 | A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses identified.<br><br>A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.                                           | All level 1 plus <b>sustainability</b> should be considered to access level 2<br><br>conclusion of which biofuel would be best attempted linked to the information given for lower mark<br><br>linked to the farmer OR population OR ecosystem for higher mark |
| Level 3 | 5-6 | A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information.<br><br>A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. | all level 2 plus<br>consideration to effect on two from farmer OR population OR ecosystem lower mark<br><br>consideration to effect on three from farmer OR population OR ecosystem higher mark                                                                |

Q27.

| Question Number | Answer                                                                                                                                                                    | Additional guidance                                                                                    | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------|
| (a)             | <ul style="list-style-type: none"> <li>(a group of) organisms that are capable of {(inter)breeding / mating / reproducing} and producing fertile offspring (1)</li> </ul> | Do not accept inbreeding<br>Accept 'offspring capable of producing offspring' as equivalent to fertile | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Additional guidance                                                                                                                                                                     | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)</b>      | <p>An explanation that includes four of the following points:</p> <ul style="list-style-type: none"> <li>as the concentration of herbicide increases the (mean) number of (insect) species decreases (1)</li> <li>increase of <math>100 \text{ mg dm}^{-3}</math> results in a decrease of {6.2 species /68.9%} (1)</li> <li>use of herbicides results in {fewer plant species / reduced plant diversity / reduced food supply (for insects)} (1)</li> <li>{(therefore) some insects (species) {leave habitat / die (from lack of food)}} (1)</li> <li>{(fewer plant species results in) fewer habitats for insects} (1)</li> </ul> | <p>Ignore converse statement<br/>Accept negative correlation</p> <p>Accept other correct reductions</p> <p>Ignore herbicides kill insects</p> <p>Accept reduced shelter for insects</p> | <b>(4)</b> |

Q28.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(a)</b>      | <p>An explanation that makes reference to three of the following points:</p> <ul style="list-style-type: none"> <li>• fewer young tree shoots eaten (after wolves were reintroduced) (1)</li> <li>• (because) elk would not graze undisturbed when wolves were around (1)</li> <li>• more (young tree shoots) were eaten in forest habitat (than riverside habitat) / fewer (young tree shoots) were eaten in riverside habitat (than forest habitat) (1)</li> <li>• (because) the mature trees provided some {camouflage / protection} (from the wolves) (1)</li> </ul> | <p>ACCEPT the percentage (of young tree shoots eaten) decreased</p> <p>ACCEPT converse<br/>ACCEPT because some elk have been eaten by wolves / fewer elk because wolves are predators (of elk)</p> <p>ACCEPT {larger/more rapid} decrease (in number of shoots eaten) in riverside habitat</p> <p>ACCEPT (because) elk can hide (from the wolves) in the forest / elk have no {hiding places / protection} from being seen (by the wolves) by the river<br/>ACCEPT predation of elk is higher in riverside (habitat)</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Additional guidance                                                                                                                                                                                     | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)</b>      | <p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• as the number of elk (per km<sup>2</sup>) increases the average beaver lifespan decreases (1)</li> <li>• {larger/rapid} decrease {initially / as population increases from 30 elk (per km<sup>2</sup>)} (1)</li> <li>• very little change in average lifespan of beavers when the number of elk increase above {70/80/90} elk per km<sup>2</sup> (1)</li> </ul> | <p>ACCEPT negative correlation</p> <p>ACCEPT {exponential / non-linear} decrease</p> <p>ACCEPT the beaver lifespan plateaus when the number of elk increase above {70/80/90} elk per km<sup>2</sup></p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                          | Additional guidance  | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------|
| <b>(c)(i)</b>   | <p>An answer which includes the following points:</p> <ul style="list-style-type: none"> <li>• (count) number of species (1)</li> <li>• {area / size} of habitat (1)</li> </ul> | ACCEPT per unit area | <b>(2)</b> |

| Question Number | Answer                           | Additional guidance                                                                                               | Mark |
|-----------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------|------|
| (c)(ii)         | $D = \frac{N(N-1)}{\sum n(n-1)}$ | <p>ACCEPT other correct equations</p> <p>e.g. simple biodiversity index = species richness ÷ species evenness</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *(d)            | <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 indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><u>Basic</u></p> <ul style="list-style-type: none"> <li>increasing numbers of wolves (until 2003) / decrease in number of wolves (from 2007 to 2010)</li> <li>overall increase in wolves / 20 more wolves in 2010 (than in 1995)</li> <li>the numbers of elk decreased as they were hunted by the wolves</li> <li>overall decrease in numbers of elk (from 1995 to 2010)</li> <li>the number of cottonwood shoots rapidly increased (after 2003)</li> <li>the number of beaver colonies increased from 1 (in 1999) to 12 (in 2009)</li> </ul> |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |
|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|  | <p><u>Linkage</u></p> <ul style="list-style-type: none"> <li>the numbers of cottonwood shoots increased {when the numbers of elk decreased / as they weren't being eaten}</li> <li>beavers and elk have similar niches / beavers were outcompeted for young tree shoots by elk</li> <li>beaver {numbers/colonies} started to increase when {elk population size decreased / more shoots were available}</li> <li>discussion of causes of decrease in wolf population e.g. decrease in elk food source • introduction of wolves increases biodiversity</li> </ul> <p><u>Sustained</u></p> <ul style="list-style-type: none"> <li>{more ponds / new habitat} increase {number of species / species richness / biodiversity}</li> <li>more trees {woodland and riverside habitats} increase {number of species / species richness / biodiversity}</li> <li>biodiversity increases due to additional species in Yellowstone National Park e.g. wolf</li> </ul> | (6)<br>Expert |
|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|

|         |     |                                                                                                                                                                                                                                                                                                                                                                                                              | Additional guidance                                               |
|---------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| Level 0 | 0   | No awardable content                                                                                                                                                                                                                                                                                                                                                                                         |                                                                   |
| Level 1 | 1-2 | Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures.<br>The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. | Information from one section                                      |
| Level 2 | 3-4 | Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts / concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures.<br>The discussion shows some linkages and lines of scientific reasoning with some structure.                                        | Information from two sections<br>linkage of 2 concepts            |
| Level 3 | 5-6 | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant biological facts / concepts. Consequences are discussed which supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures.<br>The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.         | Level 2 plus<br>Discussion of how biodiversity would be increased |

Q29.

| Question Number | Answer                                                                             | Additional guidance                                                                       | Mark |
|-----------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------|
| (a)(i)          | <ul style="list-style-type: none"> <li>correct magnification calculated</li> </ul> | ACCEPT range between x 14 000 - x 18 000<br>ACCEPT correct magnification in standard form | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                          | Additional guidance                          | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|------|
| (a)(ii)         | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>too small (<math>0.5\mu\text{m}</math>) to be viewed (under a light microscope) / magnification (of x 14 000-16 000) can't be achieved by a light microscope / resolution would be too low} (1)</li> </ul> | ecf applies<br>ignore references to 3D image | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Additional guidance                                                                                                                                                                                                                 | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (b)             | <p>An explanation that makes reference to two of the following points:</p> <ul style="list-style-type: none"> <li>plant based packaging is (more) sustainable / biodegradable / carbon neutral (than traditional oil-based packaging) (1)</li> <li>(the antimicrobial property of the oregano oil) will {reduce the numbers of (<i>L. monocytogenes</i>) bacteria / prevent bacterial growth (on the food) / prevent microbial growth} (1)</li> <li>(resulting in) fewer people getting {listeriosis / (microbial) disease} (1)</li> </ul> | <p>ACCEPT plant-based packaging is {renewable / available for future generations}</p> <p>ACCEPT kill bacteria<br/>ignore reduce microbes entering packaging</p> <p>ACCEPT so food will not go off as quick / extends shelf life</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                               | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (c)(i)          | <p>The only correct answer is C</p> <p><i>A is not correct because L. monocytogenes is least affected by the chemicals</i></p> <p><i>B is not correct because L. monocytogenes is least affected by the chemicals</i></p> <p><i>D is not correct because L. monocytogenes is least affected by the chemicals</i></p> | (1)  |

| Question Number | Answer                                                           | Additional guidance                                                                                | Mark |
|-----------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------|
| (c)(ii)         | <ul style="list-style-type: none"> <li>6.14 / 6.1 / 6</li> </ul> | <p><u>Example of calculation:</u></p> <p>11.1+0.63=11.73<br/>6.0-0.41=5.59<br/>11.73-5.59=6.14</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                             | Additional guidance                                                                                                                                                                                                                                                                 | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| (d)             | <p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>to test for side-effects (1)</li> <li>to determine {safe / minimum / effective/ suitable} {dosage / concentration} (1)</li> <li>to determine if it is more effective than {existing treatments / placebo} (1)</li> </ul> | <p>ignore to check for safety<br/>do not accept testing for side effects in context of {in-vitro/animal}</p> <p>ACCEPT to {determine optimum dosage / adjust dose}</p> <p>ACCEPT compare effectiveness with {existing treatments / placebo}<br/>ignore to see if it's effective</p> | (3)  |

Q30.

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                         | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(i)          | <p>The only correct answer is B one</p> <p>A is not correct because starch only contains <math>\alpha</math>-glucose and is stored in amyloplast</p> <p>C is not correct because starch only contains <math>\alpha</math>-glucose and is stored in amyloplast</p> <p>D is not correct because starch only contains <math>\alpha</math>-glucose and is stored in amyloplast</p> |                     | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| (a)(ii)         | <p>The only correct answer is C two</p> <p><i>A is not correct because they are all correct apart from contains <math>\alpha</math>-glucose and <math>\beta</math>-glucose</i></p> <p><i>B is not correct because they are all correct apart from contains <math>\alpha</math>-glucose and <math>\beta</math>-glucose</i></p> <p><i>D is not correct because they are all correct apart from contains <math>\alpha</math>-glucose and <math>\beta</math>-glucose</i></p> |                     | (1)  |

| Question Number | Answer                                                                                                             | Additional guidance                                                                                                                    | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(i)</b>   | <ul style="list-style-type: none"> <li>• (bacterial) chromosome</li> <li>and</li> <li>• (70S) ribosomes</li> </ul> | <p>Both structures required for the mark</p> <p>Accept nucleoid / (circular) DNA / plasmid / (m)RNA</p> <p>ignore size of ribosome</p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                    | Additional guidance                                                                                                                                                                                                                                                                           | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>(b)(ii)</b>  | <p>An explanation that includes three of the following points:</p> <ul style="list-style-type: none"> <li>• oxygen for (aerobic) respiration (1)</li> <li>• glucose for respiration / amino acids for protein synthesis (1)</li> <li>• optimum temperature for (faster) {enzyme / metabolic} reaction (1)</li> <li>• optimum pH for (faster) {enzyme / metabolic} reaction (1)</li> </ul> | <p>accept lack of oxygen for survival of obligate anaerobes</p> <p>accept water for {hydrolysis reactions / solvent}</p> <p>accept suitable stated temperature for {faster/optimum} enzyme rate of reaction</p> <p>accept suitable stated pH for {faster/optimum} enzyme rate of reaction</p> | <b>(3)</b> |