



BIOLOGY
STANDARD LEVEL
PAPER 3

Thursday 16 November 2000 (morning)

1 hour 15 minutes

Name

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Number

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INSTRUCTIONS TO CANDIDATES

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from three of the Options in the spaces provided. You may continue your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the boxes below.

OPTIONS ANSWERED	EXAMINER	TEAM LEADER	IBCA
	/15	/15	/15
	/15	/15	/15
	/15	/15	/15
NUMBER OF CONTINUATION BOOKLETS USED	TOTAL	TOTAL	TOTAL
.....	/45	/45	/45

Option A – Diet and Human Nutrition

A1. Animals which feed on fruit often choose figs rather than other types. The protein, carbohydrate and lipid contents of figs are not exceptionally high and one theory is that the calcium content may be the attraction. Figs and other wild fruits were collected from forests in Belize, Indonesia and Uganda. Their mineral contents were analysed. The mean results for calcium, sodium and phosphorus are shown in the table below.

Source	Fruit Type	Mineral content / % of dry mass		
		calcium	sodium	phosphorus
Belize	Fig	1.91	0.040	0.18
Indonesia	Fig	1.21	0.060	0.33
Uganda	Fig	1.52	0.043	0.18
Belize	Non-fig	0.39	0.063	0.17
Indonesia	Non-fig	0.47	0.057	0.42
Uganda	Non-fig	0.48	0.014	0.14

[Source: O'Brien *et al.*, *Nature* (1998), **392**, page 668]

(a) Compare the calcium content of the figs with the non-fig fruits. [2]

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(b) Suggest **one** benefit to animals of eating fruits containing calcium. [1]

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(c) Evaluate the data in the table as evidence for the theory that animals are attracted to figs by their calcium content. [2]

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(d) Suggest **one** dietary group of humans who would benefit from including figs in their diet, with a reason based on the data in the table. [2]

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A2. (a) List **three** sources of protein for humans. [1]

- 1.
- 2.
- 3.

(b) State **two** functions of protein in humans. [2]

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(c) Outline how the body responds to an intake of more protein than it needs. [2]

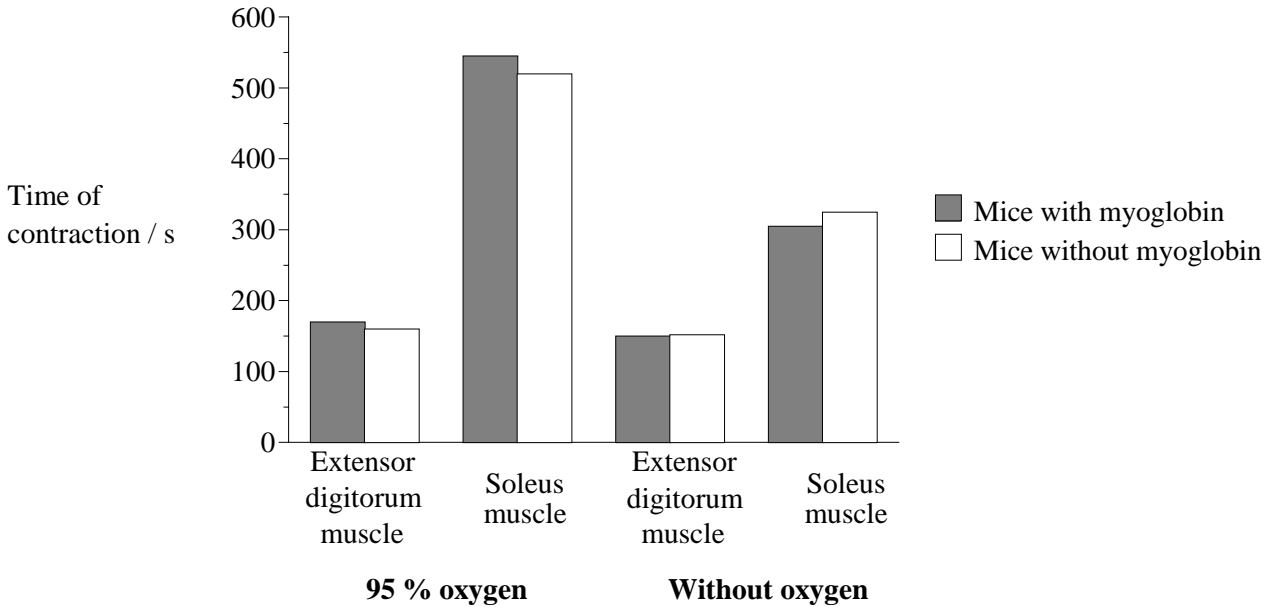
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A3. Suggest **three** causes of malnutrition in the world, with a reason for each. [3]

- 1.
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- 2.
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- 3.
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Option B – Physiology of Exercise

B1. The role of myoglobin in muscles was investigated using one group of mice that produce it and one group that does not. Two types of muscle which have different proportions of slow and fast fibres were removed from each group of mice and were then electrically stimulated to contract. The length of time that each muscle was able to remain contracted was measured. The experiment was performed twice, once with the muscles in a 95 % oxygen environment and the second time in an environment without any oxygen. The results are shown in the bar chart below.



[Source: Garry *et al.*, *Nature* (1998), **395**, pages 905–908]

(a) Using only the data for mice that produce myoglobin,

(i) compare the stamina of the two types of muscle in 95 % oxygen;

[1]

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(ii) compare the effect on the two types of muscle of oxygen deprivation;

[2]

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(iii) predict with reasons which of the two muscles has the higher proportion of fast muscle fibres.

[2]

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(This question continues on the following page)

(Question B1 continued)

- (b) Explain briefly whether results of the experiment support the hypothesis that myoglobin helps muscles to contract for a longer time without oxygen. [2]

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- B2.** Draw the structure of a sensory neurone. [4]

- B3.** Long bones such as the humerus and the femur have hollow shafts and spongy heads. Explain the reasons for

- (a) the shaft being hollow and not solid; [2]

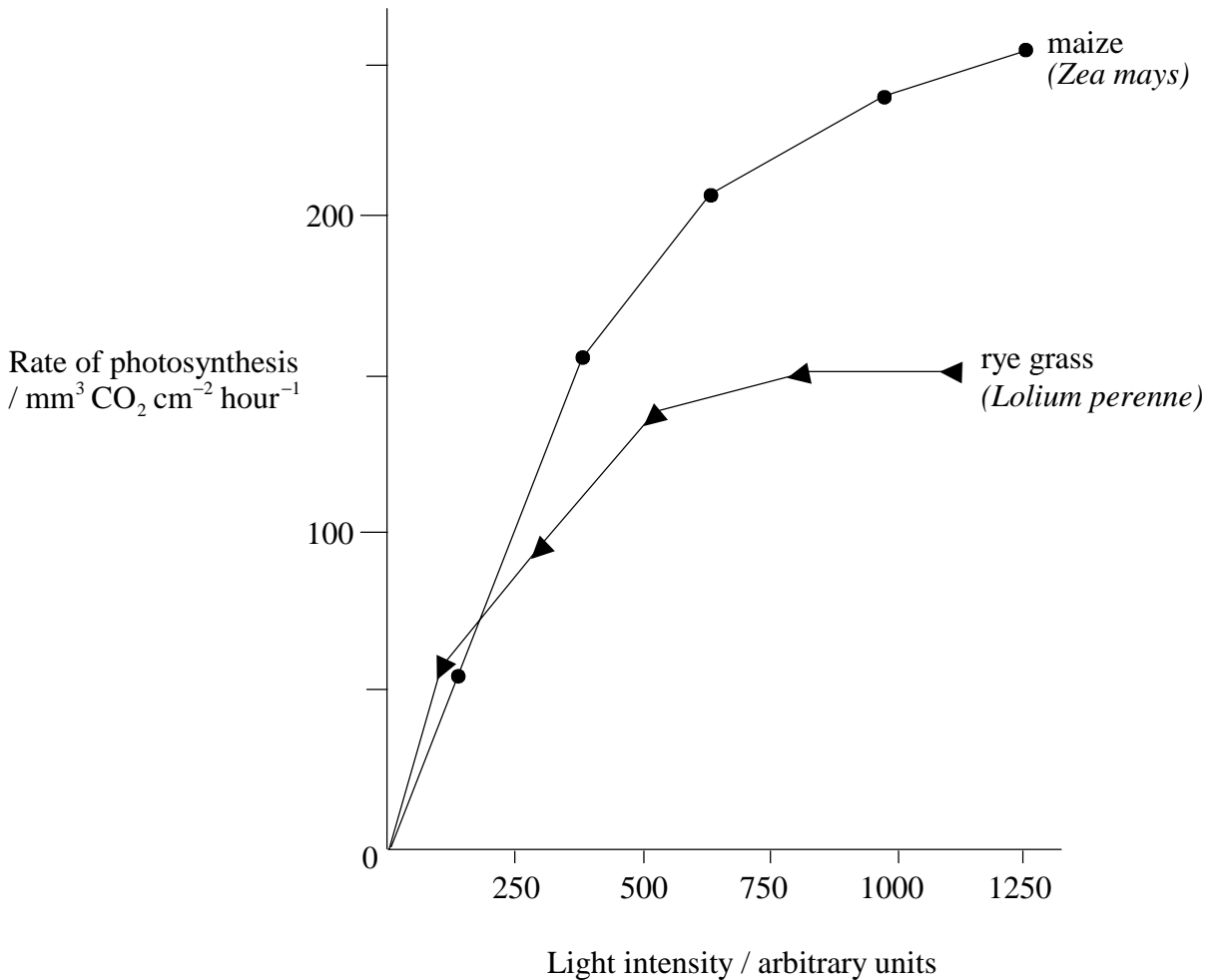
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- (b) the head being spongy and not solid. [2]

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Option C – Cells and Energy

C1. The graph below shows the relationship between light intensity and the rate of photosynthesis in two species of plant. One of the plants is a C₃ plant and the other is a C₄ plant. The rate of photosynthesis was measured in terms of carbon dioxide uptake per cm² of leaf per hour.



(a) Using only data in the graph for photosynthesis in **maize** at light intensity levels of 0–400:

(i) state the relationship between the light intensity and the rate of photosynthesis; [1]

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(ii) predict, with reasons, whether the rate of photosynthesis would be faster if a higher carbon dioxide concentration was used. [2]

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(This question continues on the following page)

(Question C1 continued)

(b) Using only the data in the graph for photosynthesis at light intensity levels above 750:

(i) state **two** differences in rates of photosynthesis between maize and rye-grass; [2]

- 1.
- 2.

(ii) deduce, with a reason, whether maize or rye-grass is a C₄ plant. [2]

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C2. Yeast cells produce ethanol under certain conditions.

(a) State the conditions that cause yeast to produce ethanol. [1]

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(b) Outline how glucose is converted into ethanol in yeast. [3]

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C3. (a) State **one** example of a fibrous protein. [1]

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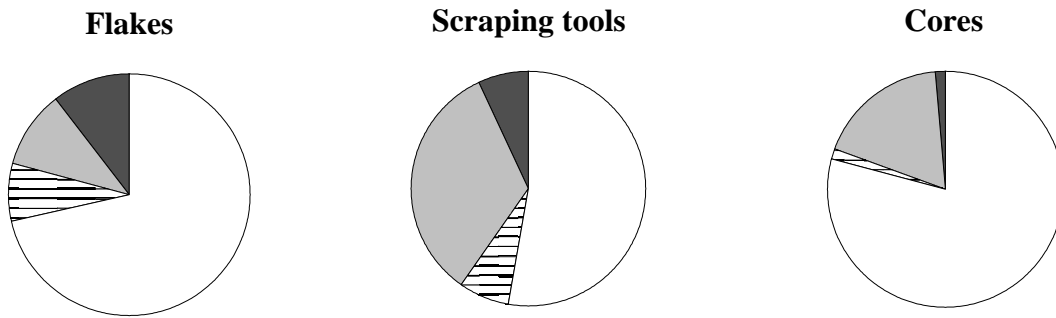
(b) Explain briefly how enzymes can be inhibited by allostery. [3]

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Option D – Evolution

D1. At Arago, in south-west France, tools made 300 000 to 400 000 years ago have been found. Some of these tools were made using rock from Arago and some using rock from elsewhere. Round pieces of hard rock including chert, chalcedony and quartzite were used. Flakes of rock were removed to leave a core with one rounded end and one sharp end. Some of the flakes were made into scraping tools by carefully chipping away the sharp edge. The flakes, cores and scraping tools were each used for different purposes. The pie charts below show the percentages of each type of tool made using rock from the various sources.

- Rock from Arago
- Rock from other regions
- Quartzite from Têt, 20 km away from Arago
- Chalcedony and chert from Roquefort, 30 km from Arago



[Source: Gowlett, *Cambridge Encyclopaedia of Human Evolution* (1992), page 344]

- (a) (i) Identify whether a higher percentage of tools was made using rock from Roquefort or from Têt. [1]

- (ii) Suggest **two** reasons for more tools being made from the source of rock identified in (i). [2]
 1.
 2.
- (b) (i) Identify which type of tool was made in the highest percentage from rock found at Arago. [1]

- (ii) Suggest **one** reason for this. [1]

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(Question D1 continued)

(c) Although apes make and use tools, they could not have made the tools found at Arago.

(i) Explain briefly why apes did not make the tools; [2]

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(ii) Explain briefly which primate is most likely to have made the tools. [1]

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D2. (a) Outline how the membranes of the first living cells on Earth could have formed. [2]

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(b) List **two** possible functions of RNA in the first living cells. [2]

1.
2.

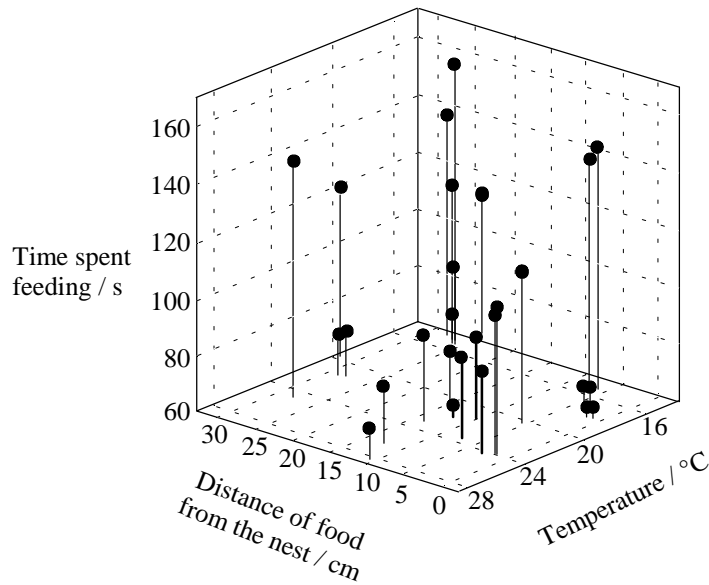
D3. Explain the evidence for evolution provided by the pentadactyl limb. [3]

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Option E – Neurobiology and Behaviour

- E1.** Ants are social insects which live in colonies and collect food from surrounding areas. The feeding behaviour of *Leptothorax albipennis*, a species of ant found in south-west England, was investigated using a dilute sugar solution. The sugar solution was placed in dishes at various distances from the ants' nest. When a worker ant visited a sugar solution three measurements were taken:
- the time spent feeding
 - the temperature of the rocks over which the ant ran to get to the food
 - the distance of the food from the nest entrance.

The results are shown in the three-dimensional scattergram below. The scattergram shows that feeding time changes with both distance of food from the nest entrance and with temperature.



[Source: Wright, *Bulletin of the British Ecological Society* (1998), page 27]

- (a) (i) Identify the relationship between the distance of food from the nest and the time spent feeding. [1]
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- (ii) Suggest a possible reason for this relationship. [1]
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- (b) (i) Identify the relationship between temperature and the time spent feeding. [1]
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- (ii) Suggest **two** reasons for this relationship. [2]
1.
-
2.
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(Question E1 continued)

When a *Leptothorax albipennis* worker finds a good food source it returns to the nest. It then attracts the attention of another worker and they run back to the food source together.

- (c) The ants that found the sugar solution in this experiment did not often take other workers to it. Suggest a reason for this. [1]

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- (d) Suggest **one** other method of communication which could be used by one worker ant to help another find a food source. [1]

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- E2.** Draw a simple diagram to show the positions of the cornea, iris, pupil and ciliary body in the eye. [3]

- E3.** (a) State **one** difference between *innate* behaviour and *learned* behaviour. [2]

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- (b) Design an experiment to find whether migration in a bird or mammal is innate behaviour or learned behaviour. [3]

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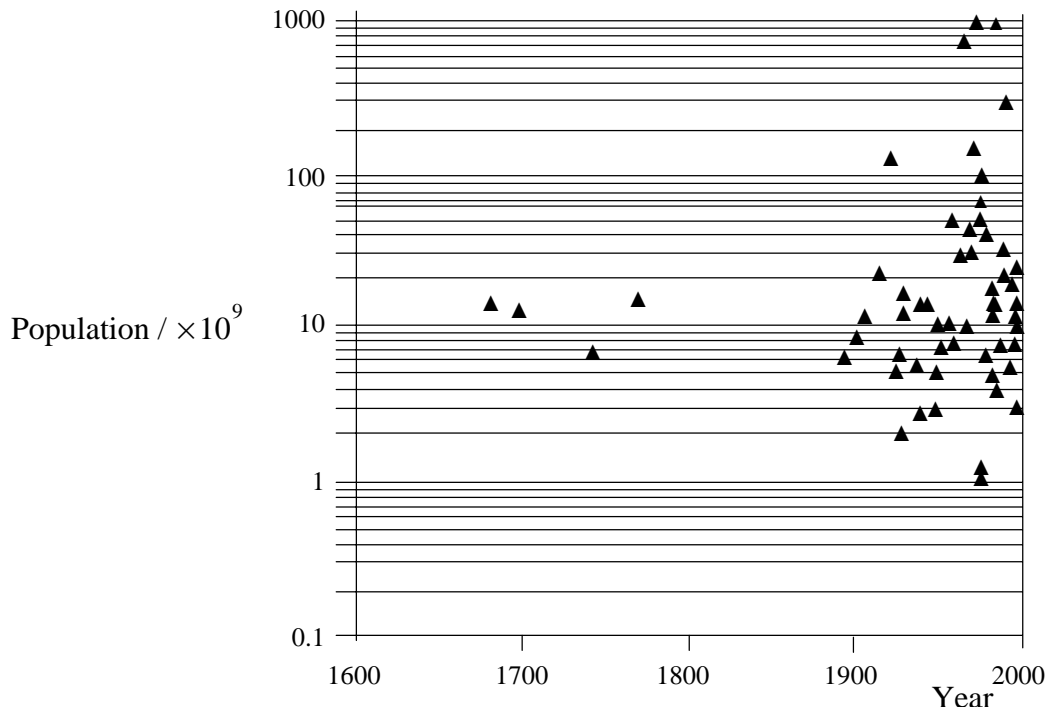
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Option F – Applied Plant and Animal Science

F1. Carrying capacity is the maximum number of a species that can be sustainably supported by the environment. In 1679 Anton van Leeuwenhoek estimated that the Earth’s carrying capacity for humans was no more than 13.4 thousand million (13.4×10^9). Many estimates of the maximum possible human population size have been published since then. The scattergram below shows estimates published between 1679 and today.



[Source: Cohen, *Journal of Applied Ecology* (1997), **34**, pages 1325–1333]

(a) Explain briefly how to estimate the Earth’s carrying capacity for humans. [3]

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(b) Outline **two** trends shown in the scattergram. [2]

1.
2.

(This question continues on the following page)

(Question F1 continued)

- (c) Evaluate the usefulness of estimates of the maximum possible human population in planning for the future. [2]

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- F2.** (a) Light, water, carbon dioxide concentration and temperature all affect plant productivity. List **two** other factors which affect plant productivity. [2]

1.
2.

- (b) Plant scientists have improved the yields of many crops. Outline the methods used to do this with any named crop plant example **other than wheat**. [3]

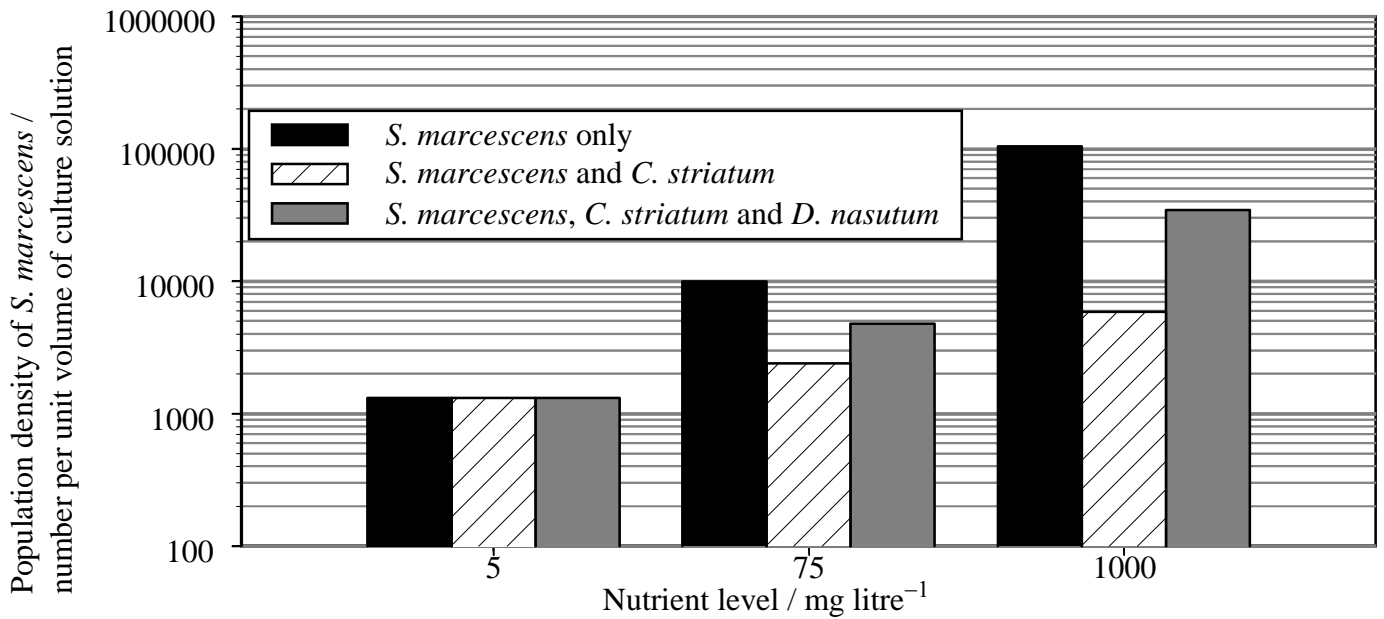
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- F3.** Explain how artificial insemination has been used to improve livestock production. [3]

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Option G – Ecology and Conservation

G1. Food chains are difficult to study in natural ecosystems so a group of ecologists set up communities in culture vessels. They used them to investigate the effects of varying nutrient concentrations. In all of the vessels an aquatic bacterium, *Serratia marcescens*, was present. Three concentrations of the nutrients on which *S. marcescens* feeds were used. In some of the cultures *Colpidium striatum*, a predator of *S. marcescens*, was added. In some of these cultures *Didinium nasutum*, a predator of *C. striatum* was added. The cultures therefore each had one, two or three trophic levels. The population density of *S. marcescens* at the end of the experiment is shown in the bar charts below.



[Source: Kaunzinger, *Nature* (1998), **395**, pages 495–496]

- (a) (i) Explain the effect of the nutrient concentration on the population density of *S. marcescens*. [1]
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- (ii) Explain the effect of the presence of *C. striatum* on the population density of *S. marcescens*. [1]
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- (iii) Explain the effect of the presence of *D. nasutum* on the population density of *S. marcescens*. [2]
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(Question G1 continued)

- (b) In the culture with the lowest nutrient level *D. nasutum* eventually died out but *C. striatum* survived. Explain the reasons for *D. nasutum* dying out. [2]

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- (c) Using the results of this investigation, predict a relationship between nutrient levels and length of food chain in natural ecosystems. [1]

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- G2.** (a) State the name of **one** plant species which has become extinct and the cause of its extinction. [2]

name of plant species

cause of extinction

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- (b) Outline the use of seed banks in preventing the extinction of plant species. [3]

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- G3.** (a) List **two** characteristics of an organism which are part of its ecological niche. [2]

1.

2.

- (b) State the maximum number of species which can occupy **one** ecological niche in an ecosystem. [1]

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