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

M02/410/S(3)

BIOLOGY
STANDARD LEVEL
PAPER 3

Friday 10 May 2002 (morning)

1 hour 15 minutes

Name

Number

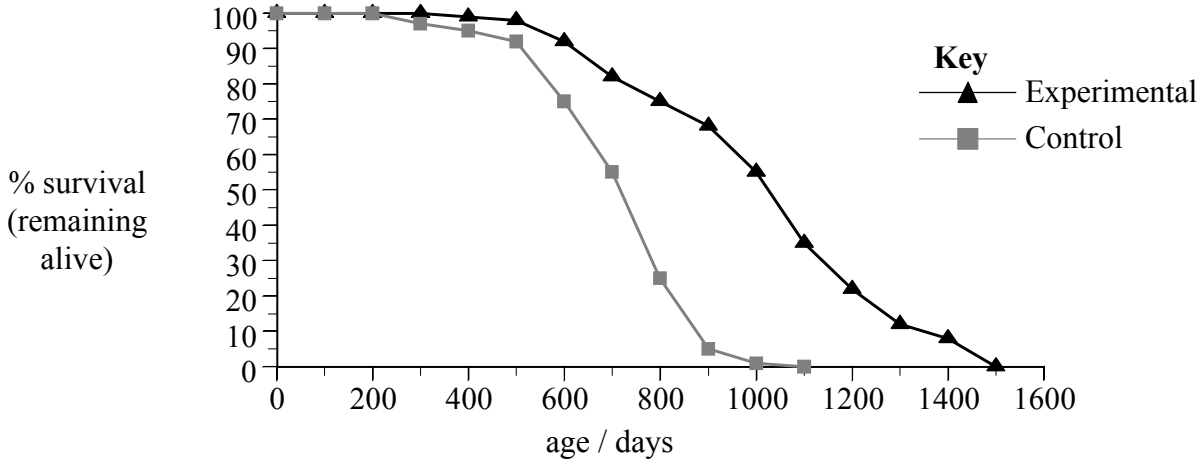
INSTRUCTIONS TO CANDIDATES

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from three of the Options in the spaces provided. You may continue your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the boxes below.

OPTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
		/15	/15	/15
		/15	/15	/15
		/15	/15	/15
NUMBER OF CONTINUATION BOOKLETS USED	. . . . .	TOTAL /45	TOTAL /45	TOTAL /45

Option A – Diet and human nutrition

A1. Researchers were investigating the factors that might affect life expectancy of humans or increase longevity. The graph below shows the effect of limited energy on longevity of rats. Rats were chosen based on their similar dietary requirements to humans. Control rats were fed a normal balanced diet, with sufficient energy, while experimental animals were fed a similar diet but with a total energy content 50 % less than the control.



[Source: Brian J Merry, (1999) *Biologist*, **46** (3), pages 114-117]

(a) Identify the percentage of rats that remain alive in each group after 800 days. *[2]*

Control: . . . . . .

Experimental: . . . . . .

(b) Outline how the graph shows the effect of energy content on longevity. *[2]*

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(c) State **three** constituents that must be present in both these diets. *[1]*

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(d) Suggest **two** reasons for the difference in survival between the two groups of rats. *[2]*

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A2. (a) Outline **one** function of iodine in the body. *[1]*

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(b) Outline the importance of fibre in the diet. *[3]*

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A3. (a) Define the term *essential amino acid*. *[1]*

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(b) Discuss the advantages and disadvantages of using chemical additives in foods. *[3]*

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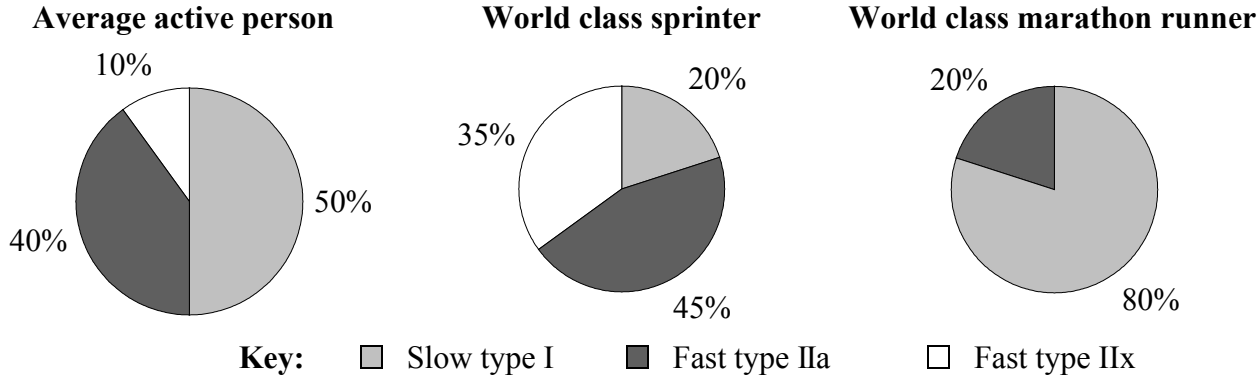
Option B – Physiology of exercise

B1. Recent findings have shown how human skeletal muscle adapts to exercise or the lack of it. Part of the myosin molecule determines the functional characteristic of the muscle. This exists in three different varieties of muscle fibres called slow type I, fast type IIa and fast type IIx. The pie charts show the total percentage of each fibre present in skeletal muscle in three groups of people.



[Source modified from: Jesper L Anderson, *et al.*, (September 2000) *Scientific American*, pages 30-37]

(a) Identify which group has the most slow muscle fibre. *[1]*

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(b) Compare the composition of muscle fibre in a world-class sprinter and a world-class marathon runner. *[2]*

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(c) An average active person takes up sprinting as a form of exercise. Identify which type of muscle fibre decreases as a percentage. *[1]*

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(d) Using the information in the charts explain which type of muscle fibre relies more on anaerobic metabolism. *[2]*

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B2. (a) Outline the function of myoglobin in muscle. *[2]*

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(b) Explain how an oxygen debt is created and repaid. *[3]*

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B3. (a) Define *fitness*. *[1]*

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(b) Explain how fitness can be measured. *[2]*

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(c) State **one** injury that can occur to the joints due to lack of fitness. *[1]*

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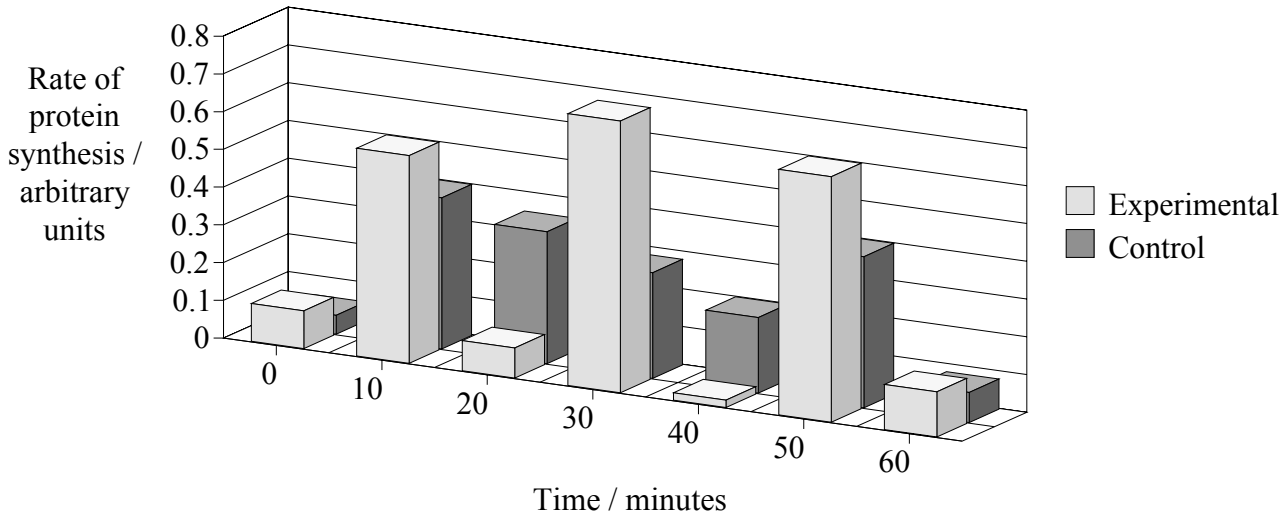
Option C – Cells and energy

C1. Cadmium ions are poisonous to most bacteria. However, some bacteria are able to resist the toxic effect by producing stress proteins. Scientists investigated the production of these proteins in *Vibrio sp* bacteria by giving them cadmium chloride solution for up to 60 minutes. The graph shows the synthesis of all proteins (measured in arbitrary units) for these bacteria and control bacteria which were not exposed to the cadmium chloride solution.



[Source: Dezider Toth, *et al.*, (1996) *Annals of the NY Academy of Sciences*, **782**, pages 252–263]

(a) Identify the rate of protein synthesis in the control group at 40 minutes. *[1]*

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(b) Identify any pattern in the rate of protein synthesis in the experimental group throughout the experiment. *[2]*

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(c) Compare the rate of protein synthesis in both groups. *[3]*

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C2. (a) Outline the role of ethanoyl (acetyl) CoA in fat metabolism. *[2]*

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(b) State **two** chemicals produced as a result of fermentation in yeast. *[1]*

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C3. (a) State **one** environmental condition that CAM plants are adapted to. *[1]*

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(b) PEP carboxylase catalyses the primary fixation of CO_2 to organic acids (malate) in CAM plants. Malate can inhibit this reaction. Explain this type of inhibition. *[3]*

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(c) Explain the concept of limiting factor with reference to light intensity in photosynthesis. *[2]*

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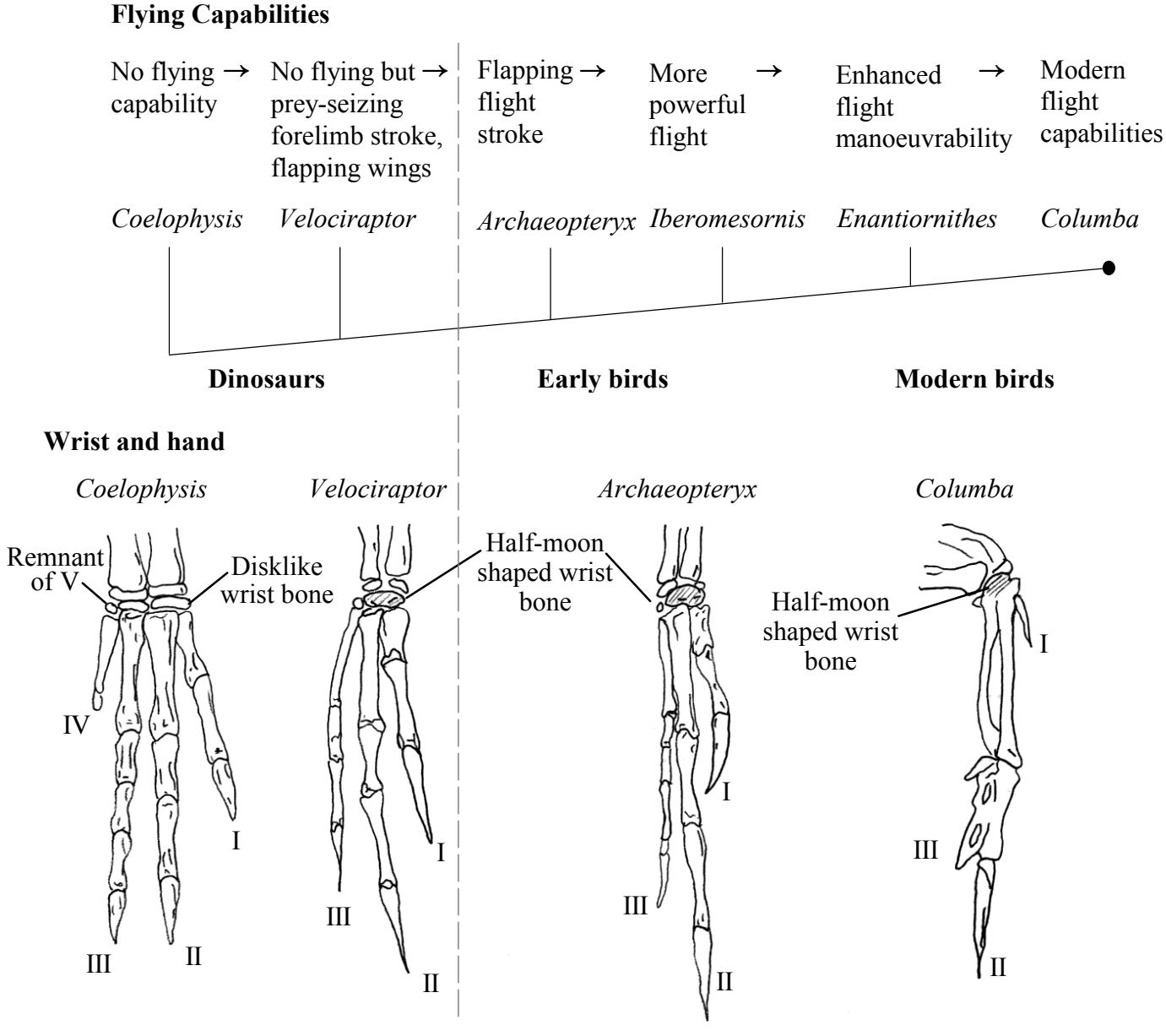
Option D – Evolution

D1. The bones of many modern birds and the fossils of bird ancestors have been compared. The body shape and how bird ancestors might have flown have been studied. This indicates that small predatory dinosaurs which lived on the ground evolved into birds with some flying capabilities. These then evolved into modern birds. The cladogram shows part of bird evolution and the drawings show anatomical structures linking birds to dinosaurs with hollow bones.



[Source: Kevin Padian and Luis M Chiappe, (February 1998) *Scientific American*, pages 28–37]

(a) Identify which bird ancestor appears most closely related to dinosaurs. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(b) Compare the flight capabilities and hand and wrist structure of *Velociraptor* and *Columba.* *[3]*

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(c) Identify the **two** types of evidence for evolution shown by the data. *[2]*

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D2. (a) State the class human beings belong to. *[1]*

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(b) Explain why the approximate date and distribution of *H. habilis* are uncertain. *[3]*

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D3. (a) Outline how the organic compounds on Earth gave rise to the first prokaryotic cells. *[3]*

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(b) Outline the evidence for panspermia. *[2]*

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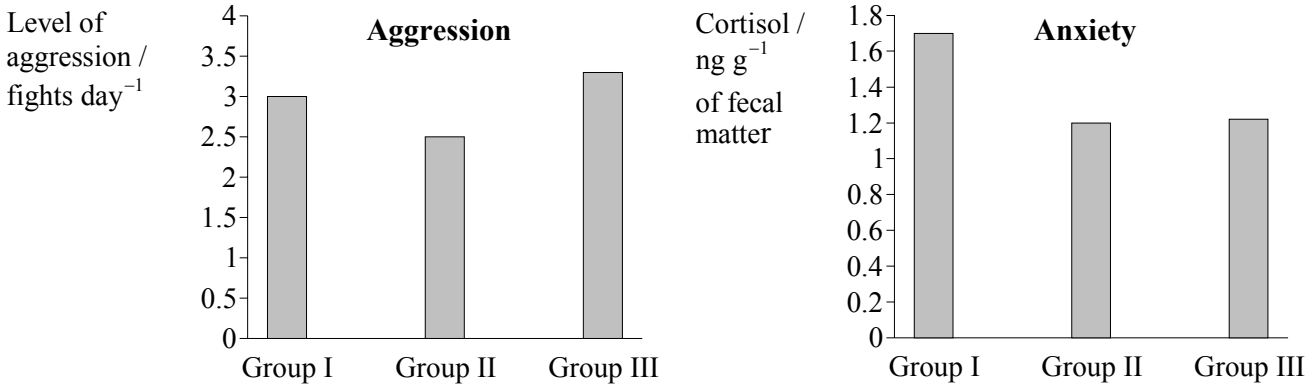
Option E – Neurobiology and behaviour

E1. The effect of population density on aggressive behaviour was studied in three groups of chimpanzees. Group I lived in a crowded space and was able to hear their neighbours. Group II lived in a crowded space, unable to hear their neighbours, and Group III lived in a large, isolated compound. The level of aggression was measured according to the average number of fights per day. Fecal matter was collected and analysed for the level of cortisol. (When anxious or stressed, chimpanzees produce more cortisol.) The bar charts summarize the results obtained.



[Source: Frans B M de Waal, *et al.*, (May 2000) *Scientific American*, pages 54–59]

(a) Identify the level of cortisol in Group III. *[1]*

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(b) Compare the difference in aggressive behaviour between Groups I and II. *[1]*

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(c) Outline the effects of living conditions on stress using the data above. *[2]*

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(d) One hypothesis suggests that stress leads to more aggressive behaviour. Evaluate whether the data supports this hypothesis. *[3]*

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E2. (a) Define *operant conditioning*. *[1]*

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(b) Outline the neural basis of memory and learning. *[2]*

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E3. (a) Describe **one** named example of courtship behaviour. *[2]*

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(b) Discuss the social effects of alcohol abuse. *[3]*

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Option F – Applied plant and animal science

F1. Sewage sludge is used as organic fertiliser. Generally it is rich in organic and inorganic nitrogen, although some of the nitrogen cannot be used by plants.

Sewage sludge was composted by heating to 55 °C for about seven weeks (the active phase) and then left to mature for approximately two months. Three samples were selected at different stages of the composting process:

I. initial non-decomposed mixture
II. end of the active phase
III. mature compost.

To test the effectiveness of the three samples, experiments were performed in a greenhouse. Ryegrass was planted in separate pots containing each of the three samples and harvested a month later. The yield (dry mass) and total nitrogen concentration of the plant material was determined. The results are shown in the table together with the chemical characteristics of the three samples.

Sample	**I**	**II**	**III**
pH	7.6	8.0	7.3
Organic nitrogen / g kg^{-1}	20.0	35.8	33.5
Inorganic nitrogen / g kg^{-1}	0.8	0.7	4.2
Yield of ryegrass / g pot^{-1}	1.8	5.5	6.5
Nitrogen concentration in ryegrass plant / %	2.3	4.5	5.0

[Source adapted from: M P Bernal *et al.,* (1998) *Soil Biol. Biochem*, **30** (3), pages 305-313]

(a) Calculate the percentage of nitrogen in sample III that is found in inorganic form. *[1]*

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(b) Compare the different crop yields of ryegrass. *[2]*

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(c) Using the data provided, discuss which sample is the best fertiliser. *[3]*

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F2. (a) Draw the generalised structure of a dicotyledonous insect-pollinated flower. *[3]*

(b) Explain how the scientific understanding of plant life cycles can improve the commercial production of cut flowers. *[2]*

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F3. (a) Outline how animal breeds were improved to make better skins for clothing. *[1]*

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(b) Explain how vaccination has been applied to improve health in animals. *[3]*

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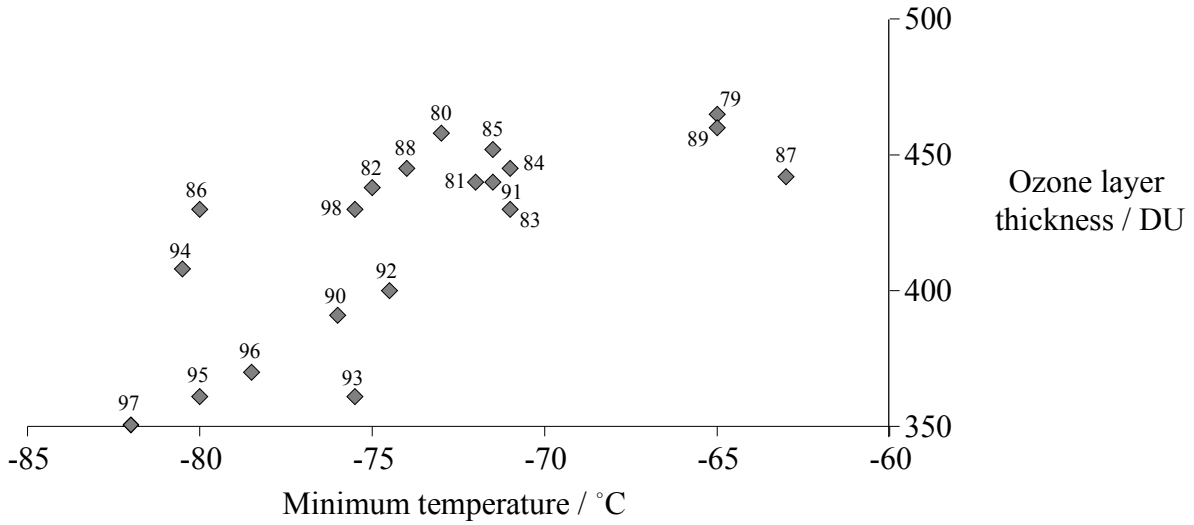
Option G – Ecology and conservation

G1. Build-up of greenhouse gases in the atmosphere is associated with global warming and ozone depletion. In order to study how the rising levels of greenhouse gases may affect ozone depletion over the Arctic, the temperature and thickness of the ozone layer were measured for several years. The scattergram below shows the ozone levels and minimum temperatures in the Arctic circle (63° to 90° N) from 1979 to 1998. The ozone layer's thickness is measured in Dobson units (DU).

[79 = 1979, *etc*.]



[Source: Ross J Salawitch, (1998) *Nature*, **392** (9), pages 551–552]

(a) Identify the year in which the ozone layer was the thinnest. *[1]*

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(b) Outline the relationship between the minimum temperature and ozone layer thickness. *[2]*

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(c) Compare the data for the years 1980 to 1989 with the years 1990 to 1998. *[2]*

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(This question continues on the following page)

(Question G1 continued)

(d) Suggest **one** reason for the higher levels of ozone measured in 1998. *[2]*

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G2. (a) Define *mutualism*, giving an example. *[2]*

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(b) Explain the differences in photosynthetic efficiency between tropical forests and deserts. *[3]*

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G3. Explain the significance of the principle of competitive exclusion. *[3]*

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