22106018

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

BIOLOGY
STANDARD LEVEL
PAPER 3

Tuesday 18 May 2010 (morning)

1 hour

Candidate session number

|	0	0								

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 and your cover sheet 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 — Human nutrition and health

A1. Body mass index (BMI) is an important indicator of health. The relationship between a high BMI and percentage risk of developing type II diabetes was studied and the following data presented.

Key: women ○ men ◻
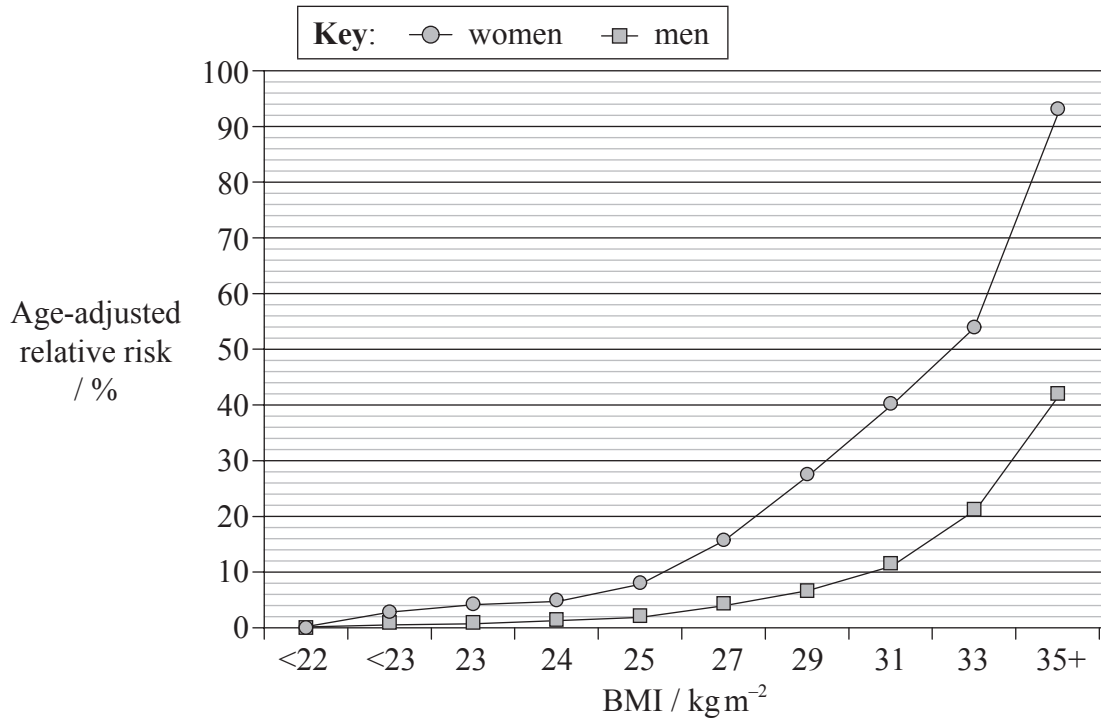
[Source: adapted from J Chan, *et al.*, (1994), *Diabetes Care*, **17**, page 961 and
G Colditz, *et al*., (1995), *Annals of Internal Medicine*, **122**, page 481]

(a)   Describe the effect of increased BMI on the risk of developing type II diabetes.   *[2]*

. . . .

. . . .

. . . .

. . . .

(b)   Identify the risk of developing type II diabetes in men with a BMI of $33\,kg\,m^{-2}$.   *[1]*

. . . .

. . . .

(c)   Determine, by indicating on the graph, the range of age-adjusted relative risk for women who are overweight but not obese.   *[1]*

(This question continues on the following page)

(Question A1 continued)

(d) Explain the dietary advice that should be given to a patient who has developed type II diabetes. *[4]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

A2. (a) Distinguish between the composition of human milk and artificial milk for bottle-feeding babies. *[2]*

. . . .

. . . .

. . . .

. . . .

(b) State a main dietary source of carbohydrates in **two named** ethnic groups. *[2]*

. . . .

. . . .

(c) Explain possible health consequences of diets rich in fats. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

0328

A3. (a) State a source of vitamin D in a human diet. *[1]*

. . . .

. . . .

(b) Discuss exposure to sunlight as a source of vitamin D. *[2]*

. . . .

. . . .

. . . .

. . . .

A3. (a)

0428

Blank page

Option B — Physiology of exercise

B1. The VO_2 max was studied for a person exercising on a treadmill. Data was collected for 13 minutes of progressively faster and steeper running until a peak VO_2 was reached.

Time / mins	VO_2 per kg / ml min^{-1} kg^{-1}	Heart rate / beats min^{-1}	Ventilation rate / breaths min^{-1}
00:47	27.4	126	26.0
02:17	36.6	134	26.0
03:47	40.9	140	26.5
05:17	45.6	149	32.2
06:46	49.2	153	31.1
08:17	53.1	162	34.0
09:47	57.2	167	37.1
11:17	59.2	172	38.4
12:47	62.4	176	41.8
13:17	63.2	177	42.9

[Source: adapted from raw data obtained from sports exhibition at Toronto Science Centre (1989)]

(a) State the maximum VO_2 per kg for this subject. *[1]*

....

(b) Determine which has had a greater percentage increase, ventilation rate **or** heart rate, during the duration of the exercise. Show your working. *[2]*

....

....

....

....

(c) The subject weighed 70.0 kg at the time of this exercise. Calculate the VO_2 max. *[1]*

....

....

....

....

(This question continues on the following page)

(Question B1 continued)

(d) Evaluate the limitations of the data provided by this research. *[2]*

. . . .

. . . .

. . . .

. . . .

B2. (a) (i) Define *stroke volume*. *[1]*

. . . .

. . . .

(ii) Define *cardiac output*. *[1]*

. . . .

. . . .

(b) As fitness increases, a person's heart rate drops. Suggest a reason for this phenomenon. *[1]*

. . . .

. . . .

. . . .

(c) Describe distribution of blood flow at rest and during exercise. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

B3. (a) State **two** methods of ATP production used by muscles during intense exercise.   *[2]*

. . . .

. . . .

(b) Discuss the ethics of using performance-enhancing substances.   *[4]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

Blank page

0928

Turn over

Option C — Cells and energy

C1. Primary production is directly related to the amount of photosynthesis that occurs in a cubic metre of water. In the waters around Bermuda (32° N) in the Atlantic Ocean, microscopic phytoplankton are the producers. They use trace nutrients from seawater in their metabolism. These nutrients are a limiting factor in total population size. A dense phytoplankton population makes the water cloudy. The data shows primary production per day for each month for the year 2000 at different water depths.
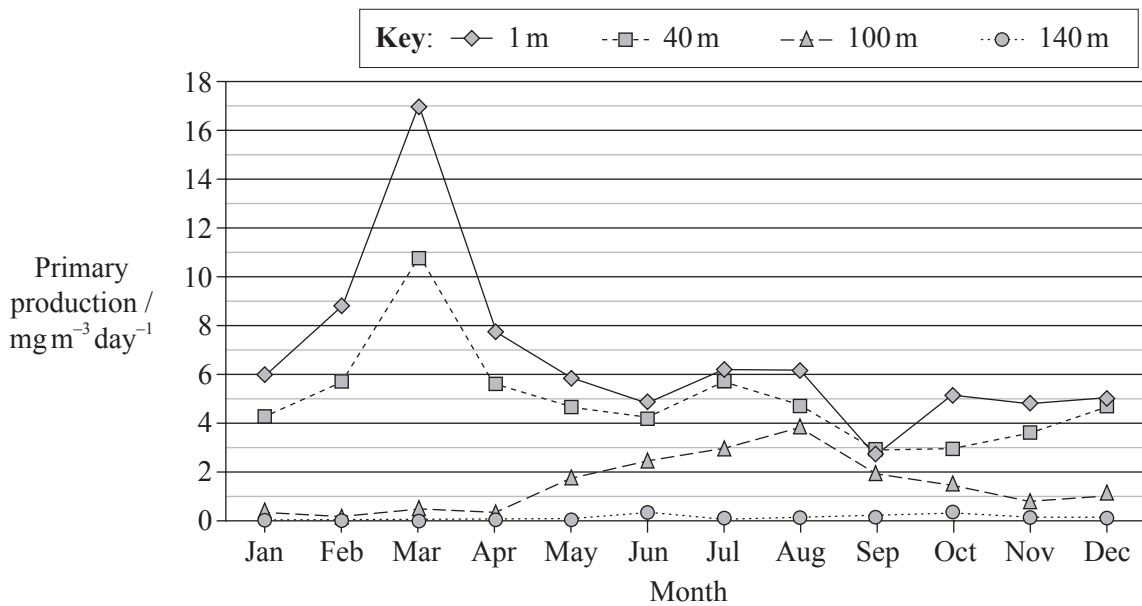
[Source: adapted from DataStreme Ocean (2004) Copyright American Meteorological Society. Used with permission]

(a) State the month when total photosynthesis was greatest. *[1]*

. . . .

(b) Identify, with a reason, the water depth that receives no light. *[1]*

. . . .

. . . .

(c) In the upper 40 m there is a drop in photosynthesis from March to June. This is probably due to lack of nutrients, reducing the population density.

Suggest, with a reason other than nutrient levels, what might have increased photosynthesis at 100 m from April to August. *[1]*

. . . .

. . . .

(This question continues on the following page)

(Question C1 continued)

(d) Compare production in March with production in September. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

C2. (a) Draw a labelled diagram showing the structure of a mitochondrion as seen in electron micrographs. *[4]*

(b) Explain the relationship between the structure of the mitochondrion and its function. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

C3. (a) List **three** functions of proteins, giving a **named** example of each. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

(b) Explain the significance of polar amino acids and non-polar amino acids in membranes. *[2]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

Blank page

1328

Option D — Evolution

D1. The HIV virus has a high rate of mutation. Scientists studied the evolution of this virus in a small group of men with a slow rate of disease progression for a period of 12 years. The viral divergence from the original viral population and the diversity within the populations were recorded over the years.

GRAPH REMOVED DUE TO COPYRIGHT REASONS.

(This question continues on the following page)

(Question D1 continued)

(a) (i) Identify the pattern of divergence of the viral sequence from the original viral population. *[1]*

    . . . .

    . . . .

    (ii) Identify the change in the pattern of diversity of the populations. *[1]*

    . . . .

    . . . .

(b) Estimate the percentage increase of the population diversity from the stage of the initial infection to the diversity 12 years later. *[2]*

. . . .

. . . .

. . . .

. . . .

(c) Using the data provided, suggest how the change in divergence and diversity of viral RNA may be of evolutionary benefit to the HIV virus. *[2]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

D2. (a) Outline the process of adaptive radiation.   *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

(b) There has been a change of thinking; moving from gradualism to punctuated equilibrium demonstrates the changing nature of science. Discuss these two ideas about the pace of evolution.   *[4]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

D3. (a) Outline, using **named** hominid fossil species, trends in hominid skull evolution.   *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

(b) Discuss the correlation between diet and brain size.   *[2]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

Blank page

1728

Turn over

Option E — Neurobiology and behaviour

E1. Drug abuse and alcohol abuse are neurobehavioural disorders of complex origin. A human gene has been identified that encodes the main enzyme (FAAH) for inactivating cannabinoid (THC). A mutation in this gene can occur and the homozygous mutation allows normal catalytic activity of FAAH but makes the FAAH more likely to be broken down. A study was conducted to test for the presence of the homozygous FAAH mutation in relation to drug and alcohol abuse. Four different groups were formed based on their use of drugs and alcohol.
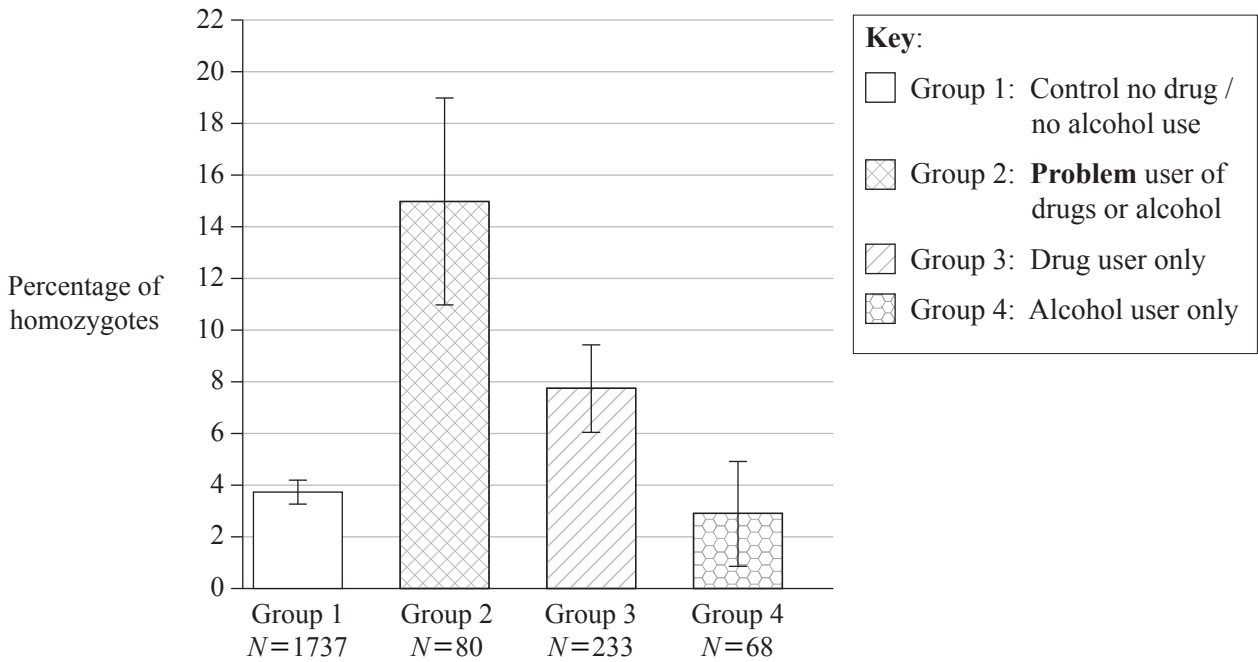
[Source: adapted from JC Sipe et al "A missense mutation in human fatty acid amide hydrolase associated with problem drug use" (2002) *PNAS*, **99** (12), pp. 8394–99: Figure 1 (adapted). Copyright 2002 National Academy of Sciences, USA]

(a) Identify the percentage of homozygotes among drug users only. *[1]*

. . . .

. . . .

(b) Calculate the actual number of homozygotes in group 2. *[2]*

. . . .

. . . .

. . . .

. . . .

(This question continues on the following page)

1828

(Question E1 continued)

(c) Evaluate the evidence to support the hypothesis that the presence of the homozygous mutation is a risk factor in drug and alcohol use. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

(d) Suggest a reason for the high incidence of homozygotes among drug and alcohol users. *[1]*

. . . .

. . . .

E2. (a) List **two** groups of sensory receptors, giving the stimulus each perceives. *[2]*

. . . .

. . . .

. . . .

(b) Explain the processing of visual stimuli. *[4]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

E3. (a) Distinguish, using examples, between innate behaviour and learned behaviour.   *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

(b) Using **two** examples, discuss how the process of learning can improve survival.   *[2]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

Blank page

Option F — Microbes and biotechnology

F1. In the year 2000, serious fires damaged two regions in Yellowstone National Park, USA. In the Glade fire there was destruction to the tops of trees while the Moran fire destroyed ground level species. After these fires, the overall nitrogen levels for ammonification (formation of ammonia) and nitrification in the soil were measured yearly.
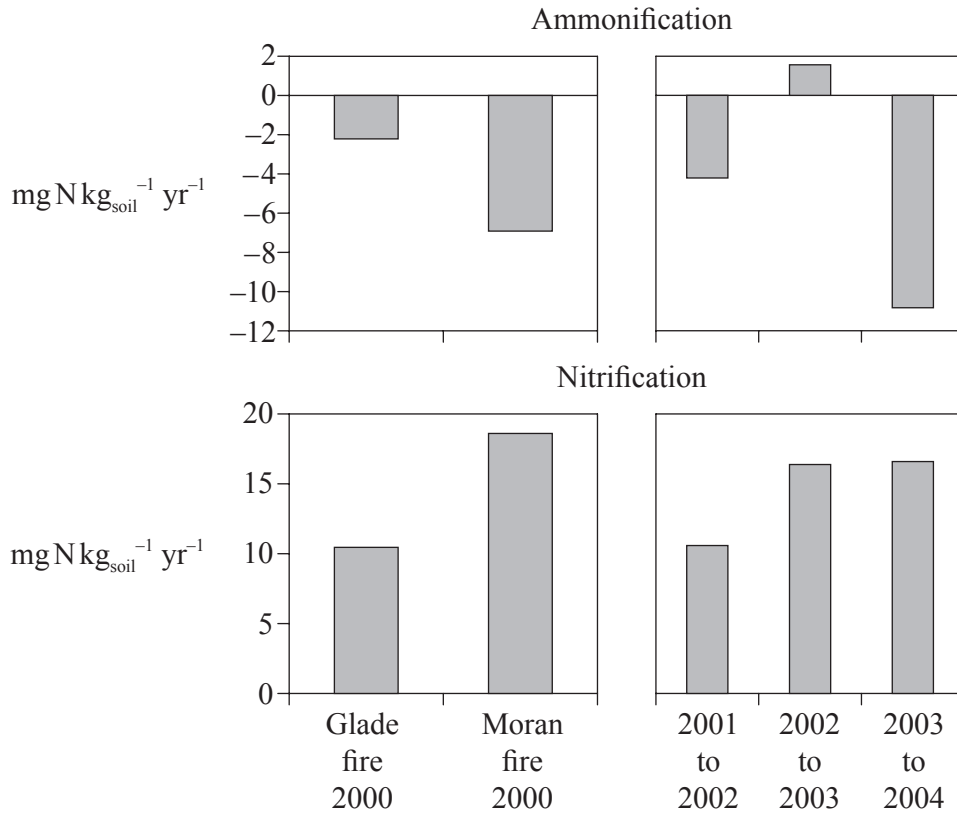
M G Turner, *et al*., (2007), *PNAS*, **104**(12), pages 4783–4789]

[Source: adapted from Monica G Turner: Inaugural Article "Inorganic nitrogen availability after severe stand-replacing fire in the Greater Yellowstone ecosystem" (2007) *PNAS*, **104** (12), pages 4782–89: Figure 3. Copyright 2007 National Academy of Sciences, USA]

(a)　(i)　Identify the years when the most ammonification occurred.　　*[1]*

....

　　(ii)　Calculate the net nitrogen level in the soil for the year of the Moran fire.　　*[1]*

....

(b)　State the name of **one** bacterium that could be responsible for nitrification levels.　　*[1]*

....

(This question continues on the following page)

(Question F1 continued)

(c) Using the data, explain what could account for the low levels of ammonia after the Moran fire. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

F2. (a) State the names of the **three** domains, giving a microbial example of each. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

(b) Traditional classification separates organisms into two groups: prokaryotes and eukaryotes. Explain the reasons for reclassification of life into three domains. *[2]*

. . . .

. . . .

. . . .

. . . .

. . . .

(c) Distinguish between the **two** domains of prokaryotes. *[2]*

. . . .

. . . .

. . . .

. . . .

2328

Turn over

F3. (a) Gene therapy may offer cures for inherited diseases and, perhaps, improve quality of life. Distinguish between somatic and germ line therapy. *[2]*

. . . .

. . . .

. . . .

. . . .

. . . .

(b) Discuss risks of gene therapy. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

Blank page

Option G — Ecology and conservation

G1. Invasion of alien species has become a serious issue in most environments of the world. This study of Nordic environments charts the presence of alien species over the last century. Relative proportions of invertebrates, vertebrates and plants and fungi are indicated in each bar.

Key: □ invertebrates   ▨ vertebrates   ■ plants and fungi

Terrestrial Ecosystem   **Freshwater Ecosystem**   **Marine Ecosystem**
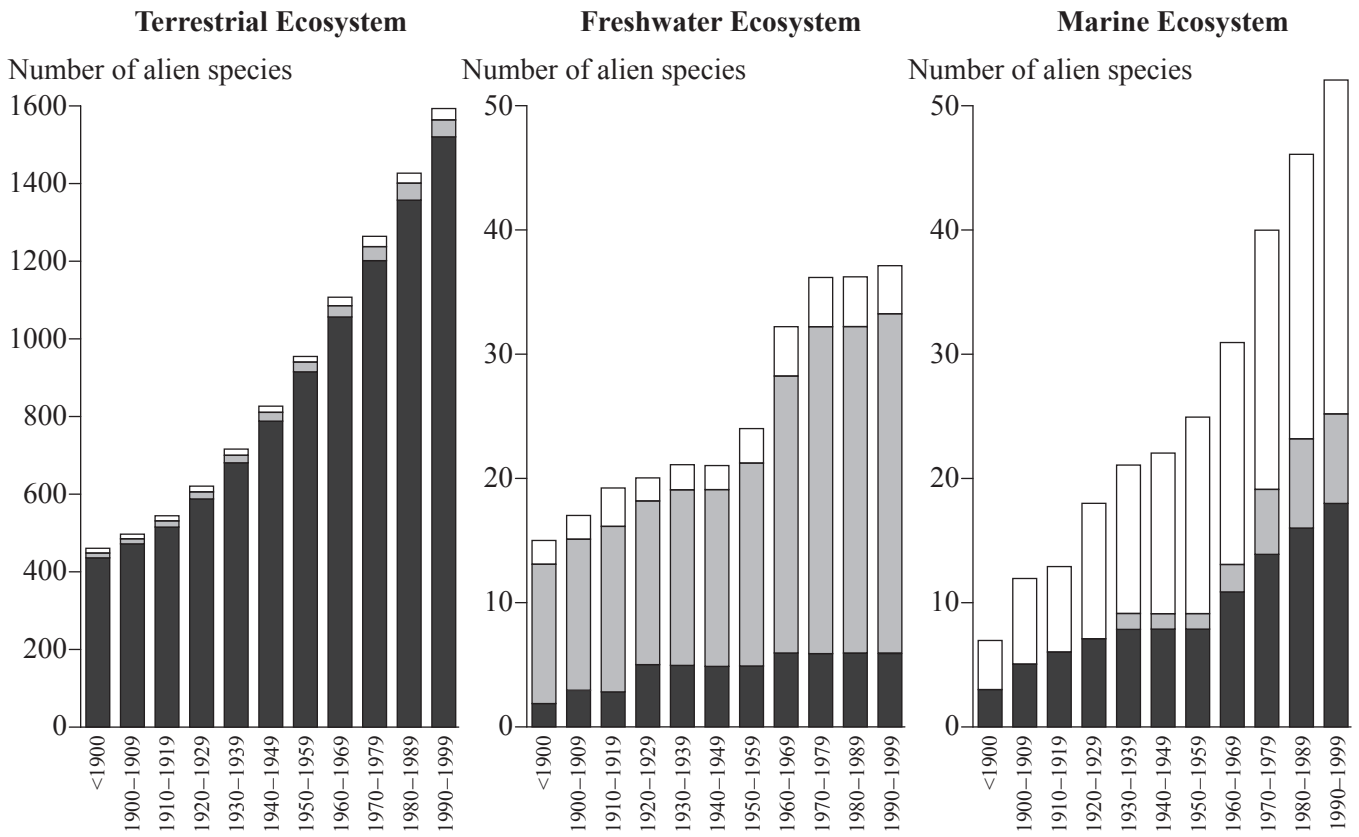
[Source: adapted from I. R. Weidema (ed), *Introduced Species in the Nordic Countries*, © Nordic Council of Ministers 2000, Copenhagen, Nord 2000:013, ISBN 92-893-0489-8]

(a)   (i)   State the ecosystem in which the proportion of alien vertebrates is the greatest.   *[1]*

....

(ii)   Describe the general pattern of the numbers of alien species in terrestrial and marine ecosystems.   *[1]*

....

....

(This question continues on the following page)

2628

(Question G1 continued)

(b) Suggest a reason why alien plant and fungi invasion is greatest in the terrestrial ecosystem. *[1]*

. . . .

. . . .

. . . .

(c) Identify how invasion of marine waters by alien invertebrates might occur. *[1]*

. . . .

. . . .

(d) Discuss the impact of alien species on ecosystems. *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

G2. (a) List **four** factors that affect the distribution of plant species. *[4]*

. . . .

. . . .

. . . .

. . . .

(b) Describe **one** effect of plants on an abiotic factor in a pioneer community. *[1]*

. . . .

. . . .

Turn over

G3. (a)   State the name of a statistical method used to quantify changes in biodiversity.   *[1]*

....

(b)   Discuss reasons for conservation of biodiversity of a **named** ecosystem.   *[5]*

....

....

....

....

....

....

....

....

....

....

2828