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BIOLOGY
STANDARD LEVEL
PAPER 3

Candidate session number

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Monday 19 November 2012 (morning)

1 hour

Examination code

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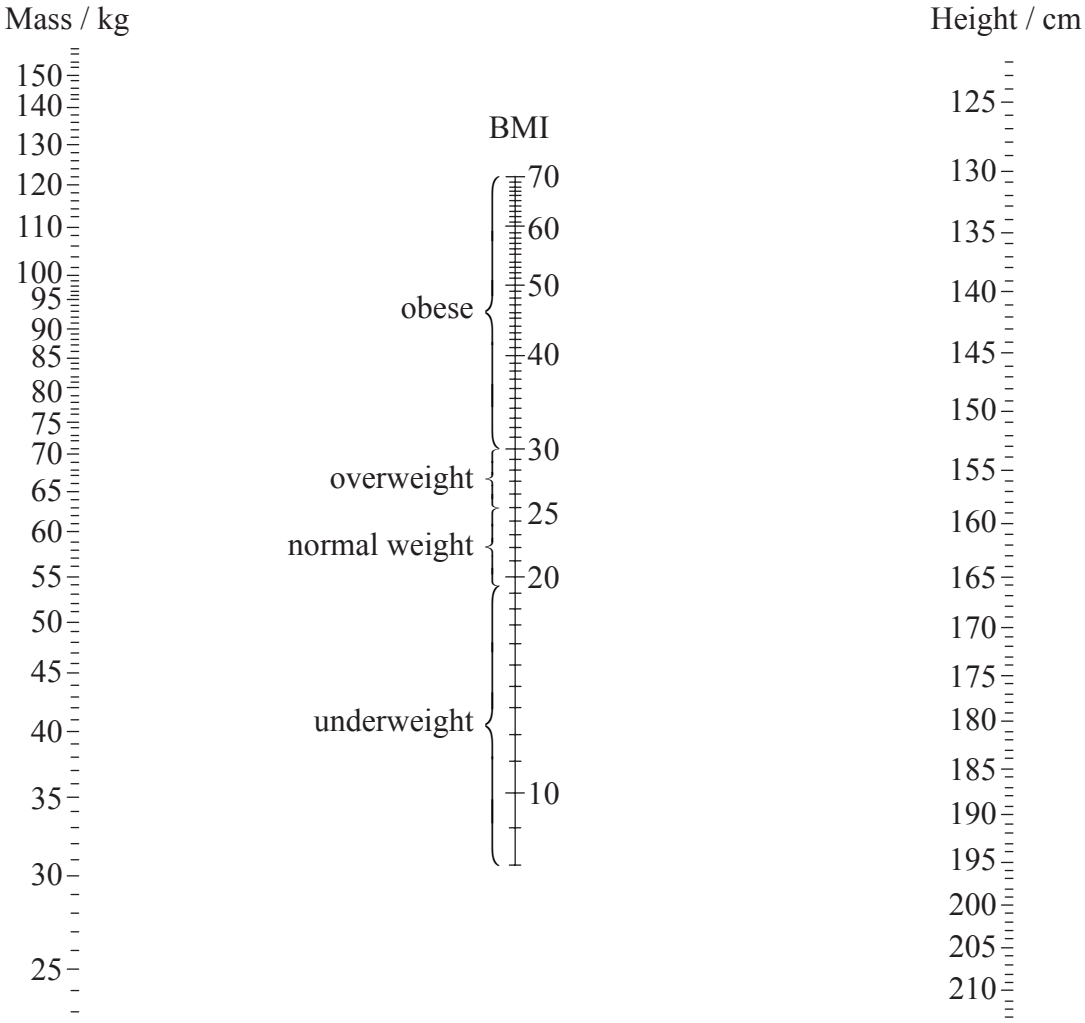
INSTRUCTIONS TO CANDIDATES

- 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 *[36 marks]*.

Option A — Human nutrition and health

A1. When assessing a patient's health, doctors very often calculate their body mass index (BMI). This is can be done using a nomogram as shown below.



[Source: http://www.domusmedica.be/documentatie/richtlijnen/overzicht/obesitas-volwassenen-horizontaalmenu-386.html. Used with permission.]

(a) State the equation used to calculate the BMI including its units. *[1]*

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(This question continues on the following page)

(Question A1 continued)

(b) (i) Identify the mass above which a man whose height is 185 cm would be classified as obese. *[1]*

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(ii) A woman whose height is 167 cm has a mass of 78 kg. Calculate the minimum mass she should lose in order to have a normal BMI. *[1]*

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(c) A woman and a man both have a height of 170 cm. The woman has a mass of 30 kg and the man has a mass of 104 kg.

(i) Identify, using the nomogram, the BMI of both people. *[1]*

The woman: . . . . . .

The man: . . . . . .

(ii) Identify a possible cause of the BMI being too high or too low in the woman and in the man. *[2]*

The woman: . . . . . .

The man: . . . . . .

(This question continues on the following page)

(Question A1 continued)

(d) Individuals whose appetite control centre does not function properly find it harder to avoid obesity. Outline the function of the appetite control centre. *[2]*

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A2. (a) Outline the difference in the molecular structure between

(i) saturated and unsaturated fatty acids. *[1]*

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(ii) *cis* and *trans* unsaturated fatty acids. *[1]*

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(Question A2 continued)

(b) The normal recommended daily dose of vitamin C is 50 mg to 100 mg. Linus Pauling (1901–1994) advocated consuming 1000 mg of vitamin C daily to avoid catching the common cold.

(i) State **one** use of vitamin C in the body. *[1]*

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(ii) Suggest the possible consequences of returning to a normal daily dose of vitamin C after a period of taking large doses. *[1]*

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A3. According to UNICEF data, the percentage of mothers breastfeeding in developed countries fell during the 1980s and 1990s, but has begun to show a marked increase in recent years.

(a) Discuss the benefits of breastfeeding. *[3]*

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(b) Explain **two** pieces of dietary advice that might be given to someone suffering from type II diabetes. *[3]*

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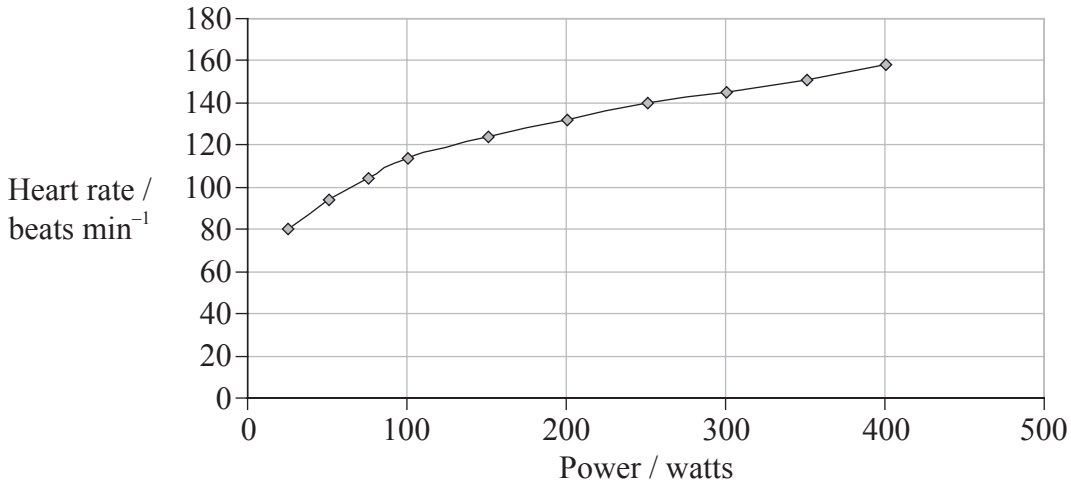
Answers written on this page
will not be marked.

Option B — Physiology of exercise

B1. The data in the graph was obtained from a physically fit rower using a calibrated rowing machine and a heart rate monitor.

Data from physically fit rower



[Source: Adapted from F. Harris, (2009), *ASE School Science Review*, 91, pages 9–14. Used with permission.]

The table shows cardiac output during exercise for an untrained person.

Data from an untrained person			
Exercise state	**Stroke volume / dm^3 beat^{-1}**	**Heart rate / beats min^{-1}**	**Cardiac output / dm^3 min^{-1}**
At rest	0.07	75	5.25
Mild exercise	0.10	100	10
Intense exercise	0.13	150	19.50

[Source: Adapted from F. Harris, (2009), *ASE School Science Review*, 91, pages 9–14. Used with permission.]

(a) Estimate, using the graph, the resting heart rate of the physically fit rower. *[1]*

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(This question continues on the following page)

(Question B1 continued)

(b) (i) Estimate, using the graph, the increase in heart rate between exercise at 25 watts and 250 watts. (Show your workings.) *[1]*

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(ii) Predict, with a reason, whether the increase would be greater **or** less in an untrained person when the power output increases from 25 watts to 250 watts. *[1]*

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(c) Using the table, discuss whether cardiac output would be higher **or** lower in a trained person for each exercise state than for the untrained person. *[2]*

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(d) Explain the changes in blood supply to the skin and brain during exercise. *[2]*

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B2. (a) Outline the roles of glycogen and myoglobin in muscle fibres. *[2]*

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(b) Draw a labelled diagram to show the structure of a sarcomere in striated muscle. *[3]*

B3. (a) Vigorous exercise sometimes causes injuries to muscles and joints. Describe **three** such **named** injuries. *[3]*

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(b) Discuss the need for warm-up routines before exercise. *[3]*

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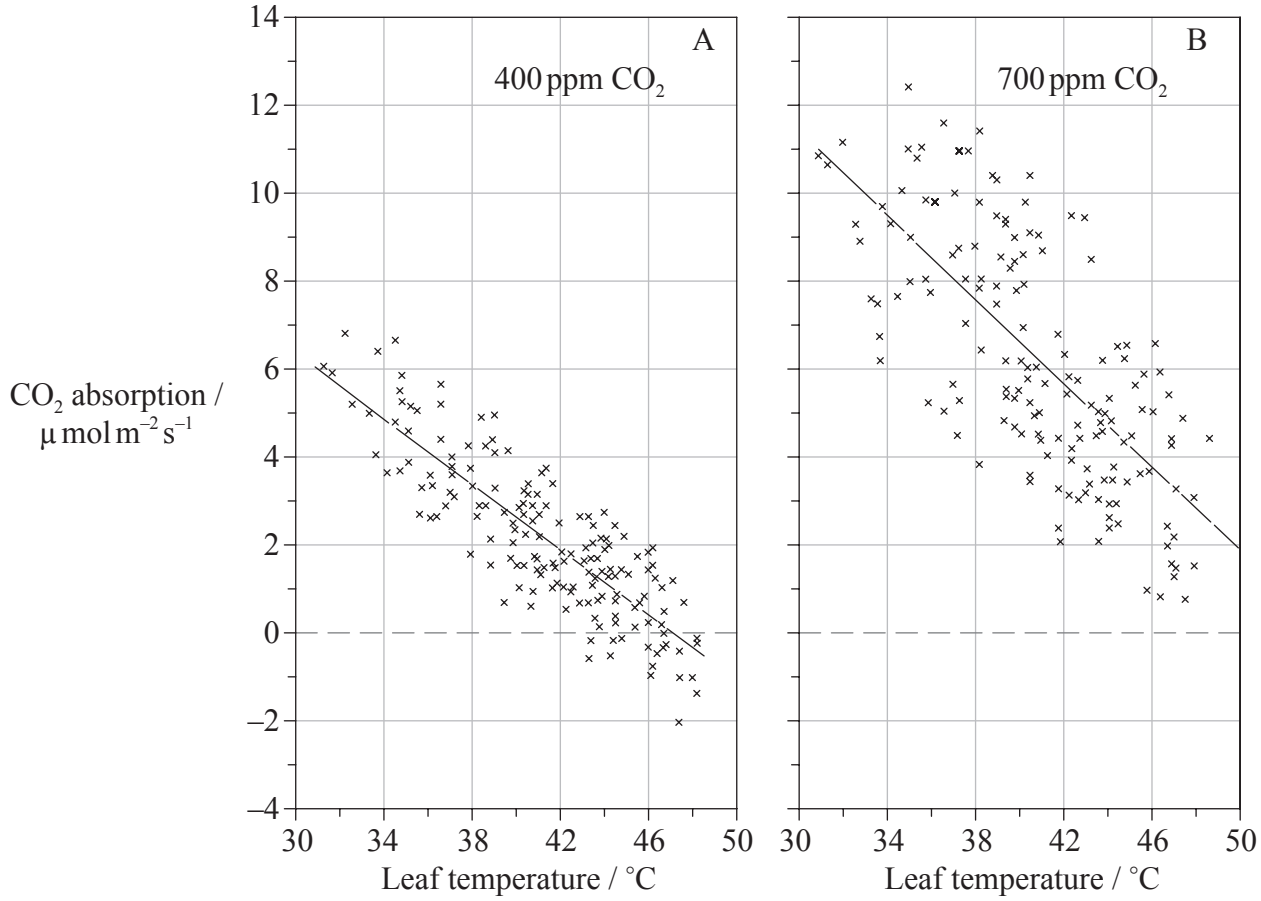
Option C — Cells and energy

C1. Sour orange trees (*Citrus aurantium* L.) were grown outdoors in Phoenix, Arizona (USA) in chambers with clear plastic sides and open tops. These chambers were continuously maintained at mean atmospheric CO_2 concentrations of either 400 or 700 ppm (parts per million) for several years. Both the rate of CO_2 absorption of sunlit leaves and the temperature of the leaves were measured on some of the hottest days.



[Source: 'Effects of atmospheric CO2 enrichment and foliar methanol application on net photosynthesis of sour orange tree (Citrus aurantium; Rutaceae) leaves'. S. B. Idso et al. 1995, *American Journal of Botany*, 82 (1), pp. 26–30. Reprinted with permission.]

(a) Identify the relationship between temperature and CO_2 absorption shown in both graphs. *[1]*

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(This question continues on the following page)

(Question C1 continued)

(b) The line on each graph indicates the mean net photosynthesis rate. Calculate the difference in net photosynthesis at 34 °C between plants grown at 400 ppm and 700 ppm CO_2. *[1]*

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(c) Compare the data for the sour orange trees growing at 400 ppm with those growing at 700 ppm. *[3]*

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(d) Identify, with a reason, whether CO_2 concentration **or** temperature is the limiting factor on photosynthesis at a temperature of 34 °C and 400 ppm CO_2. *[1]*

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(e) State **two** products that pass from the light-dependent to the light-independent stages of photosynthesis. *[1]*

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C2. (a) Describe how the tertiary protein structure relates to enzyme function. *[2]*

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(b) Explain the control of metabolic pathways by end-product inhibition, including the role of allosteric sites. *[3]*

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C3. (a) Draw a labelled diagram showing the structure of a mitochondrion as seen under an electron microscope. *[3]*

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

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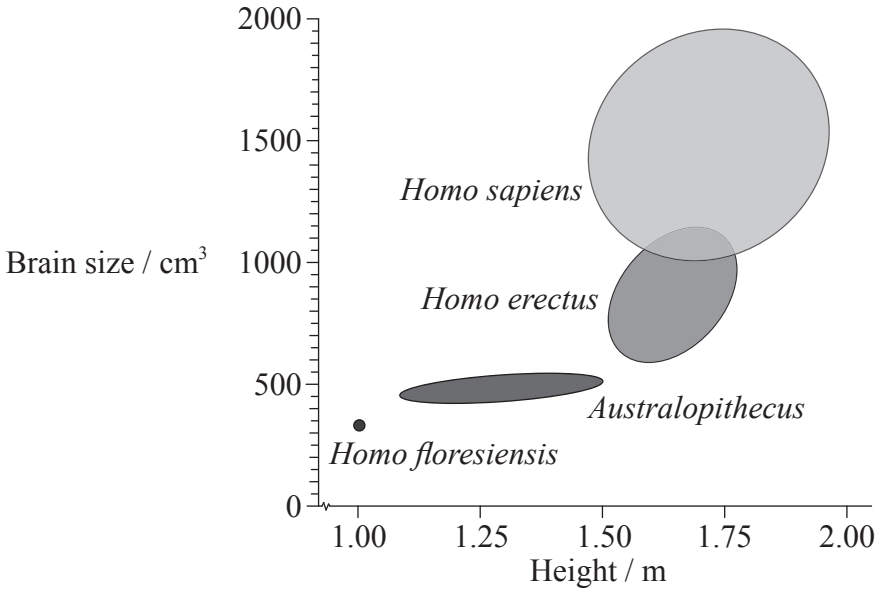
Option D — Evolution

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 **one** way, apart from brain volume, by which the skulls of the *Australopithecus* and *H. erectus* would differ in appearance. *[1]*

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D2. (a) Using the mammalian pentadactyl limb as an example, outline the process of adaptive radiation. *[2]*

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(b) Compare, using suitable examples, allopatric speciation and sympatric speciation. *[3]*

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D3. (a) Outline the contribution of prokaryotes to the creation of an oxygen-rich atmosphere. *[3]*

(b) Discuss the endosymbiotic theory for the origin of eukaryotes. *[3]*

Option E — Neurobiology and behaviour

E1.

Graph and questions E1 (a), E1 (b), E1 (c) and E1 (d) removed for copyright reasons

(This question continues on the following page)

(Question E1 continued)

Graph and questions E1 (a), E1 (b), E1 (c) and E1 (d) removed for copyright reasons

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(e) Explain how sound is perceived by the ear. *[3]*

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(Question E1 continued)

(f) Hearing is a result of the stimulation of mechanoreceptors. List **three** other main types of receptors. *[1]*

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3. . . . . .

E2. (a) Distinguish between innate behaviour and learned behaviour. *[1]*

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(b) Outline Pavlov's experiments into conditioning of dogs. *[2]*

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E3. (a) State whether the following psychoactive drugs are excitatory **or** inhibitory, using the table below. *[2]*

Psychoactive drug	**Excitatory *or* inhibitory**
Alcohol	
Amphetamines	
Benzodiazepines	
Nicotine	

(b) Explain the effects of tetrahydrocannabinol (THC) in terms of its action at synapses in the brain. *[3]*

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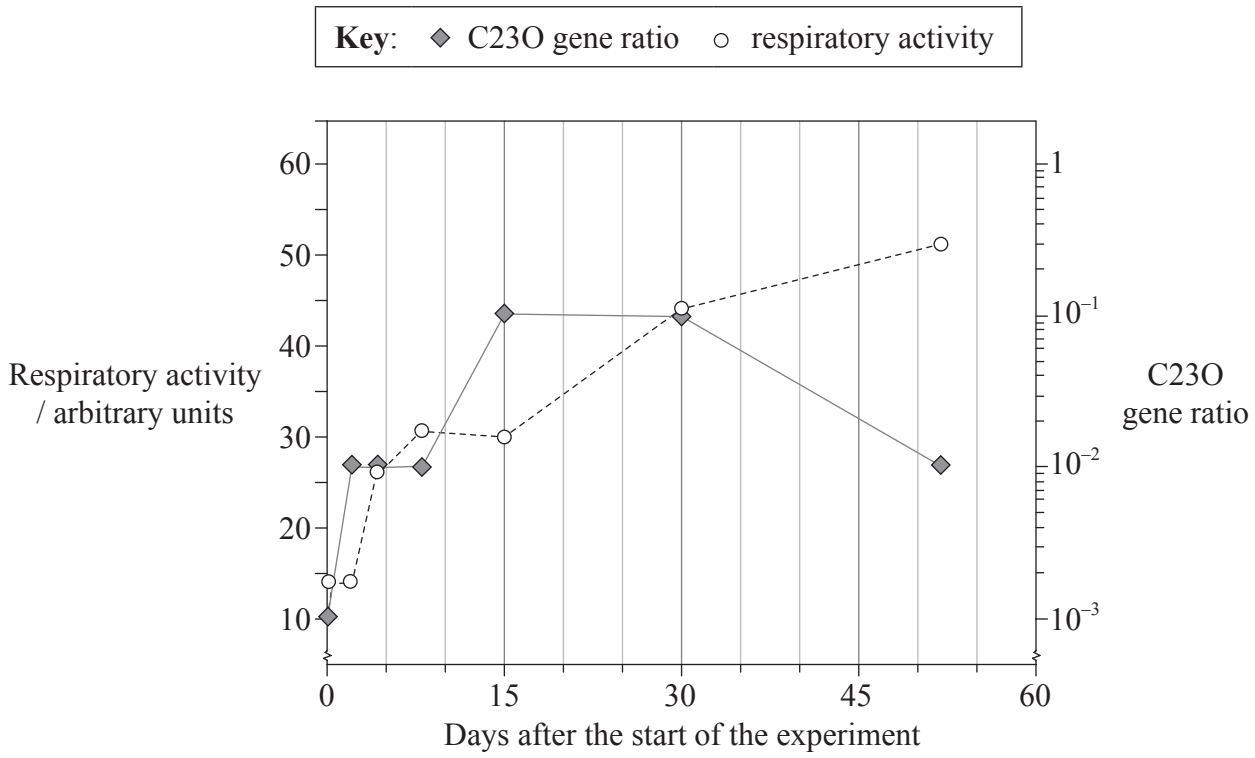
Option F — Microbes and biotechnology

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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(This question continues on the following page)

(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) 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) Outline the diversity of structure in viruses. *[2]*

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(b) Explain how reverse transcriptase is used in molecular biology. *[3]*

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F3. (a) Distinguish between *Euglena* and *Chlorella*. *[2]*

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(b) (i) Outline the role of saprotrophic bacteria in the treatment of sewage. *[2]*

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(ii) Explain the dangers of releasing raw sewage into rivers. *[3]*

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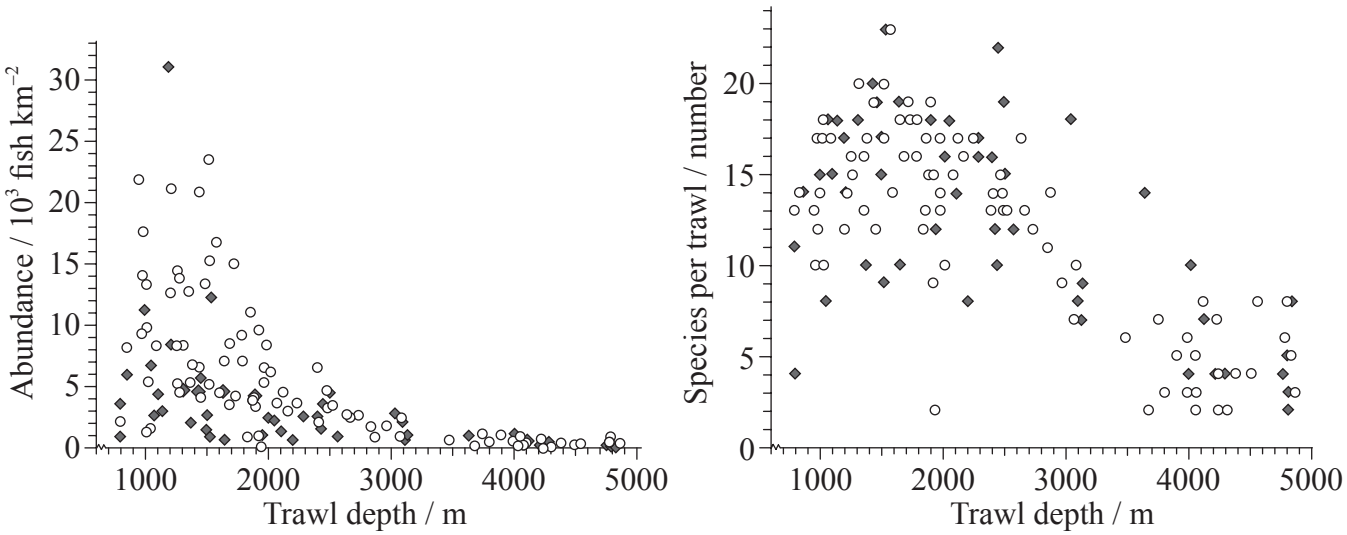
Option G — Ecology and conservation

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 800 m to 4800 m 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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(This question continues on the following page)

(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 2000 m 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]*

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2. . . . . .

G2. (a) Explain the principal of competitive exclusion. *[2]*

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

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(ii) Using a **named** example, explain a consequence of biomagnification. *[2]*

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G3. (a) Distinguish between primary succession and secondary succession, giving an example of each. *[3]*

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(b) Water is one factor that affects the distribution of plant species. Outline **three** other factors that can also affect plant distribution. *[3]*

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