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BIOLOGY
STANDARD LEVEL
PAPER 3

Candidate session number

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Friday 18 May 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]*.

0132

Option A — Human nutrition and health

A1. Iron, folic acid and vitamin B12 (cyanocobalamin) are important components of a healthy diet. These nutrients are necessary for the production of the red blood cells in the body that transport oxygen to the tissues. Deficiency of any of these nutrients can lead to anemia, a condition that causes weakness, tiredness and shortness of breath.

In a study of the Piaroa, a population living in a remote area of Venezuela, investigators discovered very high levels of anemia, especially amongst young children and females of childbearing age. The table below shows the incidence of anemia and deficiencies of iron, folic acid and vitamin B12 in this population, as a percentage.

Sex and age / years	Anemia / %	Iron deficiency / %	Folic acid deficiency / %	Vitamin B12 deficiency / %
Female				
1–3	100	56	75	0
4–10	100	31	50	10
11–20	90	55	90	20
21–40	94	41	80	5
41+	80	33	38	0
Mean	93	43	67	7
Male				
1–3	100	50	75	25
4–10	91	36	50	0
11–20	83	25	88	22
21–40	65	26	100	9
41+	90	18	57	33
Mean	86	31	74	18
Overall mean	**90**	**37**	**70**	**12**

[Source: adapted from M García-Casal, *et al.*, (2009), *Archivos Latinoamericanos de Nutrición*, www.alanrevista.org]

(This question continues on the following page)

(Question A1 continued)

(a) Identify the nutrient that is least likely to be deficient in a 45-year-old male in the Piaroa population. *[1]*

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(b) Identify the age and sex of the group that suffers from the least amount of anemia in the Piaroa population. *[1]*

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(c) Compare the data for the three nutrients in 11–20-year-old females with the data for 11–20-year-old males. *[2]*

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(d) The data in the table indicates differences in the incidence of anemia between males and females. Suggest possible causes of these differences. *[2]*

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A2. (a) Outline the importance of fibre as a component of a balanced diet. *[3]*

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(b) Distinguish between minerals and vitamins. *[1]*

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(c) Explain how diet can reduce the consequences of phenylketonuria (PKU). *[3]*

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A3. (a) Distinguish between the composition of human milk and artificial milk used for bottle-feeding babies. *[2]*

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(b) Explain the benefits of breastfeeding. *[3]*

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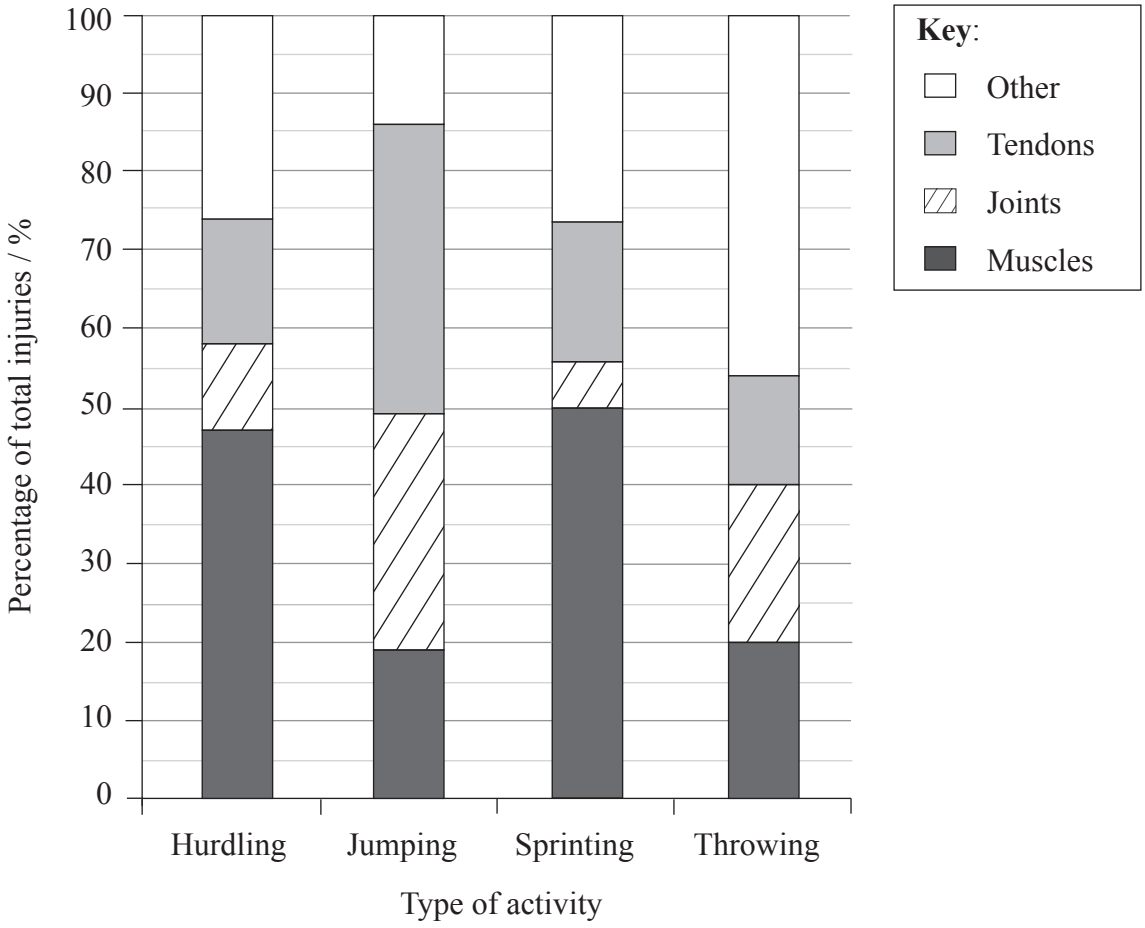
Option B — Physiology of exercise

B1. In a study of athletes in Brazil, doctors examined the relationship between the type of injuries sustained by the athletes and the type of activity in which they were competing. The percentages of injuries to muscles, joints and tendons were compared across a range of sporting activities.



[Source: adapted from C Pastre, *et al.*, (2005), *Rev Bras Med Esporte*, **11** (1), pages 48–52]

(a) State the percentage of joint injuries in throwers. *[1]*

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(This question continues on the following page)

(Question B1 continued)

(b) (i) Compare the types of injuries sustained by sprinters and hurdlers. *[2]*

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(ii) Hurdling is a sport that involves both sprinting and jumping. Using the data, suggest with a reason, which of these two activities contributes most of the injuries sustained by hurdlers. *[1]*

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(c) Discuss the importance of warm-up routines in preventing injuries. *[2]*

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B2. (a) Compare the movements of the hip joint and the knee joint. *[2]*

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(b) Compare the distribution of blood flow in the human body at rest and during exercise. *[2]*

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(c) Evaluate the use of erythropoietin (EPO) to improve performance in sports. *[2]*

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B3. (a) Draw a labelled diagram to show the structure of a sarcomere. *[3]*

(b) Describe how skeletal muscle contracts. *[3]*

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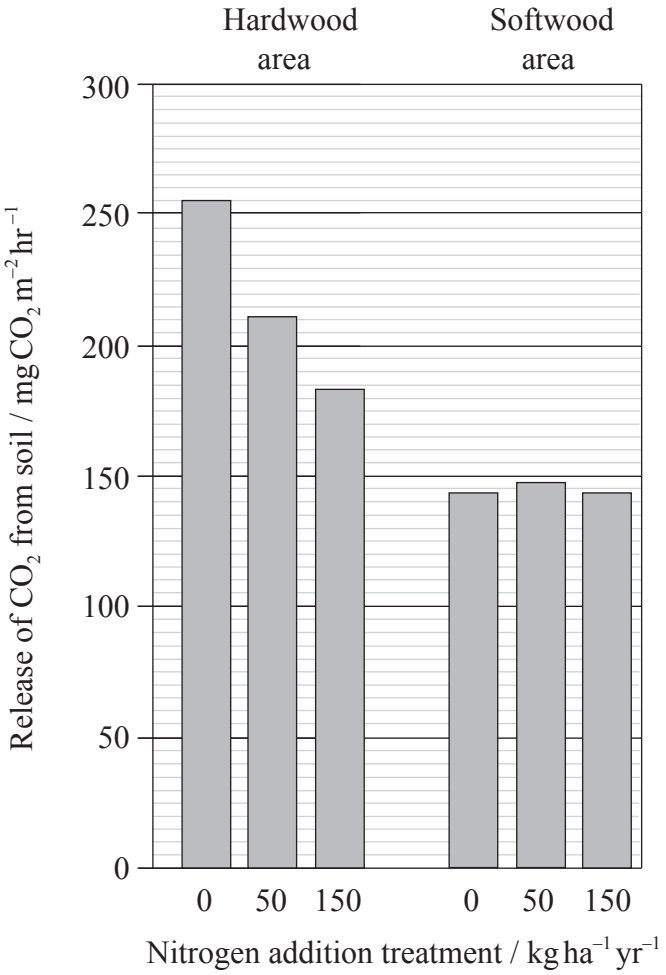
Option C — Cells and energy

C1. In a long-term experiment in Harvard Forest, Massachusetts in northeastern USA, nitrogen was added to the soil in two different areas of the forest containing either hardwood or softwood trees and the effects on release of CO_2 from the soil were measured.



[Source: adapted from I J Fernandez, Plant, Soil, and Environmental Sciences, www.climatechange.umaine.edu]

(a) Estimate the difference between the lowest and highest rates of release of CO_2 from the soil in the hardwood area, giving the units. *[1]*

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(This question continues on the following page)

(Question C1 continued)

(b) Suggest **one** process occurring in tree roots that could cause the release of CO_2 from the soil. *[1]*

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(c) (i) Describe the relationship between rates of nitrogen addition and release of CO_2 from soil in the hardwood area. *[2]*

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(ii) Suggest a reason for this relationship. *[1]*

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(d) Compare the effects of the nitrogen addition treatments on the hardwood and softwood areas of the Harvard Forest. *[2]*

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C2. (a) Distinguish between oxidation and reduction. *[2]*

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(b) Outline the process of glycolysis. *[3]*

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(c) Using light as an example, explain the concept of limiting factors in photosynthesis. *[3]*

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C3. Explain the significance of polar and non-polar amino acids in proteins. *[3]*

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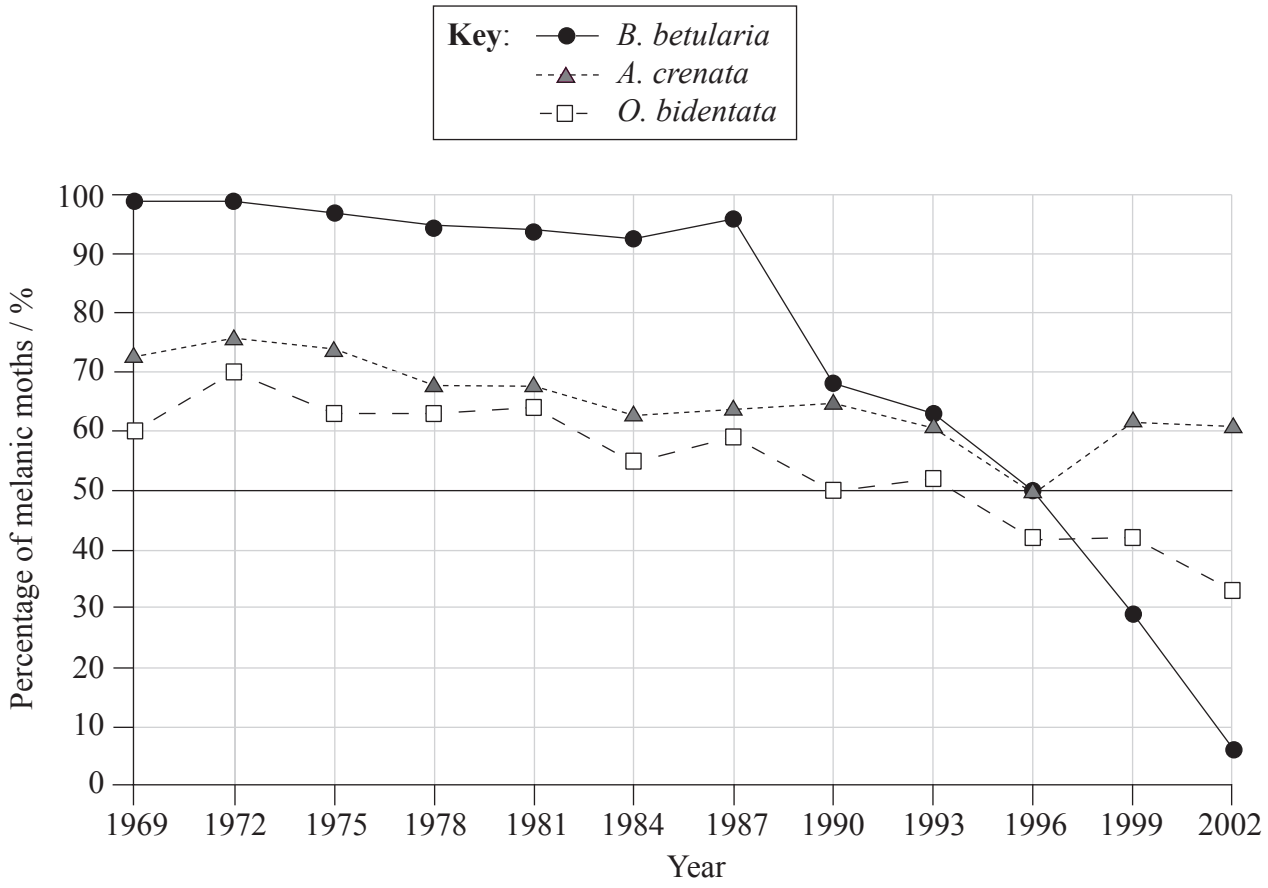
Option D — Evolution

D1. A study of the changing frequencies of the melanic (dark) and non-melanic (light) forms of three moth species *Biston betularia*, *Odontoptera bidentata* and *Apamea crenata* was carried out in the north of England. Moths were captured using mercury vapour light traps throughout the flying season. All three of the moth species fly at night and rest in the day, when they would be vulnerable to predation by birds, if visible. *B. betularia* rests on tree branches and there is evidence that the change from melanic to non-melanic forms was associated with black soot disappearing from these branches as air pollution was reduced and pale coloured lichens started to grow. *O. bidentata* rests under the leaves of trees or in cracks in tree bark. *A. crenata* rests in long grasses. The graph shows the percentage of melanic moths caught between 1969 and 2002.



[Source: adapted from LM Cook, *et al.*, (2005), *Journal of Heredity*, **96**(5), pages 522–528]

(a) Identify the year with the highest frequency of the melanic form of *O. bidentata*. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(b) Estimate the percentage of **non-melanic** forms of *A. crenata* in 1978. *[1]*

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(c) (i) Compare the trends for the three moth species during the study. *[3]*

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(ii) Suggest reasons for the differences in trends. *[2]*

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D2. (a) Discuss the definition of the term **species**. *[3]*

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(b) Outline allopatric **and** sympatric speciation. *[2]*

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D3. (a) Outline the process of adaptive radiation. *[3]*

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(b) Discuss the importance of cultural evolution in the recent evolution of humans. *[3]*

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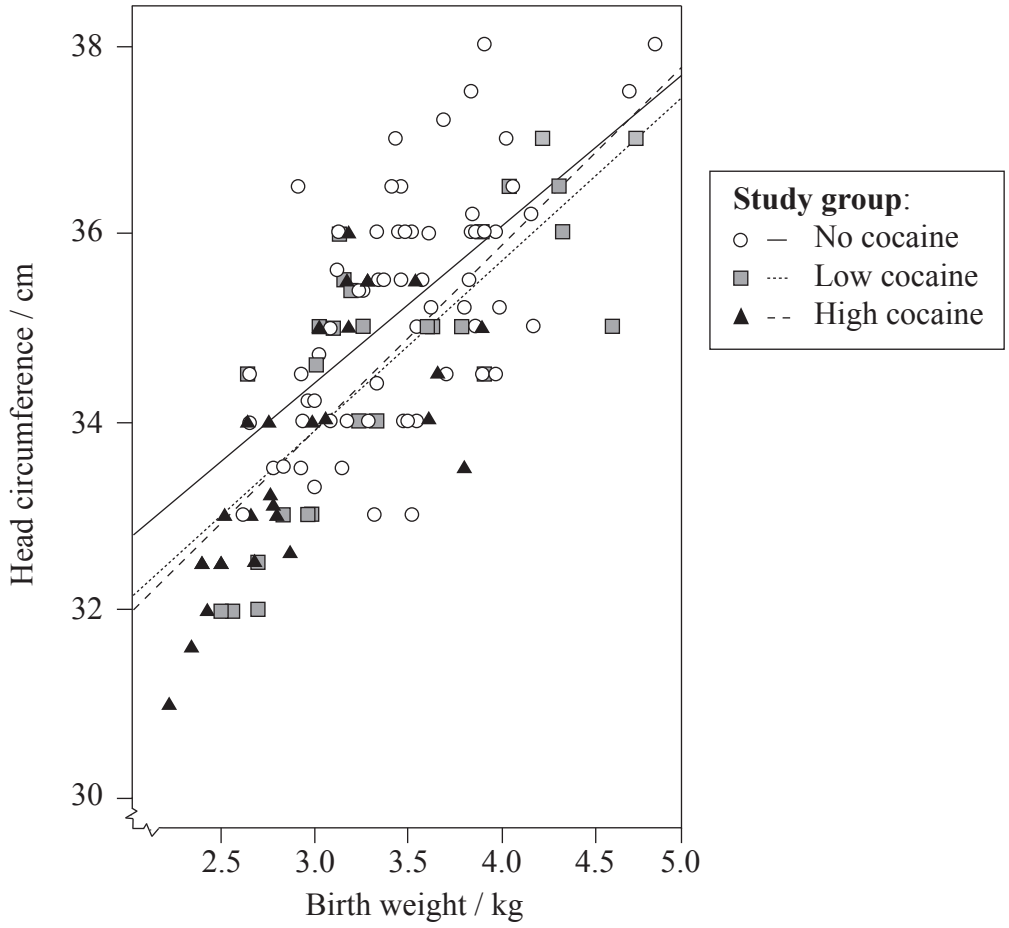
Option E — Neurobiology and behaviour

E1. The drug cocaine is believed to have an impact on fetal development. A study was carried out to evaluate the relationship between head circumference and birth weight in newborn babies exposed to cocaine when they were in the uterus.

Cocaine levels were measured in the mothers during pregnancy and the mothers were categorized into three study groups: no cocaine, low cocaine and high cocaine. Head circumference and birth weight were measured in the babies and their relationship is presented in the graph below.



[Source: adapted from DA Bateman and CA Chiriboga, (2000), *Pediatrics*, **106** (3), page 33]

(a) State the lowest head circumference measured in newborn babies born to high cocaine users, giving the units. *[1]*

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(This question continues on the following page)

(Question E1 continued)

(b) State the relationship between birth weight and head circumference in newborn babies whose mothers did not use cocaine. *[1]*

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(c) Using the data in the graph, describe the relationship between cocaine exposure and head circumference in newborn babies. *[2]*

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(d) Deduce the effect of cocaine use on the head circumference of babies with a birth weight below 3.5 kg. *[2]*

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

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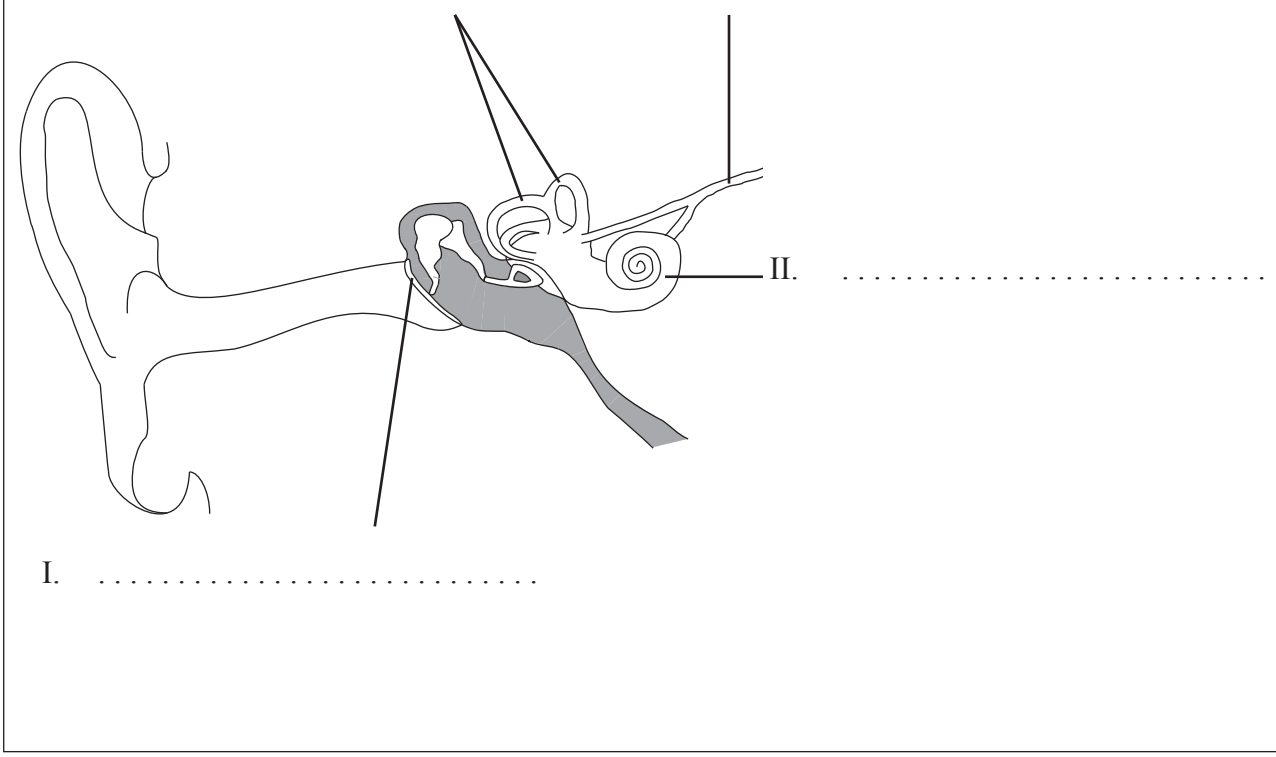
(b) Label the diagram of the ear. *[2]*



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(Question E2 continued)

(c) (i) Compare rod and cone cells. *[3]*

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(ii) Explain sympathetic and parasympathetic control of the movement of the iris. *[2]*

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E3. (a) Define the term *reflex* in animal behaviour. *[1]*

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(b) Outline the main roles of motor, sensory and relay neurons in a spinal reflex arc. *[3]*

	Main role
Motor neuron	
Sensory neuron	
Relay neuron	

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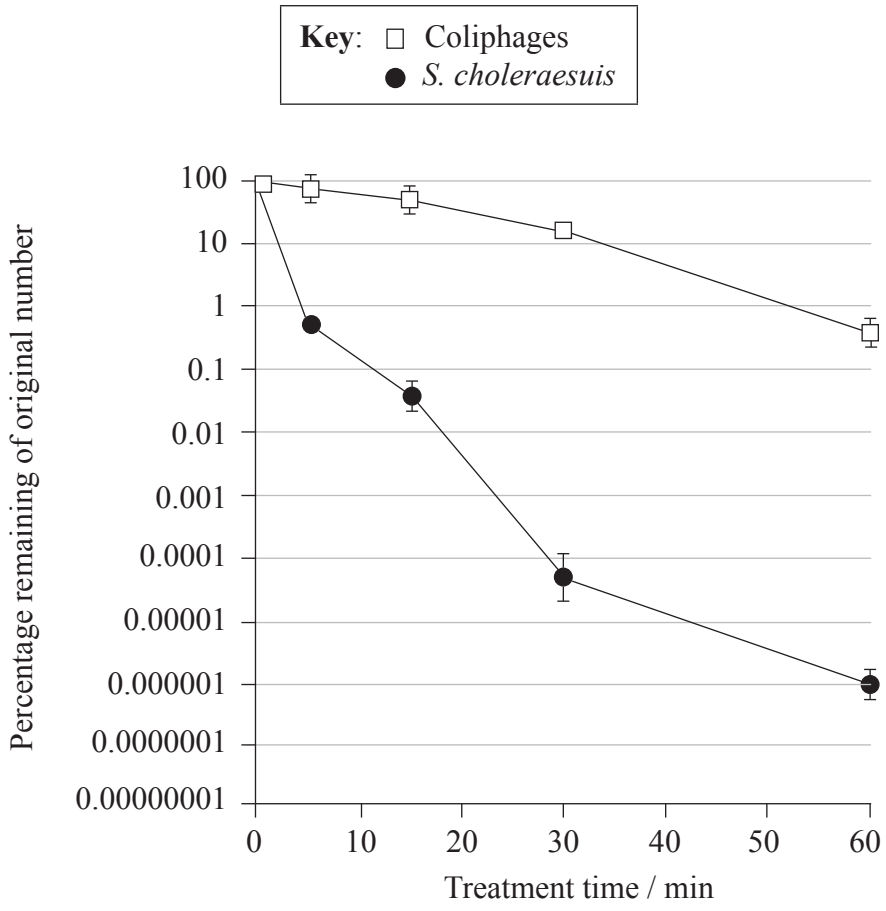
will not be marked.

Option F — Microbes and biotechnology

F1. The sludge produced in sewage treatment plants contains pathogenic microorganisms. In a study, sludge was heated to 80 °C in order to kill the pathogens and the effectiveness of this treatment was compared using viruses (coliphages) and bacteria (*Salmonella choleraesuis*) which were added as indicators. The level of activity of either of these two indicators shows whether pathogenic microorganisms may have survived in the sewage sludge.

The resistance of the indicators to heat treatment was studied and their level of activity is shown in the following graph.



[Source: adapted from L Mocé-Llivina, *et al.*, (2003), *Applied and Environmental Microbiology*, **69** (3), pages 1452–1456]

(a) State which indicator was more resistant to the heat treatment. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(b) Compare the effect of the 80 °C heat treatment on coliphages and *S. choleraesuis*. *[2]*

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(c) Discuss whether the heat treatment should be continued beyond 60 minutes if this technique were to be used in sewage treatment plants. *[2]*

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(d) In many areas, sewage is discharged directly into the environment. State **two** potential environmental consequences of releasing sewage into rivers *[2]*

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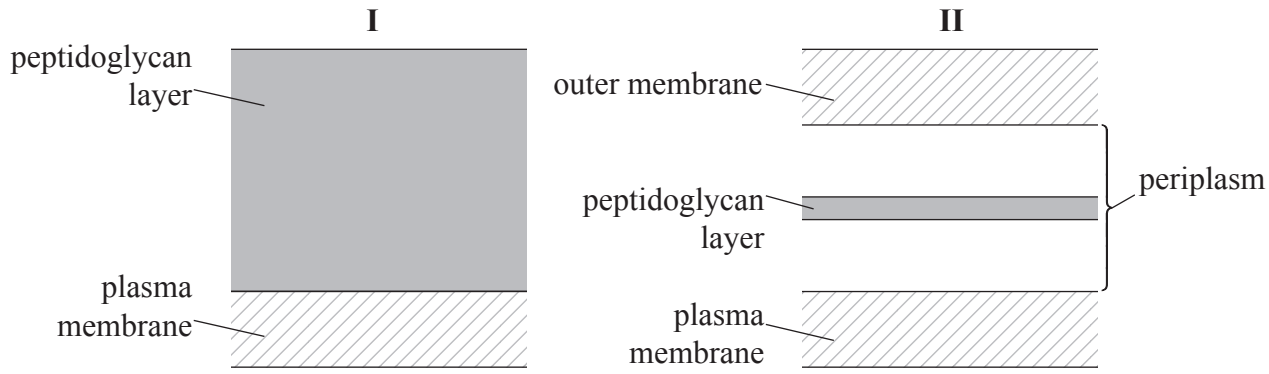
F2. (a) The diagram below represents the cell walls of two different bacteria. State, with a reason, which cell wall (I or II) is Gram-positive. *[1]*



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(b) Denitrification is part of the nitrogen cycle. Outline the conditions that favour denitrification in the environment. *[2]*

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(This question continues on the following page)

(Question F2 continued)

(c) Explain the generation of methane from biomass. *[3]*

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F3. Gene therapy is a new technology which can be used to treat hereditary diseases.

(a) Outline **two** risks of gene therapy. *[2]*

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(b) Distinguish between somatic and germ line therapy. *[3]*

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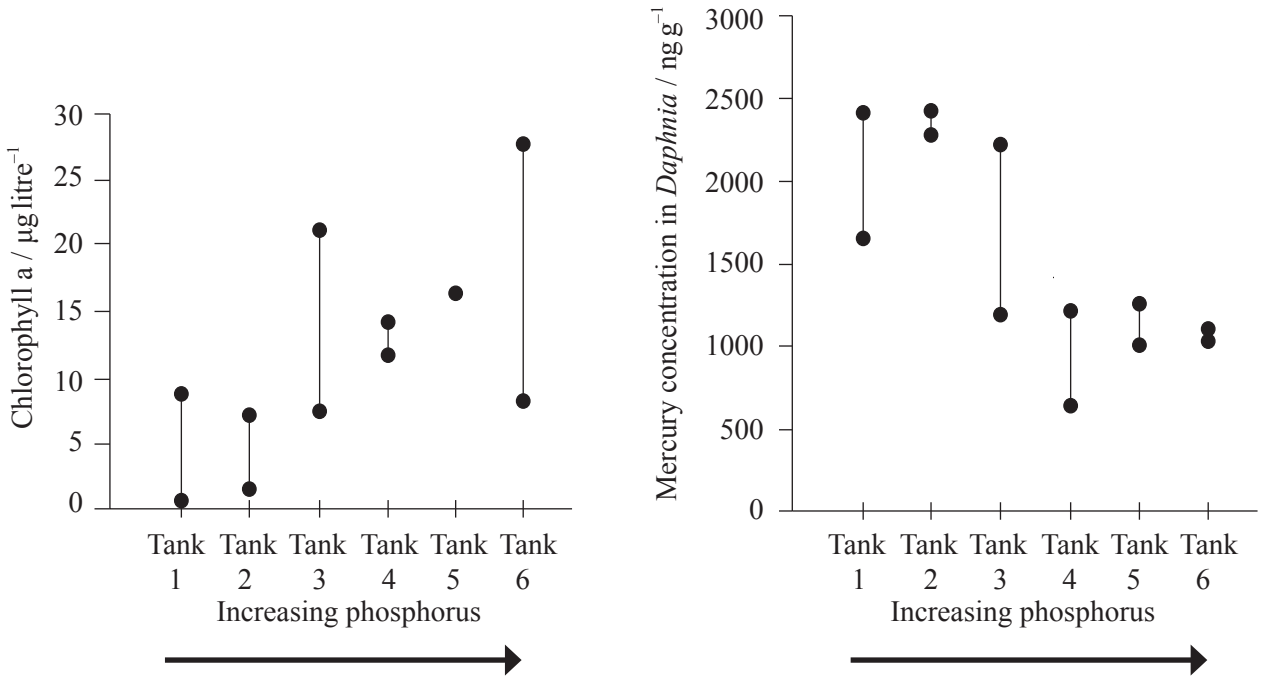
Option G — Ecology and conservation

G1. Mercury is a toxic substance and its biomagnification in aquatic food chains is a global concern. A study tested the effects of inorganic phosphorus levels on both algal growth and mercury accumulation by *Daphnia mendotae* feeding on the algae which absorb mercury from the water. *Daphnia* may subsequently be eaten by fish.

Experiments were performed in six different tanks with increasing phosphorus concentrations. The same amount of mercury was added to each tank. The quantity of algae, determined by measuring the amount of chlorophyll a, and the accumulation of mercury by *Daphnia* was measured in each tank. Chlorophyll a and mercury levels were measured twice at each of the six different phosphorus concentrations.



[Source: adapted from PC Pickhardt, *et al*., (2002), *PNAS*, **99**, pages 4419–4423]

(a) (i) Deduce the tank in which the quantity of algae was highest. *[1]*

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(This question continues on the following page)

(Question G1 continued)

(ii) Deduce the tank in which the level of mercury accumulation in *Daphnia* was lowest. *[1]*

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(b) Outline the relationship between phosphorus concentration in the water and the accumulation of mercury by *Daphnia*. *[2]*

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(c) Using the data, suggest reasons for the relationship between phosphorus concentration in the tanks and mercury concentration in *Daphnia*. *[2]*

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G2. (a) In a grassland ecosystem, the amount of energy captured by the photosynthetic organisms was $100\,000\,kJ\,m^{-2}\,yr^{-1}$. Construct a pyramid of energy indicating the predicted energy levels for **four** trophic levels, including the producers. *[3]*

(b) Define *biomass*. *[1]*

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G3. (a) Outline the effect of chlorofluorocarbons (CFCs) on the ozone layer. *[4]*

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(b) Explain how temperature and territory affect the distribution of animal species. *[4]*

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Territory:

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