

22146015

**BIOLOGY
HIGHER LEVEL
PAPER 3**

Candidate session number

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Monday 12 May 2014 (morning)

1 hour 15 minutes

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.
- A calculator is required for this paper.
- The maximum mark for this examination paper is [40 marks].

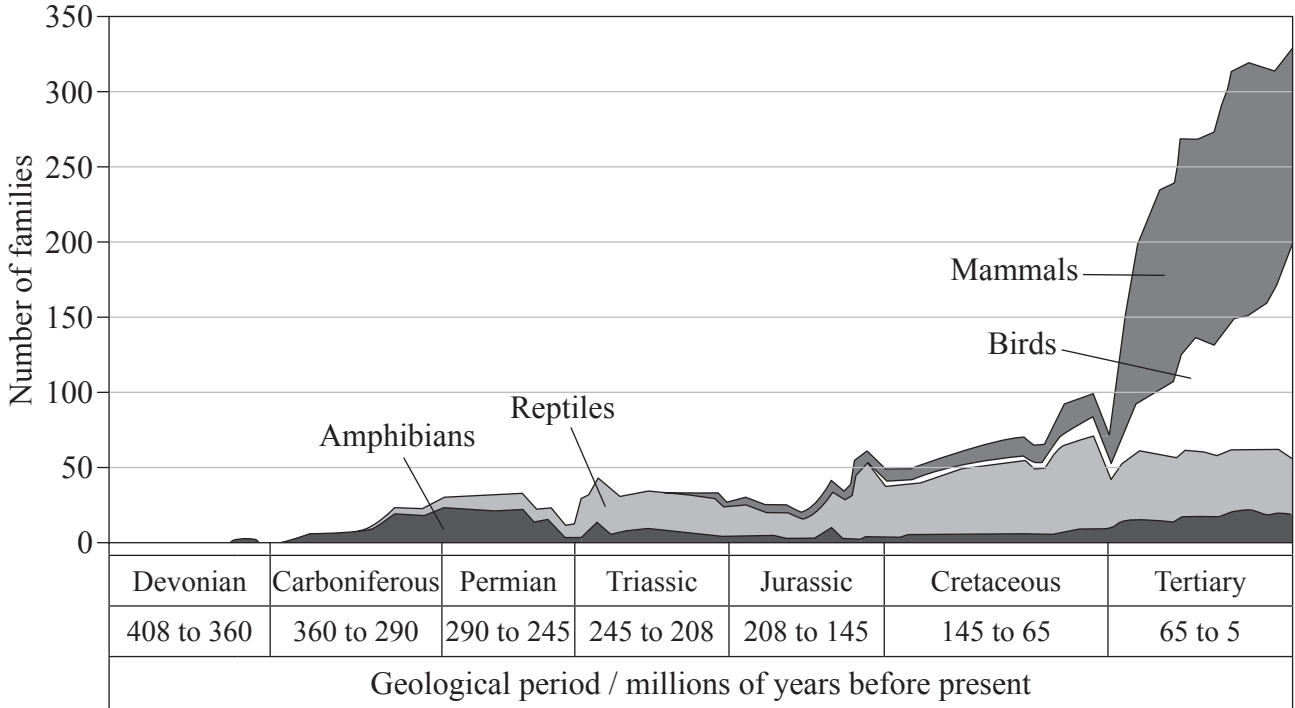
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28EP01

Option D — Evolution

- 1. Around 30 000 species of vertebrate animals with four limbs (tetrapods) are found today. They are thought to have evolved from a single amphibian species that crawled on to land around 400 million years ago during the Devonian geological period. The graph shows how the number of families of tetrapod species varied in each geological period since their first appearance.



[Source: W. Henke and T. Hardt (1999) *Handbook of Paleoanthropology: Principles, Methods and Approaches*, Volume 1, Springer. Republished with permission of Springer via Copyright Clearance Center, Inc.]

- (a) State in which geological period reptiles first appeared. [1]

- (b) Calculate how many families of mammal were present five million years ago. [1]

(Option D continues on the following page)



(Option D, question 1 continued)

- (c) Analyse the data in the graph to conclude whether mammals are more likely to have evolved from birds **or** from reptiles. [1]

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- (d) Suggest how scientists collected the data about the numbers of families. [1]

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- (e) The junction between the Cretaceous and Tertiary periods is called the K–T boundary. Using the data in the graph, discuss whether evolution at the K–T boundary fits the hypothesis of punctuated equilibrium **or** gradualism more closely. [3]

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(Option D continues on the following page)



(Option D continued)

2. (a) State how organic compounds may have been carried to Earth from space. [1]

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- (b) Identify **two** properties of RNA which may have contributed to the origin of life. [2]

1.
2.

- (c) Wings have evolved in both birds and insects enabling them to fly. State with a reason whether this is due to convergent **or** divergent evolution. [1]

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- (d) Describe how ^{14}C can be used to estimate the age of a fossil. [3]

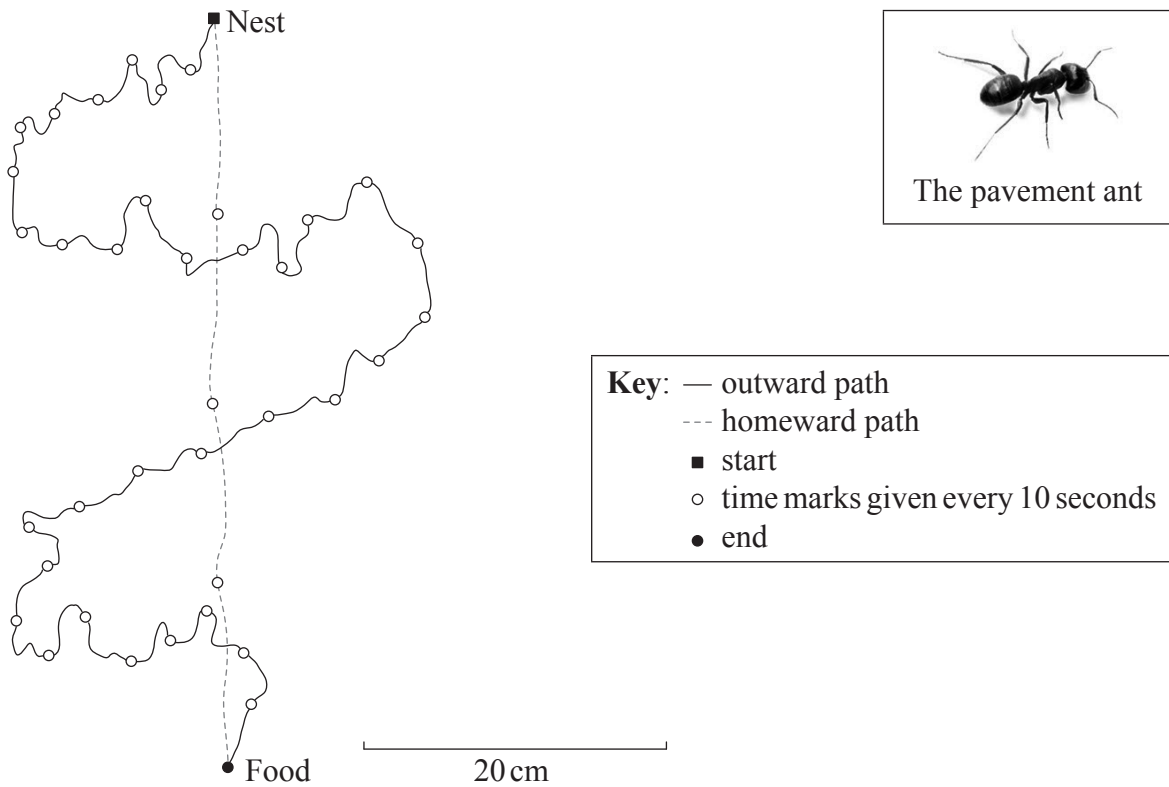
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Option E — Neurobiology and behaviour

4. The pavement ant (*Tetramorium caespitum*) eats organic matter found within its territory. Individual ants leave their nest to forage for food. When they find a suitable source of food they return and communicate to other ants in the colony where the food can be found. The diagram shows the path of one ant when foraging for food and returning to the nest after finding food.



[Source: Adapted from J. X. Shen *et al.* (1998) *Animal Behaviour*, 55, pp. 1443–1450. “Direct homing behaviour in the ant *Tetramorium caespitum* (Formicidae, Myrmicinae)”, with permission from Elsevier.]

- (a) Calculate how much time it took the ant to find the food after leaving the nest, giving the units. [1]

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(Option E continues on the following page)



(Option E, question 4 continued)

- (b) Estimate how far the ant travelled to the nest after finding the food, giving the units. [1]

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- (c) Compare the ant's journey from the nest to the food with the return journey to the nest. [2]

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- (d) (i) Suggest how the ant knew the direction to return to the nest after finding the food. [1]

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- (ii) Suggest how the other ants in the colony were able to quickly find the same source of food. [1]

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- (e) State **one** advantage to an insect of living in a colony. [1]

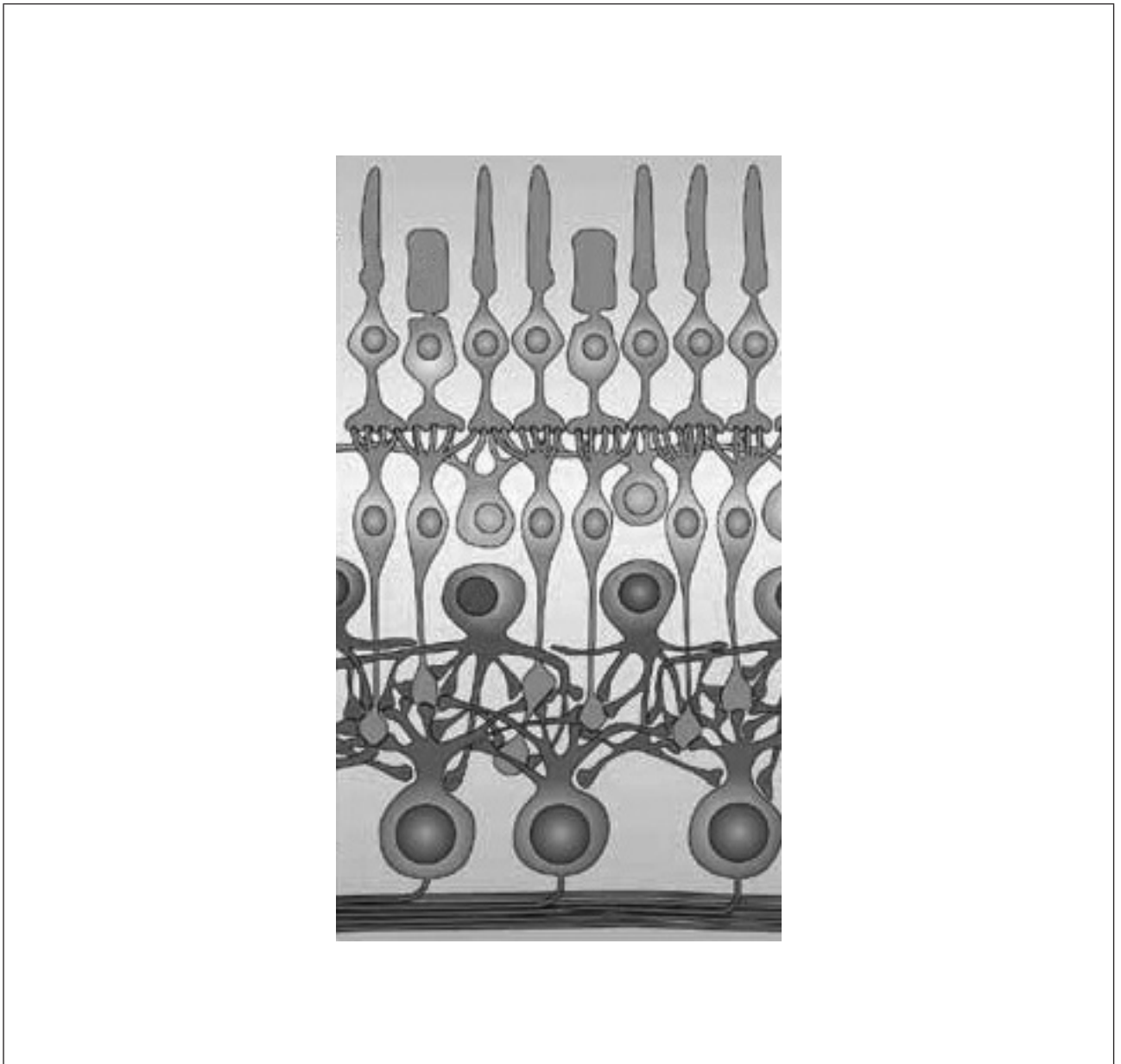
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(Option E continued)

5. (a) The following diagram represents the organization of the retina.



[Source: Reprinted by permission from Macmillan Publishers Ltd. Adapted from Heinz Wässle (2004) 'Parallel processing in the mammalian retina', *Nature Reviews Neuroscience*, 5, pp. 747–757. doi: 10.1038/nrn1497.]

- (i) Label a bipolar neuron on the diagram. [1]
- (ii) Using an arrow, annotate the diagram to show the direction in which light moves. [1]

(Option E continues on the following page)



(Option E, question 5 continued)

(b) Outline the role of the following structures in perceiving sound.

(i) Bones of the middle ear

[1]

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(ii) Hair cells of the cochlea

[1]

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(c) Distinguish between innate behaviour and learned behaviour using birdsong in young birds as an example.

[3]

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(Option E continues on the following page)



(Option E continued)

6. Discuss how experiments can be carried out to identify specific functions of parts of the brain. [6]

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End of Option E



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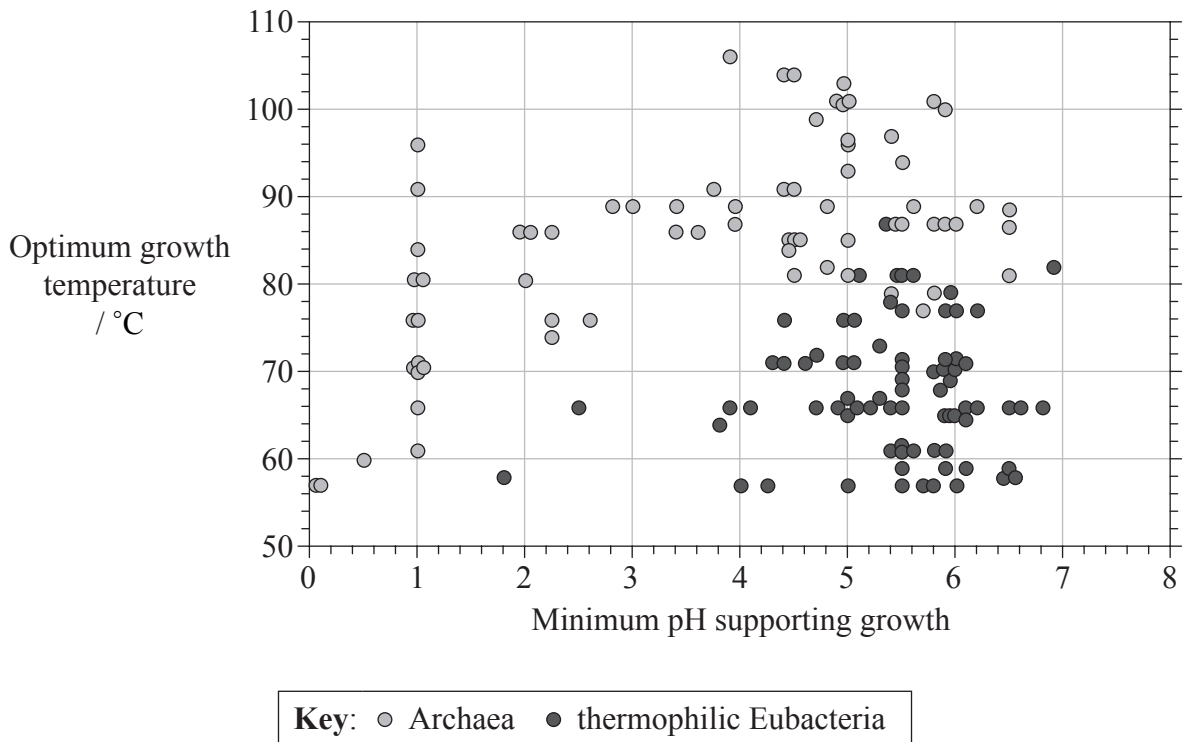


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Turn over

Option F — Microbes and biotechnology

7. One method used by microbiologists to distinguish between Archaea and Eubacteria is the conditions they need for survival. Both groups include thermophiles, which are species that are adapted to live at high temperatures. The graph shows the optimum temperature and minimum pH required for growth by selected species of Archaea and thermophilic Eubacteria.



[Source: Reprinted by permission from Macmillan Publishers Ltd: adapted from D. L. Valentine (2007), 'Adaptations to energy stress dictate the ecology and evolution of the Archaea', *Nature Reviews Microbiology*, 5, page 316.]

- (a) State the highest optimum growth temperature recorded for the thermophilic Eubacteria. [1]

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- (b) State the relationship between minimum pH supporting growth and optimum growth temperature for Archaea. [1]

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(Option F continues on the following page)



(Option F, question 7 continued)

- (c) Compare the results for the Archaea with those for the thermophilic Eubacteria. [2]

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- (d) With reference to the data, suggest why this method would not always be suitable for distinguishing between Archaea and thermophilic Eubacteria. [2]

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- (e) State a possible habitat for methanogenic Archaea. [1]

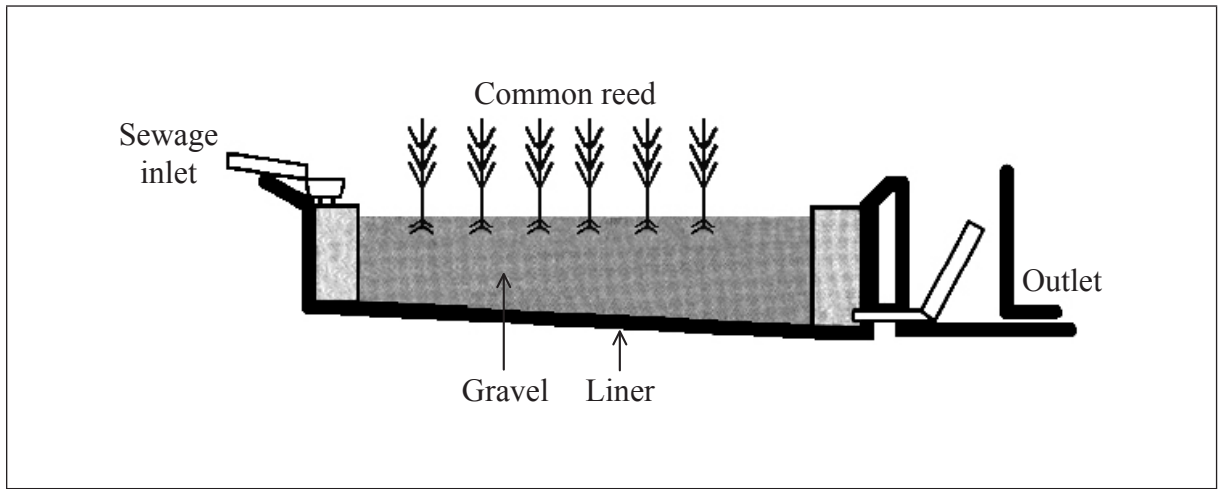
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(Option F continued)

8. (a) (i) Using an arrow, annotate the diagram to show the path of nitrates from their entry from the sewage inlet into the reed bed system. [1]



[Source: Adapted from Alan Feest, Ian Merrill and Philippa Aukett (2011), 'Does Botanical Diversity in Sewage Treatment Reed-Bed Sites Enhance Invertebrate Biodiversity?', *International Journal of Ecology*, Volume 2012 (2012), Article ID 324295, 9 pages. <http://dx.doi.org/10.1155/2012/324295>.]

- (ii) Outline the role of saprotrophic bacteria in this reed bed system. [1]

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- (b) Using the following table, compare photoautotrophs and photoheterotrophs. [2]

	Photoautotroph	Photoheterotroph
Energy source		
Carbon source		

(Option F continues on the following page)



(Option F, question 8 continued)

(c) State **one** fuel that is commonly made from biomass using microbes. [1]

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(d) Outline how viral vectors are used in gene therapy. [2]

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(Option F continues on the following page)



(Option F continued)

9. Evaluate irradiation and pasteurization as methods of controlling bacterial growth.

[6]

Irradiation:

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Pasteurization:

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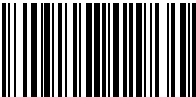
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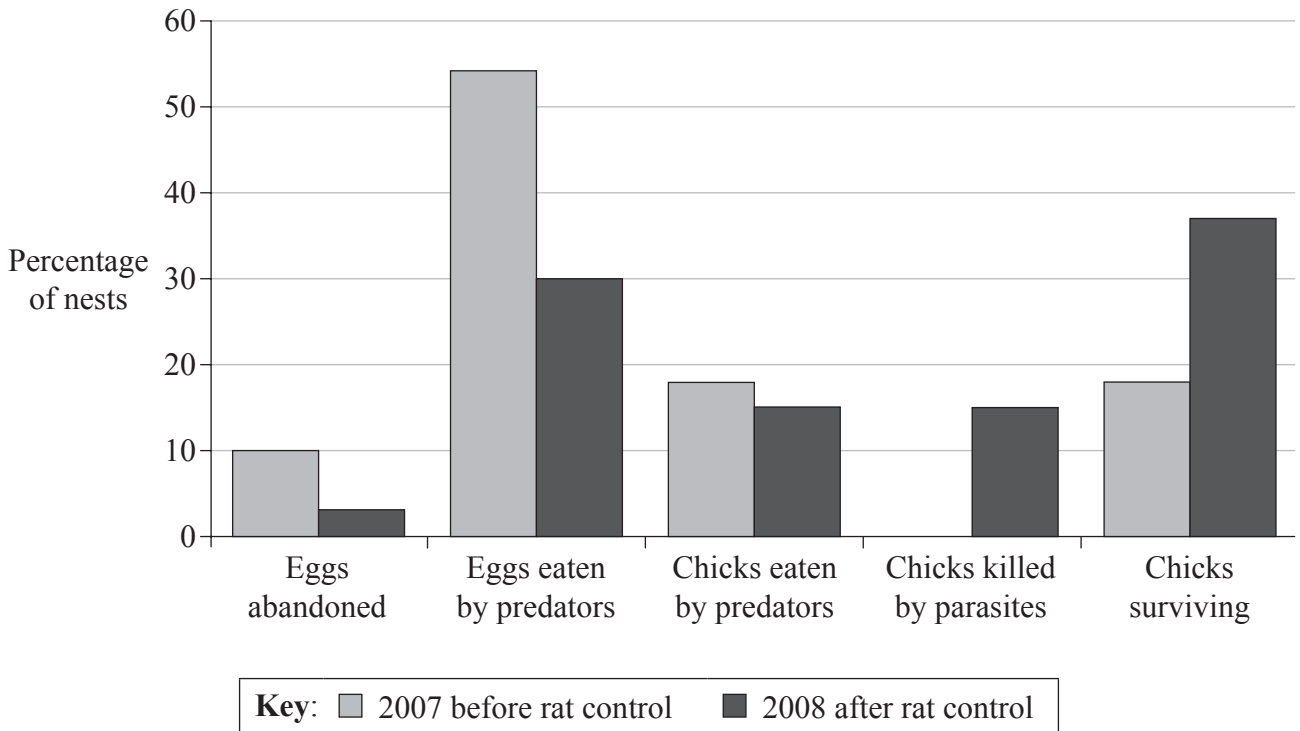


28EP17

Turn over

Option G — Ecology and conservation

10. Predation by alien species is one reason for the disappearance of several populations of Darwin’s finches from the Galapagos Islands. The critically endangered mangrove finch, (*Camarhynchus heliobates*) is now confined to three small mangroves on Isabella Island and the total population is thought to be around 110 birds. The main predators of the finches are black rats (*Rattus rattus*) which eat both the eggs and the newly hatched chicks. The chicks are also killed from infestation by larvae of the parasitic fly (*Philornis downsi*). Before the 2008 breeding season, rats were caught in traps to reduce the number. The bar chart shows the outcome of all of the nests that contained eggs in the breeding seasons before and after rat control.



[Source: Adapted from B. Fessl *et al.* (2010), ‘How to save the rarest Darwin’s finch from extinction: the mangrove finch on Isabela Island’, *Philos. Trans. R. Soc. Lond. B Biol. Sci.*, 365 (1543), pp. 1019–1030, by permission of the Royal Society.]

(a) State the effect rat control had on the number of chicks eaten by predators. [1]

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(Option G continues on the following page)



(Option G, question 10 continued)

- (b) Calculate the percentage of nests in which the eggs did not hatch in the breeding season before rat control. [1]

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- (c) Suggest a reason for the change in the number of chicks killed by parasites before and after rat control. [1]

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- (d) Evaluate the success of rat control in preventing extinction of the mangrove finch. [2]

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- (e) Apart from predation and parasites suggest **two** other reasons why the finch population on the island has been declining. [2]

1.
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2.
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(Option G continues on the following page)



(Option G continued)

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

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(b) Annotate the equation to show the relationship between gross production, net production and respiration. [1]

_____ + _____ = _____

(c) A school football field has plantain plants (*Plantago media*) growing on it as well as grass. Each plantain plant has a short stem with a circle of wide leaves. Outline how the size of the plantain population could be estimated using a quadrat method. [2]

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(d) Discuss the advantages *in situ* conservation has over *ex situ* conservation. [3]

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(Option G continues on the following page)



(Option G continued)

12. Discuss reasons why biodiversity in a rain forest should be conserved.

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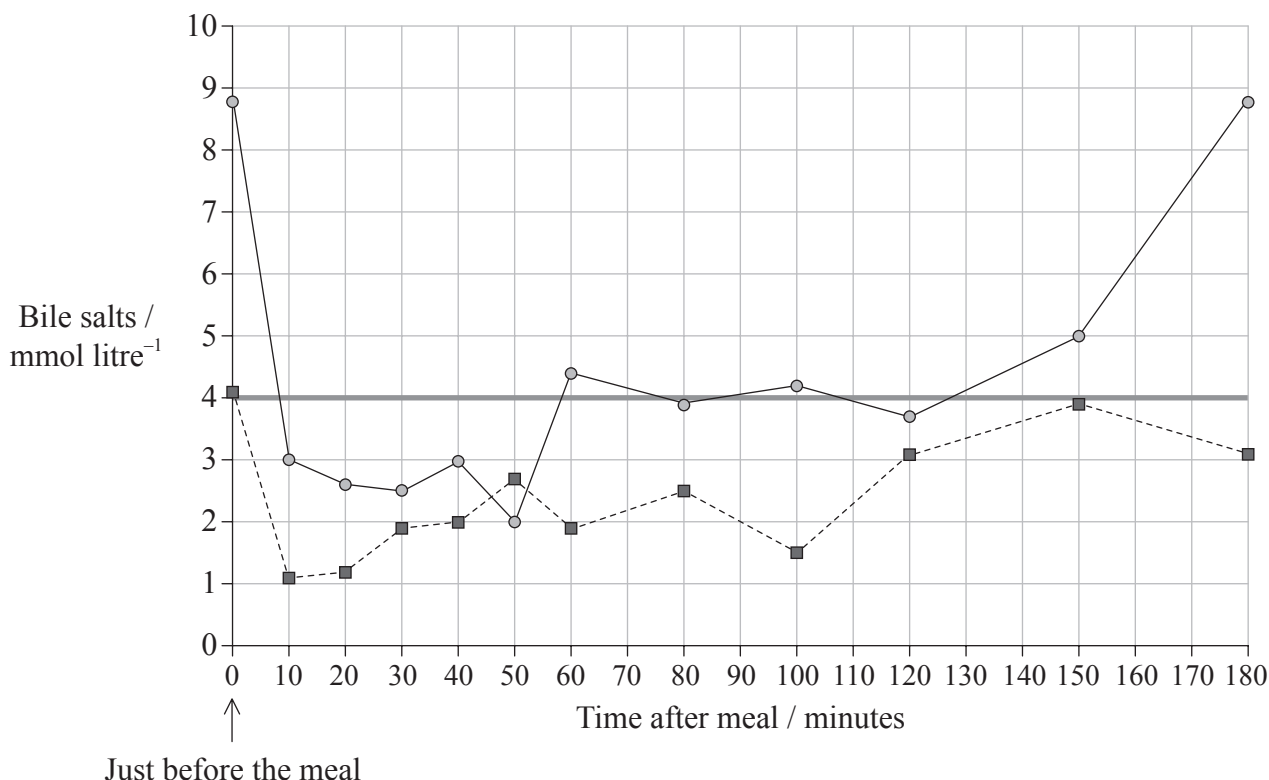


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Option H — Further human physiology

13. Premature babies born before the end of the full gestation period have difficulty absorbing fats into their bloodstream. In a study, nine premature babies were fed only cow milk and another nine premature babies were fed only human milk from the ages of 11 to 14 days old. It was found that the premature babies fed with cow milk absorbed 60% of the fats while those fed with human milk absorbed 75% of the fats. The graph shows the concentration of bile salts found in the babies' duodenum on day 14, just before a meal and in the three hours after the meal. The concentration of bile salts considered normal for a baby of that age is also shown.



Key: —○— cow milk - -■- - human milk — normal level

[Source: Adapted from E. Signer *et al.* (1974) 'Role of bile salts in fat malabsorption of premature infants', *Archives of Disease in Childhood*, 49, p. 174, with permission from BMJ Publishing Group Ltd.]

- (a) State the time after the meal when the bile salt concentration in babies fed with cow milk was lowest, giving the units. [1]

(Option H continues on the following page)



(Option H, question 13 continued)

- (b) Calculate the difference in bile salt concentration for the two types of milk just before the meal, giving the units. [1]

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- (c) Compare the bile salt concentration after the meal for babies fed with cow milk with those fed with human milk. [2]

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- (d) Outline the function of bile in fat digestion. [1]

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- (e) Analyse the data from the study to draw conclusions about the effects of the type of milk on babies. [2]

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(Option H continues on the following page)



(Option H continued)

14. (a) State the function of the SA (sinoatrial) node in the heart. [1]

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(b) State which enzyme activates trypsin in the duodenum. [1]

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(c) Outline how the secretion of gastric juice is controlled. [2]

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(d) Explain how ADH secretion is controlled by negative feedback. [3]

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(Option H continues on the following page)



(Option H continued)

15. Explain how the Bohr shift affects the oxygen dissociation curve of hemoglobin.

[6]

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28EP28