Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 2

14 May 2024

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

Candidate session number

2 hours 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 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 **[72 marks]**.

23 pages

2224 – 6008

Section A

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

1. Albatrosses (belonging to the Family Diomedeidae) are large marine birds that can live for up to 50 years and feed at the highest trophic level. They have a very large wing span (up to 3 m) and can use winds to travel long distances over water while foraging for food at sea. However, their survival and reproduction are threatened by both climate change and accidental death. This may be caused by being caught in the lines or nets of commercial fishing vessels that are in their foraging areas.

A 31-year study analysed population data of three different species: the wandering albatross (*Diomedea exulans*), the grey-headed albatross (*Thalassarche chrysostoma*) and the black-browed albatross (*T. melanophris*). All three species breed in colonies on the same island in the Antarctic.

(a) Although they feed at the highest trophic level, their survival can be threatened by processes in the lowest levels of the food chain.

(i) Suggest a change that could occur in a food chain that would affect the survival of albatrosses. [1]

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(ii) Suggest how climate change could impact albatross survival. [1]

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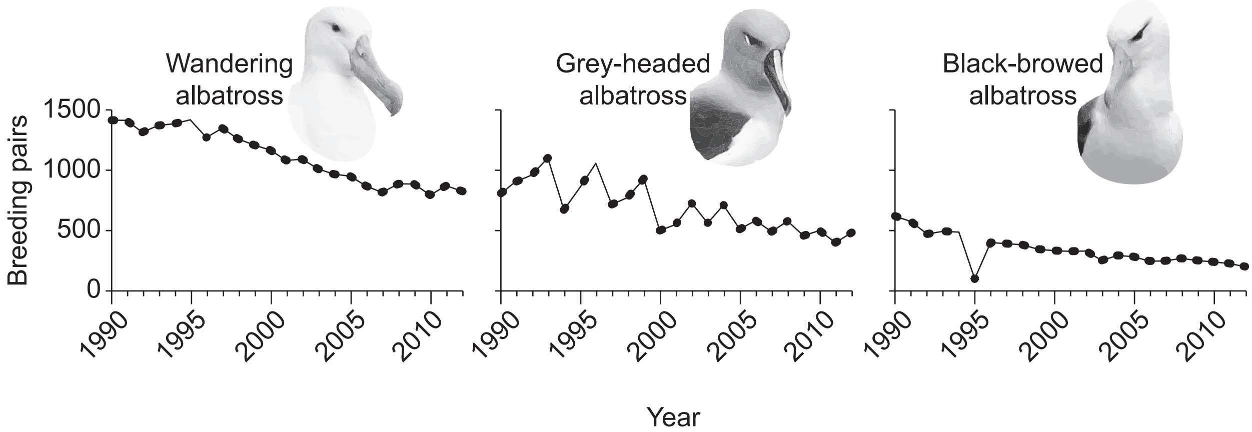
(Question 1 continued)

The graphs show the number of breeding pairs for each species over a 22-year period.



(b) Describe the trend in the number of breeding pairs in the three species over the 22-year period. [1]

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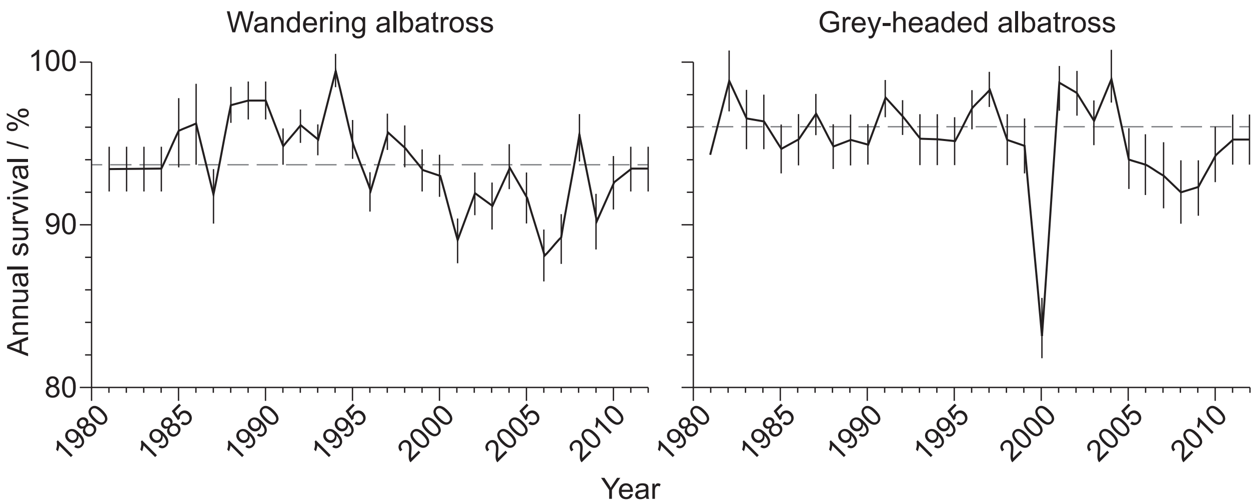
(Question 1 continued)

(c) The graphs show the percentage of albatrosses that survive to the end of each year with respect to the population at the start of the same year (annual survival). Data for two species of albatross was recorded over a 31-year period.



Key: – – Mean annual survival over 31 years

(i) Compare and contrast the data on the annual survival of the wandering and grey-headed albatrosses over the 31-year period. [3]

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(ii) Suggest a reason for the differences in survival between the two species. [1]

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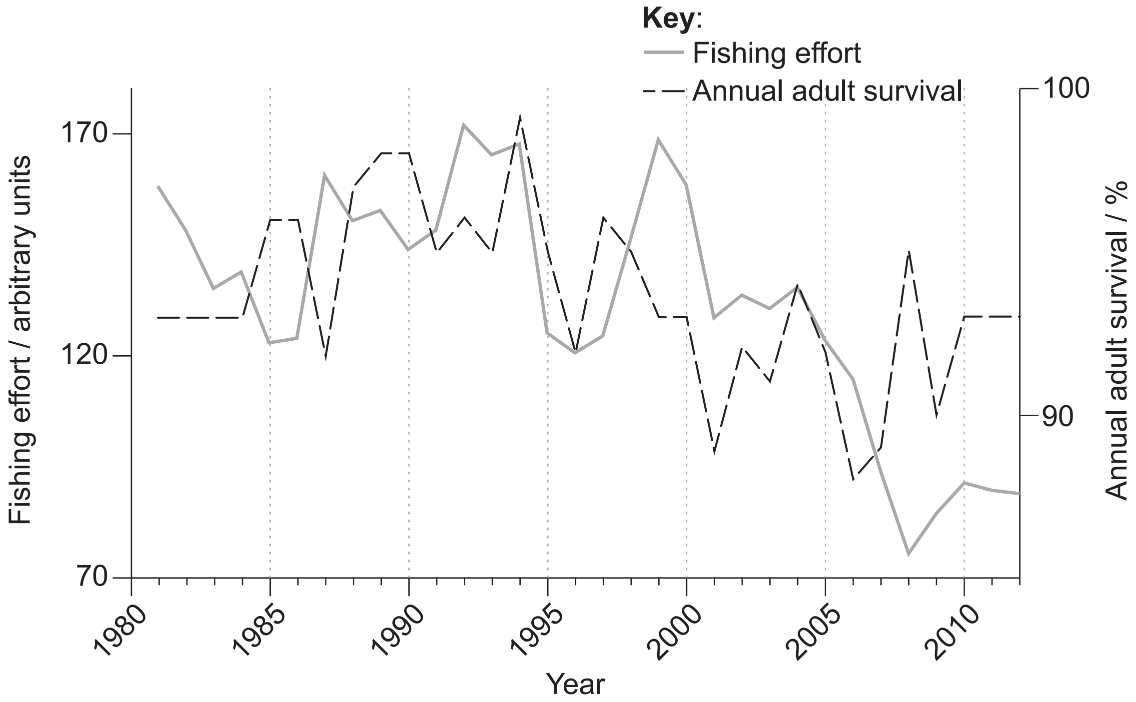
(Question 1 continued)

(d) The scientists looked for possible correlations between the percentage of adult wandering albatross that survived each year (annual survival) and human fishing efforts over the period shown in the graphs. A higher fishing effort refers to more fish caught.



(i) State the year with the highest fishing effort. [1]

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(ii) Using evidence from the graph, describe the relationship between fishing effort and adult survival over the years. [2]

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(Question 1 continued)

(e) Krill are tiny marine crustaceans that have a very important role in the Antarctic food chains. Krill are a major source of food for many marine species, including whales, seals, fish and albatrosses. The graph shows the survival of adult grey-headed albatross related to krill density between 1996 and 2011.

(i) Calculate the percentage increase in krill density from 1996 to 2002. [1]

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(ii) Evaluate the hypothesis that the annual adult survival of the grey-headed albatross is dependent on changes in krill density, making reference to changes over specific periods of time. [2]

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(Question 1 continued)

Different aspects of the life cycle of the black-browed albatross were studied in relation to two variables.

Variable	Aspect of the life cycle	
	Number of eggs laid	**Chick survival / %**
Change in optimum wind conditions	0	–
Increase in breeding pairs	+	0

Key: + positive effect, – negative effect, 0 no significant effect

(f) Using all the information presented, suggest **two** possible reasons for the effect of each variable on the two aspects of the life cycle shown in the table. [4]

Variable	**Possible reasons**
Change in optimum wind conditions	. . . .
Increase in breeding pairs	. . . .

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

Answers written on this page
will not be marked.

2. Scientists measure phloem transport rates in plants using aphid stylets.

(a) Outline how radioactive $^{14}CO_2$ and aphids are used to measure phloem transport rates. [2]

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(b) Explain how sugars are transported from sources to sinks in the phloem. [2]

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3. (a) State which type of organic compounds store the most energy per mass in the human body. [1]

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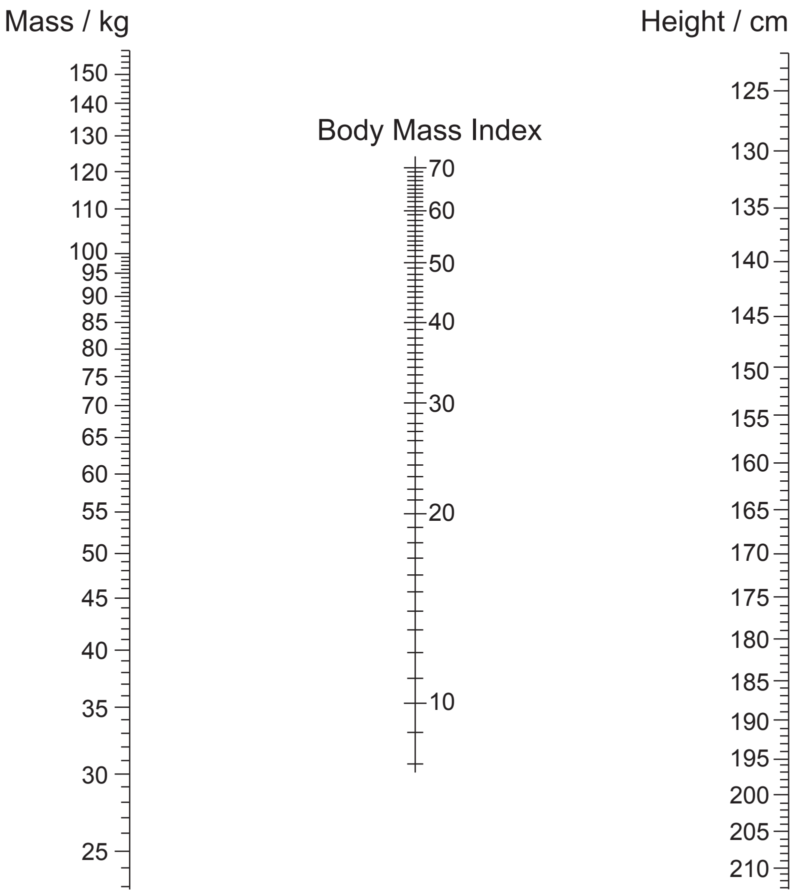
(b) Nomograms can be used to determine a person's body mass index (BMI).



(i) Using the nomogram, determine the body mass index of a person who is 165 cm tall and weighs 75 kg. [1]

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(ii) Explain **one** possible health recommendation for a person with this BMI. [1]

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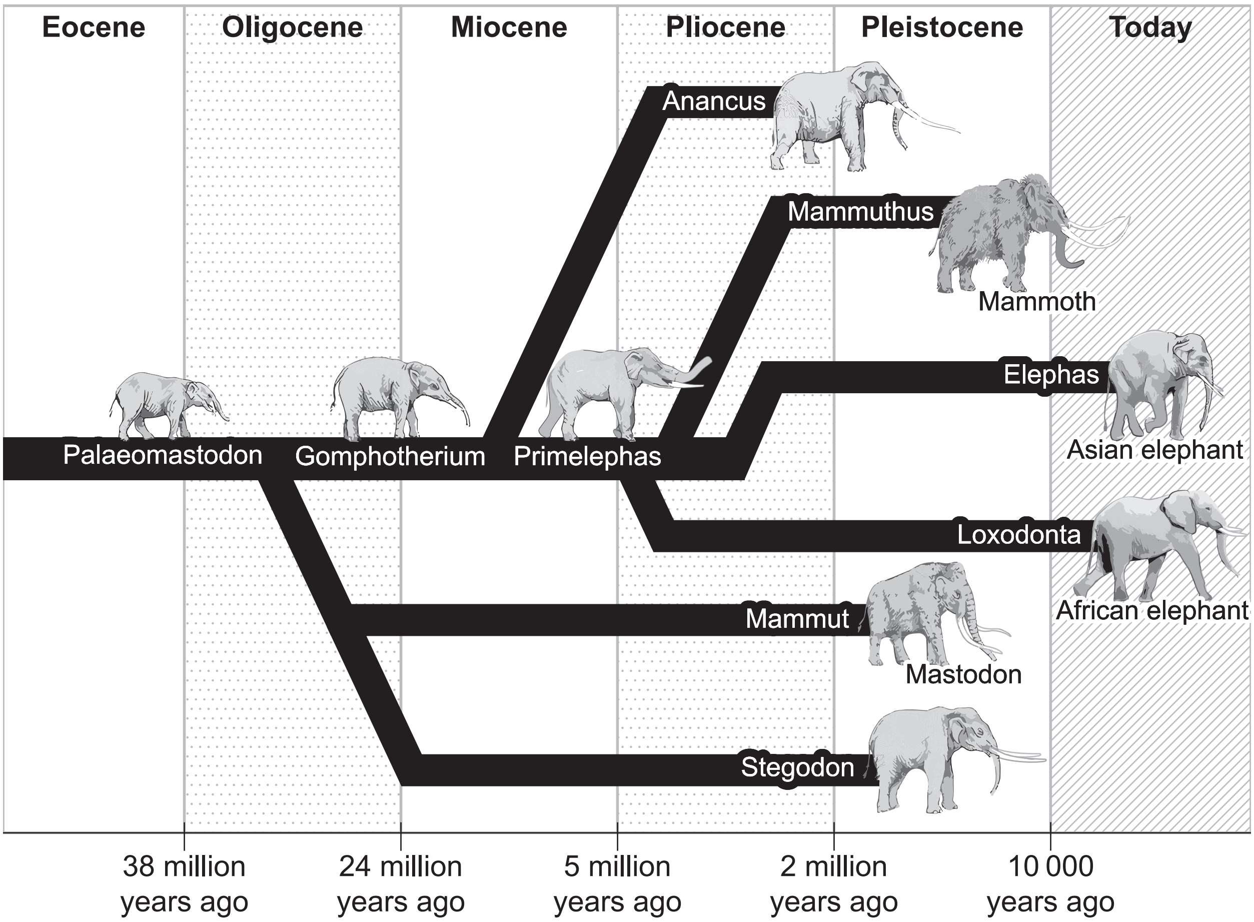
4. Evolution occurs when heritable characteristics of a species change. The diagram shows an evolutionary chart of elephants.



(a) (i) Identify which species is most closely related to the Asian elephant. [1]

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(ii) State the type of evolution that occurred with the elephants and their ancestors. [1]

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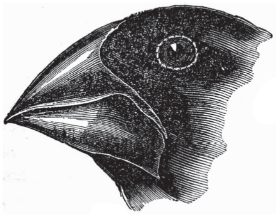
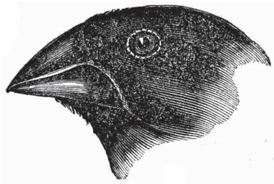
(Question 4 continued)

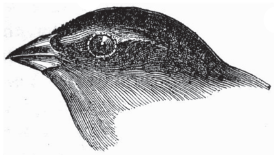
(b) Charles Darwin observed differences in the beaks of several finch species on the Galapagos Islands.



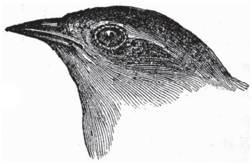
1. *G. magnirostris*



2. *G. fortis*



3. *G. parvula*



4. *C. olivacea*

(i) Outline the development of beak differences in these finches. [3]

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(Question 4 continued)

(ii) All organisms of the same species have the same number of chromosomes. Describe the processes that maintain a constant chromosome number in new body cells of a growing organism. [3]

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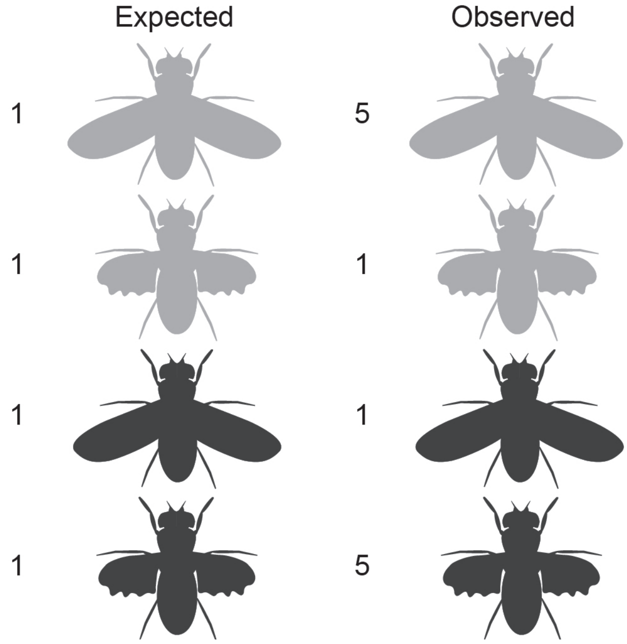
5. In fruit flies (*Drosophila melanogaster*), the allele for brown body (B) is dominant to black body (b) and the allele for long wings (L) is dominant to short wings (l). A dihybrid cross was made between a fruit fly heterozygous for both traits and a black, short-winged fruit fly, as shown in the image.

Brown body, long wings   Black body, short wings

The expected and observed ratios of offspring of the cross are given.



(a) Explain the differences between the expected and observed phenotypic ratios of the cross. [3]

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(Question 5 continued)

(b) Fruit flies are sometimes kept in enclosed glass mesocosms to study their population dynamics, genetics and interactions with the abiotic environment.

Explain the advantages of using mesocosms in these studies. [2]

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(c) Outline the experiment carried out by Hershey and Chase that provided evidence that DNA is the genetic material in organisms. [3]

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Section B

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

6. Carbon dioxide and oxygen are essential gases in many biological processes.

(a) Outline anaerobic cell respiration. [4]

(b) Describe conditions necessary in the lungs for efficient gas exchange in humans. [3]

(c) With reference to Calvin's experiment, explain the fixation of carbon dioxide in photosynthesis. [8]

7. Reproduction depends on numerous factors both genetic and hormonal.

(a) Outline the process of transcription. [4]

(b) Describe how non-disjunction can cause Down syndrome. [4]

(c) Explain the roles of **named** hormones in the development and function of the sexual reproductive systems in males and females. [7]

8. The human body has defence systems to prevent the entry of harmful bacteria and to destroy those that do enter.

(a) Draw a fully-labelled diagram of a bacterial cell. [4]

(b) Describe how disease-causing bacteria are prevented from entering the body. [3]

(c) Explain how the body develops immunity against pathogenic bacteria. [8]

References:

1. Pardo, D., Forcada, J., Wood, A.G. and Phillips, R.A., 2017. *PNAS* 114 (50) E10829–E10837 [e-journal]. https://doi.org/10.1073/pnas.1618819114. Source adapted.

3. (b) National Research Council, 1989. *Implications for Reducing Chronic Disease Risk*. Washington, DC: The National Academies Press, p. 564. https://doi.org/10.17226/1222. Source adapted.

4. (a) African elephant: michaklootwijk, n.d. *Female African elephant in golden light*. [image online] Available at: https://www.gettyimages.co.uk/detail/photo/female-african-elephant-in-golden-light-royalty-free-image/1034192370 [Accessed 18 May 2023]. Source adapted.

Asian elephant: Wayne Marinovich, n.d. *Asiatic Elephant walks through the long grass in Kaziranga National Park, India*. [image online] Available at: https://www.gettyimages.co.uk/detail/photo/asiatic-elephant-walks-through-the-long-grass-in-royalty-free-image/1322823772 [Accessed 18 May 2023]. Source adapted.

4. (b) Reproduced with permission from John van Wyhe ed. 2002. *The Complete Work of Charles Darwin Online*. [image online] Available at: http://darwin-online.org.uk/ [Accessed 5 April 2023]. Source adapted.