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

N04/4/BIOLO/SP3/ENG/TZ0/XX

88046006

BIOLOGY
STANDARD LEVEL
PAPER 3

School code

Candidate code

Thursday 11 November 2004 (morning)

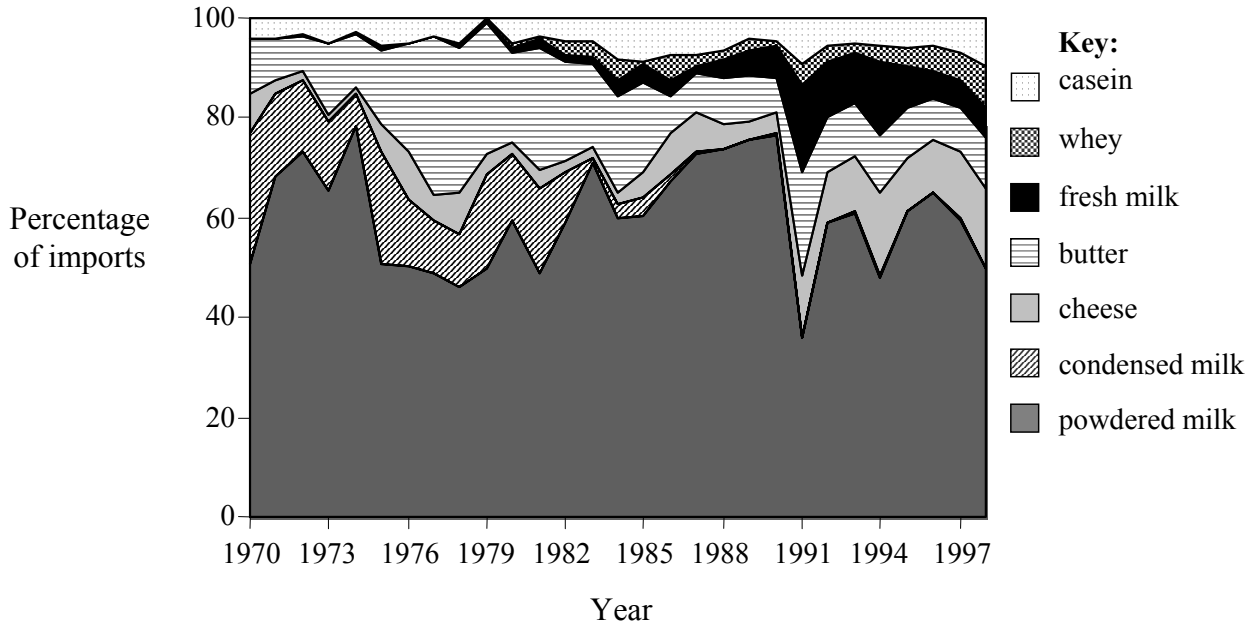
1 hour

INSTRUCTIONS TO CANDIDATES

- Write your school code and candidate code 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 school code and candidate code 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. Mexico has had an increasing demand for milk and dairy products over the last 30 years. The proportion of the different groups of milk products imported over a 27-year period is shown in the graph below.



[Source: R D Amendola, (2002), *A Dairy System Based on Forages and Grazing in Temperate Mexico*, PhD thesis: Wageningen University, page 15]

(a) Identify the year in which the importation of butter was greatest. *[1]*

. . . . . .

(b) State the relationship between the importation of condensed milk and fresh milk. *[1]*

. . . . . .

. . . . . .

(c) Determine which group of dairy products increased most in percentage of imports from 1973 to 1991. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question A1 continued)

(d) Suggest **two** reasons for the increase in importation of fresh products. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(e) State **two** essential constituents of a balanced diet found in milk products. *[1]*

. . . . . .

. . . . . .

A2. (a) State **two** main functions of carbohydrates absorbed from food. *[2]*

. . . . . .

. . . . . .

. . . . . .

(b) Suggest how environmental conditions cause malnutrition. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

A3. (a) (i) Identify where in the body cholesterol is synthesized. *[1]*

. . . . . .

(ii) Outline how the body uses cholesterol. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) (i) Define the term *malnutrition*. *[1]*

. . . . . .

. . . . . .

(ii) Discuss the importance of vitamins and minerals in the diet and the risk of deficiencies in vegan diets. *[4]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

Blank page

Option B – Physiology of Exercise

B1. The winning times of male athletes in different events in the 1964 Tokyo Olympic Games and in the 1968 Mexico City Olympic Games are given in the table below.

	1964 Tokyo (at sea level)	**1968 Mexico City** (at 2 200 m)
Short races		
100 m	10.0 s	9.9 s
200 m	20.3 s	19.8 s
400 m	45.1 s	43.8 s
800 m	1 min 45.1 s	1 min 44.3 s
1 500 m	3 min 38.1 s	3 min 34.9 s
Long races		
3 000 m	8 min 30.8 s	8 min 51.0 s
5 000 m	13 min 48.8 s	14 min 5.0 s
10 000 m	28 min 24.4 s	29 min 27.4 s
marathon	2 h 12 min 11.2 s	2 h 20 min 26.4 s
50 000 m walk	4 h 11 min 11.2 s	4 h 20 min 13.6 s

[Source: Powers and Howley, (1994), *Exercise Physiology. Theory and Application to Fitness and Performance*, 2nd edition, Brown and Benchmark, pages 514 and 515]

(a) Calculate the percentage change from Tokyo to Mexico City in the winning times of the following races.

(i) 400 m . . . . . *[1]*

. . . . . .

(ii) Marathon . . . . . *[1]*

. . . . . .

(b) Compare the winning times for short and long races between Tokyo and Mexico City. *[1]*

. . . . . .

. . . . . .

(c) State the main type of respiration that provides energy in the marathon. *[1]*

. . . . . .

(This question continues on the following page)

(Question B1 continued)

(d) Suggest reasons for the differences in performance in Tokyo and Mexico City. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

B2. (a) Outline **two** different treatments used for soft-tissue injuries. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Draw and label the structure of skeletal muscle as seen in electron micrographs. *[3]*

B3. (a) Discuss speed as a measure of fitness. *[2]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(b) (i) State the type of neuron that carries an impulse to a muscle. *[1]*

. . . . . .

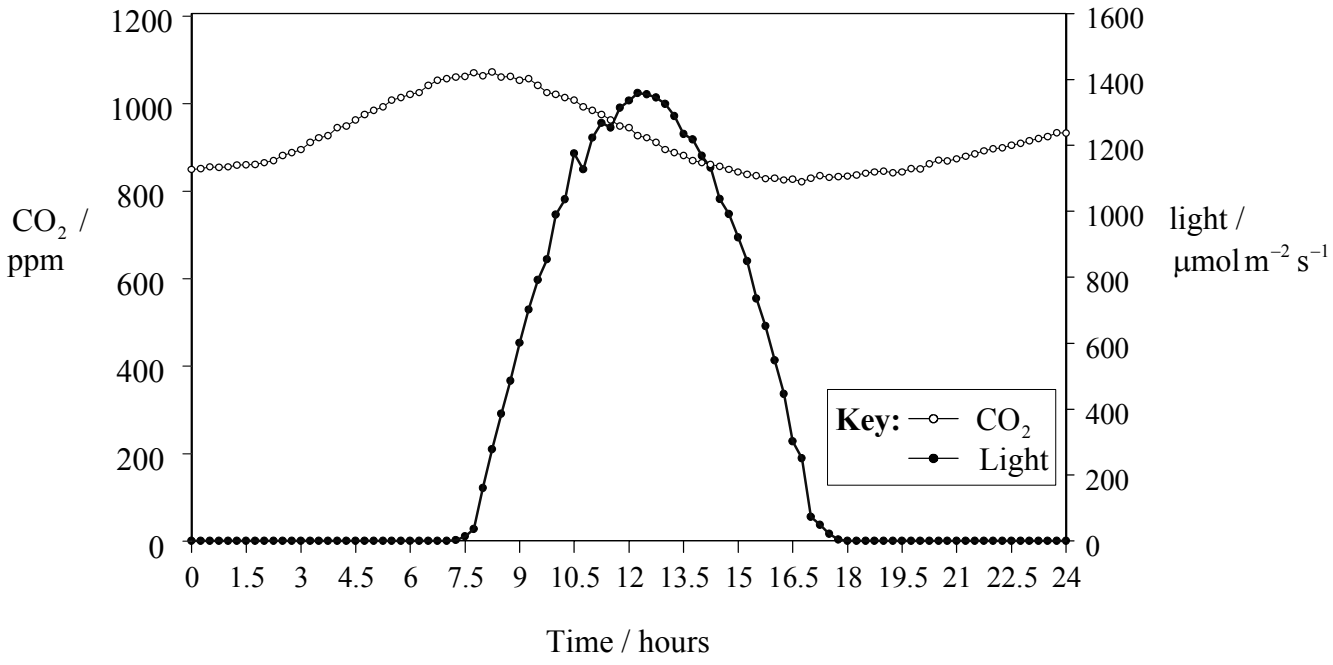
(ii) Explain how contraction of a muscle is controlled. *[4]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Blank page

Option C – Cells and Energy

C1. Biosphere 2, an enormous greenhouse built in the Arizona desert in the USA, has been used to study five different ecosystems. It is a closed system so measurements can be made under controlled conditions. The effects of different factors, including changes in carbon dioxide concentration in the greenhouse, were studied. The data shown below were collected over the course of one day in January 1996.



[Source: http://www.Ideo.columbia.edu/martins/climate_water/labs/lab6/labinstr6/html]

(a) (i) Identify the time of day when the sun rose. *[1]*

. . . . . .

(ii) Identify the time of minimal CO_2 concentration. *[1]*

. . . . . .

(b) Determine the maximum difference in the concentration of CO_2 over the 24-hour period. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question C1 continued)

(c) Suggest reasons for changes in CO_2 concentration during the 24-hour period. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

C2. (a) State **two** functions of proteins with a named example of each. *[2]*

. . . . . .

. . . . . .

. . . . . .

(b) Explain chemiosmosis as it occurs during cell respiration. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

C3. (a) Outline the induced fit model of enzyme activity. *[3]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(b) (i) State **two** products of the light-dependent reactions of photosynthesis. *[2]*

. . . . . .
. . . . . .

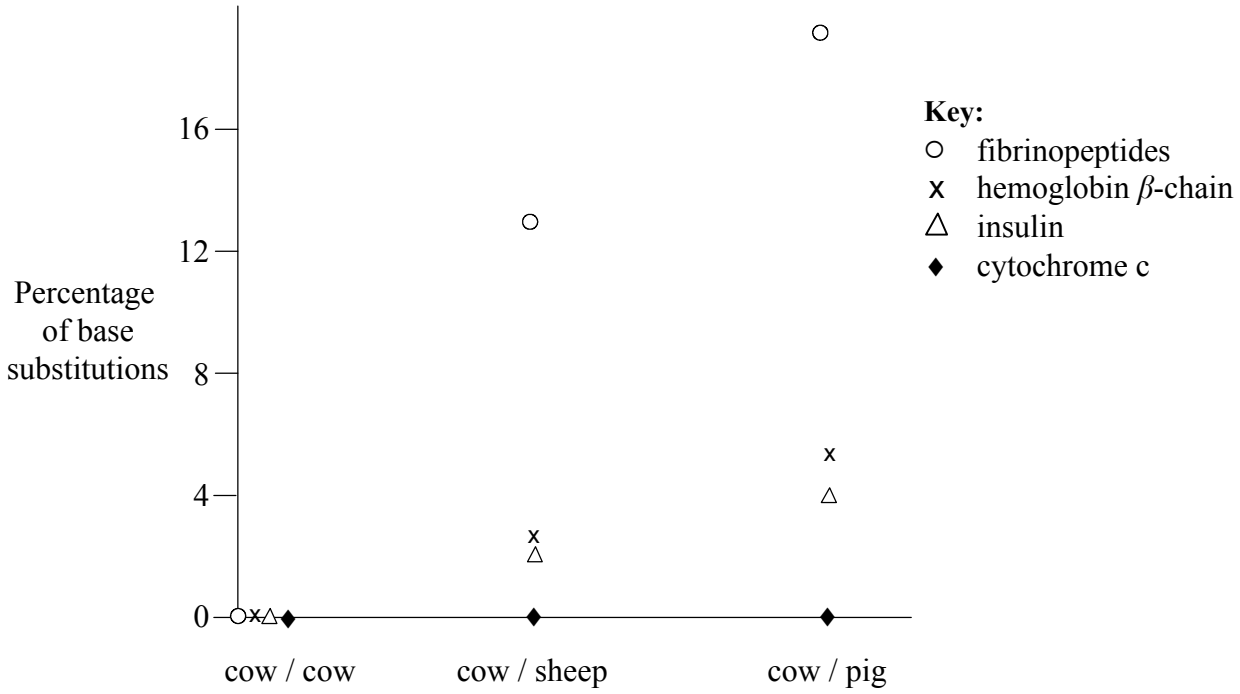
(ii) Explain the light-**independent** reactions in photosynthesis. *[4]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Blank page

Option D – Evolution

D1. A comparison was made of the base sequences of genes coding for the same four proteins found in three different mammals: the cow, sheep and pig. The graph below shows the differences in base sequence expressed as a percentage.



[Source: U Goodenough, (1978), *Genetics*, 2nd edition, Holt, Rinehart and Winston, page 759]

(a) Identify a protein that is identical in all three mammals. *[1]*

. . . . . .

(b) Calculate the difference in the percentage of base substitutions for the hemoglobin *β*-chain and fibrinopeptides when comparing the cow with sheep. *[1]*

. . . . . .

. . . . . .

(c) Deduce, giving a reason, whether the ancestors of pigs or sheep diverged more recently from those of cows. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question D1 continued)

(d) Explain how the variations in these molecules can indicate the evolutionary history of these groups of mammals. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

D2. (a) (i) Outline the difference between genetic and cultural evolution. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(ii) Define the term *half-life* of a radioisotope. *[1]*

. . . . . .

. . . . . .

(b) Explain the evidence for evolution provided by the pentadactyl limb. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

D3. (a) (i) State the name given to Darwin's theory of evolution. *[1]*

. . . . . .

(ii) Describe Darwin's theory of evolution. *[4]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

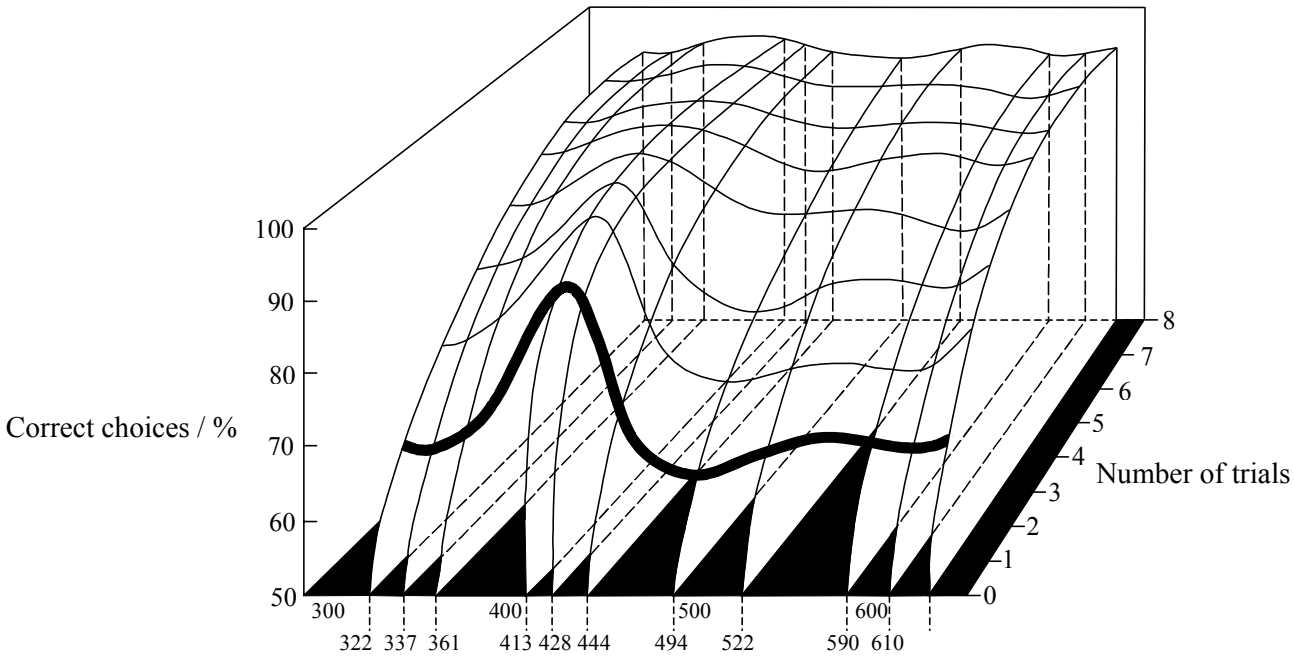
(b) Discuss the possible origins of prokaryotic cells. *[3]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Blank page

Option E – Neurobiology and Behaviour

E1. Experiments were done to see if honeybees could learn to associate a reward of sugar solution with a specific colour. Small plates were placed on a table and different wavelengths of light were used to illuminate them. Two plates, each illuminated with a different colour, were presented at one time. Only one contained a sugar solution as a reward. Bees were tested individually to find whether they chose the plate with the reward with each successive trial. Eight trials were conducted at eleven different wavelengths. The results are shown in the graph below. The bold line represents the results of the first trial.



Wavelength used to illuminate plate containing sugar solution / nm

[Source: T J Carew, (2000), *Behavioural Neurobiology*, Sinauer Associates Inc, page 279]

(a) State the relationship between the number of trials and the percentage of correct choices at any given wavelength. *[1]*

. . . . . .

. . . . . .

(b) Identify the wavelength at which the bees learned most quickly. *[1]*

. . . . . .

(c) Compare the percentage of correct choices made by the bees on the second trial, at wavelengths of 322 nm and 494 nm. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question E1 continued)

(d) Suggest a method based on this experiment to test the long-term memory of bees. *[2]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

E2. (a) Compare rod cells and cone cells in the retina. *[3]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(b) (i) State **one** example of altruistic behaviour. *[1]*

. . . . . .
. . . . . .

(ii) Explain the role of the example given in (i) in the social organization of the population. *[2]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

E3. (a) Explain, using a named example, how taxes increase an animal's chances of survival. *[4]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(b) Outline classical conditioning, giving a named example. *[3]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

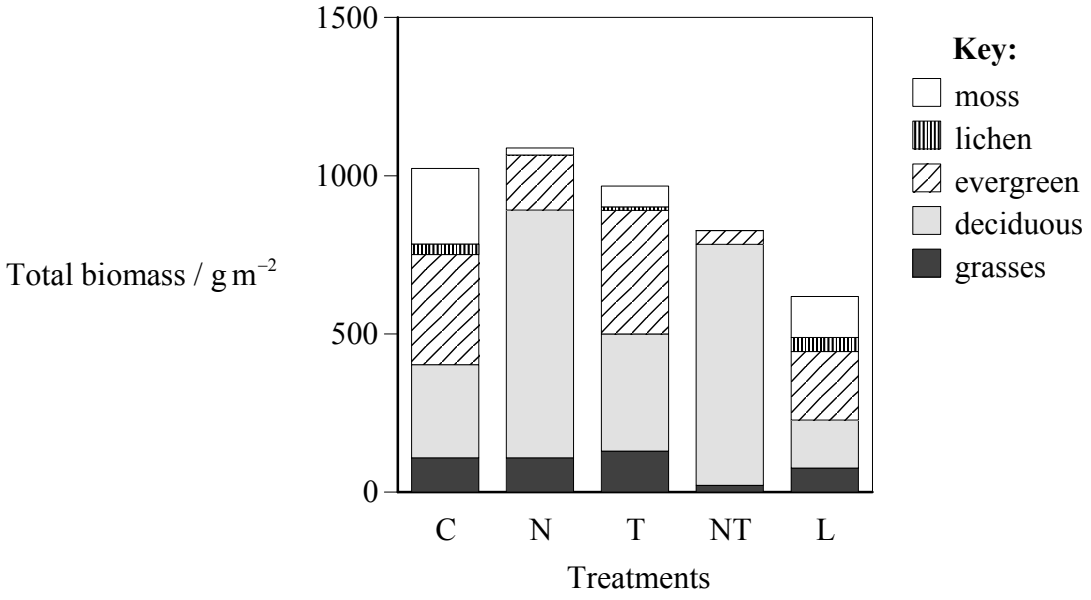
Blank page

Option F – Applied Plant and Animal Science

F1. A nine-year study was carried out on plants that grow in the arctic tundra. The effects of different environmental factors were studied:

- nutrient addition
- use of a greenhouse to raise the summer air temperature by 3 °C
- use of a "fertilized greenhouse" (increased temperature plus nutrient addition)
- shade to reduce light by 50 %.

The results are shown in the graph below.



Control (C), nutrient addition (N), greenhouse (T), fertilized greenhouse (NT), and shading (L).

[Source: UNEP, (1995), *Global Biodiversity Assessment*, Press Syndicate of the University of Cambridge, page 295]

(a) Identify the treatment that produced *[1]*

(i) the greatest evergreen biomass.

. . . . . .

(ii) the greatest lichen biomass. *[1]*

. . . . . .

(This question continues on the following page)

(Question F1 continued)

(b) Compare the effects of nutrient addition, raising the temperature and shading on the biomass of deciduous plants. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Suggest reasons for the differences in total biomass of plants in response to the different treatments. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

F2. (a) Outline the need to maintain biodiversity of **wild** plants. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Explain how **one** veterinary technique improves the health of animals. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

F3. (a) Outline the roles of auxin in plants. *[3]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(b) (i) State **one** problem that may be caused by intensive monoculture. *[1]*

. . . . . .
. . . . . .

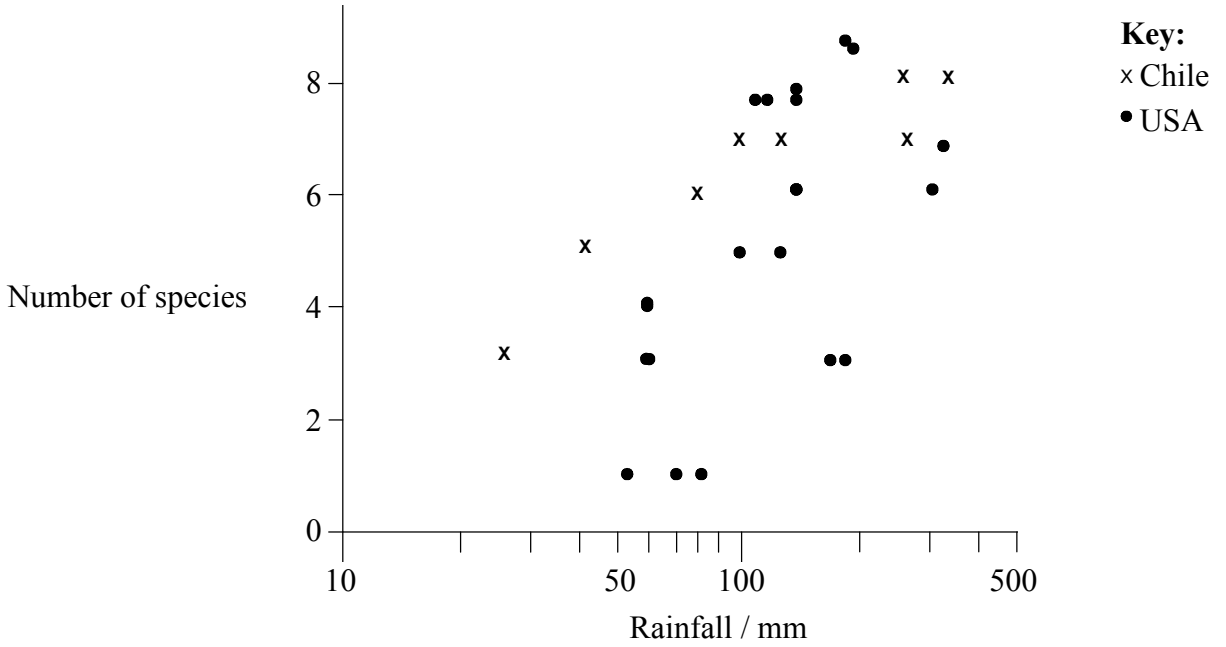
(ii) Discuss the biological issues of organic versus non-organic farming methods. *[4]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Blank page

Option G – Ecology and Conservation

G1. The relationship between the numbers of rodent species and rainfall was studied in dry areas of Chile and in the south-west of the United States. The results of the study are shown in the scattergraph below.



[Source: UNEP, (1995), *Global Biodiversity Assessment*, Press Syndicate of the University of Cambridge, page 154]

(a) Calculate the difference between the number of species found at 80 mm of rainfall and at 100 mm of rainfall in *[1]*

(i) Chile.

. . . . . .

. . . . . .

(ii) the USA. *[1]*

. . . . . .

. . . . . .

(b) Compare the relationship between the number of rodent species and rainfall in Chile with that of the USA. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question G1 continued)

(c) Suggest **two** reasons for the relationship between the number of rodent species and rainfall in each country. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

G2. (a) Outline changes caused in marine ecosystems by over-fishing. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Explain the low numbers of organisms in higher trophic levels of a food chain. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

G3. (a) Describe the use of *ex situ* conservation measures. *[3]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(b) (i) Define the term *niche*. *[1]*

. . . . . .
. . . . . .

(ii) Explain the niche concept using a named organism. *[4]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .