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**BIOLOGY
HIGHER LEVEL
PAPER 3**

Monday 19 November 2012 (morning)

1 hour 15 minutes

Candidate session number

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Examination code

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INSTRUCTIONS TO CANDIDATES

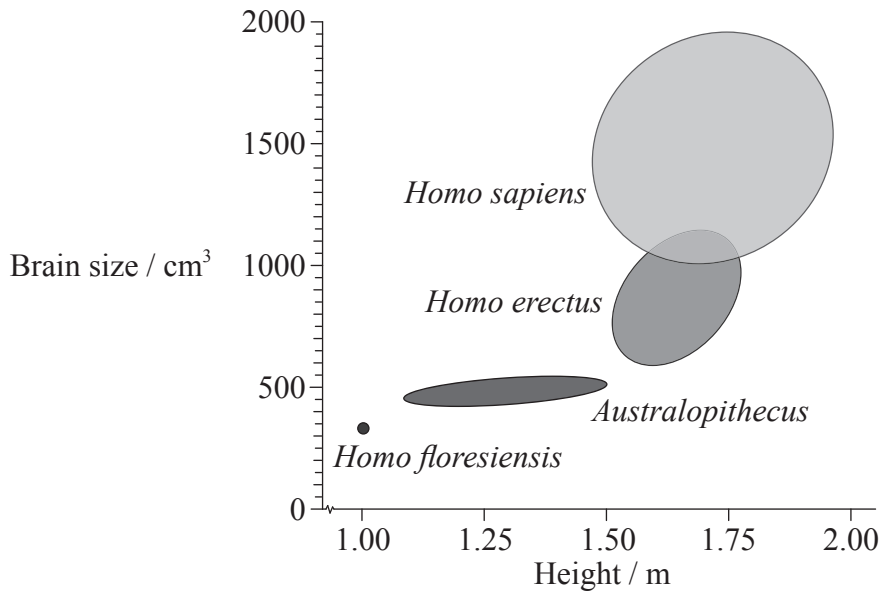
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is [40 marks].



0128

Option D — Evolution

D1. The diagram shows the range of heights and brain sizes found in four groups of hominids.



[Source: Reprinted by permission from Macmillan Publishers Ltd: *Nature*, Marta Mirazon Lahr and Robert Foley, 'Palaeoanthropology: human evolution writ small', 431, pp 1043-1044 © 2004.]

(a) State the range in brain size of *H. erectus*. [1]

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(b) Distinguish between the characteristics of the *Australopithecus* and *H. erectus* using the data. [2]

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(Question D1 continued)

- (c) Evaluate the hypothesis that an increase in hominid height makes an increase in brain size necessary. [3]

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- (d) State **two** ways, apart from brain volume, by which the skulls of the *Australopithecus* and *H. erectus* would differ in appearance. [2]

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2.



D2. (a) (i) Define the term *gene pool*. [1]

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(ii) State **two** examples of barriers between gene pools. [1]

1.
2.

(b) Describe sickle-cell anemia as an example of balanced polymorphism. [2]

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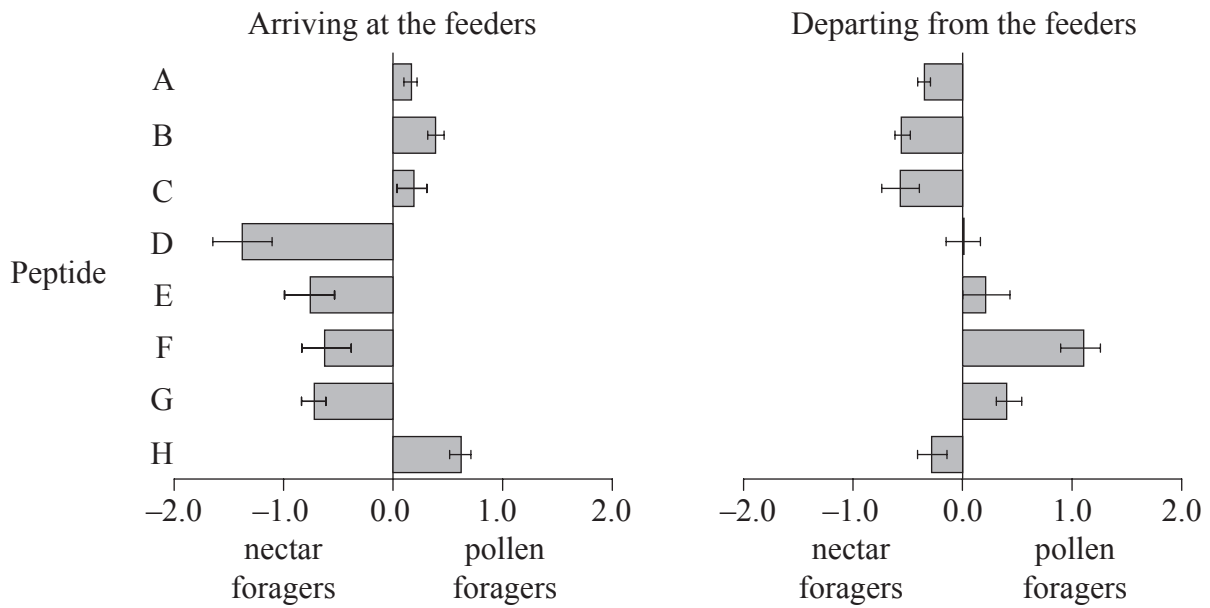
(c) During a screening campaign of 281 884 babies in Sao Paulo, Brazil, it was found that the frequency of the sickle-cell anemia allele was 0.02. Calculate the expected number of babies **not** carrying the allele. [2]

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Option E — Neurobiology and behaviour

E1. In order to investigate the hypothesis that honeybees (*Apis mellifera*) have an instinct to forage for either nectar or pollen, but not both, researchers installed different feeders containing either nectar alone or pollen alone. They collected four different groups of honeybees (those arriving at the nectar feeders, arriving at the pollen feeders, departing from the nectar feeders and departing from the pollen feeders) and measured the abundance of eight peptides in their brains. The relative difference of these brain peptides was then calculated by subtracting the abundance in nectar foragers from the abundance in pollen foragers and is shown by the bars on the graphs below.



Change in peptide abundance between nectar and pollen foragers / arbitrary units

[Source: 'Quantitative peptidomics reveal brain peptide signatures of behaviour'. Axel Brockmann, Suresh P. Annangudi, Timothy A. Richmond, Seth A. Ament, Fang Xie, Bruce R. Southey, Sandra R. Rodriguez-Zas, Gene E. Robinson and Jonathan V. Sweedler (2009) *PNAS*, 106 (7), pp. 2383–2388.]

(a) Identify which peptide shows the greatest difference between pollen foragers and nectar foragers departing from the feeders. [1]

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(Question E1 continued)

- (b) Distinguish between the difference in abundance of peptides in nectar and pollen foragers arriving at the feeders. [2]

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- (c) Evaluate the hypothesis that honeybees have an instinct to forage for **either** nectar **or** pollen, but not both. [2]

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- (d) Discuss how this type of foraging behaviour could optimize food intake. [2]

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E2. (a) Outline **one** function for each of the following parts of the brain. [2]

Part of brain	Function
Cerebellum	
Medulla oblongata	

(b) The following diagram shows a section through the spinal cord.



[Source: CAMPBELL, NEIL A., REECE, JANE B., *BIOLOGY*, 7th edition. ©2005, p. 1013. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ.]

(i) Label cells X and Y. [1]

X:
Y:

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(Question E2 continued)

(ii) Outline the direction of nerve impulses through the cells labelled X and Y. [1]

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(iii) Define the term *reflex*. [1]

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(c) State whether the following psychoactive drugs are excitatory **or** inhibitory, using the table below. [2]

Psychoactive drug	Excitatory <i>or</i> inhibitory
Alcohol	
Amphetamines	
Benzodiazepines	
Nicotine	



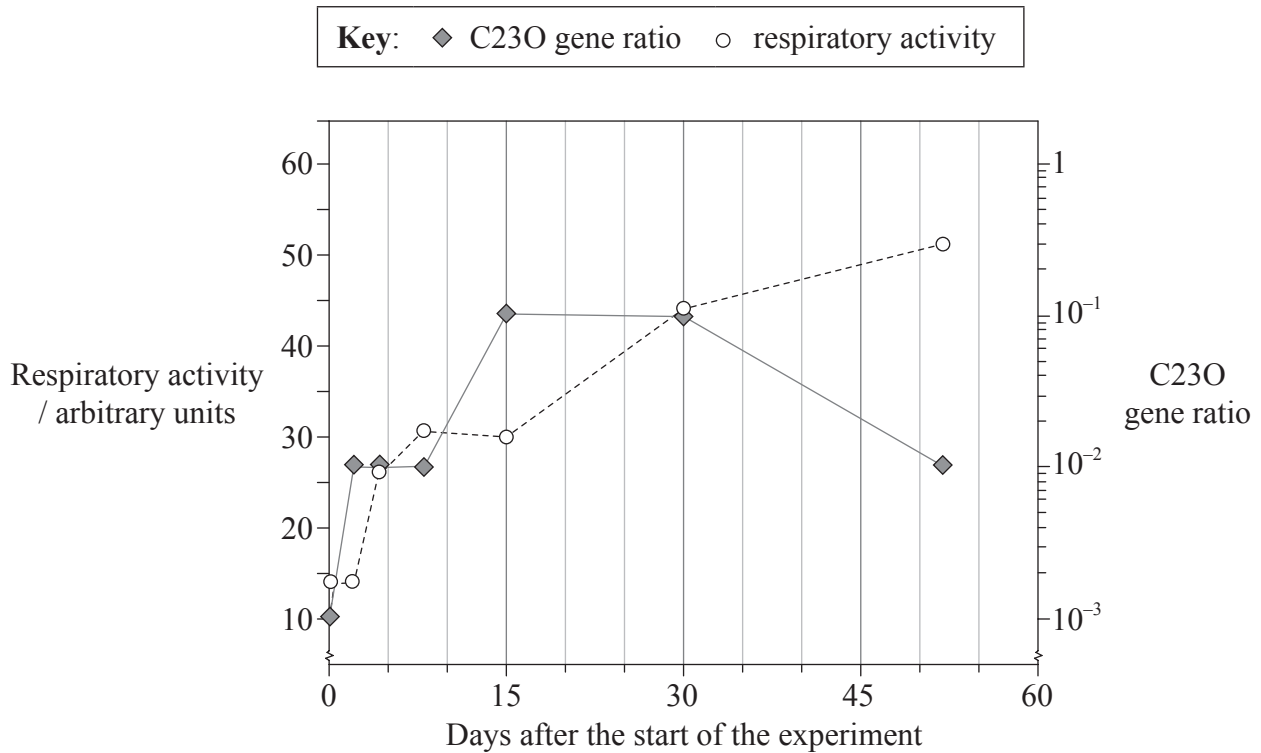
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Option F — Microbes and biotechnology

F1. Soil contaminated with crude oil contains a very high amount of hydrocarbons, which may be an environmental hazard. In order to understand how bacteria could be helpful to remedy such a situation, scientists created laboratory samples of soil contaminated with crude oil and analysed the bacteria growing in it by measuring the respiratory activity and C23O gene ratio. The respiratory activity is an indication of the total amount of live bacteria in soil. The C23O gene ratio is an indication of the proportion of soil bacteria capable of hydrocarbon degradation compared to the total amount of bacteria.



[Source: adapted from M. Zucchi, L. Angiolini, S. Borin, L. Brusetti, N. Dietrich, C. Gigliotti, P. Barbieri, C. Sorlini and D. Daffonchio (2003) 'Response of bacterial community during bioremediation of an oil-polluted soil.' *Journal of Applied Microbiology*, 94 (2), pp. 248–257. Published by Wiley Blackwell. Reprinted with permission.]

(a) State the respiratory activity when the C23O gene ratio first reached its highest level. [1]

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(Question F1 continued)

- (b) Describe the respiratory activity as the soil treatment progresses. [2]

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- (c) The data in the graph indicates that hydrocarbon degradation occurred during the first 30 days of the experiment. Explain the evidence for this conclusion. [2]

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- (d) Using your knowledge, state the energy source category of the bacteria used in this experiment. [1]

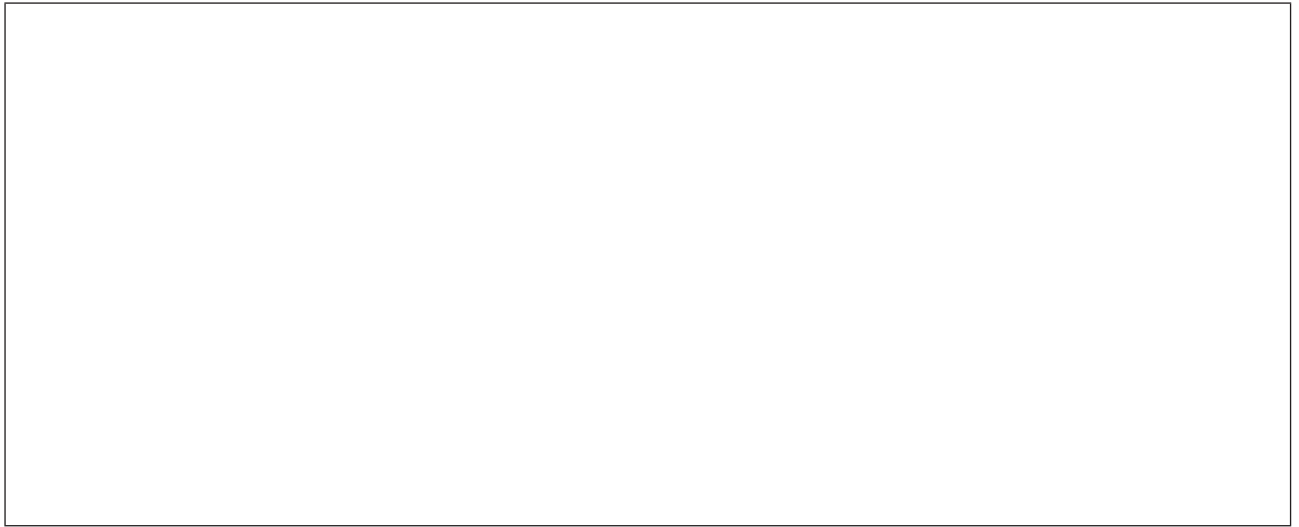
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- (e) Scientists are interested in inserting the C23O genes into bacteria to clean up oil spills in the sea. State the term used to qualify the bacteria that are able to survive in a saline habitat. [1]

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F2. (a) Draw a labelled diagram of a filamentous cyanobacterium. [2]



(b) Define the term *epidemiology*. [1]

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(c) Distinguish between endotoxins and exotoxins. [2]

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(d) Explain how the use of high sugar concentrations can preserve food. [2]

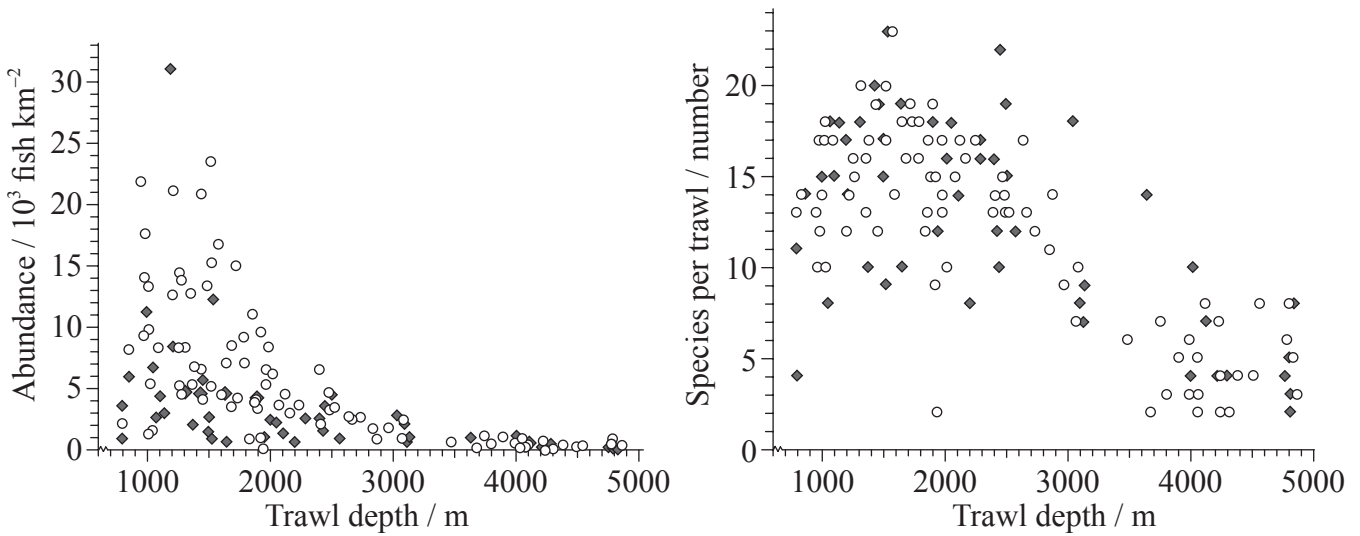
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Option G — Ecology and conservation

G1. Knowledge of deep-water fish is important for fisheries and marine reserve management. Scientists analysed data from scientific trawls made from 1977 to 1989 (early period) and from 1997 to 2002 (late period). These were at depths from 800m to 4800m in the Porcupine Seabight and Porcupine Abyssal Plain area southwest of Ireland. The graphs represent the abundance of fish and the number of species for each of these trawls.

Key: ○ 1977 to 1989 (early period) ◆ 1997 to 2002 (late period)



[Source: D.M. Bailey, M.A. Collins, J.D.M. Gordon, A.F. Zuur and I.G. Priede, 'Long-term changes in deep-water fish populations in the northeast Atlantic: a deeper reaching effect of fisheries?' *Proceedings of the Royal Society B* (2009), 276 (1664), pp. 1965–1969. By permission of the Royal Society.]

(a) State the depth at which the maximum number of species per trawl were caught. [1]

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(Question G1 continued)

- (b) (i) Compare the abundance of fish between the early period (1977 to 1989) and the late period (1997 to 2002). [2]

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- (ii) Suggest **one** reason for the difference in the abundance of fish at depths down to 2000m between the early period and the late period. [1]

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- (c) Discuss the evidence in these data for a decline in the biodiversity of fish between the early period and the late period. [2]

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- (d) State **two** types of interactions that are most likely to occur among deep-water fish. [1]

1.
2.

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(Question G1 continued)

- (e) Outline the concept of maximum sustainable yield in the conservation of fish stocks. [2]

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

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(b) Scientists measured the following values for a young pine plantation in England.

Respiration	38 900 kJ m ⁻² year ⁻¹
Net primary production	31 400 kJ m ⁻² year ⁻¹

[Source: adapted from E. P. Odum (1971) *Fundamentals of Ecology*, Third Edition, p. 46.
Published by Brooks Cole, part of CENGAGE Learning (US)]

(i) Calculate the value for the gross primary production. [1]

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(ii) Define the term *biomass*. [1]

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(c) Describe **one** technique used to estimate the population size of mice. [2]

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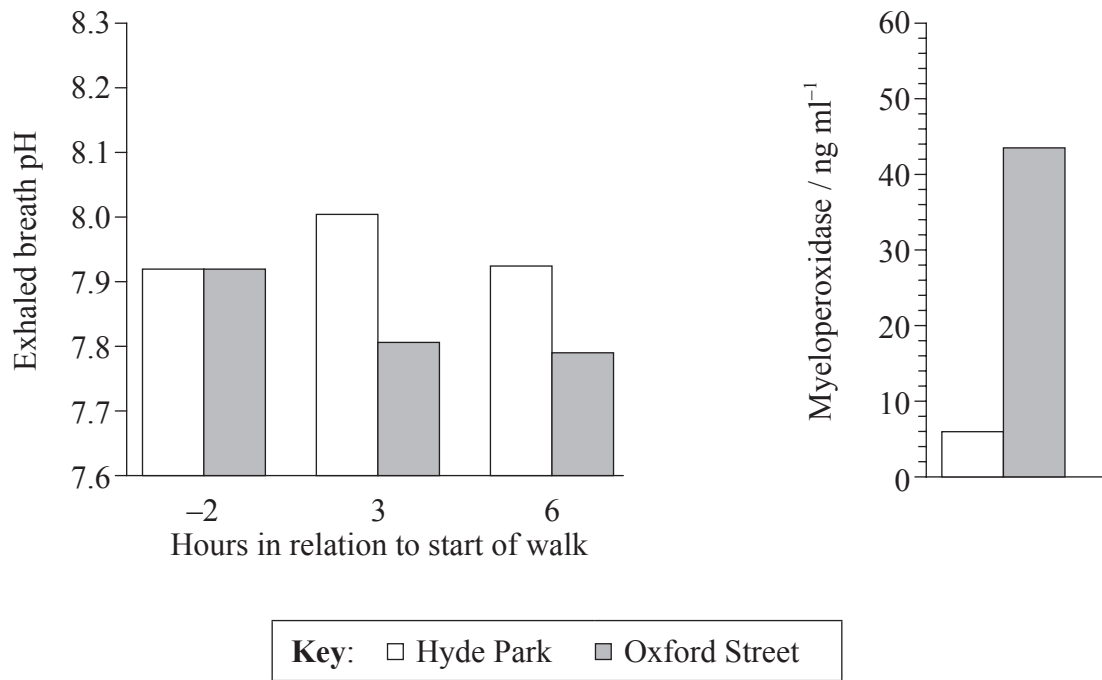
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Option H — Further human physiology

H1. Researchers explored the effects of roadside traffic exposure in London on people with asthma. Each participant walked for two hours through Hyde Park, a large traffic-free park, and on a separate occasion along Oxford Street, where diesel-powered buses and taxicabs are permitted. The researchers measured the pH of the participants' exhaled breath two hours before each walk and three hours and six hours after the start of each walk. The level of an inflammation indicator, myeloperoxidase, was also measured the day after the experiment.



[Source: From *The New England Journal of Medicine*, James McCreanor, Paul Cullinan, Mark J. Nieuwenhuijsen et al., Respiratory Effects of Exposure to Diesel Traffic in Persons with Asthma, 357, 23. Copyright © (2007) Massachusetts Medical Society. Reprinted with permission from Massachusetts Medical Society]

- (a) Calculate the percentage increase of myeloperoxidase between Hyde Park and Oxford Street for participants. [1]

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(Question H1 continued)

- (b) (i) Compare the changes in exhaled breath pH caused by walking through Hyde Park and along Oxford Street. [2]

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- (ii) Explain the changes in exhaled breath pH caused by walking along Oxford Street in people with asthma. [2]

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- (iii) Some of the participants reported more symptoms of asthma after walking along Oxford Street. Evaluate the hypothesis that an asthma attack is associated with bronchiole congestion and inflammation. [1]

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- (c) State **two** possible causes of an asthma attack, other than those suggested by this experiment. [1]

1.
2.



H2. The table shows the death rate due to coronary heart disease (CHD) in two different countries.

Country	Deaths / 10^{-5} individuals
USA	97.6
Japan	32.1

[© International Baccalaureate Organization, 2013]

(a) Using the table below, outline **three named** factors that could be responsible for the differences between the two populations. [3]

Factor	Outline

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(Question H2 continued)

(b) (i) State **four** glands secreting digestive juices into the alimentary canal. [2]

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(ii) Describe how inactive precursors of pepsin and trypsin are activated. [2]

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