88096006

International Baccalaureate®
Baccalauréat International
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BIOLOGY
STANDARD LEVEL
PAPER 3

Wednesday 11 November 2009 (morning)

1 hour

Candidate session number

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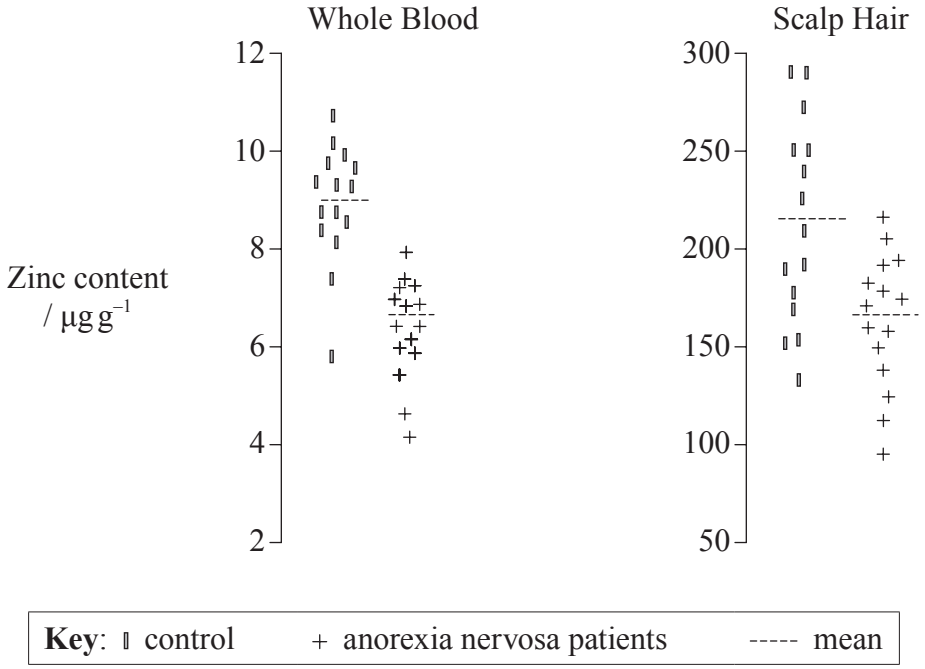
INSTRUCTIONS TO CANDIDATES

- 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.

0126

Option A — Human nutrition and health

A1. Zinc (Zn) is an important dietary nutrient. More than 200 enzymes that are dependent on zinc have been identified. One consequence of zinc deficiency is suppression of appetite, due to reduced sensitivity to tastes and smells. A recent study compared the presence of zinc in tissue and fluid samples collected from 15 patients with anorexia nervosa to that from 15 control patients. The results are shown in the graphs below.



[Source: adapted from T E Tuormaa, (1995), *Journal of Orthomolecular Medicine*, **10**, pages 149–164]

(a) Compare the zinc content of scalp hair of the control group with that of the anorexia nervosa group. *[2]*

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(This question continues on the following page)

(Question A1 continued)

(b) Discuss whether whole blood zinc content of $6\,\mu g\,g^{-1}$ would indicate that a person has anorexia nervosa. *[2]*

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(c) Discuss whether dietary zinc supplementation would be an effective treatment for anorexia nervosa. *[2]*

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(d) Zinc is a mineral. Distinguish between a mineral and a vitamin. *[1]*

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(e) State the body mass index (BMI) below which a person is considered to be underweight. *[1]*

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A2. (a) State **one** consequence of protein deficiency malnutrition. *[1]*

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(b) Outline the reasons for increasing rates of clinical obesity in some countries. *[3]*

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(c) Discuss whether consumers should choose foods to minimize food miles. *[3]*

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A3. Outline the variation in the structure of fatty acids. *[3]*

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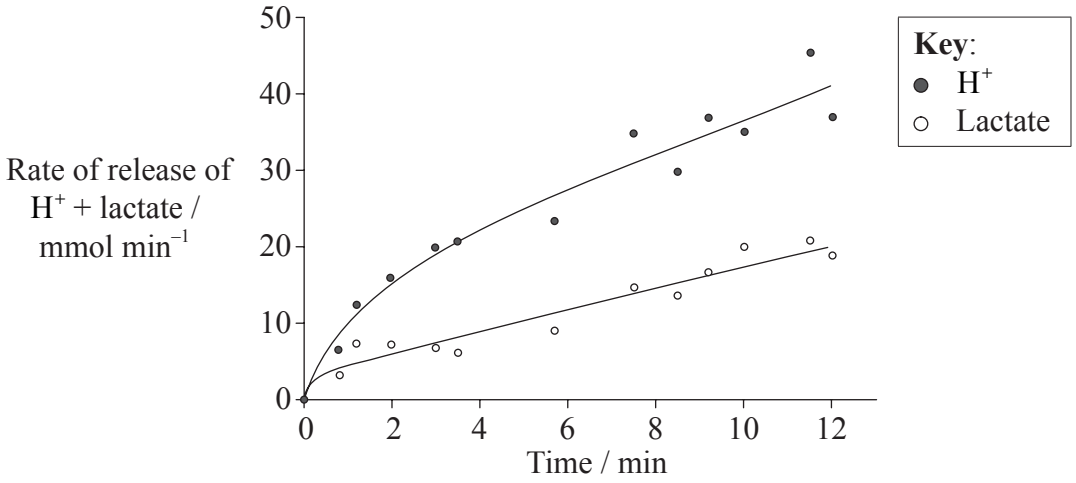
Option B — Physiology of exercise

B1. A build-up of hydrogen ions (H^+) in muscles causes a condition known as acidosis. Anaerobic cell respiration of glucose in the muscles leads to the production of lactate and H^+. One molecule of glucose is converted into two lactate ions and two H^+ (a 1:1 ratio of lactate to H^+).

The development of acidosis during intense exercise has traditionally been explained by the increased production of lactate and H^+ from the breakdown of glucose. This hypothesis has led to the interpretation that anaerobic cell respiration causes acidosis which leads to muscle fatigue during intense exercise. The graph below shows the quantities of H^+ and lactate released from contracting muscles during vigorous exercise.



[Source: Figure 6 , Carsten Juel, Christina Klarskov, Jens Jung Nielsen, Peter Krustrup, Magni Mohr, Jens Bangsbo. "Effect of high-intensity intermittent training on lactate and H+ release from human skeletal muscle." *American Journal of Physiology Endocrinology and Metabolism* 286: E245-E251, 2004. First published October 14, 2003; 10.1152/ajpendo.00303.2003. Used with permission.]

(a) Compare the rate of release of lactate with the rate of release of H^+ in contracting muscles during vigorous exercise. *[2]*

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(b) Evaluate the hypothesis that acidosis in muscles is due entirely to H^+ production as a result of anaerobic glucose breakdown. *[2]*

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(Question B1 continued)

(c) Predict the results if the data had been collected beyond 12 minutes. *[2]*

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B2. (a) Draw a labelled diagram to show the structure of a skeletal muscle sarcomere. *[3]*

(b) Outline the role of myoglobin in muscle fibres. *[2]*

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B3. (a) Outline the relationship between the intensity of exercise and the proportions of carbohydrate and fat used in respiration. *[2]*

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(b) Compare the distribution of blood flow at rest and during exercise. *[2]*

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(c) Discuss speed and stamina as measures of fitness. *[3]*

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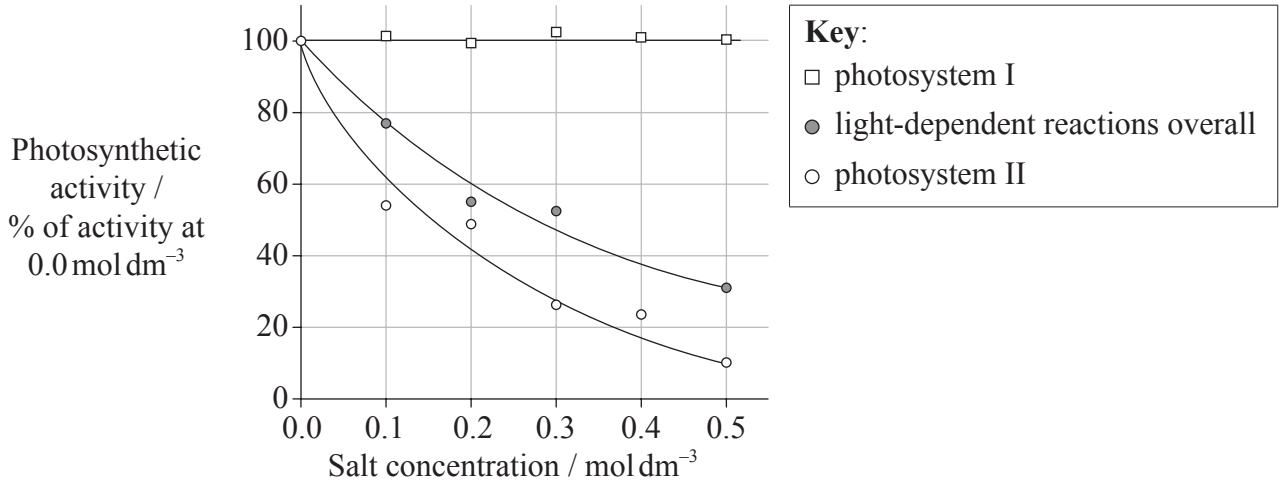
Option C — Cells and energy

C1. The graph below shows the results of an experiment to determine the effect of salt (NaCl) concentration on photosynthesis of the freshwater green alga *Chlorella vulgaris*. The experiment attempted to determine the effect of salt concentration on the light-dependent reactions overall and separately on photosystem I and photosystem II.



[Source: M M El-Sheekh, "Inhibition of the water splitting system by sodium chloride stress in the green alga *Chlorella vulgaris*", *Brazilian Journal of Plant Physiology*, Volume 16, Issue 1, Figure 1, (2004)]

(a) Describe the effect of salt concentration on the activity of the light-dependent reactions overall. *[1]*

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(b) Compare the effect of increasing salt concentration on photosystem I with the effect on photosystem II. *[1]*

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(c) When salt concentration is increased, some algal cells increase their rates of cyclic photophosphorylation. Deduce the reasons for this. *[2]*

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(Question C1 continued)

(d) Using the graph, predict the effect of high salt concentration on the growth of *Chlorella vulgaris*. Give a reason for your answer. *[2]*

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C2. (a) State **one** example of a fibrous protein. *[1]*

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(b) Distinguish between the secondary structure and tertiary structure of proteins. *[3]*

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(c) Explain what is meant by allosteric inhibition. *[3]*

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C3. (a) State the location of high proton concentration caused by electron transport in the mitochondrion. *[1]*

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(b) Outline the role of oxygen in cellular respiration. *[2]*

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(c) Explain how any **two** structural features of the mitochondrion are related to its function. *[2]*

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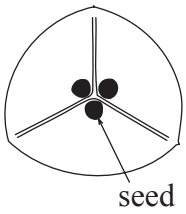
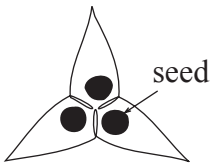
Option D — Evolution

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 two members of the Sapindaceae family.



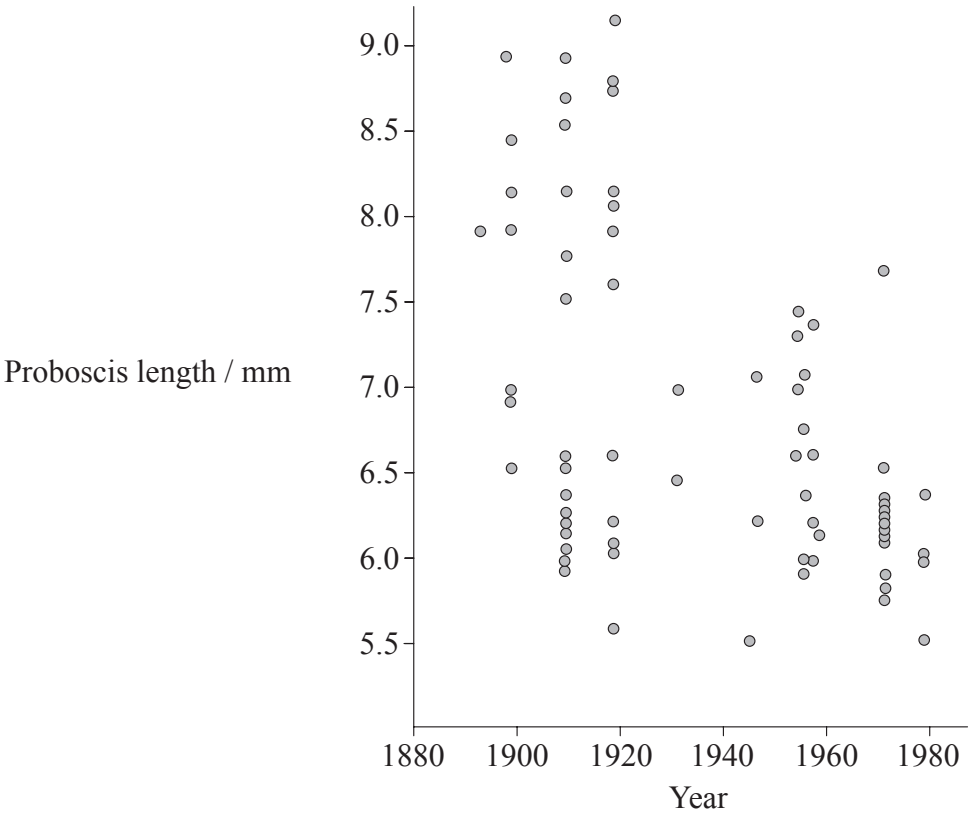
Cardiospermum corindum
(native species)



Koelreuteria elegans
(introduced species)

[Source: adapted from S P Carroll and C Boyd, (1992), *Evolution*, **46**, pages 1052–1069]

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. 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]

(This question continues on the following page)

(Question D1 continued)

(a) Compare the fruit of the native species with that of the introduced species. *[2]*

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(b) (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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D2. (a) State the conclusion drawn from the Miller-Urey experiment. *[1]*

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

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D3. (a) Compare sympatric speciation and allopatric speciation. *[2]*

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(b) (i) State **one** species in the genus *Australopithecus*. *[1]*

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(ii) For this species, state the geographical distribution and approximately how many years ago it lived. *[2]*

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(c) Discuss the concept of punctuated equilibrium. *[3]*

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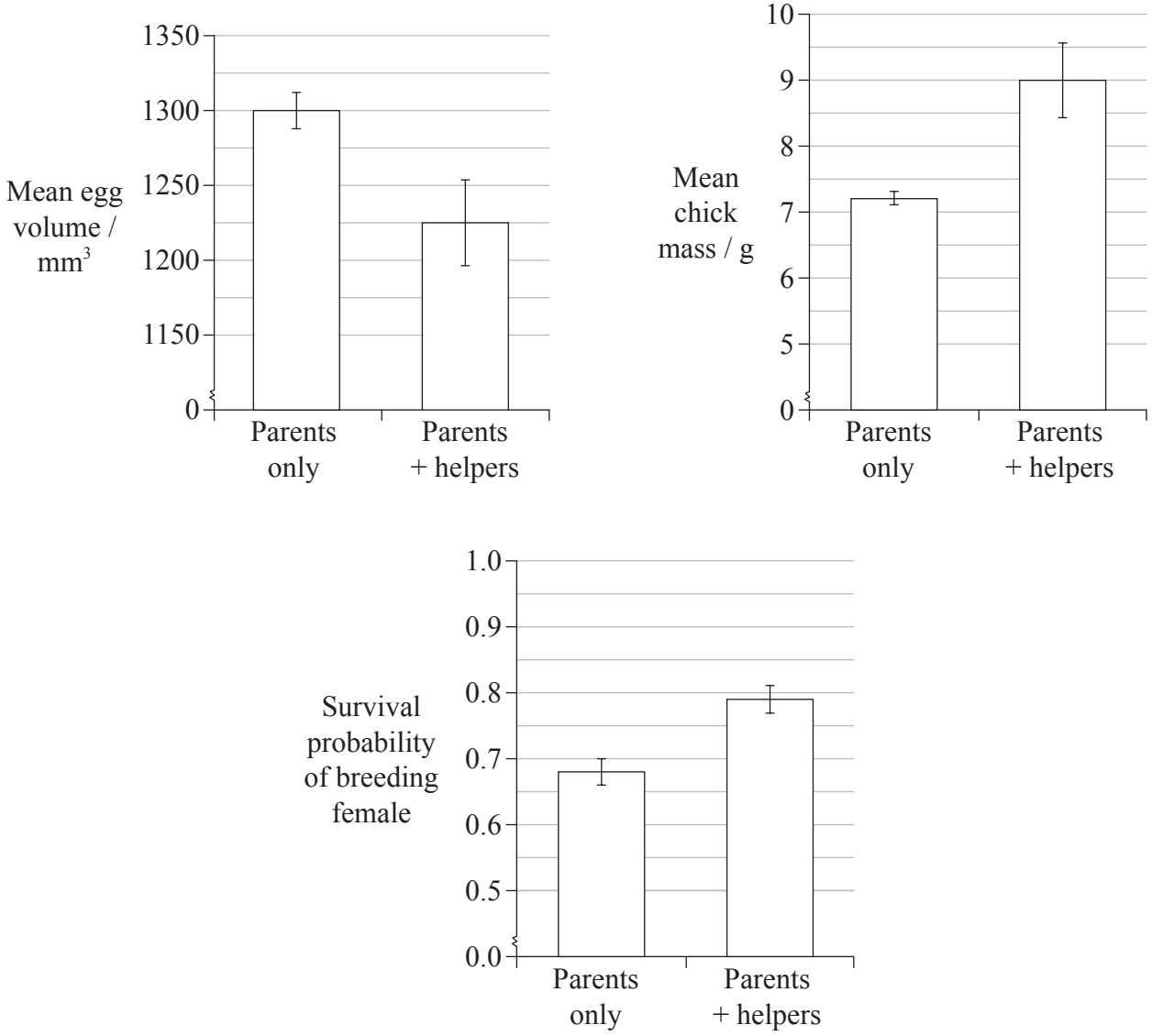
Option E — Neurobiology and behaviour

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: adapted from AF Russell, *et al*., (2007), *Science*, **317**, pages 941–944]

(This question continues on the following page)

(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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E2. (a) Compare rods and cones. *[3]*

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(b) Explain the role of receptors, sensory neurons and motor neurons in the response of animals to stimuli. *[3]*

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(c) List **four** general kinds of sensory receptor. *[2]*

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E3. (a) Distinguish between a conditioned response and an unconditioned response. *[2]*

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(b) Explain the effect of tetrahydrocannabinol (THC) on brain function. *[2]*

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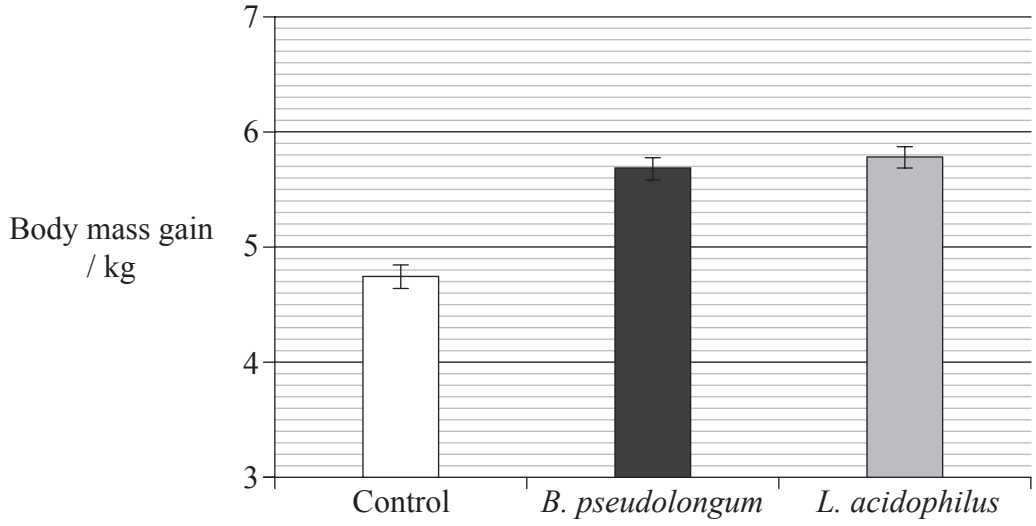
Option F — Microbes and biotechnology

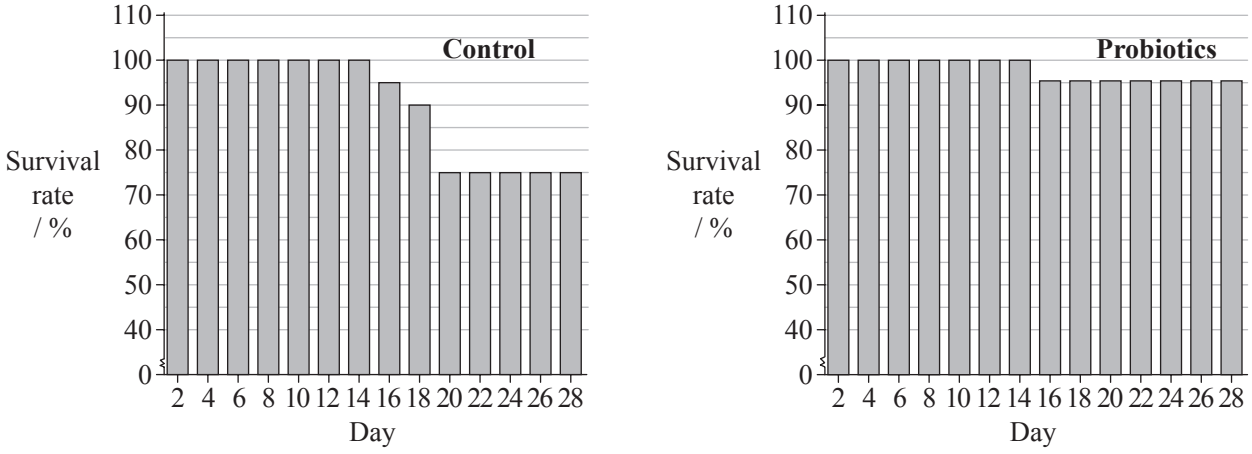
F1. Probiotics are live microorganisms that can have beneficial effects when ingested. Like antibiotics, they can reduce the effect of pathogens in the gut. During experimental trials, the probiotics *Bifidobacterium pseudolongum* and *Lactobacillus acidophilus* were given orally to newborn piglets.

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: adapted from F Abe, *et al.*, (1995), *Journal of Dairy Science*, **78**, pages 2838–2846]

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: adapted from F Abe, *et al.*, (1995), *Journal of Dairy Science*, **78**, pages 2838–2846]

(This question continues on the following page)

(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) Probiotics reside in intestines. State the name of **one** group of Archaea that can be found in animal intestines. *[1]*

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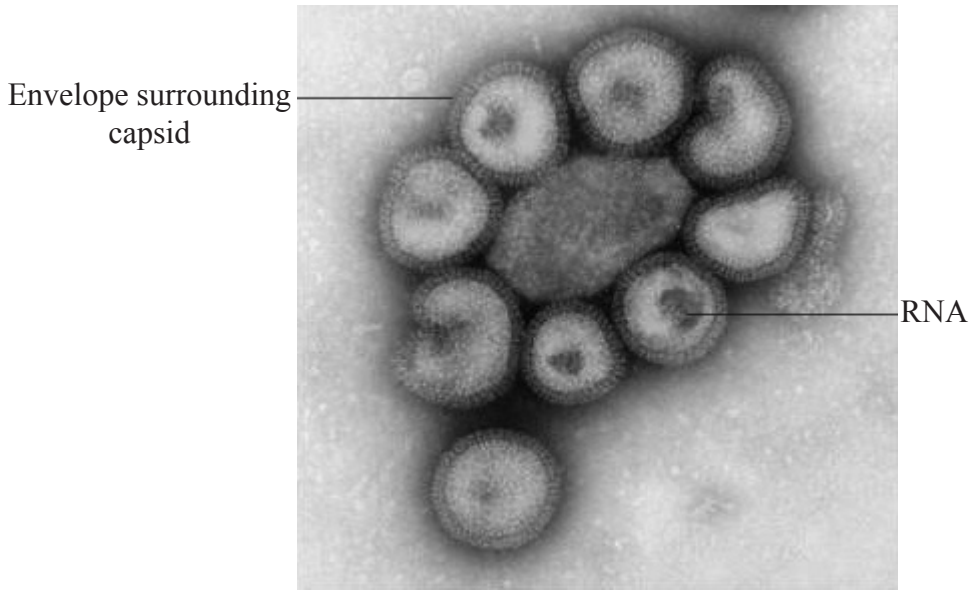
F2. The electron micrograph below shows a pathogen.



[Source: Professor Frederick A Murphy (University of Texas Medical Branch). Reprinted with permission.]

(a) Identify the type of pathogen shown in the electron micrograph, giving reasons for your answer. *[2]*

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(b) Outline the use of viral vectors in gene therapy. *[3]*

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F3. (a) State **two** fuels that can be produced from biomass using microbes. *[2]*

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(b) Explain the significance of *Saccharomyces* in the production of bread. *[3]*

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(c) Distinguish between *Saccharomyces* and *Chlorella* in terms of mode of nutrition. *[1]*

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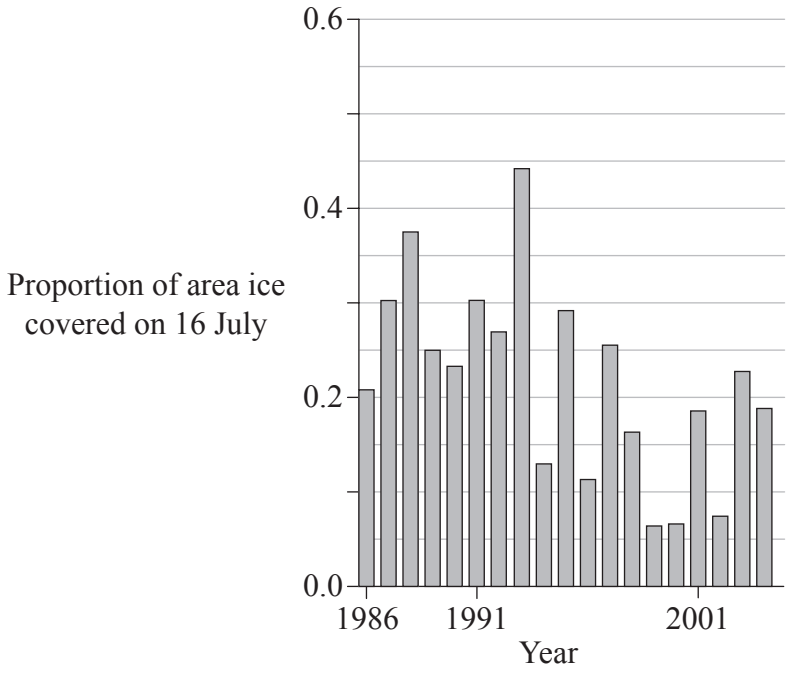
Option G — Ecology and conservation

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: adapted from A Gaston, *et al*., (2005), *Journal of Animal Ecology*, **74**, pages 832–841]

(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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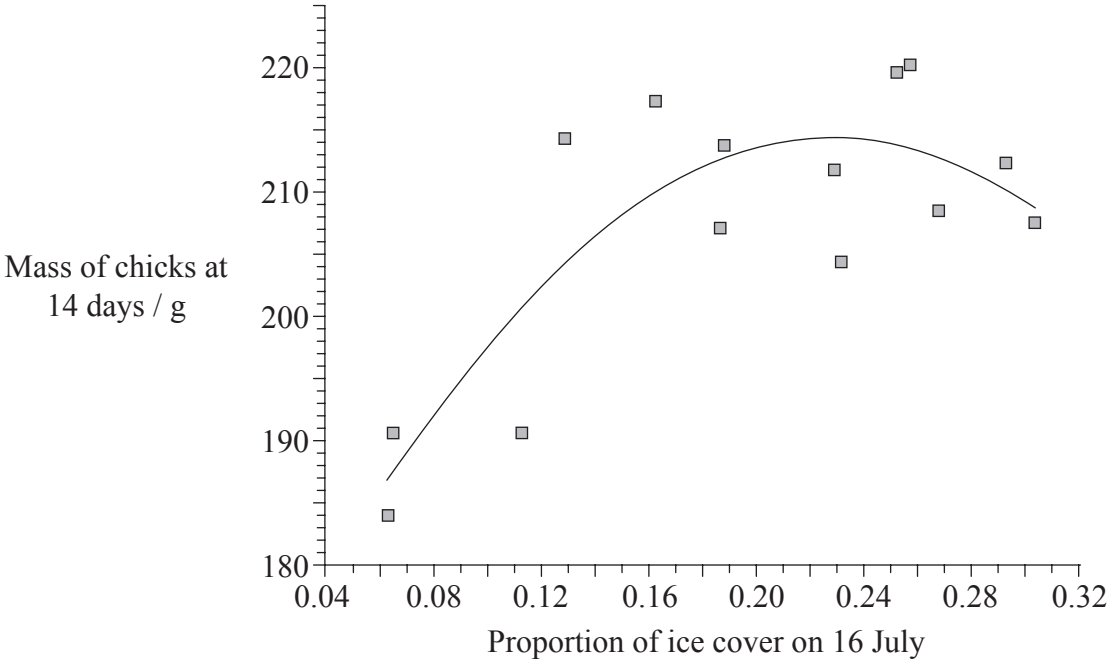
(This question continues on the following page)

(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: adapted from A Gaston, *et al*., (2005), *Journal of Animal Ecology*, **74**, pages 832–841]

(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) Outline **one** example of herbivory. *[2]*

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(b) State the units used in a pyramid of energy. *[1]*

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(c) Explain the small biomass of organisms in higher trophic levels. *[2]*

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G3. (a) Discuss the impacts of a **named** alien species introduced as a biological control measure. *[3]*

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(b) Outline the effects of ultraviolet radiation on living tissues. *[2]*

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