PEARSON EDEXCEL IAL BIOLOGY · YBI11

BIOLOGY



EXAM QUESTION PACK

UNIT 2: PLANT STRUCTURE AND FUNCTION, BIODIVERSITY AND CONSERVATION

SCORE	PERCENTAGE
/310	%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. Pearson Edexcel has not endorsed, approved or been involved in the production of it. Pearson Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

Pearson Edexcel publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

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.

(2)

.....

.....

.....

.....

.....

.....

(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.

(2)

.....

.....

.....

.....

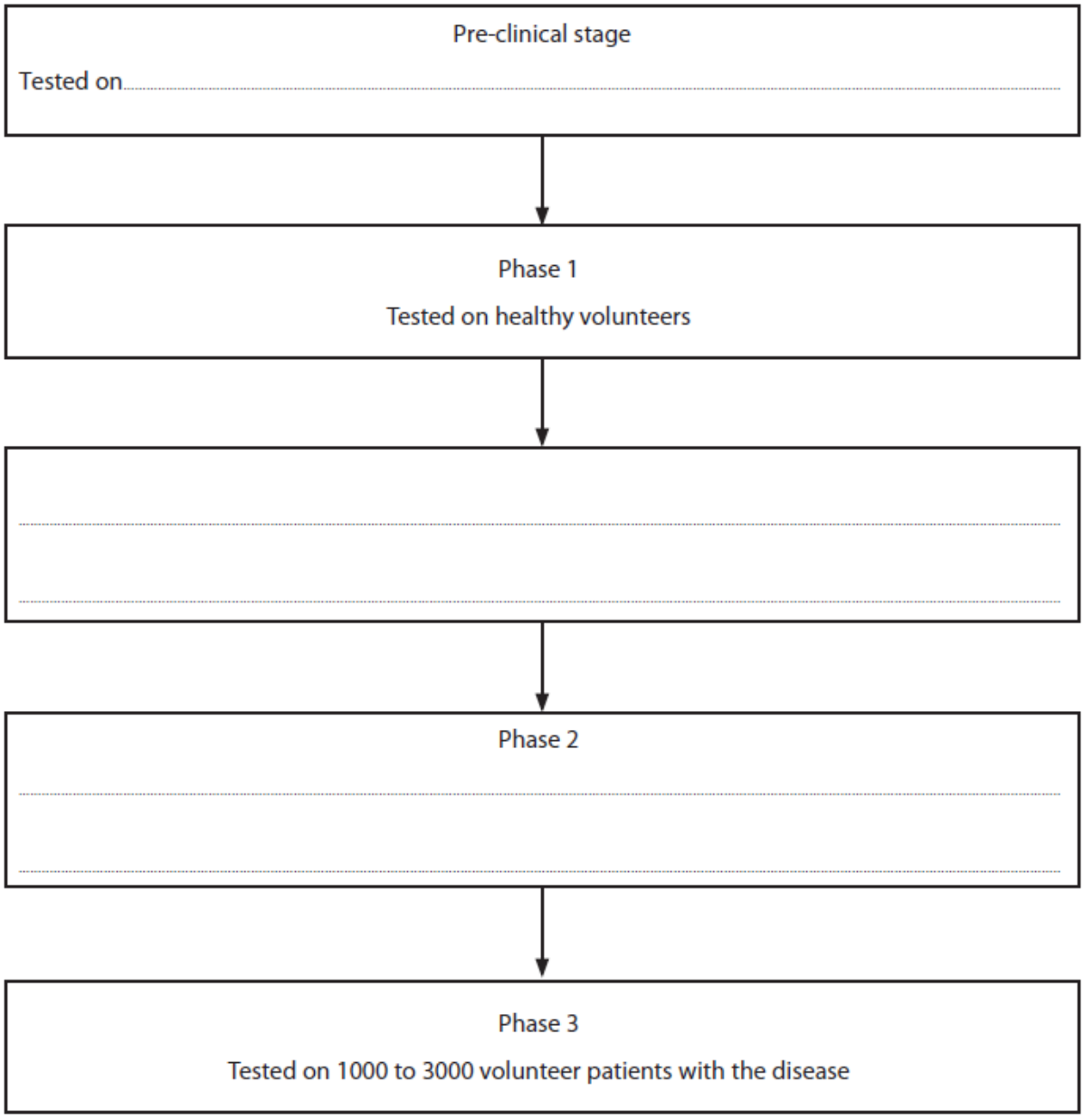
.....

.....

(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.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

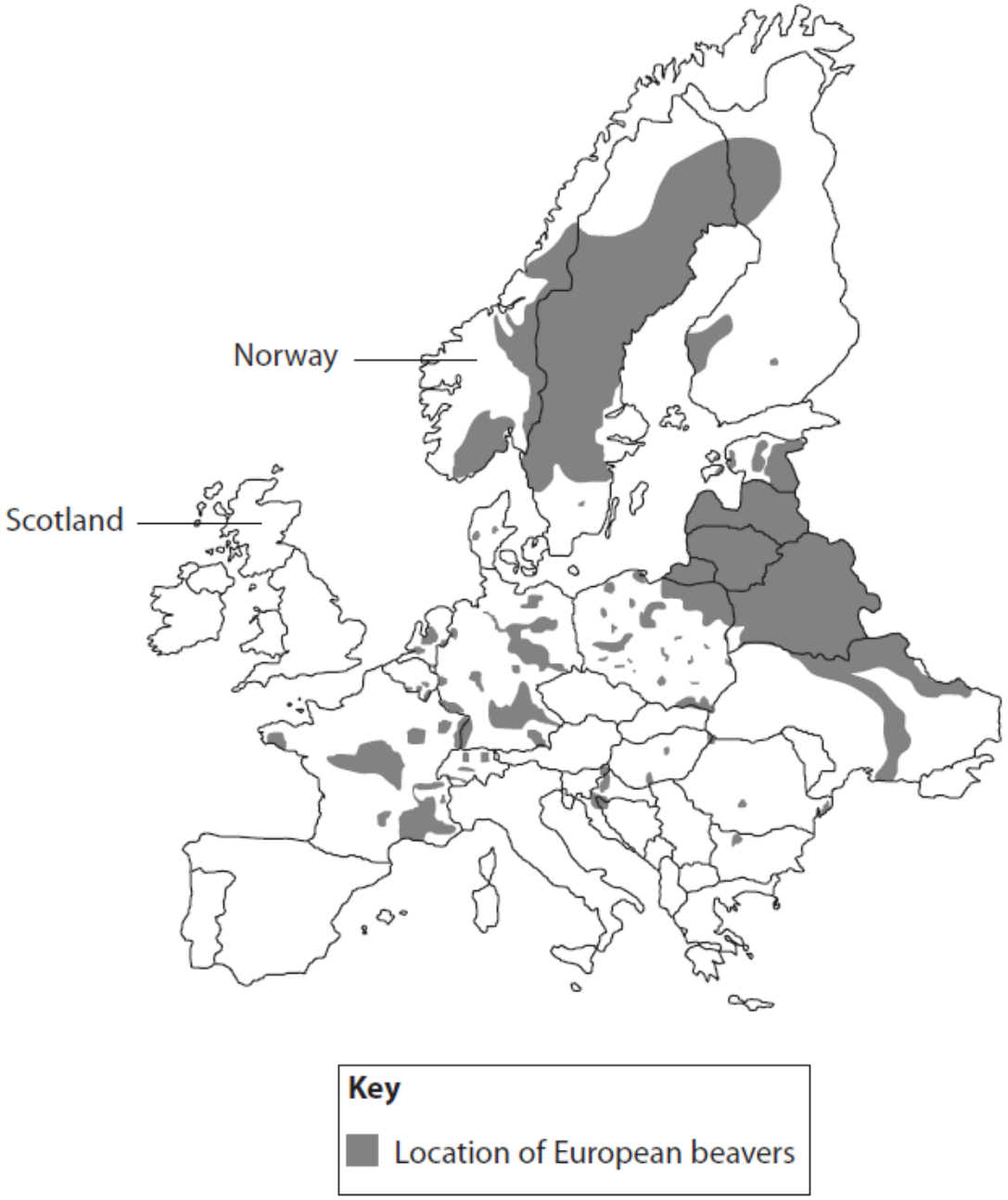
*(b) Some scientists were concerned that the low numbers of beavers reintroduced

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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) In a beaver population, the frequency of a recessive homozygous genotype is 0.09.

Calculate the percentage of beavers in this population that are homozygous for the dominant allele, using the equation

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

(3)

Answer ..... %

(Total for question = 13 marks)

Q3.

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

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



© kaschibo/Shutterstock

Magnification ×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
☐ **A**	anatomical	behavioural	physiological
☐ **B**	anatomical	physiological	behavioural
☐ **C**	physiological	anatomical	behavioural
☐ **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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

(2)

.....

.....

.....

.....

.....

.....

(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.

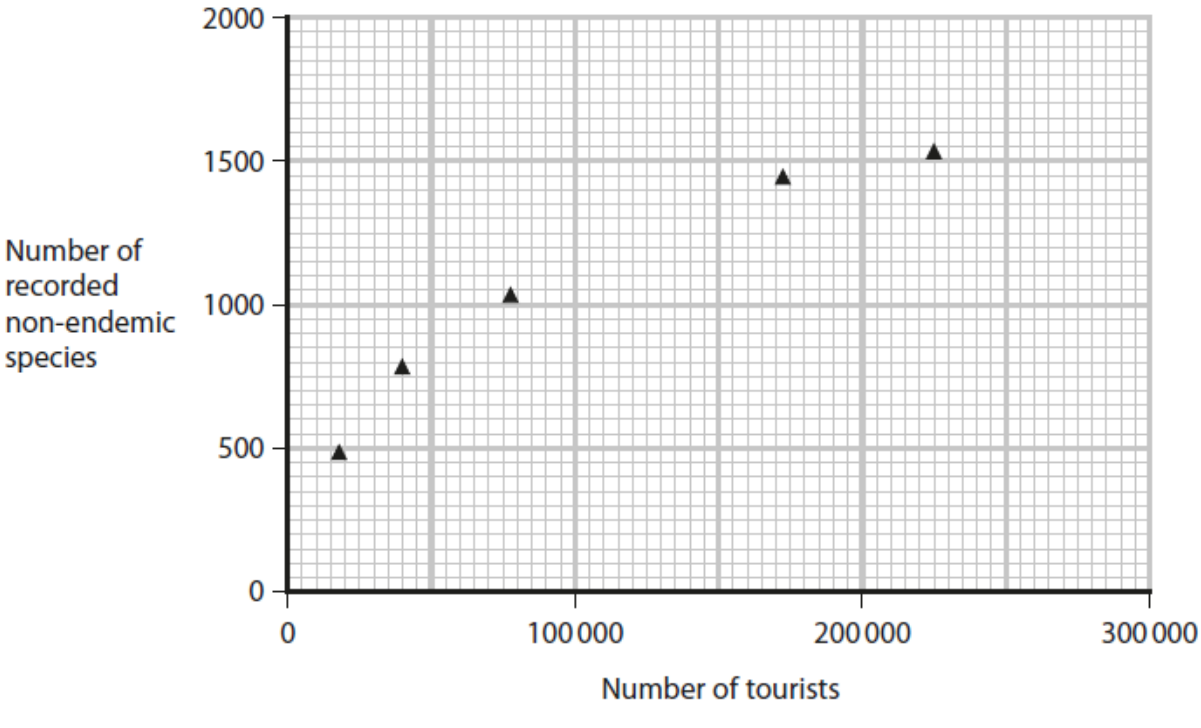
Assume that the rate of increase stays constant.

(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)

.....

.....

.....

.....

(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.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

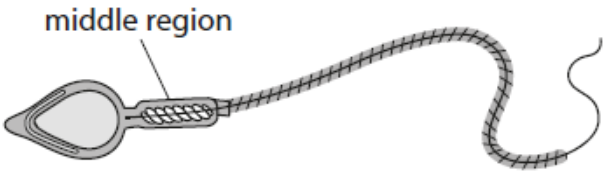
.....

.....

.....

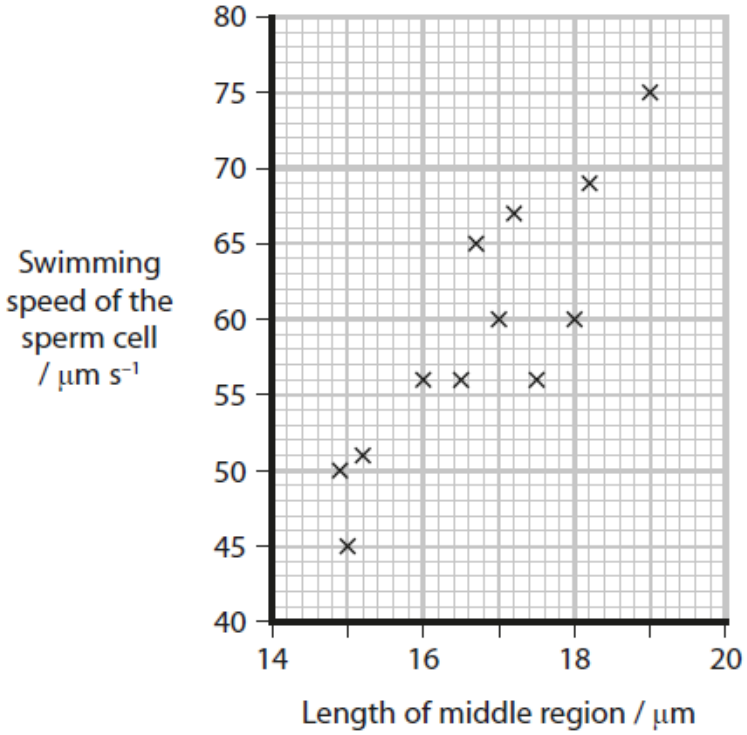
*(b) Organisms have evolved different mating strategies such as:

- 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.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

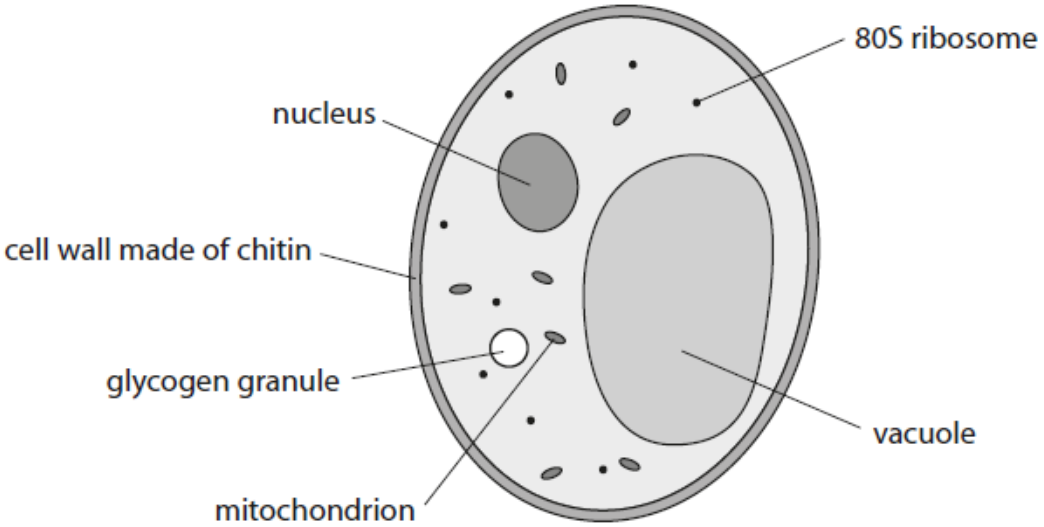
.....

(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.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

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



© blickwinkel / Alamy Stock Photo

The fungus *Epichloë festucae* lives within darnel 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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

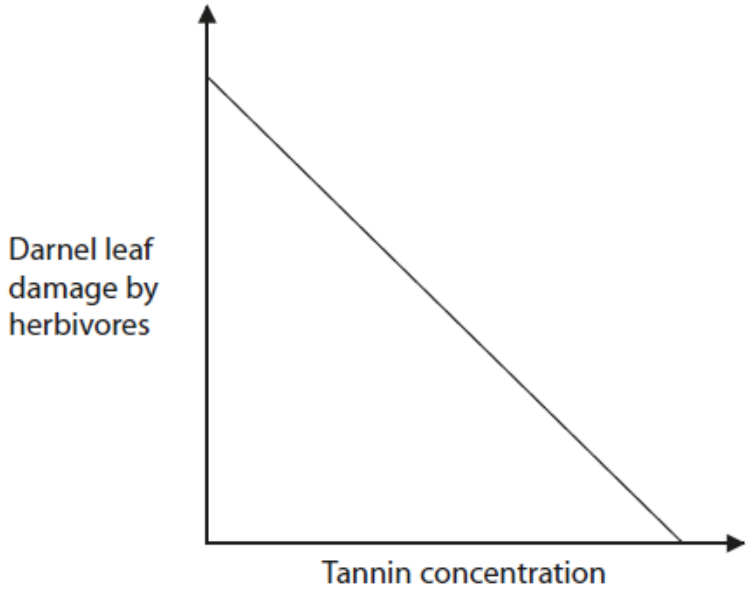
*(ii) The fungus and the plant both benefit from this relationship.

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 / $\mu g\ cm^{-3}$	Diameter of inhibition zone / 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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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.

(2)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

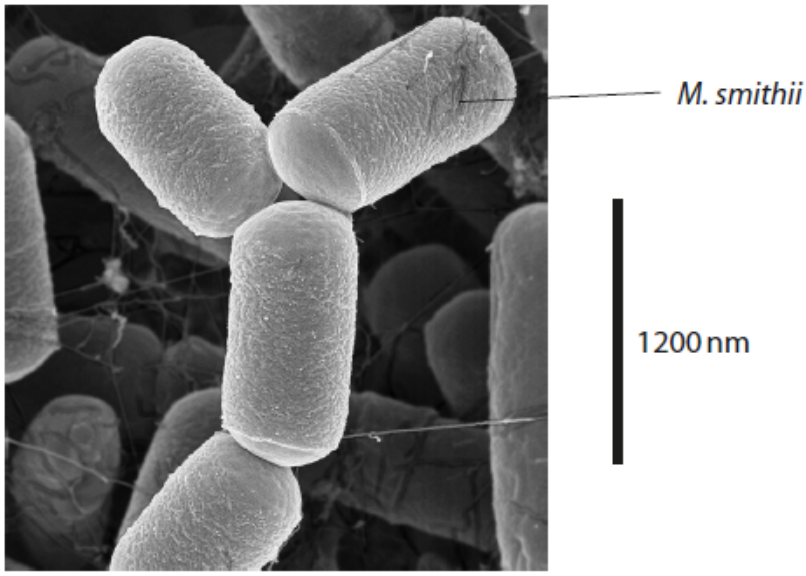
.....

(Total for question = 15 marks)

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)

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

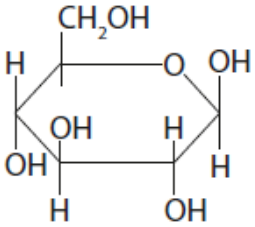
(Total for question = 9 marks)

Q8.

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** α-glucose

☒ **B** β-glucose

☒ **C** starch

☒ **D** sucrose

(ii) Which is a feature of cellulose molecules?

(1)

☒ **A** contain peptide bonds

☒ **B** contain α-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)

.....

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

(1)

.....

(Total for question = 5 marks)

Q9.

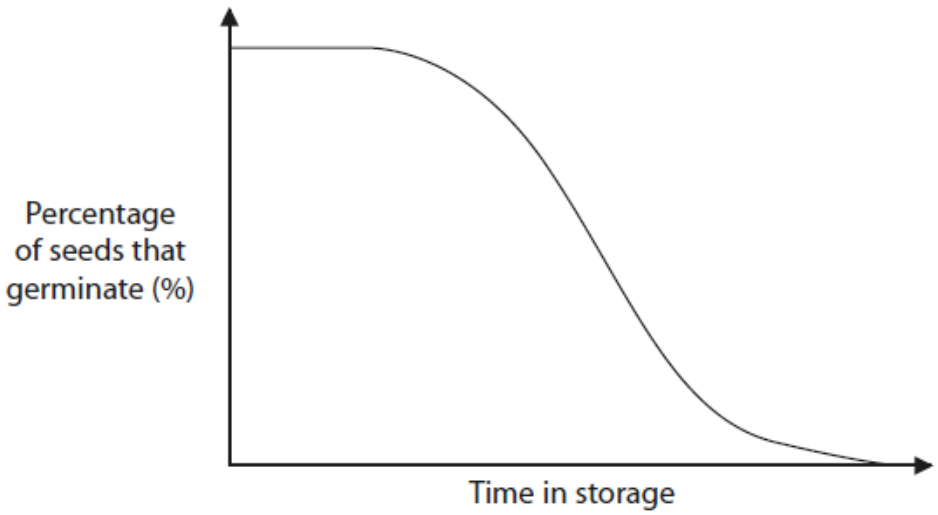
Seed banks are used to store seeds from a wide variety of plants. Some plants are a sustainable source of bioplastics.

(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)

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

(2)

.....

.....

.....

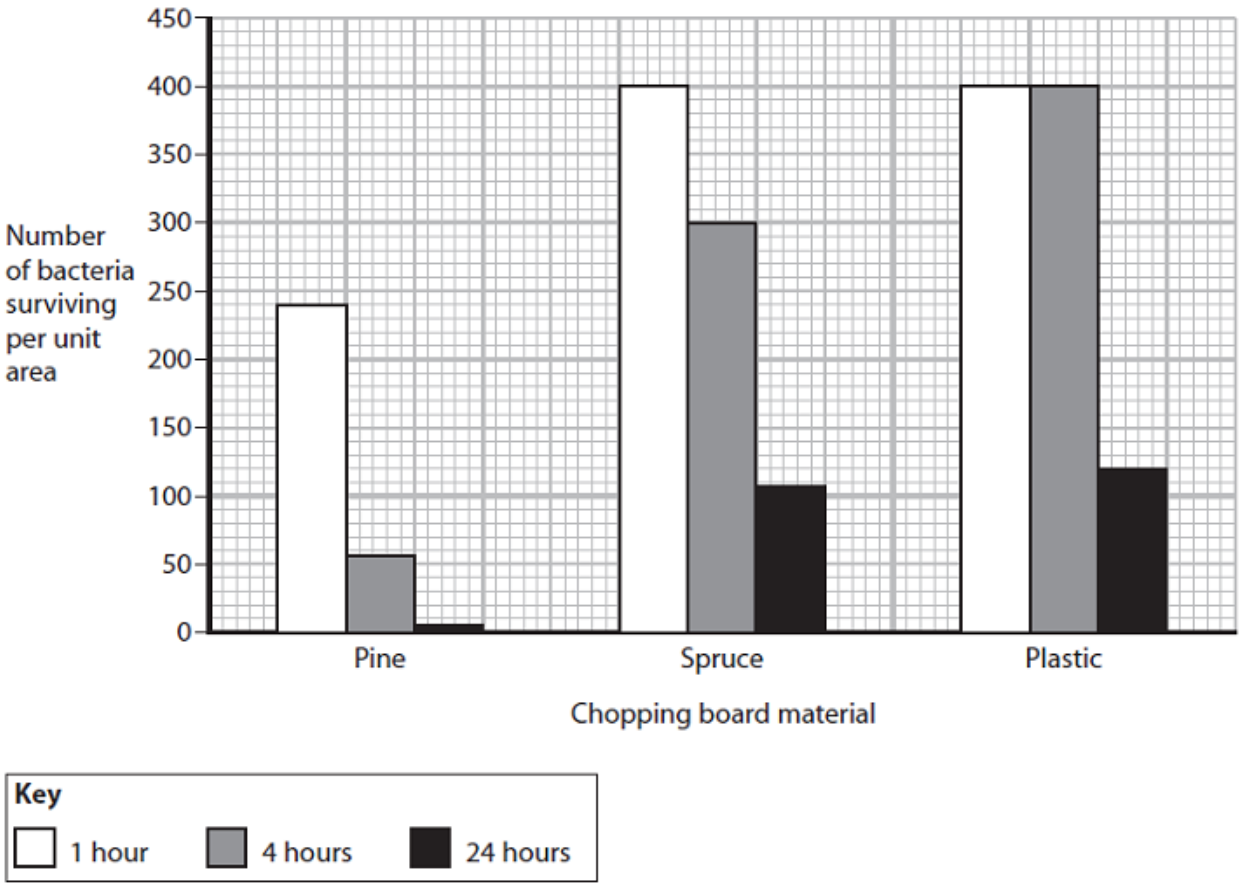
.....

.....

.....

(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)

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

(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.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

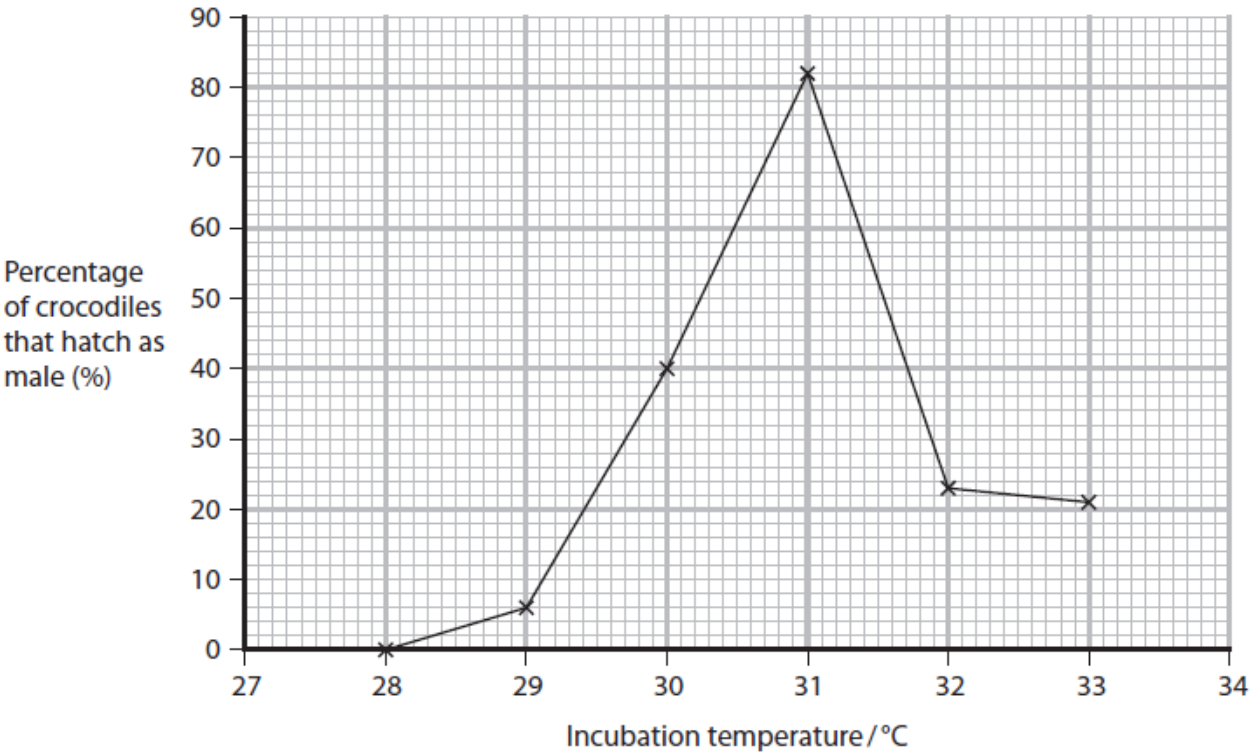
(c) Scientists are involved in conservation projects to increase the numbers of endangered saltwater crocodiles, without causing a reduction in the genetic diversity of future populations.

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.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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^3

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

(2)

.....

.....

.....

.....

.....

.....

(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?

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

(1)

☒ **A** none

☒ **B** one

☒ **C** two

☒ **D** three

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

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

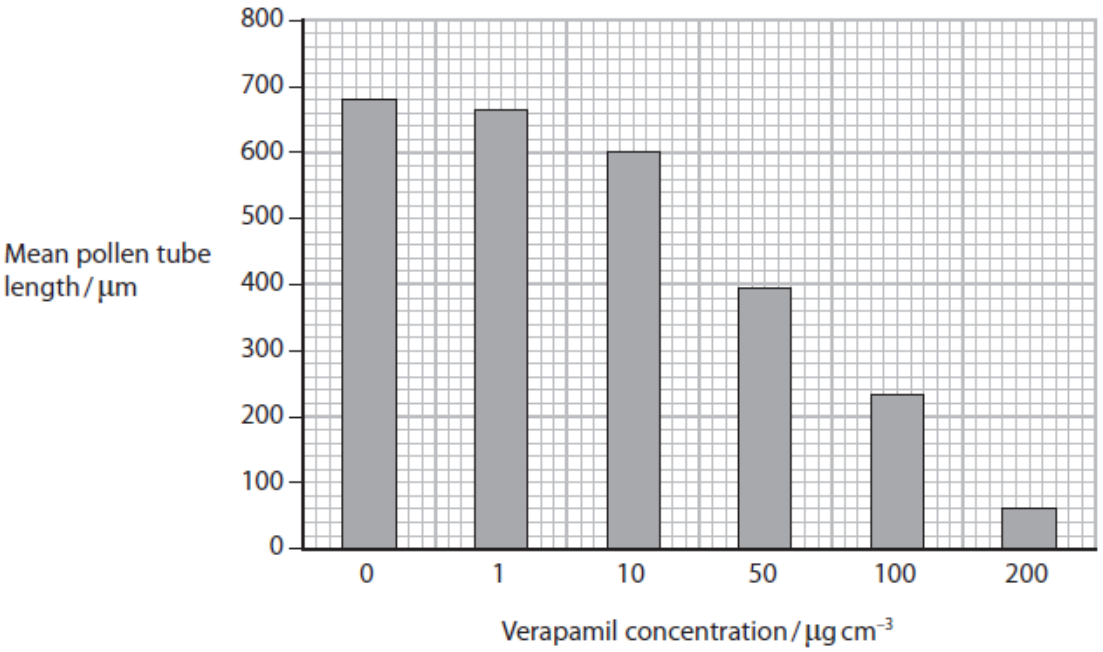
(c) Verapamil is a substance that inhibits the uptake of calcium ions by the pollen tube.

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)

.....

.....

.....

.....

.....

.....

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

(3)

.....

.....

.....

.....

.....

.....

.....

.....

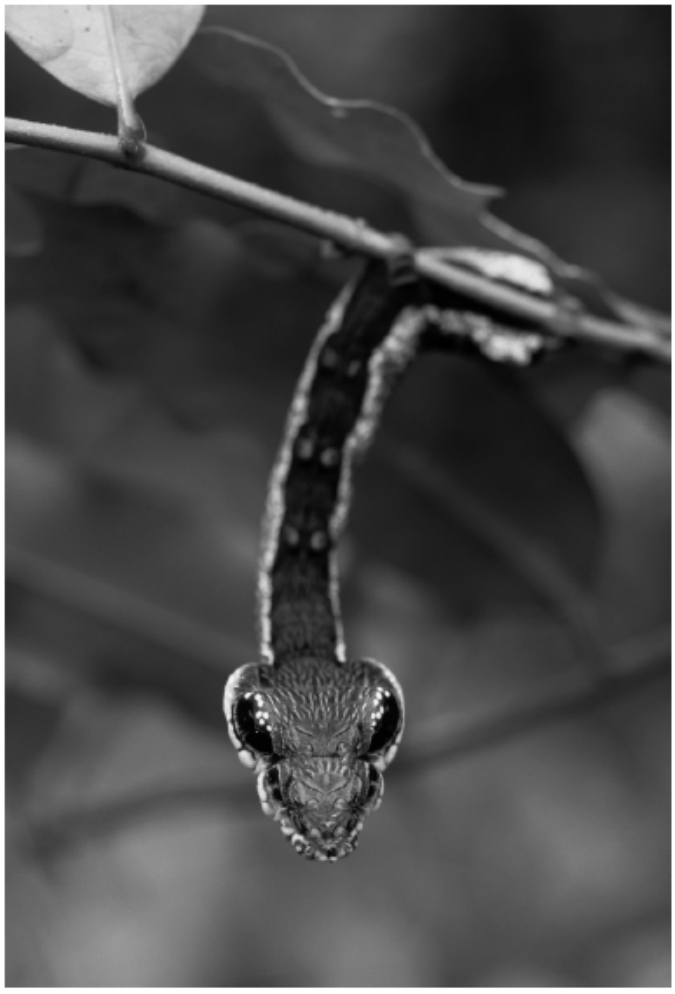
.....

(Total for question = 11 marks)

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)

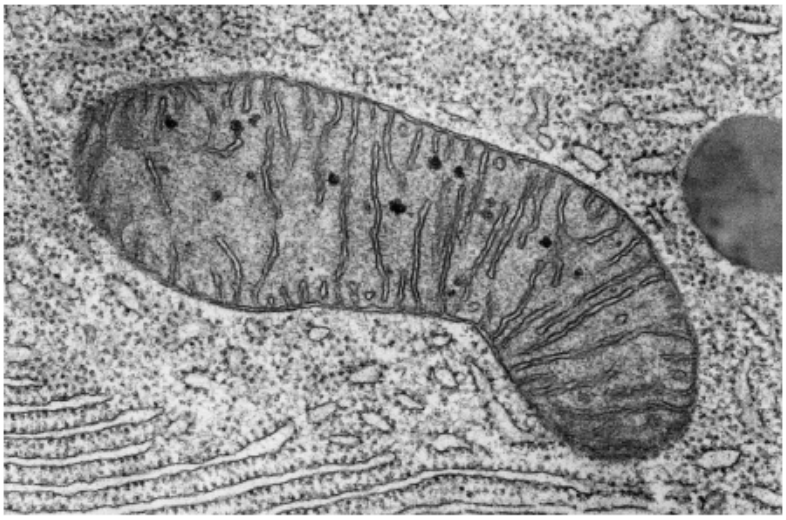
(a) This caterpillar is adapted to its niche.

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 × 72 500

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

(1)

.....

(ii) Describe the function of this organelle.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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

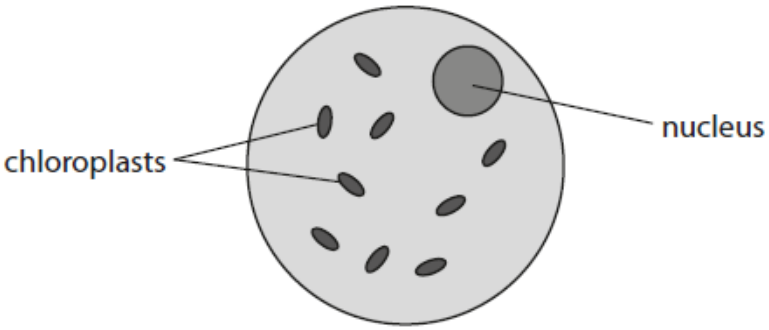
☒ **B** animal and plant cells only

☒ **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 µm.

Calculate the magnification of the diagram.

(2)

Answer .....

(ii) This cell contains chloroplasts.

State the function of these chloroplasts.

(1)

.....

.....

.....

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

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

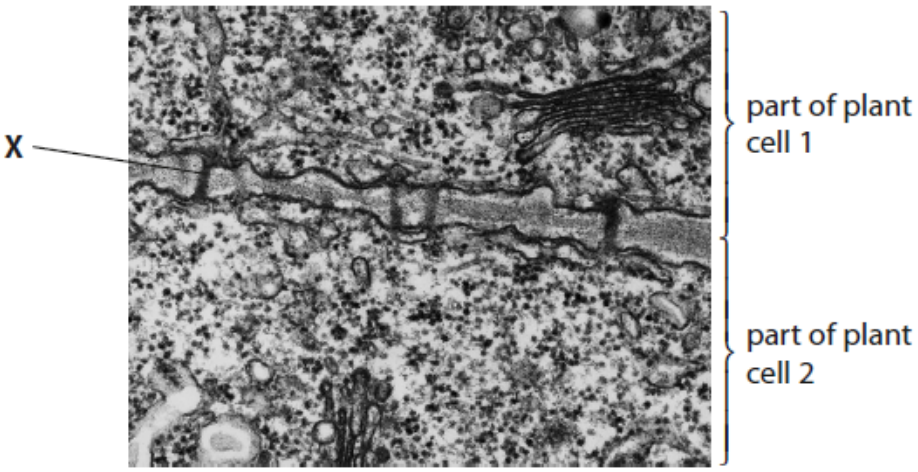
(1)

.....

.....

.....

(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)

.....

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

(2)

.....

.....

.....

.....

.....

.....

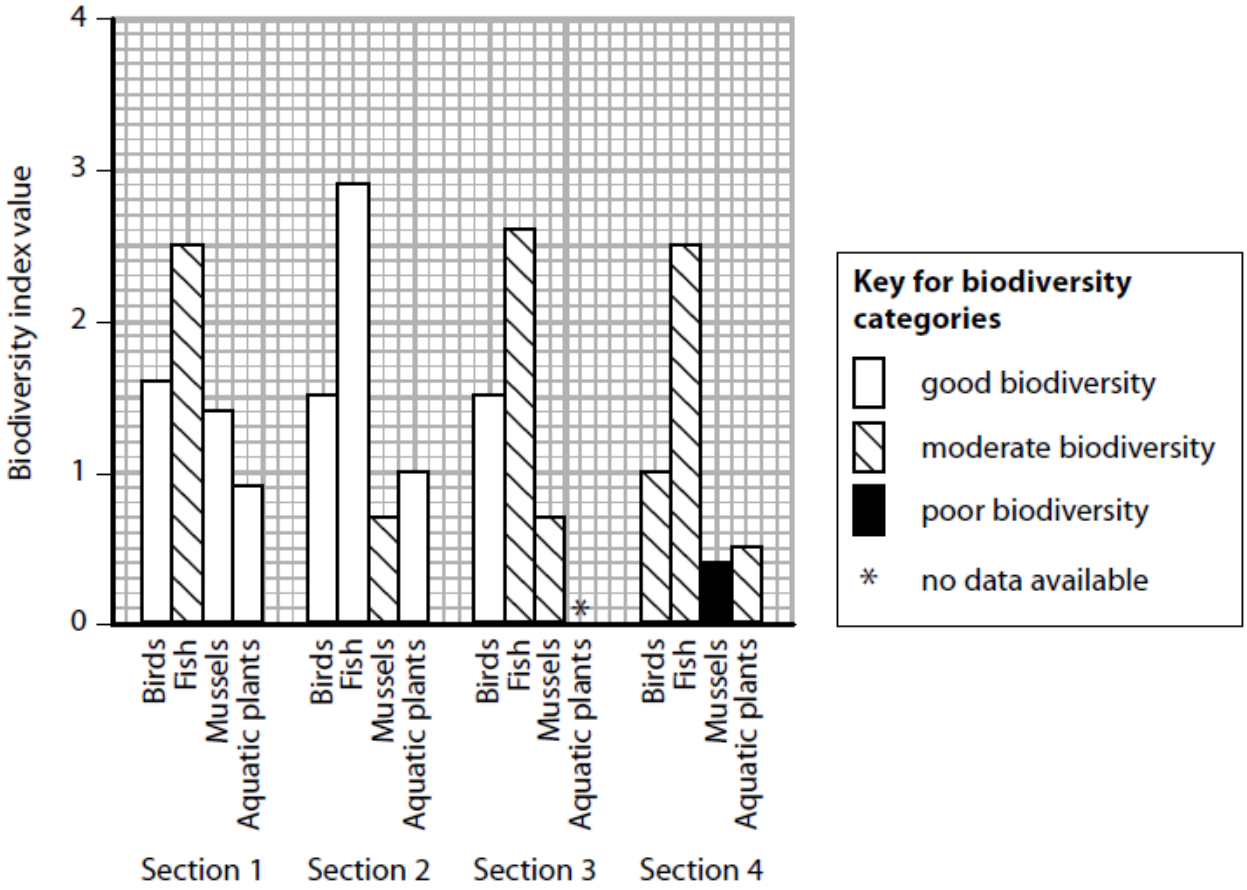
(Total for question = 9 marks)

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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

(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:

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

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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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^{-1}	Mean mass of mucus / g	Mean area of ulcer / mm^2
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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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.

(2)

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)

.....

.....

.....

.....

.....

.....

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

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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 mm2 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)

.....

.....

.....

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

(3)

.....

.....

.....

.....

.....

.....

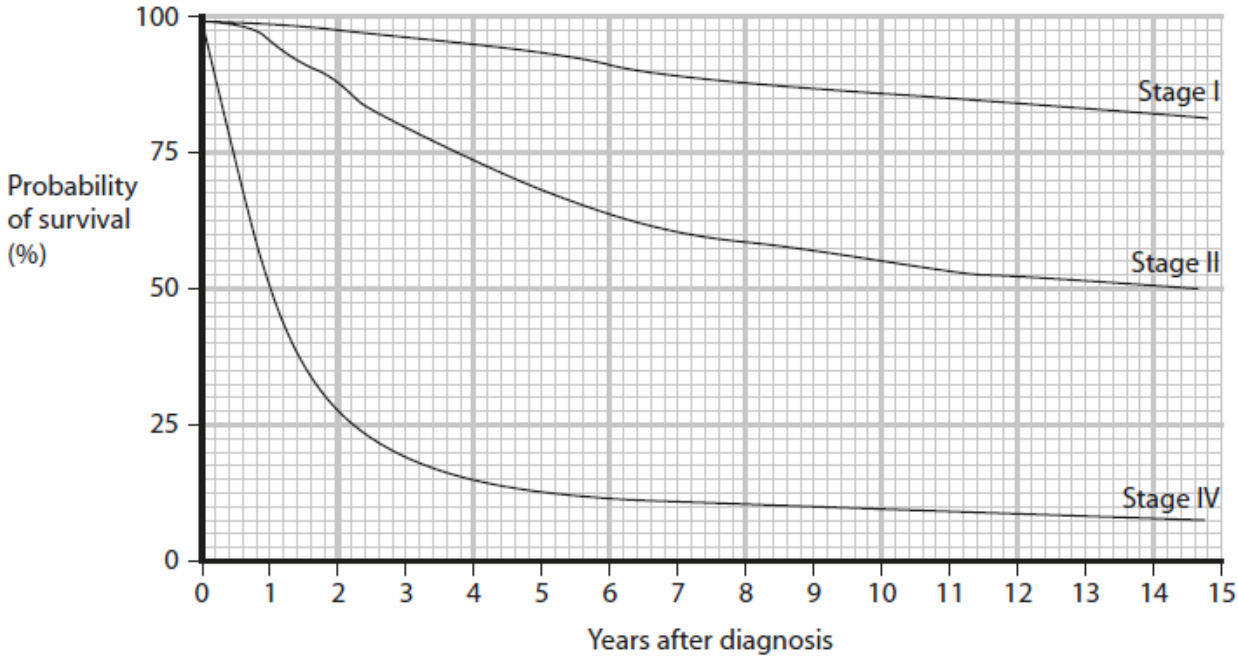
.....

.....

.....

.....

(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)

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

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

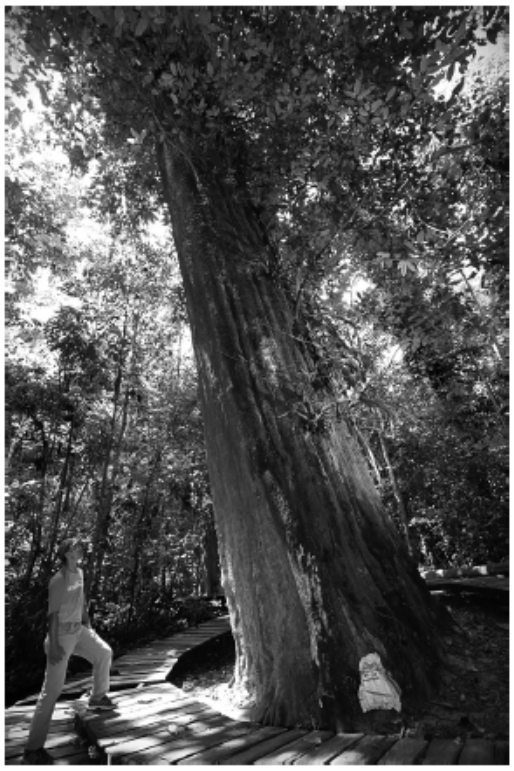
(Total for question = 13 marks)

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)

1 .....

.....

.....

2 .....

.....

.....

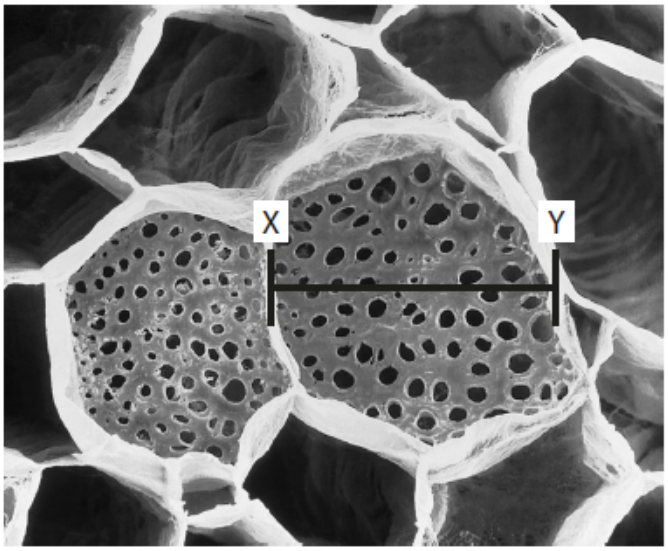
3 .....

.....

.....

(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 ×200

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

Give your answer in standard form.

(3)

Answer ..... µm

(ii) Describe the role of phloem.

(2)

.....

.....

.....

.....

.....

.....

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

- they contain cellulose microfibrils

- they contain pits
- they contain cytoplasm

(1)

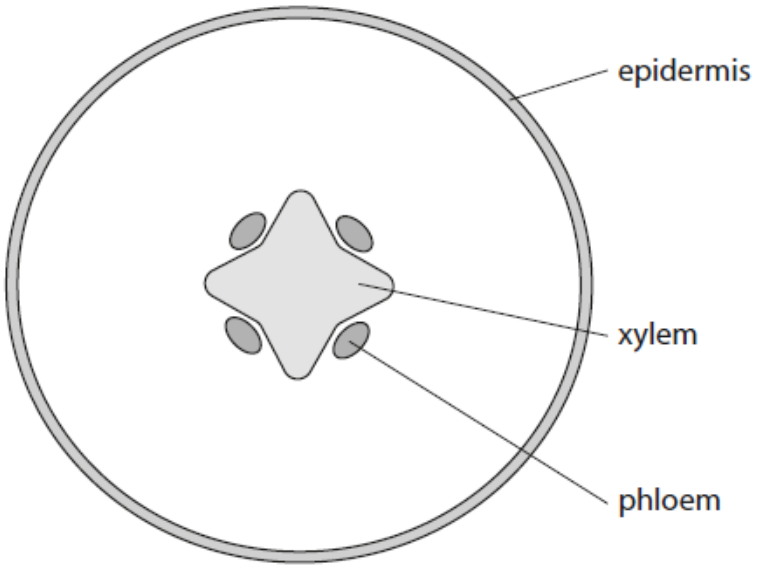
☒ **A** none

☒ **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 .....

.....

.....

(Total for question = 12 marks)

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)

.....

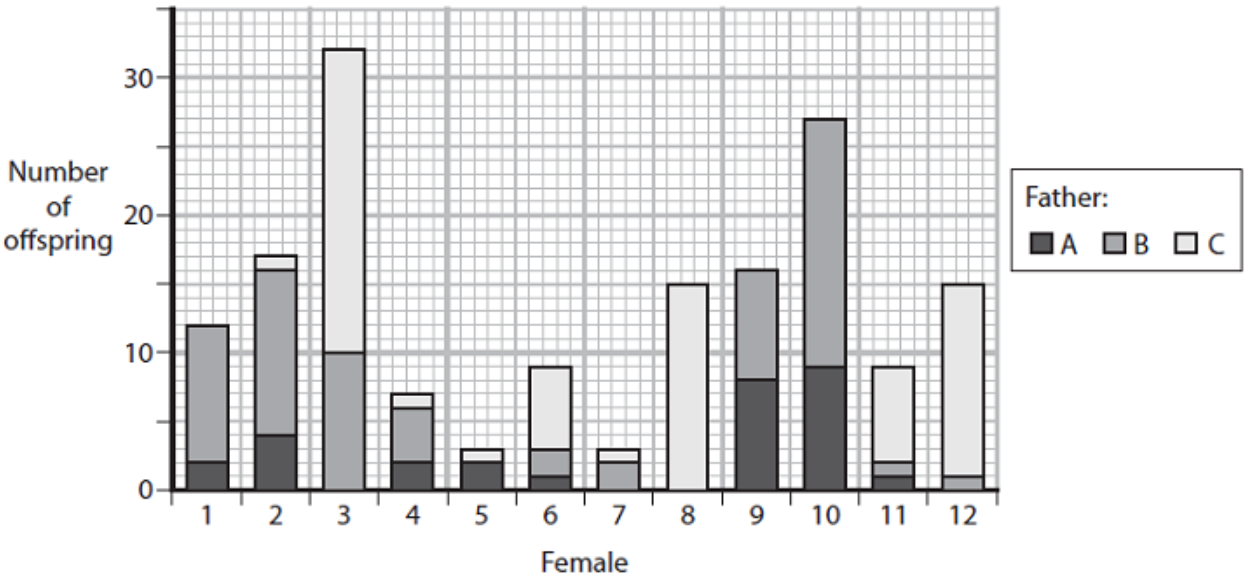
.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

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

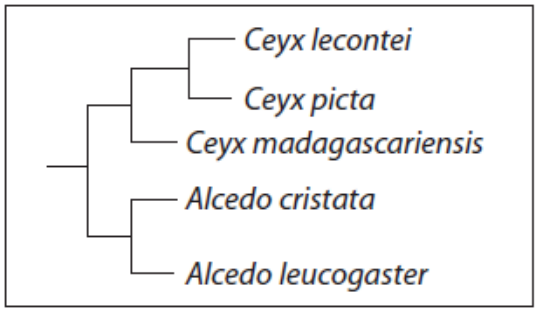
(1)

.....

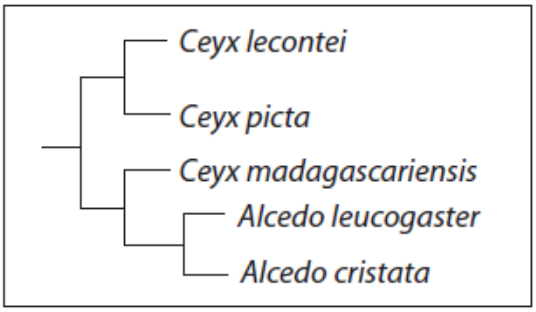
(b) A scientist recently collected new data about the classification of kingfishers, using molecular evidence.

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)

.....

.....

.....

.....

.....

.....

(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.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

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

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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

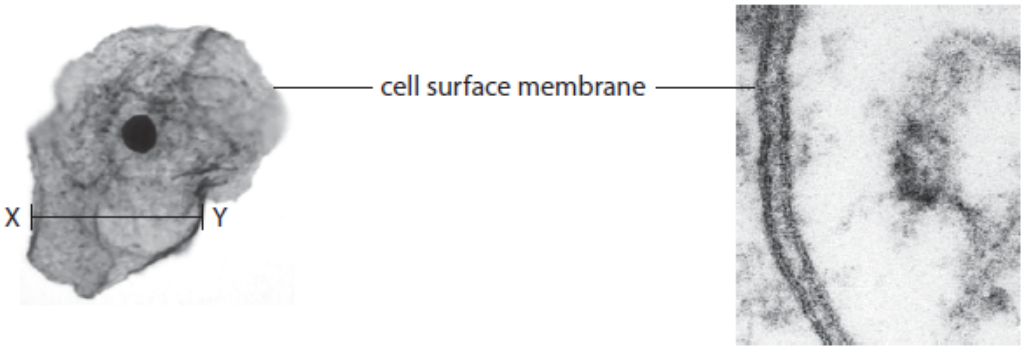
(ii) Eukaryotic cells contain a nucleus.

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.



(Source: © Komsan Loonprom/Shutterstock)

Cell seen using a light microscope

(Source: © Dennis Kunkel Microscopy /Science Photo Library)

Part of cells seen using an electron microscope

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

(2)

.....

.....

.....

.....

.....

.....

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

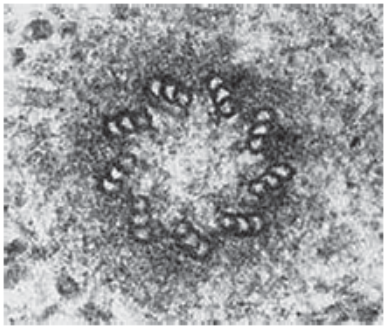
Calculate the actual width of this cell by measuring the line XY.

Give your answer in µm.

(3)

Answer ..... µm

(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)

.....

.....

.....

.....

.....

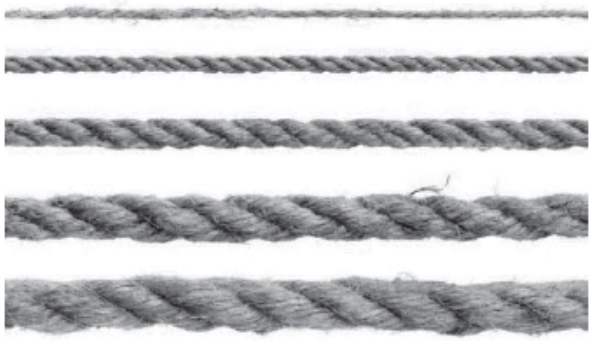
.....

(Total for question = 12 marks)

Q26.

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

.....

.....

.....

.....

Difference

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

(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 $\times 10^6$ dm^3
2000	17 000
2011	84 600

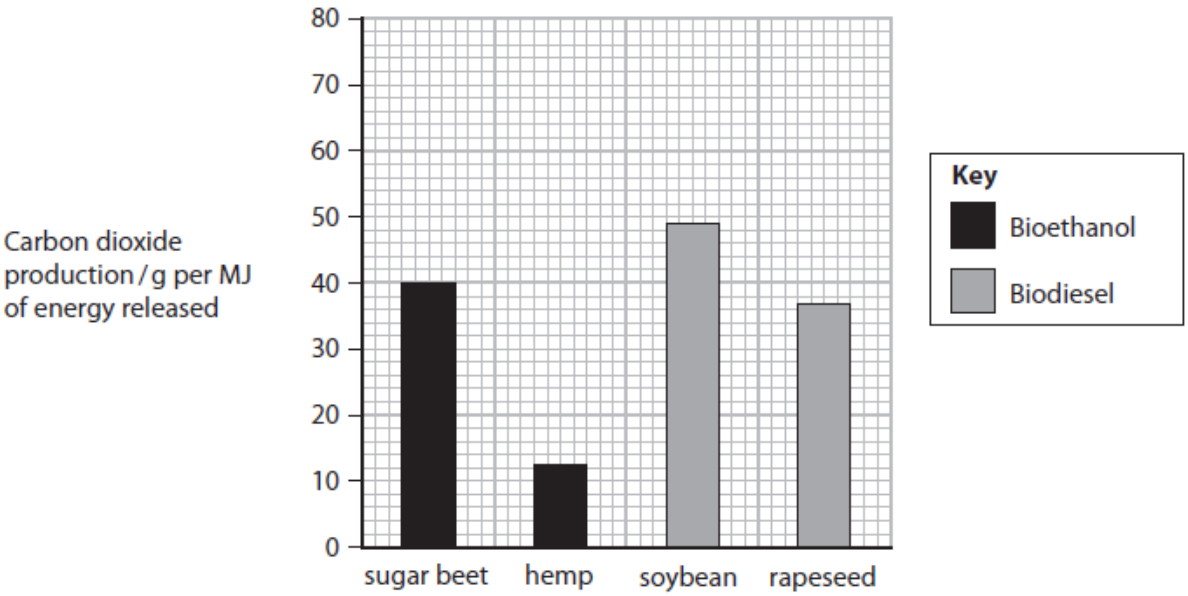
Determine what the global bioethanol production will be in 2020.

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.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 14 marks)

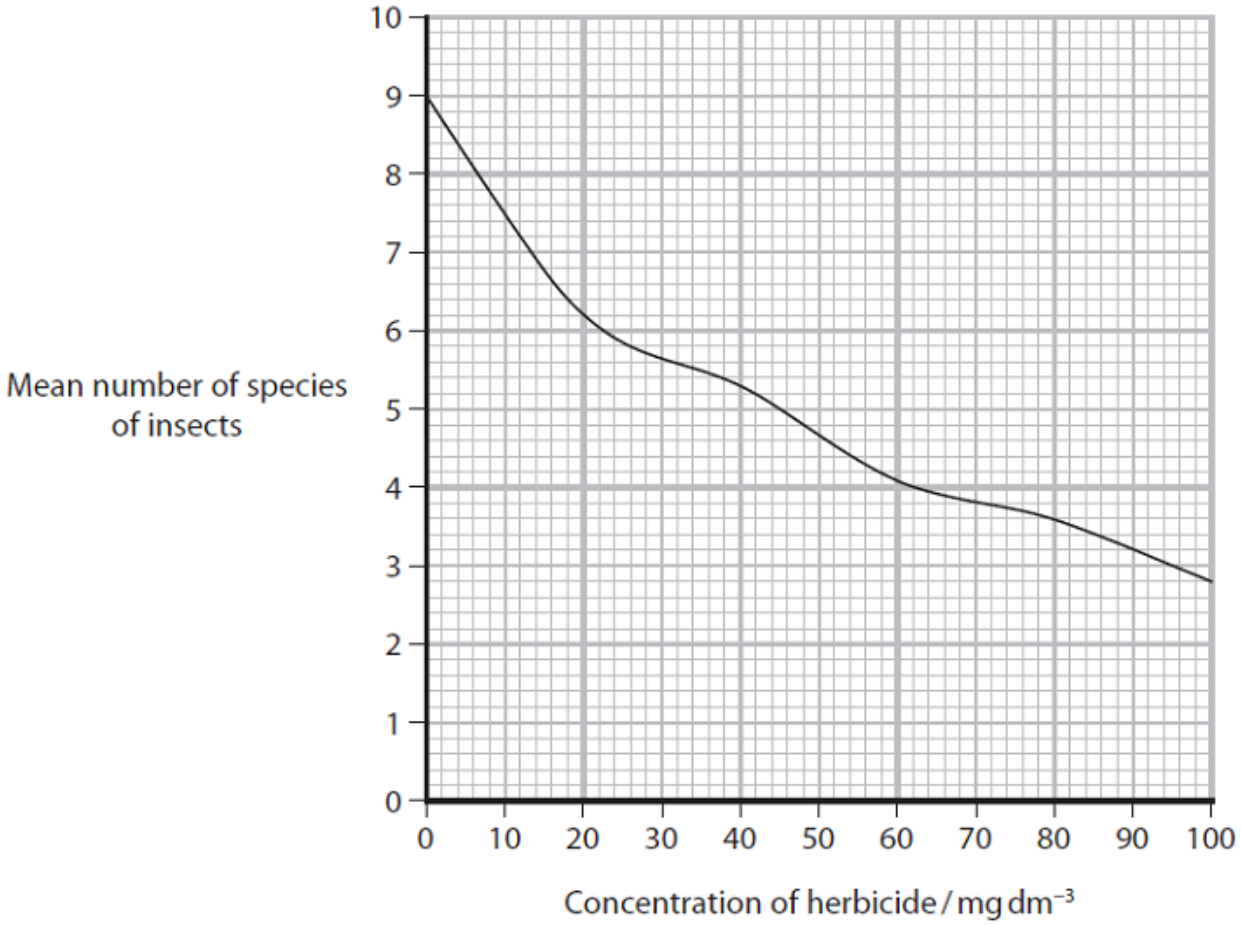
Q27.

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)

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

.....

.....

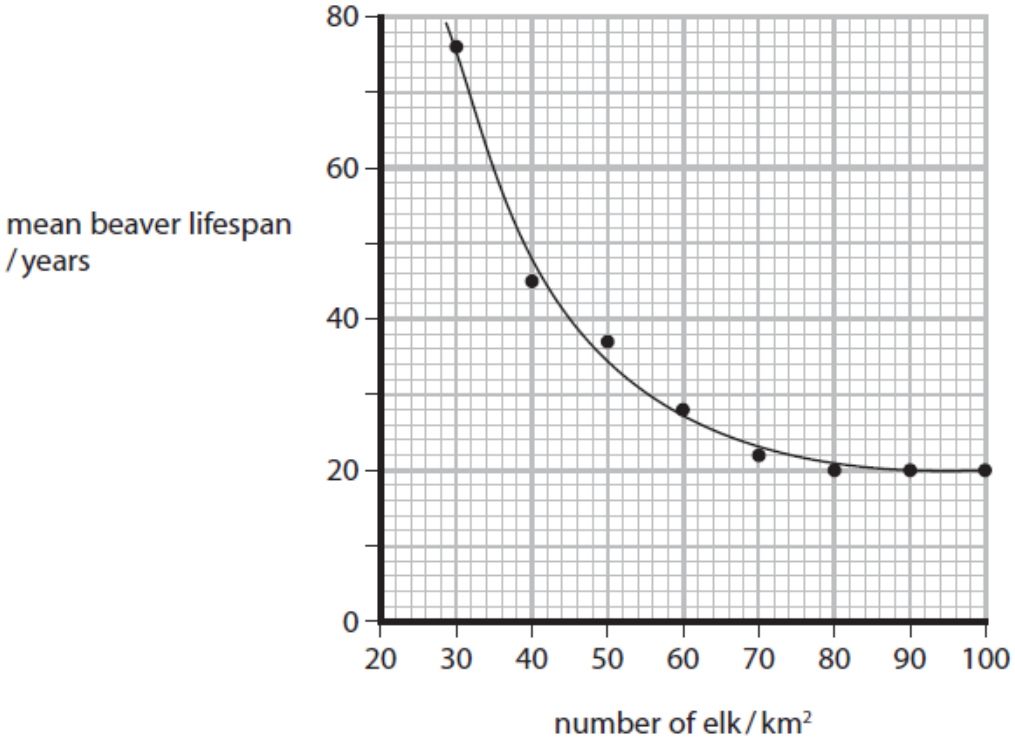
.....

(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^2.



Describe the relationship shown in the graph.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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)

.....

.....

.....

.....

.....

.....

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

(1)

.....

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

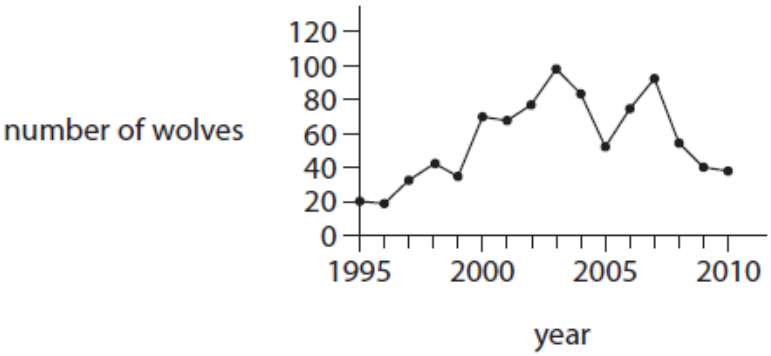
Beavers use older trees to build dams in the rivers, which create new habitats, such as ponds.

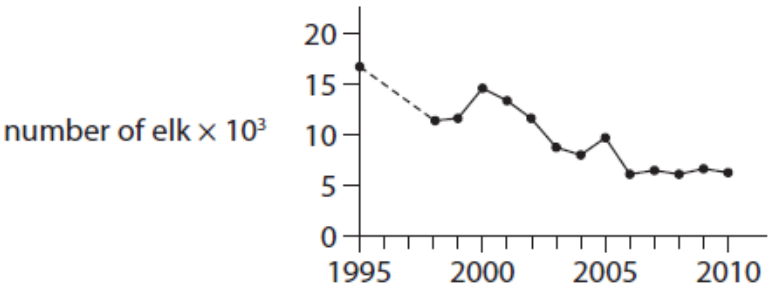
Beavers live in colonies of up to 8 individuals.

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

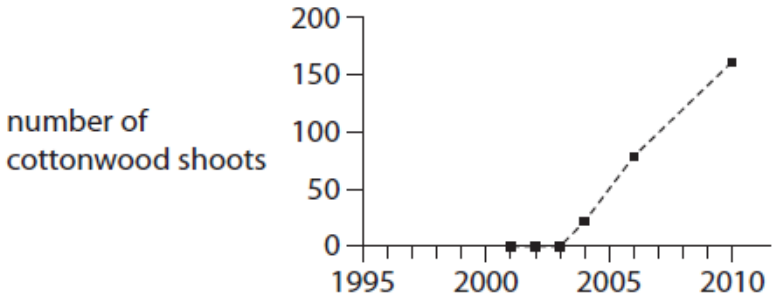
They also recorded the number of young cottonwood shoots that were taller than 5 cm.

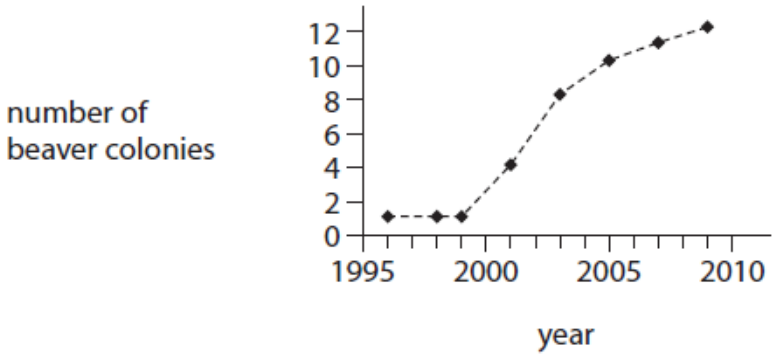
The graphs show the data collected by these scientists.





year





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.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

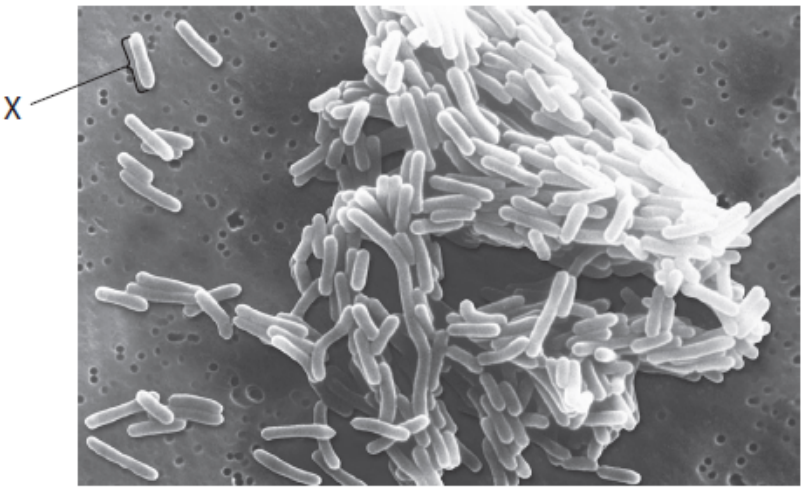
(Total for question = 15 marks)

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 µm 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)

.....

.....

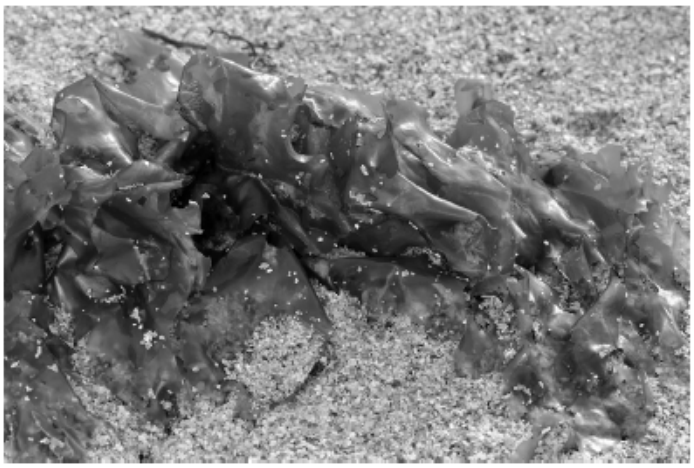
.....

.....

.....

.....

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



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

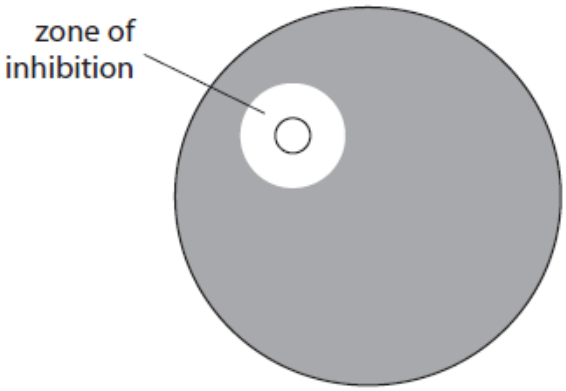
Sea lettuce contains chemicals called fucoxanthins that have antimicrobial properties.

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
E. coli	10.2	±0.72
S. aureus	11.1	±0.63
L. monocytogenes	6.0	±0.41
P. aeruginosa	7.5	±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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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 α-glucose and β-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 α-glucose and β-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)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)