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

N02/410/H(3)

BIOLOGY
HIGHER LEVEL
PAPER 3

Thursday 14 November 2002 (morning)

1 hour 15 minutes

Name

Number

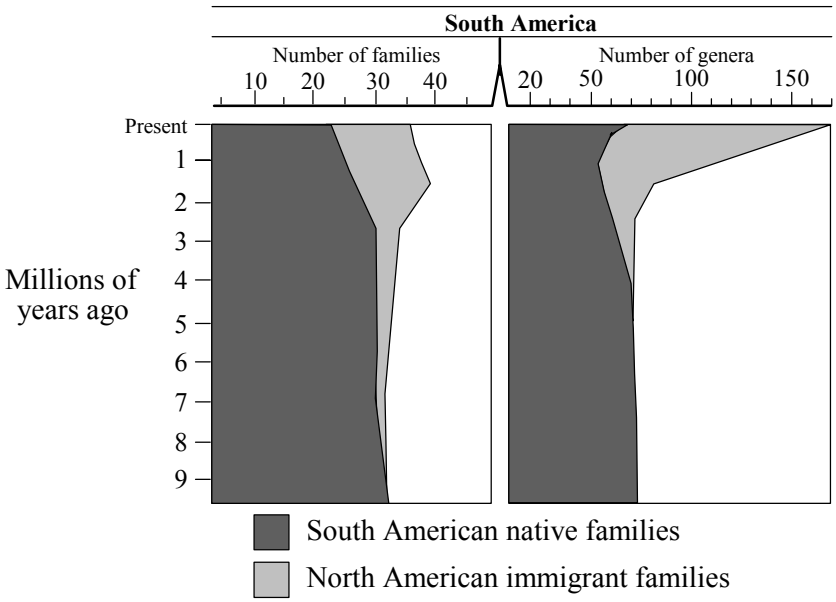
INSTRUCTIONS TO CANDIDATES

- 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 two 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
		/20	/20	/20
		/20	/20	/20
NUMBER OF CONTINUATION BOOKLETS USED	. . . . .	TOTAL /40	TOTAL /40	TOTAL /40

Option D – Evolution

D1. About 2.5 million years ago, falling sea levels resulted in the joining together of North America and South America through a narrow land bridge, the isthmus of Panama. This event allowed two-way traffic of land mammals between the formerly isolated continents. A redistribution of families and genera (plural form for genus) occurred. The following graphs show the total number of known native and immigrant families and genera in South America over a time span ranging from 9 million years ago to the present.



[Source: Marshall, *Science* (1982), **215**, pages 1351–1357]

(a) Compare the changes in the number of South American native families and the number of North American immigrant families in the 1 million years after the formation of the land bridge. *[2]*

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(b) Suggest a reason for the decline in the number of South American native families and the number of North American immigrant families within the last 1.5 million years. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(c) Using the data from 9 million years ago and the present, calculate the percentage increase in the total number of genera found in South America. *[1]*

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(d) Discuss why the percentage increase in genera is much greater than the apparent percentage increase in families. *[2]*

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(e) State a form of evidence on which the data in the graphs is based. *[1]*

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D2. (a) Using the Hardy-Weinberg principle, calculate the percentage of carriers in a population where the occurrence of the condition cystic fibrosis is 1 in 2500 births. *[2]*

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(b) Predict the effect on a gene pool in succeeding generations if the conditions of the Hardy-Weinberg principle are not met. *[1]*

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D3. (a) Explain how variation in a population results from the recombination of alleles. *[7]*

(b) Outline consequences of an increase in brain size for the Homo lineage. *[3]*

Option E – Neurobiology and behaviour

E1. (a) Explain how the autonomic nervous system controls the heart rate and salivary glands. *[6]*

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(b) Describe how the neuron may be involved in memory and learning. *[4]*

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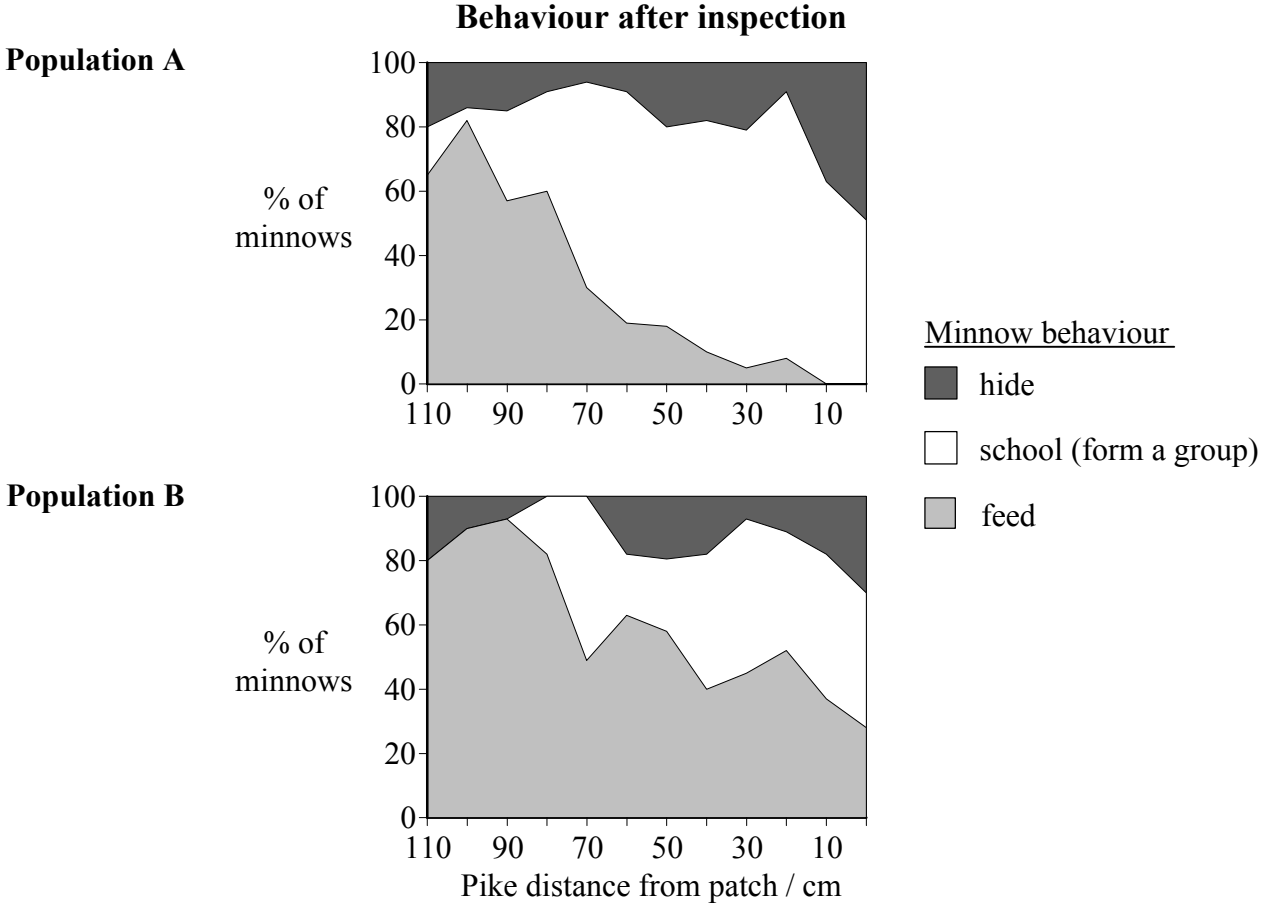
E2. Various freshwater locations in the United Kingdom contain minnows (*Phoxinus phoxinus*), a type of small fish. Minnows are often eaten by pike (*Esox lucius*), a large predatory fish. After encountering a pike for the first time, minnows begin predator inspection behaviour to confirm recognition of the predator. An experiment was performed to investigate how minnows behave **after** inspecting a pike. Two different populations of minnows were observed in two identical tanks, each equipped with an identical pike model. At the start of the experiment each minnow population was feeding on a patch of food at one end of each tank. The pike model was placed at the other end of each tank and moved towards the minnows.



[Source: Magurran, *Behaviour Ecology Sociobiology* (1986), **19**, pages 267–273]

(a) For each population, estimate the percentage of minnows which are hiding when the pike model is at the greatest distance from the patch of food. *[1]*

Population A: . . . . . .

Population B: . . . . . .

(This question continues on the following page)

(Question E2 continued)

(b) Compare the behaviour of population A with population B when the pike model is at a distance of 30 cm from the patch of food. *[1]*

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(c) Determine, giving a reason, which population was collected from a location where pike are a natural predator. *[2]*

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(d) Using the data from the graphs, deduce the factor which determines minnow behaviour after inspection. *[1]*

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(e) Suggest a reason for schooling behaviour in minnows. *[1]*

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E3. (a) Outline the Hering-Bruer reflex. *[2]*

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(b) Describe, using an example, the role of altruistic behaviour. *[2]*

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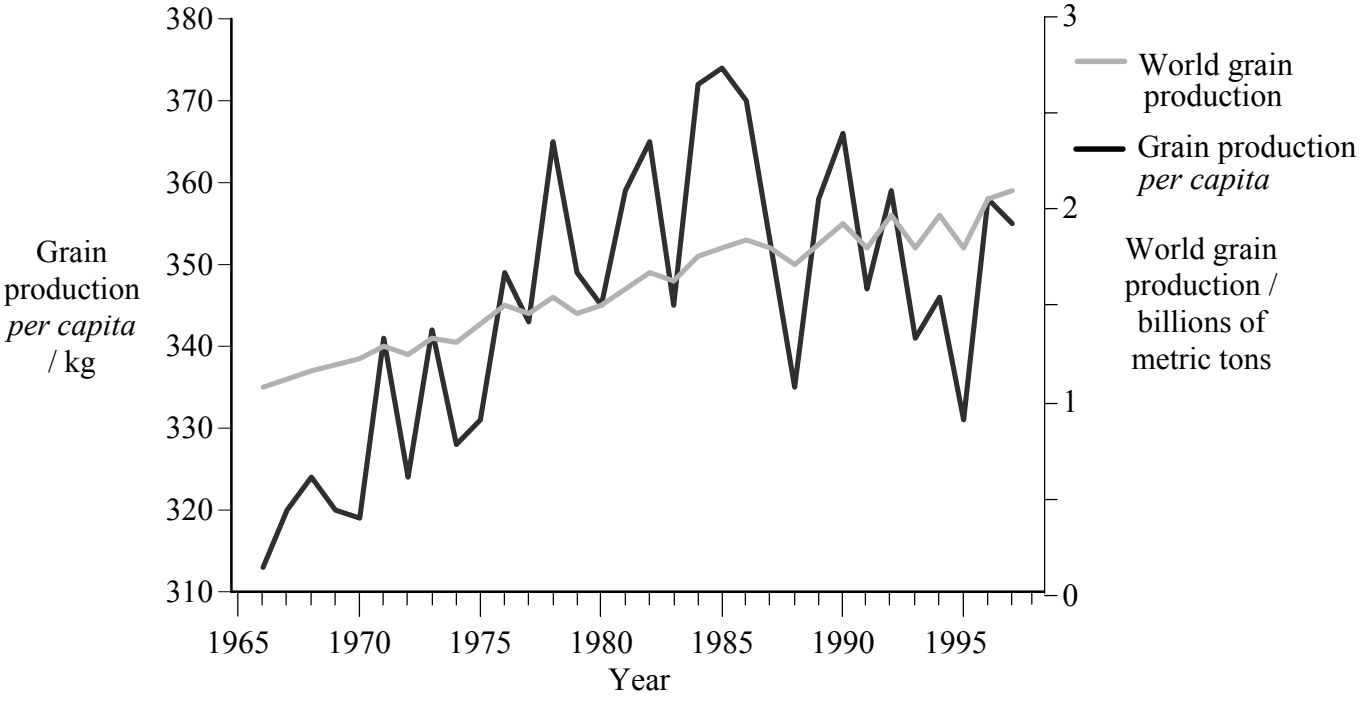
Option F – Applied plant and animal science

F1. In the l950s and 1960s, scientists in the Philippines and Mexico developed improved crop varieties and agricultural management techniques collectively known as the Green Revolution. The Green Revolution together with other developments has had a significant effect on world grain harvests. The graph below shows the effects of the Green Revolution on world grain production and grain production *per capita* (total grain production divided by the global population).



[Source: Mann, *Science* (1999), **283**, pages 310–314]

(a) Estimate the percentage increase in world grain production since 1966. *[1]*

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(b) Suggest **one** reason for the fluctuations in grain production *per capita.* *[1]*

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(c) Compare the overall trend in world grain production with grain production *per capita* from 1966 to l985. *[2]*

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(Question F1 continued)

(d) Analyse the graph during the period from 1985 to 1997. *[2]*

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F2. (a) Explain how the dramatic increase in wheat yield over the past 50 years has resulted from the application of knowledge of genetics. *[7]*

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(b) Describe how hormones can be used as weed killers in cultivated cereal. *[3]*

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F3. (a) Outline the biological advantages of "organic" farming methods. *[3]*

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(b) State **two** techniques used in modern plant production. *[1]*

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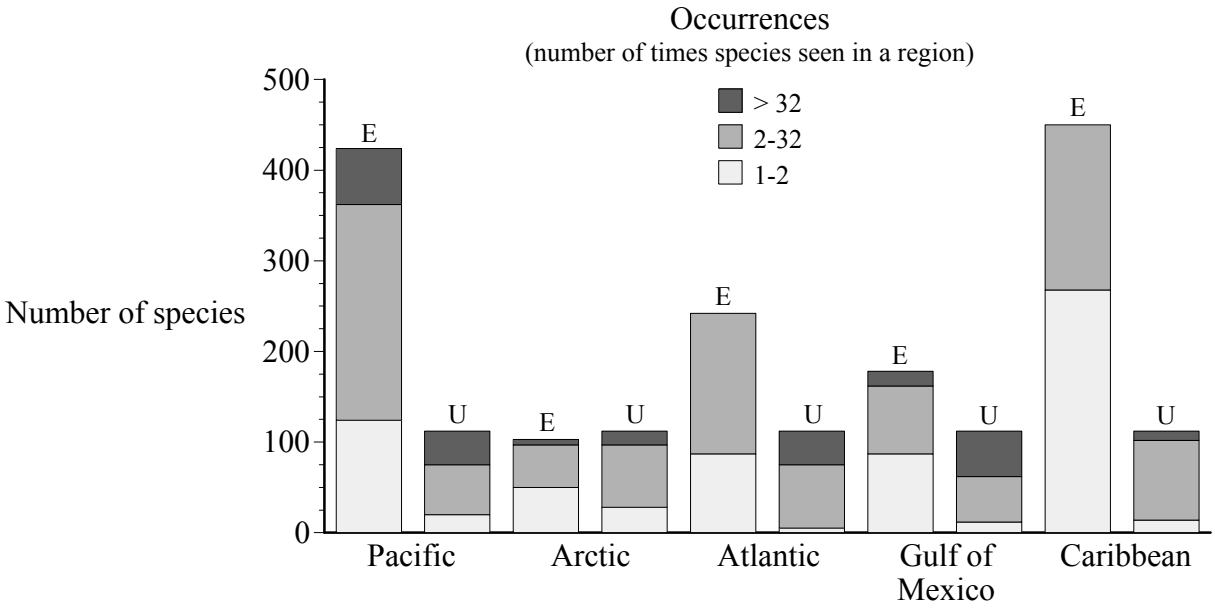
Option G – Ecology and conservation

G1. (a) Discuss reasons why the biodiversity of rain forests should be conserved. *[7]*

(b) Outline how increased UV radiation can affect life on Earth. *[3]*

G2. Foraminifera are small protozoans found in the sediment of all marine ecosystems. Several thousand species of foraminifera live in the Earth's oceans. Because a large number of individuals can be found in a small amount of sediment and because they exist worldwide, foraminifera are useful in examining the distribution of species. The bar graph below summarises data gathered from five coastal regions around North America. Those species occurring in all five regions are considered to be *ubiquitous* and those species occurring in only one area are considered to be *endemic*. The species of foraminifera were placed into three classes based on the number of times each species occurred at the five coastal regions.



Number of endemic (E) and ubiquitous (U) species in three occurrence classes in five coastal regions around North America.

[Source: Buzas and Culver, *BioScience* (1991), **41**, pages 483-489]

(a) Calculate the percentage of endemic species occurring in the Pacific region. *[1]*

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(b) Among the five regions, deduce the region where it would be easiest to find most of the ubiquitous species. *[1]*

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(This question continues on the following page)

(Question G2 Continued)

(c) Compare the occurrence of endemic species in the Pacific and Caribbean regions. *[2]*

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(d) Suggest, giving a reason, which of the Pacific, Atlantic **or** Caribbean regions will have a greater extinction rate. *[2]*

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(e) Identify which region has the lowest species diversity. *[1]*

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G3. Compare the roles of *Rhizobium* and *Pseudomonas denitrificans* in the nitrogen cycle. *[3]*

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Option H – Further human physiology

H1. A major requirement of the body is to eliminate carbon dioxide (CO_2). In the body, carbon dioxide exists in three forms: dissolved CO_2, bound as the bicarbonate ion, and bound to proteins (*e.g.* haemoglobin in red blood cells or plasma proteins). The relative contribution of each of these forms to overall CO_2 transport varies considerably depending on activity, as shown in the table below.

CO_2 Transport in Blood Plasma at Rest and During Exercise

Form of transport	Arterial mmol l^{-1} blood	**Rest** Venous mmol l^{-1} blood	**Exercise** Venous mmol l^{-1} blood
dissolved CO_2	0.68	0.78	1.32
bicarbonate ion	13.52	14.51	14.66
CO_2 bound to protein	0.3	0.3	0.24
Total CO_2 in plasma	14.50	15.59	16.22
pH of blood	7.4	7.37	7.14

[Source: Geers and Gros, *Physiological Reviews* (2000), **80**, pages 681–715]

(a) Calculate the percentage of CO_2 found as bicarbonate ions in the plasma of venous blood at rest. *[1]*

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(b) (i) Compare the changes in total CO_2 content in the venous plasma due to exercise. *[1]*

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(ii) Identify which form of CO_2 transport shows the greatest increase due to exercise. *[1]*

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(This question continues on the following page)

(Question H1 continued)

(c) Explain the pH differences shown in the data. *[3]*

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H2. (a) Describe how the ileum uses active transport in the absorption of food. *[3]*

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(b) Outline how the blood is routed to the liver, through the liver, and from the liver. *[3]*

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(c) List **two** substances resulting from the breakdown of haemoglobin in the liver. *[1]*

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H3. Explain the events of the cardiac cycle. *[7]*

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