IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M04/412/H(2)

BIOLOGY
HIGHER LEVEL
PAPER 2

Candidate number

Tuesday 11 May 2004 (afternoon)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

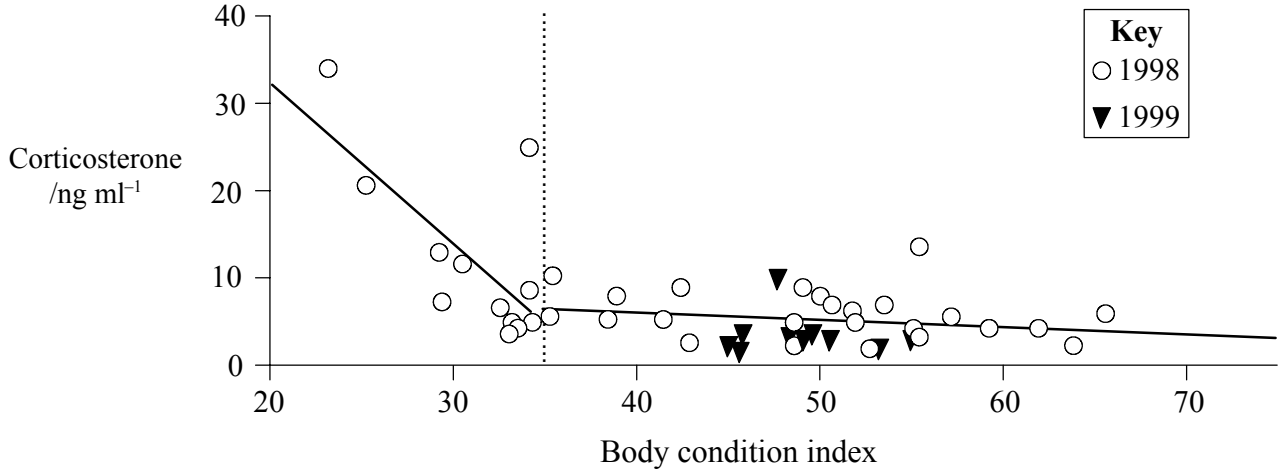
- Write your candidate number in the box above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer two questions from Section B. Write your answers on answer sheets. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

*Answer **all** the questions in the spaces provided.*

1. Marine iguanas *(Amblyrhynchus cristatus)* are herbivorous lizards that are endemic to the Galapagos islands in the Pacific Ocean. They warm their bodies by basking on rocks next to the sea and then dive into the water to feed on algae. Microorganisms in their guts help to digest the algae. In 1998, the algae disappeared from most areas as a result of El Niño, an occasional disturbance to conditions in the ocean around the Galapagos islands.

When marine iguanas are subjected to stress, levels of the hormone corticosterone rise in their blood. Biologists measured blood corticosterone levels in randomly selected individuals on six of the Galapagos islands, in May 1998 and again in May 1999. The marine iguanas' mass and body length were measured at the same time. A body condition index was calculated from the mass and body length. Individuals with an index of 30 or less are extremely thin. The fattest individuals have an index of 60–70. The scattergraph below shows the body condition index and blood corticosterone levels of individuals on Santa Fe, one of the six islands sampled. Two regression lines are shown, for body condition indices above and below 35.



[Source: Romero and Wikelski, *Proceedings of the National Academy of Sciences* (2001), **98**, pages 7366-7370]

(a) (i) Compare the body condition indices of marine iguanas in 1998 with the indices in 1999. *[2]*

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(ii) State a reason for an increase in body condition index between 1998 and 1999. *[1]*

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(Question 1 continued)

(b) No individuals were found with a body condition index of less than 20 in either year on any of the islands. Suggest a reason for this. *[1]*

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(c) (i) Describe the relationship between body condition index and blood corticosterone level **in 1998**. *[2]*

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(ii) Suggest a reason for the relationship. *[1]*

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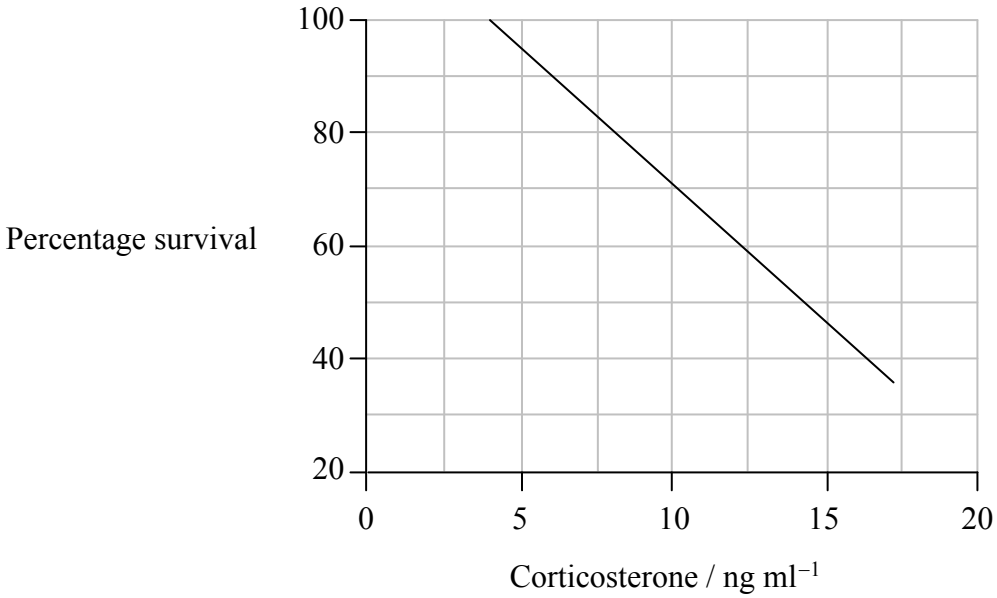
(Question 1 continued)

The biologists found that by measuring the mean blood corticosterone level of a population of marine iguanas, they could predict the percentage survival of the population over the following year. The graph below shows the relationship between blood corticosterone level and percentage survival.



[Source: Romero and Wikelski, *Proceedings of the National Academy of Sciences* (2001), **98**, pages 7366-7370]

On 17 January 2001, an oil tanker ran aground on San Cristobal, one of the Galapagos islands. Three million litres of oil were spilt. Corticosterone levels were measured immediately before and after the oil spill in the blood of marine iguanas on Santa Fe. The level before the oil spill was 4 ng ml^{-1}. Afterwards it was 11.5 ng ml^{-1}.

(d) Using the data in the graph, predict the change in percentage survival caused by the oil spill. *[2]*

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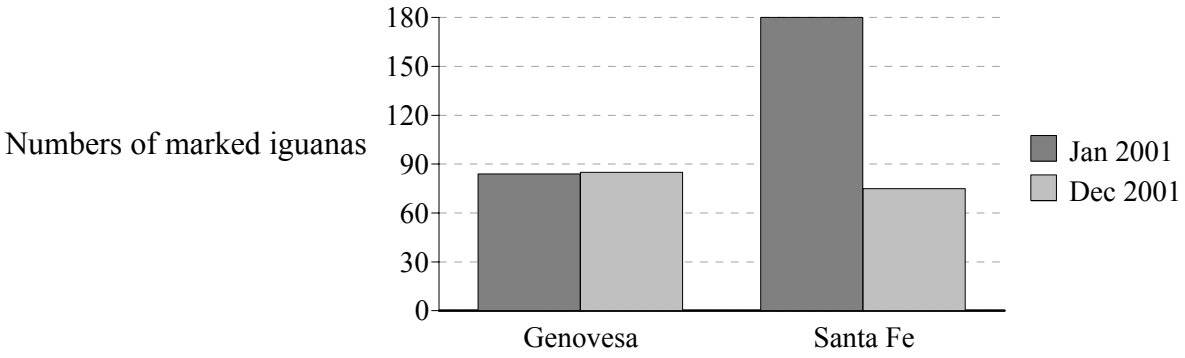
(Question 1 continued)

The populations of marine iguanas were being monitored on Santa Fe and on Genovesa, another Galapagos island that was unaffected by the oil spill. Some of the marine iguanas had been permanently marked on each island. The bar chart below shows the numbers of marked individuals recaptured before the oil spill in January 2001 and eleven months afterwards in December 2001.



[Source: Wikelski, *et al*., *Nature* (2002), 417, pages 607-608]

(e) The percentage change in the population on Genovesa between January and December 2001 was +4 %. Use the data in the bar chart to calculate the percentage change over the same period on Santa Fe. Show your working. *[2]*

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The level of oil contamination on Santa Fe was low and it is unlikely that it was directly toxic to the marine iguanas.

(f) Suggest **two** reasons for an oil spill affecting the chances of survival of marine iguanas other than by poisoning them. *[2]*

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(g) Evaluate the use of blood corticosterone level to predict survival rates of marine iguanas. *[2]*

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2. In *Zea mays*, the allele for coloured seed (C) is dominant over the allele for colourless seed (c). The allele for starchy endosperm (W) is dominant over the allele for waxy endosperm (w). Pure breeding plants with coloured seeds and starchy endosperm were crossed with pure breeding plants with colourless seeds and waxy endosperm.

(a) State the genotype and the phenotype of the F_1 individuals produced as a result of this cross. *[2]*

genotype . . . . . .

phenotype . . . . . .

(b) The F_1 plants were crossed with plants that had the genotype c c w w. Calculate the expected ratio of phenotypes in the F_2 generation, assuming that there is independent assortment. Use the space below to show your working. *[3]*

Expected ratio . . . . . .

The observed percentages of phenotypes in the F_2 generation are shown below.

coloured starchy	37 %	colourless starchy	14 %
coloured waxy	16 %	colourless waxy	33 %

The observed results differ significantly from the results expected on the basis of independent assortment.

(c) State the name of a statistical test that could be used to show that the observed and the expected results are significantly different. *[1]*

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(Question 2 continued)

(d) Explain the reasons for the observed results of the cross differing significantly from the expected results. *[2]*

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3. The proximal convoluted tubule is a part of the nephron (kidney tubule). Its function is selective reabsorption of substances useful to the body.

(a) Outline how the liquid that flows through the proximal convoluted tubule is produced. *[2]*

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(b) (i) Water and salts are selectively reabsorbed by the proximal convoluted tubule. State the name of **one** other substance that is selectively reabsorbed. *[1]*

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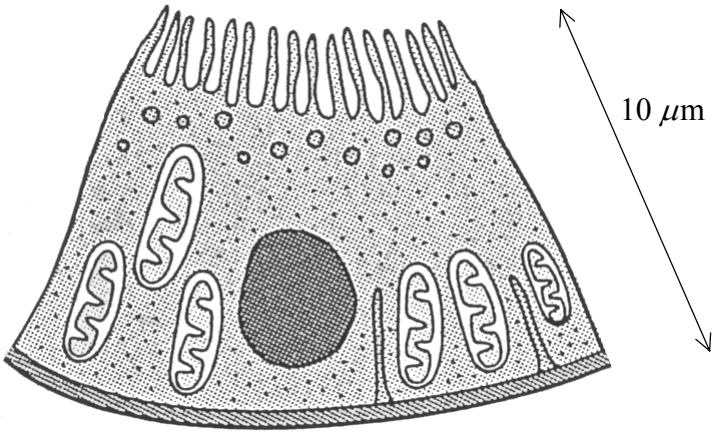
(ii) State the names of the processes used to reabsorb water and salts. *[2]*

water . . . . . salts . . . . . .

The drawing below shows the structure of a cell from the wall of the proximal convoluted tubule.



(c) The actual size of the cell is shown on the diagram. Calculate the linear magnification of the drawing. Show your working. *[2]*

Answer . . . . . .

(This question continues on the following page)

(Question 3 continued)

(d) Explain how the structure of the proximal convoluted tubule cell, as shown in the diagram, is adapted to carry out selective re-absorption. *[2]*

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SECTION B

*Answer **two** questions. Up to two additional marks are available for the construction of your answers. Write your answers on the answer sheets provided. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

4. (a) Production of semen involves a series of processes, which in total take many weeks to carry out. Outline the processes involved in semen production from the start of sperm formation (spermatogenesis) to ejaculation. *[8]*

(b) Explain the roles of LH and FSH in the menstrual cycle, including the timing of their secretion during the cycle. *[6]*

(c) Discuss the ethical arguments for and against the cloning of humans. *[4]*

5. (a) The structure of the DNA double helix was described by Watson and Crick in 1953. Explain the structure of the DNA double helix, including its subunits and the way in which they are bonded together. *[8]*

(b) Compare DNA transcription with translation. *[4]*

(c) Outline the process of DNA profiling (genetic fingerprinting), including ways in which it can be used. *[6]*

6. (a) Discuss possible exceptions to the cell theory. *[4]*

(b) Explain how a muscle fibre contracts, following depolarization of its plasma membrane. *[6]*

(c) Describe the roles of structures at the elbow joint, including nerves, muscles and bones, in movements of the human forearm. *[8]*

7. (a) The leaves of plants are adapted to absorb light and use it in photosynthesis. Draw a labelled diagram to show the arrangement of tissues in a leaf. *[6]*

(b) Explain the reactions involving the use of light energy that occur in the thylakoids of the chloroplast. *[8]*

(c) Outline ways in which leaves take part in the carbon cycle in ecosystems, apart from photosynthesis. *[4]*