



22116018



BIOLOGY
STANDARD LEVEL
PAPER 3

Thursday 19 May 2011 (morning)

1 hour

Candidate session number

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Examination code

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INSTRUCTIONS TO CANDIDATES

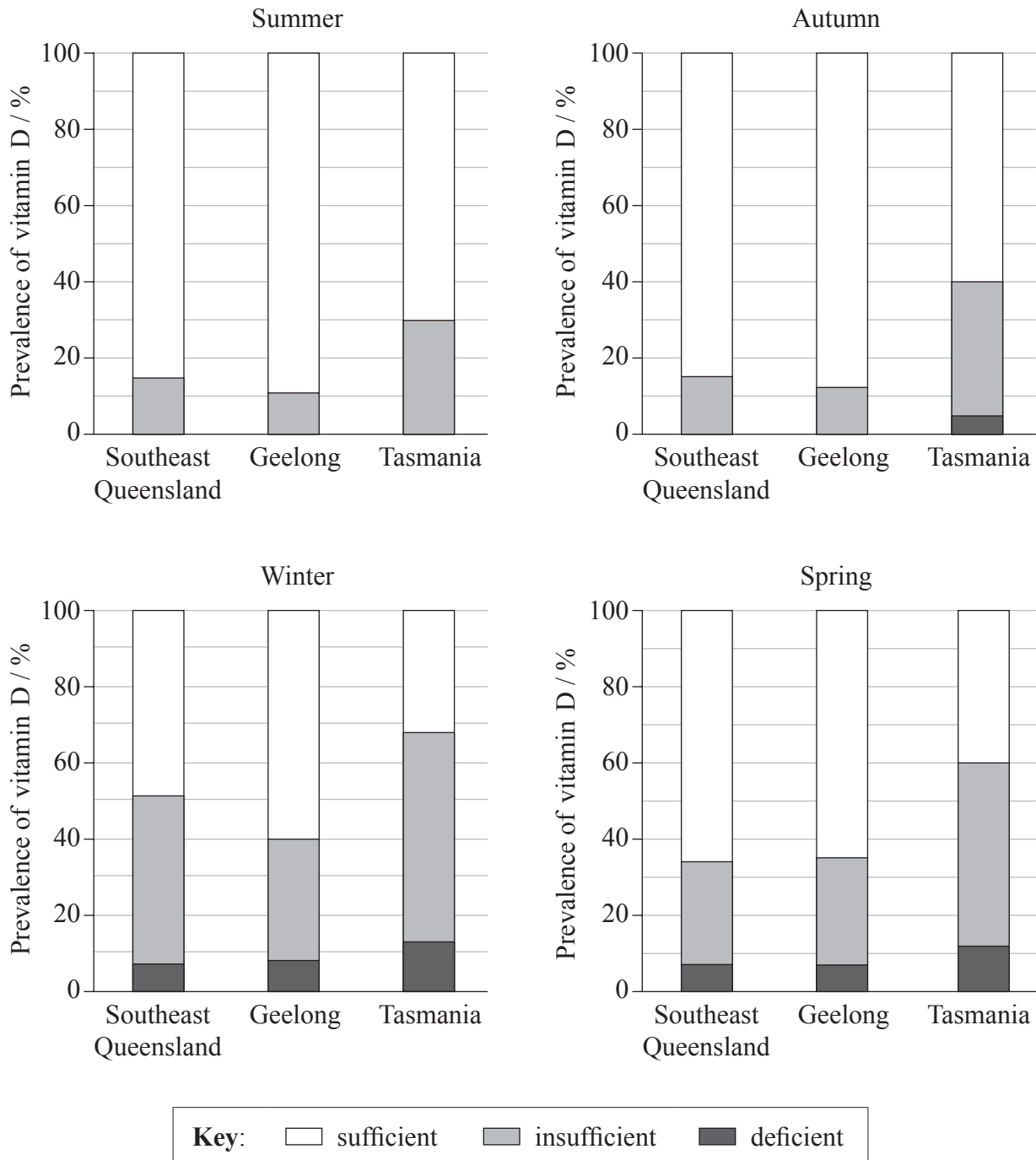
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options.
- Write your answers in the boxes provided.



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Option A — Human nutrition and health

A1. In Australia, a study was undertaken among women to determine the vitamin D levels in their blood. Levels of vitamin D were categorized as sufficient, insufficient and deficient to determine how prevalent each category was. Three locations at three different latitudes and four different seasons were used. A data summary is shown in the graphs below.



Van der Mei, I.A., Ponsonby, A.-L., Engelsen, O., Pasco, J.A., McGrath, J.J., *et al.* (2007) "The high prevalence of vitamin D insufficiency across Australian populations is only partly explained by season and latitude". *Environ. Health Perspect.*, 115(8): doi:10.1289/ehp.9937.

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(Question A1 continued)

- (a) (i) Identify the season when the women are least likely to suffer from vitamin D deficiency. [1]

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- (ii) Using the data from all four seasons, identify the **two** locations where the patterns of vitamin D are most similar. [1]

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- (iii) Determine what percentage of women in Geelong have insufficient vitamin D levels in winter. [1]

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- (b) Compare the deficiency levels of vitamin D at all three locations. [3]

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(Question A1 continued)

- (c) Location and season were found to account for only a small part of the deficiencies. Suggest, with reasons, how the behaviours of different people could influence the levels of vitamin D in their blood. [2]

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- A2.** (a) Distinguish between the energy content per 100 g of fat, protein and carbohydrate. [1]

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- (b) Outline consequences of protein deficiency malnutrition. [2]

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(Question A2 continued)

(c) Discuss ethical issues concerning the eating of animals and animal products. [4]

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A3. Describe the causes, consequences and diagnosis of phenylketonuria (PKU). [3]

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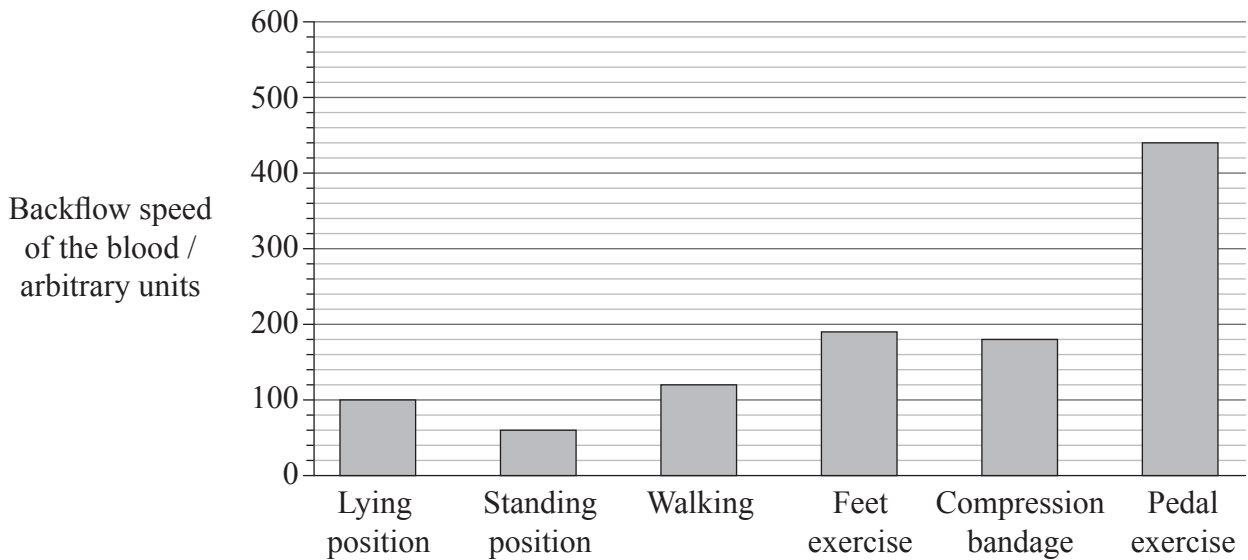
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Turn over

Option B — Physiology of exercise

B1. Backflow is the return of blood to the heart. In legs, backflow is enhanced by the pumping action of leg muscles during movement. When this does not occur efficiently, serious health problems can arise. The backflow speed of 40 patients was measured during the application of different therapy methods. The lying position is the control.



[Source: adapted from postdoctoral thesis of Erich Meyer, Medical faculty of the University of Erlangen-Nürnberg]

(a) (i) State which activity reduces backflow speed in relation to the control. [1]

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(ii) Suggest a reason why backflow speed is reduced by the activity stated in (a)(i). [1]

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(Question B1 continued)

(b) Determine the difference in backflow speed between the lying position and pedal exercise. [1]

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(c) Discuss the benefits of exercising to promote high backflow speed. [3]

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B2. (a) The following are micrographs of muscle tissue.

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(Question B2 continued)

(b) Distinguish between fast muscle fibres and slow muscle fibres.

[3]

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B3. (a) (i) Define the term *fitness*. [1]

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(ii) Outline measures of fitness. [2]

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(b) Explain the effects of training on heart rate and stroke volume during exercise. [3]

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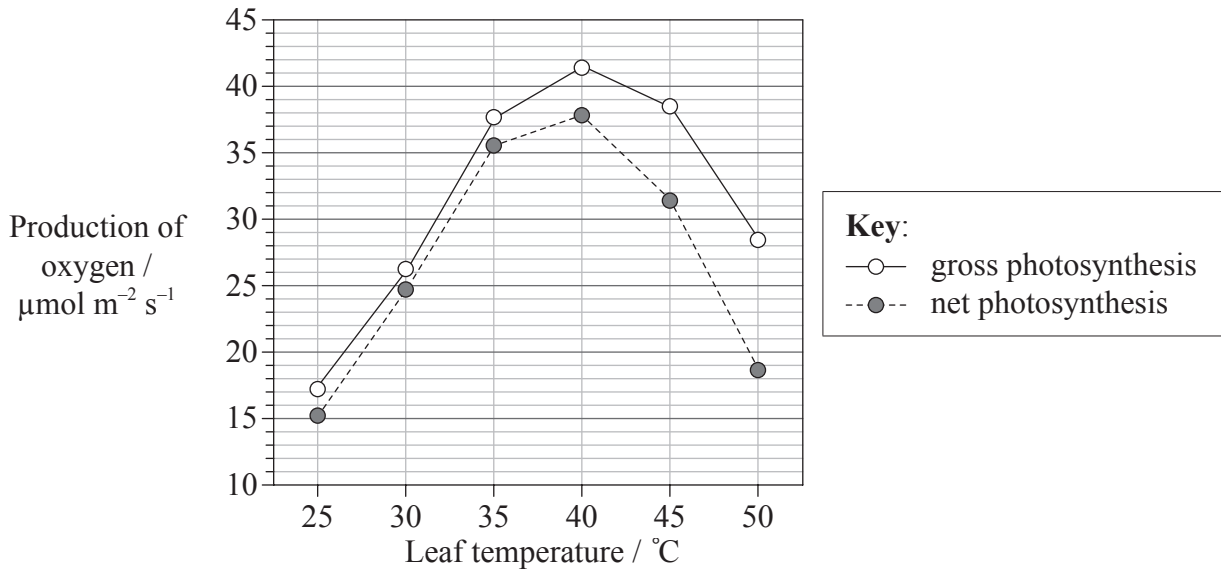
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Option C — Cells and energy

C1. The effect of temperature on photosynthesis was studied in sweet orange (*Citrus sinensis*) using leaf discs. The production of oxygen was used to measure the rate of photosynthesis. Gross photosynthesis refers to the sum of net photosynthesis and respiration. Net photosynthesis was calculated by subtracting the rate of respiration in the dark from gross photosynthesis.



[Source: adapted from R Ribeiro, *et al.*, (2006), *Ciência e Agrotecnologia*, **30**, pages 670–678]

(a) Identify the optimum temperature for photosynthesis in this plant. [1]

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(b) Determine the difference between gross photosynthesis and net photosynthesis at 40 °C and 50 °C. [2]

40 °C:

50 °C:

(This question continues on the following page)



(Question C1 continued)

- (c) Deduce what happens to the rate of respiration as the temperature increases between 40 °C and 50 °C. [1]

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- (d) (i) Describe the general pattern of change in photosynthesis in sweet orange as the temperature increases. [1]

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- (ii) Compare the effect of temperature on photosynthesis with the effect of temperature on respiration in sweet orange. [2]

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C2. (a) Distinguish between fibrous proteins and globular proteins giving **one** example of each. [3]

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(b) Outline the differences between competitive and non-competitive inhibitors. [4]

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C3. Explain the link reaction that occurs between glycolysis and the Krebs cycle.

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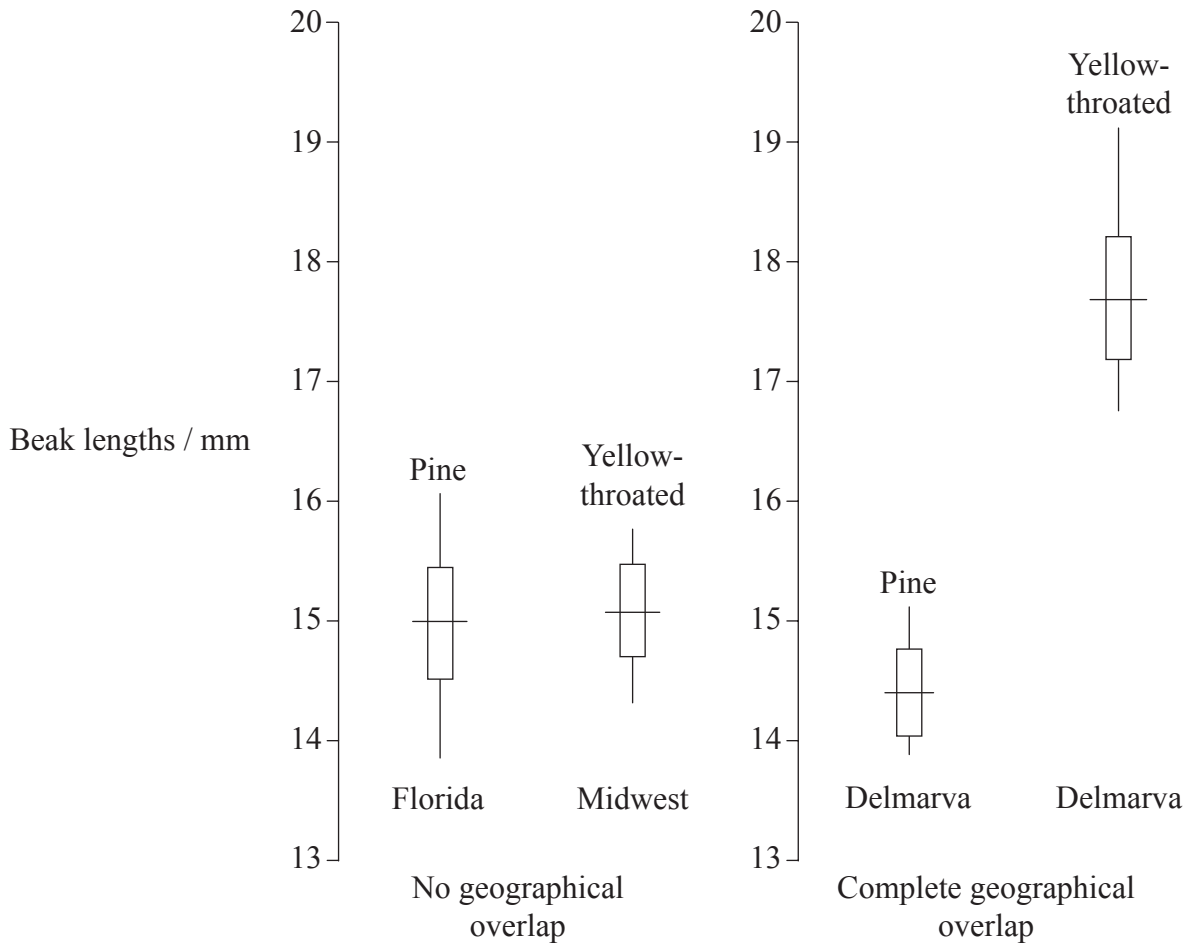
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Option D — Evolution

D1. Competition between genetically similar species of birds may lead to changes of one or more characteristics. One characteristic that results from this kind of selection is differences in the beaks. Researchers studied the beak lengths of two species of warblers. The graphs below show the beak lengths of Pine Warblers (*Dendroica pinus*) and Yellow-throated Warblers (*Dendroica dominica*) from three geographically isolated areas in the USA.



Key:

- the vertical line represents the range of beak length
- the horizontal line represents the mean beak length

R. Ficken *et al.* (1968) *Evolution*, 27, pp. 307–314. Republished with the permission of Wiley-Blackwell.

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(Question D1 continued)

- (a) (i) Identify the species with the shortest mean beak length. [1]

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- (ii) Determine the difference in the mean beak length of the two populations of Yellow-throated Warblers in Midwest and Delmarva. [1]

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- (iii) Compare the range of variation in beak length of the Yellow-throated Warblers in Midwest to the beak length of the Yellow-throated Warblers in Delmarva. [1]

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- (b) Suggest an advantage for the longer beaks of Yellow-throated Warblers in Delmarva. [1]

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(Question D1 continued)

- (c) Using the Yellow-throated Warbler as an example, outline the concept of allopatric speciation. [3]

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- D2.** (a) Describe processes needed for spontaneous origin of life on Earth. [3]

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- (b) Outline the contribution of prokaryotes to the creation of an oxygen-rich atmosphere. [2]

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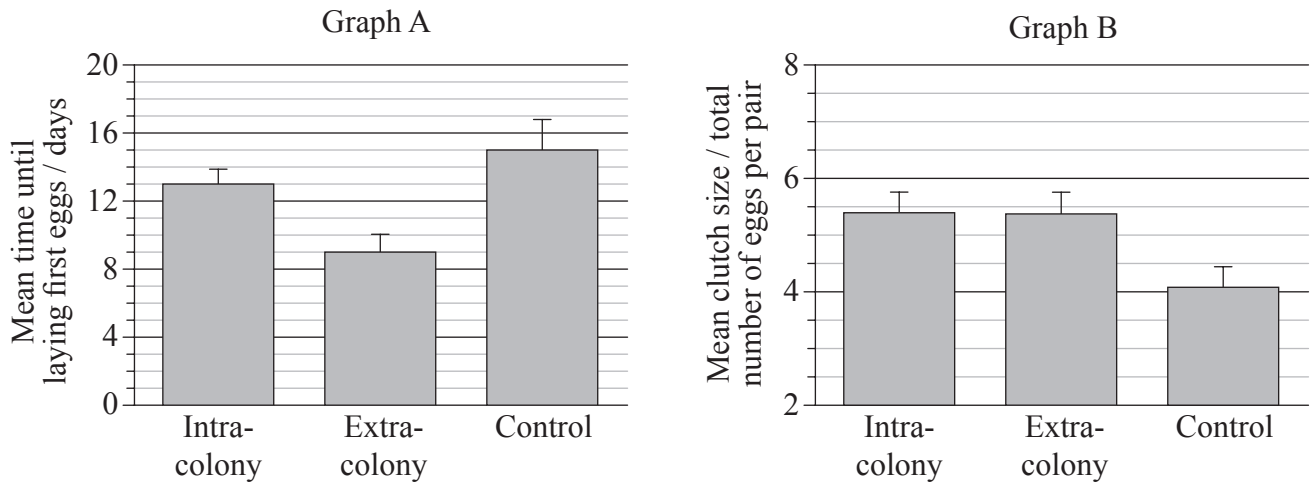
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Option E — Neurobiology and behaviour

E1. The effect of social stimulation on the reproductive patterns of egg-laying female Zebra finches (*Taeniopygia guttata*) was studied. The sounds of the same colony (intra-colony) and of a different colony (extra-colony) were recorded and played to different pairs of Zebra finches.

Graph A shows the mean time until the laying of the first eggs. Graph B shows the mean clutch size (total number of eggs per pair). The control pairs had no recordings played to them.



J. Waas *et al.* (2005) *Proceedings of the Royal Society*, 272, pp. 383–388. Reproduced with permission.

(a) Identify the mean time until the laying of the first eggs in the control group of Zebra finches. [1]

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(Question E1 continued)

- (b) Calculate the percentage decrease between the mean time until the laying of the first eggs in pairs of Zebra finches exposed to intra-colony sounds and in pairs exposed to extra-colony sounds. Show your working. [2]

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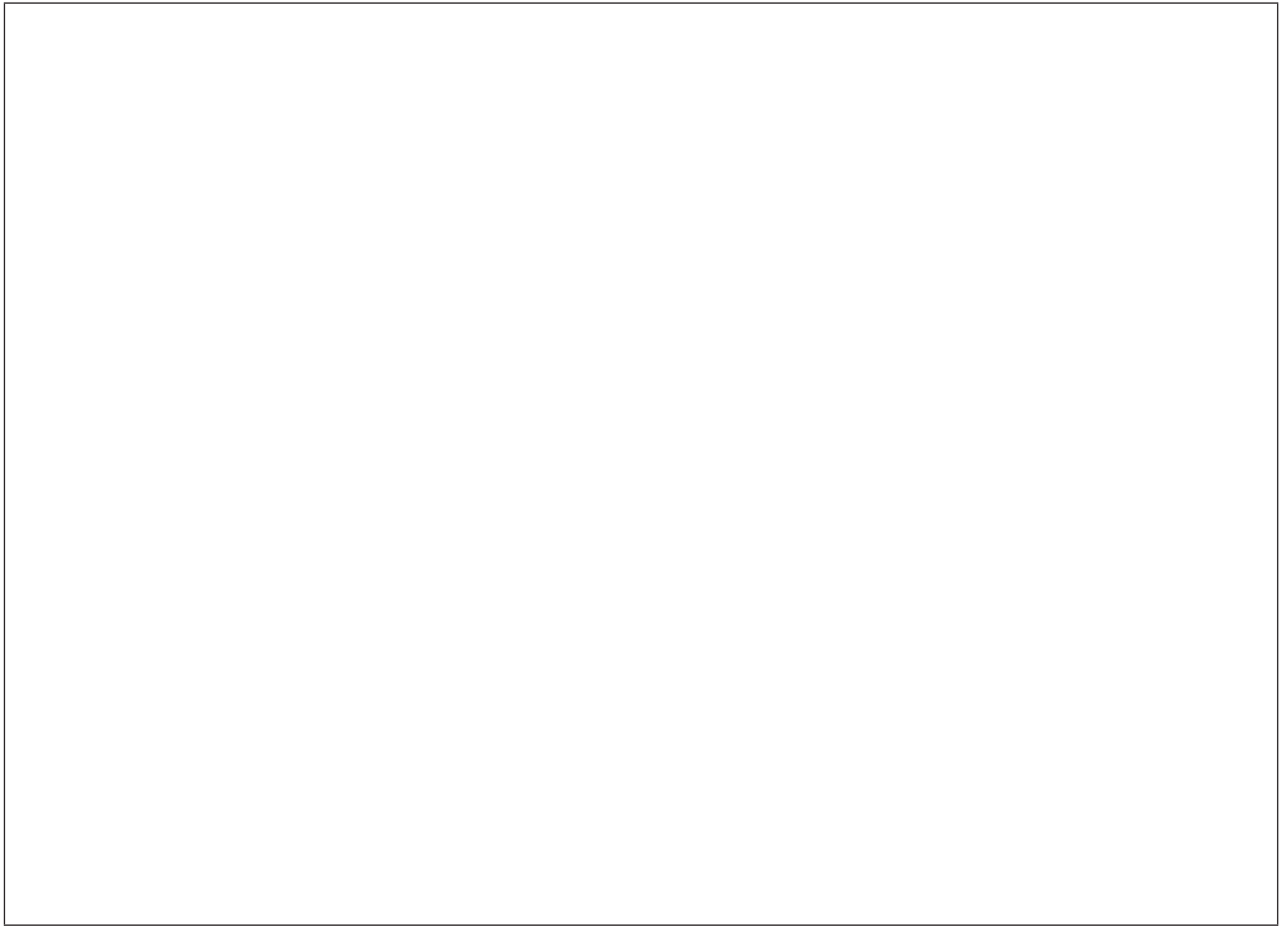
- (c) Evaluate the effect of the recorded colony sounds on the reproductive pattern of laying eggs in Zebra finches. [3]

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E2. Draw a labelled diagram of a reflex arc for a pain withdrawal reflex.

[4]



E3. (a) State **one** example of an excitatory and **one** example of an inhibitory psychoactive drug. [2]

Excitatory:
Inhibitory:

(b) Explain the effects of cocaine on the brain. [3]

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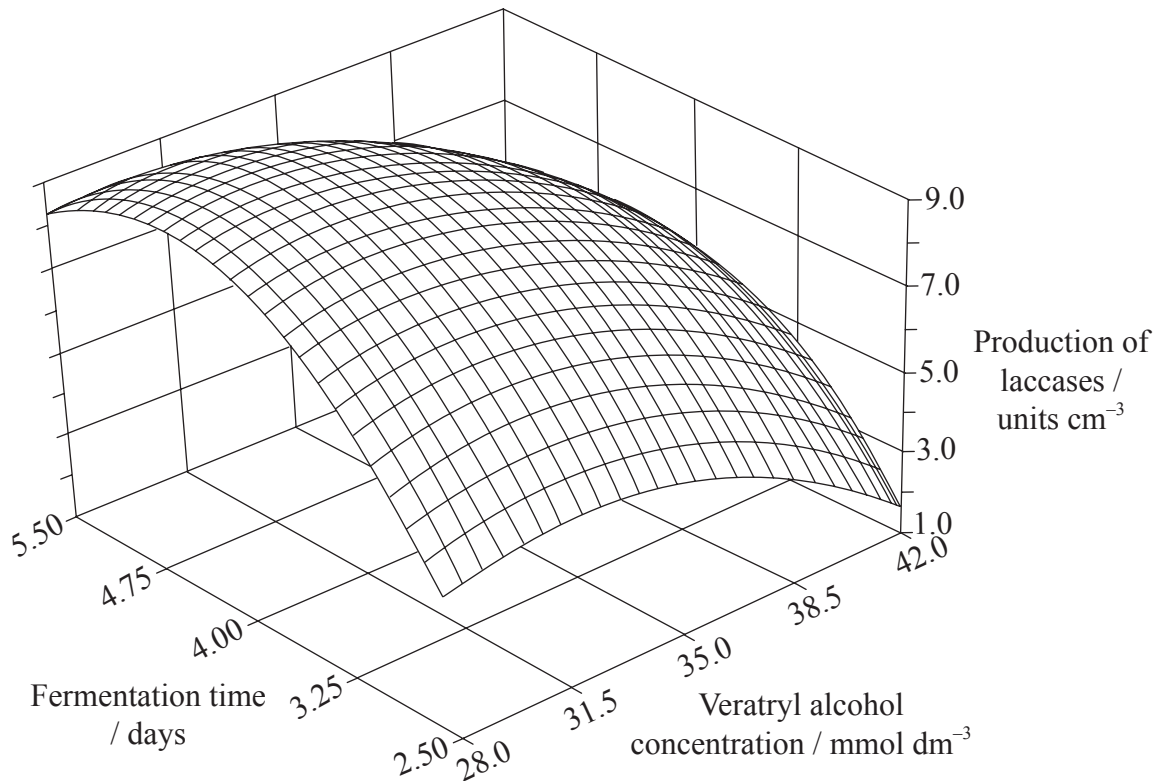
(c) Discuss causes of addiction. [3]

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Option F — Microbes and biotechnology

F1. Fungi of the genus *Botryosphaeria* have been found to produce certain oxidizing enzymes, laccases, that are effective in treating contaminated water and soils. Studies were undertaken to test the effects of veratryl alcohol concentrations and fermentation time in order to optimize the industrial production of laccases. Statistical analysis of the data was used to develop the graph below.



Reprinted from *Process Biochemistry*, Volume 35/Issue 10. Ana Flora D. Vasconcelos, Aneli M. Barbosa and Maria Inês Rezende. "Optimization of laccase production by *Botryosphaeria* sp. in the presence of veratryl alcohol by the response-surface method", Pages 1131-1138, Copyright (2000), with permission from Elsevier

- (a) (i) Identify the amount of laccases produced when the veratryl alcohol concentration is at its highest level and the fermentation time is at its shortest. [1]

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(Question F1 continued)

- (ii) Identify the amount of laccases produced when the veratryl alcohol concentration is at its lowest level and the fermentation time is at its longest. [1]

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- (b) Analyse the overall effects of the veratryl alcohol concentration and fermentation time on the production of laccases. [3]

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- (c) Deduce from the graph the optimal conditions for maximizing the biotechnological production of laccases. [2]

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F2. (a) Describe the use of viral vectors in gene therapy.

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(b) Outline the role of microorganisms in the production of soy sauce.

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F3. (a) State **one** condition that favours denitrification.

[1]

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(b) Explain the consequences of releasing raw sewage and nitrate fertilizer into rivers.

[4]

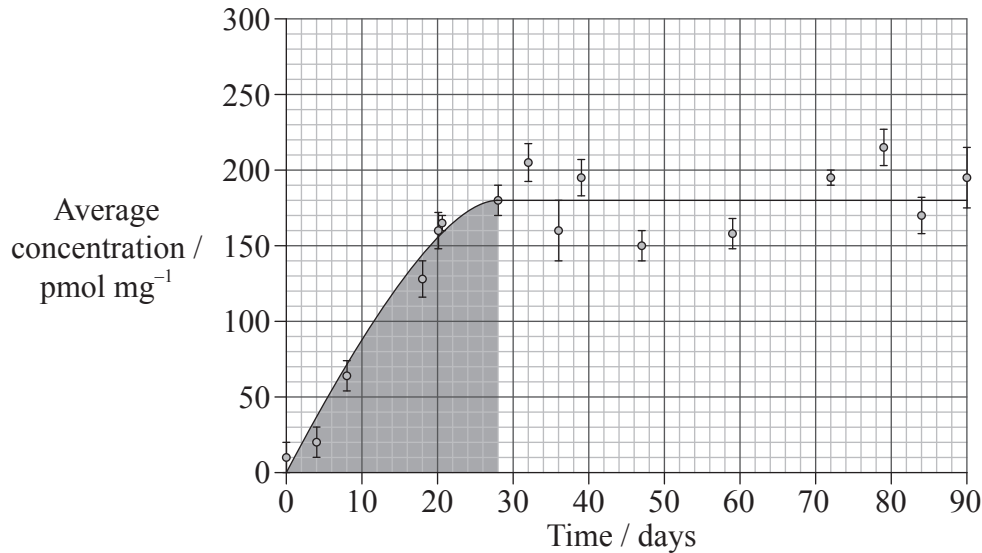
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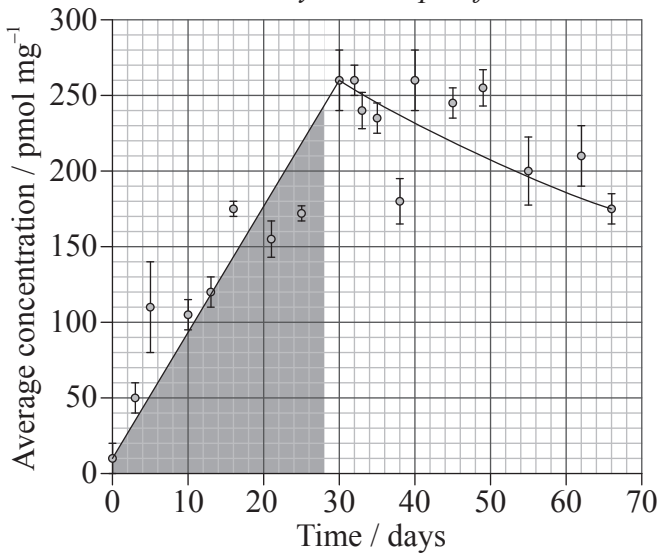
Option G — Ecology and conservation

G1. Cadmium is a heavy metal that can be toxic to many species. In a study, the concentration of cadmium was examined in the tissues of three soil arthropods, *Neobisium muscorum*, *Platynothrus peltifer* and *Notiophilus biguttatus*. The shaded area of each graph indicates the time that the organisms were exposed to cadmium in their environment, while the unshaded area indicates the time when cadmium was not present in their environment.

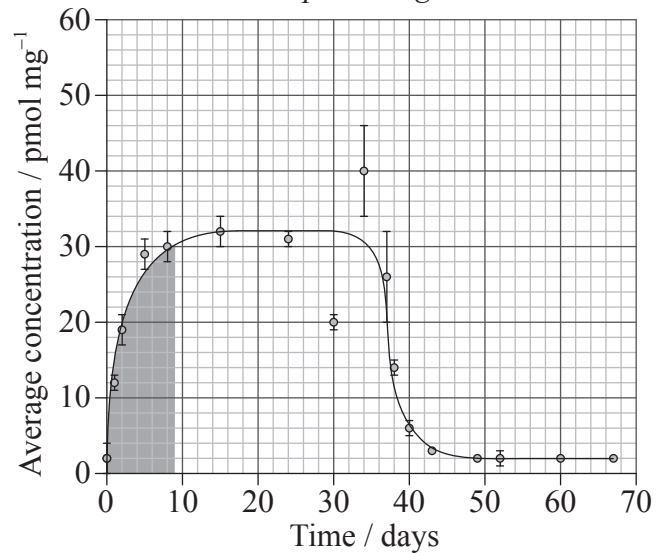
Neobisium muscorum



Platynothrus peltifer



Notiophilus biguttatus



JANSSEN, M.P.M., BRUINS, A., DE VRIES, T.H., & VAN STRAALLEN, N.M. (1991) Comparison of cadmium kinetics in four soil arthropod species. *Arch. Environ. Contam. Toxicol.*, 20: 305-312

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(Question G1 continued)

- (a) Identify the highest average concentration of cadmium found in *P. peltifer*. [1]

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- (b) Determine, with a reason from the data, which species is unable to eliminate cadmium. [2]

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- (c) (i) State the species that accumulates the least cadmium. [1]

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- (ii) Suggest, with observations from the data, a reason why the species stated in (c)(i) accumulates the least cadmium. [2]

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(Question G1 continued)

- (d) Describe the possible effects of the presence of cadmium in food chains involving these arthropods. [2]

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- G2.** (a) Explain the concept of an ecological niche. [2]

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- (b) Distinguish between fundamental niches and realized niches. [2]

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G3. (a) Outline characteristics of a **named** biome. [3]

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(b) Explain the factors that affect the distribution of animal species. [3]

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