IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M05/4/BIOLO/SP3/ENG/TZ1/XX+

22056012

BIOLOGY
STANDARD LEVEL
PAPER 3

Thursday 12 May 2005 (morning)

1 hour

Candidate session number

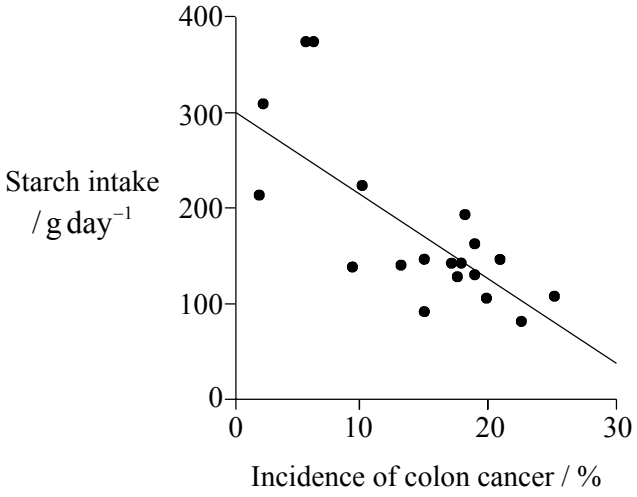
INSTRUCTIONS TO CANDIDATES

- 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 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.

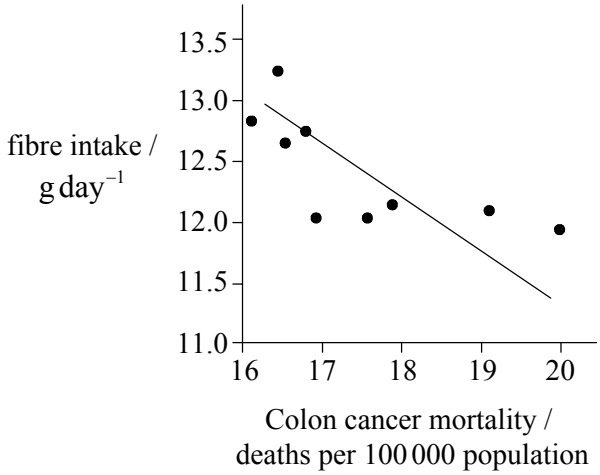
Option A — Diet and Human Nutrition

A1. Cancer of the colon is the fourth most common cancer throughout the world. A number of epidemiological studies have shown that dietary starch and fibre can influence the incidence of colon cancer. The results of two of these studies are shown below. Each point on the graphs represents the human population of one region.

Starch intake and colon cancer



Fibre intake and colon cancer



[Source: adapted from *Food, Nutrition and the Prevention of Cancer: a Global Perspective, World Cancer Research Fund, A.I.C.R.*, (1997), page 380]

(a) Outline the relationship between fibre intake and colon cancer mortality. *[1]*

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(b) (i) Determine the predicted mortality due to colon cancer at a daily fibre intake of 12.5 g day^{-1}. *[1]*

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(ii) Calculate how much more starch a person would have to consume per day to reduce the cancer risk by 10 %. *[1]*

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(This question continues on the following page)

(Question A1 continued)

(c) Compare the effect of fibre and starch on cancer of the colon. *[2]*

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(d) Discuss the effect of daily fibre intake on lowering the mortality rates of cancer of the colon. *[2]*

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A2. (a) Outline the functions of retinol. *[2]*

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(b) Discuss the reasons for the variation in energy requirements in humans. *[4]*

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A3. (a) Suggest how malnutrition can be caused by social and cultural conditions. *[3]*

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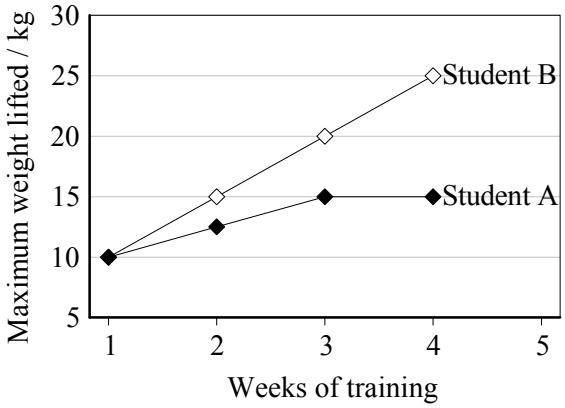
(b) State **one** function of zinc and **one** function iodine. *[2]*

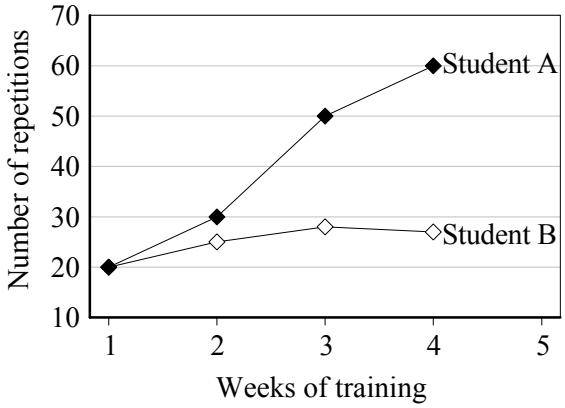
Zinc: . . . . . .

Iodine: . . . . . .

Option B — Physiology of Exercise

B1. Student A and Student B began a weight training program. A and B started by each lifting a 5 kg weight. They both exercised three times a week using a 5 kg weight. During each session, Student A lifted the 5 kg weight as many times as possible. In contrast, when Student B was able to lift a weight eight times, he used a heavier weight during the next exercise session. After each week, A and B had a contest to see who could lift the heaviest weight and who could perform the most repetitions lifting a light weight. The data is shown below.





[Source: unpublished data Drs. P Taylor and L Taylor, Glenville State College, Glenville, West Virginia, USA]

(a) Compare the effects of training on student A with the effects on student B. *[2]*

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(b) Suggest why the amount of weight student A can lift levels off after three weeks of training. *[2]*

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(This question continues on the following page)

(Question B1 continued)

(c) State **two** ways in which training affects the muscles of student A. *[2]*

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B2. (a) Outline synaptic transmission at the neuromuscular junction of skeletal muscles. *[3]*

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(b) Explain how actin and myosin cause muscle contraction. *[3]*

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B3. A sprinter is exhausted after running a 100 m sprint, while a marathon runner is exhausted after running a marathon.

(a) State the process by which each runner obtains energy (ATP). *[2]*

Sprinter: . . . . . .

Marathon runner: . . . . . .

(b) Outline the primary cause of muscle fatigue in a sprinter and a long distance runner. *[2]*

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(c) Explain how lactic acid build up during exercise relates to oxygen debt. *[2]*

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Option C — Cells and Energy

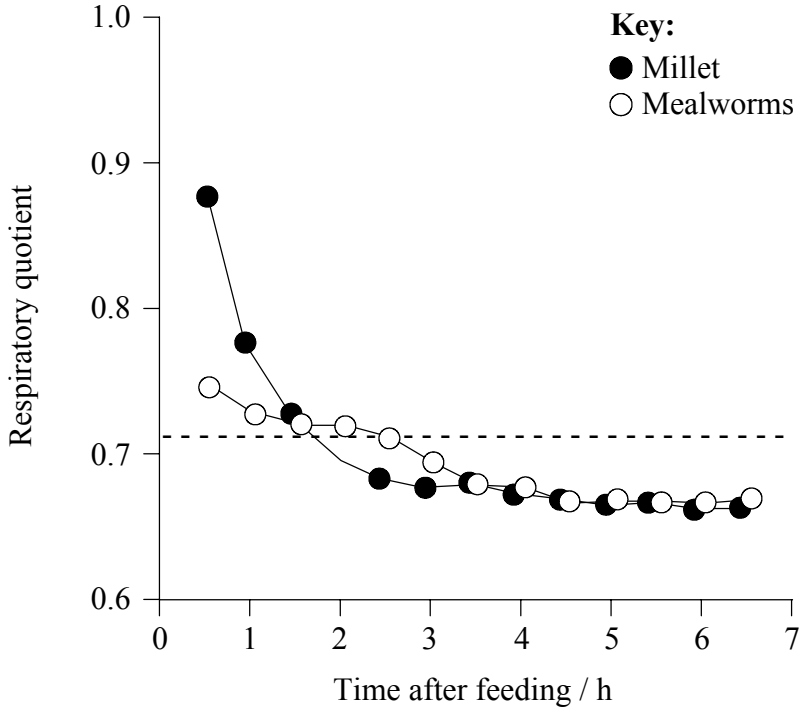
C1. The respiratory quotient (RQ) is a measure of the metabolic activity of an animal. It is the ratio of CO_2 produced to O_2 consumed. In general, the lower the RQ value the higher the energy yield. The RQ is dependent on the diet consumed by the animal. The following table lists the typical RQ values for specified diets.

Diet	RQ
Lipid	0.71
Carbohydrate	1.00
Protein	0.74

[Source: Walsberg and Wolf, *Journal of Experimental Biology*, (1995), **198**, pages 213-219]

In an experiment to assess RQ values for house sparrows, the birds were fed a diet of pure mealworms (beetle larvae) or millet (a type of grain).

The graph below shows the RQ values of a house sparrow fed on a high carbohydrate diet (millet) and a high lipid diet (mealworms).



[Source: Walsberg and Wolf, *Journal of Experimental Biology*, (1995), **198**, pages 213-219]

(This question continues on the following page)

(Question C1 continued)

(a) Compare the RQ values for millet and mealworms between 1 hour and 6 hours after feeding. *[2]*

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The expected RQ value for house sparrows metabolizing millet is 0.93. The expected value when metabolizing mealworms is 0.75.

(b) Explain why the expected RQ values for millet and mealworms are different. *[2]*

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(c) Suggest reasons for

(i) the high initial RQ values for house sparrows fed on millet. *[1]*

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(ii) the rapid fall in RQ values for house sparrows fed on millet. *[1]*

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C2. (a) State **one** type of secondary structure of a protein. *[1]*

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(b) Outline the differences between globular and fibrous proteins, giving a named example of each. *[3]*

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(c) Explain the significance of polar amino acids for membrane proteins. *[2]*

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C3. (a) State where, in the chloroplast, the enzymes of the Calvin cycle are located. *[1]*

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(b) Explain how the proton gradient in the chloroplast is generated by chemiosmosis. *[3]*

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(c) Explain the relationship between the position of a leaf on a tree and the photosynthetic rate of the leaf. *[2]*

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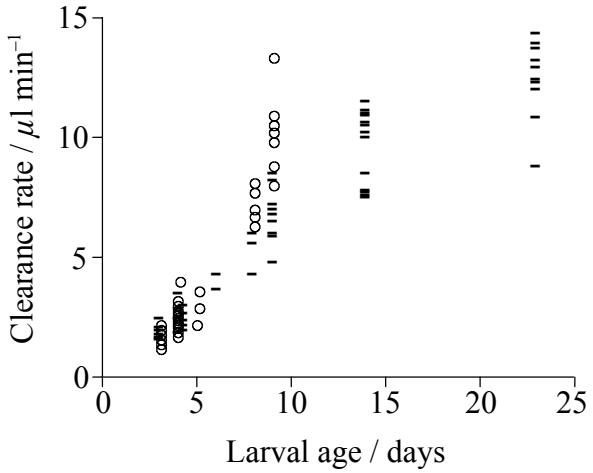
Option D — Evolution

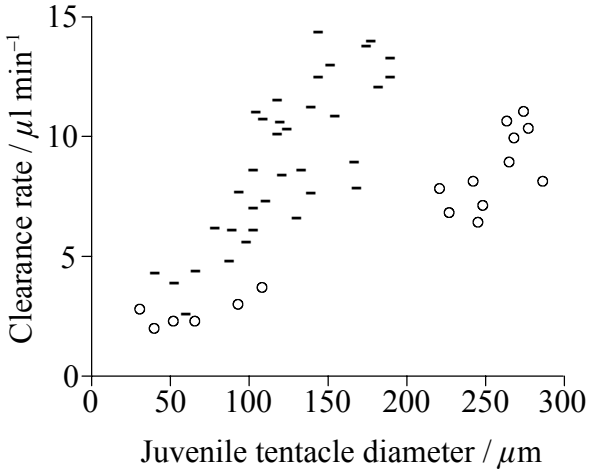
D1. In starfish larvae (*Dendraster excentricus*) there is a correlation between food availability, the diameter of the tentacle and early development to the adult stage.

Larvae were placed in tanks with high food availability (shown by ○) and low food availability (shown by -). The "clearance rate" (shown in Graph 1) is a direct indication of how quickly food can be digested and used for growth. In Graph 2, the juvenile tentacle diameter is an indication of the larval development. This graph shows a sample of larvae of the same age. The greater the tentacle diameter the further advanced the larva is in its development to an adult. When larvae were placed in a high food availability tank, 68 % changed into the adult stage. When larvae were placed in a low food availability tank, only 42 % changed into the adult stage after 10 days.

Graph 1



Graph 2



[Source: adapted from Hart and Strathmann, *Biological Bulletin*, (1994), **186**, pages 291–299]

(a) State the relationship between low food availability and tentacle diameter of larvae. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(b) (i) Compare low and high food availability larvae with respect to larval age up to 10 days. *[2]*

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(ii) Suggest a reason for the increased percentage of larvae changing into adults in a high food availability tank. *[1]*

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(c) Discuss the selective advantages of larvae having a large tentacle diameter. *[2]*

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D2. (a) Describe evidence for evolution as shown by geographical distribution of marsupial and placental animals. *[3]*

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(b) Outline how remains of living organisms have become preserved as fossils. *[3]*

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(c) Suggest **one** reason why isolation of DNA from fossilized remains can **not** lead to the re-emergence of dinosaurs. *[1]*

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D3. (a) Compare genetic and cultural evolution. *[3]*

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(b) State **two** physical features that define humans as primates. *[2]*

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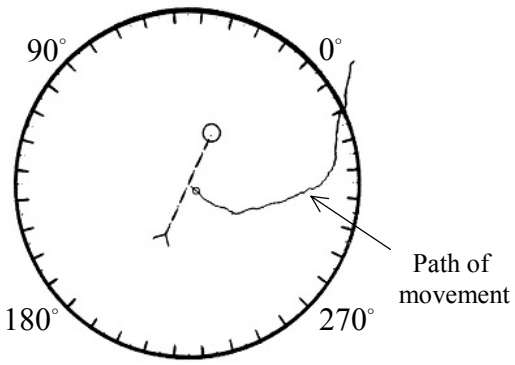
Option E — Neurobiology and Behaviour

E1. The antennae of the American cockroach (*Periplaneta americana*) are very sensitive to touch. Tapping an antenna causes a quick turning and running response.

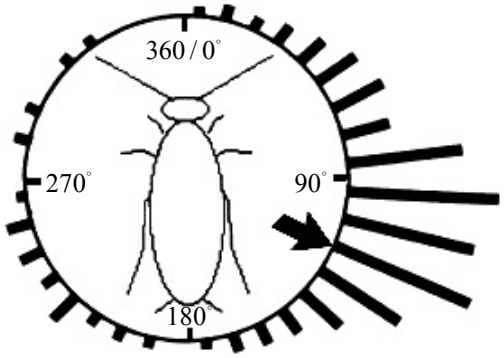
The figures below summarize the results of touch trials. The cockroach in Figure A is shown by a symbol in the centre to indicate orientation; the circle represents its head. The cockroach was tapped on one of its antennae and the path of the cockroach's movement was plotted.

The circular histogram in Figure B shows the initial angle of turn for cockroaches tapped on the left antenna. The arrow points to the mean angle of turn. Figure C shows the response time (the time between touch and actual movement) for 215 trials.

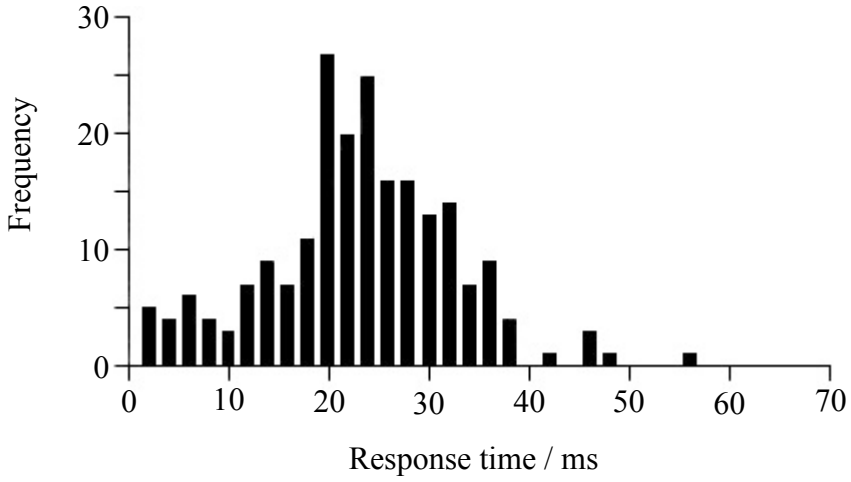
A.



B.



C.



[Source: Ye and Comer, *Journal of Neuroscience*, (1996), **16**, pages 5844–5853]

(This question continues on the following page)

(Question E1 continued)

(a) (i) State the mean angle of turn. *[1]*

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The circular histogram in Figure B can be divided into four 90° quadrants, starting at 0°.

(ii) Identify the quadrant which scored the lowest number of cockroach runs. *[1]*

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(b) (i) State the response time with the greatest frequency. *[1]*

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(ii) State the range of response times. *[1]*

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(iii) Suggest **one** reason for the variation in response time. *[1]*

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(c) Using Figure A, deduce, giving a reason, which antenna was tapped. *[1]*

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(d) Discuss the survival value of the behaviour of cockroaches demonstrated by this investigation. *[2]*

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E2. (a) Draw a labelled diagram showing the main parts of the human brain. *[2]*

(b) State **one** function for each of **two** structures labelled in (a). *[2]*

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E3. (a) State what is meant by the terms *mechanoreceptors*, *chemoreceptors* and *thermoreceptors* and give a named example of each. *[3]*

Mechanoreceptors: . . . . . .

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Chemoreceptors: . . . . . .

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Thermoreceptors: . . . . . .

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(b) Explain the need for quantitative data in studies of behaviour. *[3]*

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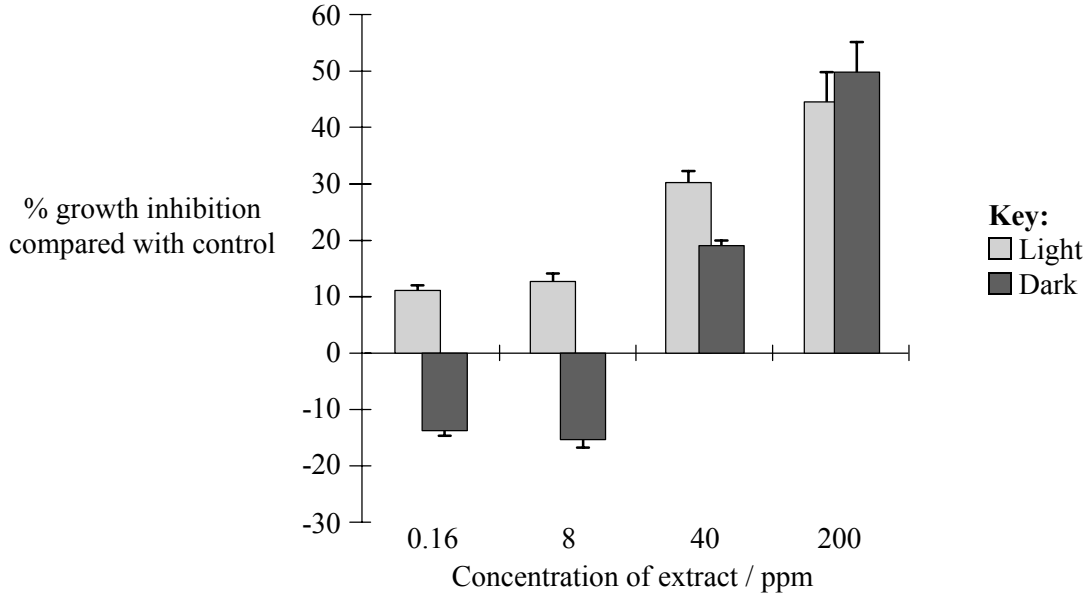
Option F — Applied Plant and Animal Science

F1. The leaves of the plant Tree of Heaven (*Ailanthus altissima L.*) have been reported to contain compounds that act as both herbicides and pesticides. Chemicals were extracted from the leaves and the bioactivity of these was tested on the growth of alfalfa seedlings. The results are shown in the bar chart below. Negative values for growth inhibition indicate increased growth.



[Source: adapted from Tsao *et al*., *BMC Ecology*, (2002), **2**, pages 1–6]

(a) (i) Determine the concentration of the extract that had the greatest difference between dark and light conditions. *[1]*

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(ii) State the largest percentage growth inhibition for seedlings grown in the light. *[1]*

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(b) Outline the effect of extract concentration on growth in the dark. *[2]*

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(This question continues on the following page)

(Question F1 continued)

(c) Suggest reasons for testing the bioactivity of the extract on seedlings in the dark and in the light. *[2]*

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F2. (a) Discuss the biological issues surrounding biological and chemical pest control. *[4]*

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(b) Discuss the use and misuse of antibiotics in livestock production. *[3]*

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F3. (a) Distinguish between plant growth regulators and fertilizers. *[2]*

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(b) Explain the role of auxin in phototropism. *[3]*

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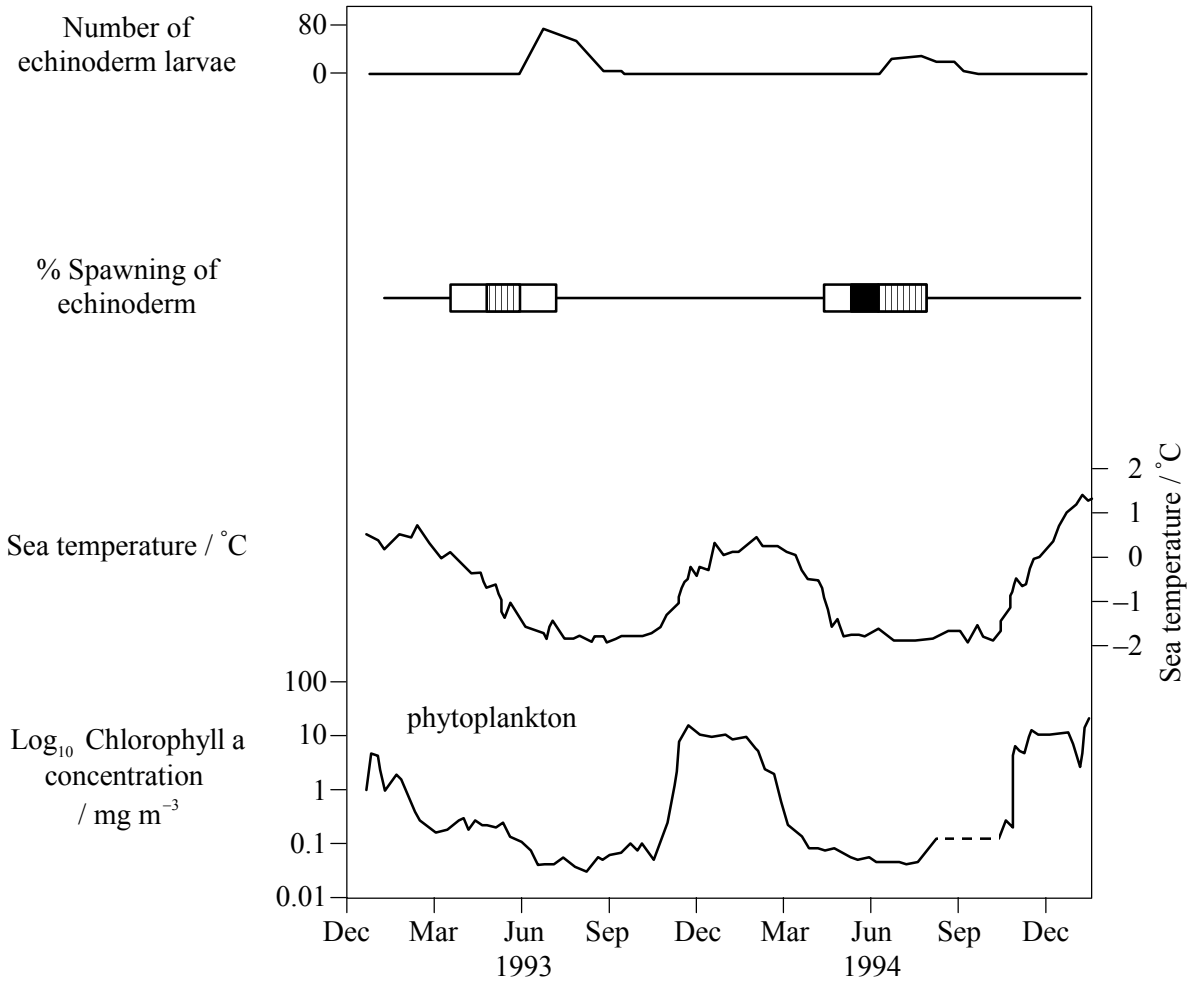
Option G — Ecology and Conservation

G1. Sea water temperature has an effect on the spawning (release of eggs) of echinoderms living in Antarctic waters. Echinoderm larvae feed on phytoplankton. In this investigation, the spawning of echinoderms and its effect on phytoplankton was studied.

In the figure below, the top line indicates the number of larvae caught (per 5000 litres of sea water). The shaded bars below show when spawning occurred in echinoderms.

□ = 0 % to 25 %
▥ = 25 % to 75 %
■ = 75 % to 100 %

The concentration of chlorophyll gives an indication of the concentration of phytoplankton. **Note:** that the seasons in the Antarctic are reversed from those in the northern hemisphere.



[Source: adapted from Stanwell-Smith and Peck, *Biological Bulletin*, (1998), **194**, pages 44–52]

(This question continues on the following page)

(Question G1 continued)

(a) State the trophic level of echinoderm larvae. *[1]*

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(b) Identify the period during which the spawning of echinoderm lies between 25 % and 75%. *[1]*

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(c) Explain the relationship between the seasons and the concentration of phytoplankton. *[2]*

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(d) (i) Outline the effect of sea water temperature on echinoderm larvae numbers. *[2]*

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(ii) Using the data in the figure, predict the effect of global warming on echinoderm larvae numbers. *[2]*

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G2. (a) List **three** factors that affect the distribution of animal species. *[2]*

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(b) Explain the competitive exclusion principle. *[3]*

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G3. (a) Outline the damage caused to marine ecosystems by over-exploitation of fish. *[2]*

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(b) Explain the use of indicator species in monitoring environmental change. *[3]*

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