IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
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M07/4/BIOLO/HP2/ENG/TZ1/XX+

22076008

BIOLOGY
HIGHER LEVEL
PAPER 2

Monday 14 May 2007 (afternoon)

2 hours 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

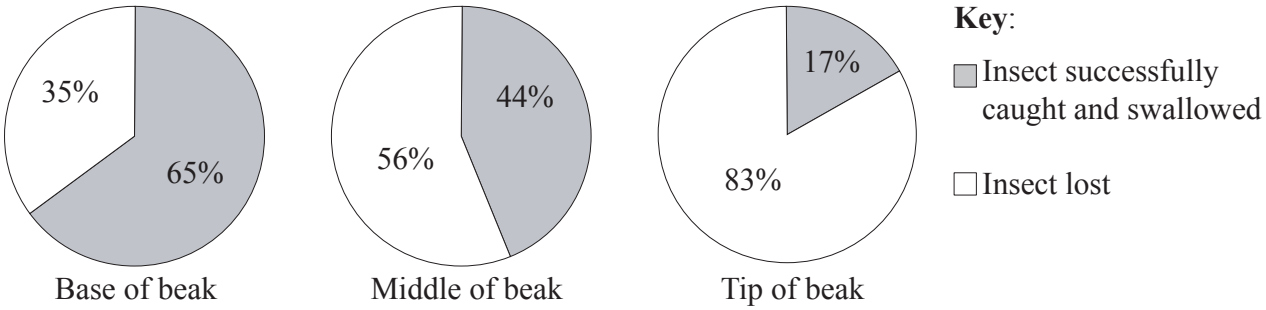
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer two questions from Section B. Write your answers on answer sheets. Write your session number on each answer 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.

0110

SECTION A

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

1. Hummingbirds have long narrow beaks that adapt them to collecting nectar from flowers. Nectar provides energy in the form of sugar, but has very low concentrations of amino acids and protein. Therefore, hummingbirds have to supplement their diet by catching flying insects. They do this by flying with their beaks wide open towards insects. Scientists have used high-speed video to study the success rate for catching insects. The pie charts below show the results, according to which part of the beak the insect touches first.



[Source: Yanega, 2004, *Nature,* **428**, page 615. Reprinted with the permission of the Company of Biologists.]

(a) (i) State the relationship between the part of the beak that insects first touch and the success rate. *[1]*

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

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Birds that feed only on flying insects have a different shape of beak from hummingbirds.

(b) Predict, with a reason, the shape of beak in a species of bird that feeds only on flying insects. *[2]*

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(This question continues on the following page)

(Question 1 continued)

Very rapid wing beats keep a hummingbird's body steady near a flower while it collects nectar. This unusual type of flight behaviour is called hovering. Measurements were taken to investigate hovering in four hummingbird species. The body mass and maximum frequency of wing beats were measured. The velocity of the wing tips was measured when the wings were beating at their maximum frequency. The mean results are shown in the table below.

	Hummingbird species			
Variable	Blue-throated (*Lampornis clemenciae*)	Magnificent (*Eugenes fulgens*)	Black-chinned (*Archilochus alexandri*)	Rufous (*Selasphorus rufus*)
Body mass / g	8.40	7.40	3.00	3.30
Maximum frequency of wing beats per second	30.70	31.90	59.70	62.20
Velocity of wing tips / m s^{-1}	16.80	16.50	15.80	16.90

[Source: Chai, 1997, *Journal of Experimental Biology*, **200**, page 2757–2763]

(c) State the relationship between body mass and maximum frequency of wing beats. *[1]*

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The data in the table indicates that there is a similar maximum velocity for wing tip movement whatever the overall size of the bird.

(d) Suggest **one** problem that would be caused by a velocity of wing tip movement greater than this. *[1]*

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Hummingbirds are the smallest birds in the world, with adult masses ranging from approximately 2 g to 20 g.

(e) Using the data in the table, suggest a reason why hummingbirds with a mass larger than 20 g have not evolved. *[1]*

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(This question continues on the following page)

(Question 1 continued)

Hummingbirds maintain constant internal body temperature despite variation in external temperature. The effect of external temperature on Anna's hummingbird (*Calypte anna*) was studied in a series of experiments. At 40 °C the hummingbirds were observed to rest after short flights and ventilate their lungs rapidly to cool their bodies by evaporation of water (panting).

The hummingbirds were placed in different external temperatures and a dilute solution of sucrose was given to them. Between 20 °C and 40 °C the volume of sucrose solution taken in per hour did not vary significantly and was 0.7–0.8 cm^3. At 10 °C the volume was significantly higher at 1.2 cm^3 per hour.

(f) Explain why the volume taken in per hour was higher at 10 °C than at the higher temperatures. *[2]*

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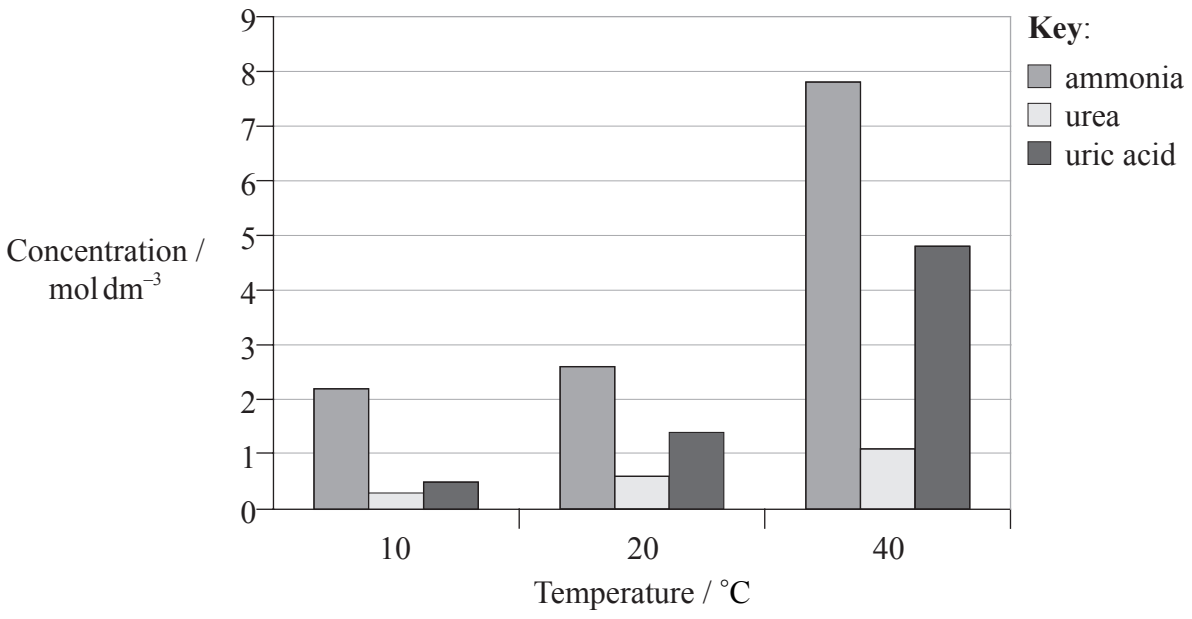
Urine was collected from the hummingbirds at the three different external temperatures and was analysed to find the concentrations of nitrogenous waste products. The results are shown in the bar chart below.



(g) Suggest **one** reason for the higher overall concentration of nitrogenous waste products in urine at 40 °C. *[1]*

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(This question continues on the following page)

(Question 1 continued)

The ratio between the concentration of ammonia and the concentration of uric acid in the urine of hummingbirds changes as the temperature rises. The ratio at 10 °C is 4.4:1.

(h) (i) Calculate the ratio between the concentration of ammonia and the concentration of uric acid at 40 °C. *[1]*

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(ii) Explain the difference in the relative amounts of ammonia and uric acid at 10 °C and at 40 °C. *[2]*

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Hummingbirds use energy at a faster rate than any other bird or mammal.

(i) Explain **two** reasons for the high rate of energy use in hummingbirds. *[2]*

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2. . . . . .

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2. (a) State **two** differences between the structure of DNA and RNA. *[2]*

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2. . . . . .

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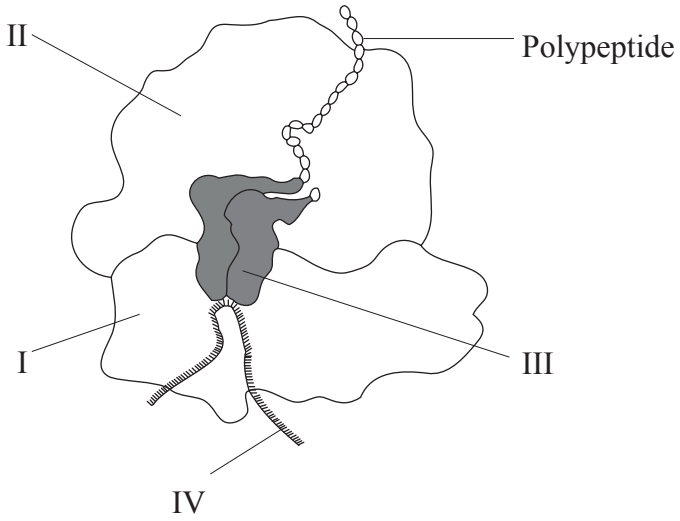
The diagram below shows the structure of a ribosome during protein synthesis.



(b) State the names of the structures labelled above. *[2]*

I. . . . . .

II. . . . . .

III. . . . . .

IV. . . . . .

(c) State the name of a structure shown on the diagram that has an anticodon. *[1]*

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(d) Explain why the process used during protein synthesis in cells is called *translation*. *[2]*

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(This question continues on the following page)

(Question 2 continued)

(e) Explain briefly how termination of *translation* occurs. *[2]*

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3. A gene in humans called APC is located on chromosome 5. This gene controls cell division and is known as a tumour suppressor gene. Mutations of APC cause a genetic disease called FAP (Familial Adenomatous Polyposis).

(a) State, with a reason, whether FAP is a sex-linked genetic disease or not. *[1]*

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50 % of the gametes produced by a person with FAP have an APC gene with the mutation.

(b) Identify, with a reason, whether FAP follows a dominant or recessive pattern of inheritance. *[2]*

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In a person with FAP, each cell contains a copy of the APC gene with the mutation. If a mutation occurs on the cell's other copy of the APC gene, the cell becomes a tumour cell. Almost everyone with FAP develops cancer before the age of 50.

(c) Explain why almost everyone with FAP eventually develops cancer. *[2]*

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(This question continues on the following page)

(Question 3 continued)

In 2004, doctors in Britain were given permission to test embryos to see whether an APC gene with the mutation is present. This test can be used where one of the parents is known to have FAP. The procedure involves the parents using in-vitro fertilisation (IVF) to produce embryos, testing the embryos for the gene and implanting only embryos that do not have the mutation.

(d) (i) State the name of this type of test. *[1]*

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(ii) State **one** advantage and **one** disadvantage of testing embryos in this way. *[2]*

Advantage: . . . . . .

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Disadvantage: . . . . . .

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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 session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

4. (a) The plasma membrane controls the movement of substances into and out of cells. Draw a labelled diagram to show the structure of a biological membrane such as the plasma membrane. *[5]*

(b) Explain how ion movements cause a nerve impulse to pass along a neurone. *[8]*

(c) Outline the process of water uptake by root epidermis cells. *[5]*

5. (a) The activity of enzymes determines the rate at which chemical reactions occur in living organisms. Outline the effects of **two** factors that can both increase and decrease enzyme activity. *[6]*

(b) Explain how end product inhibition is used to control the rate of chemical reactions in cells. Include an example in your answer with the names of both the enzyme and the inhibitor. *[8]*

(c) Outline the process of blood clotting. *[4]*

6. (a) The carbon cycle involves both the production and the fixation of carbon dioxide. Draw a labelled diagram to show the processes involved in the carbon cycle. *[5]*

(b) Explain the **light-independent** reactions of photosynthesis. *[8]*

(c) Outline the consequences of rising carbon dioxide concentrations in the Earth's atmosphere. *[5]*

7. (a) The male reproductive system produces huge numbers of sperm, each of which is genetically different. Draw a labelled diagram of the male reproductive system. *[5]*

(b) Explain the events in meiosis that lead to the genetic diversity of sperm. *[8]*

(c) Outline the events after meiosis in the male reproductive system that result in the production of semen. *[5]*