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Biology
Standard level
Paper 2

Wednesday 11 May 2022 (afternoon)

Candidate session number

1 hour 15 minutes

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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.
- Section A: answer all questions.
- Section B: answer one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.



Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. There is growing evidence of a decrease in bee populations. This decrease is a serious problem because of their valuable role as pollinators in the ecosystems where they live. Neonicotinoid pesticides have been implicated in this decrease because they have been found at trace levels in the nectar and pollen of crop plants and in the bee colonies.

Scientists placed colonies of a species of bumblebee, *Bombus terrestris*, in the laboratory to test the effects of different levels of a neonicotinoid on their development. They divided the colonies into three groups:

- The control colonies were given a solution of water and sugar that resembled nectar produced by flowers.
- A second group of colonies was given the same sugar solution containing a neonicotinoid dissolved in it at low concentrations, similar to those found in nature.
- A third group of colonies was given the same sugar solution containing a neonicotinoid dissolved in it at high concentrations, similar to those found in nature.

After two weeks, all colonies were placed in the field to allow the bumblebees to feed naturally.

- (a) (i) Describe the effect of neonicotinoid pesticides on the nervous system of insects. [1]

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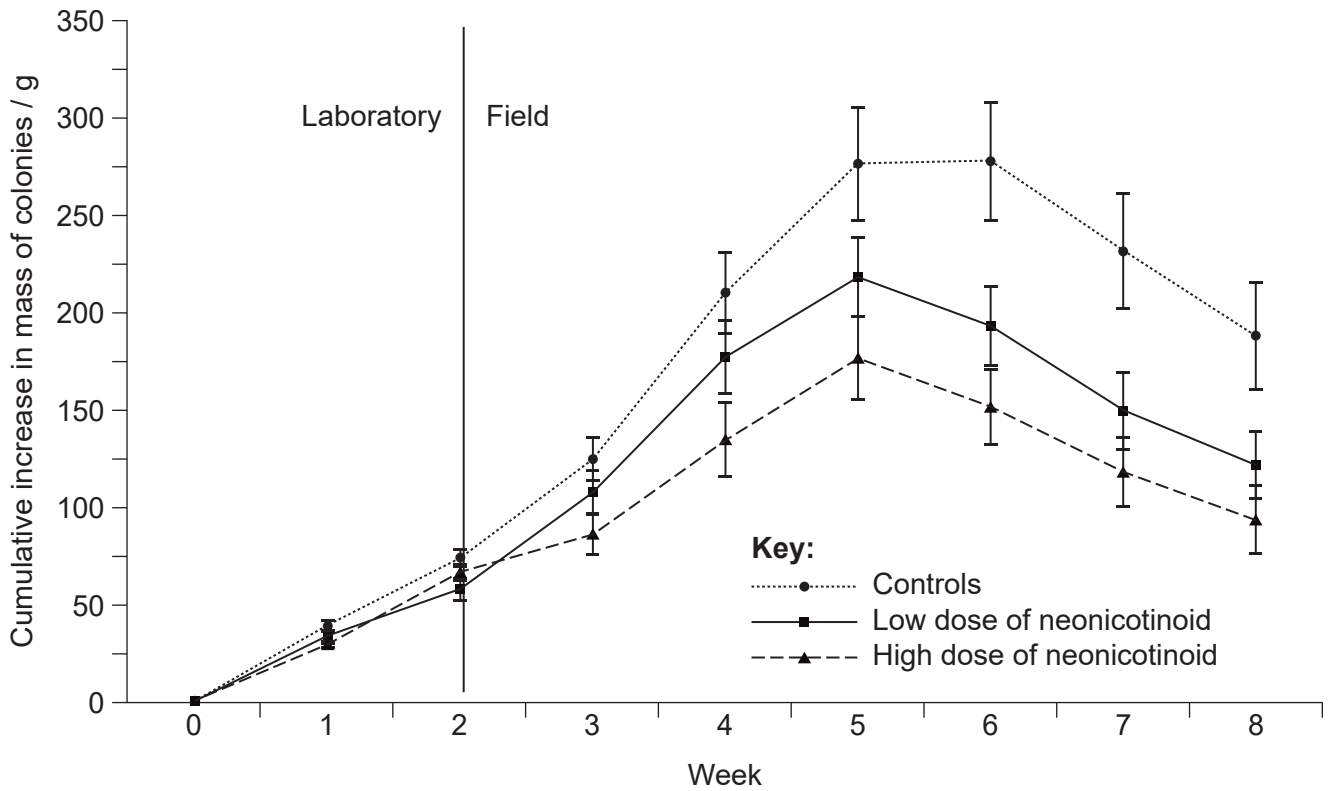
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(Question 1 continued)

The mass of the colonies, including adult bumblebees, wax, honey and larvae, was recorded every week. The cumulative increase in mass was calculated and is shown on the graph.



[Source: Adapted from Whitehorn, P.R., O'Connor, S., Wackers, F.L. and Goulson, D., 2012. Bumble Bee Colony Growth and Queen Production. *Science*, [e-journal] 336(6079), pp. 351-352. [http://dx.doi.org/10.1126/science.1215025.](http://dx.doi.org/10.1126/science.1215025)]

(ii) State the cumulative increase in the mass of control colonies at 7 weeks. [1]

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(iii) Compare and contrast the cumulative increase in mass of the three groups of colonies once they were placed in the field. [2]

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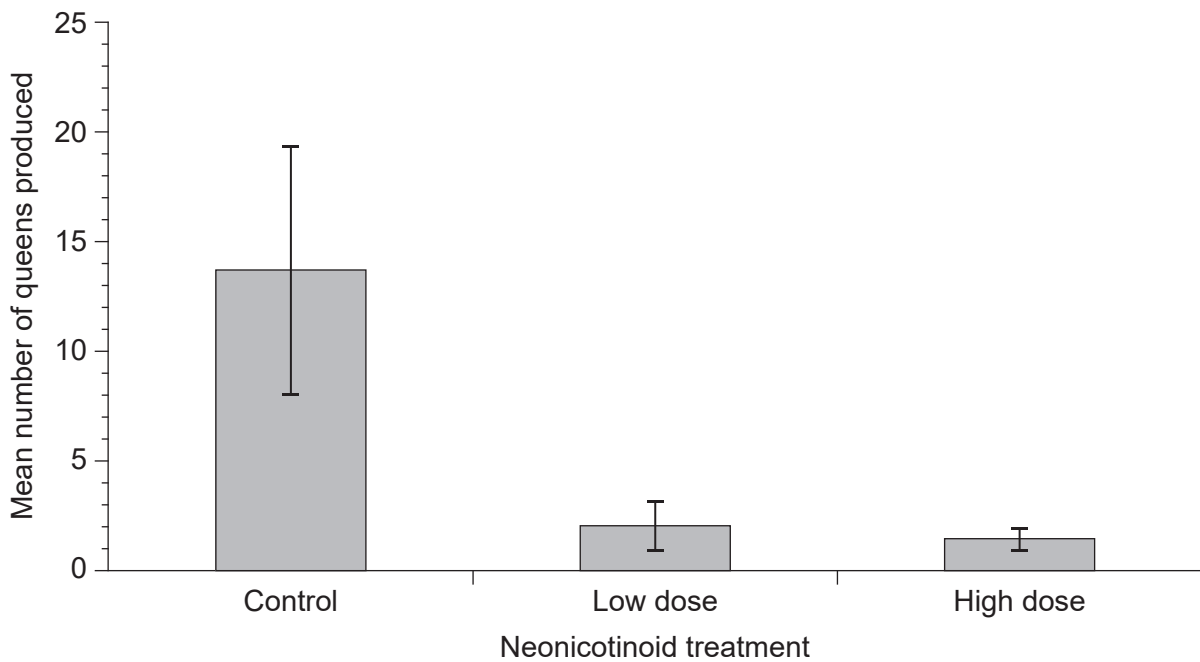
(Question 1 continued)

(iv) Suggest a reason for the changes in mass in the colonies between weeks 6 and 8. [1]

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The number of queen bumblebees produced in each colony was recorded. New bumblebee colonies are started by a queen.



[Source: Adapted from Whitehorn, P.R., O'Connor, S., Wackers, F.L. and Goulson, D., 2012. Bumble Bee Colony Growth and Queen Production. *Science*, [e-journal] 336(6079), pp. 351-352. <http://dx.doi.org/10.1126/science.1215025>.]

(b) Using the data in the graph, predict how the use of neonicotinoid pesticides will affect bumblebee populations. [3]

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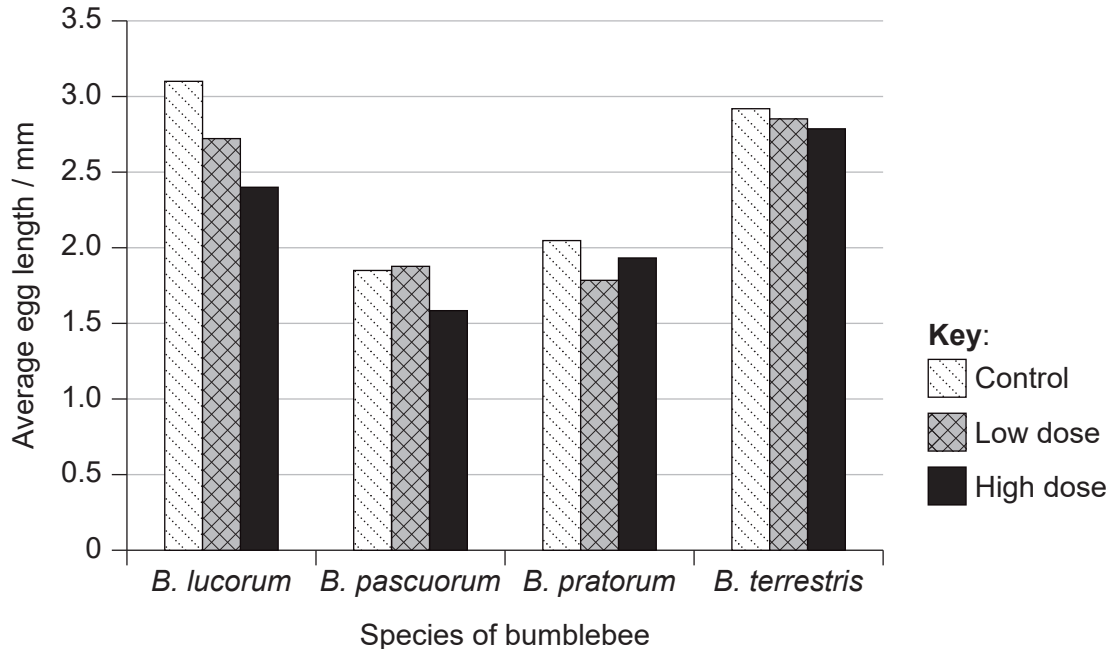
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(Question 1 continued)

A similar study compared the effect of a different neonicotinoid on four different species of bumblebees. The queens were exposed to either control conditions (with no pesticide), or low or high doses of neonicotinoid. The scientists then measured the average length of the developing eggs in the ovaries of the queens.



[Source: Baron GL, Raine NE, Brown MJF. 2017 General and species-specific impacts of a neonicotinoid insecticide on the ovary development and feeding of wild bumblebee queens. *Proc. R. Soc. B* 284: 20170123. <http://dx.doi.org/10.1098/rspb.2017.0123> Licensed under a Creative Commons Attribution 4.0 International License <https://creativecommons.org/licenses/by/4.0/> Source adapted.]

(c) (i) Identify the species whose eggs are most affected by a high dose of neonicotinoid.

[1]

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(ii) Describe the overall effects of low and high doses of neonicotinoid on the egg lengths of all four species.

[2]

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(Question 1 continued)

- (d) Deduce, based on the data presented, whether the levels of neonicotinoids used in agriculture cause direct harm to *B. terrestris*.

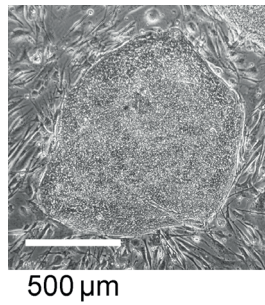
[1]

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2. An oval-shaped stem cell cluster is shown in the micrograph.



(a) State the main characteristic of stem cells. [1]

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(b) Calculate the maximum diameter of the stem cell cluster on the micrograph, showing your working and giving the units. [1]

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(c) State **one** therapeutic role of stem cells. [1]

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(d) Discuss how the use of stem cells to treat hereditary diseases could affect the person who received the treatment **and** their progeny. [2]

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3. (a) Describe anaerobic respiration in humans and in yeast. [3]

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(b) Methane can be the product of anaerobic respiration in some organisms.

(i) Distinguish between the thermal properties of water and methane. [2]

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(ii) Explain the role of methane in climate change. [2]

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4. (a) Melatonin helps to control circadian rhythms in the body. The graph shows the mean levels of melatonin in the body in day and night workers over 24 hours.

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- (i) State where melatonin is produced in the body. [1]

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- (ii) Describe **one** difference between melatonin levels of day and night workers. [1]

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- (iii) Deduce, with a reason, what time of day would be a good time to take melatonin if you have travelled over several different time zones and are jet-lagged on your arrival. [1]

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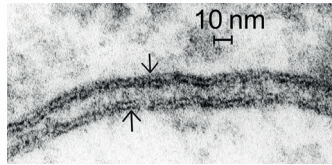
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(Question 4 continued)

- (b) The Davson-Danielli model of membrane structure was proposed in the 1930s. When electron micrographs of membranes were first produced, they were used as evidence for this model. The micrograph shows two adjacent membranes (indicated with arrows).



Explain how the appearance of membranes in electron micrographs was used as evidence to support the Davson-Danielli model.

[3]

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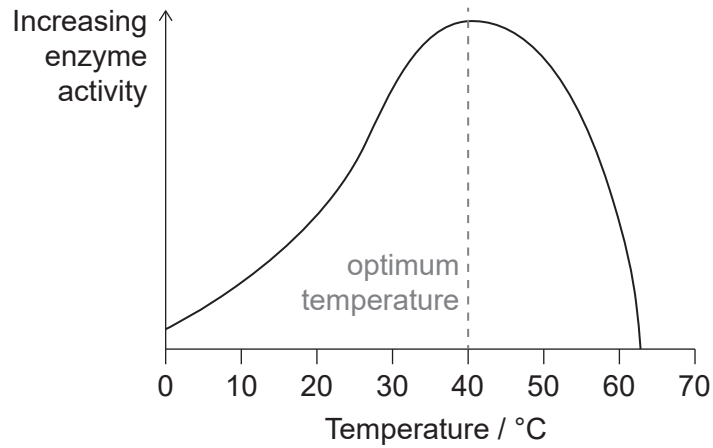
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5. Enzyme activity is affected by temperature and pH.



(a) Explain the decrease in activity of the enzyme on either side of the optimum temperature. [2]

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(b) In biotechnology, enzymes are used to transfer genes to bacteria. Outline how **two** specific enzymes are used for the transfer. [2]

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Section B

Answer **one** question. Up to one additional mark is available for the construction of your answer. Answers must be written within the answer boxes provided.

6. People with the inherited disease hemophilia have a deficiency in one of the proteins that act as clotting factors in blood.
- (a) Outline how a protein is made in a cell by the process of translation. [5]
 - (b) A family has a history of hemophilia that is caused by a sex-linked recessive allele. A woman from this family is a carrier and marries a man who does not have the allele. Showing your working, determine the probability of their children having the disease. [3]
 - (c) Explain how blood clotting occurs and the consequence for a person who has hemophilia. [7]
7. The growing human population has an increasing demand for energy derived from crop plants. At the same time, increasing droughts that are part of climate change make it difficult to grow crops in some parts of the world.
- (a) Outline energy flow through a community in a natural ecosystem. [5]
 - (b) Explain how natural selection can cause traits such as drought resistance to develop in wild plants. [7]
 - (c) Suggest possible benefits **and** risks of using genetic modification to develop varieties of crop plant with traits such as drought resistance. [3]



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16EP13

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16EP15

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References:

1. (a) Adapted from Whitehorn, P.R., O'Connor, S., Wackers, F.L. and Goulson, D., 2012. Bumble Bee Colony Growth and Queen Production. *Science*, [e-journal] 336(6079), pp. 351–352. <http://dx.doi.org/10.1126/science.1215025>.
1. (b) Adapted from Whitehorn, P.R., O'Connor, S., Wackers, F.L. and Goulson, D., 2012. Bumble Bee Colony Growth and Queen Production. *Science*, [e-journal] 336(6079), pp. 351–352. <http://dx.doi.org/10.1126/science.1215025>.
1. (c) Baron GL, Raine NE, Brown MJF. 2017 General and species-specific impacts of a neonicotinoid insecticide on the ovary development and feeding of wild bumblebee queens. *Proc. R. Soc. B* 284: 20170123. <http://dx.doi.org/10.1098/rspb.2017.0123> Licensed under a Creative Commons Attribution 4.0 International License <https://creativecommons.org/licenses/by/4.0/> Source adapted.
2. Sontag, S., Förster, M., Seré, K. and Zenke, M., 2017. [online] Available at: <https://bio-protocol.org/e2419> [Accessed 6 December 2019]. Source adapted.
4. (b) DENNIS KUNKEL MICROSCOPY/SCIENCE PHOTO LIBRARY.

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