



88096003



BIOLOGY
HIGHER LEVEL
PAPER 3

Wednesday 11 November 2009 (morning)

1 hour 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

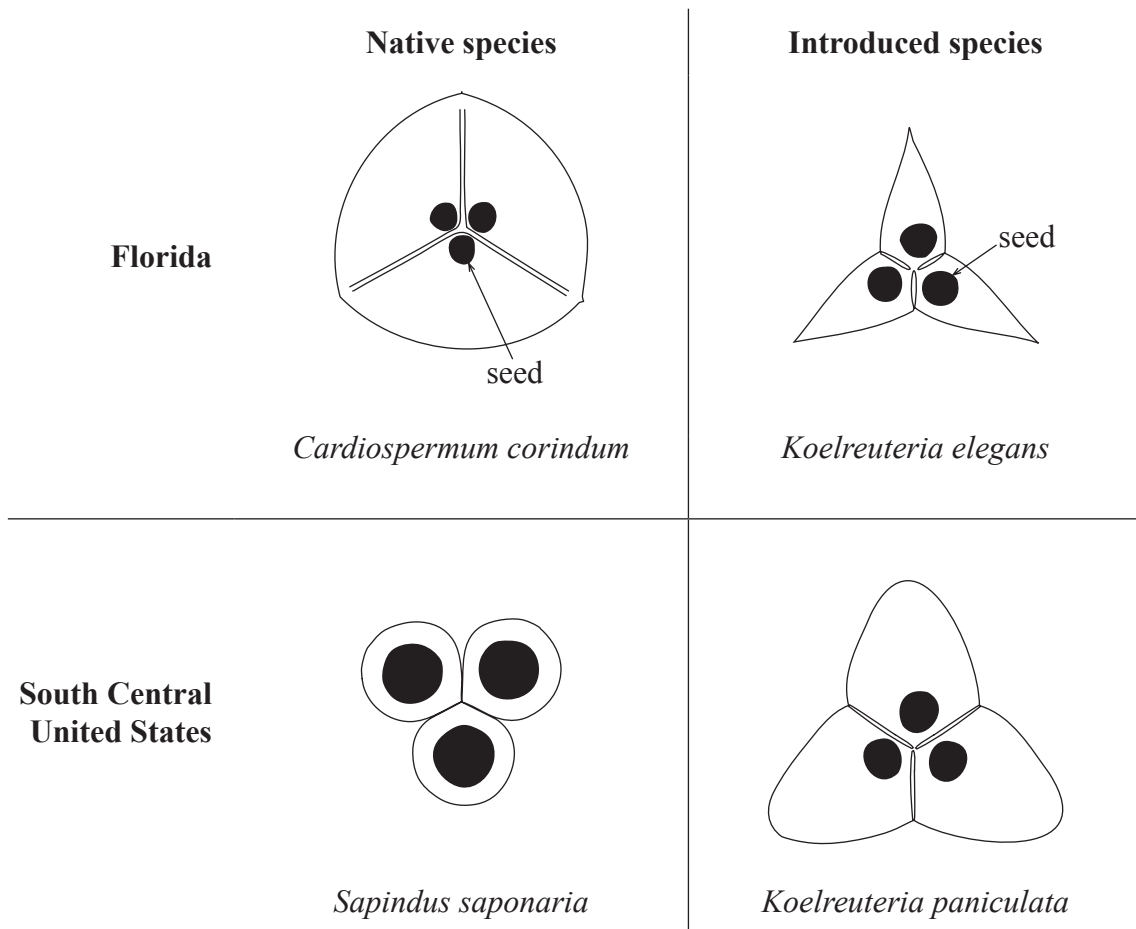
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.



Option D — Evolution

D1. The soapberry bug (*Jadera haematoloma*) feeds on the seeds of plants from the soapberry family (Sapindaceae). It does this by penetrating the fruit containing the seeds with mouthparts called the proboscis.

The diagrams below show sections through the fruits taken from four members of the Sapindaceae family.



[Source: Adapted from S P Carroll and C Boyd, “Host race radiation in the soapberry bug: Natural history, with the history”, *Evolution*, Vol 46, pages 1052-1069. © John Wiley & Sons]

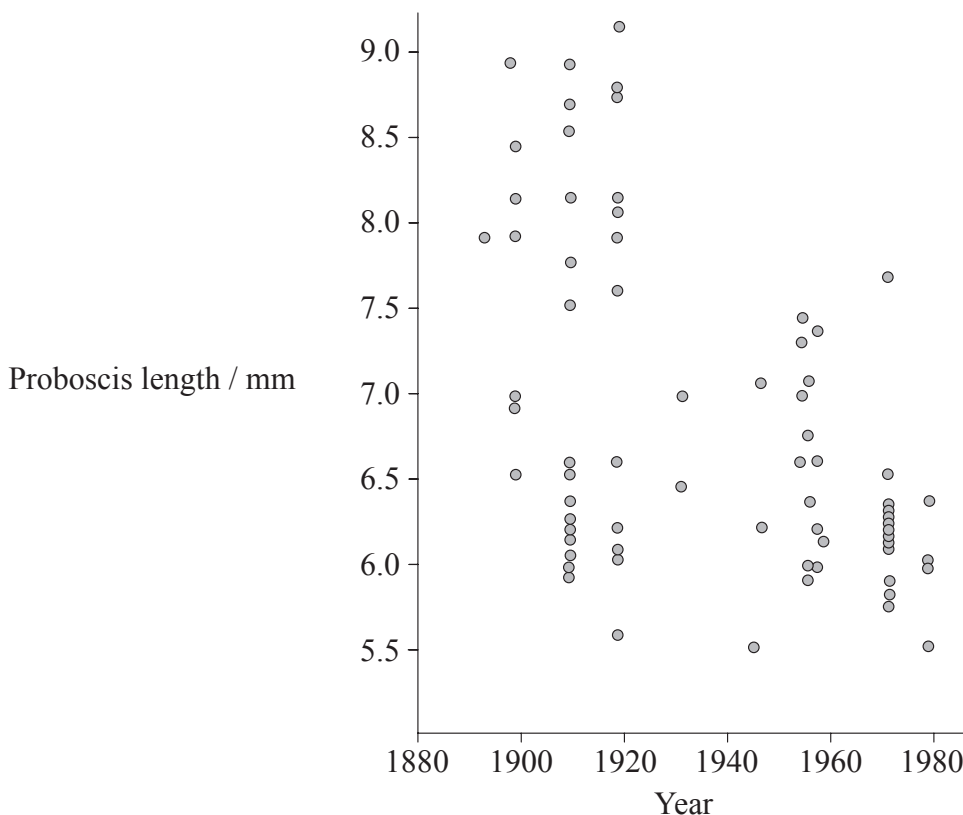
In Florida, *Cardiospermum corindum* is native to the area while *Koelreuteria elegans* is a species that was introduced in the 1890s and is now common in Florida. In the South Central United States, *Sapindus saponaria* is native while *Koelreuteria paniculata* is an introduced species which has become more common over the past 70 years.

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(Question D1 continued)

The graph below shows proboscis lengths of samples of adult female soapberry bugs in Florida between 1880 and 1980.



[Source: Adapted from S P Carroll and C Boyd, "Host race radiation in the soapberry bug: Natural history, with the history", *Evolution*, Vol 46, pages 1052-1069. © John Wiley & Sons]

(a) (i) Outline the trends in proboscis length in soapberry bugs shown in the graph. [2]

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(ii) Explain how the change in proboscis length could have occurred. [3]

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(Question D1 continued)

- (b) Suggest, giving a reason, the expected trend in the proboscis length of the soapberry bug in the South Central United States over the past 70 years. [2]

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- D2.** (a) Compare sympatric speciation and allopatric speciation. [2]

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- (b) Define analogous characteristics using **one** example to illustrate your answer. [1]

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- (c) Outline **two** pieces of evidence that support the endosymbiotic theory for the origin of eukaryotes. [2]

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- (d) List **two** anatomical features that define humans as primates. [2]

1.

2.



D3. Explain the biochemical evidence for the common ancestry of living organisms. [6]

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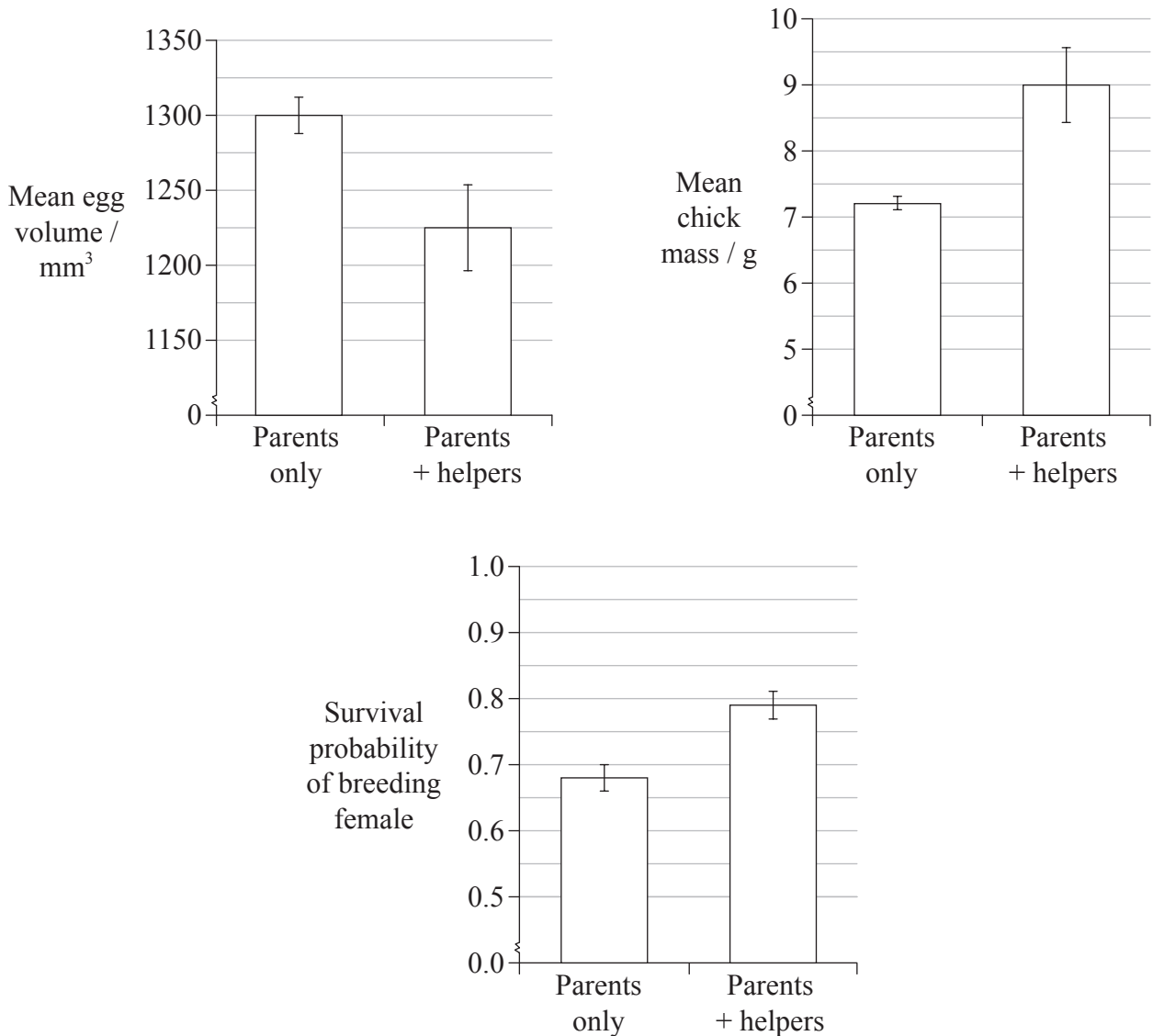
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Option E — Neurobiology and behaviour

E1. Cooperative breeding in birds occurs when more than two birds of the same species help to rear the young from one nest. For the Australian superb fairy-wren (*Malurus cyaneus*), mature non-breeding birds help to protect and rear the young, although they are not parents of any of them.

The bar charts below show the effect of the presence of helpers on mean egg volume, mean mass of six-day-old chicks and the probability of survival of the breeding females until the next breeding season.



[Source: From A F Russell, et. al., (2007), *Science*, 317, pages 941-944. Reprinted with permission from AAAS.]

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(Question E1 continued)

(a) State the effect of the presence of the helpers on

(i) mean chick mass.

[1]

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(ii) the probability of survival of the breeding females until the next breeding season.

[1]

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(b) Calculate the percentage decrease in mean egg volume found in the presence of helpers as compared to the parents only. Show your working.

[2]

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(c) With reference to the data, suggest why the activity of the helper affects the probability of survival of the breeding female until the next breeding season.

[2]

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(d) Cooperative breeding is an altruistic behaviour. Outline the evolution of altruistic behaviour.

[2]

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E2. (a) Explain the role of the neurons used in the pain withdrawal reflex. [3]

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(b) Distinguish between taxis and kinesis. [2]

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(c) State **one** effect of tetrahydrocannabinol (THC) on brain function. [1]

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E3. Discuss the concept of brain death and the use of the pupil reflex in testing for brain death. [6]

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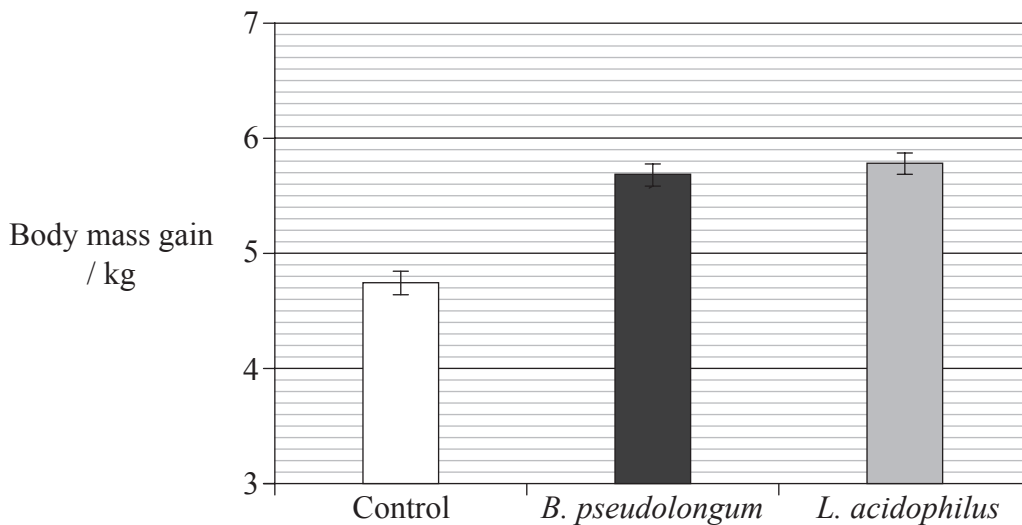
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Option F — Microbes and biotechnology

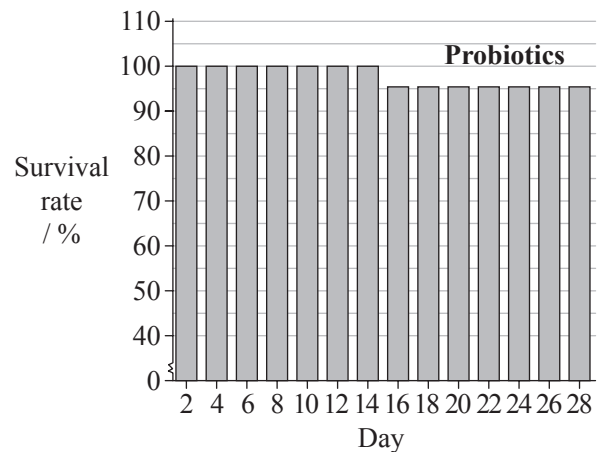
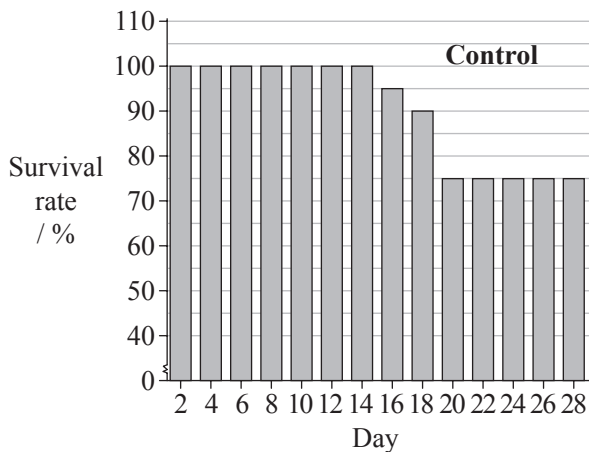
F1. Probiotics are live microorganisms that can have beneficial effects when ingested. Like antibiotics, they can reduce the effect of pathogens in the gut. During experimental trials, the probiotics *Bifidobacterium pseudolongum* and *Lactobacillus acidophilus* were given orally to newborn piglets.

The effects of both probiotics on increase in body mass were measured at 28 days and compared to control piglets who were not given probiotics. The mean results are shown in the bar chart below.



[Source: JOURNAL OF DAIRY SCIENCE by Fumiaki Abe. © 1995 by AMERICAN DAIRY SCIENCE ASSOCIATION/ADSA. Reproduced with permission of AMERICAN DAIRY SCIENCE ASSOCIATION/ADSA in the format CD ROM via Copyright Clearance Center.]

The bar charts below show the effect of probiotics on the survival of the newborn piglets. There were 20 piglets in each of the groups.



[Source: JOURNAL OF DAIRY SCIENCE by Fumiaki Abe. © 1995 by AMERICAN DAIRY SCIENCE ASSOCIATION/ADSA. Reproduced with permission of AMERICAN DAIRY SCIENCE ASSOCIATION/ADSA in the format CD ROM via Copyright Clearance Center.]

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(Question F1 continued)

- (a) Calculate the difference in body mass gain between the control group and the *L. acidophilus* group. [1]

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- (b) Calculate the number of piglets that died by the end of day 20 in the control group. [1]

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- (c) Evaluate, using the data in all of the bar charts, the evidence for the benefits of using probiotics. [3]

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- (d) Suggest **one** advantage of using probiotics rather than antibiotics to reduce the effects of disease-causing pathogens in the piglets. [1]

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- (e) Outline the use of antibiotics as a medicine using a **named** mechanism for how antibiotics work. [2]

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- F2.** (a) Distinguish between the cell walls of Gram-positive and Gram-negative bacteria using the table below. [2]

Bacteria	Peptidoglycan content
Gram-positive	
Gram-negative	

- (b) State **one** example of a chemoautotroph. [1]

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- (c) Draw a labelled diagram of a filamentous cyanobacterium. [3]



F3. Discuss the risks of gene therapy including safety, conflict of interest and ethical arguments. [6]

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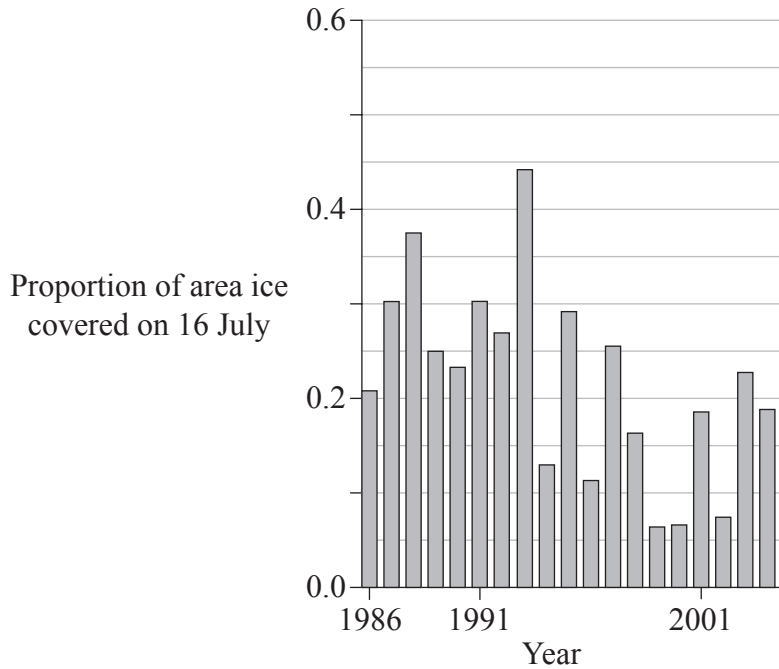
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Option G — Ecology and conservation

G1. A colony of a marine diving bird, Brunnich’s guillemot (*Uria lomvia*), lives on the southern limits of the Arctic on Coats Island. Brunnich’s guillemots feed principally on Arctic cod (*Arctogadus glacialis*) which are characteristic of Arctic waters.

The graph shows the changes in ice cover on Coats Island over a period of 19 years.



[Source: A Gaston, et al., “Climate change, ice conditions and reproduction in an Arctic nesting marine bird: Brunnich’s guillemot (*Uria lomvia* L.)”, *Journal of Animal Ecology*, Volume 74, number 5, pages 832-841. © John Wiley & Sons, Inc. Reproduced with permission.]

(a) (i) Outline the changes in ice cover shown in the data above. [2]

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(ii) Suggest **one** reason for the changes in ice cover. [1]

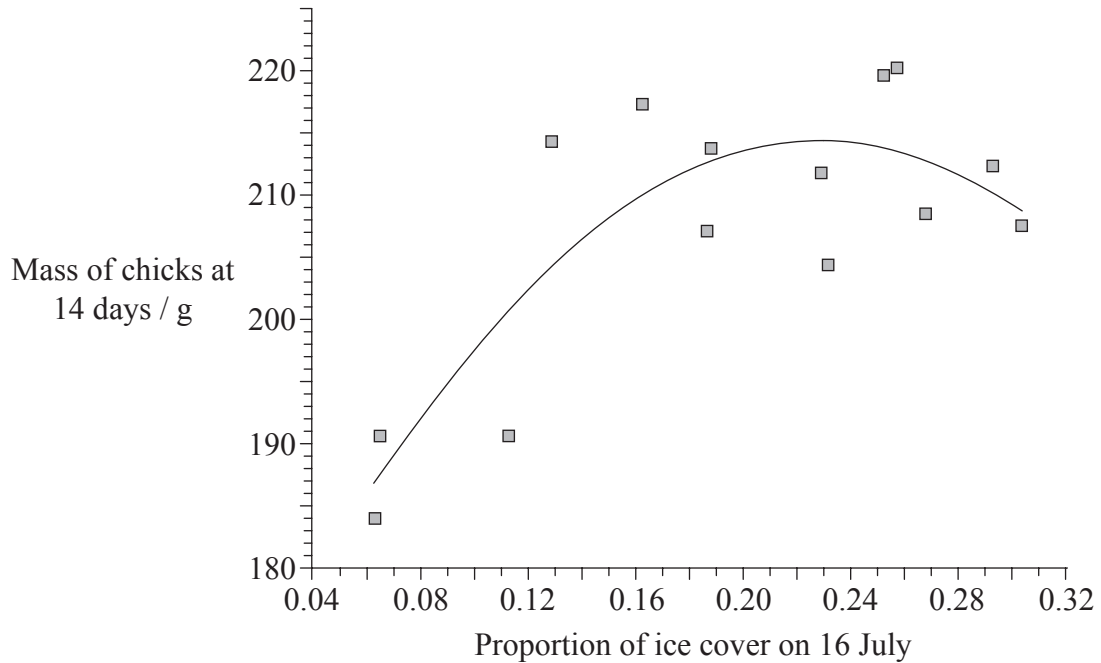
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(Question G1 continued)

At Coats Island, chick mass at 14 days was measured in most years between 1988 and 2002. The scattergraph below shows the results, plotted against proportion of ice cover.



[Source: A Gaston, et al., "Climate change, ice conditions and reproduction in an Arctic nesting marine bird: Brunnich's guillemot (*Uria lomvia L.*)", *Journal of Animal Ecology*, Volume 74, number 5, pages 832-841. © John Wiley & Sons, Inc. Reproduced with permission.]

(b) (i) Outline the relationship between ice cover and the mass of 14-day-old chicks on Coats Island. [2]

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(ii) Suggest reasons for the relationship. [2]

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(c) Predict, with a reason, the change in the mass of chicks in the years ahead. [1]

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G2. (a) (i) Define *biomagnification*. [1]

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(ii) Outline a **named** example of biomagnification. [2]

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(b) Outline the characteristics of a tropical rainforest biome. [3]

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G3. Discuss international measures that would promote the conservation of fish, including methods used to measure conservation of fish stocks. [6]

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(Question H1 continued)

- (a) 47% of the control group had been infected with *H. pylori*. Calculate the percentage of the group with stomach cancer that had been infected. Show your working. [2]

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- (b) Using all of the data, evaluate the hypothesis that *H. pylori* causes stomach cancer. [3]

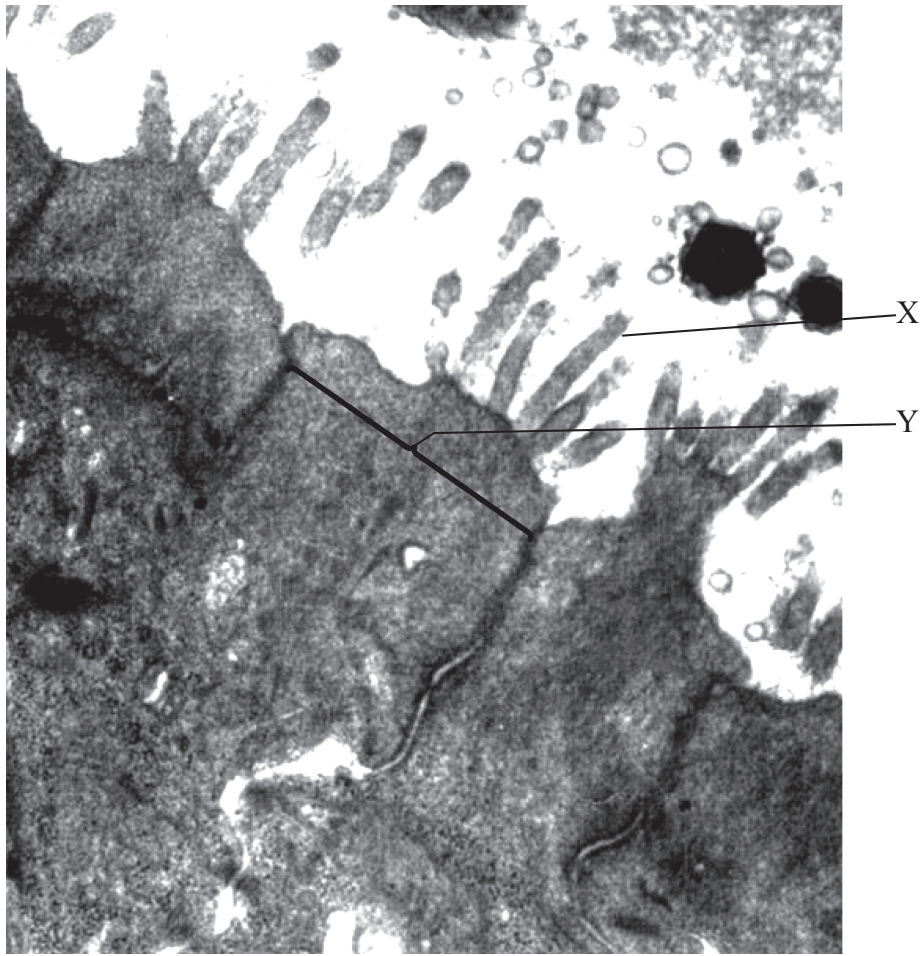
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- (c) A study in gerbils indicated that infection with *H. pylori* leads to a decrease in the secretion of hydrochloric acid. Discuss the consequences of this finding for the digestion of proteins in the stomach in humans. [2]

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H2. The electron micrograph below shows cells from the intestine.



[Source: C Candalh, Inserm, magnification $\times 10000$]

(a) In the electron micrograph above, state the name of the

(i) structure labelled X.

[1]

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(ii) type of cells labelled Y.

[1]

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(b) Define *hormone*.

[2]

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(Question H2 continued)

(c) Outline the circulation of blood through liver tissue.

[3]

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H3. Explain how and why ventilation rate varies with exercise.

[6]

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