Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 15 January 2024

Morning (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

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.*

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 labelled 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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P 7 5 5 9 0 A 0 1 3 6

Pearson

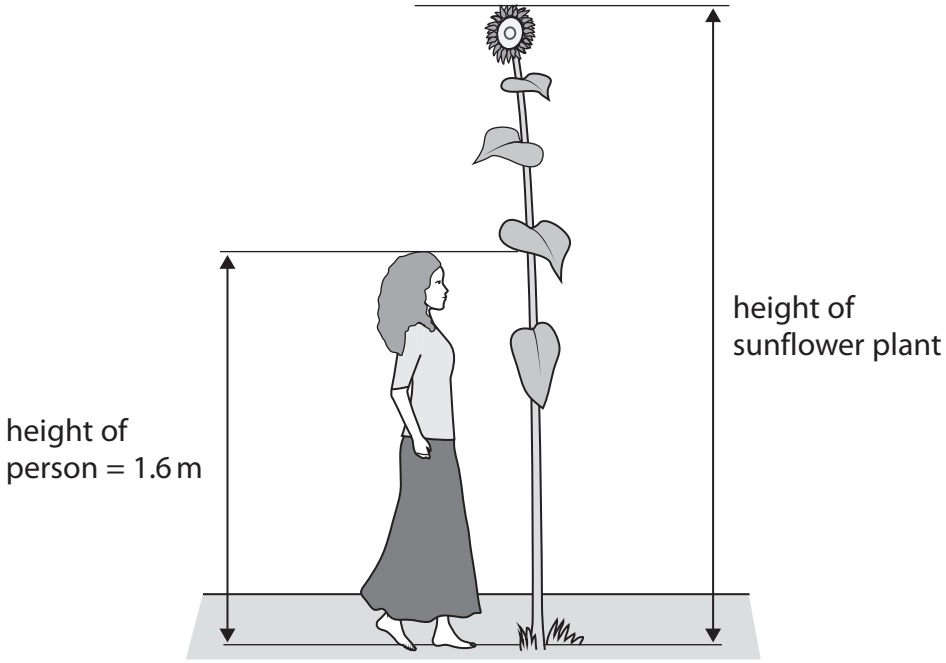
Answer ALL questions.

Write your answers in the space 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 Plants contain tissues involved in the transport of substances.

The diagram shows a sunflower plant.



(a) Estimate the height of the sunflower, using the information in the diagram.

Give your answer with appropriate units.

(1)

Answer .....

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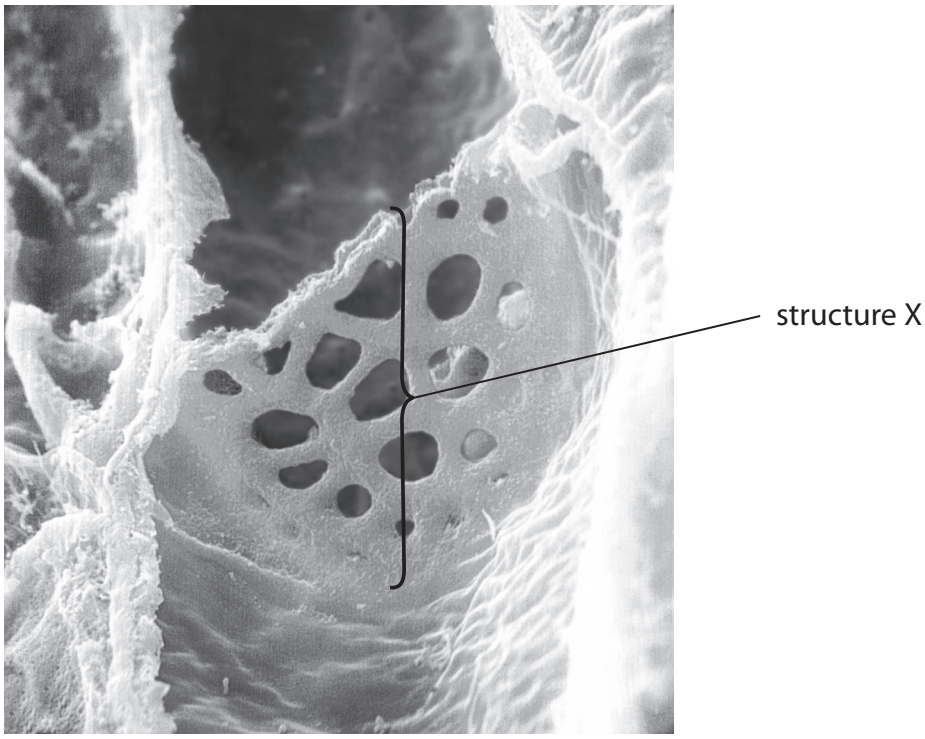
(b) The photograph shows a structure that would be found in a sunflower plant.



(Source: © Dr. Richard Kessel and Dr. Gene Shih / Science Photo Library)

(i) Name the tissue that would contain structure X.

(1)

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(ii) Describe how **two** structures in this tissue enable it to carry out its function.

(2)

Structure 1 .....

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Structure 2 .....

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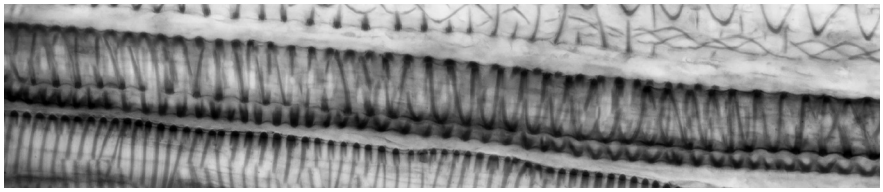
(c) The photograph shows some rings of lignin, as seen using a microscope.



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

(i) Which of the following tissues contain lignin?

1. phloem
2. sclerenchyma
3. xylem

(1)

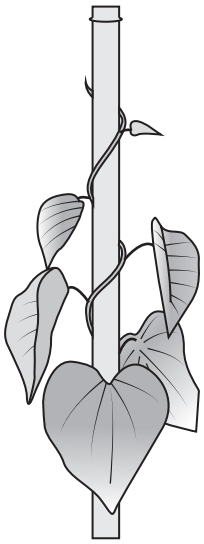
☒ **A** 1 only

☒ **B** 1 and 3 only

☒ **C** 2 and 3 only

☒ **D** 3 only

(ii) The diagram shows a climbing plant that is growing up a bamboo pole.



Suggest **two** reasons why a climbing plant may have a **lower** lignin content than a sunflower plant of the same height and diameter.

(2)

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(Total for Question 1 = 7 marks)

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2 Fish are often packaged for transport to markets.

The bacteria *E.coli* and *S. aureus* are found on the surface of fish. These bacteria can cause disease in humans.

(a) Which structures enable *E.coli* to stick to the surface of fish?

(1)

- ☒ **A** capsule and flagellum
- ☒ **B** capsule and pili
- ☒ **C** flagellum and pili
- ☒ **D** flagellum and ribosomes

(b) High-density polyethylene (HDPE) and polystyrene are two examples of oil-based plastics.

The photograph shows polystyrene boxes that have been used to transport fish to a fish market.

(Source: © Roberto Fumagalli / Alamy Stock)

(i) Plant-based packaging is more sustainable than oil-based packaging.

Explain what is meant by **sustainable**.

(2)

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(ii) The effect of packaging material on the growth of viable bacteria on the surface of fish was investigated.

The number of *S. aureus* bacteria on four groups of fish was determined before each group of fish was placed in a different type of container.

The containers of fish were kept at 1 °C for one week.

The table shows the means and standard deviations for the decrease in the number of colonies of *S. aureus* bacteria.

Container packaging material	**Mean decrease in the number of *S. aureus* bacteria / colonies cm^{-2}**
Poplar wood	0.79 ± 0.44
Pine wood	7.14 ± 0.28
HDPE	0.00 ± 0.02
Polystyrene	0.08 ± 0.02

Comment on the results of this investigation.

(4)

(Total for Question 2 = 7 marks)

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3 Migration is when many individuals of a species move from one geographical region to another.

Monarch butterflies migrate from Canada and North America to Mexico each autumn.

The photograph shows a cluster of migrating Monarch butterflies on a branch of a tree.

(Source: © Patrick Stoll/Alamy Stock Photo)

(a) (i) Migration is an example of which type of adaptation?

(1)

- ☒ **A** anatomical
- ☒ **B** behavioural
- ☒ **C** isolational
- ☒ **D** physiological

(ii) The heterozygosity index for a cluster of 8 000 Monarch butterflies was calculated as 0.166.

Calculate the number of heterozygotes in this cluster.

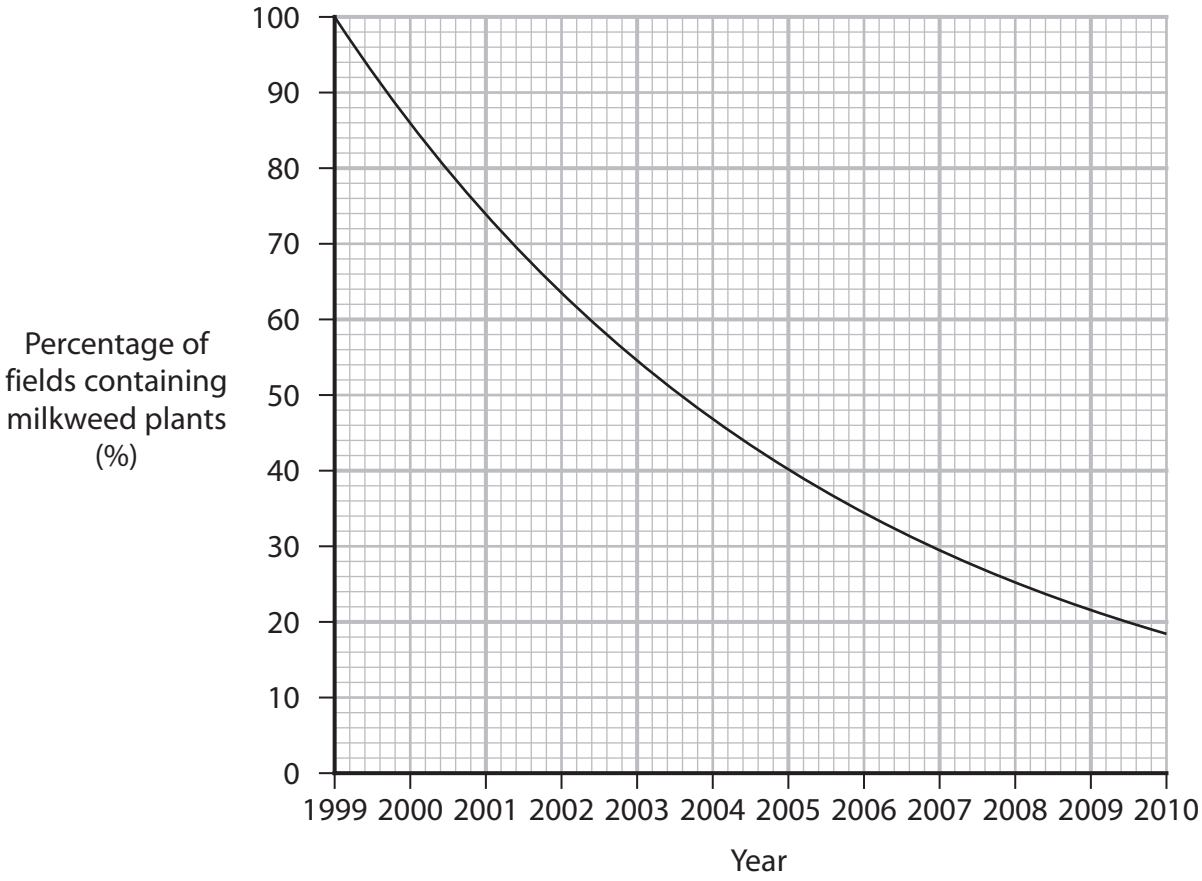
(1)

Answer .....

(b) Female Monarch butterflies lay fertilised eggs on the leaves of milkweed plants.

Herbicides can be used by farmers to kill plants such as milkweed. Farmers in the USA have increased the use of glyphosate herbicide since 1999 to kill plants, such as milkweed.

The graph shows the percentage of fields in the USA containing milkweed plants from 1999 to 2010.



Explain what effect this human activity would have had on populations of Monarch butterflies, including their genetic diversity, after 2010.

Use the information in the graph to support your answer.

(3)

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(c) The photograph shows a hen (female chicken) that has just laid an egg.

(Source: © Angela Hampton Picture Library / Alamy Stock Photo)

The rate of egg laying by hens is an example of polygenic inheritance.

This phenotype shows continuous variation.

(i) State what is meant by **polygenic inheritance** with reference to this phenotype.

(1)

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(ii) Sketch a **labelled** graph to show the expected egg laying rate for a population of hens.

(2)

(Total for Question 3 = 8 marks)

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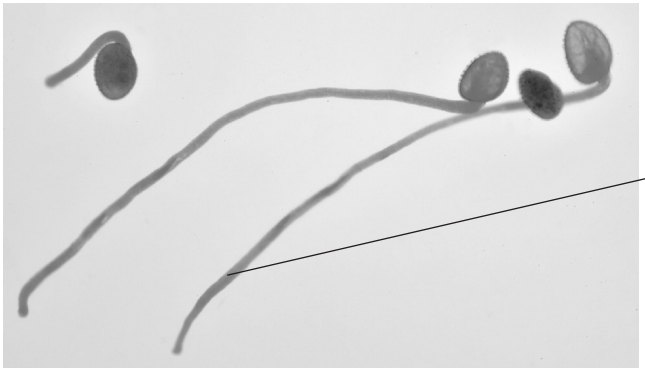
4 The photograph shows some pollen tubes growing from pollen taken from a lily flower, as seen using a light microscope.



Magnification ×100

(Source: © agefotostock/Alamy Stock Photo)

(a) (i) The pollen tube growth rate is 0.2 μm s^{-1}.

How long would it take the pollen tube to grow 15 mm?

(1)

- ☒ **A** 75 seconds
- ☒ **B** 125 minutes
- ☒ **C** 1 250 minutes
- ☒ **D** 7 500 seconds

(ii) State how to calculate the actual length of one of the pollen tubes in the photograph.

(1)

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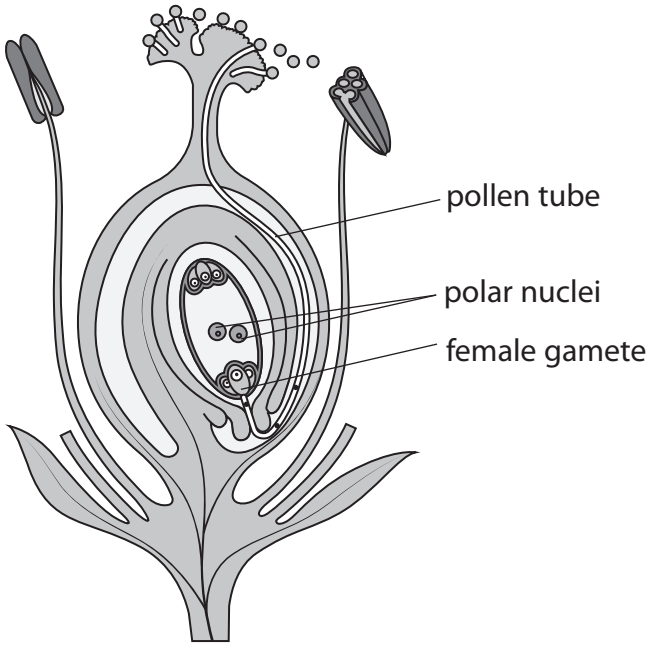
(b) The diagram shows a pollen tube that has grown to reach an ovule.



Fertilisation of the female polar nuclei results in the production of endosperm tissue.

Fertilisation of the female gamete results in the production of an embryo.

Explain why an embryo cell and an endosperm cell contain **different** quantities of DNA.

(4)

(c) The photograph shows part of a Madonna lily plant (*L. candidum*).

(Source: © Zoonar GmbH/Alamy Stock Photo)

An extract made from *L. candidum* has been used in traditional medicine as a treatment for human skin burns.

Describe a drug trial method that a scientist could use to determine if this extract is:

- safe to use in humans
- more effective than the current skin burn treatment used in a hospital.

(5)

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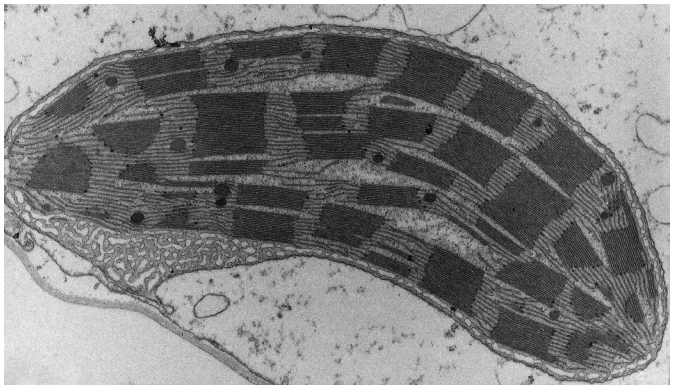
(Total for Question 4 = 11 marks)

5 (a) The photograph shows an organelle found in many plant cells, as seen using a microscope.



(Source: © Ashley Cooper pics / Alamy Stock Photo)

(i) Give the name and function of this organelle.

(1)

Name .....

Function .....

.....

.....

(ii) Name the type of microscope used for this photograph.

Give **one** reason for your answer.

(2)

Name .....

Reason .....

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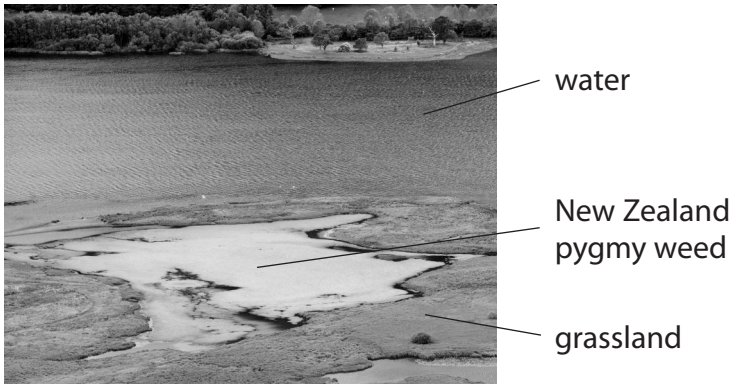
(b) The photograph shows a lake partly covered with New Zealand pygmy weed plants (*C. helmsii*).



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

The effect of New Zealand pygmy weed on the biodiversity of a lake was investigated.

Species richness and an index of diversity were determined.

(i) State what is meant by **species richness**.

(1)

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(ii) The number of individuals of different species in this area of the lake was measured **before** the appearance of the New Zealand pygmy weed.

The table shows these results.

Species	Number of individuals (n)	(n – 1)	n(n – 1)
A	54	53	2862
B	12		
C	3	2	6
D	31	30	930
E	7	6	42
F	46	45	
	Total (N) =		$\sum n(n-1) =$

Calculate the index of diversity (D) for this area of the lake using the formula:

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

Use the table to help you.

Give your answer to **two** decimal places.

(3)

Answer .....

(iii) A year **after** the appearance of the New Zealand pygmy weed in this lake the index of diversity (D) was found to be 1.8.

Suggest the effect of the New Zealand pygmy weed on the diversity of this part of the lake.

(2)

(Total for Question 5 = 9 marks)

6 All living organisms are made of cells.

(a) The table shows some structures found in living cells.

Complete the table to show in which type of cells these structures are present (✔) or absent (✗).

(4)

Structure	Animal cell ✔ = present ✗ = absent	Plant cell ✔ = present ✗ = absent	Prokaryotic cell ✔ = present ✗ = absent
amyloplast			
circular DNA			
mitochondria			
nucleolus			

(b) The smallest living cell has a diameter of 0.2 μm.

The volume of a sphere is calculated using the formula:

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

Which of the following shows the volume of this cell in standard form?

(1)

☒ **A** 4.2×10^{-3} μm^3

☒ **B** 4.2×10^{3} μm^3

☒ **C** 3.4×10^{-2} μm^3

☒ **D** 3.4×10^{2} μm^3

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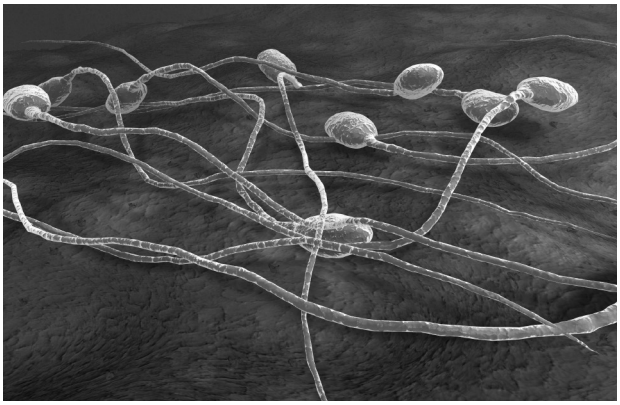
(c) Gamete cells are specialised for their function.

(i) The photograph shows some sperm cells, as seen using a microscope.



×4000

(Source: © MedicalRF.com/Alamy Stock Photo)

Which of the following statements about human sperm cells are correct?

1. they contain the same quantity of DNA as a body cell
2. they contain hydrolytic enzymes
3. the release of energy from starch enables the rotation of the flagellum

(1)

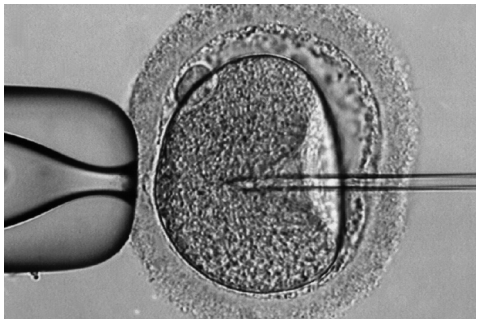
☒ **A** 1, 2 and 3

☒ **B** 2 and 3 only

☒ **C** 2 only

☒ **D** 3 only

*(ii) The photograph shows a sperm cell being injected into a human egg cell during the process of in-vitro fertilisation (IVF).



(Source: © Phanie / Alamy Stock Photo)

Scientists have suggested that one cause of human infertility is the production of egg cells with a zona pellucida thickness greater than 18 μm.

The table shows the mean thickness of the zona pellucida of fertilised egg cells and unfertilised egg cells.

Type of egg cell	Mean zona pellucida thickness / μm
fertilised	16.6 ± 3.2
unfertilised	18.9 ± 4.0

Sperm cells are released from the male by ejaculation.

Another suggested cause of infertility is a longer time between sperm cell ejaculation and the cells reaching an egg cell in the female.

Scientists wish to increase the number of successfully fertilised egg cells by IVF. They have proposed that the technique of injecting recently obtained sperm cells should be used for egg cells with a zona pellucida thicker than 18 μm.

Evaluate this proposal.

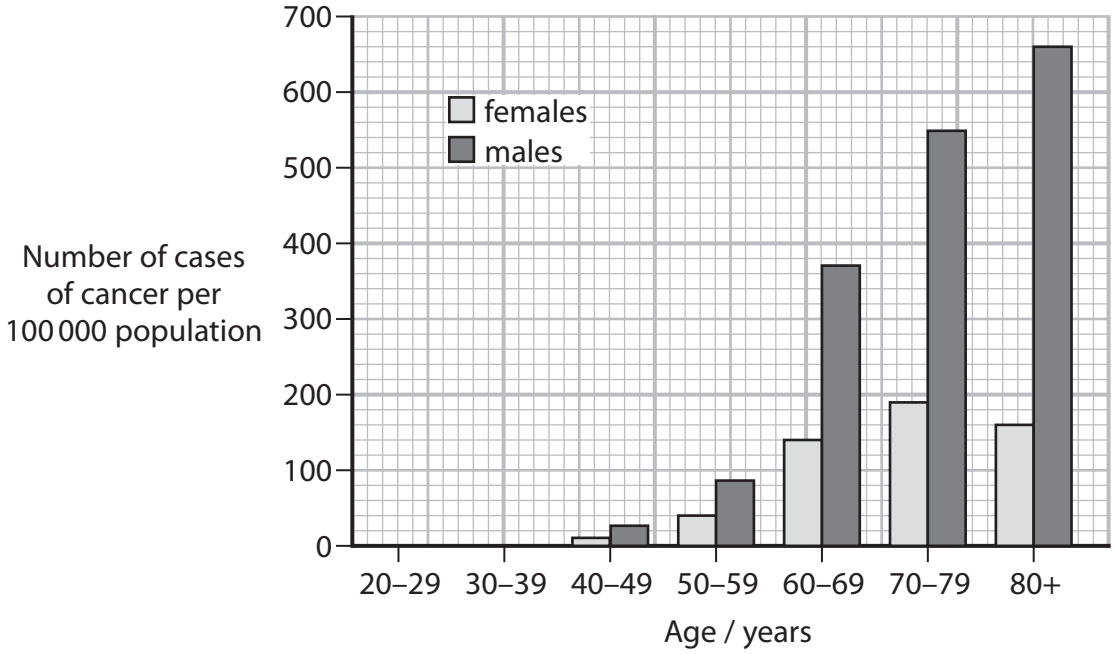
Use the information provided in the question and your own knowledge to support your answer.

(6)

(Total for Question 6 = 12 marks)

7 A change in the base sequence of a gene can give rise to cancer.

The graph shows the number of cases of one type of cancer in a human population.



(a) (i) Deduce the effect of age and sex on the number of cases of this cancer.

(3)

(ii) A city had a population of 2 million people. Three per cent (%) of this population were males over the age of 80.

Calculate how many of the males over the age of 80 would have this cancer.

(2)

Answer .....

(b) A sample of tissue was taken from a patient with this type of cancer in order to calculate the mitotic index.

(i) This sample was stained before being viewed using a microscope.

State why the cells in this sample were stained before being viewed using a microscope, in order to calculate the mitotic index.

(1)

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(ii) Describe how the mitotic index of the tissue sample would be determined.

(2)

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(c) One treatment for this type of cancer prevents the condensing of chromosomes of cancer cells.

(i) In which stage of mitosis do chromosomes start to condense?

(1)

- ☒ **A** anaphase
- ☒ **B** metaphase
- ☒ **C** prophase
- ☒ **D** telophase

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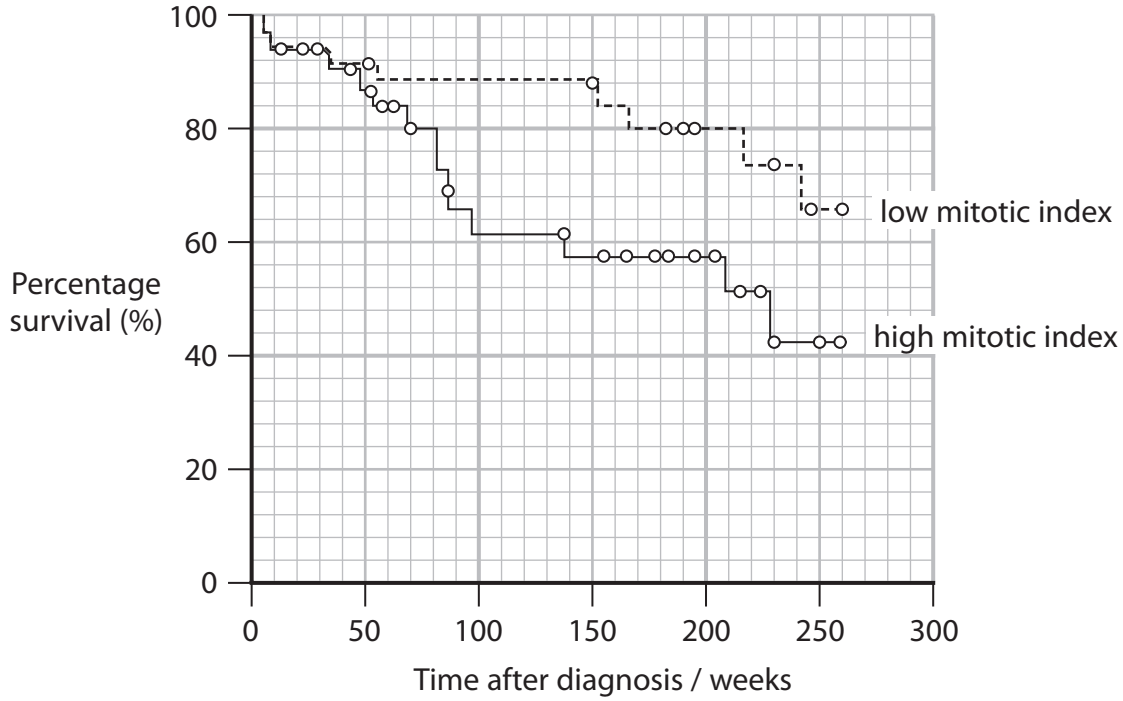
(ii) The graph shows the effect of the mitotic index on the percentage survival for people with a type of cancer.

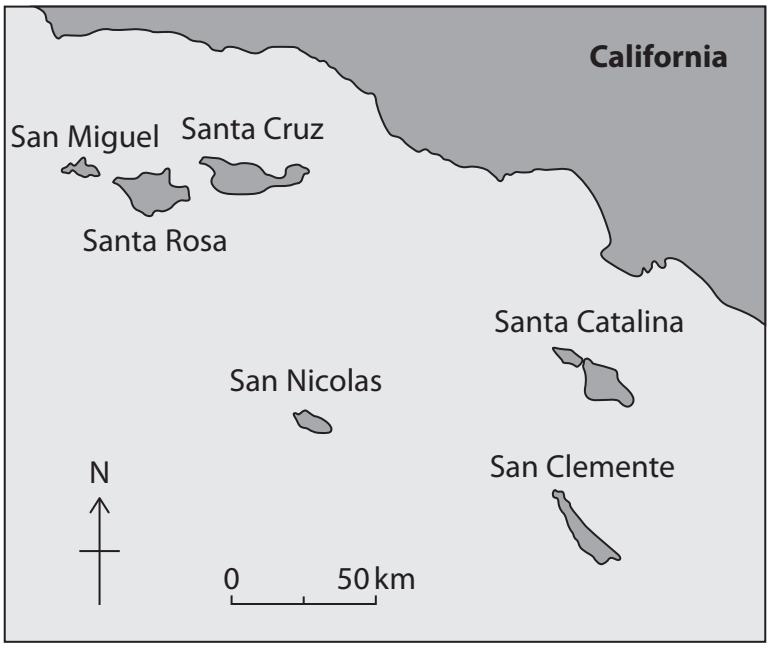


Explain how preventing the condensation of chromosomes would affect the survival of a patient with this type of cancer.

(3)

(Total for Question 7 = 12 marks)

8 The map shows six islands near the coast of California.



Each of these islands has a population of island foxes descended from the California grey fox.

Each island fox population has developed different characteristics from the fox populations on the other islands.

The photograph shows a fox from the population found only on the island of Santa Cruz.

(Source: © Christian Loader/Alamy Stock Photo)

(a) (i) Which of the following is a term used to describe the fact that this subspecies of island fox is found only on Santa Cruz?

(1)

- ☒ **A** diversity
- ☒ **B** endemic
- ☒ **C** mutation
- ☒ **D** specific

(ii) Explain how isolation caused the formation of six fox populations with different characteristics.

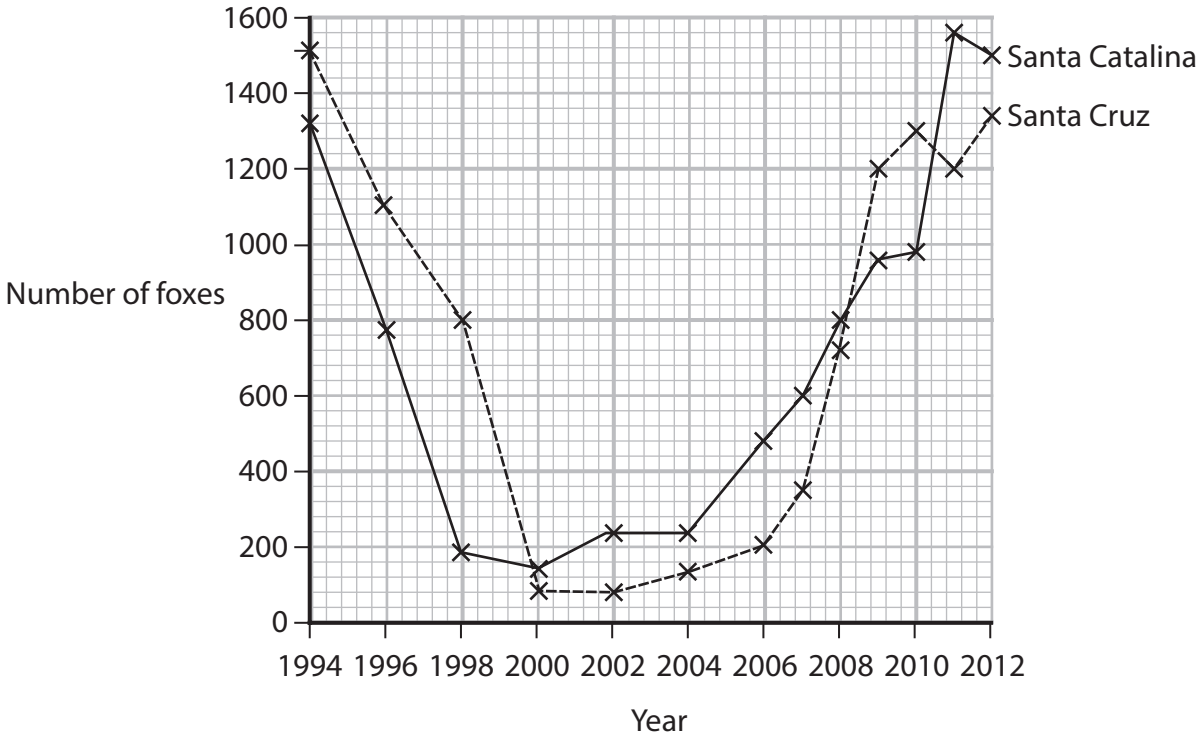
Use the information in the question to support your answer.

(4)

(iii) Explain how molecular evidence could be used to determine which of the other five fox populations is the most closely related to the fox population on Santa Cruz.

(2)

(b) The graph shows the sizes of two fox populations from 1994 to 2012.



Two main causes for the decrease in island fox populations from 1994 to 2000 were predation by golden eagles and diseases transmitted from dogs and raccoons.

(i) Calculate the percentage decrease in the Santa Cruz fox population from 1994 to 2002.

(1)

Answer ..... %

(ii) Explain how the Hardy–Weinberg equation can be used to show the change in the frequency of a recessive allele in the Santa Cruz population from 1994 to 2000.

(2)

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(iii) In 2004, a conservation plan was produced to:

- increase the sizes of the Santa Cruz and Santa Catalina fox populations
- maintain the genetic diversity of the Santa Cruz and Santa Catalina fox populations.

Explain how conservation could achieve these goals.

Use the information in the question and your own knowledge to support your answer.

(4)

(Total for Question 8 = 14 marks)

TOTAL FOR PAPER = 80 MARKS

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