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

M05/4/BIOLO/HP3/ENG/TZ2/XX+

22056015

BIOLOGY
HIGHER LEVEL
PAPER 3

Thursday 12 May 2005 (morning)

1 hour 15 minutes

Candidate session number

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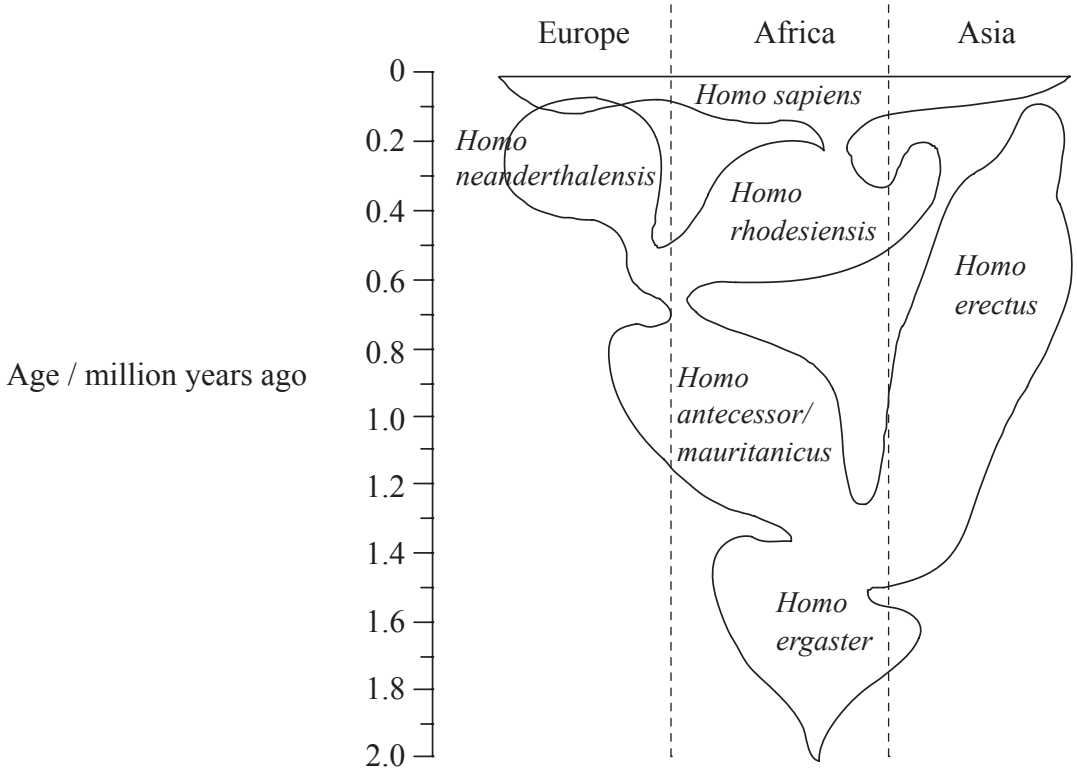
INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue 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 letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

0120

Option D — Evolution

D1. Recently discovered fossilized partial skulls from Ethiopia have raised new questions about early human evolution. This has led to different theories about the origins of *H. sapiens*. One of these theories is illustrated by the following map.



[Source: Stringer, *Nature*, (2003), **423**, pages 692–695]

(a) Identify the species that shows the greatest geographic distribution. *[1]*

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(b) Using the data, outline the view that human evolution originated in Africa. *[2]*

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(This question continues on the following page)

(Question D1 continued)

(c) Using the data, analyse the relationship between *H. neanderthalensis* and *H. sapiens*. *[2]*

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(d) Evaluate whether *H. antecessor/mauritanicus* or *H. erectus* would likely provide the most fossil evidence. *[2]*

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D2. (a) State an example of a radioisotope used in dating rocks and an example used in dating fossils. *[1]*

Rocks: . . . . . .

Fossils: . . . . . .

(b) Define the term *half-life.* *[1]*

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(c) State **two** ways in which past living organisms have been preserved. *[1]*

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D3. (a) Discuss how the origin of life on Earth may have depended on RNA. *[6]*

(b) Describe the importance of changes in allele frequency for the evolution of one species into another. *[4]*

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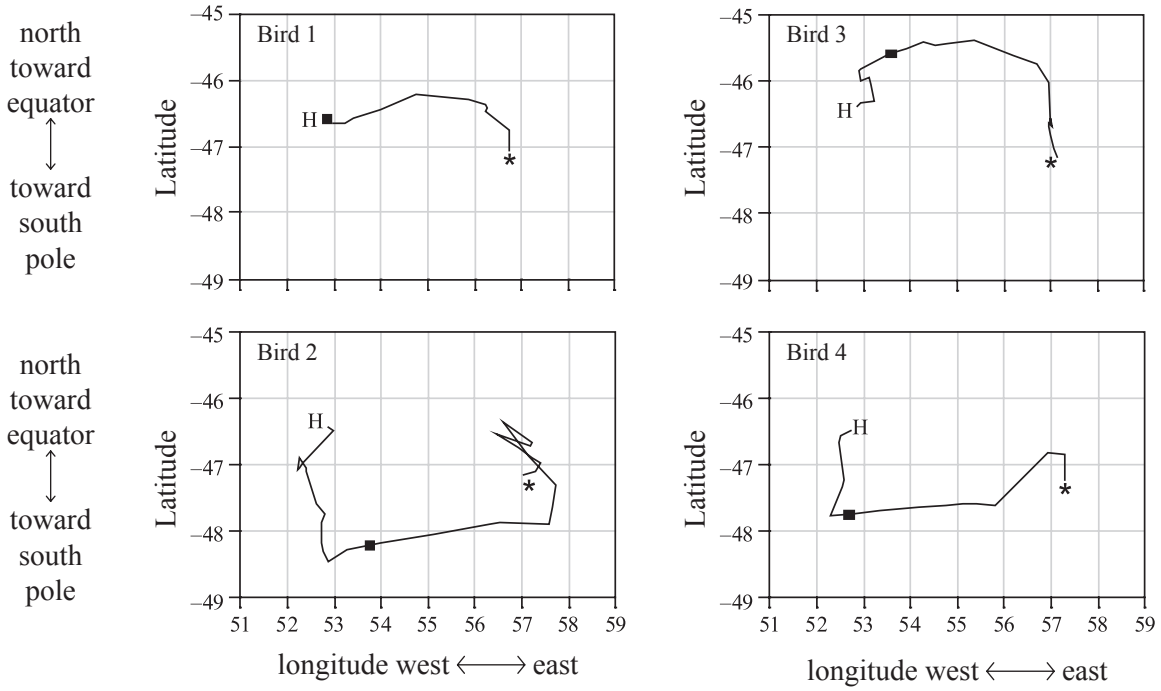
Option E — Neurobiology and Behaviour

E1. During the nesting period, white-chinned petrels (*Procellaria aequinoctialis*) make journeys to gather food. They travel several thousand kilometres across open ocean from their isolated breeding island in the southern Indian Ocean. Four birds were tested to determine if they rely on geomagnetic information to find their way home. The birds were released at night above the sea, 300-360 km from home, during cloudy conditions. They were enclosed during the journey from their nesting area to the release site so that they could not gain information about the route. Also, a mobile magnet was attached to their heads which prevented them from using the geomagnetic field at the release site and during their flight home. The birds were equipped with satellite transmitters to record their journeys. This data is shown in the diagrams below.



Key: * = release site
H = breeding site (46.4°S, 51.9°E)
■ = location of birds 15–16 h after release
100 km

[Source: Jouventin *et al.*, *Animal Behaviour*, (2003), **65**, pages 729–734]

(a) Identify the direction in which the birds travelled during the early stage of their flight home. *[1]*

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(This question continues on the following page)

(Question E1 continued)

(b) Deduce, giving a reason, which bird flew home most directly. *[2]*

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(c) (i) Calculate the approximate flying speed of bird 4. *[1]*

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(ii) Compare the relative flying speeds of birds 1 and 2. *[1]*

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(d) Suggest how the birds navigate before they can see their island home. *[1]*

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E2. (a) (i) State the role of sensory receptors. *[1]*

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(ii) List **two** types of sensory receptors. *[1]*

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(b) State the role of the autonomic nervous system. *[1]*

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(c) Distinguish between the terms *taxis* and *kinesis*. *[1]*

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E3. (a) Outline the value of quantitative data in studies of behaviour. *[4]*

(b) Explain, using examples, how inhibitory psychoactive drugs affect brain physiology. *[6]*

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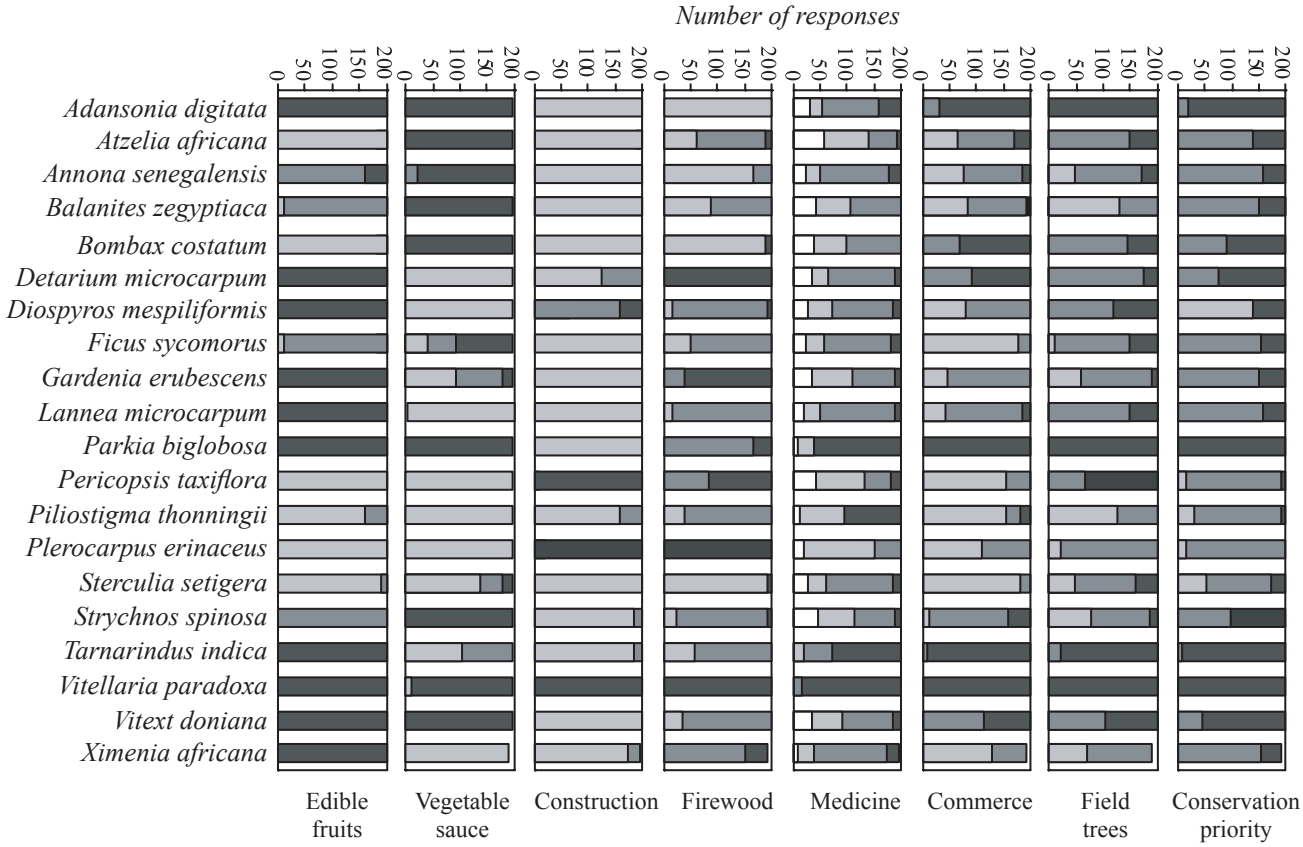
Option F — Applied Plant and Animal Science

F1. Use and conservation preferences for savanna trees were investigated in a West African country. Residents from different villages evaluated the importance of 20 woody species for eight different uses: edible fruits, vegetable sauce, construction, firewood, medicine, commerce, field trees and conservation. The following data is based on answers from 200 residents.



[Source: Kristensen and Lykke, *Economic Botany*, (2003), **57**, pages 203–217]

(a) Identify the most important tree species to the villagers. *[1]*

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(b) State the category of use for which villagers have most difficulty in finding useful species. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(c) Compare the usefulness of species in providing edible fruit with their usefulness for vegetable sauce. *[2]*

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(d) Determine the percentage of species that are valued **entirely** as "very important" in at least three categories. *[1]*

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(e) Suggest a property of the wood from *P. erinaceus* that makes it one of the preferred species for use in building houses. *[1]*

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F2. (a) State **two** adaptations of insect-pollinated flowers. *[2]*

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(b) Define the term *net assimilation rate*. *[1]*

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(c) Predict what will happen to the flowering process of a short day plant if the minimal dark period is interrupted by brief exposure to light. *[1]*

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F3. (a) Outline the use of transgenic techniques in agriculture, using **one** named animal example. *[3]*

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(b) Discuss the practice of intense monoculture in present-day agriculture. *[7]*

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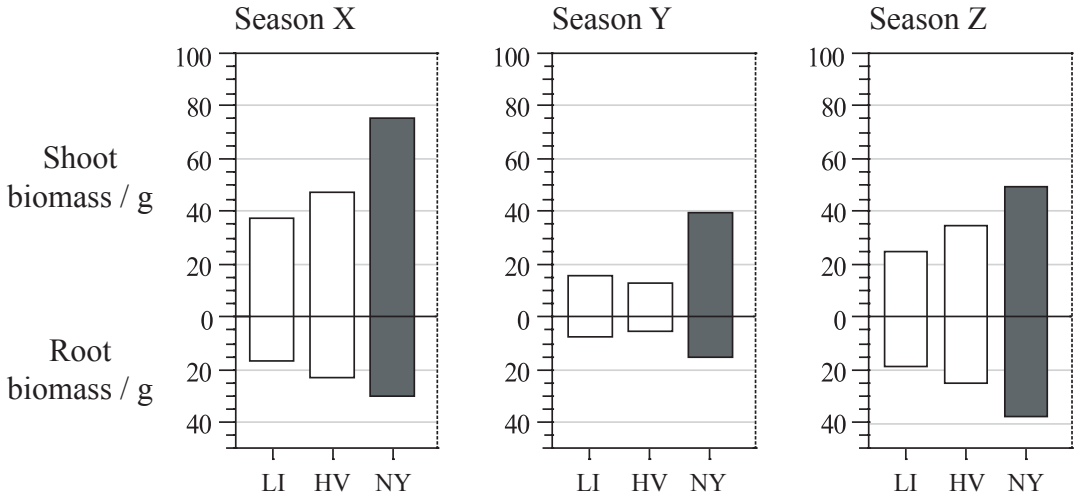
Option G — Ecology and Conservation

G1. A study was conducted to investigate the growth factors affecting plants in urban areas compared to rural areas. Fast-growing clones of Eastern cottonwood trees (*Populus deltoids*) were grown in both urban and rural sites. The results of three successive growing seasons (X, Y, and Z) are shown below.



Key: LI and HV are rural sites and NY is an urban site

[Source: Gregg *et al*., *Nature* (2003), **424**, pages 183–187]

(a) Identify the site which most favours the growth of cottonwood trees. *[1]*

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(b) Calculate the ratio of shoot biomass to root biomass in site LI during season X. *[1]*

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(c) Analyse the data for growth patterns over the three years of the study. *[3]*

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(Question G1 continued)

A further study showed that differences in light, temperature, water, CO_2 concentration, and the soil could not account for the differences in growth of the cottonwoods in the urban and rural areas.

(d) Suggest a reason which could account for the growth differences. *[1]*

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G2. (a) (i) State **one** factor that contributed to the recent extinction of a named animal species. *[1]*

Name of species: . . . . . .

Factor: . . . . . .

(ii) List **two** *ex situ* conservation measures. *[1]*

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(b) List **two** abiotic conditions that favour nitrification. *[1]*

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(c) State a fuel that can be made from biomass. *[1]*

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G3. (a) Outline the biological consequences of acid rain. *[4]*

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(b) Explain how an organism's abiotic environment can be affected by ecological succession. *[6]*

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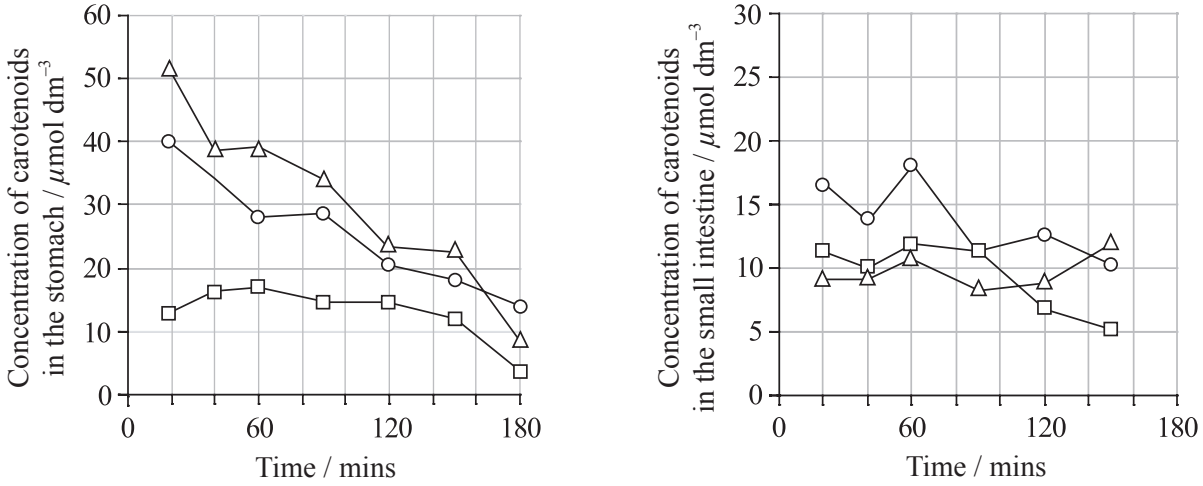
Option H — Further Human Physiology

H1. Carotenoids are plant pigments which occur in different forms, such as lutein (from spinach), *β*-carotene (from carrots), and lycopene (from tomatoes). Researchers investigated the processing of carotenoids from vegetables in the stomach and small intestine. Healthy men were fed three test meals differing only in the vegetable added. The carotenoid content of each test meal was the same. Although the meals were basically liquid, the spinach meal had been made from chopped spinach leaves. The meals were ingested in random order with three-week intervals between them. Prior to the first meal, tubes leading directly into the stomach and small intestine were fitted to each man. Samples of stomach and small intestine contents were collected from these tubes at regular intervals after each meal. Data from this study is shown below.



Key: □ = lutein (spinach meal) ○ = *β*-carotene (carrot meal) △ = lycopene (tomato meal)

[Source: Tyssandier *et al*., *American Journal of Physiology*, **284**, (2003), pages 913–922]

(a) (i) Calculate the rate of decrease of lycopene concentration in the period 60 minutes to 120 minutes after ingestion in the stomach. *[1]*

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(ii) Predict how many minutes from ingestion it will take lycopene to completely leave the stomach. *[1]*

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(This question continues on the following page)

(Question H1 continued)

(b) Describe the changes in stomach content of lutein, β-carotene and lycopene during the 180 minutes following ingestion. *[2]*

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(c) Suggest a reason why the concentration of lycopene stays relatively constant in the small intestine. *[1]*

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H2. (a) State a hormone which is a

(i) steroid. *[1]*

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(ii) peptide. *[1]*

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(b) List **three** structural features of exocrine glands. *[3]*

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H3. (a) Outline the process of bile secretion. *[4]*

(b) Explain the Bohr shift of an oxygen dissociation curve during gas exchange. *[6]*