

APOLLO

Populations and communities

HL

Biology

First assessment 2025

14 questions | questions

36. A capture–mark–release–recapture experiment was used, together with the Lincoln index formula (population size estimate = $M \times N/R$), to estimate the population size of common periwinkles (*Littorina littorea*) on a rocky shore. The table shows the data collected.

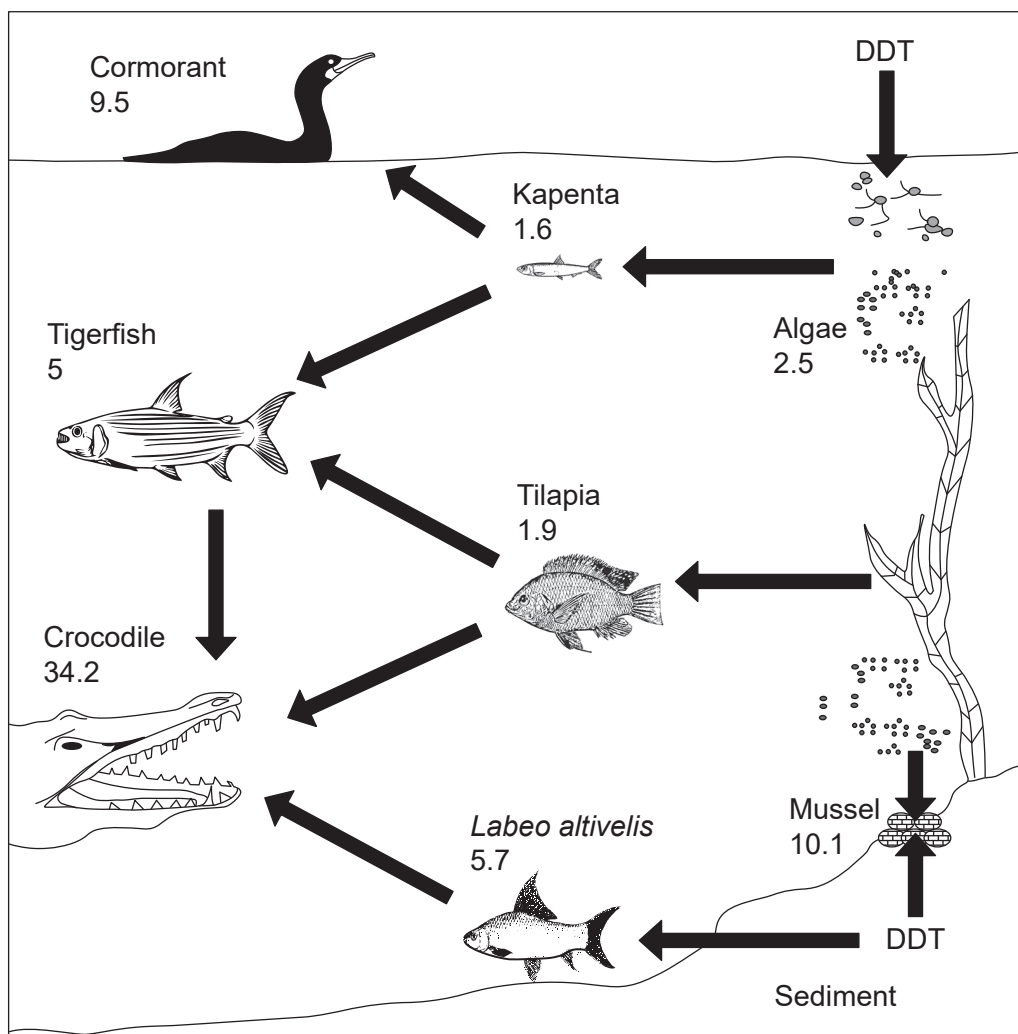


Individuals captured and marked initially	100
Individuals recaptured	50
Marked individuals recaptured	10

What is the estimated size of the population?

- A. 160
- B. 500
- C. 1000
- D. 5000

2. The diagram shows levels of DDT, a pesticide, in an aquatic food web in Lake Kariba, Africa. Numbers represent ppm (parts per million) of DDT in fat tissue.



- (a) Justify the observation that the crocodile has a higher mean DDT level than the cormorant or tigerfish.

[2]

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(Question 2 continued)

(b) Identify, with a reason, which fish would be the safest to consume. [2]

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(c) Outline how the population size of tilapia could be estimated. [3]

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(d) Discuss the impact of overfishing in Lake Kariba and how sustainable harvesting of resources can be assessed. [4]

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Turn over

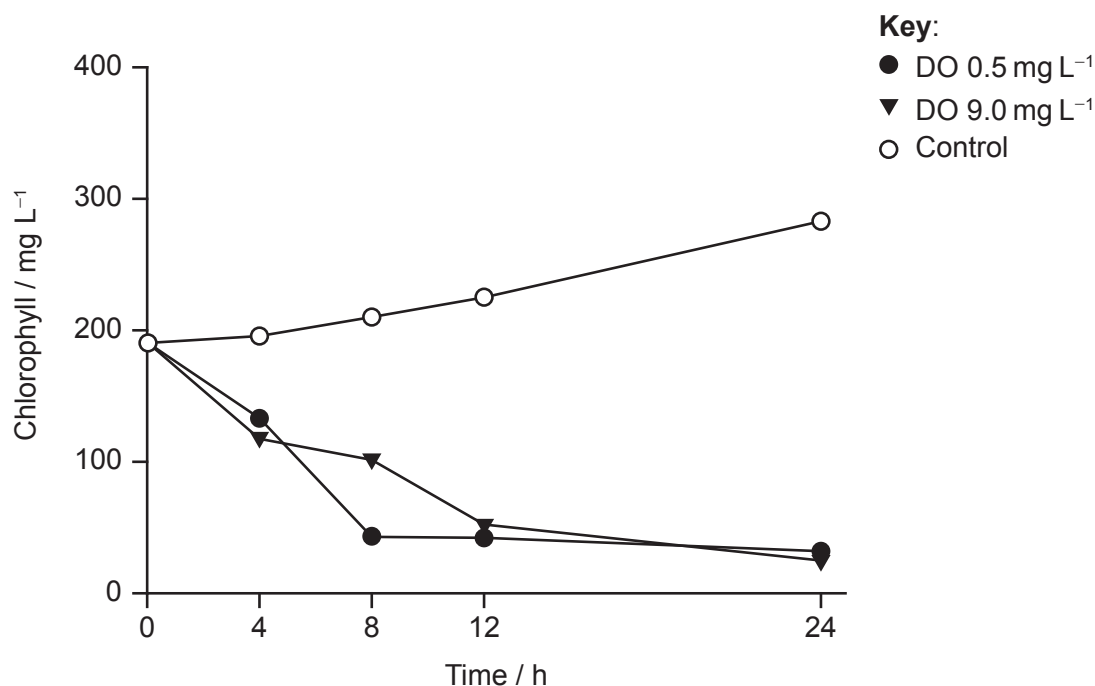
Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Freshwater mussels are molluscs found in rivers and lakes worldwide. They filter water for food and remove algae, bacteria and detritus, improving the water quality.



Researchers in South Korea placed mussels (*U. douglasiae*) in water containing cyanobacteria, a type of photosynthetic bacteria that cause eutrophication of rivers and lakes. The density of cyanobacteria is proportional to the concentration of chlorophyll in the water. The filtration rate by mussels can be determined by measuring the change in concentration of chlorophyll at various time intervals. The experiments were conducted with two different levels of dissolved oxygen in the water (DO). In the control experiment, no mussels were present and the DO level was 9.0 mg L^{-1} .



(This question continues on the following page)



(Question 1 continued)

- (a) Estimate the concentration of chlorophyll in the water of the control after 18 hours. [1]

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- (b) Distinguish between the density of cyanobacteria when mussels are absent (control) and when mussels are present at $\text{DO} = 9.0 \text{ mg L}^{-1}$. [1]

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- (c) Suggest a reason for the change in the chlorophyll concentration of the control during the experiment. [1]

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- (d) Compare and contrast the filtration by the mussels at the different oxygen levels over the period of the experiment. [2]

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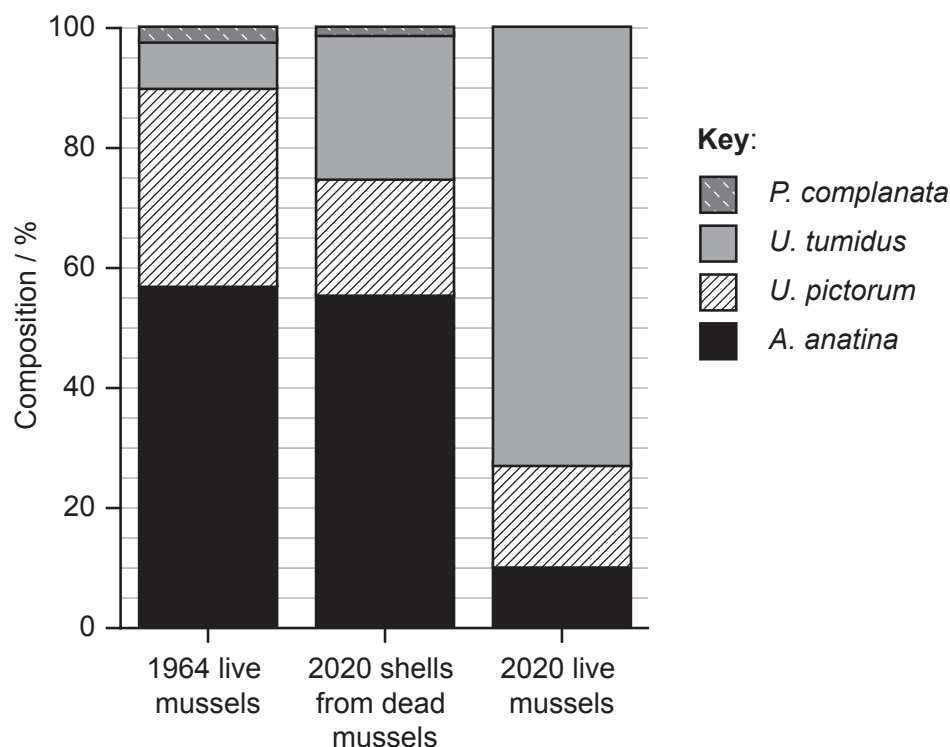
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Turn over

(Question 1 continued)

In 2020, scientists studied the population density of four species of mussel (*A. anatina*, *U. pictorum*, *U. tumidus* and *P. complanata*) in the River Thames in the United Kingdom. The results were compared with a previous study carried out at the same location in 1964. The chart shows the percentage of each type of live mussel found in both studies, as well as the percentage of shells from dead mussels found in 2020.



- (e) Estimate the percentage of live mussels found in 1964 that were *U. pictorum*. [1]

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- (f) State, giving **one** reason, whether the population of mussel shells found in 2020 more closely resembled the live percentage composition found in 1964 or 2020. [1]

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(Question 1 continued)

- (g) Discuss whether the data shows that the population of *U. tumidus* has increased since 1964. [2]

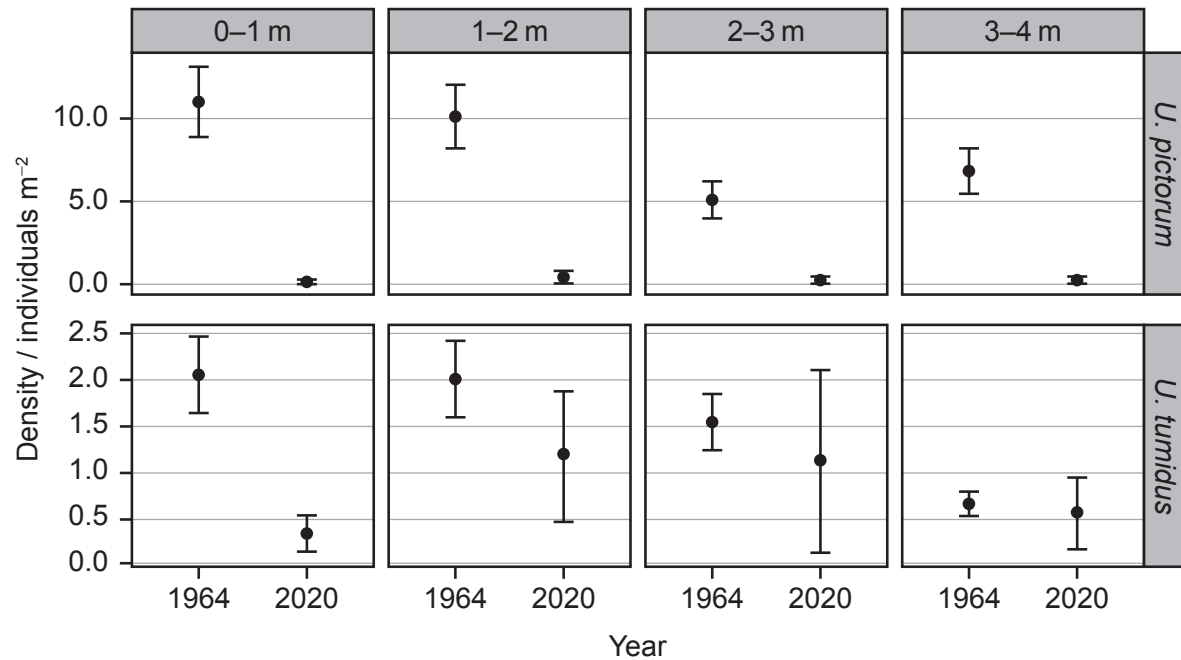
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Turn over

(Question 1 continued)

The researchers also studied the density of mussels at ranges of different water depths. The graph shows the results for two species, *U. pictorum* and *U. tumidus*.



- (h) Calculate the mean percentage decrease in *U. pictorum* density in 1964 when increasing depth from 1–2m to 2–3m. [1]

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- (i) Compare and contrast changes in mean density of both species between 1964 and 2020. [2]

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(Question 1 continued)

- (j) Using all the data, deduce with reasons whether the water quality of the River Thames changed from 1964 to 2020. [2]

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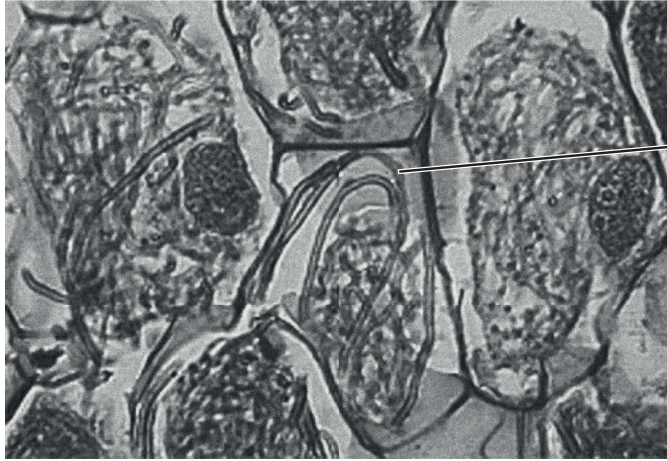


Turn over

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

3. The image shows mycorrhizal fungi growing between the cells of a recently germinated orchid plant.



Mycorrhizal fungi

- (a) (i) State the type of interspecific relationship shown by mycorrhizal fungi and plants in the orchid family (*Orchidaceae*).

[1]

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- (ii) State **one** benefit of the relationship experienced by the orchid.

[1]

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- (b) Explain how a **named** plant can reduce competition by allelopathy.

[3]

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Turn over

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

5. The photograph shows Japanese knotweed, *Reynoutria japonica*, which is native to Japan, China and Korea. It has been introduced into other regions of the world and is now an invasive alien species in parts of Europe and North America. Dense groups of stems often develop with a height of up to 3 metres, which prevent other plants from growing.



- (a) State the biological term for a group of organisms of the same species living in an area. [1]

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- (b) Suggest **two** ways in which a plant such as *Reynoutria japonica* could prevent the growth of other plants. [2]

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(Question 5 continued)

- (c) Some insect species form interspecific relationships with *Reynoutria japonica*. Identify the relationship with these insect species:

- (i) *Apis mellifera* (honey bee), which collects nectar from the flowers of *Reynoutria japonica*;

[1]

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- (ii) *Aphalara itadori*, which feeds on the shoots and young leaves of *Reynoutria japonica*.

[1]

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**Turn over**

- 36.** In the mutualistic relationship between mycorrhizae and Orchidaceae, what role do mycorrhizae play?
- A. Nutrient absorption
 - B. Photosynthesis
 - C. Carbon dioxide production
 - D. Providing shelter

Turn over

- 39.** Surtsey, a volcanic island approximately 32 km from the south coast of Iceland, is a new island formed by volcanic eruptions that took place from 1963 to 1967. It has been legally protected since its formation and is free from human interference.

What changes are likely to have been observed since the formation of Surtsey?

- A. Cyclical succession as the climax community changes
- B. Secondary succession when animal species arrived
- C. Arrested succession due to the drainage of wetlands
- D. Primary succession including an increase in size of plants

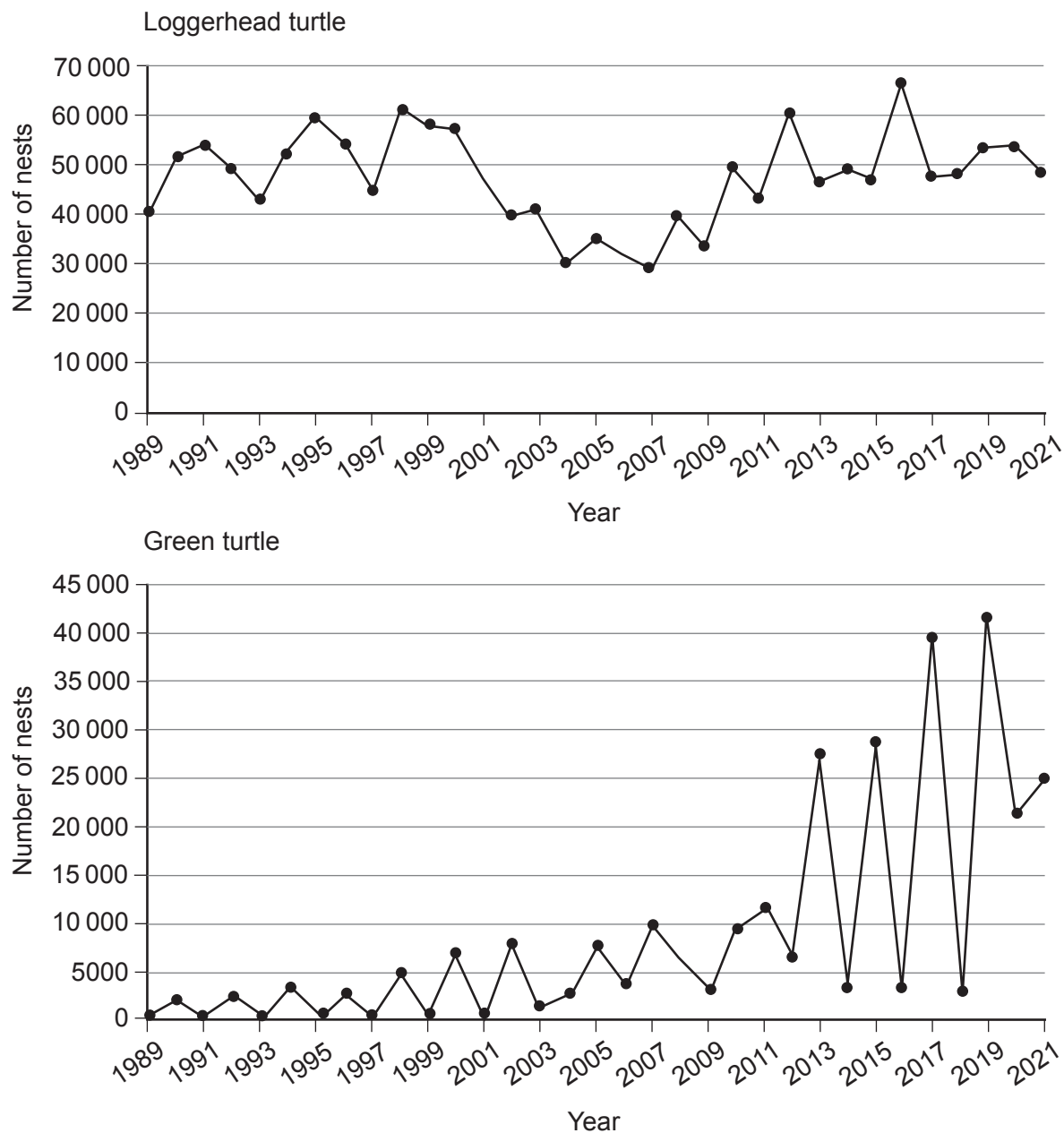
Turn over

- 36.** What is an example of a population control mechanism within a community?
- A. Bottom-up control of herbivores by a top predator
 - B. Top-down control of grasses by consumers
 - C. Top-down control of a plant species by soil nutrient availability
 - D. Bottom-up control of dissolved oxygen by corals

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

- To estimate the size of the turtle population, the Fish and Wildlife Research Institute (FWRI) conducted an annual survey along the coast of Florida from 1989 to 2021. They counted the number of turtle nests on selected beaches where turtles lay their eggs. The graphs show the results for the loggerhead turtle (*Caretta caretta*) and the green turtle (*Chelonia mydas*).



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(Question 1 continued)

(a) State the year in which most loggerhead turtle nests were counted in the survey. [1]

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(b) Compare and contrast the change in the annual number of nests for the two species of turtle. [3]

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(c) Suggest the limitations of only using nesting turtles to estimate the annual population. [2]

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Turn over

(Question 1 continued)

Mortality or injury from being struck by a motorized water vessel (boat or craft) is a considerable risk for all turtles. Researchers studied stranded (dead, sick or injured) turtles found in Florida from 1986 to 2014, and identified those with a vessel strike injury (VSI). The turtles were classified as having either a definite vessel strike injury (DVSI) or a probable vessel strike injury (PVSI). The table shows the results for six species of turtle.

Species	Number of stranded turtles	Number with a DVSI	Number with a DVSI or a PVSI	% with a DVSI	% with a DVSI or a PVSI
Loggerhead (<i>Caretta caretta</i>)	19 111	4217	5983	22.1	31.3
Green (<i>Chelonia mydas</i>)	11 631	2763	3758	23.8	32.3
Kemp's ridley (<i>Lepidochelys kempii</i>)	2738	413	714	15.1	26.1
Leatherback (<i>Dermochelys coriacea</i>)	620	133	213	21.5	34.4
Hawksbill (<i>Eretmochelys imbricata</i>)	635	57	94	9.0	14.8
Olive ridley (<i>Lepidochelys olivacea</i>)	4	0	0	0.0	0.0
Unknown	1067	108	200	10.1	18.7

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(Question 1 continued)

(d) State which species had the greatest percentage of stranded turtles with a DVSI. [1]

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(e) Suggest a reason for the difference between the percentage of each species that had DVSI. [1]

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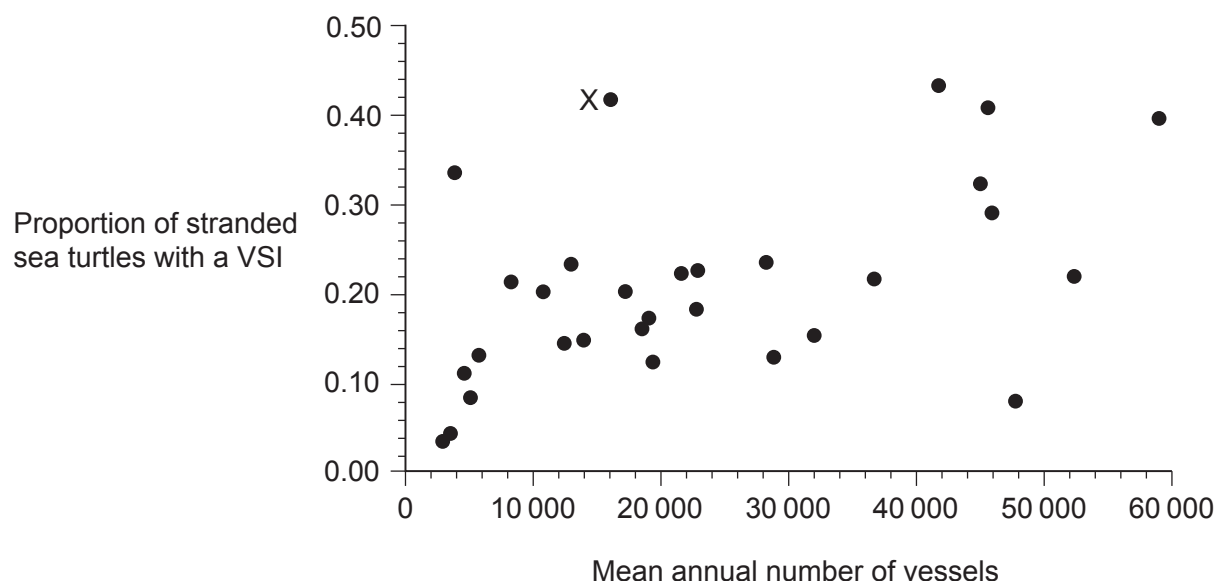
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Turn over

(Question 1 continued)

The graph shows the mean annual number of vessels in coastal regions of Florida and the proportion of stranded turtles found with a VSI.



- (f) State the relationship between mean annual number of vessels and turtles with VSIs. [1]

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- (g) A researcher suggested that the point labelled X is considered atypical. Outline a reason for this researcher's opinion. [1]

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(Question 1 continued)

(h) Evaluate the hypothesis that water vessels are the main cause of turtle deaths in Florida. [3]

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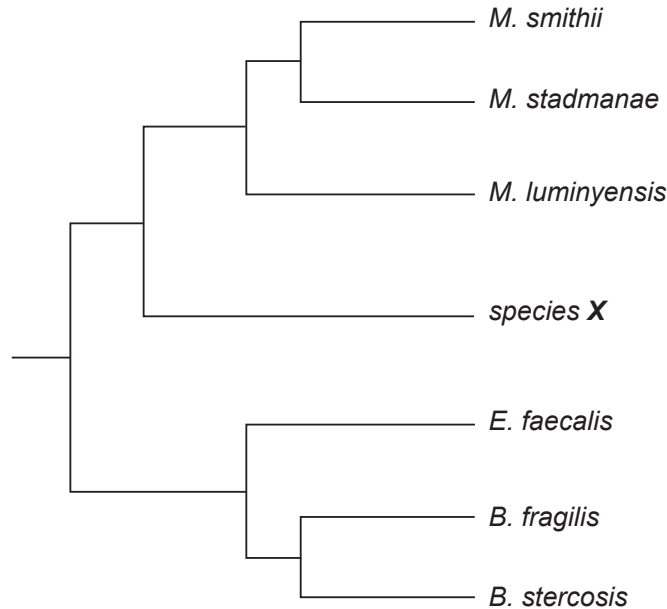


Turn over

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

7. The gut of a healthy human contains more than 1000 species of bacteria. Some of these species are shown in the cladogram.



- (a) Identify, with a reason, whether the cladogram shows species **X** is more closely related to *M. luminyensis* or to *E. faecalis*.

[2]

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(Question 7 continued)

- (b) Scientists have found that *B. fragilis* and *B. stercosis* are keystone species in the human gut ecosystem.

(i) Define keystone species.

[2]

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- (ii) Over time, the populations of different species of bacteria in the human gut can produce a stable climax community.

Suggest how some antibiotics, prescribed for bacterial infections, can disrupt the climax community in the gut.

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- (c) Outline a difficulty in applying the biological species concept to bacteria.

[1]

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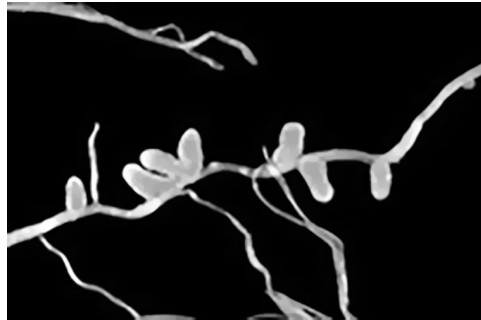
Turn over

37. Which is a density-independent limiting factor for a kangaroo?

- A. A forest fire
- B. Predation
- C. Climate change
- D. Eutrophication

- 38.** Black walnut (*Juglans nigra*) secretes the chemical juglone into the soil surrounding its roots. Juglone inhibits cell respiration in other species of plants. What does this example illustrate?
- A. Mutualism
 - B. Intraspecific competition
 - C. Allelopathy
 - D. Parasitism

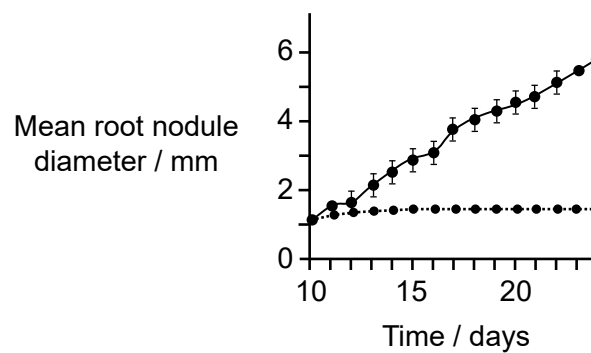
3. *Rhizobium* is a genus of bacteria that live in the roots of flowering plants in the family Fabaceae. The plants form nodules surrounding a population of *Rhizobium*. The bacteria fix nitrogen from the air into nitrogen compounds, especially ammonium, which are made available to the host plant.



The graph shows changes in the diameter of root nodules for plants grown in a nitrate-enriched environment and a control group grown in a nitrate-free environment.

Key:

—— control nitrate-enriched environment



- (a) Outline the concept of mutualism with respect to this example.

[2]

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(This question continues on the following page)



(Question 3 continued)

(b) Distinguish between the cells in *Rhizobium* and Fabaceae. [2]

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(c) Suggest a reason that mutualistic relationships often involve species from distantly related groups of organisms. [1]

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(d) Analyse the results of the experiment. [3]

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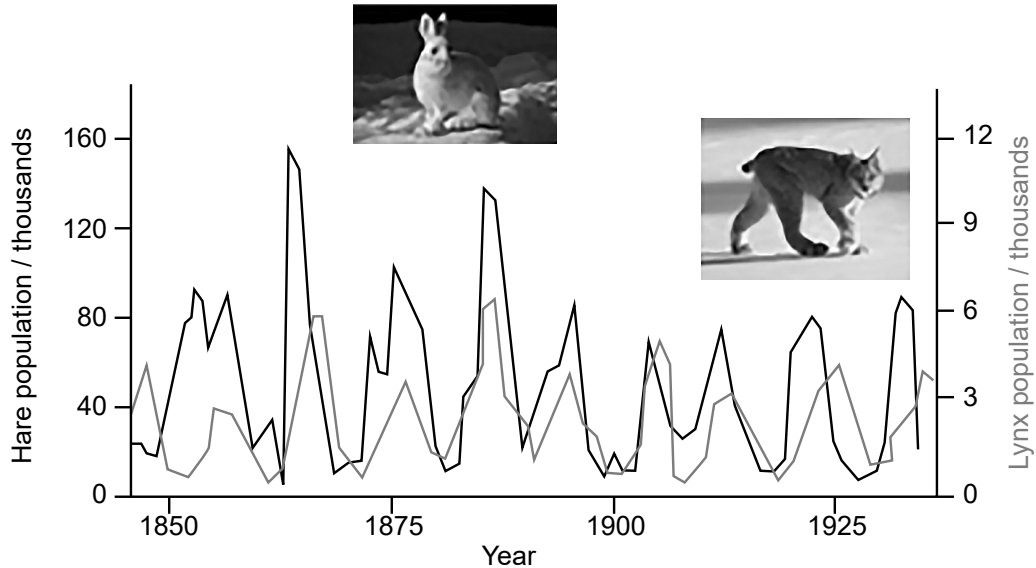


Turn over

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

5. Predation may result in a cyclic pattern of population changes, as for example in the case of the lynx, *Lynx canadensis* (predator), and the hare, *Lepus americanus* (prey).



- (a) The predator benefits from a predator-prey relationship by obtaining food. Suggest how the hare population could benefit from this relationship.

[1]

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- (b) Outline the factors that contribute to the carrying capacity of prey organisms in a predator-prey relationship.

[2]

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(This question continues on the following page)



(Question 5 continued)

- (c) (i) Outline how the hare population size can be estimated using the mark-release-recapture method. [2]

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- (ii) State **one** assumption that is made when using this method to estimate population size. [1]

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Turn over