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

M07/4/BIOLO/SP3/ENG/TZ1/XX+

22076012

BIOLOGY
STANDARD LEVEL
PAPER 3

Tuesday 15 May 2007 (morning)

1 hour

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 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.

0128

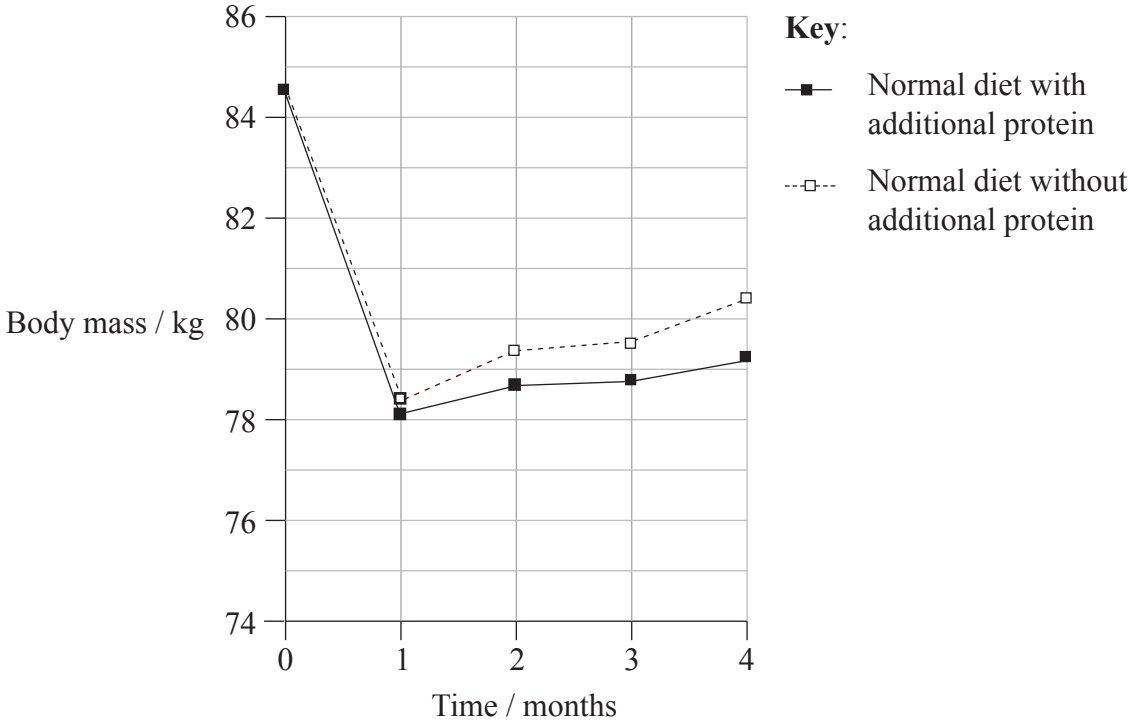
Option A — Diet and Human Nutrition

A1. Dieticians studied the effect of dieting in obese adults. They found that although many of the adults lost body mass when they were prescribed low energy diets, they regained body mass once the diet was relaxed.

The dieticians wanted to test the hypothesis that during overfeeding, a relatively high percentage of dietary energy eaten as protein limits the amount of body mass gained.

148 obese adults were selected. They were first given a very low energy diet for one month to achieve at least 4 kg loss in body mass.

After the first month, the adults were allowed to return to their normal diet but half of them were given 48.2 g of additional protein per day. The body mass of each adult was measured over the following three months. The results are shown below.



[Source: M S Westerterp-Plantenga *et al*, (2004), *International Journal of Obesity*, **28**, page 57]

(a) Identify **two** nutrients that are sources of dietary energy apart from protein. *[1]*

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(This question continues on the following page)

(Question A1 continued)

(b) Compare the changes in body mass for both groups when normal diet is resumed. *[2]*

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(c) Calculate the percentage difference in body mass at the end of the four months between the group with additional protein compared with the group without additional protein (show your calculations). *[2]*

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(d) Evaluate the hypothesis that consuming energy in the form of protein limits the gain in body mass. *[3]*

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A2. (a) List **four** vitamins necessary in human diets. *[2]*

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(b) Explain the importance of vitamins in a balanced diet. *[3]*

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A3. (a) State where cholesterol is synthesized by the body. *[1]*

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(b) Discuss whether cholesterol should be included in a balanced diet. *[4]*

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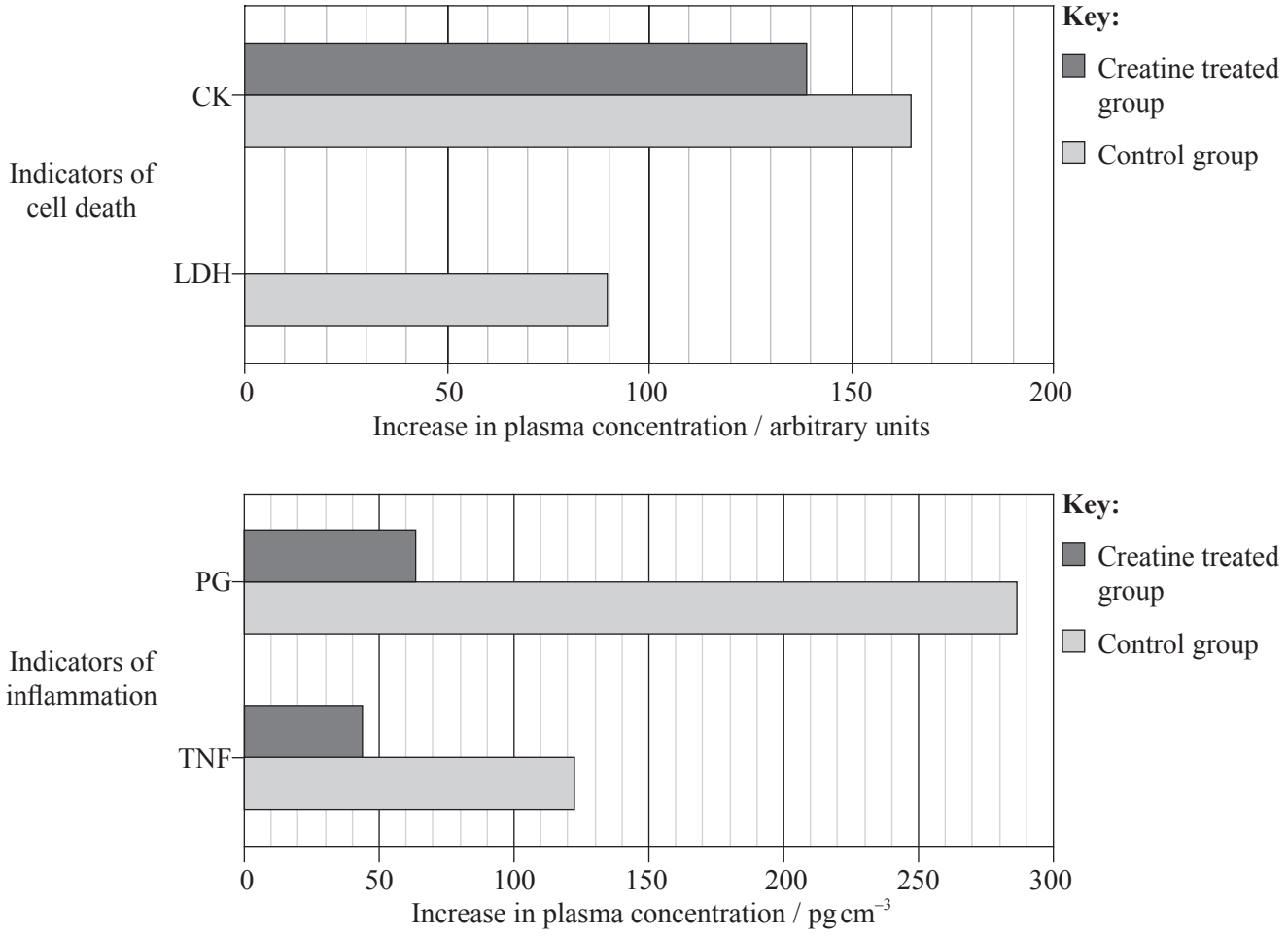
Option B — Physiology of Exercise

B1. Long distance runners often suffer from injuries during and after their training. These are commonly muscle injuries due to uneven contractions, the impact of feet on the ground and the high number of repetitions of the same movement. Muscle injury involves cell death and inflammation, which causes pain 24–48 hours after the exercise.

Sports physiologists investigated the effect of taking creatine on the recovery from injury of long distance runners during training. The scientists measured the levels of creatine kinase (CK) and lactate dehydrogenase (LDH), enzymes which are indicators of cell death, as well as prostaglandin (PG) and tumour necrosis factor (TNF) which are indicators of inflammation. These were measured from blood samples taken 15 minutes before and 24 hours after a 30 km race.

Thirty-four athletes were split into two groups. One group was given a dose of creatine (creatine group) mixed with sugar for five days before the race. The control group was given a placebo containing sugar only. The levels of all the indicators just before the race were not significantly different between the creatine treated group and the control group.

The results of the increase in the indicators after the race are shown below.



[Source: R V T Santo, R A Bassit *et al*, (2004), *Life Sciences*, **75**, page 1917, © Elsevier 2004]

(This question continues on the following page)

(Question B1 continued)

(a) Calculate the decrease in tumour necrosis factor (TNF) with the creatine treatment. *[1]*

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(b) Outline the effects of creatine on the indicators of cell death. *[2]*

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(c) Evaluate the capacity of creatine to reduce inflammation after a race. *[3]*

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(d) Discuss the use of creatine as a possible performance enhancing drug. *[4]*

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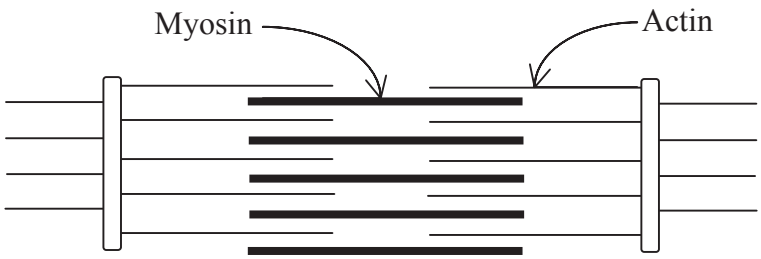
B2. The diagram below shows the arrangement of filaments in a relaxed muscle as seen under the electron microscope.



(a) Draw a labelled diagram to show the filaments in a fully contracted muscle, in the space provided below. *[2]*

(b) Explain why the ventilation rate rises with exercise. *[2]*

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(c) State **two** changes in muscle tissue during exercise which cause muscle fatigue. *[2]*

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B3. Outline the organization of the human nervous system. *[2]*

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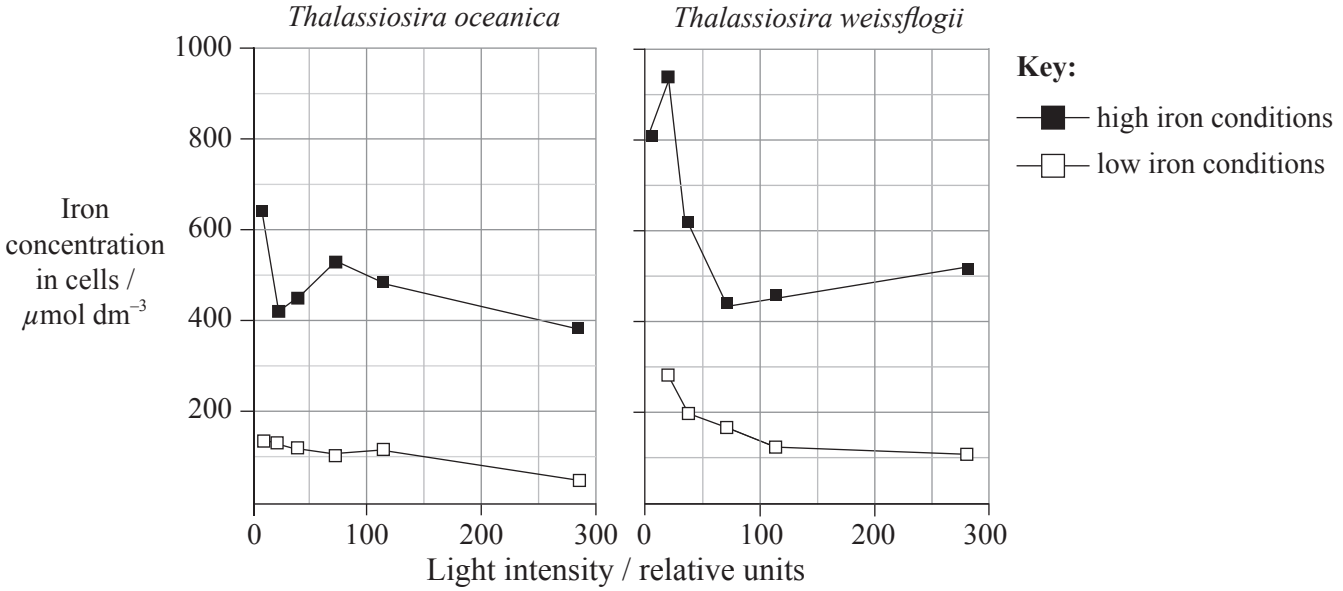
Option C — Cells and Energy

C1. Diatoms are unicellular algae which live as plankton in fresh water and oceans. Biochemists investigated two species of diatom, *Thalassiosira oceanica* which lives in the open ocean where the water is clear and *Thalassiosira weissflogii* which lives in coastal waters where the water is often cloudy. Iron is an important part of a number of molecules involved in photosynthesis. Iron however is often deficient in the waters of the open ocean. The scientists investigated the amount of iron present in the cells of the diatoms when they were grown at different intensities of light, in both high and low iron conditions.



[Source: R F Strzepek and P J Harrison, (2004), *Nature*, **431**, page 689]

(a) Compare the iron concentrations in the cells of *T. oceanica* and *T. weissflogii* under high iron conditions. *[2]*

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(b) Suggest a reason for the response of *T. weissflogii* to low light intensities. *[2]*

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(This question continues on the following page)

(Question C1 continued)

When the growth of these two species was compared in the two iron conditions it was found that the growth of *T. oceanica* was not affected by low iron concentrations but the growth of *T. weissflogii* was reduced by about 20 %.

(c) Explain how *T. oceanica* is adapted to oceanic waters. *[3]*

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(d) Predict what would be the effect on the populations of these diatoms if atmospheric pollution reduced light intensities over the oceans. *[1]*

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C2. (a) Draw and label the structure of a mitochondrion as seen in electron micrographs, in the space provided below. *[3]*

(b) State what happens during a chemical reaction that involves reduction. *[1]*

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C3. (a) Explain the secondary and tertiary levels of protein structure. *[4]*

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(b) Outline the induced fit model for enzyme action. *[2]*

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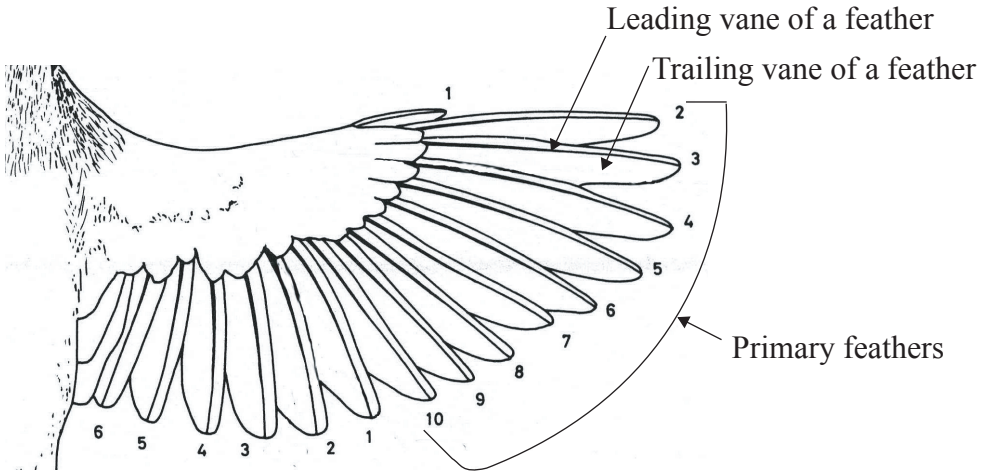
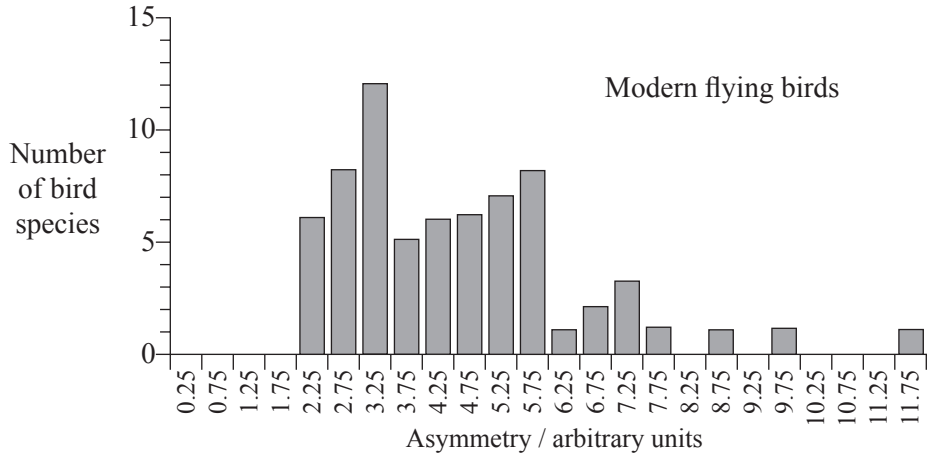
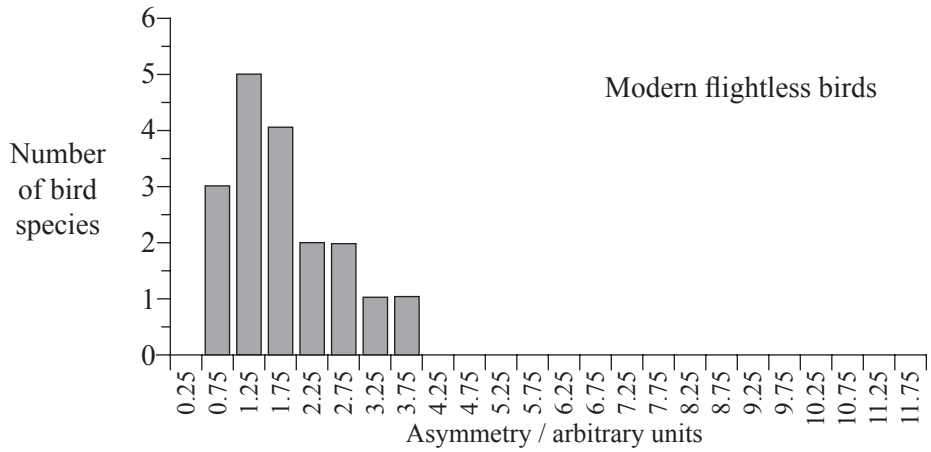
Option D — Evolution

D1. Birds have a series of flight feathers, which grow out from their hands called primaries. Each primary feather is shaped like an aeroplane wing, which provides the bird with lift during flight. The flat surfaces of the feather are called vanes and they are asymmetric (not equal in shape).

The primary feathers on the wings of 71 different bird species which can fly were measured for their asymmetry. The same measurements were carried out on 18 different species of flightless birds. These data are shown in the charts below.







[Source: J R Speakman and S C Thomson, (1994), *Nature*, **370**, page 514]

(This question continues on the following page)

(Question D1 continued)

(a) Calculate the mean asymmetry for the modern flightless birds. (Show your working) *[2]*

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(b) Compare the degree of asymmetry between the modern flying birds and the modern flightless birds. *[2]*

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(c) (i) *Archaeopteryx* is a fossil bird whose wing feathers have been preserved. Primary feathers of two fossil *Archaeopteryx* specimens were measured. The mean asymmetry for this bird is 1.44. On the basis of the data given, predict with a reason, whether *Archaeopteryx* could fly or not. *[2]*

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(ii) Evaluate the evidence for your prediction in (i). *[2]*

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D2. (a) List **four** physical features that define humans as primates. *[2]*

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(b) Explain the evolution of *H. habilis* from earlier hominids in terms of a response to possible ecological changes in Africa. *[4]*

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D3. (a) State **two** molecules used to provide evidence of the common ancestry of living organisms. *[1]*

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2. . . . . .

(b) Outline the theory of panspermia. *[3]*

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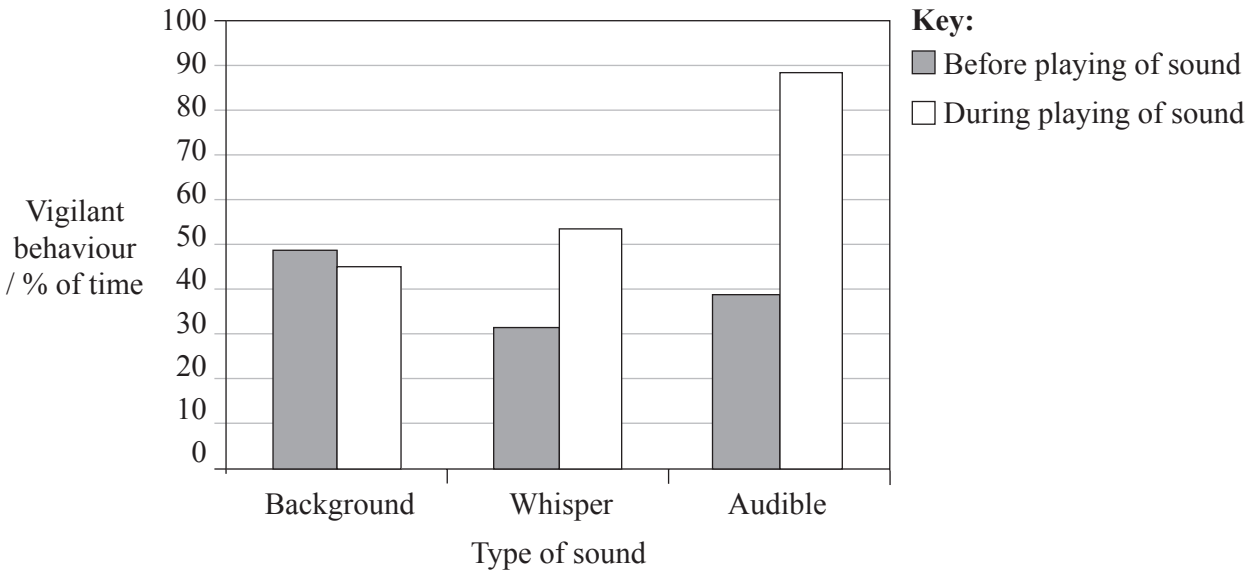
Option E — Neurobiology and Behaviour

E1. Ground squirrels communicate using sound. Recently one species, Richardson's ground squirrel (*Spermophilus richardsonii*), has been shown to use an audible alarm call as well as an ultrasound alarm call. The audible alarm call carries further and covers a broader area. The ultrasound alarm or "whisper" call does not travel so far and is highly directional.

Ethologists observed nineteen wild Richardson's squirrels before and during the playing of three types of sound:

- background noise
- the whisper call
- the audible alarm call.

The time each squirrel spent in vigilant behaviour (watching out for danger) was recorded. The results are shown below.



[Source: D R Wilson and J F Hare, (2004), *Nature*, **430**, page 523]

(a) State the role of the background noise in this experiment. *[1]*

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(This question continues on the following page)

(Question E1 continued)

(b) (i) Compare the effect of playing the whisper call to the effect of playing the audible call on the behaviour of squirrels. *[2]*

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(ii) Suggest a reason for the difference in the behaviour of the squirrels to the whisper call and the audible call. *[1]*

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(c) Alarm calls may attract the attention of a predator to the caller. Discuss the role of altruism in the use of whisper calls and audible calls. *[4]*

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E2. (a) State the difference between innate behaviour and learned behaviour. *[1]*

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(b) Explain how kinesis and taxis improves an organism's chance of survival. *[4]*

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(c) Outline Lorenz's experiments on imprinting in geese. *[3]*

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E3. State the name of the receptors labelled below. *[2]*

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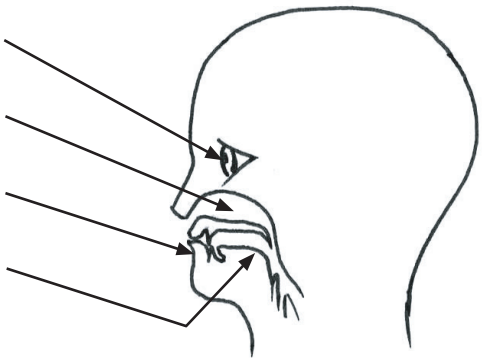
II. . . . . .

III. . . . . .

IV. . . . . .



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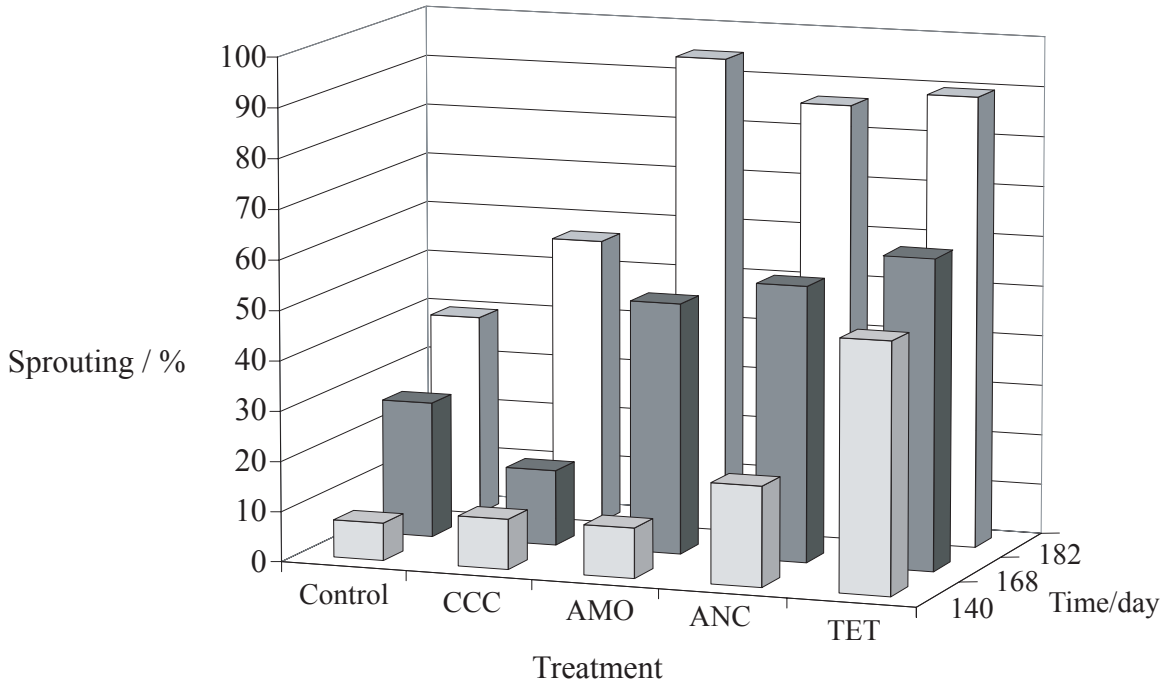
Option F — Applied Plant and Animal Science

F1. Potatoes are stem tubers. They are swollen underground stems with buds. When potatoes are harvested they are dormant and their buds will not sprout. The beginning of sprouting is difficult to predict, it changes the nutritional value of the potato and results in serious financial losses in the potato industry. Plant physiologists wanted to determine the role of gibberellic acid, a plant growth regulator (plant hormone), on sprouting in potatoes.

Potatoes were treated with four different inhibitors of gibberellic acid synthesis (CCC, AMO, ANC and TET). Their effects were observed on sprouting at different times after harvesting. The results are shown below.



[Source: J C Suttle, (2004), *Journal of Plant Physiology*, **161**, page 157, © Elsevier 2004]

(a) Calculate the difference between sprouting in potatoes treated with ANC at 140 and 168 days. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(b) Compare the effects of CCC and AMO on the sprouting of the potatoes. *[3]*

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(c) Deduce the effects of gibberellic acids on sprouting in potatoes. *[2]*

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(d) Suggest a treatment which could be used to delay sprouting in potatoes. *[1]*

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F2. (a) State **one** example of a plant species that is important in each of the categories listed below. *[1]*

Fuel: . . . . . .

Clothing:. . . . . .

Building materials: . . . . . .

(b) Explain how intensive monoculture can lead to increased crop production and, at the same time, increased risk of pest invasion. *[4]*

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(c) State **two** uses of growth hormones in livestock production. *[2]*

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2. . . . . .

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F3. (a) Define the term *inbreeding*. *[1]*

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(b) Discuss the need to maintain ancient breeds of farm animals. *[3]*

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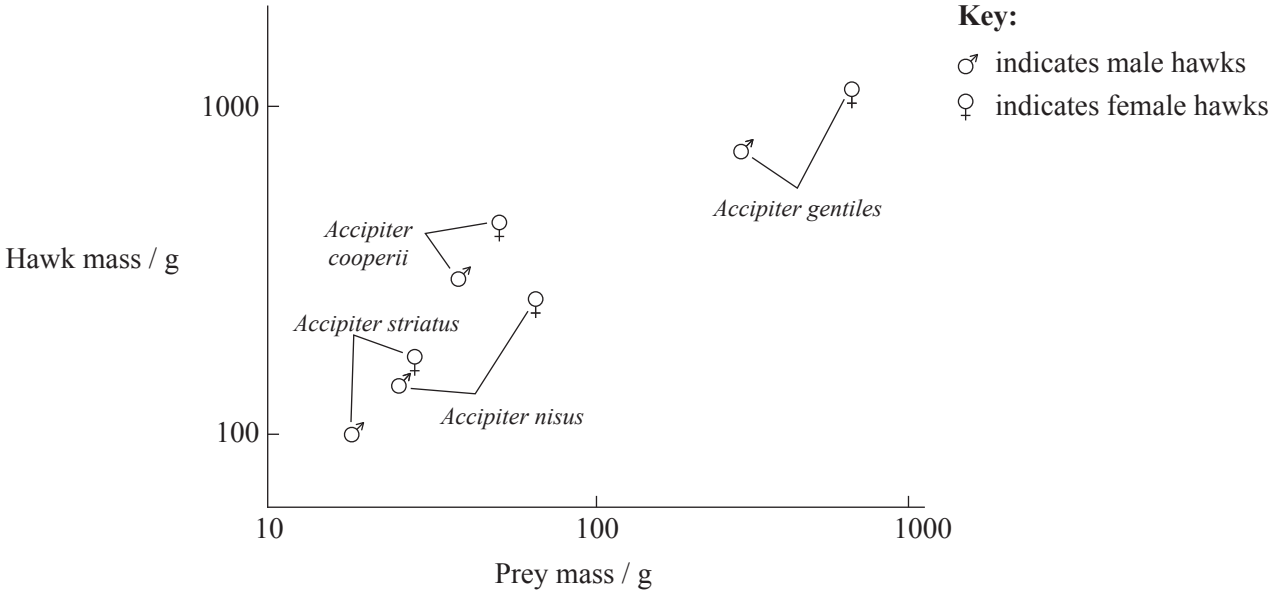
Option G — Ecology and Conservation

G1. Ornithologists studied the size of birds of prey and compared them with the sizes of their prey. The diagram below shows the mean results for four species of hawk.



[Source: Norberg, U. M. (1981): Flight, morphology and the ecological niche in some birds and bats. *Symposia of the Zoological Society of London* No. 48: 173–97. Reprinted with permission]

(a) State the relationship between the mass of the hawks and the mass of their prey. *[1]*

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(b) (i) Describe the differences between the masses of the hawks and the masses of their prey. *[2]*

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(ii) Explain how the difference in the mass between the hawks and their prey can result in a lower biomass at higher trophic levels. *[1]*

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(This question continues on the following page)

(Question G1 continued)

(c) Compare the masses of the different sexes of these species. *[1]*

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(d) Suggest reasons for the differences in the masses of the male and the female hawks. *[2]*

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G2. (a) Explain the role of CITES in conservation. *[4]*

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(b) Explain what is meant by the niche concept. *[3]*

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(This question continues on the following page)

(Question G1 continued) *[1]*

(c) State **one** example of an indicator species and the environmental factor it indicates.

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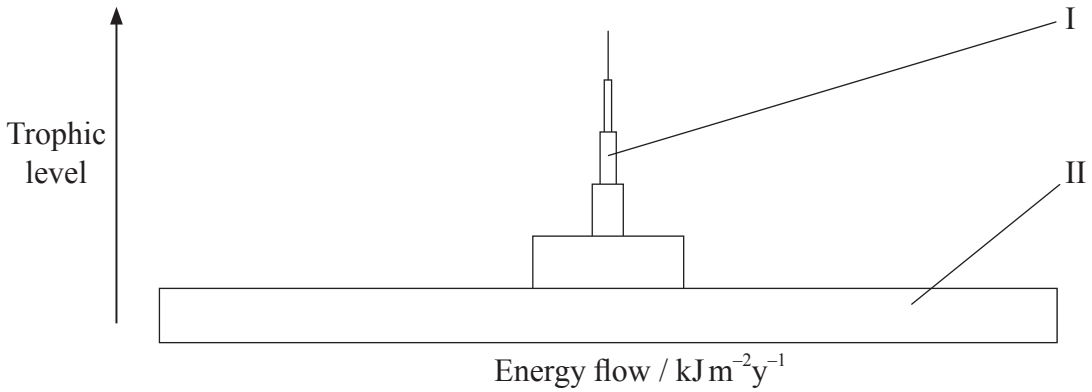
G3. (a) The diagram below represents a pyramid of energy for a community of organisms. State what the bars labelled I and II indicate. *[2]*



I. . . . . .

II. . . . . .

(b) Define the term *biomass*. *[1]*

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