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 – 4024

19 pages

Section A

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

1. A mass extinction happened 205 million years ago, at the end of the Triassic period. At this time, atmospheric carbon dioxide (CO_2) concentrations increased, possibly to as high as 3000 parts per million (ppm). This is estimated to have caused an increase in mean global temperatures of 3 to 4 °C.

Fossilized plants have been discovered in Sweden, in layers of rock deposited at the end of the Triassic and start of the Jurassic periods. The fossils show differences in leaf structure. The table shows the mean number of stomata per unit area of leaf (stomatal density) in the fossils found in 20 layers of rock.

Time ↓

Period	Layer of rock (in the sequence of 20 layers)	Mean stomatal density / stomata mm^{-2} ± standard error
Triassic	9	107.9 ± 4.6
	11	47.7 ± 3.5
	12	28.5 ± 2.0
	14	19.1 ± 2.0
Jurassic	15	92.5 ± 7.1
	20	73.2 ± 2.4

(a) Deduce with a reason whether the differences in stomatal density between the layers of rock are likely to be statistically significant. [1]

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(b) Outline the trends in stomatal density during the end of the Triassic period and into the start of the Jurassic period. [2]

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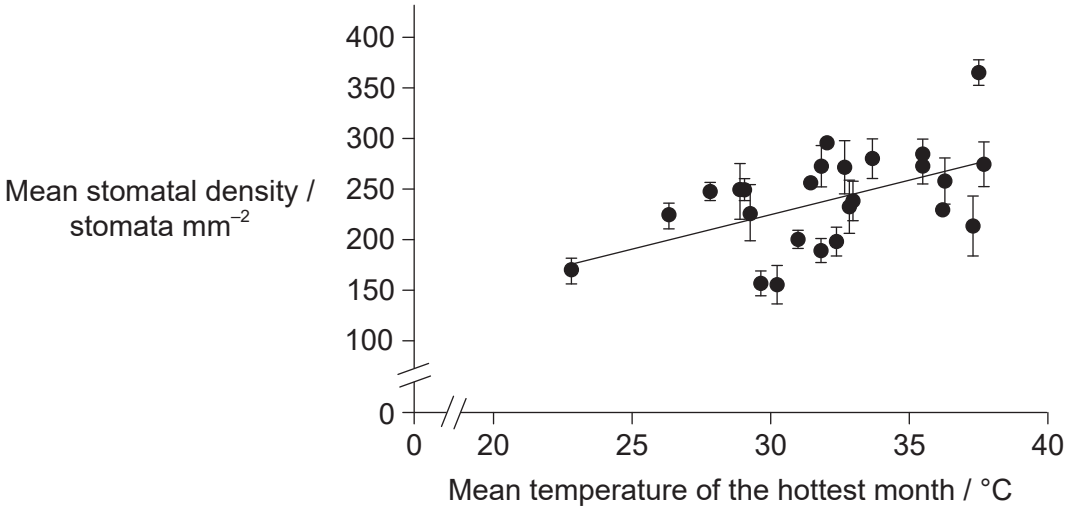
(Question 1 continued)

Natural selection can cause changes to stomatal density. To investigate this process, stomatal density was measured in specimens of the shrub *Dodonaea viscosa*, collected from many locations in South Australia. These locations varied in latitude and altitude, so climate also varied. The graph shows the mean temperature of the hottest month and mean stomatal density for *D. viscosa* at each location.



(c) Identify the relationship between temperature and stomatal density shown by the data in the graph. [1]

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(d) Suggest **two** reasons for differences in stomatal density between plants growing in hotter and cooler habitats. [2]

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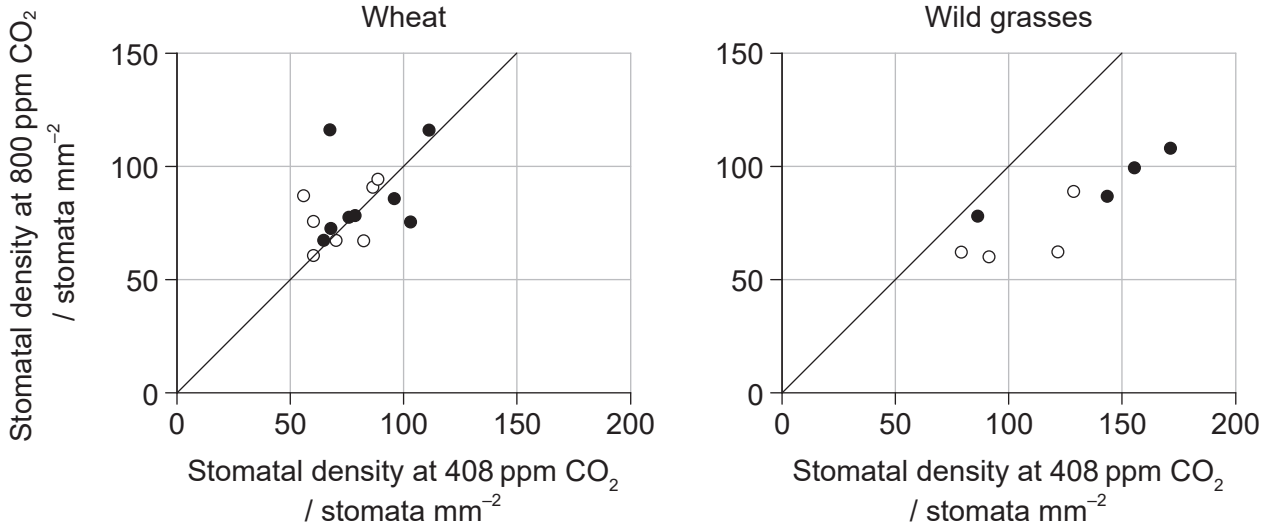
(Question 1 continued)

An experiment was done to test the hypothesis that if plants are placed in elevated atmospheric CO_2 concentrations, they will grow leaves with a lower stomatal density. Wheat species (*Triticum sp.*) and wild grasses (such as *Aegilops*) were grown at current atmospheric CO_2 concentrations (408 parts per million, ppm) as well as elevated CO_2 concentrations (800 ppm). Stomatal densities of both the lower and upper epidermis were then measured.



(e) State the maximum stomatal density of the upper epidermis of wild grasses in atmospheric CO_2 concentrations of 408 ppm. [1]

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(f) Suggest an advantage to plants of having a reduced stomatal density if growing in increased atmospheric CO_2 concentrations. [1]

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(Question 1 continued)

(g) Deduce whether this data provides support for the hypothesis that elevated CO_2 concentrations cause plants to grow leaves with reduced stomatal densities in either the upper or lower epidermis. [2]

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(h) Predict, using evidence from the data in any part of this question, whether stomatal density will increase or decrease in response to the changes in atmospheric CO_2 concentration and global temperatures that are currently happening on Earth. [4]

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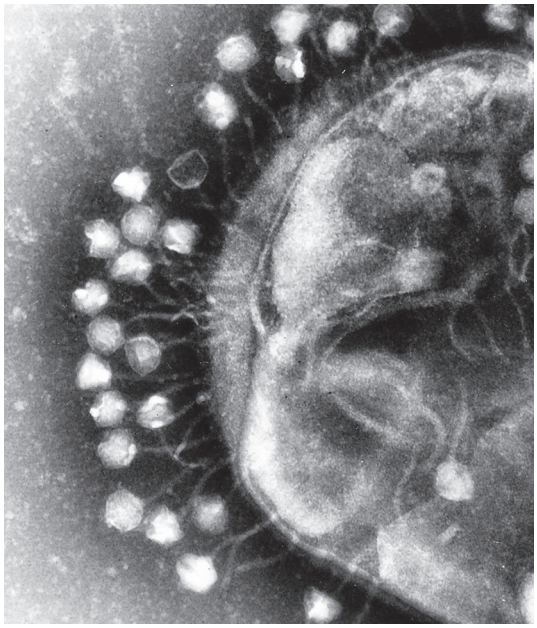
Answers written on this page
will not be marked.

2. The electron micrograph shows bacteriophages on the surface of a bacterium.



(a) Deduce the process that is happening at this stage in the lytic cycle of the bacteriophage. [1]

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(b) A virus depends on its host for many processes. State **two** processes essential for a virus in the lytic cycle that are performed by the host cell. [2]

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(c) Justify the hypothesis that viruses evolved from living cells, and that this happened many times rather than just once. [2]

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3. Bluebells are native plants to north-western Europe, where they grow in both grassland and forest. The climate in north-western Europe is temperate.

(a) Identify **two** abiotic variables that affect whether forest or grassland develops in an area. [2]

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Two species of bluebell grow in natural ecosystems in Britain: *Hyacinthoides non-scripta* and *Hyacinthoides hispanica*. In dry temperate woodland, *H. hispanica* produces more offspring than *H. non-scripta*, but in damp temperate woodland and grassland in areas with high annual rainfall, *H. non-scripta* produces more offspring.

(b) Using your understanding of interspecific competition and ecological niches, predict the likely survival in Britain of these two species in the future. [2]

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(Question 3 continued)

(c) *H. non-scripta* root cells have 16 chromosomes.

(i) State the number of chromosomes in *H. non-scripta* leaf cells. [1]

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(ii) *H. non-scripta* can hybridize with *H. hispanica*, and the F1 offspring are fertile. Predict, with a reason, the diploid chromosome number of the F1 hybrids. [1]

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(d) Bluebell leaves contain alkaloids and substances that are toxic to humans. Outline the benefit to plants of producing toxic substances. [1]

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4. Plants produce phytohormones to control growth, development and response to stimuli.

(a) State **one** example of a phytohormone produced by shoot tips and **one** example produced by root tips. [2]

Phytohormone produced by shoot tips: . . . . . .

Phytohormone produced by root tips: . . . . . .

(b) Outline how a shoot tip responds if the brightest light source is on one side of the shoot rather than above the shoot. [3]

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5. Primary production is the accumulation of biomass by autotrophs. Secondary production is the accumulation of biomass by heterotrophs.

(a) Distinguish between autotrophs and heterotrophs. [2]

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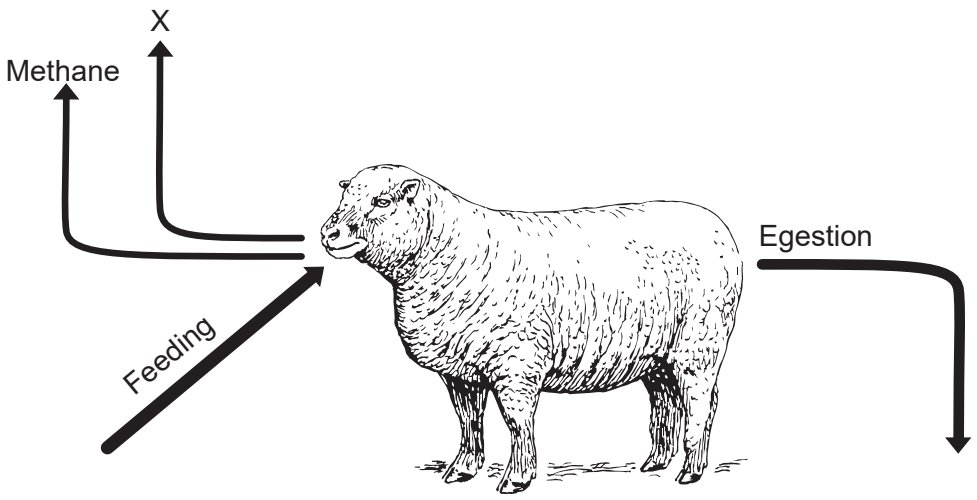
(Question 5 continued)

(b) The diagram shows processes that increase or decrease the biomass of a sheep.



(i) Identify the gas labelled X and the process that results in its production in sheep. [2]

Gas X: . . . . . .

Process: . . . . . .

(ii) Sheep feed on grass and seedlings of trees and shrubs. State the trophic level of humans if they feed on sheep. [1]

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(c) Outline how farming of sheep contributes to climate change. [2]

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(Question 5 continued)

(d) During ecological succession, there is a sequence of changes to the ecosystem. Explain how sheep can cause arrested succession, where one ecosystem persists instead of being replaced by a different ecosystem. [3]

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6. The base sequence of mRNA is translated into a polypeptide on a ribosome.

(a) To initiate translation, the small subunit of the ribosome binds to the mRNA molecule. Describe the next steps in initiation. [2]

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(b) To elongate a polypeptide, a repeated cycle of steps occurs involving the A, P and E binding sites. Outline the roles of the A and E sites. [2]

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(c) Explain the role of tRNA in translation. [2]

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(d) Amino acids from a damaged or unused polypeptide can be recycled in a cell. State which cell structure is used to break down these polypeptides. [1]

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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.

7. Many biological processes are specific in their directionality.

(a) Outline the structures that prevent backflow of blood in the human circulatory system. [3]

(b) Explain how signals are transmitted in one direction only across synapses. [7]

(c) Describe the implications of the directionality of DNA for its replication. [5]

8. Variation generated by sexual reproduction contributes to evolution.

(a) Draw a labelled diagram of an insect-pollinated flower to indicate the structures that produce gametes. [4]

(b) Explain how variation is generated by sexual reproduction. [7]

(c) Compare and contrast sympatric and allopatric speciation. [4]

9. Glucose has properties that allow it to play key roles in metabolism.

(a) Distinguish between the structure and function of alpha-glucose and beta-glucose. [4]

(b) Explain how blood glucose concentration is kept within limits in humans. [7]

(c) Outline how glucose is converted to pyruvate in glycolysis. [4]

References:

1.(a) Data from J. C. McElwain et al., Fossil Plants and Global Warming at the Triassic-Jurassic Boundary. *Science* 285,1386–1390(1999). DOI:10.1126/science.285.5432.1386.

1.(c) Used with permission of CSIRO Publishing, from Temperature influences stomatal density and maximum potential water loss through stomata of *Dodonaea viscosa* subsp. *angustissima* along a latitude gradient in southern Australia, CSIRO (Australia), Australian Academy of Science, Volume 62, Issue 8, 2015; permission conveyed through Copyright Clearance Center, Inc.

1.(e) Wall, S., Cockram, J., Vialet-Chabrand, S., Van Rie, J., Gallé, A. and Lawson, T., 2023. The impact of growth at elevated [CO_2] on stomatal anatomy and behavior differs between wheat species and cultivars. *Journal of Experimental Botany*, 74(9), pp. 2860–2874. [e-journal] https://doi.org/10.1093/jxb/erad011. Source adapted.

2. Professor Graham Beards. https://commons.wikimedia.org/wiki/File:Phage.jpg. Licensed under CC BY-SA 3.0 https://creativecommons.org/licenses/by-sa/3.0.

3. Floresphotographic, 2021. *Close-up a British native bluebell*. [online] Available at: https://www.gettyimages.co.uk/detail/photo/close-up-a-british-native-bluebell-royalty-free-image/1304550019 [Accessed 29 January 2025]. Source adapted.

5.(b) Pearson Scott Foresman. https://commons.wikimedia.org/wiki/File:PSFa_S-830003.png. Public domain.