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

M05/4/BIOLO/HP3/ENG/TZ1/XX+

22056009

BIOLOGY
HIGHER LEVEL
PAPER 3

Thursday 12 May 2005 (morning)

1 hour 15 minutes

Candidate session number

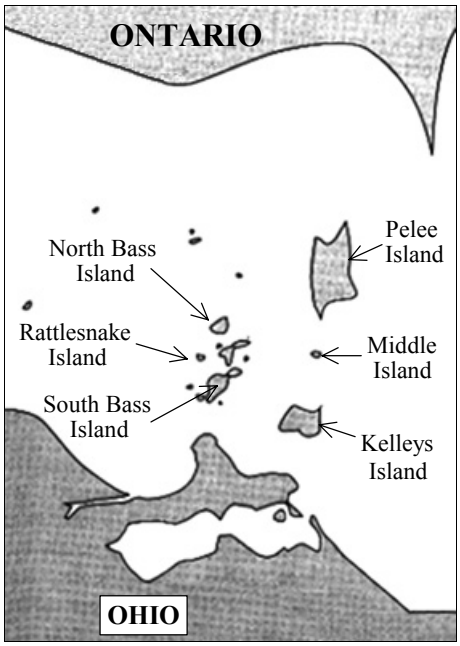
INSTRUCTIONS TO CANDIDATES

- 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.

Option D — Evolution

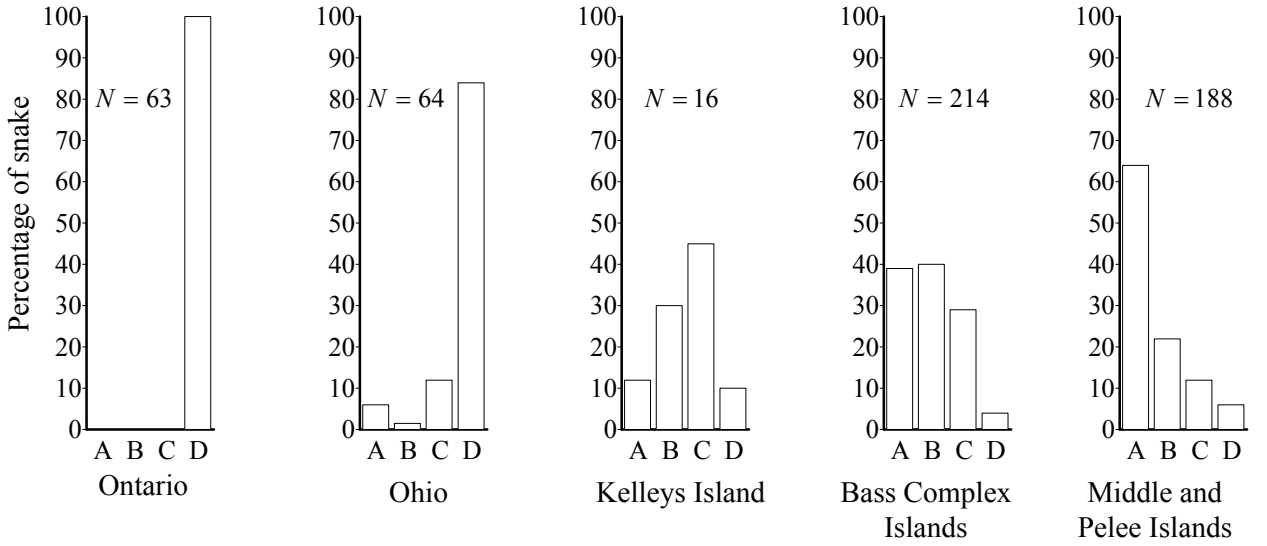
D1. The water snake (*Nerodia sipedon*) lives on the mainland surrounding Lake Erie and on the islands in the lake. The snakes vary in their appearance from banded through intermediate to unbanded. Recent research has shown that snakes from the mainland migrate to the islands every year. Mark-recapture studies on the islands indicate that young snakes which are unbanded have a higher rate of survival on the islands than do banded snakes. However, banded snakes have a higher rate of survival than unbanded snakes on the mainland.

Five different populations were studied and the frequency of banded, intermediate, and unbanded snakes were determined for the two mainland areas (Ontario and Ohio) and the islands of Lake Erie.



The histograms below show the variation in colour pattern within and between populations. Category A snakes are unbanded, category B and C snakes are intermediate, category D snakes are strongly banded.

Key: *N* = sample size



[Source: S Freeman and J C Herron, *Evolutionary Analysis*, (2002), 2nd edition, Prentice Hall, pages 159–160]

(This question continues on the following page)

(Question D1 continued)

(a) (i) State the percentage of unbanded snakes found on Middle and Pelee islands. *[1]*

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(ii) Calculate the number of strongly banded snakes found on the Ohio mainland. *[1]*

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(b) Compare the percentages of unbanded and strongly banded snakes on the mainland areas to the percentages on the islands. *[3]*

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(c) Suggest, giving reasons, how the maintenance of the banded/unbanded polymorphism is maintained in the island populations. *[2]*

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D2. (a) Define the term *half-life* of a radioisotope. *[1]*

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(b) Outline the role of ^{40}K in dating fossils found in rocks. *[2]*

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D3. (a) Describe the possible roles of RNA in the origin of life. *[4]*

(b) Discuss the adaptations that were required for bipedalism and their consequences in human evolution. *[6]*

Option E — Neurobiology and Behaviour

E1. In many vertebrate species, individuals of one or both sexes select for some features among potential mates in an effort to optimize their reproductive success. Snakes rely extensively upon the production and perception of sex pheromones for their reproductive behaviour. Sex pheromones are chemicals that help in chemical communication between individuals of the same species. The male red-garter snake (*Thamnophis sirtalis*) displays a courtship preference for larger female snakes. Researchers tested the hypothesis that males could distinguish among females of varying size by the composition of the skin lipids which act as pheromones.

Skin lipid samples were collected from small females (46.2 ± 2.7 cm in length) and large females (63 ± 2.6 cm in length). The samples were analysed by gas chromatography and the relative concentrations of saturated and unsaturated lipids were determined. The graphs show the time profiles when different lipids emerged from the gas chromatography column.

The shaded peaks represent saturated lipids and the unshaded peaks represent unsaturated lipids.

Figure 1 Data for small female snakes

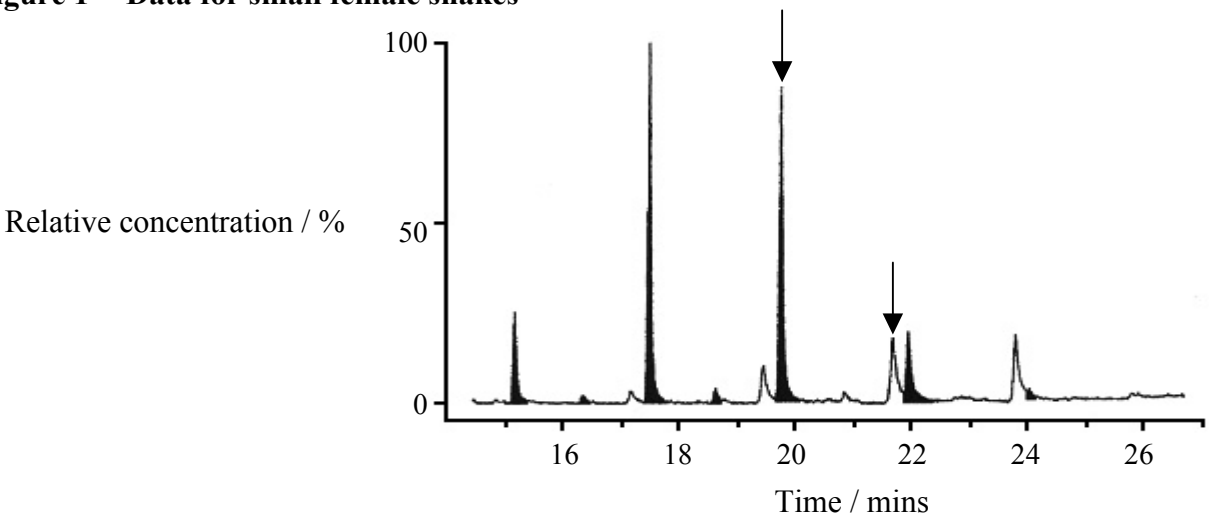
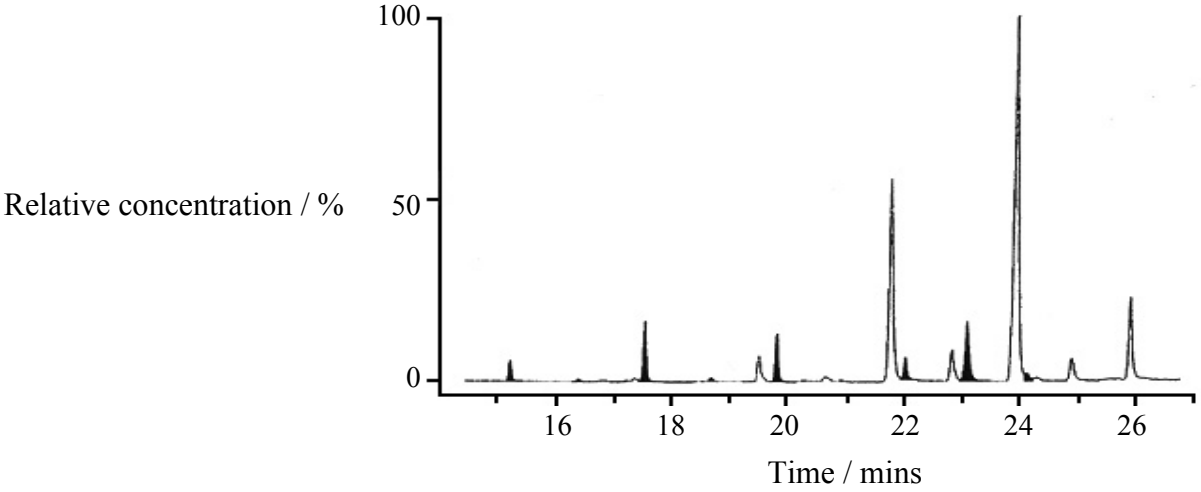


Figure 2 Data for large female snakes



[Source: M P LeMaster and R T Mason, *Journal of Chemical Ecology*, (2002), **28**, page 1269]

(This question continues on the following page)

(Question E1 continued)

(a) Using Figure 2, state the relative concentration of the unsaturated lipid corresponding to the peak at 26 minutes. *[1]*

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(b) Using Figure 1, calculate the ratio of unsaturated to saturated lipids indicated by the arrows. *[1]*

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(c) Compare the pheromone profile of large female snakes with the profile of small female snakes. *[2]*

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(d) (i) Suggest an experiment to test the hypothesis that the male red-garter snake could discriminate between larger and smaller female snakes. *[2]*

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(ii) Suggest an advantage for male snakes selecting larger females. *[1]*

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E2. (a) Define the term *innate behaviour*. *[1]*

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(b) Discuss the use of the pupil reflex for indicating brain death. *[2]*

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E3. (a) Explain the effects of excitatory psychoactive drugs using **two** named examples. *[6]*

(b) Compare the roles of the parasympathetic and sympathetic nervous system. *[4]*

Option F — Applied Plant and Animal Science

F1. Kochia (*Kochia scoparia*) is a common weed in the Great Plains of the United States and Canada. Kochia affects crops by reducing the yield of wheat and corn. Kochia is difficult to control because of its leaf characteristics. The leaves either prevent herbicide contact or the herbicide spray droplets roll off the leaf. Chemicals known as surfactants are detergents which help to aid the retention of herbicides on the leaves of the weeds. Research was undertaken to study the influence of surfactants on the effectiveness of three herbicides in aiding the control of Kochia.

The table below shows the percentage biomass reduction of Kochia using three herbicides with different surfactants.

	Percentage Biomass Reduction		
Surfactant	**Bromoxynil**	**2,4-D-amine**	**Glyphosphate**
No surfactant	95	27	21
Allinol	97	40	9
Mon 0818	95	44	82
Oxysorbic	92	43	71
R-11	94	40	26

[Source: Harbour, *et al*., *Weed Science*, (2003), **51**, page 430]

(a) (i) State which herbicide was most effective in controlling Kochia with no surfactant. *[1]*

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(ii) State which surfactant was least effective in controlling Kochia. *[1]*

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(iii) Calculate the mean percentage biomass reduction when using surfactants with glyphosphate. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(b) Using the data in the table, discuss the advice that should be given to farmers on the use of surfactants. *[3]*

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F2. (a) State **two** examples of transgenic techniques in agriculture involving animals. *[2]*

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(b) Outline the use of antibiotics in livestock production. *[2]*

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F3. (a) Describe how flowering is controlled in long day plants (LDP). *[4]*

(b) Discuss the ethical issues surrounding the use of biological and chemical pest control. *[6]*

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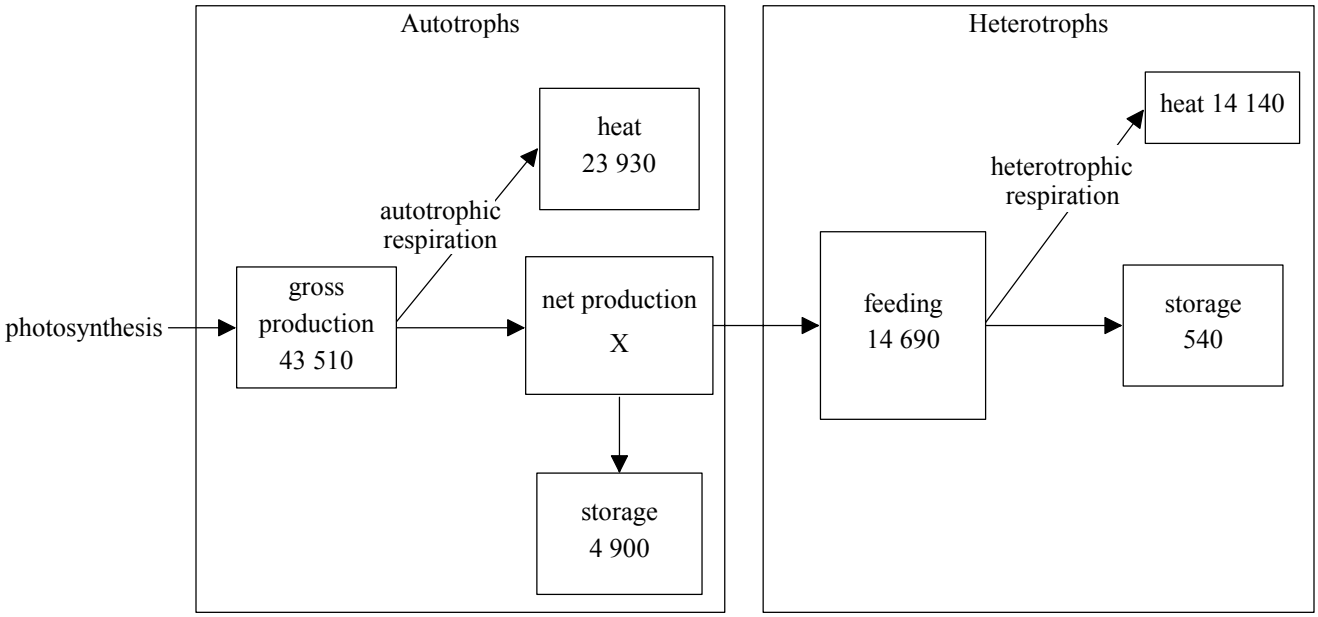
Option G — Ecology and Conservation

G1. The energy flow diagram below for a temperate ecosystem has been divided into two parts. One part shows autotrophic use of energy and the other shows the heterotrophic use of energy. All values are $kJ\,m^{-2}\,yr^{-1}$.



(a) Calculate the net production of the autotrophs. *[1]*

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(b) (i) Compare the percentage of heat lost through respiration by the autotrophs with the heterotrophs. *[1]*

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(ii) Most of the heterotrophs are animals. Suggest **one** reason for the difference in heat losses between the autotrophs and animal heterotrophs. *[1]*

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(Question G1 continued)

The heterotrophic community can be divided into food webs based upon decomposers and food webs based upon herbivores. It has been shown that of the energy consumed by the heterotrophs, 99 % is consumed by the decomposer food webs.

(c) State the importance of decomposers in an ecosystem. *[1]*

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(d) Deduce the long-term effects of sustained pollution which kills decomposers on autotrophic productivity. *[2]*

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G2. (a) Define the term *competitive exclusion.* *[1]*

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(b) List **three** advantages of *in situ* conservation of endangered species. *[3]*

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G3. (a) Discuss the ecological and economic arguments to be considered in the conservation of biodiversity in tropical rainforests. *[6]*

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(b) Outline the actions taken by farmers to increase nitrogen fertility in the soil. *[4]*

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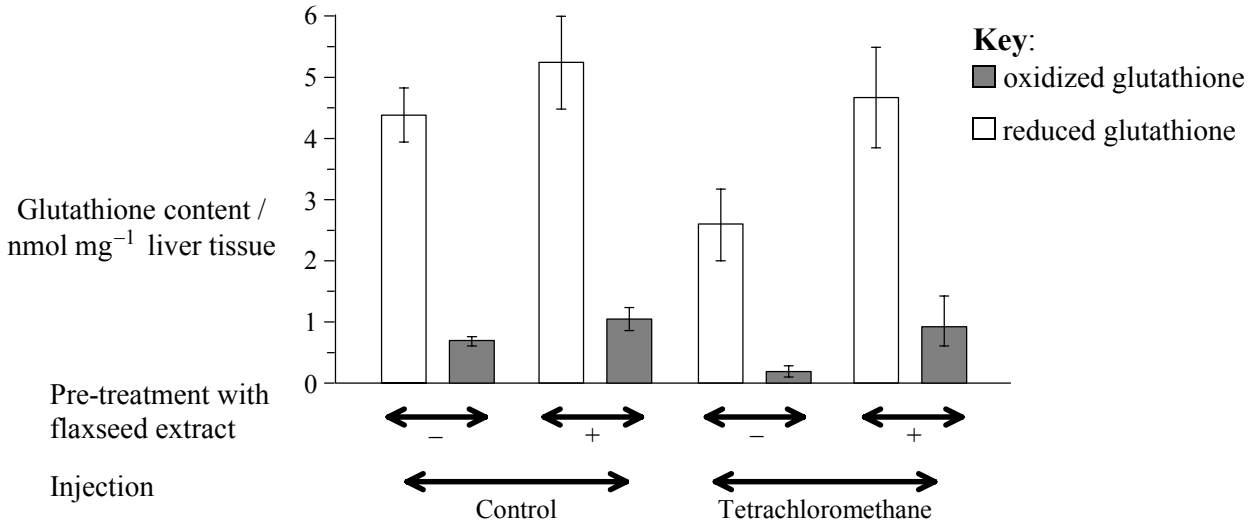
Option H — Further Human Physiology

H1. A number of chemicals have been shown to cause tissue damage due to the production of free radicals. Free radicals are chemicals, such as superoxides and peroxides, which can react to damage DNA and lipids. Antioxidants produced by our body, such as reduced glutathione, combine with free radicals and decrease tissue damage. Reduced glutathione reacts with free radicals and in the process is converted to oxidized glutathione.

Recently dietary antioxidants such as lignins, have also been shown to protect against tissue damage. Flaxseed is known to contain lignins but its antioxidant effects have yet to be evaluated. Research was done to see if flaxseed could help prevent damage to the liver by tetrachloromethane. Metabolism of tetrachloromethane by the liver leads to the formation of free radicals. Rats were pretreated by oral injection with flaxseed extract (+) or corn oil (–) (control) for three days and then injected with buffered saline solution (control) or tetrachloromethane. The glutathione levels were then measured.



[Source: Endoh, *et al*., *J Vet Medical Science*, (2002)**, 64**, page 761]

(a) (i) State the reduced glutathione content of liver tissue injected with tetrachloromethane with no flaxseed pretreatment. *[1]*

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(ii) Calculate the total glutathione content (oxidized + reduced) in liver tissue treated with flaxseed extract but not injected with tetrachloromethane. *[1]*

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(Question H1 continued)

(b) Describe the effect of tetrachloromethane injection on total glutathione and reduced glutathione content in liver tissue without flaxseed pretreatment. *[2]*

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(c) Predict, using the data, the effect of using flaxseed extract in protecting liver tissue from damage due to tetrachloromethane. *[3]*

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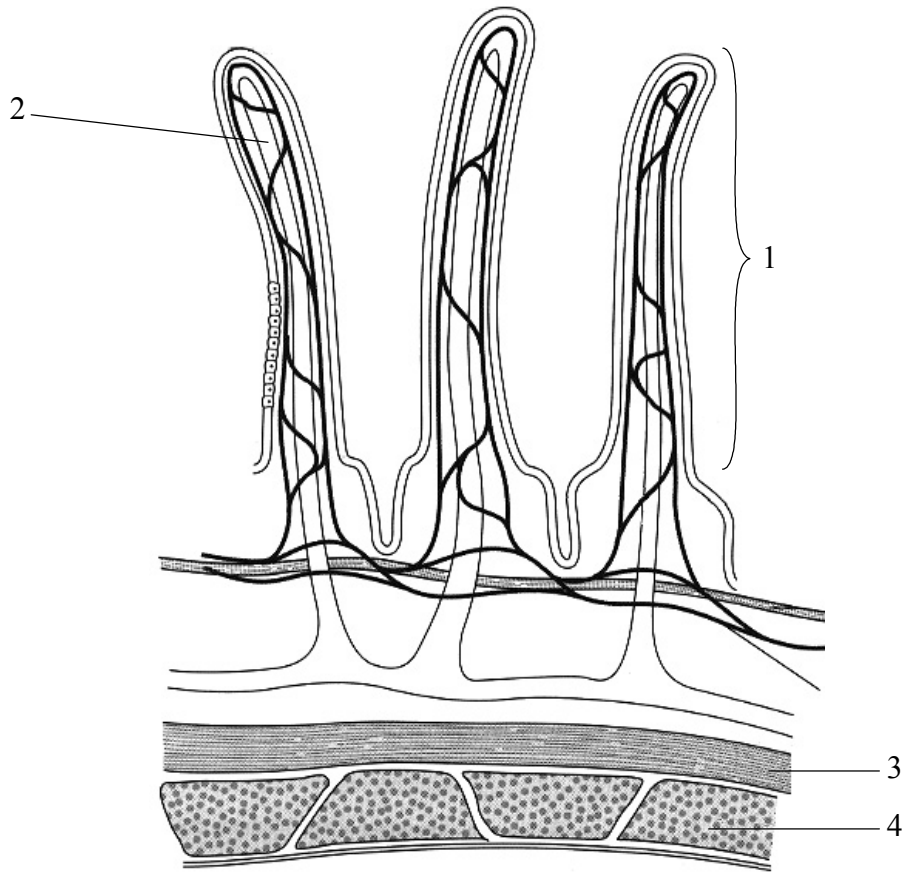
H2. The diagram below shows a transverse section of the ileum.



[Source: P H Raven and G B Johnson, *Biology*, (2002), 6th edition, McGraw-Hill, page 1024]

(a) (i) State the name **and** function of the structures labelled 1 and 2. *[2]*

1: . . . . . .

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2: . . . . . .

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(ii) Distinguish between the muscles labelled 3 and 4. *[1]*

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H3. (a) Describe how carbon dioxide is carried by the blood. *[4]*

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