



22096012



BIOLOGY
STANDARD LEVEL
PAPER 3

Thursday 7 May 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.



22096012



0126

Option A — Human nutrition and health

A1. A study investigated the dietary patterns in Chinese rural and urban populations between 1982 and 1992. The overall energy intake did not change significantly over this period.

DIAGRAM REMOVED FOR COPYRIGHT REASONS

[Source: adapted from S Yusuf, *et al.*, (2001), *Circulation*, **104**, pages 2746–2753]

(a) Identify the food source that changed least in percentage of total energy intake between 1982 and 1992 in rural Chinese populations. [1]

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(b) Compare the changes in energy contribution by food source between urban and rural populations over the ten-year period. [3]

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(Question A1 continued)

- (c) Suggest possible health concerns that could result from the changing nature of the Chinese diet over this period. [3]

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- A2.** (a) Outline the role of the brain in how appetite is controlled. [2]

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- (b) Describe the consequences of anorexia nervosa. [2]

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- A3.** (a) Outline a method used to determine the recommended daily intake of vitamin C. [3]

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- (b) Discuss the amount of vitamin C that adults should consume per day. [4]

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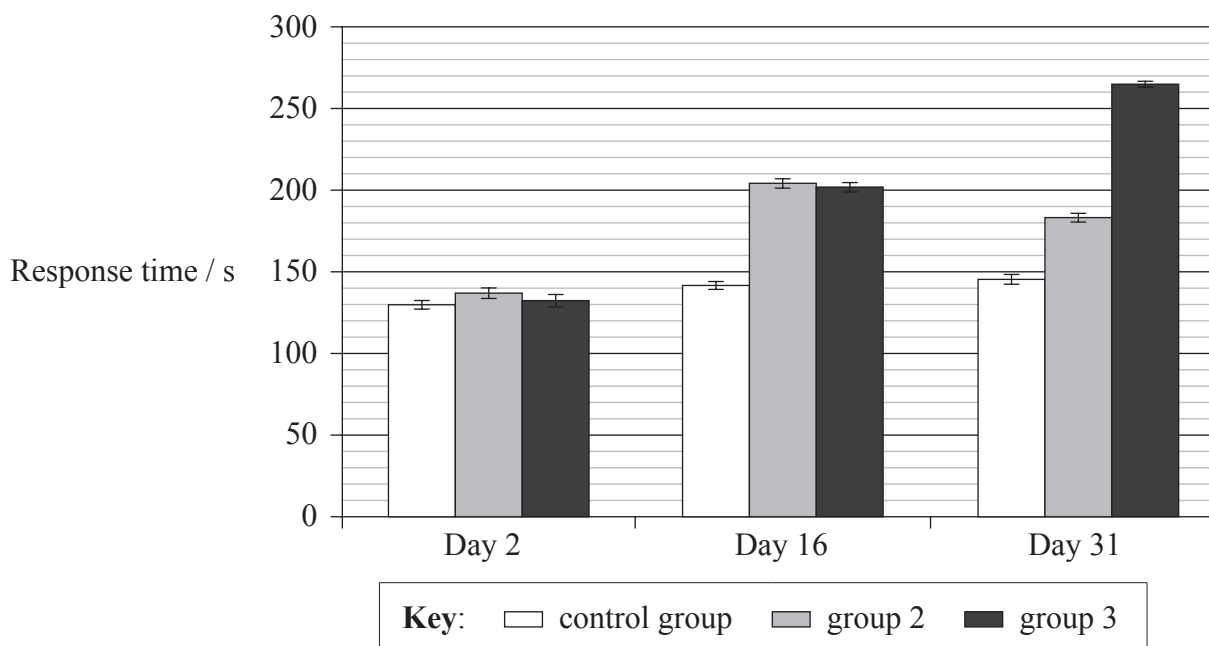


Option B — Physiology of exercise

B1. Researchers have been keen to investigate whether the benefits of regular exercise go beyond physical fitness. A recent study investigated the effect of ongoing exercise on brain function:

- A control group of rats had no exercise.
- A second group of rats swam for 10 minutes each day for 15 days only.
- A third group of rats swam for 10 minutes each day for 30 days.

All three groups were tested for response to electrical stimuli during the experimental period and the response time was measured. Longer response time suggested that the rats had learnt to avoid the stimuli.



[Source: Adapted and reprinted from the *Journal of Sports Science and Medicine*, Vol. 4, Milind Parle, Mani Vasudevan and Nirmal Singh, “Swim every day to keep dementia away”, pp. 37–46, 2005, with permission from the *Journal of Sports Science and Medicine*.]

(a) Identify the response time of the 15-day swimming group on day 31 of the study. [1]

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(b) Calculate the percentage difference in response time of the control group from day 2 to day 31. [1]

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(Question B1 continued)

(c) Compare the trend in response time in the 15-day and 30-day swimming groups. [2]

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(d) Using the data above, discuss the relationship between exercise and learning. [3]

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B2. (a) Define the terms: [2]

Vital capacity:

Tidal volume:

(b) Outline the effects of training on the pulmonary system. [2]

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B3. (a) Define *fitness*. [1]

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(b) Distinguish between fast and slow muscle fibres. [2]

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(c) Evaluate the effectiveness of dietary supplements containing creatine phosphate in enhancing performance in sports. [4]

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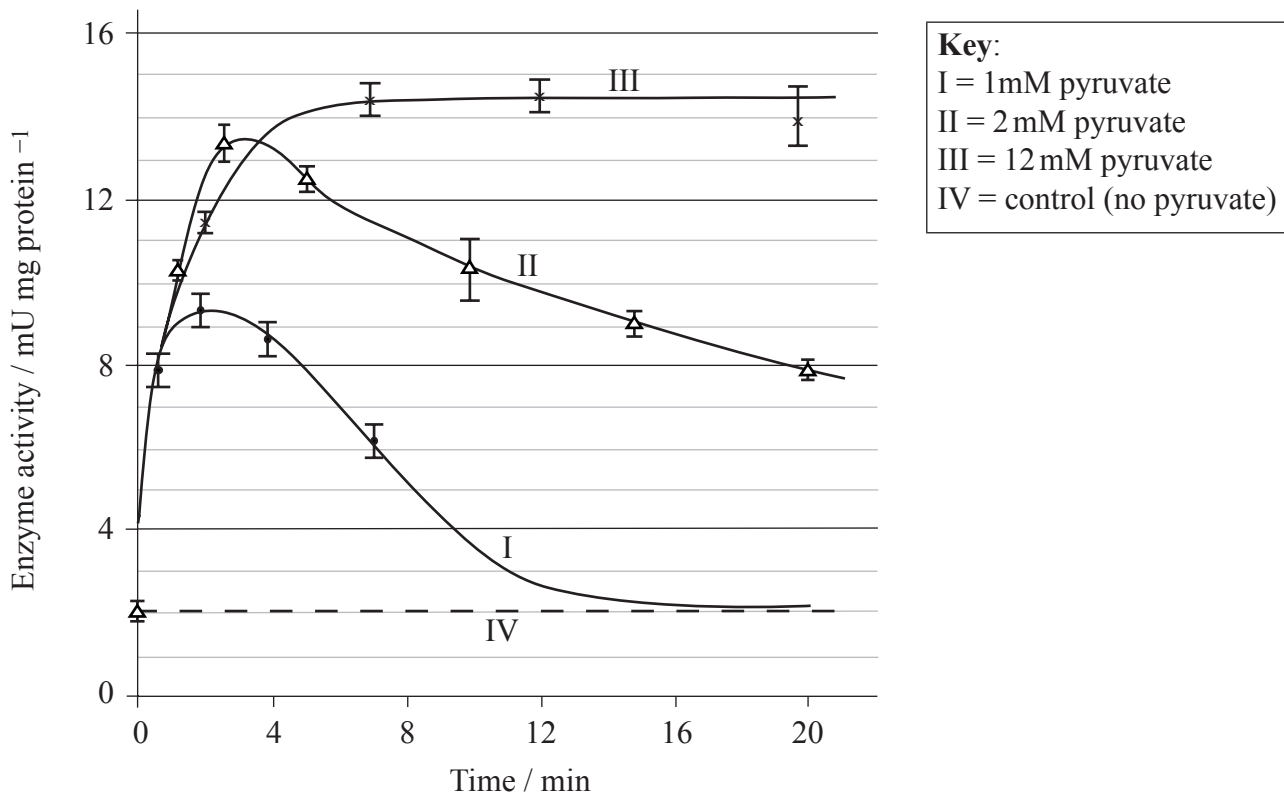


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Option C — Cells and energy

C1. Pyruvate dehydrogenase is an enzyme involved in respiration in mitochondria. A study investigated the effect of varying levels of pyruvate on the activity of this enzyme in the mitochondria of rats.



[Source: Rudolf Portenhauser, Otto Wieland, "Regulation of Pyruvate Dehydrogenase in Mitochondria of Rat Liver", *European Journal of Biochemistry*, Volume 31, Issue 2, pp. 308–314. Copyright Wiley-Blackwell. Reprinted with permission.]

(a) (i) State the enzyme activity at 2 mM concentration after 10 minutes. [1]

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(ii) Predict the minimum concentration of pyruvate required to reach saturation of pyruvate dehydrogenase. [1]

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(b) Describe the effect of increasing concentration of pyruvate on pyruvate dehydrogenase activity. [2]

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(Question C1 continued)

- (c) Suggest an explanation for the relationship between pyruvate and pyruvate dehydrogenase activity. [3]

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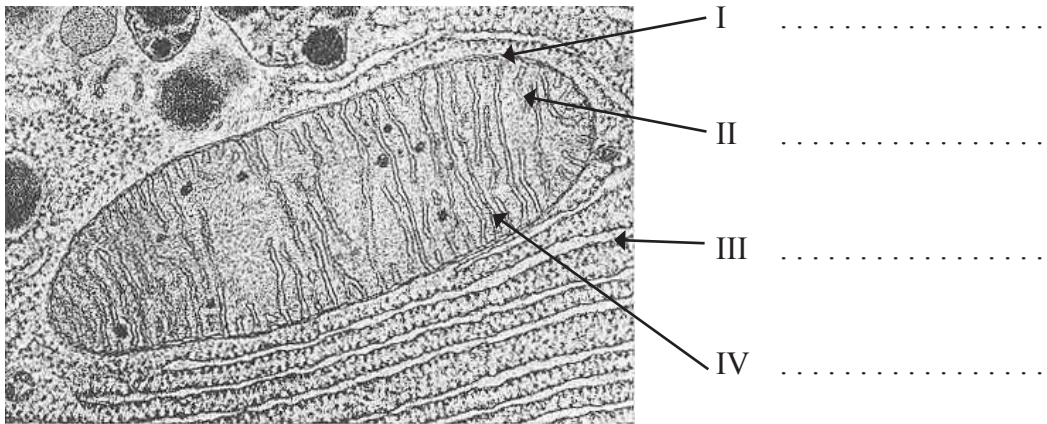
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C2. (a) Label the structures in the electron micrograph showing part of a cell containing a mitochondrion. [2]



[Copyright M. Tribe and P. Whittaker, Chloroplasts and Mitochondria, Edward Arnold Publishers, 1972]

(b) Outline the relationship between the structure of the mitochondrion and its function. [2]

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C3. (a) State **one** enzyme involved in photosynthesis. [1]

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(b) Describe the induced fit model of enzyme action. [2]

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(c) Explain the control of metabolic pathways by end-product inhibition. [4]

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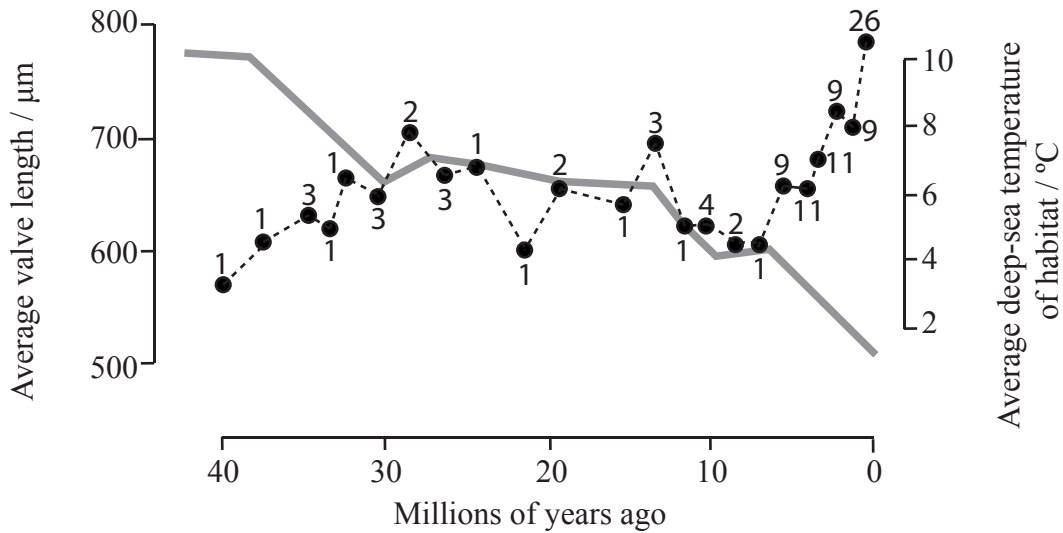


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Option D — Evolution

D1. There is evidence that body size of animals tends to increase over time. In this study, fossils and living species from the genus *Poseidonamicus*, deep-sea ostracods, were used to test this hypothesis. The numbers on the dotted line represent the number of different *Poseidonamicus* species found either as fossils or living. For each time period, the average valve length of all species studied is plotted. Valve length is an indication of total body size. The continuous line is the estimated temperature of their deep-sea habitat.



[Source: Gene Hunt and Kaustuv Roy, “Climate change, body size evolution, and Cope’s Rule in deep-sea ostracodes”, Proceedings of the National Academy of Sciences, Volume 103, Issue 5, January 31 2006, pp. 1347–1352: Figure 1C. Copyright 2006 National Academy of Sciences, USA.]

(a) Calculate the percentage increase in valve length between the species studied from 40 million years ago and the species from the present day. [2]

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(b) Suggest **two** reasons for the increase in the number of species of *Poseidonamicus* over time. [2]

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(Question D1 continued)

- (c) Evaluate the hypothesis that changes in size of *Poseidonamicus* are caused by changes in sea temperature. [3]

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

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- (b) Discuss the endosymbiotic theory for the origin of eukaryotes. [3]

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D3. (a) Describe **two** major anatomical features of humans that define them as primates. [2]

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(b) Discuss the implications of the incompleteness of the fossil record on our understanding of human evolution. [3]

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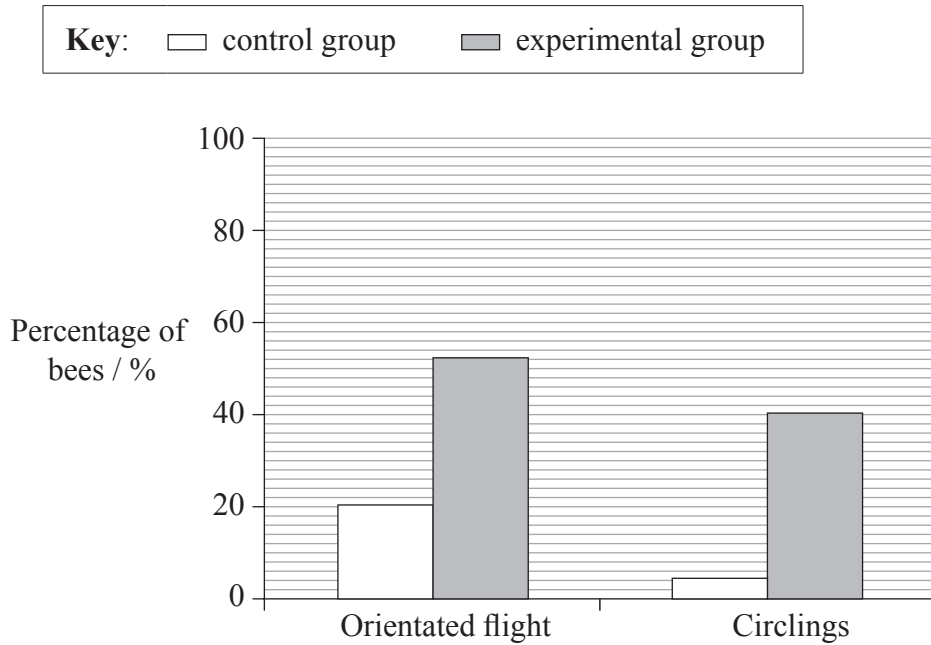


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Option E — Neurobiology and behaviour

E1. Evidence suggests that the behaviour of bees is often a response to odours. Scientists placed bees 200 cm away from an attractive odour source. An experimental group of bees had previous exposure to the odour, a control group had no previous exposure. Both the percentage of bees flying towards (orientated flight) and the percentage circling the odour source were measured.



[Source: adapted from A Chaffiol, *et al.*, (2005), *Journal of Experimental Biology*, **208**, pages 3731–3737]

(a) Calculate the percentage increase in orientated flight between the control group and the experimental group. [1]

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(b) Describe the effect of previous exposure to the odour on the flight of bees. [2]

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(Question E1 continued)

(c) Outline the type of behaviour that the experimental group demonstrates. [1]

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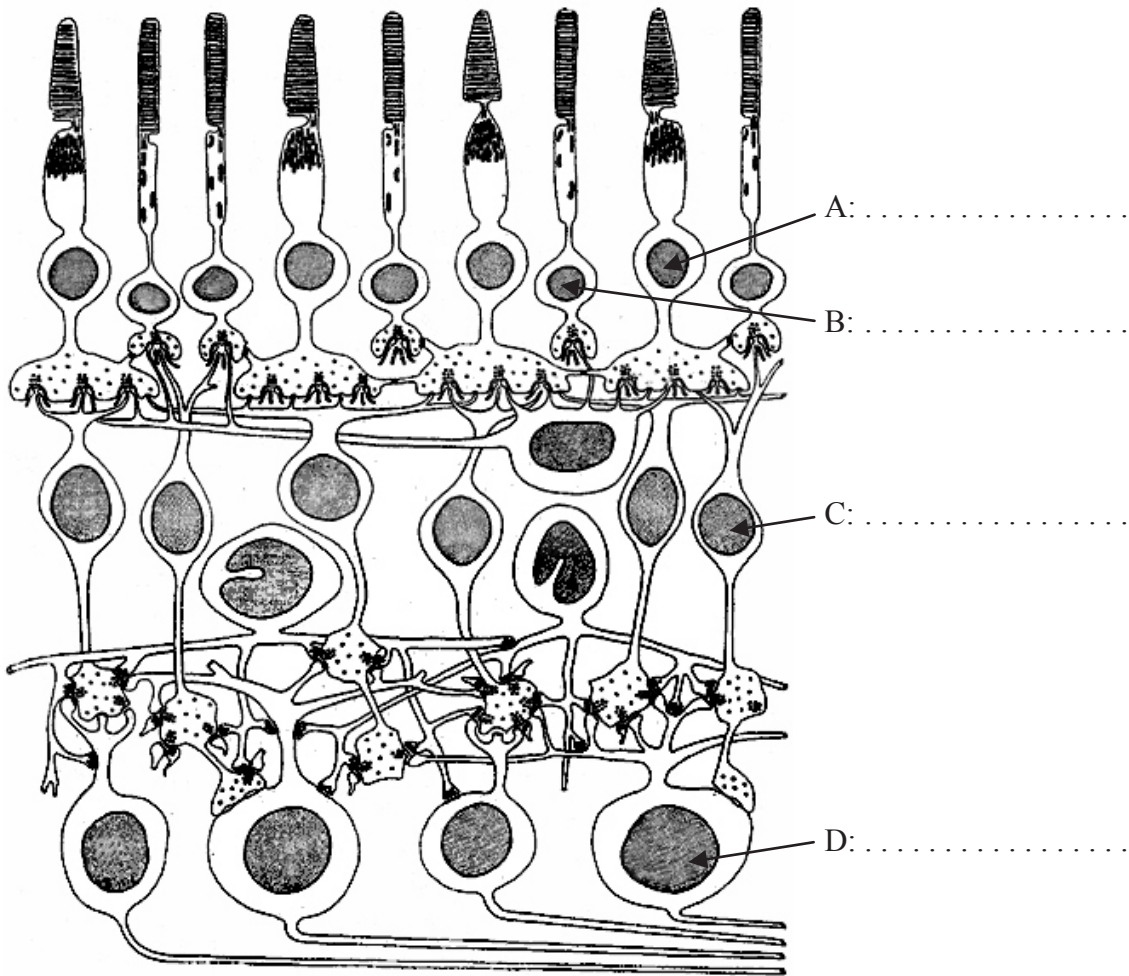
(d) Discuss the implications of this study for the survival of bees. [3]

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E2. (a) Label the diagram of the retina below.

[2]



[Source: J. E. Dowling and B. B. Boycott, "Organization of the Primate Retina: Electron Microscopy", *Proceedings of the Royal Society B*, Volume 166, No. 1002, pp. 80-111. Reproduced with permission.]

(b) Draw an arrow on the diagram above to indicate the direction in which light is moving. [1]

(c) Compare the functions of rod and cone cells. [3]

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E3. (a) List **two** examples of inhibitory psychoactive drugs. [1]

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- 2.

(b) Discuss the role of genetic predisposition and dopamine secretion in addiction. [4]

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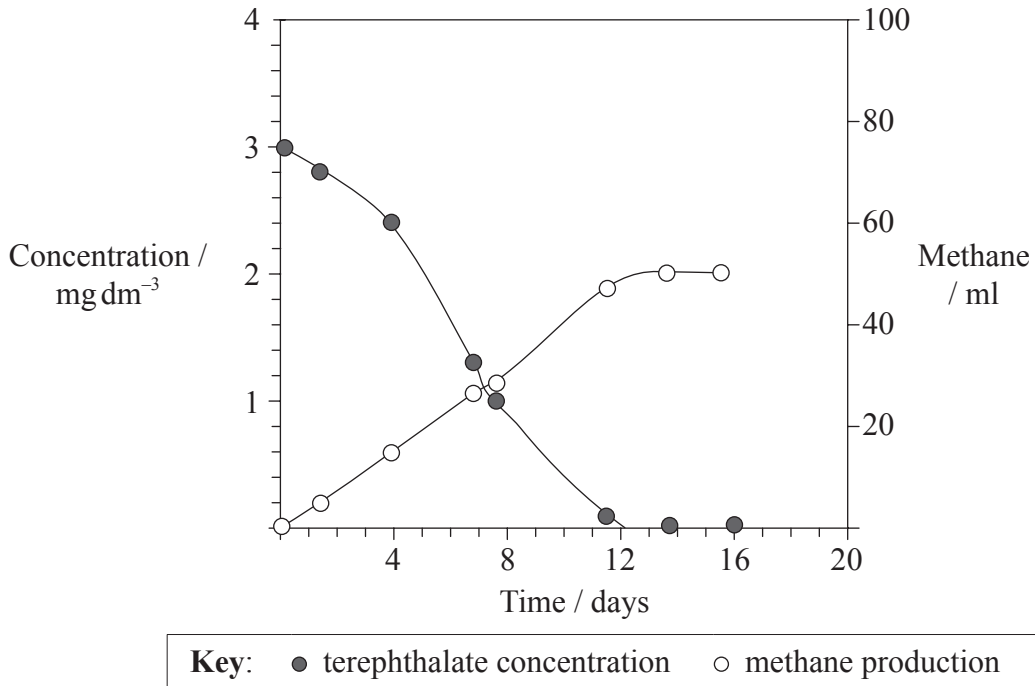
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Option F — Microbes and biotechnology

F1. Wastewater from factories producing polyester fibres contains high concentrations of the chemical terephthalate. Removal of this compound can be achieved by certain bacteria. The graph below shows the relationship between breakdown of terephthalate and conversion into methane by these bacteria in an experimental reactor.



[Source: Jer-Horng Wu, Wen-Tso Liu, I-Cheng Tseng, and Sheng-Shung Cheng, “Characterization of microbial consortia in a terephthalate-degrading anaerobic granular sludge system”, *Microbiology*, Volume 147 (2001), pp. 373-382, © Society for General Microbiology. Reprinted with permission.]

(a) The reactor has a volume of 12 litres. Calculate the initial amount of terephthalate in the reactor. [1]

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(b) Describe the relationship between terephthalate concentration and methane production. [2]

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(Question F1 continued)

(c) Suggest which bacteria can be used for the degradation of terephthalate. [1]

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(d) Evaluate the efficiency of the terephthalate breakdown into methane. [2]

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F2. (a) Outline the use of a viral vector in gene therapy. [3]

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(b) Discuss the risks involved in gene therapy. [2]

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F3. (a) Explain how chemicals may be used in food preservation. [4]

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(b) Outline the symptoms and treatment of a **named** example of food poisoning. [3]

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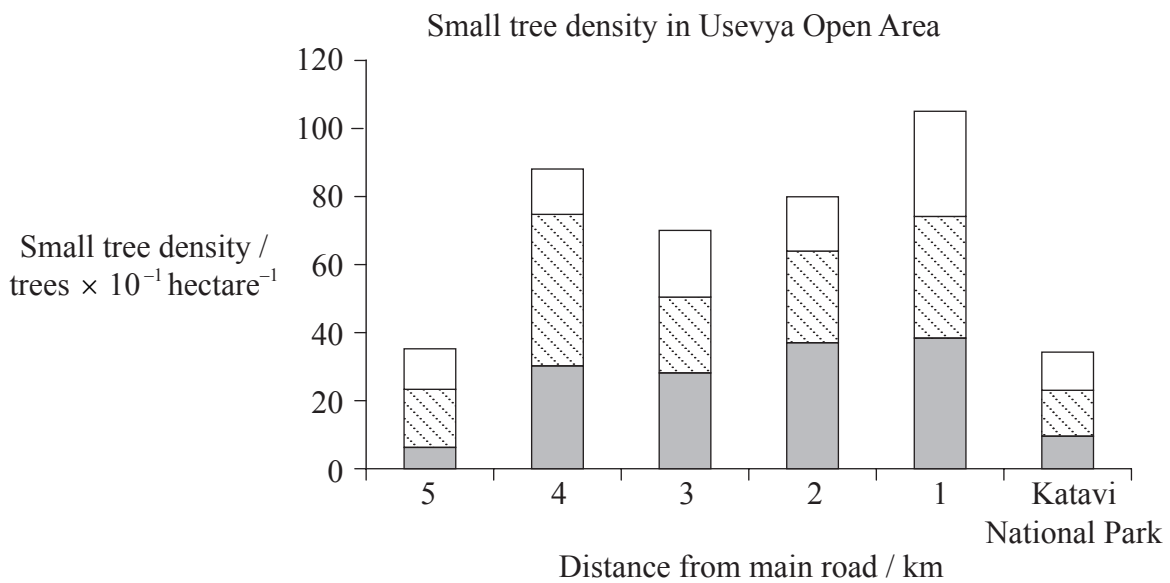


Option G — Ecology and conservation

G1. In south-central Africa trees are used for furniture production or building material by the local population. Large trees are cut down selectively. The densities of small trees were studied in Usevya Open Area where there are three settlements. Katavi National Park, where tree cutting is not allowed, is next to Usevya Open Area.

The graph below shows the density of three categories of small trees up to 25 cm in diameter at set distances from the main road.

Key: □ 10–25 cm diameter ▨ 5–10 cm diameter ■ 2–5 cm diameter



[Source: M. W. Schwartz, T. M. Caro, “Effect of selective logging on tree and understory regeneration in miombo woodland in western Tanzania”, *African Journal of Ecology*, Volume 41, Issue 1, pp. 75–82. Copyright Wiley-Blackwell. Reprinted with permission.]

(a) Identify the density of trees with a diameter between 5–10 cm in Usevya Open Area at a distance of 4 km from the main road. [1]

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(Question G1 continued)

- (b) In Usevya Open Area, describe the relationship between distance from the main road and small trees. [2]

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- (c) Outline the density of small trees in Usevya Open Area. [1]

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- (d) Discuss the distribution of small trees in Katavi National Park with those at a distance of 5 km from the road. [3]

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- G2.** (a) Discuss the impact of an alien species on an ecosystem. [3]

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- (b) Outline the temperature and vegetation characteristics of **one** major biome. [2]

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G3. (a) Define *biomass*. [1]

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(b) Describe how biomass may be measured. [2]

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(c) Explain the biomass change in different trophic levels. [3]

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