Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 2

23 October 2024

Zone A morning | **Zone B** morning | **Zone C** 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]**.

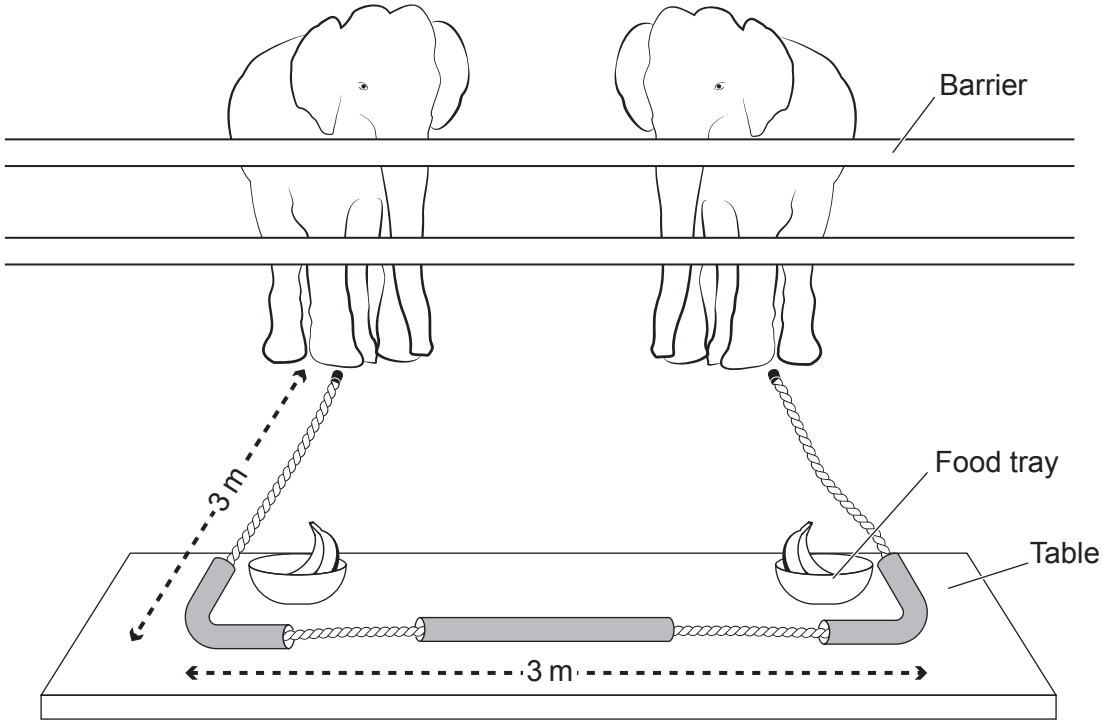
8824 – 6005

19 pages

Section A

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

1. A group of nine semi-wild Asian elephants (*Elephas maximus*) from an elephant camp in Myanmar were trained to pull two ends of a single rope to get access to food in food trays located on a table behind a barrier. When both elephants pulled the rope, the table moved towards them making the food trays accessible. The task required two elephants to work together in cooperation for mutual benefit to obtain food.



The graph shows the rate of cooperation between pairs of elephants in pulling the rope when there were two food trays, one at each end of the table (as shown in the diagram), or when there was one food tray placed in the centre of the table. The cooperation rate was the number of successful cooperative attempts divided by the number of all attempts in one session. The experiment was repeated for many sessions on successive days.

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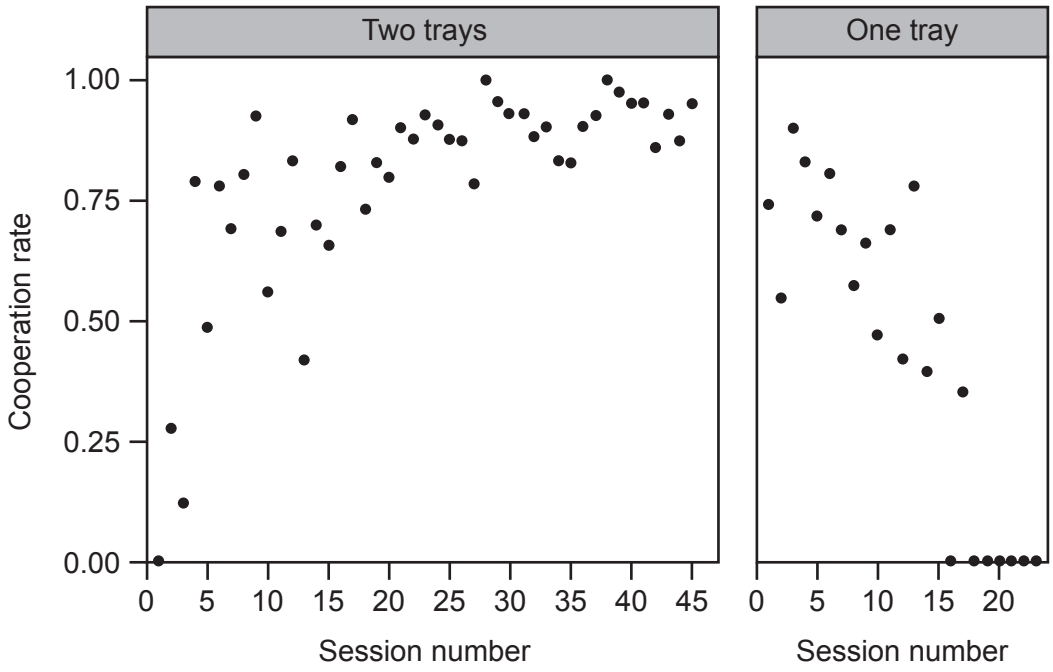
(Question 1 continued)



(a) Using the graph, describe how the elephants cooperated when two food trays were available. [2]

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(b) Outline the reason that the one-tray experiment was carried out for fewer sessions than the two-trays experiment. [1]

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(c) Suggest a reason for the difference in the response of the elephants between the two-tray and one-tray experiments. [1]

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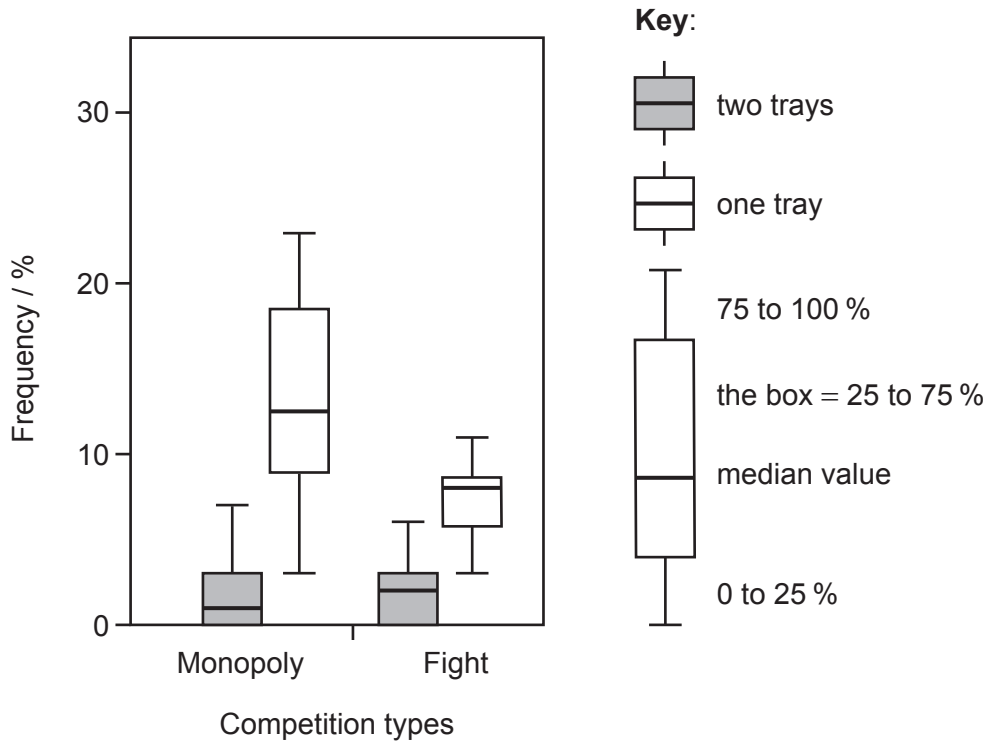
(Question 1 continued)

When not cooperating, the elephants show different types of competitive behaviour, such as monopoly or fighting.

Monopoly – One elephant takes all the food on the table.
Fight – An elephant uses its tusks, head or trunk to push another elephant away.

The box-and-whisker plots show the frequency of these types of competition for experiments with either one or two trays of food.



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(Question 1 continued)

(d) Deduce the reason that there are no values shown for 0 to 25 % monopoly with two trays of food. [1]

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(e) Compare and contrast the frequency of monopoly and fighting when there is a change from two trays to one tray of food. [2]

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(f) Suggest a reason for the observed changes in competition. [1]

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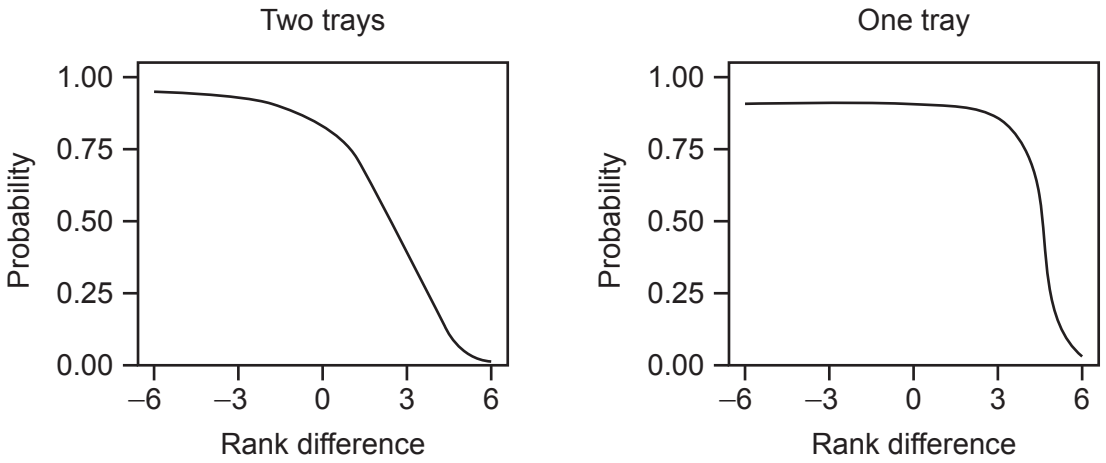
Answers written on this page
will not be marked.

(Question 1 continued)

The probability of a fight occurring between two elephants depends on differences in their dominance rank in the group. Rank difference was calculated using the rank of the elephant starting the fight minus the rank of the target elephant. The researchers modelled a graph of the probability of elephants fighting back when another elephant attempted to start a fight if presented with two trays or one tray of food.



(g) Estimate the probability of a fight occurring when an elephant of rank 5 initiates a fight with an elephant of rank 2 if they are presented with two trays of food. [1]

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(h) Compare and contrast the chances of a fight occurring with two trays and one tray of food. [2]

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(i) Evaluate the hypothesis the researchers put forward from their experiments that in some circumstances natural selection favours competitive behaviour. [2]

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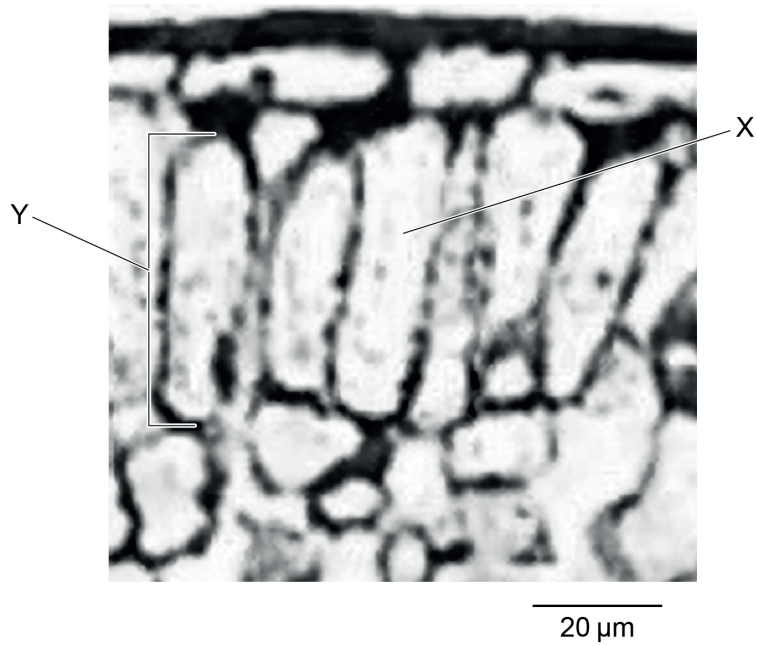
2. The micrograph shows cells from the leaf of a hellebore plant (*Helleborus sp*.), an angiospermophyte.



(a) (i) Identify the type of cell labelled X in the micrograph. [1]

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(ii) Calculate the length of cell Y between the marker lines. [1]

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(b) State **one** feature of a hellebore plant that would be absent in a bryophyte. [1]

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(Question 2 continued)

(c) Explain the endosymbiotic theory for the origin of eukaryotic cells. [3]

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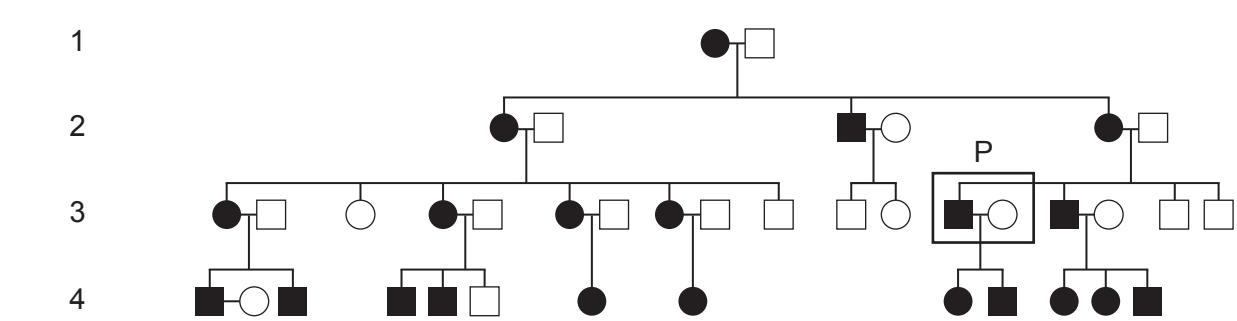
3. Huntington's disease is a dominant genetic disorder that causes the progressive breakdown of nerve cells in the brain. The pedigree chart shows the inheritance of the disease in a family over four generations.

Key:

□ unaffected male ■ affected male

○ unaffected female ● affected female



(a) State the possible genotypes of the female in generation 1, using the symbols H and h. [1]

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(b) Draw a Punnett grid to show all the possible genotypes of the children of couple P, using the symbols H and h. [2]

(c) Explain the use of restriction endonucleases during gene transfer. [2]

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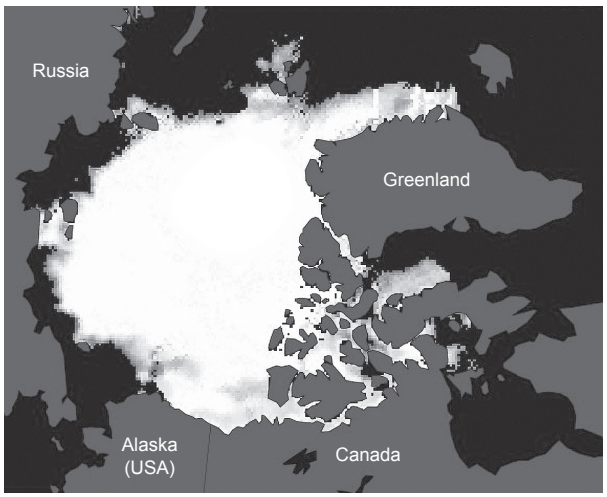
4. The two satellite images, compiled by NASA, show the amount of sea ice in the Arctic in 1984 and 2012. The white areas of the images represent ice.



September 1984

September 2012

Explain how combustion of fossil fuels may contribute to the change in the sea ice. [3]

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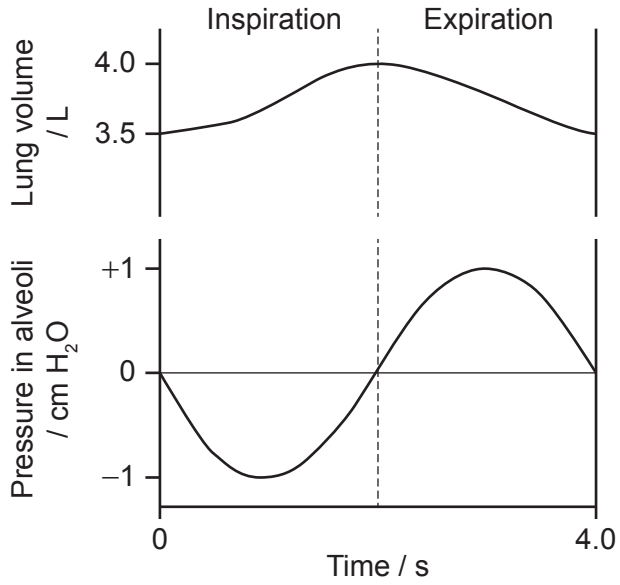
5. (a) The graph shows the changes that take place in the volume of the lungs and pressure in the alveoli during one breath at rest.



(i) State the tidal volume in litres. [1]

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(ii) Calculate the ventilation rate. [1]

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(iii) Explain how muscles in the thorax cause the pressure change in the alveoli in the first second. [3]

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(Question 5 continued)

(b) Describe the circulation of blood to the lungs. [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. Biological membranes separate the interior of a cell from the external environment and create a boundary between one part of the cell and another.

(a) Outline how the amphipathic properties of phospholipids help determine membrane structure. [4]

(b) Describe how substances cross the cell membrane by facilitated diffusion. [4]

(c) Explain how nerve impulses are transmitted along neurons. [7]

7. Nucleic acids store and transmit genetic information from one generation to the next and regulate the process of protein synthesis.

(a) Draw a labelled diagram to show the structure of a single nucleotide of RNA. [3]

(b) Explain the role of RNA in translation, resulting in the formation of polypeptide chains. [7]

(c) Outline how changes in the nucleic acids of bacteria can lead to antibiotic resistance. [5]

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References:

1. Diagram and graphs: Li, L.-L., Plotnik, J.M., Xia, S.-W., Meaux, E. and Quan, R.-C., 2021. Cooperating elephants mitigate competition until the stakes get too high. *PLOS Biology* [e-journal]. https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3001391#. Source adapted.

2. Balazs, V., et al, 2020. [Figure 2-i]. [image online] available at: https://www.researchgate.net/publication/338685542_Ethnobotanical_historical_and_histological_evaluation_of_Helleborus_L_genetic_resources_used_in_veterinary_and_human_ethnomedicine [Accessed 11 November 2024]. Source adapted.

4. NASA Earth Observatory image by Jesse Allen, using data from the Advanced Microwave Scanning Radiometer 2 AMSR-2 sensor on the Global Change Observation Mission 1st-Water (GCOM-W1) satellite. Available at: https://earthobservatory.nasa.gov/images/79256/visualizing-the-2012-sea-ice-minimum [Accessed 3 November 2024]. Public domain