Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 2

Friday 28 October 2022 (morning)

Candidate session number

1 hour 15 minutes

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]**.

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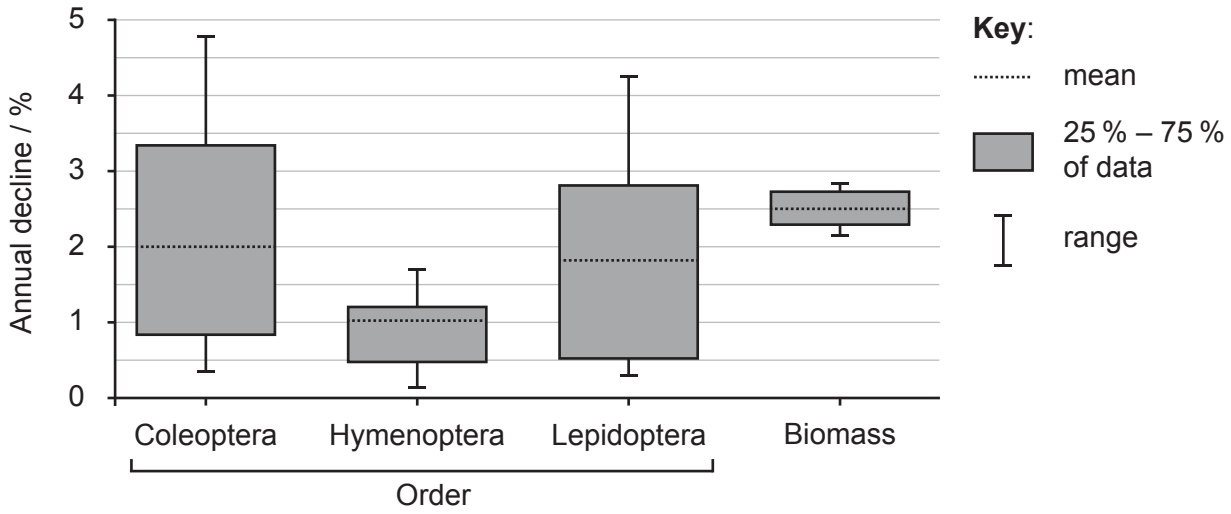
Please **do not** write on this page.

Answers written on this page
will not be marked.

Section A

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

1. The biodiversity of insects worldwide is in decline. Destruction of habitats, pollution and climate change have contributed to the decline in global insect populations and to the extinction of insect species. A comprehensive literature review was carried out to determine the annual global rate of decline in insect species. The graph shows the results for three major orders of terrestrial insects and the total decline in insect biomass worldwide.



(a) State the mean annual decline in insect biomass. [1]

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(b) Compare and contrast the results for Hymenoptera and Lepidoptera. [2]

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(Question 1 continued)

(c) Calculate the number of Coleoptera species that would be expected to exist after one year from a starting number of 400 000 species, assuming the mean rate of decline. [1]

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One species of the order Hymenoptera is the buff-tailed bumblebee (*Bombus terrestris*), which feeds on pollen and nectar obtained from specific plants.

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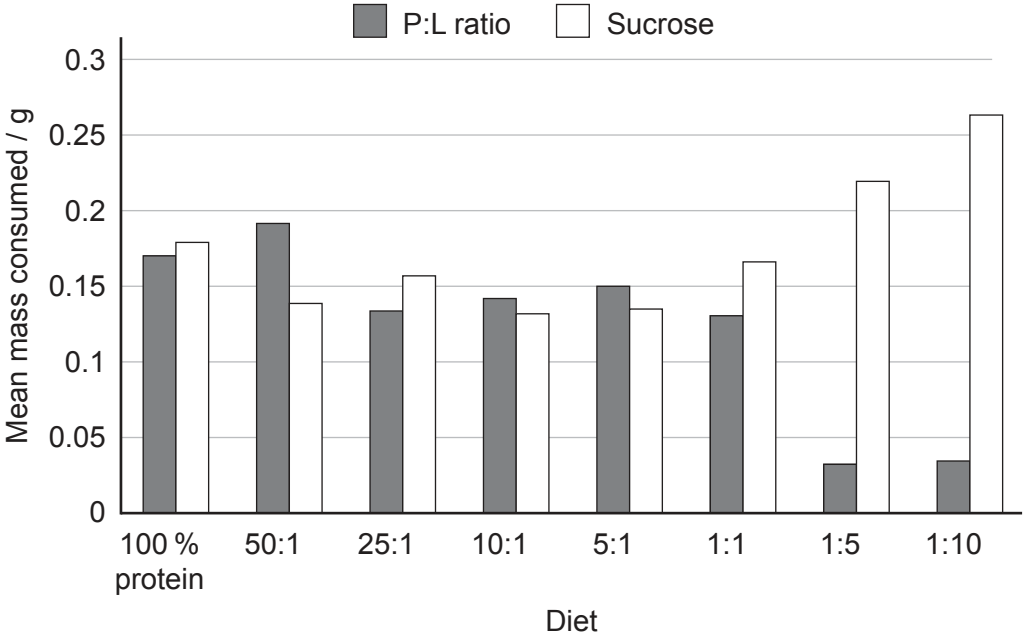
(Question 1 continued)

Destruction of preferred habitats has affected the size of bumblebee populations and for survival, bumblebees have to feed on pollen from other available plant habitats. To simulate different pollens, researchers fed bumblebees on eight diets consisting of a mixture of proteins and lipids in different ratios (P:L). The bumblebees also had access to sucrose. There was no restriction on the amount of each food the bumblebees could consume. The chart shows the mean daily mass of food eaten for eight diets with different P:L ratios.



[Source: adapted from Vaudo, A.D., Stabler, D., Patch, H.M., Tooker, J.F., Grozinger, C.M and Wright, G.A., 2016. Bumble bees regulate their intake of essential protein and lipid pollen macronutrients. *Journal of Experimental Biology* 219, pp. 3962–3970.]

(d) Identify in how many of the diets sucrose was the greatest mass of food consumed. [1]

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(e) Compare and contrast the results for the 1:1 and the 1:10 P:L diets. [2]

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(Question 1 continued)

(f) Calculate the mass of lipid eaten when the bumblebees were presented with the 5:1 diet. [1]

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(g) Suggest a reason that the mass of protein and lipid mixture eaten at 25:1 is lower than at 50:1. [1]

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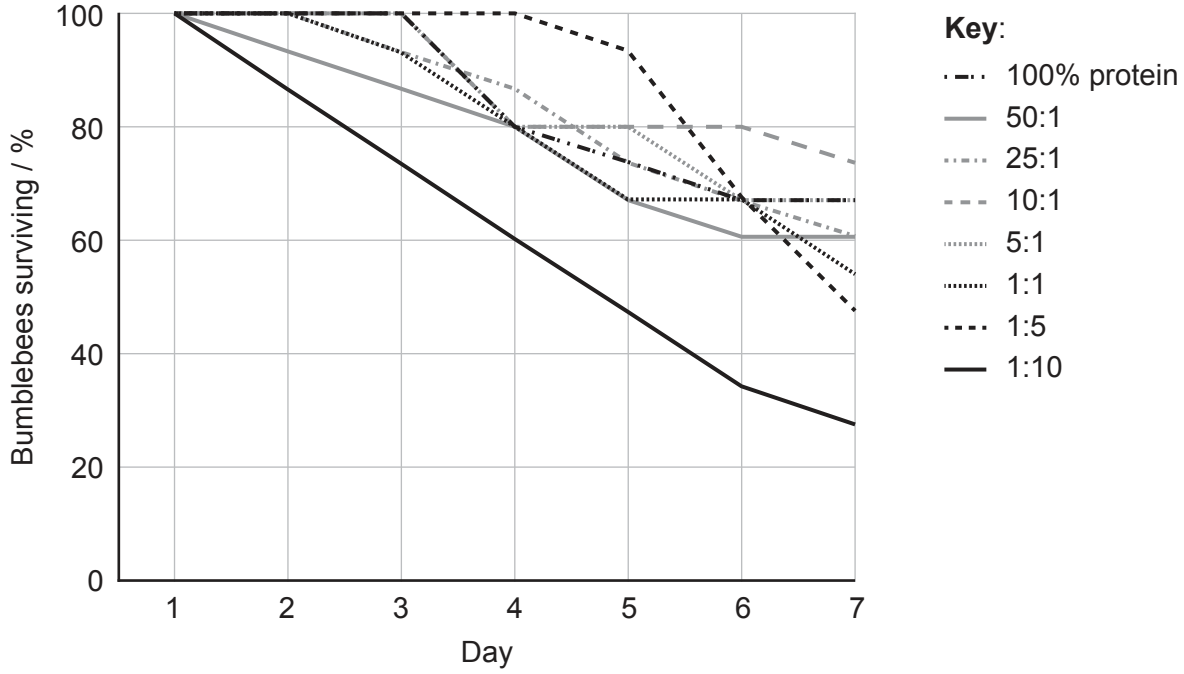
The graph shows the percentage of bumblebees that survived each day while being fed on different P:L diets. For each trial, n = 15.



[Source: adapted from Vaudo, A.D., Stabler, D., Patch, H.M., Tooker, J.F., Grozinger, C.M and Wright, G.A., 2016. Bumble bees regulate their intake of essential protein and lipid pollen macronutrients. *Journal of Experimental Biology* 219, pp. 3962–3970.]

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(Question 1 continued)

(h) State the relationship between high lipid content and survivability on day 7. [1]

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(i) Suggest with a reason which P:L diet is closest to the normal diet of these bumblebees. [1]

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(j) Discuss whether these studies show that habitat destruction can affect global bumblebee numbers. [2]

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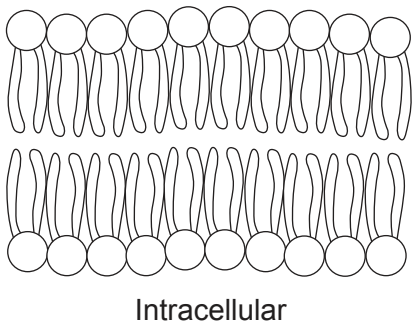
2. The image shows a phospholipid bilayer that is a component of the cell membrane.



(a) Annotate the diagram to illustrate the amphipathic nature of phospholipids. [2]

(b) Outline a function of cholesterol in cell membranes. [1]

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(c) Describe **two** pieces of evidence that show that eukaryotic cells originated by endosymbiosis. [2]

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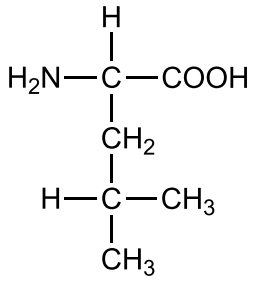
3. The diagram shows the molecular structure of the amino acid leucine.



(a) Draw a circle on the diagram to enclose the carboxyl group. [1]

(b) State one protein that acts as a hormone. [1]

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(c) Explain how enzymes are used in the preparation of milk suitable for individuals who are lactose intolerant. [2]

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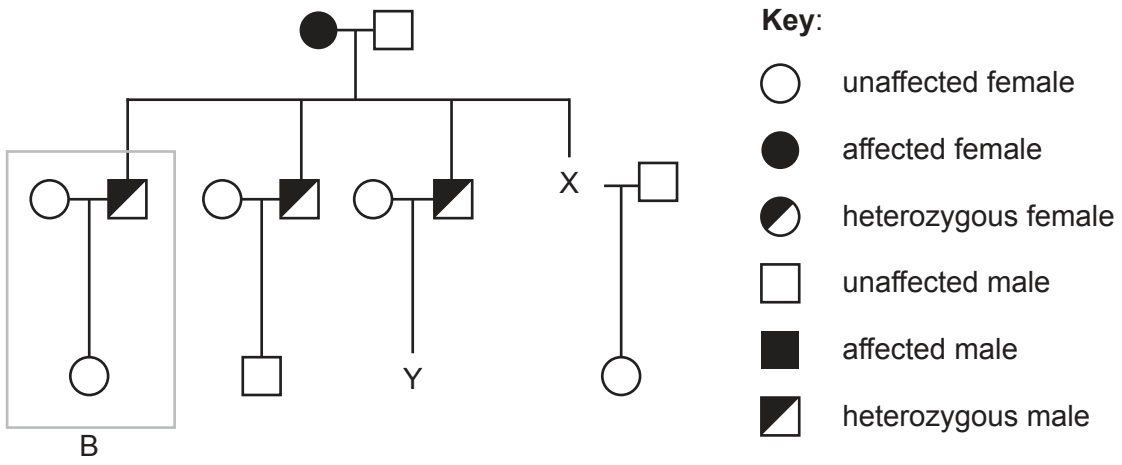
4. Thrombophilia is a human genetic condition where the blood has an increased tendency to clot. The condition is caused by a single base substitution mutation in DNA. If a person is homozygous for the gene, they are at greater risk for developing a blood clot than an individual who is heterozygous. The pedigree chart shows the inheritance of thrombophilia in a family.



(a) Draw the symbol for individual X on the diagram. [1]

(b) Calculate the probability of male Y having an allele for the disorder. [1]

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(c) Explain how the information in the box labelled B indicates that the gene is **not** sex-linked. [2]

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(d) Explain how a single base substitution mutation in DNA can cause a change to a protein. [2]

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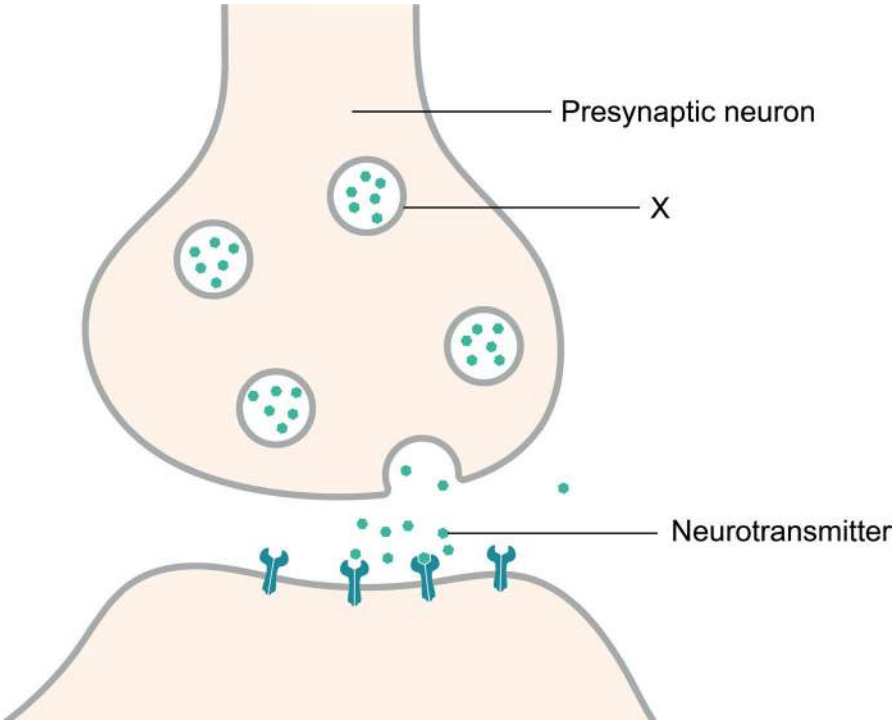
5. The diagram shows the release of a neurotransmitter across a synapse.



(a) Identify the structure labelled X. [1]

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(b) Outline how the neuron is stimulated to release the neurotransmitter. [2]

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(Question 5 continued)

(c) Explain the action of neonicotinoid pesticides in insects. [3]

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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. The continued survival of all living organisms depends on sustainable communities in which plants play a vital role.

(a) Outline how energy flows in an ecosystem. [4]

(b) Describe how plants affect the amount of carbon dioxide in the atmosphere. [4]

(c) Explain how a newly discovered plant species would be classified and named. [7]

7. Humans ingest food which provides energy and nutrients to carry out life processes.

(a) Outline how starch in the diet is modified for absorption in humans. [3]

(b) Describe how the small intestine is adapted for efficient absorption of nutrients. [5]

(c) Blood transports nutrients to all tissues of the body. Explain the initiation of the heartbeat and how blood flow is controlled in the heart. [7]

Disclaimer:

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References:

1d. Buhl, V., 2010. *Bombus terrestris*. [image online] Available at: https://commons.wikimedia.org/wiki/File:2010-04-28_(35)_Erdhummel,_Buff-tailed_bumblebee,_Bombus_terrestris.jpg [Accessed 6 December 2021].

[chart] Adapted from Vaudo, A.D., Stabler, D., Patch, H.M., Tooker, J.F., Grozinger, C.M and Wright, G.A., 2016. Bumble bees regulate their intake of essential protein and lipid pollen macronutrients. *Journal of Experimental Biology* 219, pp. 3962–3970.

1.h [graph] Adapted from Vaudo, A.D., Stabler, D., Patch, H.M., Tooker, J.F., Grozinger, C.M and Wright, G.A., 2016. Bumble bees regulate their intake of essential protein and lipid pollen macronutrients. *Journal of Experimental Biology* 219, pp. 3962–3970.

2. Boundless Learning. Course Hero. *Phospholipids*. [diagram online] Available at: https://www.coursehero.com/study-guides/introchem/phospholipids/ [Accessed 1 November 2021].

4. From *The New England Journal of Medicine*, Hopmeier, P. and Krugluger, W., n.d. Factor V Leiden and Thrombophilia. [diagram online] Available at: https:// www.nejm.org/doi/full/10.1056/nejm199505183322014 [Accessed 2 November 2021], Vol. 332 No. 20. Page No. 1381. Copyright © 1995 Massachusetts Medical Society. Reprinted with permission from Massachusetts Medical Society.

5. Splettstoesser T., 2015. *SynapseSchematic* [diagram online] Available at : https://commons.wikimedia.org/w/index.php?curid=41349083 [Accessed 14 January 2023].

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