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

M03/410/H(3)+

BIOLOGY
HIGHER LEVEL
PAPER 3

Candidate number

Thursday 8 May 2003 (morning)

1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your candidate number in the box 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 candidate 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.

Option D – Evolution

D1. The discovery of well preserved fossil hominids has been particularly valuable as body size can be estimated. These new data show that different parts of the hominid body evolved at different times and at various rates. Eight species of hominid, five of *Australopithecus* and three of *Homo* were analyzed. The table below shows the geological dates and the estimated body and brain sizes of these species and of three modern African apes.
*(**Note**: Myr = millions of years ago)*

Primates	Species	Dates / Myr	Body mass / kg		Brain volume / cm^3
			Male	Female	
Australopithecus	*A. afarensis*	4.0 – 2.8	45	29	384
	A. africanus	3.0 – 2.3	41	30	420
	A. aethiopicus	2.7 – 2.3	–	–	399
	A. boisei	2.1 – 1.3	49	34	488
	A. robustus	1.8 – 1.0	40	32	502
Homo	*H. habilis*	2.4 – 1.6	52	32	597
	H. erectus (early)	1.8 – 1.5	58	52	804
	H. erectus (late)	0.5 – 0.3	60	55	980
	H. sapiens	0.4 – 0	58	49	1350
Modern African apes	*Pan paniscus*	0	38	32	343
	Pan troglodytes	0	49	41	395
	Gorilla gorilla	0	140	70	505

[Source: H McHenry, *Proceedings of the National Academy of Science, USA*, (1994), **91**, pages 6780–6786]

(a) (i) Identify, giving a reason, which hominid species is the **least** related to *H. sapiens*. *[1]*

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(ii) Suggest **one** reason why there is no data on body mass for *A. aethiopicus*. *[1]*

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(Question D1 continued)

(b) Compare the body mass of the **three** different primate groups. *[2]*

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(c) Lamarck, Huxley and Darwin speculated that bipedalism occurred before encephalization (increase in brain size), but they had no fossil proof. Using the data in the table evaluate this hypothesis. *[3]*

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D2. (a) Outline **one** modern example of observed evolution by natural selection. *[2]*

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

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D3. (a) Outline cystic fibrosis as an example of gene mutation. *[4]*

(b) Explain the Hardy-Weinberg equation and why it is used. *[6]*

Option E – Neurobiology and behaviour

E1. (a) Explain how the sympathetic and parasympathetic systems control the heart, the salivary glands and the iris of the eye. *[7]*

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(b) Outline how enkephalins can act as painkillers. *[3]*

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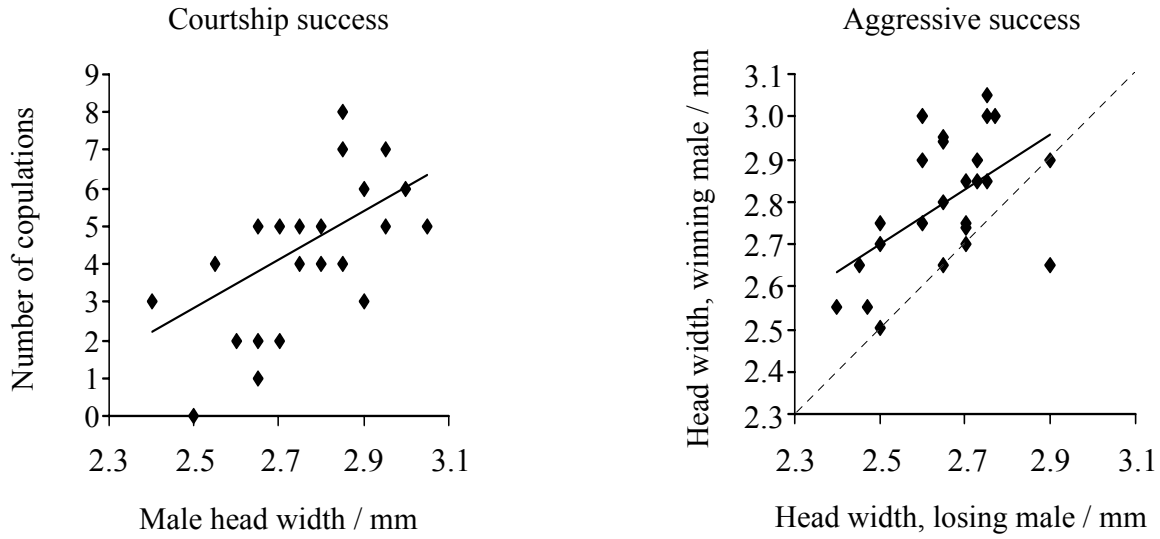
E2. The hypothesis is that the female Hawaiian picture-winged fly (*Drosophila heteroneura*) sexually selects larger-headed males. This was tested by examining the two major contributors to sexual selection, courtship and aggressive success.

For courtship success, males with different head widths were housed in individual chambers and tested on each of ten days with a different virgin *D. heteroneura* female. The number of copulations was recorded as the courtship success.

For tests of aggressive success, males were marked by painting a yellow dot on either the left or the right of the thorax. Two males per chamber were observed for one hour. The aggressive interactions of high intensity were noted. Such fights usually had decisive outcomes, in which the winning male stood his ground and the other retreated.

The graphs below show the associations between head width and courtship and aggressive success of *D. heteroneura.*

Key: ——— best fit line - - - - - line of equal size flies



[Source: Boake *et al.*, *Proceedings of the National Academy of Science, USA*, (1997), **94**, pages 12442–12445]

(a) State the relationship between head width and the number of copulations. *[1]*

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(b) Describe the effect a larger head has on the aggressive success. *[2]*

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(This question continues on the following page)

(Question E2 continued)

(c) The scientists proposed that the male head width is important in mate selection. Discuss whether the data from the graphs support this hypothesis. *[3]*

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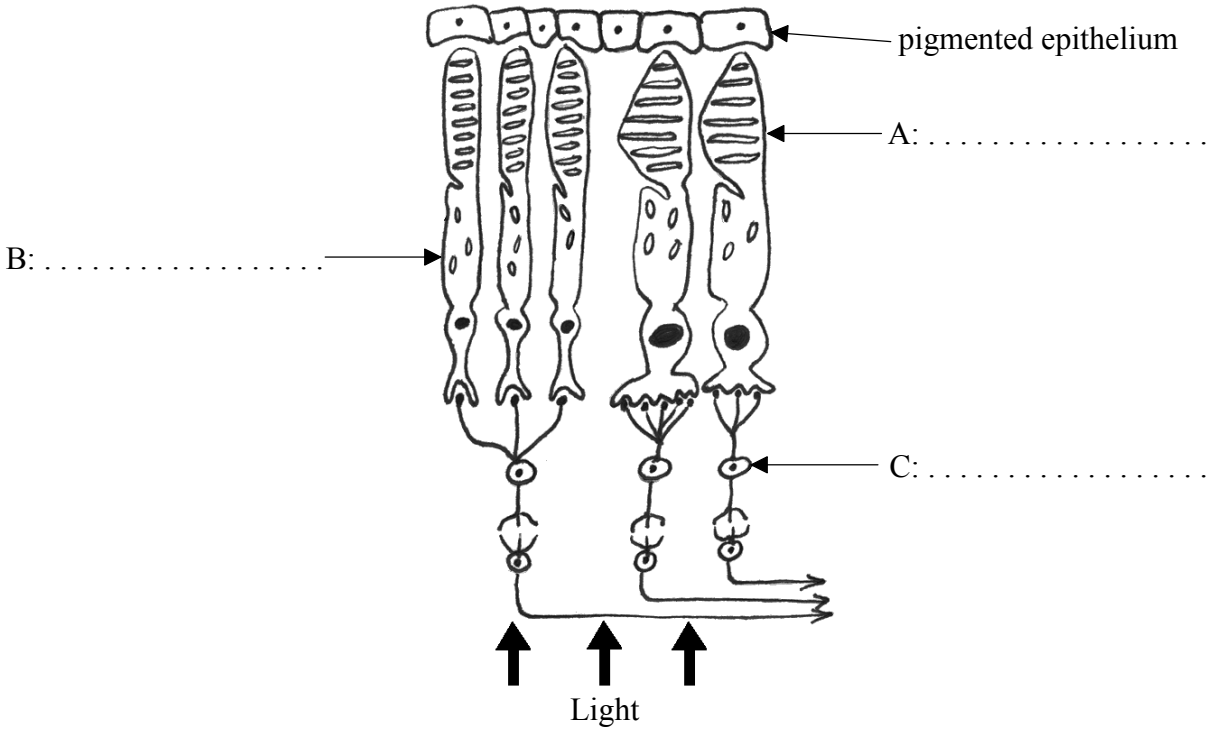
E3. (a) Label the diagram of the human retina shown below. *[2]*



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

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(ii) State **one** function of the medulla oblongata. *[1]*

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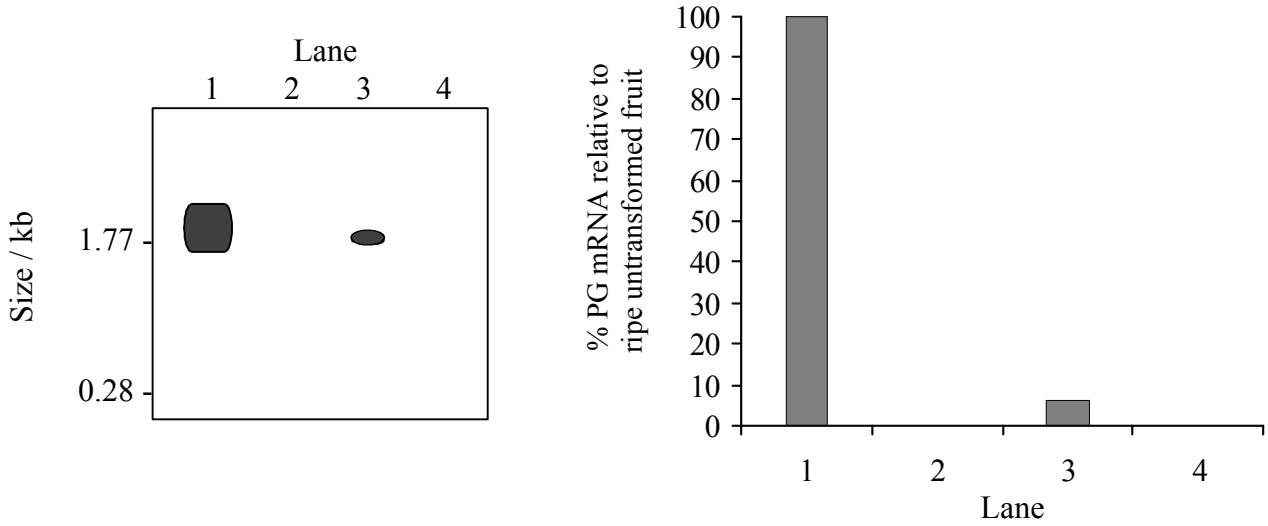
Option F – Applied plant and animal science

F1. Polygalacturonase (PG) plays an important role in fruit softening by making the pectin of the cell wall more soluble. It is synthesized only when the fruit is ripe.

In order to slow down the ripening of tomatos (*Lycopersicon esculentum*), antisense RNA technology was used. Messenger RNA from untransformed and transformed fruit was hybridized to a radioactively labelled probe specific to the PG sense strand.

The results of a gel electrophoresis of mRNA are given below. (The size of the mRNA strands is expressed in kilobases, kb.) The histogram shows these results expressed as the percentage of PG mRNA in ripe untransformed fruit.

Lane 1: Ripe untransformed fruit
Lane 2: Unripe untransformed fruit
Lane 3: Ripe transformed fruit
Lane 4: Unripe transformed fruit



[Source: Smith *et al*., *Nature*, (1988), **334**, pages 724–726]

(a) State the percentage of PG mRNA in ripe transformed fruit. *[1]*

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(b) Compare the results obtained for ripe and unripe fruit. *[2]*

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(This question continues on the following page)

(Question F1 continued)

(c) Using the information provided, explain how the antisense technology affects transformed fruit. *[3]*

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F2. (a) State **one** way in which we make use of domesticated animals. *[1]*

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(b) (i) Define the term *interspecific hybridization* in plant breeding. *[1]*

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(ii) Outline **one** example of polyploidy. *[2]*

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F3. (a) Outline crop production by hydroponics. *[3]*

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(b) Explain the technique used in cloning by micropropagation. *[7]*

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Option G – Ecology and conservation

G1. (a) Outline the effects of UV radiation on living tissues. *[4]*

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(b) Explain how methane is produced from biomass. *[6]*

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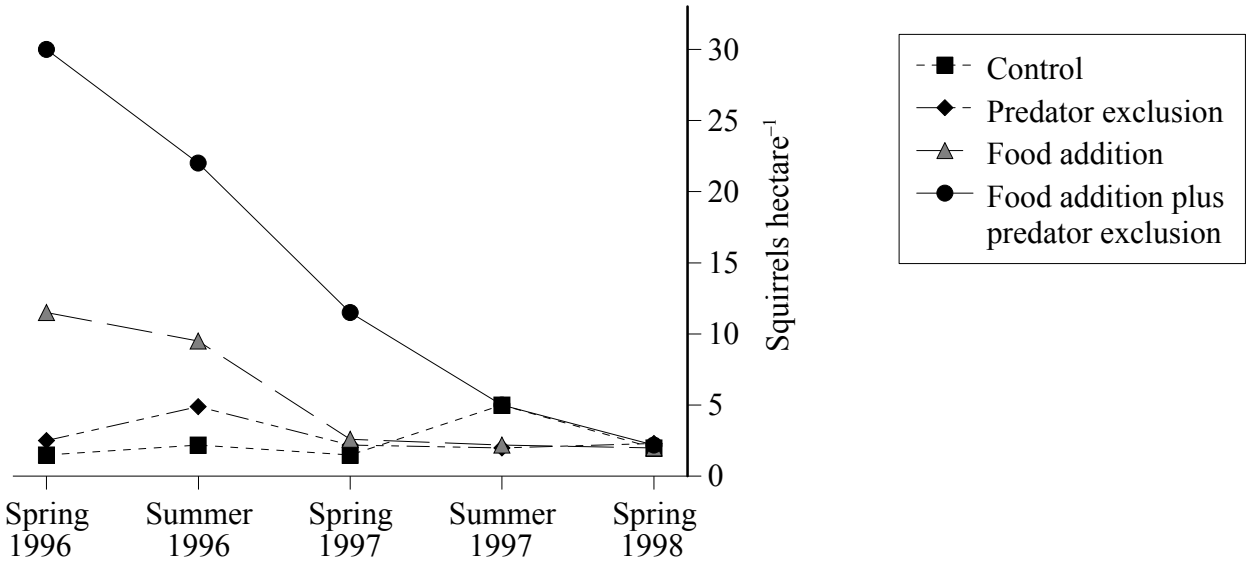
G2. The Kluane boreal forest ecosystem project was a large scale ten year experimental manipulation of food and predators on arctic ground squirrel population (*Spermophilus parryii plesius*).

Three areas were set up:

- a food addition area
- a predator exclusion area
- a food addition area enclosed within a predator exclusion area.

The areas were monitored from 1986 to 1996. In spring 1996 all fences were dismantled and food addition was stopped.

As a further experiment, spring and summer mark-recapture population estimates of the squirrels were conducted from spring 1996 to spring 1998. The results for these two years are shown below. The areas are labelled according to the conditions imposed during the previous ten years.



[Source: Karels *et al*, *Nature*, (2000), **408**, pages 460–463]

(a) State the squirrel population in the food addition plus predator exclusion area in spring 1996. *[1]*

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(b) Describe the effect of ending food addition on the squirrel population. *[2]*

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(This question continues on the following page)

(Question G2 continued)

(c) Scientists believed that the number of ground squirrels in the boreal forests was limited by an interaction between food and predators that acted primarily through changes in reproduction. Using the data, discuss this hypothesis. *[3]*

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G3. (a) Define the term *net production*. *[1]*

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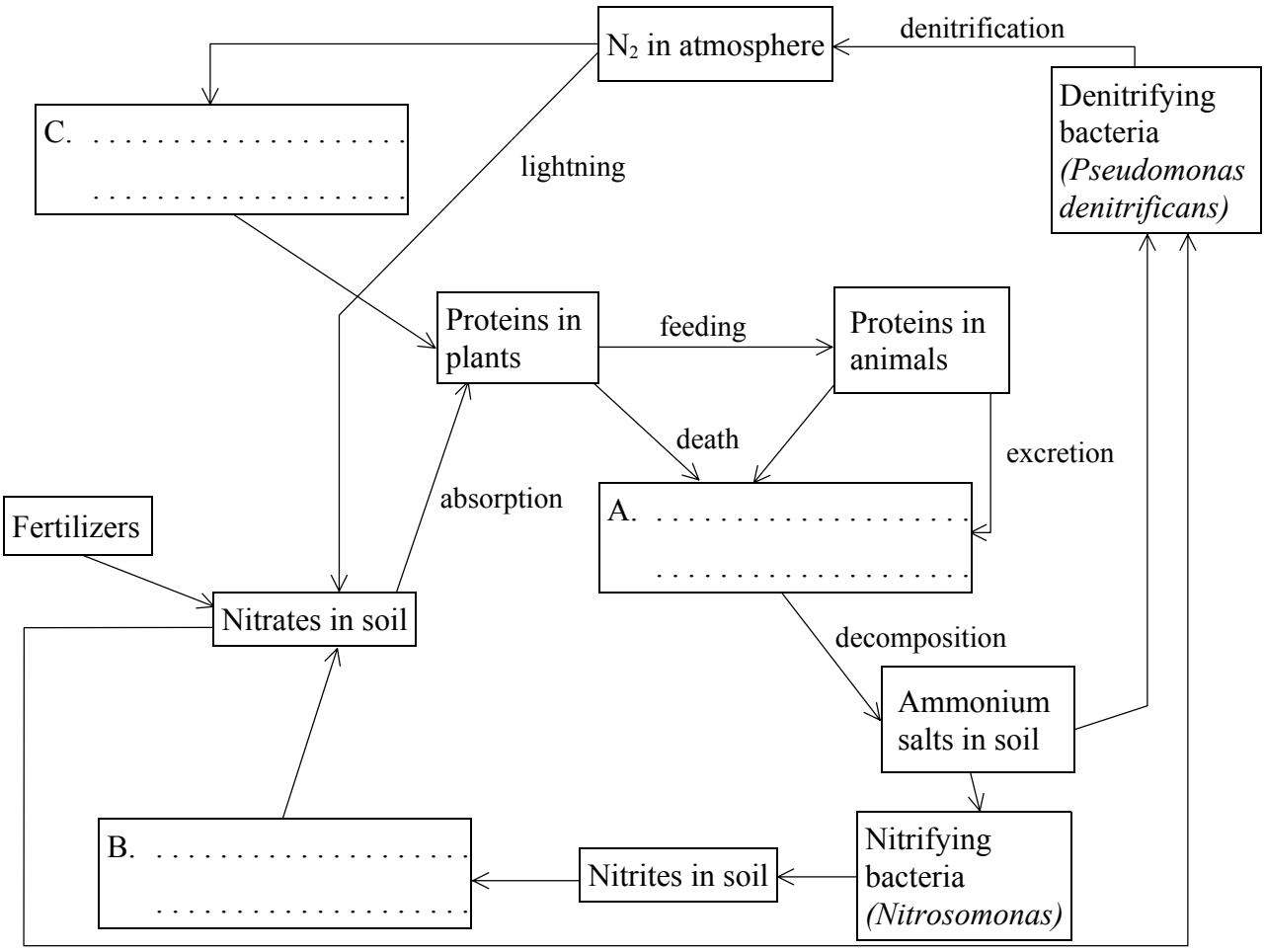
(b) Complete the diagram of the nitrogen cycle by naming the organisms involved in processes A, B and C below. *[3]*



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Option H – Further human physiology

H1. Research into how the lungs perform during general anesthetics has increased because there are so many pulmonary complications during operations. It is believed that many inhaled anesthetics affect pulmonary epithelial permeability.

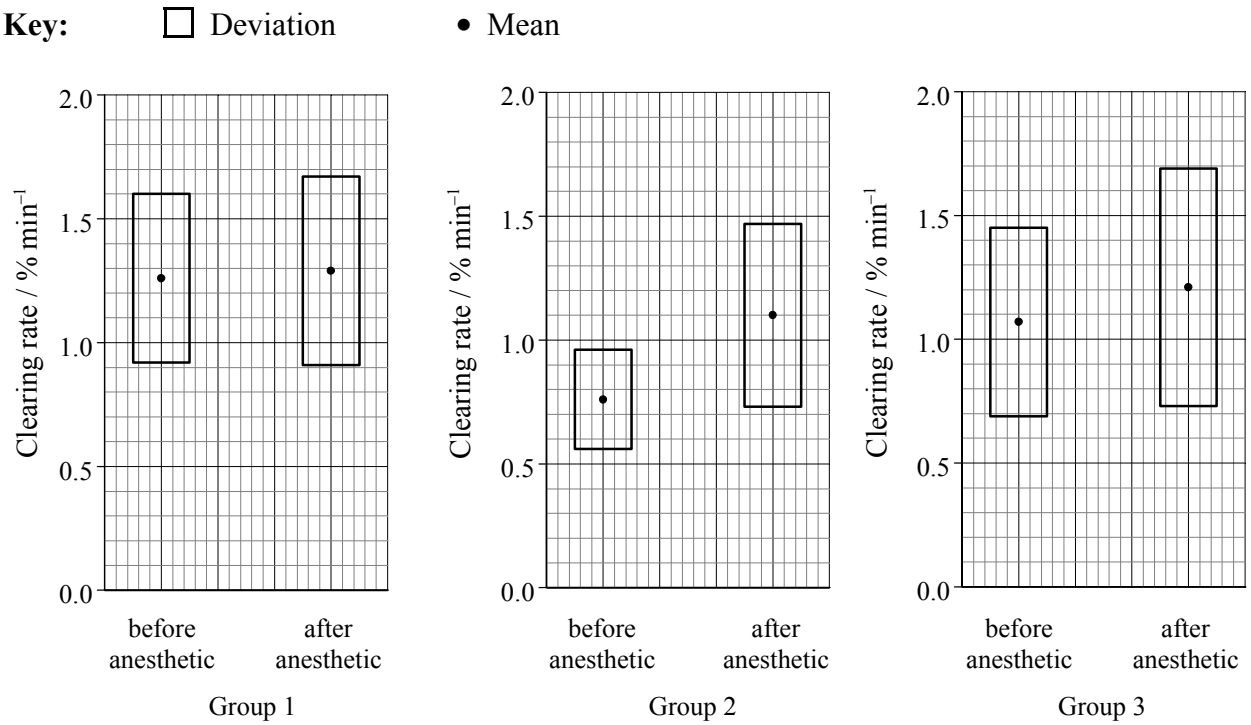
Pulmonary clearing is an indication of whether the alveolar-capillary barrier has been damaged. It can be measured as the rate at which radioactivity decreases in lungs after inhalation of a radioactive aerosol. The greater the clearing rate, the greater the damage to the alveolar-capillary barrier. Smoking and lung diseases (such as cancers and asthma) also significantly increase the clearing rate of radioactive aerosols.

In an experiment, doctors wanted to test the effect of inhaled anesthetics on the permeability between the alveoli and capillaries. Patients were tested by inhaling a radioactive aerosol one day before their operation and one hour after their operation.

Three groups of patients each received a different type of anesthetic.

Group 1: 1% halotane
Group 2: 1.5% isoflurane } inhaled anesthetics

Group 3: intravenous anesthetic (phentanyl and propofol)



[Source: Chang Lai *et al*., *Respiration*, (2000), Vol II, **3**, pages 202–206]

(This question continues on the following page)

(Question H1 continued)

(a) Compare the effect of each inhaled anesthetic on the permeability of the alveoli. *[2]*

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(b) Using the data from the graphs, explain whether or not inhaled anesthetics are more dangerous than intravenous anesthetics. *[3]*

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(c) Suggest **one** reason why asthmatic patients were not used in this experiment. *[1]*

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H2. (a) State **two** components of saliva, other than water. *[1]*

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(b) Outline the circulation of blood through the liver. *[3]*

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H3. (a) Describe the mode of action of steroid hormones and peptide hormones. *[4]*

(b) Explain the control of ADH secretion. *[6]*