22096018

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BIOLOGY
STANDARD LEVEL
PAPER 3

Thursday 7 May 2009 (morning)

1 hour

Candidate session number

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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 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.

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Option A — Human nutrition and health

A1. One recommendation for a healthy diet is to decrease the intake of saturated fatty acids. However, the relative benefit of replacing them with monounsaturated fatty acids, polyunsaturated fatty acids, or carbohydrates is still being debated. Diets with the same energy value, but rich in different fatty acids or carbohydrates, were fed to mice. The table below shows the composition of plasma triglycerides, cholesterol, very low density lipoprotein (VLDL), low density lipoprotein (LDL) and high density lipoprotein (HDL) in the diets.

Diet rich in:	**Mean plasma concentration / $mg\,dl^{-1}$**				
	Triglycerides	Cholesterol	VLDL	LDL	HDL
Saturated fatty acids	221	1014	373	608	90
Monounsaturated fatty acids	346	1834	831	788	84
Polyunsaturated fatty acids	101	801	242	526	89
Carbohydrates	178	1518	672	744	93

[Source: M Merkel, *et al.*, (2001), *Proceedings of the National Academy of Sciences*, **98**, pages 13294–13299]

(a) State which diets increase the levels of cholesterol more than a diet rich in saturated fatty acids. *[1]*

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(b) Calculate the percentage increase in VLDL when changing from a diet rich in saturated fatty acids to a diet rich in carbohydrates. *[1]*

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(c) Compare a diet rich in saturated fatty acids and a diet rich in monounsaturated fatty acids. *[2]*

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(This question continues on the following page)

(Question A1 continued)

(d) Evaluate the hypothesis that changing from a diet rich in saturated fatty acids to a diet rich in polyunsaturated fatty acids is healthy. *[3]*

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A2. (a) State **one** food source rich in vitamin D. *[1]*

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(b) Outline how appetite is controlled. *[3]*

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A3. (a) (i) State **one** cause of type II diabetes. *[1]*

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(ii) List **two** symptoms in a patient with type II diabetes. *[2]*

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(b) Explain how a special diet can reduce the consequences of phenylketonuria (PKU). *[4]*

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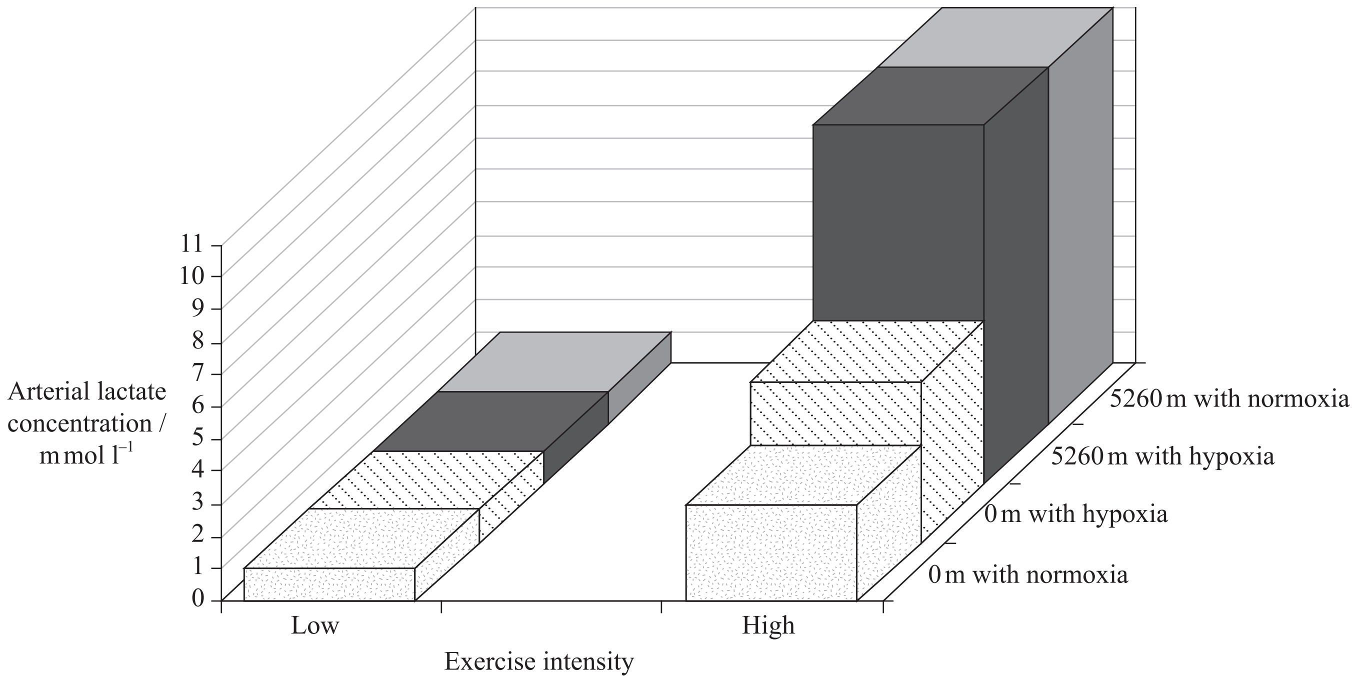
Option B — Physiology of exercise

B1. At high altitude the optimum oxygen saturation of hemoglobin is harder to achieve due to the decrease in air pressure.

The effects of lack of oxygen (hypoxia) and of altitude were studied in a group of men. The arterial lactate concentrations were measured during bicycle exercise under four different conditions.

Location / altitude	**Oxygen conditions**
in Copenhagen (0 m at sea level)	breathing normal air (normoxia)
	breathing an air mixture containing low levels of O_2 (hypoxia)
on Mount Chacaltaya, in Bolivia (5260 m above sea level)	breathing a gas mixture with high levels of O_2, allowing normal hemoglobin saturation (normoxia)
	after nine weeks of acclimatization breathing normal mountain air (hypoxia)



[Source: adapted from G van Hall, *et al.*, (2001), *Journal of Physiology*, **536.3**, pages 963–975]

(This question continues on the following page)

(Question B1 continued)

(a) State the arterial lactate concentration measured at 0 m (sea level) with normoxia when exercise intensity is high. *[1]*

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(b) State the effect of increasing exercise intensity on the arterial lactate concentration. *[1]*

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(c) Explain how altitude and oxygen concentration affect the arterial lactate concentration at high exercise intensity. *[3]*

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(d) Outline the fate of the lactate after the exercise has finished. *[2]*

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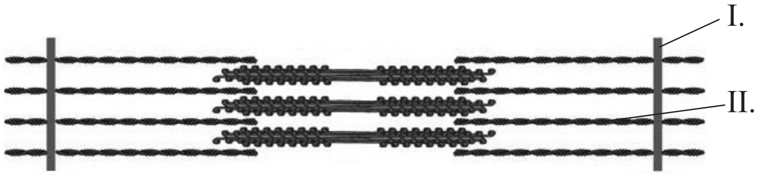
B2. (a) Label the parts of the sarcomere indicated below. *[2]*



I. ....

II. ....

(b) (i) Distinguish between fast muscle fibres and slow muscle fibres. *[2]*

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(ii) Discuss the need for warm-up routines. *[3]*

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B3. (a) Define the term *vital capacity*. *[1]*

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(b) Evaluate the risks and benefits of using EPO (erythropoietin) to improve performance in sports. *[3]*

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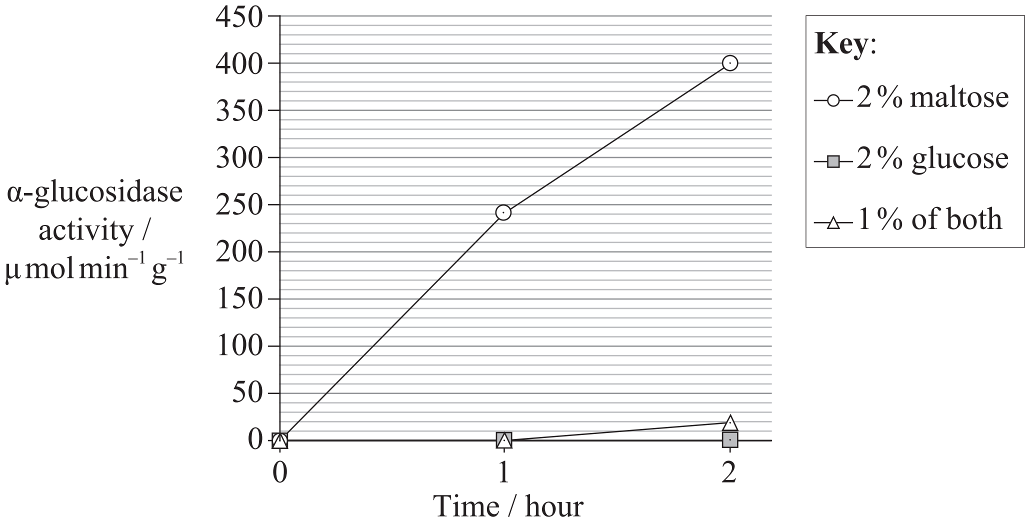
Option C — Cells and energy

C1. Glucose has an important regulatory function in carbohydrate metabolism in yeast (*Saccharomyces cerevisiae*). The enzyme α-glucosidase catalyses the breakdown of maltose to two glucose molecules. The activity of yeast α-glucosidase was measured in cells which were grown in three different media containing : 2 % maltose, 2 % glucose and 1 % of both.



[Source: This figure (adapted) was published in Boris U. Stambuk, "A simple experiment illustrating metabolic regulation: induction versus repression of yeast α-glucosidase", *Biochemical Education*, Volume 27, Issue 3, pp. 177-180, © Elsevier 1999.]

(a) Calculate the difference in α-glucosidase activity at two hours in yeast grown with 2% maltose compared to yeast grown with 1% of both. *[1]*

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(b) Distinguish between α-glucosidase activity in yeast incubated only with glucose and yeast incubated only with maltose. *[1]*

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(This question continues on the following page)

(Question C1 continued)

(c) Suggest the effect of incubating the yeast cells with both maltose and glucose in terms of metabolic pathways. *[3]*

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(d) Outline the metabolism of glucose during glycolysis. *[2]*

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C2. (a) (i) Explain the primary structure of proteins and secondary structure of proteins. *[3]*

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(ii) Using **named** examples, distinguish between fibrous protein and globular protein. *[2]*

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(b) State **one** difference between oxidation and reduction. *[1]*

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C3. (a) State the location in the chloroplast of the following reactions of photosynthesis. *[2]*

Light-independent reactions: . . . .

Light-dependent reactions: . . . .

(b) Explain what happens to the electrons in the light-dependent reactions of photosynthesis. *[3]*

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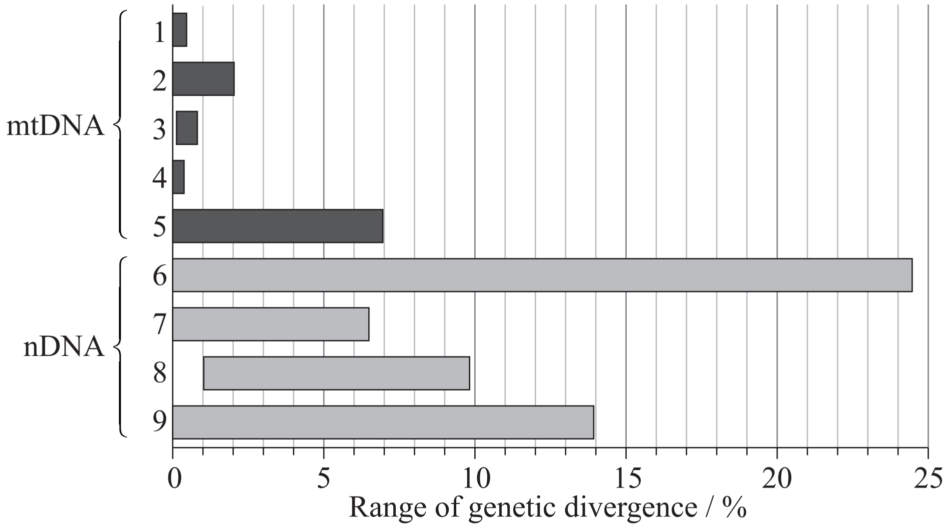
Option D — Evolution

D1. The rate of nucleotide substitution is used as an indication of evolutionary change. A study was carried out on mitochondrial DNA and nuclear DNA of different species of *Acropora*, a Pacific Ocean coral.

The dark grey bars represent the range of genetic sequence divergence between the species for specific mitochondrial DNA sequences (mtDNA) and the light grey bars represent specific nuclear DNA sequences (nDNA).



[Source: T. L. Shearer, M. J. H. van Oppen, S. L. Romano, G. Worheide, "Slow mitochondrial DNA sequence evolution in the Anthozoa (Cnidaria)", *Molecular Ecology*, Volume 11, Issue 12, pp. 2475–2487. Copyright Wiley-Blackwell. Reprinted with permission.]

(a) Measure the percentage of maximum genetic divergence for the mtDNA2 sequence. *[1]*

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(b) Calculate the maximum difference in genetic divergence between the mtDNA5 sequence and nDNA6 sequence. *[1]*

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(c) Compare the variations in the range of genetic divergence of the mtDNA and nDNA sequences. *[3]*

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(This question continues on the following page)

(Question D1 continued)

(d) State which theory is supported by the presence of DNA in mitochondria. *[1]*

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D2. (a) State **two** properties of RNA that would allow it to play a role in the origin of life. *[2]*

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(b) Outline the experiment of Miller and Urey into the origin of organic compounds. *[3]*

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D3. (a) Define the term *gene pool*. *[1]*

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(b) Compare allopatric speciation and sympatric speciation. *[4]*

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(c) Explain the correlation between the change in diet and increase in brain size during hominid evolution. *[2]*

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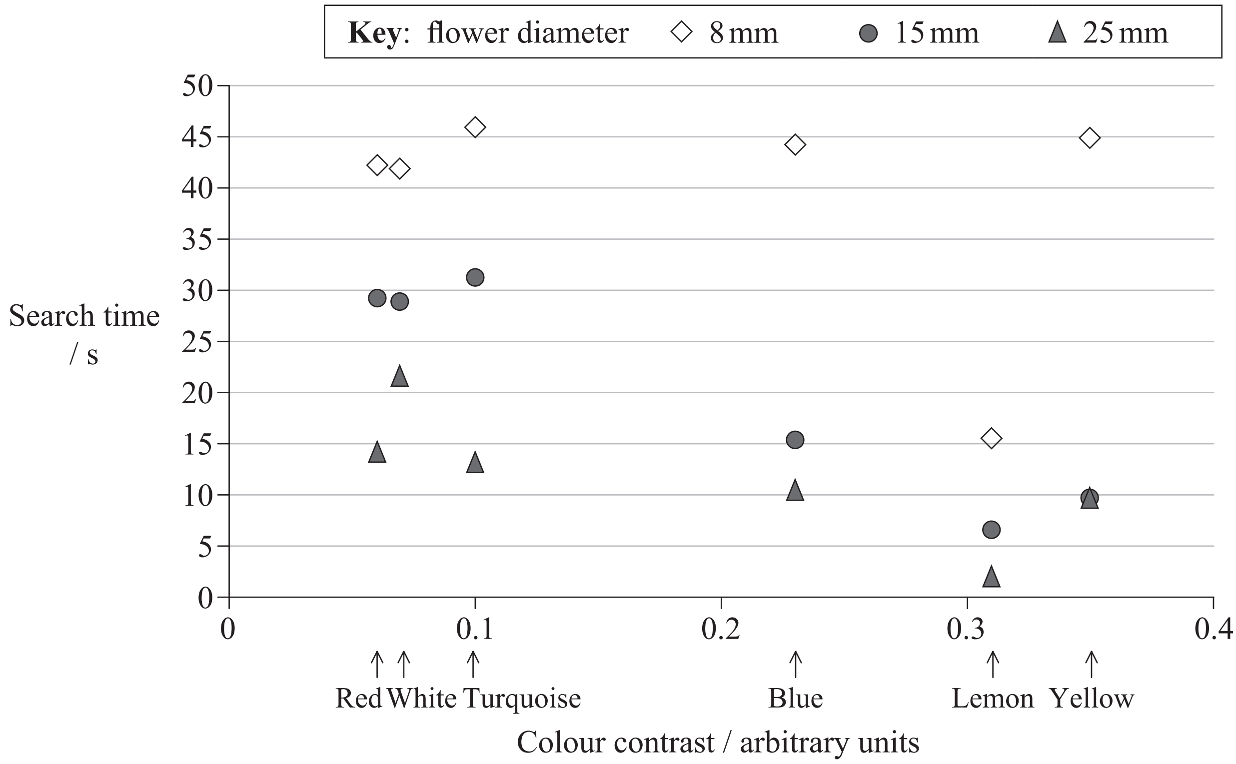
Option E — Neurobiology and behaviour

E1. Scientists studied the flight behaviour of bumblebees (*Bombus terrestris*) searching for artificial flowers of various sizes and colours. The search time is the time taken from leaving the first flower to landing on the second flower. The colour contrast is an arbitrary value which shows the colour contrast of the flowers with their green leaf-like type background. The graph below shows the search time for flowers of different colours and sizes.



[Source: J. Spaethe, J. Tautz and L. Chittka, "Visual constraints in foraging bumblebees: Flower size and color affect search time and flight behavior", Proceedings of the National Academy of Sciences, Volume 98, Issue 7, March 27 2001, pp. 3898–3903: Figure 3a. Copyright 2001 National Academy of Sciences, USA.]

(a) State the time it takes bumblebees to reach a blue flower of 15 mm diameter from another flower. *[1]*

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(b) State the colour of flower the bumblebees find in least time. *[1]*

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(This question continues on the following page)

(Question E1 continued)

(c) Describe the effect of colour contrast on search time for the larger flowers (25 mm diameter). *[1]*

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(d) When searching for smaller flowers, bumblebees changed the strategies used for larger flower detection. Evaluate this hypothesis using the data. *[3]*

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(e) Suggest the type of behavior shown by bumblebees in this experiment and how it can affect their chances of survival. *[1]*

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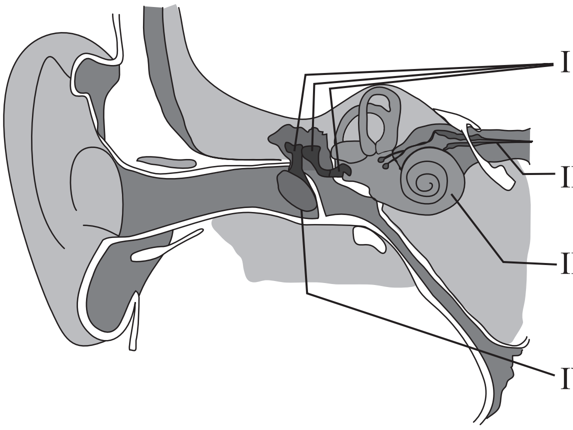
E2. (a) Label the **four** parts of the ear indicated on the drawing below. *[2]*



(b) Discuss how the process of learning can increase chances of survival. *[2]*

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(c) Outline Pavlov’s experiment into conditioning of dogs. *[2]*

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E3. (a) Define the terms *stimulus* and *reflex*. *[2]*

Stimulus: . . . .

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Reflex: . . . .

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(b) Explain how excitatory psychoactive drugs affect the brain. *[3]*

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Option F — Microbes and biotechnology

F1. Nitric oxide is an intermediate product which inhibits respiratory electron transport chains during denitrification. A series of experiments were carried out to study the impact of nitric oxide produced by denitrifying bacteria on the growth of non-denitrifying bacteria which do not produce nitric oxide.

Different strains of the denitrifying bacteria *Rhodobacter sphaeroides* (a, b, and c) and *Achronobacter cycloclastes* (Ac) were used to measure the inhibition of the growth of three non-denitrifying bacteria due to the antimicrobial activity of nitric oxide.

DIAGRAM REMOVED FOR COPYRIGHT REASONS

[Source: adapted from P Choi, *et al*., (2006), *Applied and Environmental Microbiology*, March, pages 2200–2205, Figure 3, page 2202 and http://aem.asm.org/cgi/content/abstract/72/3/2200]

(a) (i) Identify the non-denitrifying bacterium that was **most** inhibited by the strain *R. sphaeroides* a. *[1]*

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(ii) Identify the denitrifying bacterium that had the **least** inhibitory effect overall on the non-denitrifying bacterium 2. *[1]*

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(Question F1 continued)

The error bars on the graph opposite represent ± 1 standard deviation.

(b) (i) Measure the standard deviation of the inhibition of strain *R. sphaeroides* b on the non-dentrifying bacterium 3. *[1]*

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(ii) State the percentage of the sample that is represented by ± 1 standard deviation. *[1]*

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(c) Compare the results of strain *R. sphaeroides* c and *A. cycloclastes* (Ac) denitrifying bacteria on the inhibition of the growth of the three non-denitrifying bacteria. *[2]*

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(d) Deduce which denitrifying bacterium **least** affects ATP production in non-denitrifying bacteria. *[1]*

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F2. (a) Outline the diversity of structure in viruses. *[3]*

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(b) Explain, with the use of a specific example, how reverse transcriptase is used in molecular biology. *[3]*

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F3. (a) State **one** example of a characteristic shown by aggregates of a **named** bacterium not present in an individual of that same species. *[2]*

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(b) Explain the use of *Saccharomyces* in the production of beer. *[3]*

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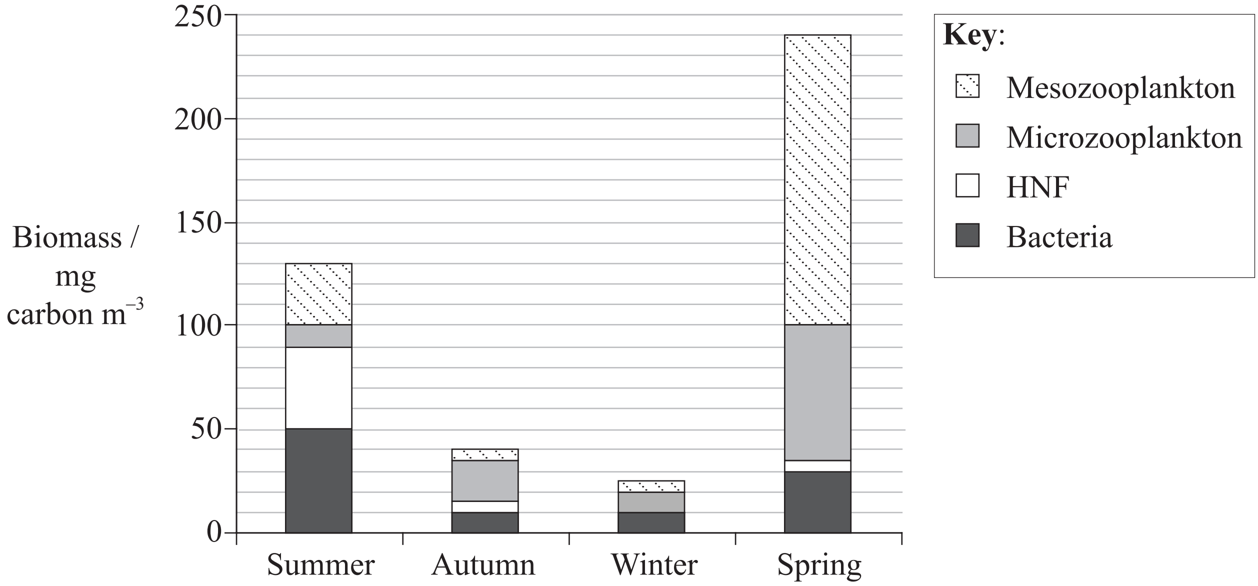
Option G — Ecology and conservation

G1. Seasonal changes of heterotrophic plankton biomass were measured in the western arctic Pacific during a one year period. The mesozooplankton, whose size is greater than 330 µm, was formed mainly by copepods. The microzooplankton, ranging from 10 to 200 µm, comprised mainly of ciliates and flagellates. Heterotrophic nanoflagellates (HNF), size range 2 to 10 µm, are organisms that feed on small flagellates and bacteria. The results are shown below.



[Source: A. Shinada, et. al., "Seasonal dynamics of planktonic food chain in the Oyashio region, western subarctic Pacific", *Journal of Plankton Research*, Volume 23, Issue 11, pp. 1237–1248, by permission of Oxford University Press]

(a) State the biomass of HNF found in this region in summer. *[1]*

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(b) Calculate the percentage increase in mesozooplankton from summer to spring. Show your working. *[2]*

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(This question continues on the following page)

(Question G1 continued)

(c) Suggest how the seasonal changes cause the differences in biomass of heterotrophic plankton. *[3]*

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(d) Suggest **one** method which could have been used in this study to measure the biomass of heterotrophic plankton. *[1]*

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G2. (a) Define the terms *gross production* and *net production.* *[2]*

Gross production: . . . .

Net production: . . . .

(b) Using the table below, compare the characteristics of the following biomes. *[3]*

Biome	Temperature	Moisture	Characteristic of vegetation
Desert			
Tropical rainforest			
Tundra			

G3. (a) (i) State **one** example of a deliberate release of an alien species, including the name of the organism and where it was released. *[1]*

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(ii) Using the example from (a)(i), outline the reason for its release and the impact it had on the environment. *[2]*

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(b) Explain, using a **named** example, the cause and consequence of biomagnification. *[3]*

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