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

M05/4/BIOLO/SP3/ENG/TZ2/XX+

22056018

BIOLOGY
STANDARD LEVEL
PAPER 3

Thursday 12 May 2005 (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.

Option A — Diet and Human Nutrition

A1. In China there is a high occurrence of vitamin D (calciferol) deficiency among adolescents, particularly in the winter. In 1995, a population study investigated this deficiency in 1248 Beijing girls aged between 12–14 years from three different areas: the countryside, the city suburbs and the city. Nutrient and energy intake were determined to identify the average diet of the girls.

Nutrient intake	Countryside	City Suburbs	City	RDA*
Calcium / mg day^{-1}	318.00	352.00	396.00	1200.00
Vitamin D / μg day^{-1}	0.59	0.75	1.55	10.00
Phosphorus / mg day^{-1}	705.00	736.00	764.00	1200.00
Protein / g day^{-1}	47.00	51.00	52.00	80.00
Energy / kJ day^{-1}	6962.00	7003.00	7021.00	9628.00

*RDA: Chinese recommended daily allowance (RDA) for adolescent females.

[Source: Xueqin Du, *et* al., *American Journal of Clinical Nutrition*, (2001), **74**, (4), pages 494–500]

(a) State which group has the greatest vitamin D deficiency. *[1]*

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(b) Compare the nutrient intake of countryside girls and city girls. *[2]*

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(This question continues on the following page)

(Question A1 continued)

(c) (i) Calculate the mean calcium intake for the three groups. *[1]*

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(ii) Determine what percentage of the RDA the value calculated in (c) (i) represents. *[1]*

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(iii) List **two** different types of food that are good sources of calcium. *[1]*

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(d) Suggest ways in which the development of rickets in these girls can be avoided. *[3]*

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A2. (a) Define the term *essential amino acids*. *[1]*

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(b) Discuss the relationship between nutrition and anaemia. *[2]*

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A3. (a) Describe how a balanced diet meets the needs of the body. *[2]*

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(b) Distinguish the differences between a vegan diet and a vegetarian diet. *[1]*

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(c) Discuss the importance of fibre in the diet. *[3]*

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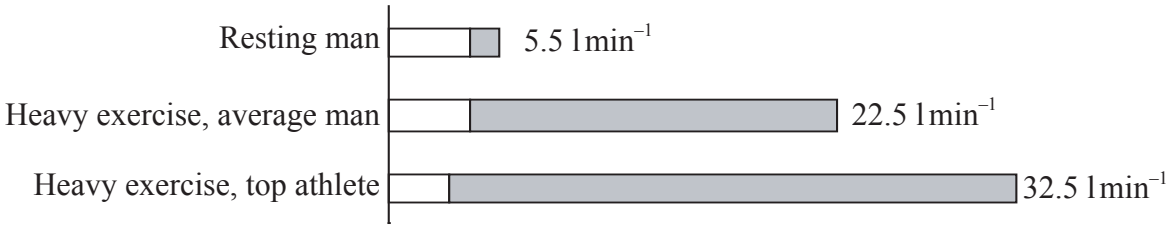
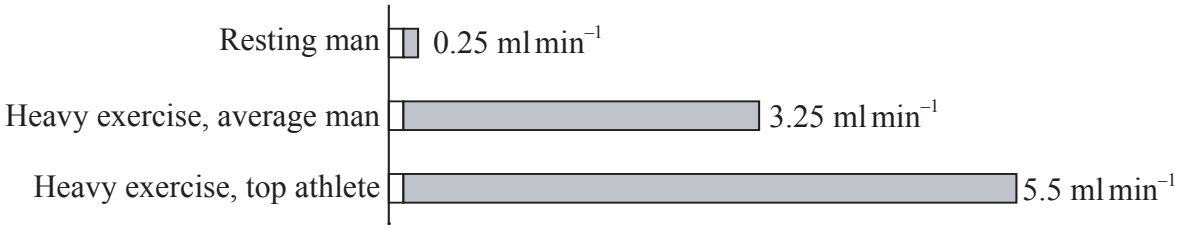
Option B — Physiology of Exercise

B1. During muscular activity the heart must deliver more blood to the tissues due to increased oxygen demand. Graph 1 shows the distribution of total blood flow (cardiac output) between muscles (shaded bars) and all other parts of the body (unshaded bars) in resting men, and in both average men and top athletes doing heavy exercise. Graph 2 shows oxygen consumption by the muscles and all other parts of the body in the three groups. The value given for each bar represents the total body values.

Graph 1: Cardiac output / (litres) $l\ min^{-1}$



Graph 2: Oxygen consumption / (millilitres) ml min^{-1}



[Source: K Schmidt-Nielsen, *Animal Physiology: Adaptation and Environment*, (1987), Cambridge University Press, pages 148–149]

(a) Describe the relationship between exercise and total cardiac output. *[1]*

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(b) (i) Calculate the percentage of cardiac output to the muscles for an average man during heavy exercise as compared to the total body value. *[1]*

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(ii) Calculate the increase in total oxygen consumption (ml min^{-1}) for a top athlete during heavy exercise as compared to a resting man. *[1]*

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(This question continues on the following page)

(Question B1 continued)

(c) Using the data, explain how training affects an athlete's body with respect to cardiac output and oxygen consumption. *[3]*

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B2. (a) State the **two** divisions of the human skeletal system. *[1]*

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(b) Identify the division of the human nervous system in which the spinal cord is found. *[1]*

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(c) Explain how the contraction of skeletal muscle is controlled by the nervous system. *[4]*

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B3. (a) (i) Define the term *oxygen debt*. *[1]*

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(ii) State the name of an organ where oxygen debt is repaid. *[1]*

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(b) Outline **two** different injuries that may occur to joints. *[2]*

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(c) Explain the need for warm-up and cool-down routines during exercise. *[2]*

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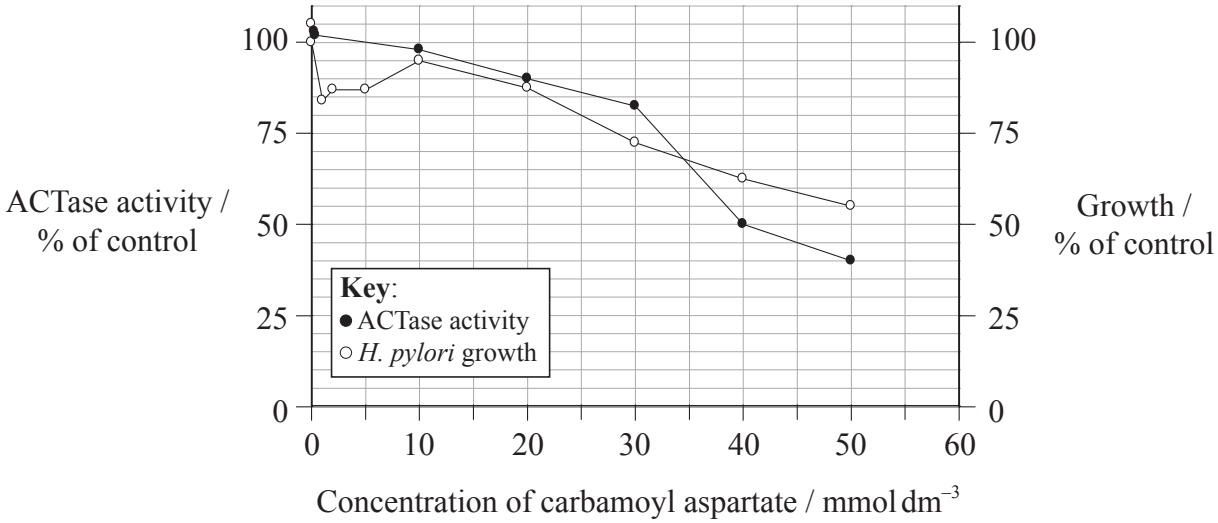
Option C — Cells and Energy

C1. The enzyme aspartate carbomyltransferase (ACTase) is a key regulatory enzyme in nucleotide metabolism in bacteria. The activity of this enzyme was studied in the bacterium *Helicobacter pylori*, an important human pathogen. ACTase activity and the growth of *H. pylori* were measured at different concentrations of carbomoyl aspartate (CAA), the end product of the reaction catalysed by ACTase.



[Source: Burns, *et al.*, *Biological Procedures Online*, (1998), www.biologicalprocedures.com]

(a) (i) State the growth of *H. pylori* at a CAA concentration of 30 mmol dm^{-3}. *[1]*

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(ii) Calculate the change in ACTase activity between CAA concentrations of 20 and 40 mmol dm^{-3}. *[1]*

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(b) Compare the effect of increasing CAA concentration on the growth of *H. pylori* and ACTase activity. *[2]*

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(This question continues on the following page)

(Question C1 continued)

(c) Explain the effect of CAA on ACTase activity. *[2]*

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(d) Suggest a direct medical application of this information. *[1]*

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C2. (a) State **two** products of the process of glycolysis. *[1]*

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(b) Explain the significance of polar and non-polar amino acids within the cell. *[3]*

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C3. (a) Draw and label the structure of the chloroplast as seen in the electron microscope. *[3]*

(b) Explain the relationship between the structure of the chloroplast and its function. *[2]*

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(c) Outline the process of chemiosmosis. *[2]*

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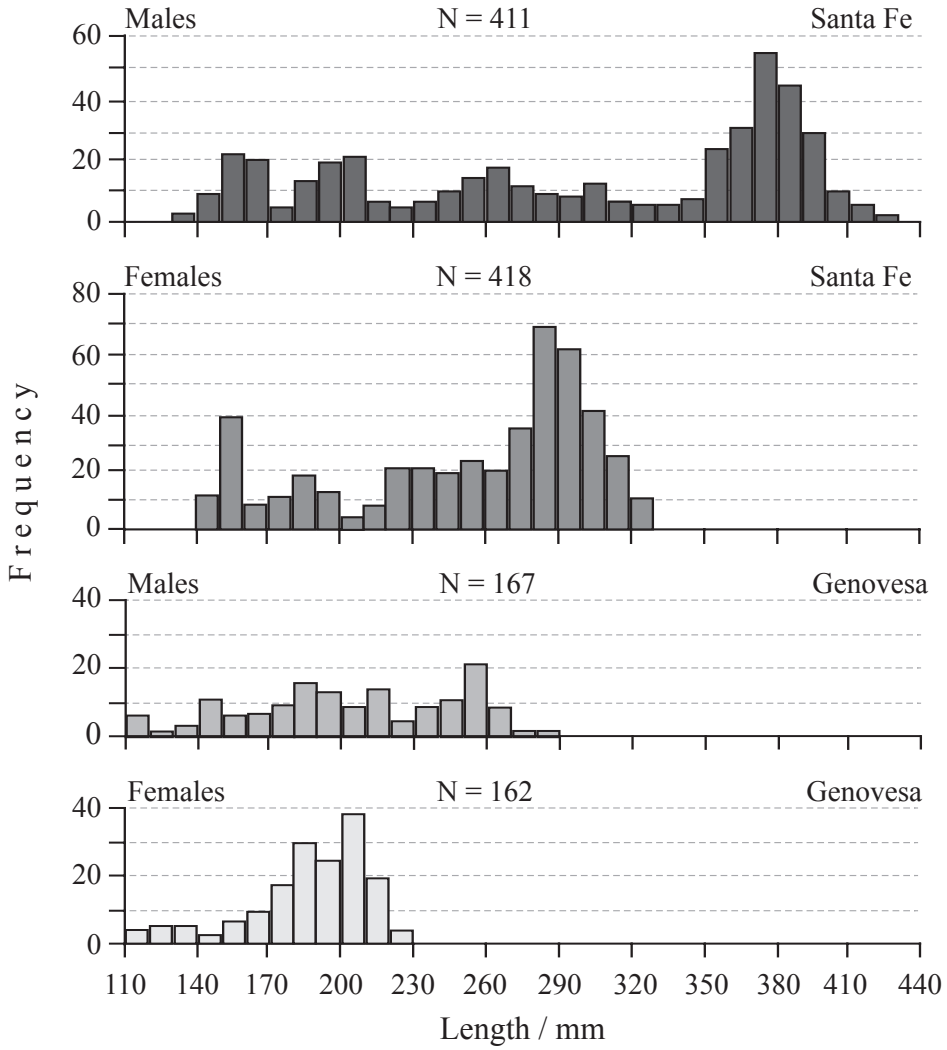
Option D — Evolution

D1. Marine iguanas (*Amblyrhynchus cristatus*) are found on the Galapagos islands of Genovesa and Santa Fe. Marine iguanas are unique among lizards in that they feed on algae in the intertidal zone. Between feeding they lie in the sun to warm themselves. Male iguanas establish territories on the rocks where females lie. Males provide no parental care of offspring while females guard the nest for a few days. Females mate once and use up 20 % of their body mass in reproduction, while males try to mate more than once and do not use up much of their body mass.

The graphs below show the lengths of males and females on the two different islands. The sample size (N) is indicated for each graph.



[Source: Freeman and Herron, *Evolutionary Analysis*, (2000), 2nd edition, page 296]

(a) (i) State the most frequent range of body sizes of males on Santa Fe and males on Genovesa. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(ii) Suggest **one** reason for the difference in size between male marine iguanas on Santa Fe and Genovesa. *[1]*

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(b) Compare the body size of males and females. *[2]*

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(c) Explain, using the theory of natural selection, the significance of size in males and females. *[2]*

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D2. (a) In the classification system, state the order and family of humans. *[1]*

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(b) Discuss the relative importance of genetic and cultural evolution in the evolution of humans. *[4]*

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D3. (a) State **two** radioisotopes used to date rocks and fossils. *[1]*

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(b) Discuss the incompleteness of the fossil record with respect to human evolution. *[3]*

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(c) Describe the evidence for evolution as shown by the geographical distribution of living organisms. *[3]*

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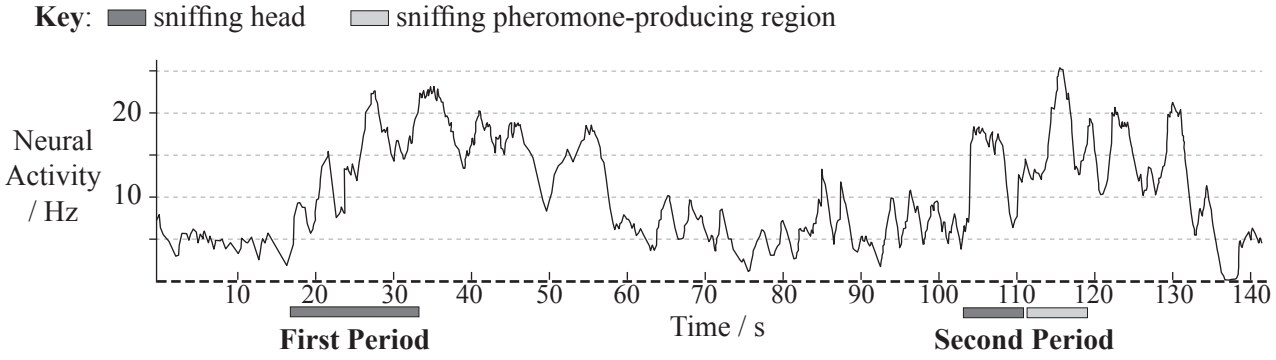
Option E — Neurobiology and Behaviour

E1. Mammals produce pheromones which are chemicals that stimulate reproductive and social behaviour. In mice, one neural pathway that detects pheromones is the accessory olfactory system (AOS). A recording device was implanted in the AOS of male mice. Each male was then placed in an enclosure with a sleeping female mouse. The movements of the male mice were videotaped and correlated with their neural activity as they sniffed the female.

The graph below represents the neural activity of neurons in the AOS measured in (Hertz) Hz. The first period represents the male sniffing the female's head. The second period represents the male sniffing the female's head and the pheromone-producing region. The interval between the two periods represents random movement within the enclosure.



[Source: M Luo, *et al*., *Science*, (2003), **299**, pages 1196–1201]

(a) (i) Identify the highest neural activity of the mouse. *[1]*

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(ii) Calculate the length of time the male spent sniffing the female's head in the first period. *[1]*

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(b) Describe the relationship between the mouse's movement and the activity of the AOS. *[3]*

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(This question continues on the following page)

(Question E1 continued)

(c) Suggest a simple experiment to show that the activity of the AOS was due to pheromones and not just the act of investigating the female mouse. *[1]*

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E2. (a) State **one** function of the

(i) medulla oblongata. *[1]*

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(ii) cerebellum. *[1]*

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(b) Outline **one** spinal reflex. *[3]*

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(c) Discuss how the pupil reflex is used to test for brain death. *[2]*

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E3. (a) Define the term *innate behaviour*. *[1]*

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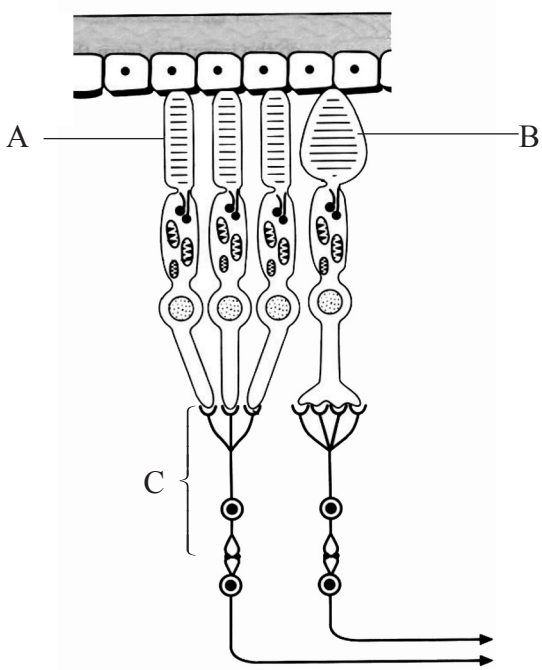
(b) Identify structures A, B and C shown on the diagram below of the human retina. *[2]*



[Source: adapted from J Vellacott and S Side, *Understanding Advanced Human Biology*, (1998), Holder & Stoughton, page 192]

A: . . . . . .

B: . . . . . .

C: . . . . . .

(c) Explain why quantitative data is necessary in studies of behaviour. *[2]*

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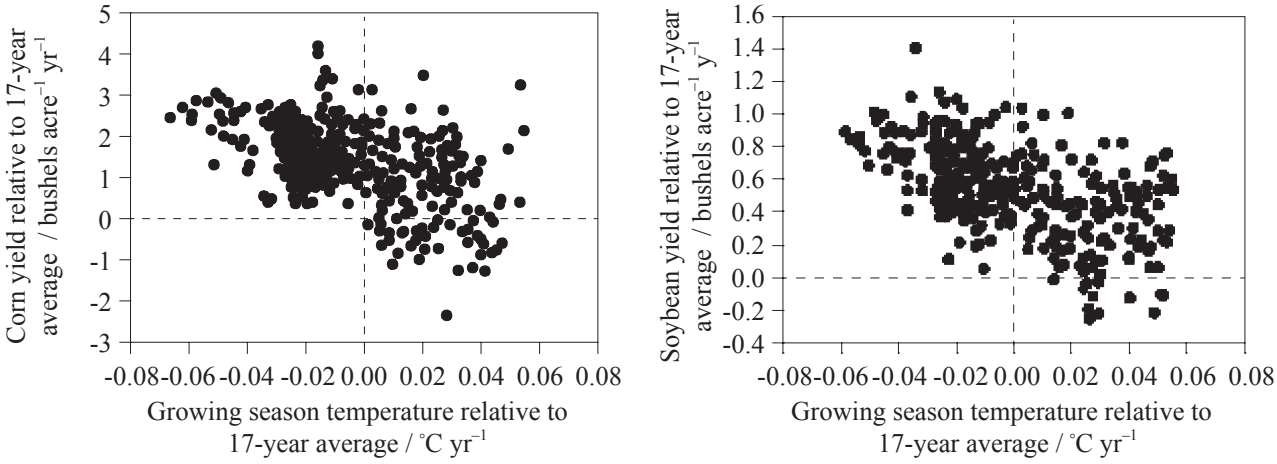
Option F — Applied Plant and Animal Science

F1. Major increases in crop yields are required in order to meet future world food demands. However, changes in climate may limit this ability in many regions of the world. A study in the US midwest compared the annual yield of corn and soyabean with the average annual yield of the same two crops over a 17-year period. These results were then compared with the variations from average June-August temperatures over the same 17-year period. The graphs below show the correlations between crop yields and growing season temperature variations over this period.



[Source: D Lobell and G Asner, *Science*, (2003), **299**, page 1032]

(a) State the overall relationship between crop yield and growing season temperature. *[1]*

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(b) Calculate the difference between the highest and lowest yield of corn. *[1]*

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(c) Compare the yields of corn and soyabean. *[2]*

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(This question continues on the following page)

(Question F1 continued)

(d) Suggest how variations in growing season temperature could have affected the yields of both crops. *[3]*

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F2. (a) (i) Define the term *net assimilation rate*. *[1]*

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(ii) Outline how net assimilation rate can be used to measure plant productivity. *[1]*

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(b) Explain how greenhouses are used to improve plant productivity. *[4]*

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F3. (a) Define the term F_1 *hybrid vigour*. *[1]*

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(b) State what techniques of animal breeding programmes have improved egg yield in poultry. *[1]*

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(c) Discuss intensive animal rearing techniques in terms of yield. *[3]*

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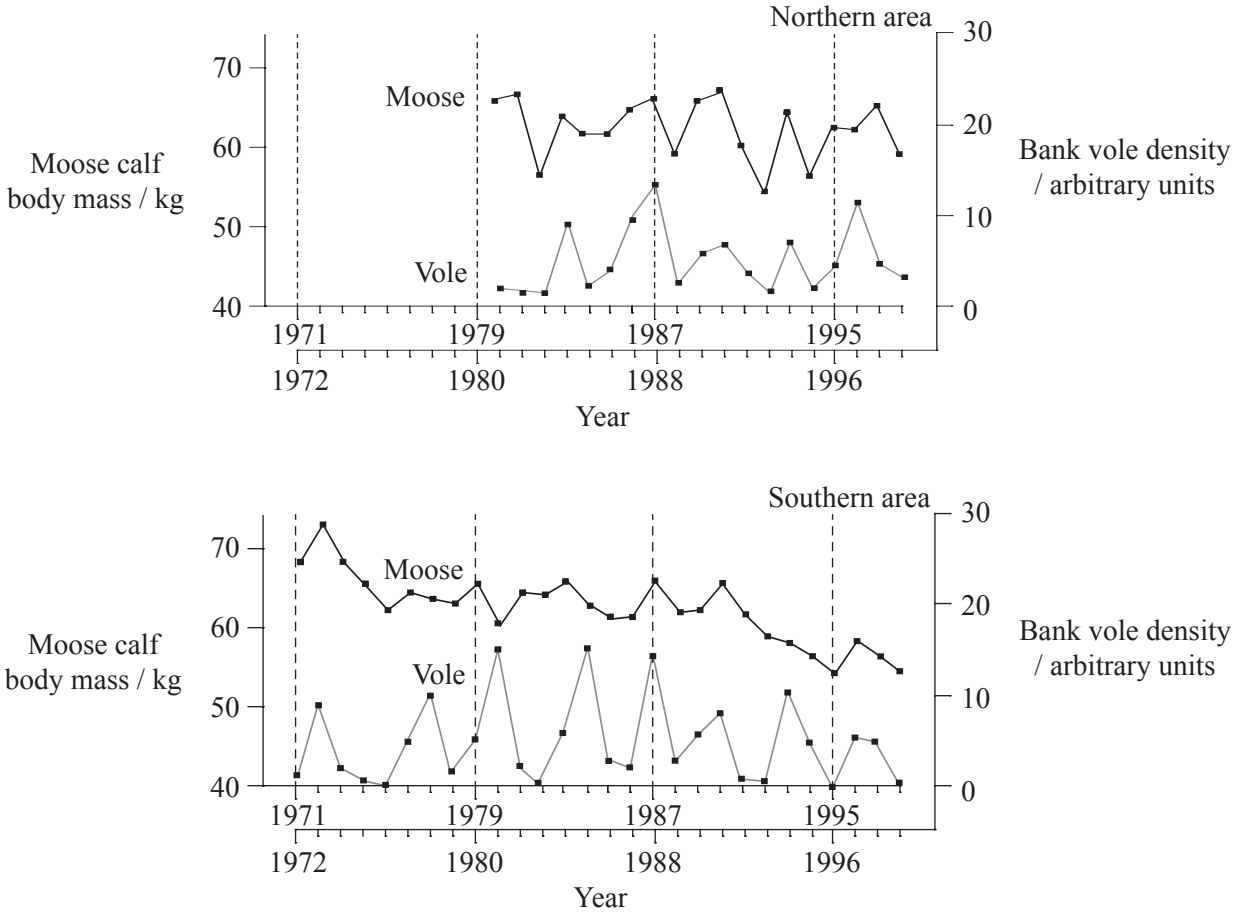
Option G — Ecology and Conservation

G1. In Norway the body masses of young moose (calves) fluctuate from year-to-year in the fall (autumn). Because of the regularity of the pattern, the fluctuation was thought to be related to food availability. Moose (*Alce alce*) eat bilberry (*Vaccinium myrtillus*), as do the bank vole (*Clethrionomys glareolus*). It was known that the bank vole populations peaked the year after high bilberry production.

These population changes were studied in a Northern area and a Southern area of Norway. The variation in mean fall (autumn) body mass of moose calves and the bank vole density are shown for the two areas in the graphs below.



[Source: V Selâs *et al*., *OIKOS*, (2001), **92**, pages 271–278]

(a) (i) State the lowest body mass of moose calves in the Northern area. *[1]*

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(ii) Determine the year in which bank vole density was highest in the Northern area. *[1]*

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(This question continues on the following page)

(Question G1 continued)

(b) Compare the variations in the moose calf body mass in both areas. *[2]*

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(c) Evaluate the hypothesis that both populations vary according to the availability of the common food source, the bilberry. *[2]*

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G2. (a) State **two** factors that affect the distribution of animal species. *[1]*

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(b) Explain the principal of competitive exclusion. *[3]*

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(c) Outline the process of ecological succession. *[2]*

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G3. (a) State the use of the Simpson diversity index. *[1]*

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(b) Outline the role of the WWF in conservation measures. *[2]*

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(c) Discuss international measures that would promote the conservation of fish. *[3]*

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