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Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 2

12 May 2026

Zone A morning | **Zone B** morning | **Zone C** morning

Session number

2 hours 30 minutes

Instructions to students

- 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 two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.

2226 – 4030

23 pages

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Section A

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

1. The bark beetle *Ips typographus* is a pest of trees and can lead to the death of infected trees. A biological control agent is an organism that is used to kill a pest species. Several biological control agents, such as the fungi *Beauveria bassiana* and *Beauveria pseudobassiana*, have been considered to control the spread of bark beetles.

Scientists investigated the effect of *B. bassiana* on the mortality, survival time and percentage of bark beetles infected with the fungus. They infected beetles with different concentrations of *B. bassiana* fungal spores, and control groups were treated with sterile water. The table shows the results after 14 days.

Concentration of *B. bassiana* fungal spores / spores ml^{-1}	**Mean mortality of bark beetles / %**	**Mean survival time of bark beetles / days**	**Mean percentage of bark beetles infected / %**
0 (control)	38	9.8	10
1×10^6	93	6.1	92
1×10^7	100	4.2	99
1×10^8	100	4.0	98

(a) Calculate the difference in mean survival time between the 1×10^8 concentration of *B. bassiana* fungal spores and the control. [1]

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(This question continues on the following page)

(Question 1 continued)

(b) Distinguish between the results for the groups infected with 1×10^6 concentration of *B. bassiana* fungal spores and the control groups. [2]

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(c) Deduce whether it is an advantage to increase the concentration of *B. bassiana* fungal spores from 1×10^7 to 1×10^8 spores ml^{-1} to treat trees infected with bark beetles. [1]

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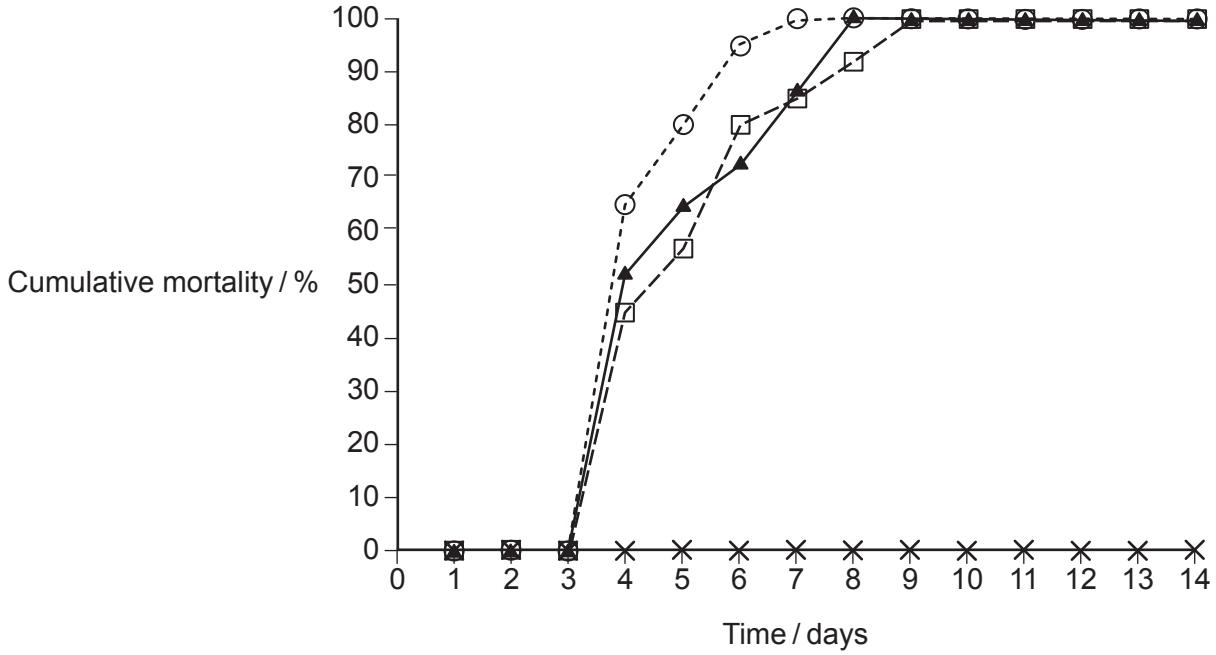
Answers written on this page
will not be marked.

(Question 1 continued)

In a different study, scientists investigated the mortality of bark beetles when infected with different concentrations of *B. pseudobassiana* fungal spores. Control groups were treated with sterile water. The cumulative mortality of each group was recorded over 14 days. The graph shows their results.



(d) Identify the concentration of *B. pseudobassiana* fungal spores that killed all the bark beetles in the shortest time. [1]

. . . . . .spores ml^{-1}

(e) Discuss whether bark beetles are more vulnerable to *B. bassiana* or to *B. pseudobassiana* infection after 14 days. [2]

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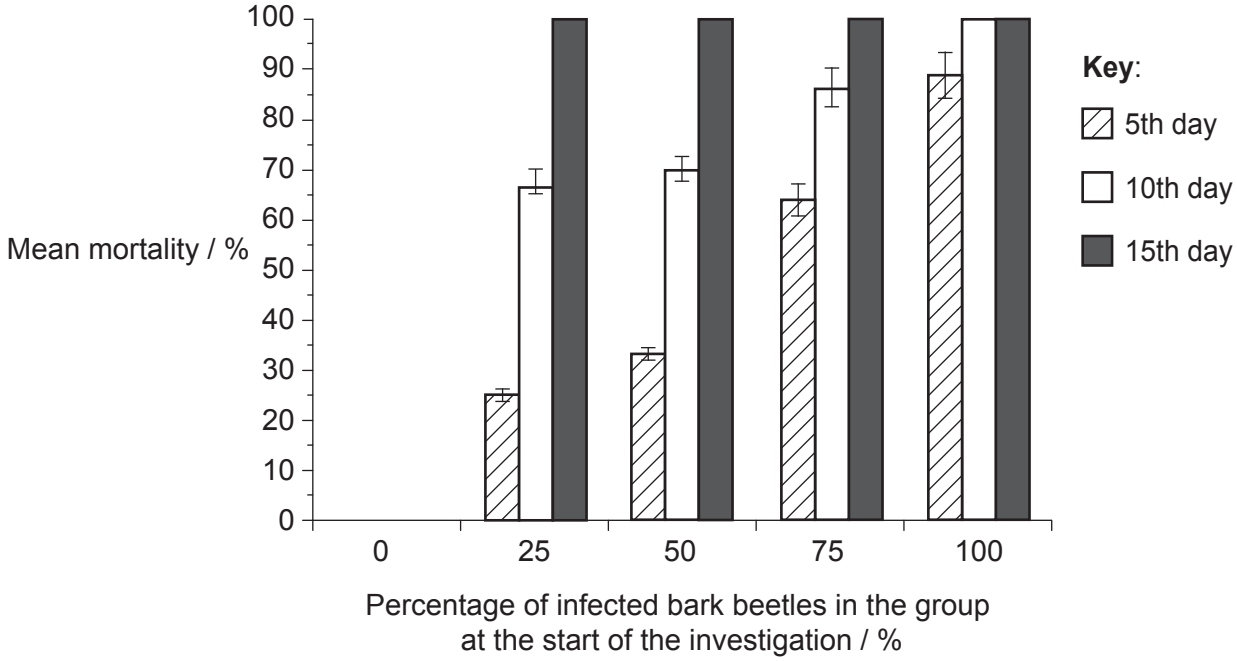
(This question continues on the following page)

(Question 1 continued)

Scientists investigated the potential of *B. pseudobassiana* fungal transmission within a population of adult bark beetles.

Non-infected bark beetles and bark beetles infected with *B. pseudobassiana* were kept together in five groups, each with 36 beetles in total. Each group had a different percentage of infected bark beetles at the start of the investigation. The percentage mortality was recorded every five days for 15 days.



(f) Calculate the mean number of bark beetles still alive in the 25 % group on the 5th day. [1]

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(This question continues on the following page)

(Question 1 continued)

(g) Compare and contrast the mortalities of bark beetles for the 25% group and 75% group for the three recorded days. [3]

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(h) Using all the data provided, discuss whether the fungi of the genus *Beauveria* are a possible biological control agent for bark beetles. [3]

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2. Viruses, such as the coronavirus which caused the COVID-19 pandemic, can evolve. Studies of the genome of coronaviruses from 99 countries showed that there is little genetic diversity of coronaviruses in circulation in different continents.

(a) Identify the type of genetic material found in coronaviruses. [1]

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(b) Genetic diversity can be due to mutations. List **two** ways in which mutations could have appeared in coronaviruses. [2]

1 . . . . . .

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2 . . . . . .

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(c) Explain the reasons, other than a high mutation rate, that viruses may evolve rapidly. [2]

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3. (a) State **one** abiotic factor that could affect the distribution of both plants and animals. [1]

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

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(c) Describe the upslope range shift for tropical-zone montane bird species in New Guinea. [2]

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4. The image shows adult seed beetles, *Callosobruchus maculatus*, feeding on seeds.

(a) State the trophic level of the seed beetles. [1]

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(b) (i) Crowding of the seed beetles causes intraspecific competition.
Define intraspecific competition. [1]

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(ii) Explain the effect of intraspecific competition on fitness. [2]

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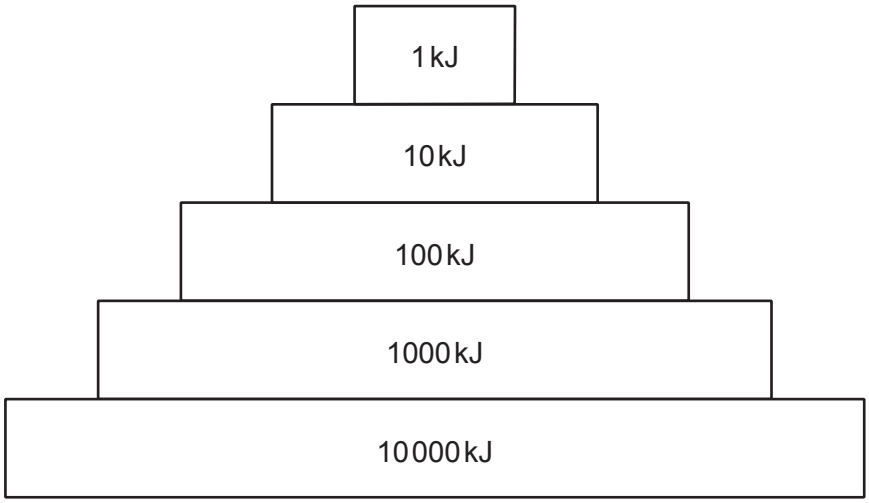
(Question 4 continued)

(c) The diagram shows the flow of energy between trophic levels of a food chain.

diagram not to scale



Explain the reduction of energy from one trophic level to the next. [3]

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5. The transpiration rate and water potential (ψ_w) of a leaf can vary at different times of the day.

(a) State **one** environmental factor that affects transpiration rate. [1]

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(b) Outline the effect of transpiration rate on water potential (ψ_w) in the leaf cells. [1]

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(c) Explain how increasing the solute potential (ψ_s) in the leaf cells affects their water potential (ψ_w). [2]

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(d) Explain how root pressure is generated. [2]

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6. The proteasome complex 26S is involved in the breakdown of the enzyme lysozyme.

(a) State the full name of the ATP molecule. [1]

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(b) Outline the use of ATP in lysozyme breakdown. [1]

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(c) State the final product of lysozyme breakdown. [1]

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(d) Justify the need for protein breakdown by proteasomes. [3]

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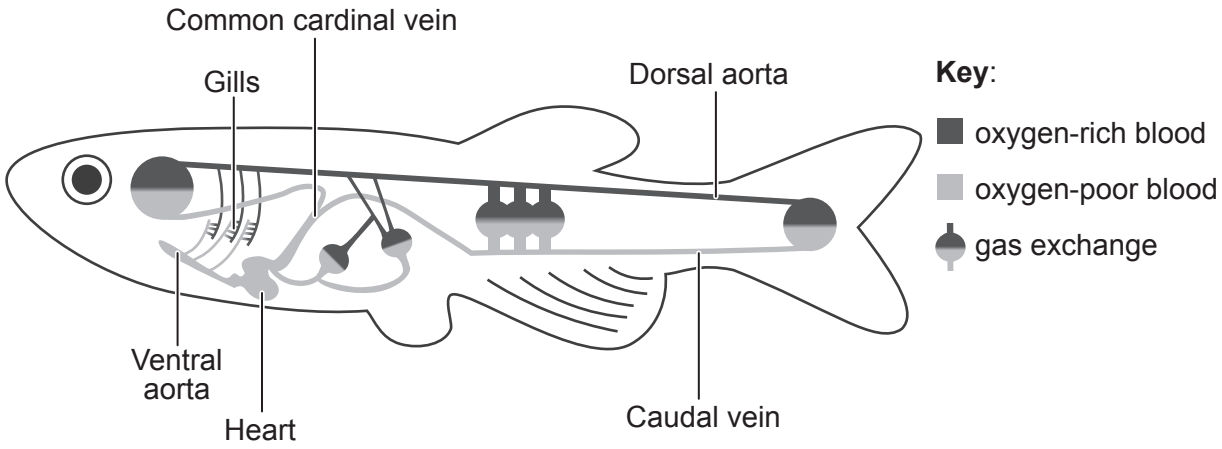
will not be marked.

7. The diagram shows blood circulation in a bony fish.



(a) State the molecule that transports oxygen in vertebrates. [1]

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(b) Distinguish between blood circulation in bony fish and in mammals. [2]

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(c) Outline **two** adaptations of arteries for the transport of blood. [2]

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Section B

Answer **two** questions. One additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

8. Carbon forms part of all living organisms.

(a) Outline the conditions on early Earth that led to the formation of a great variety of carbon compounds. [4]

(b) Describe ways to ensure that agriculture is sustainable. [4]

(c) Explain the structure of starch and how it is suited to its role of storage in a plant cell. [7]

9. DNA is the genetic material of all living organisms, and its structure allows hereditary information to be stored.

(a) Draw a diagram showing **two pairs** of nucleotides in a DNA molecule. [4]

(b) Describe the use of whole genome sequencing to find evolutionary relationships between species. [4]

(c) Explain the importance of genes and phenotypic plasticity in the determination of the observable traits of an organism. [7]

10. Communication is important in biological systems.

(a) Describe quorum sensing in bacteria as a mode of communication. [4]

(b) Outline the use of calcium ions as an example of chemical signalling in animal cells. [4]

(c) Explain the role of phytohormones as signalling chemicals controlling growth in plants. [7]

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References:

1.(a) Kreutz, J., Vaupel, O. and Zimmermann, G., 2004. Efficacy of *Beauveria bassiana* (Bals.) Vuill. against the spruce bark beetle, *Ips typographus* L., in the laboratory under various conditions. *Journal of Applied Entomology*, 128(6), pp. 384–389. [e-journal] https://doi.org/10.1111/j.1439-0418.2004.00813.x. Copyright © 2004, John Wiley and Sons. Source adapted.

1.(d) and (f) KOCAÇEVİK, S, SEVİM, A, EROĞLU, M, DEMİRBAĞ, Z, & DEMİR, İ (2016). Virulence and horizontal transmission of *Beauveria pseudobassiana* S.A. Rehner & Humber in *Ips sexdentatus* and *Ips typographus* (C*oleoptera*: *Curculionidae*). *Turkish Journal of Agriculture and Forestry* 40 (2): 241–248. https://doi.org/10.3906/tar-1504-64.

4.(a) Originality1988. https://commons.wikimedia.org/wiki/File:Callosobruchus_maculatus_on_blackeyed_peas.JPG. Licensed under CC BY-SA 3.0 https://creativecommons.org/licenses/by-sa/3.0.

4.(c) Entropyrider. https://commons.wikimedia.org/wiki/File:Trophic_pyramid.png. Public domain.

7. Hoareau, M., El Kholti, N., Debret, R. and Lambert, E., 2022. *International Journal of Molecular Sciences*, 23, 2102. [e-journal] https://doi.org/10.3390/Ijms23042102. Reference redacted. Source adapted.