Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 30 minutes

Paper reference **WBI12/01**

Biology

International Advanced Subsidiary/Advanced Level
UNIT 2: Cells, Development, Biodiversity and Conservation

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

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Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Q:1/1/1/1/1/1/

P 7 0 9 6 1 A 0 1 3 2

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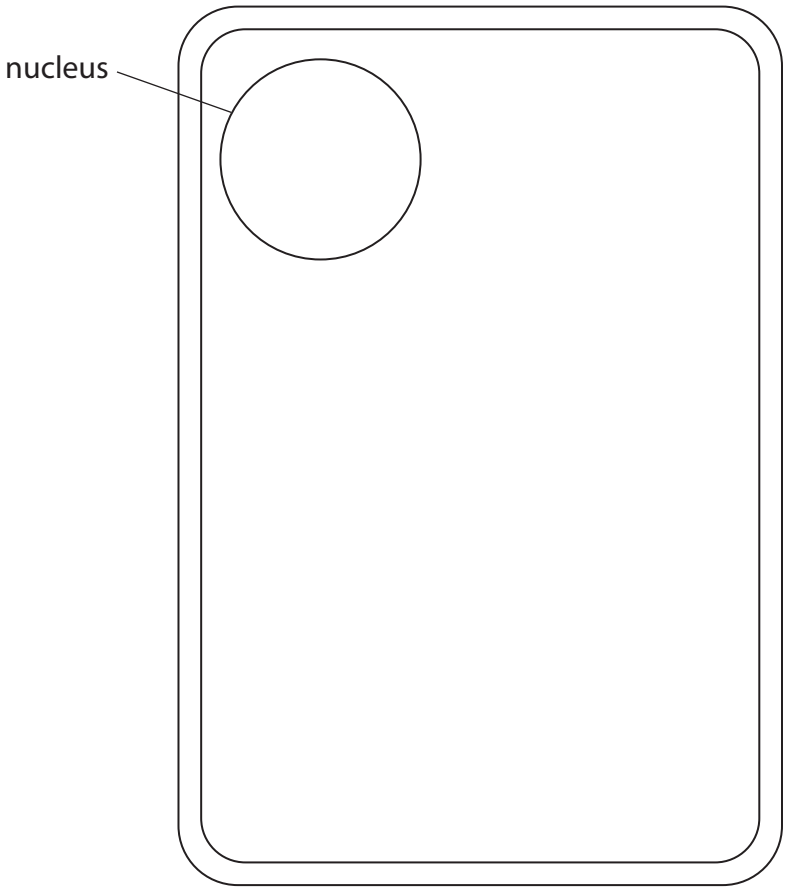
Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Woese classified organisms into a three-domain system.

Plant cells were classified into the Eukarya domain.

The diagram shows an incomplete cell from a plant.



(a) Complete the diagram by drawing an amyloplast, a chloroplast and the tonoplast to show their location and relative size in this cell.

Label these three structures.

(3)

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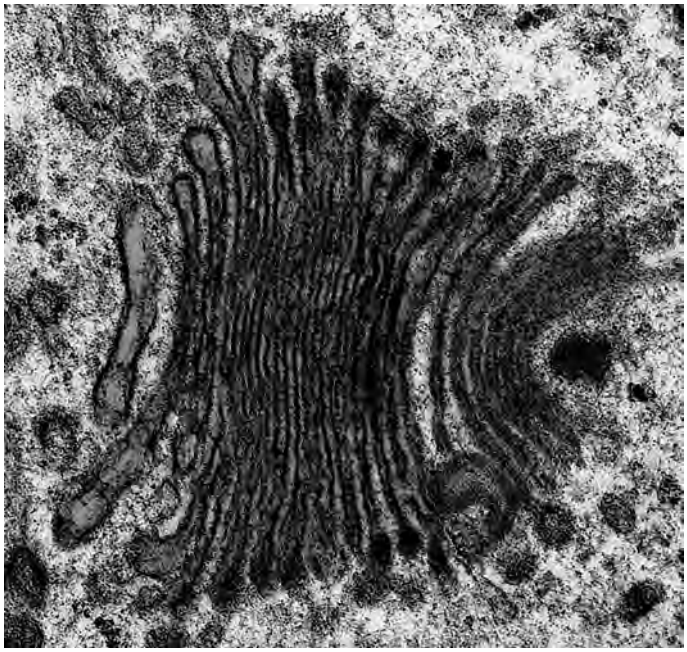
(b) The photograph shows an organelle found in a plant cell, as seen using an electron microscope.



(Source: © SCIENCE PHOTO LIBRARY)

State the function of this organelle.

(1)

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(c) The other domains in the three-domain system are Archaea and Bacteria. Complete the table to show in which of the domains the following structures would be found.

(4)

Structure	Archaea only	Bacteria only	Eukarya only	More than one domain
cell membrane	☒	☒	☒	☒
nucleolus	☒	☒	☒	☒
cell wall	☒	☒	☒	☒
70S (small) ribosome	☒	☒	☒	☒

(Total for Question 1 = 8 marks)

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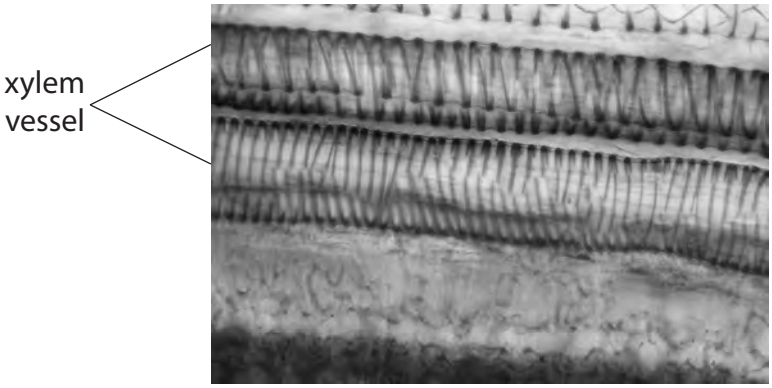
2 Abaca plants are found in the Philippines.

The photograph shows a mat made from abaca plant fibres.

(Source: © Mehmet Çetin / Alamy Stock Photo)

Plant fibres include xylem vessels.

(a) The photograph shows some xylem vessels, as seen using a light microscope.



(Source: © STEVE GSCHMEISSNER / SCIENCE PHOTO LIBRARY)

A stain was added to the xylem before viewing using a microscope.

Give a reason why it is usual to stain specimens in microscopy.

(1)

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(b) Explain how the arrangement of cellulose molecules and secondary thickening in xylem vessels contributes to the physical properties of the cell wall.

(4)

(Total for Question 2 = 5 marks)

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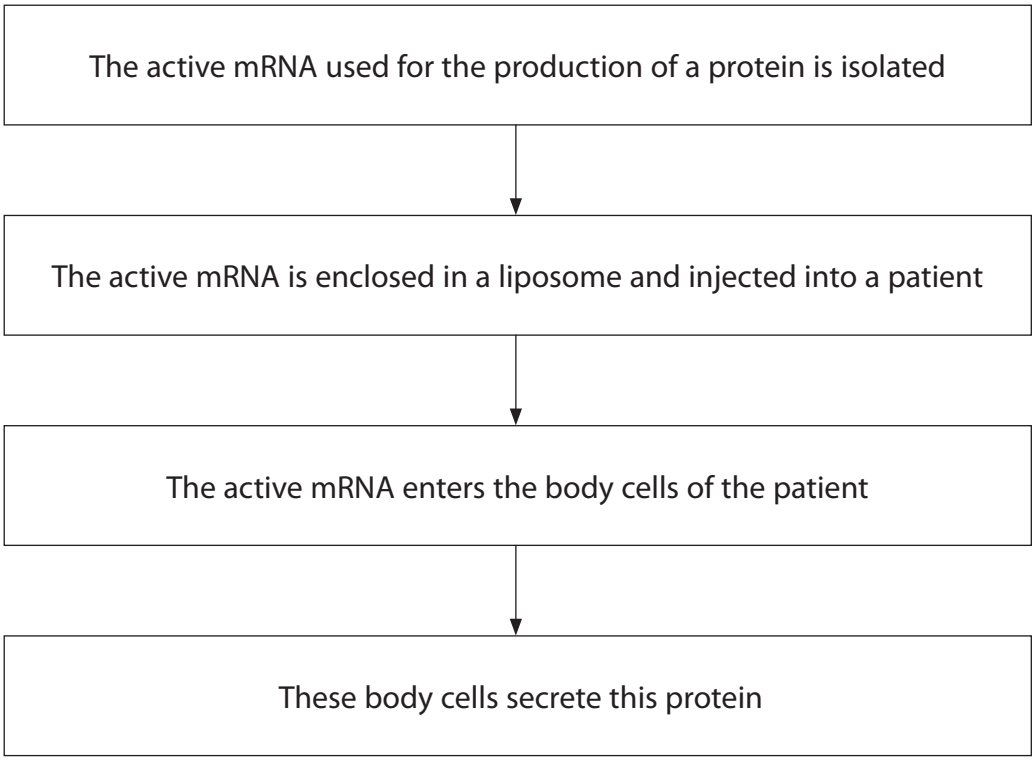
3 A new vaccine has been developed that contains active mRNA.

The flow diagram shows how this vaccine causes body cells to produce a new protein.



(a) The diameter of one spherical liposome was 75 nm.

Calculate the volume of this liposome using the formula:

$$V = \frac{4}{3}\pi r^3$$

Give your answer in standard form.

(2)

Answer ..... nm^3

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(b) Active mRNA is formed after post-transcriptional modification of pre-mRNA.

The structure of pre-mRNA produced from transcription is different from the structure of active mRNA.

Compare and contrast the structures of pre-mRNA and active mRNA.

(4)

(Total for Question 3 = 6 marks)

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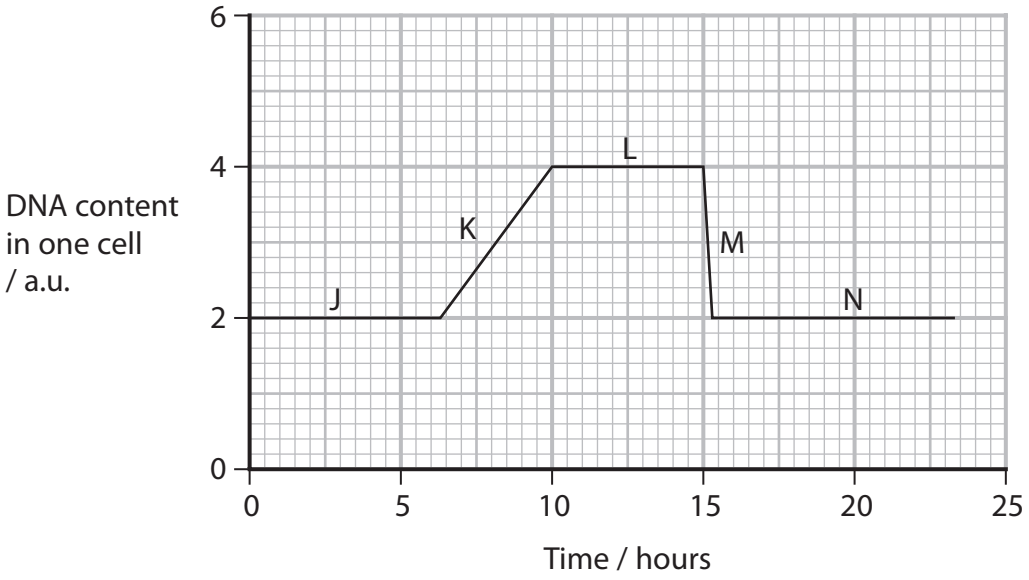
4 The graph shows the changes in the DNA content of one cell during one cell cycle.



(a) (i) In which part of the graph is the DNA being replicated?

(1)

- ☒ **A** J
- ☒ **B** K
- ☒ **C** L
- ☒ **D** M

(ii) In which part of the graph would the condensation of chromosomes be completed?

(1)

- ☒ **A** J
- ☒ **B** L
- ☒ **C** M
- ☒ **D** N

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(b) Centrioles are involved in spindle formation.

(i) Name the stage of mitosis when spindle fibres begin to form.

(1)

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(ii) Explain the role of the spindle in mitosis.

(2)

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(iii) Draw a plant cell undergoing cell division, after mitosis has just finished.

(2)

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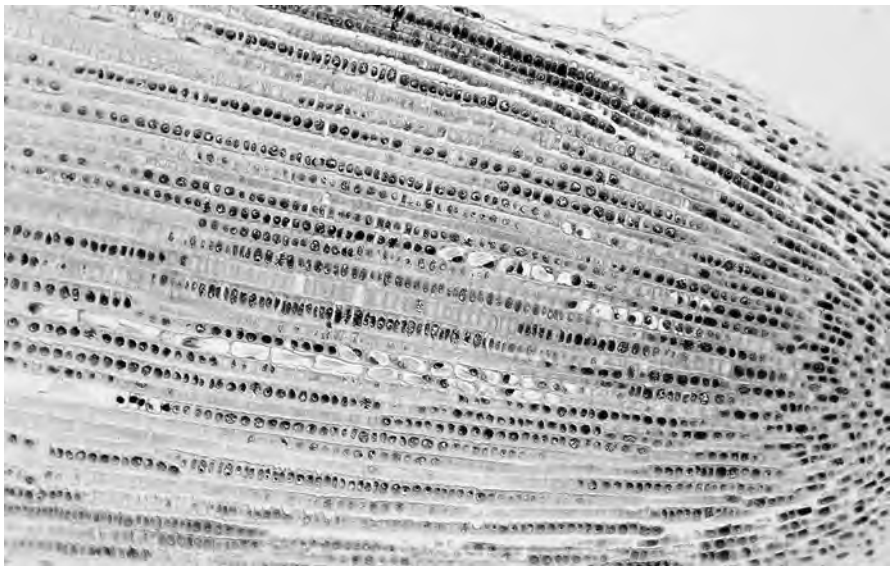
(c) The photograph shows a section through a root tip, as seen using a microscope.



(Source: © agefotostock / Alamy Stock Photo)

Describe how to determine the mitotic index of this tissue.

(2)

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(Total for Question 4 = 9 marks)

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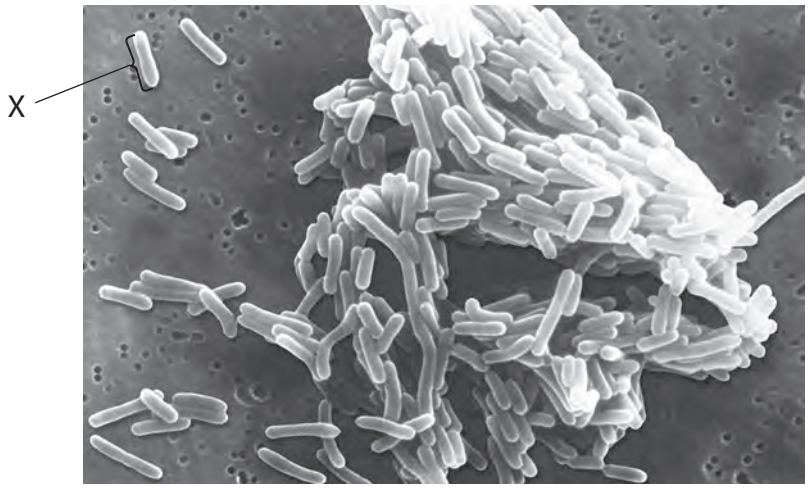
5 *Listeria monocytogenes* is a bacterium that contaminates food and causes the disease listeriosis.

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)

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

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

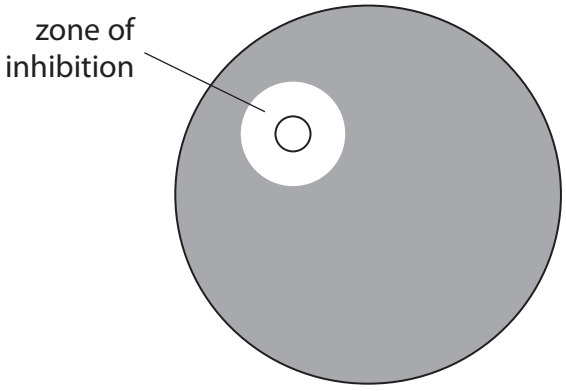
Sea lettuce contains chemicals called fucoxanthins that have antimicrobial properties.

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

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(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 5 = 9 marks)

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6 Skin colour is an example of continuous variation in some species.

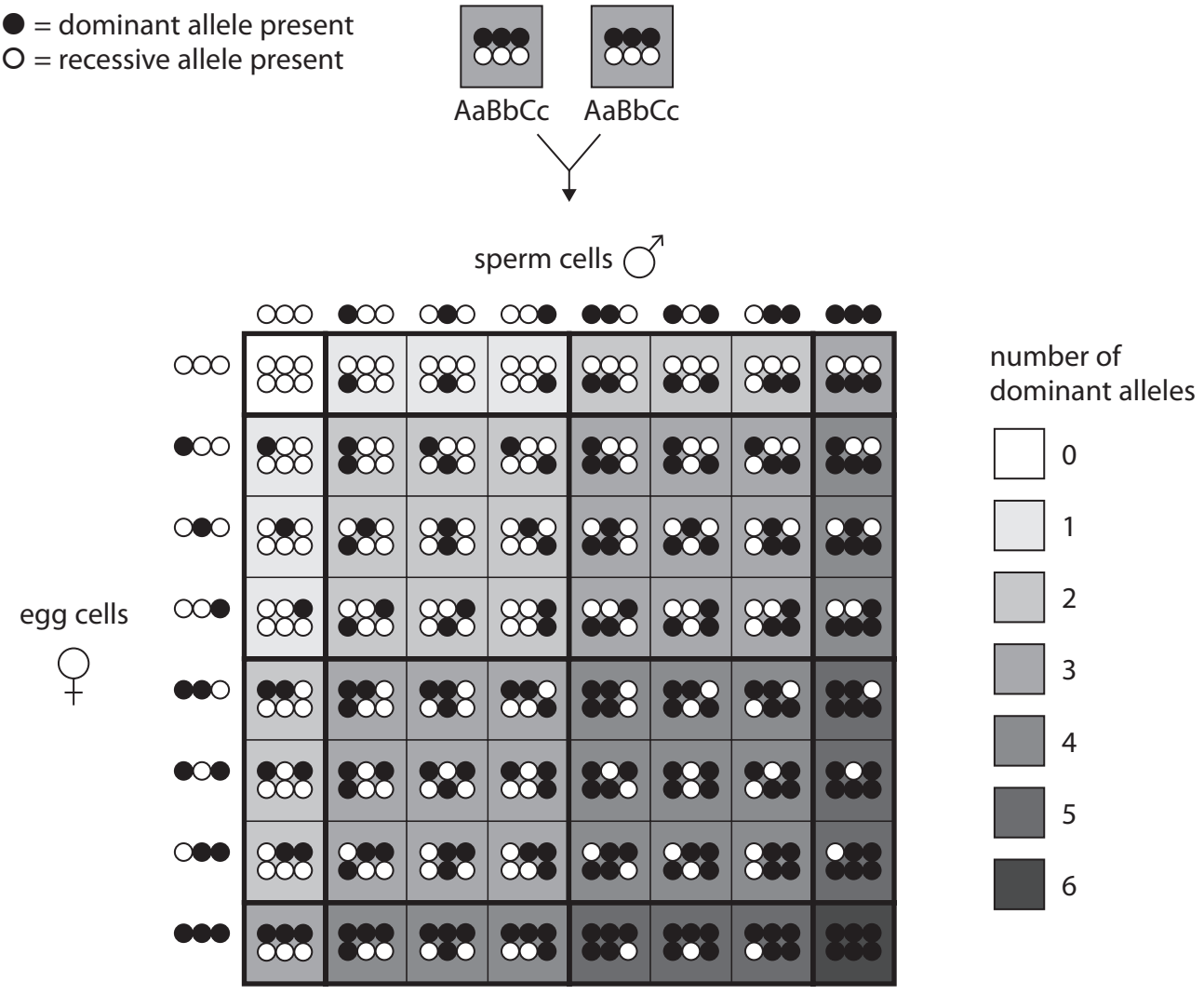
In one species skin colour is polygenic and controlled by three genes: A, B, and C.

Two individuals heterozygous for each of these three genes were crossed.

The diagram shows the possible allele combinations present in the gametes and the offspring produced in this cross.

The shading indicates the darkness of the skin colour of the offspring.

● = dominant allele present
○ = recessive allele present



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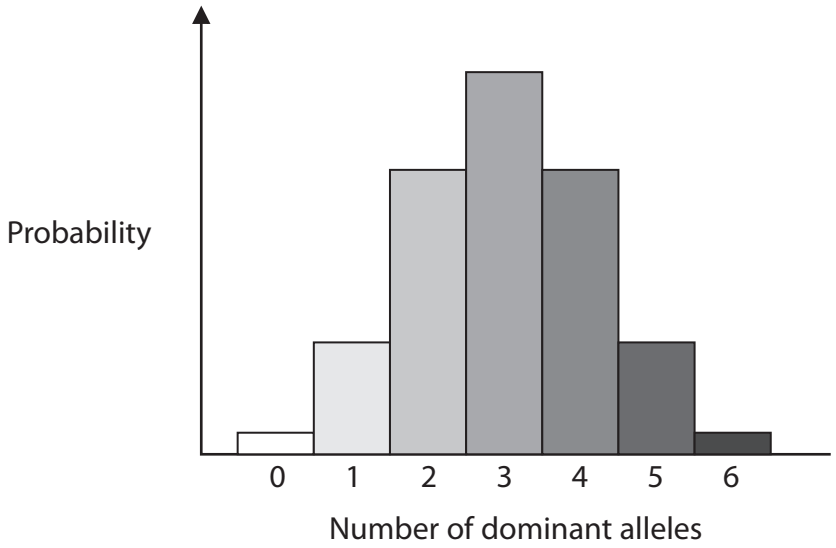
The graph shows the probability of the skin colours of the offspring from this cross.



*(a) Explain why there is a large variation in the skin colour of the offspring produced from this cross.

Use information from the question, and your own knowledge, to help support your answer.

(6)

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(b) Suggest **two** reasons why individuals that have inherited the genotype AaBbCc, may have a darker skin colour than other individuals with the same genotype.

(2)

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(Total for Question 6 = 8 marks)

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7 The photograph shows a titan arum plant (*Amorphophallus titanum*).

(Source: © Khairil Azhar Junos / Alamy Stock Photo)

This plant is native to Sumatra, Indonesia, and is critically endangered.

There are fewer than 1 000 individuals in the wild and 500 in botanical gardens around the world.

(a) Sumatra is described as having a high species richness.

State what is meant by the term **species richness**.

(1)

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(b) Seed banks often conserve endangered plants by storing samples of their seeds.

The seeds are dried and then frozen.

Explain the advantages of drying seeds before storage.

(2)

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(c) Scientists have stated that more than a third of critically endangered plant species cannot be saved from extinction by storing seeds in seed banks.

The titan arum is one of these plants.

This plant flowers once every 10 years and the flowers last for two to three days.

The plant can reproduce asexually or sexually. In order to reproduce sexually it relies on insects to transfer pollen to other titan arum plants.

Scientists are developing ways to conserve this plant without losing genetic diversity.

Some of the suggestions include:

- grow more plants produced by asexual reproduction in botanical gardens
- collect pollen when an individual plant flowers and store it in a seed bank
- create a studbook for the species
- artificially pollinate plants in the wild and in botanical gardens.

(i) The heterozygosity index can be calculated using an equation.

Write this equation.

(1)

(ii) The heterozygosity index of the 500 titan arum plants in botanical gardens was found to be 0.166.

Calculate the number of heterozygotes in this population.

(1)

Answer .....

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*(iii) Discuss the suggestions, proposed by these scientists, for conserving the titan arum.

(6)

(Total for Question 7 = 11 marks)

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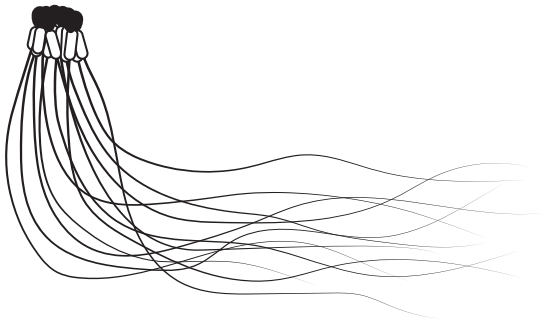
8 Gametes are specialised for their function.

Egyptian female desert ants (*Cataglyphis savignyi*) mate with more than one male.

A male desert ant has an adaptation to improve the chances of his sperm fertilising a female's egg cell.

The sperm are released in bundles with the heads held together by a sticky protein.

The diagram shows a bundle of desert ant sperm.



(a) Suggest how the sticky proteins would have been secreted.

(2)

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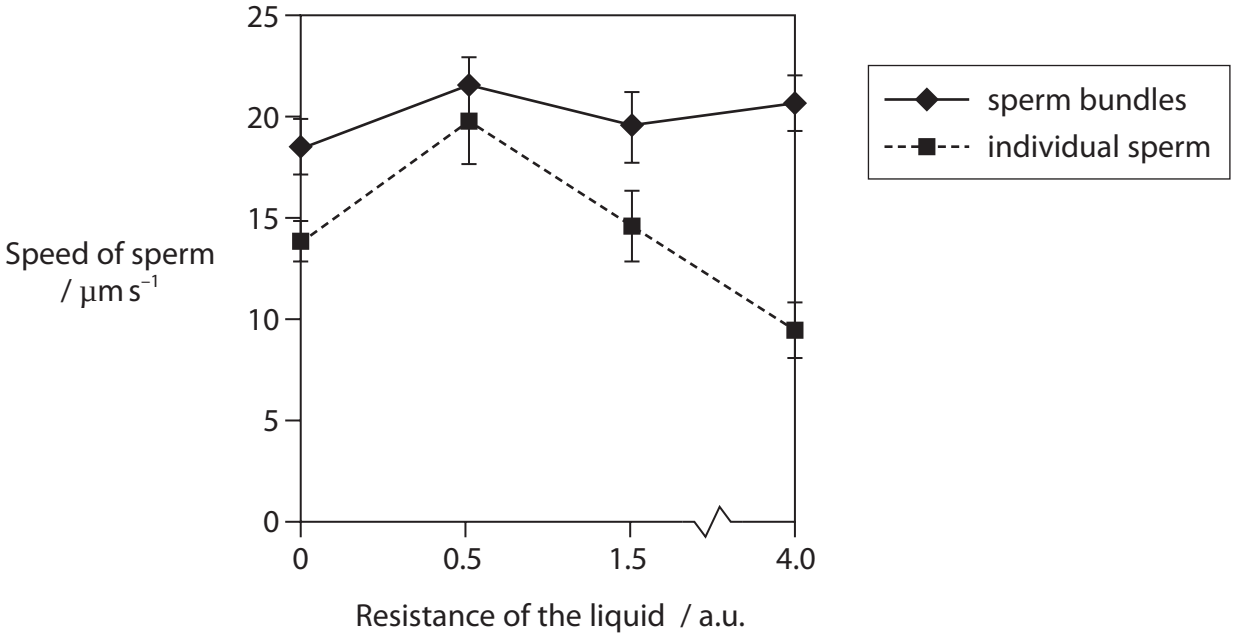
(b) The graph shows the speed of individual sperm compared with bundles of sperm in liquids of different resistance.



Comment on the results of this investigation.

(4)

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(c) The photograph shows an Amur leopard found in southeastern Russia and northern China.

In-vitro fertilisation (IVF) techniques are being developed to help conserve this endangered species of leopard.

(Source: © NaturaLight / Alamy Stock Photo)

These techniques are being developed using mice.

IVF involves the removal of egg cells from the female mice. The zona pellucida can be damaged during this process.

The effect of damaging the zona pellucida was investigated.

Three hundred mouse egg cells were distributed equally in three Petri dishes containing nutrient solutions.

Samples of sperm of different concentrations were added to each Petri dish. The volume of each sample added was the same.

The experiment was repeated for egg cells which had their zona pellucida damaged.

The graph shows the percentage of egg cells fertilised by more than one sperm (percentage polyspermy).

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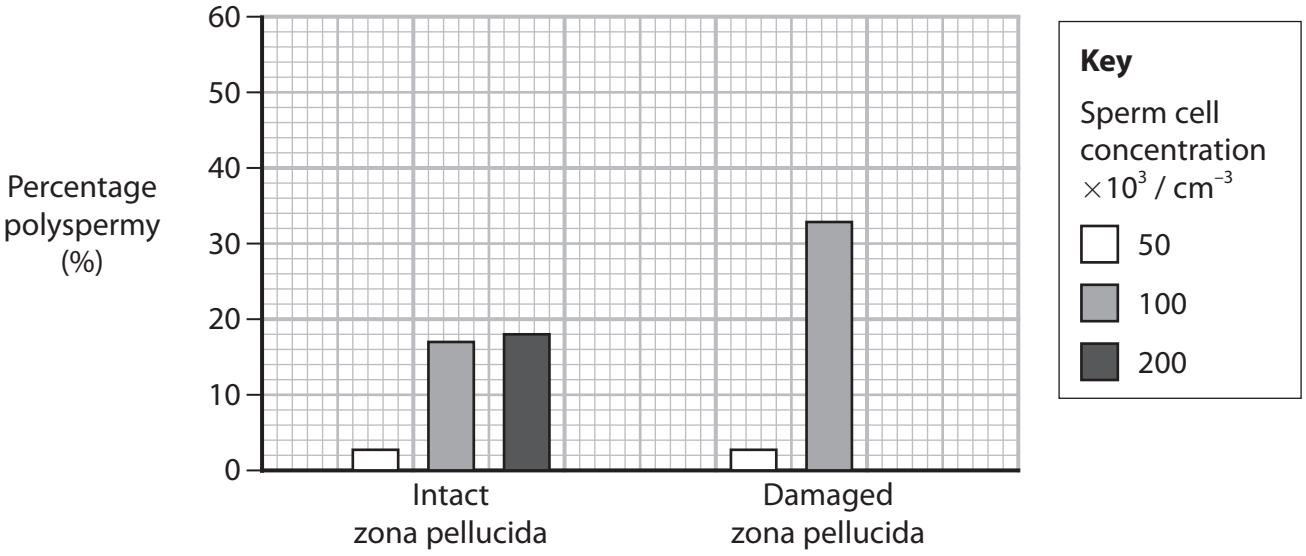

(i) When the highest sperm concentration was added to the egg cells with damaged zona pellucida, the percentage polyspermy was 52%.

Plot this result on the graph.

(1)

(ii) Explain the results of this investigation.

(4)

(Total for Question 8 = 11 marks)

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9 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

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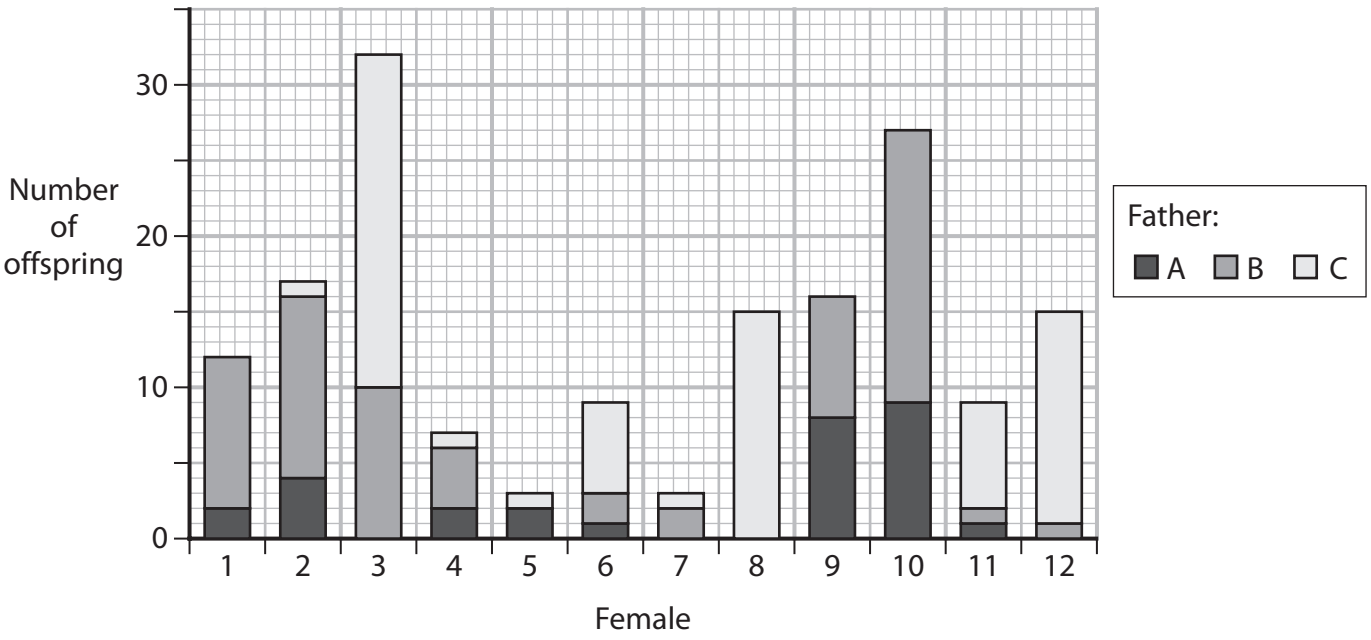
(c) In 1963, there were only three males and 12 females of *C. hoodensis* left in the wild.

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 ..... %

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(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 9 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

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