# Adaptation

## Question Paper

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| Level | Pre U |
| Subject | Biology |
| Exam Board | Cambridge International Examinations |
| Topic | Ecology |
| Sub Topic | Adaptation |
| Booklet | Question Paper |

**Time Allowed:** **86 minutes**

**Score:** **/71**

**Percentage:** **/100**

## Part - A

1 Fig. 23.1 is a photomicrograph of the lower epidermis of the leaf of an oleander, *Nerium oleander*. Fig. 23.2 is a photomicrograph of the lower epidermis of the leaf of a privet, *Ligustrum vulgare*. Both photomicrographs are to the same scale.

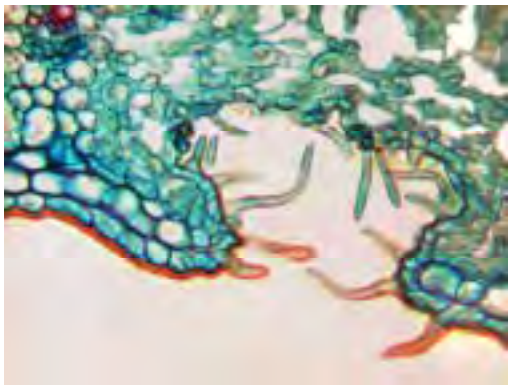

**Fig. 23.1**

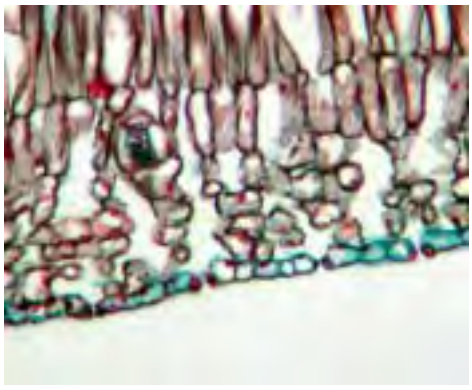

**Fig. 23.2**

**(a)** State two ways, visible in Fig. 23.1 and Fig. 23.2, in which the epidermis of oleander differs from the epidermis of privet. In each case explain how oleander is adapted to survive severe drought conditions.

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The concentration of three ions, potassium, chloride and phosphate, were determined in guard cells of closed and open stomata. Fig. 23.3 shows these concentrations measured in arbitrary units, which are the same for all three ions.

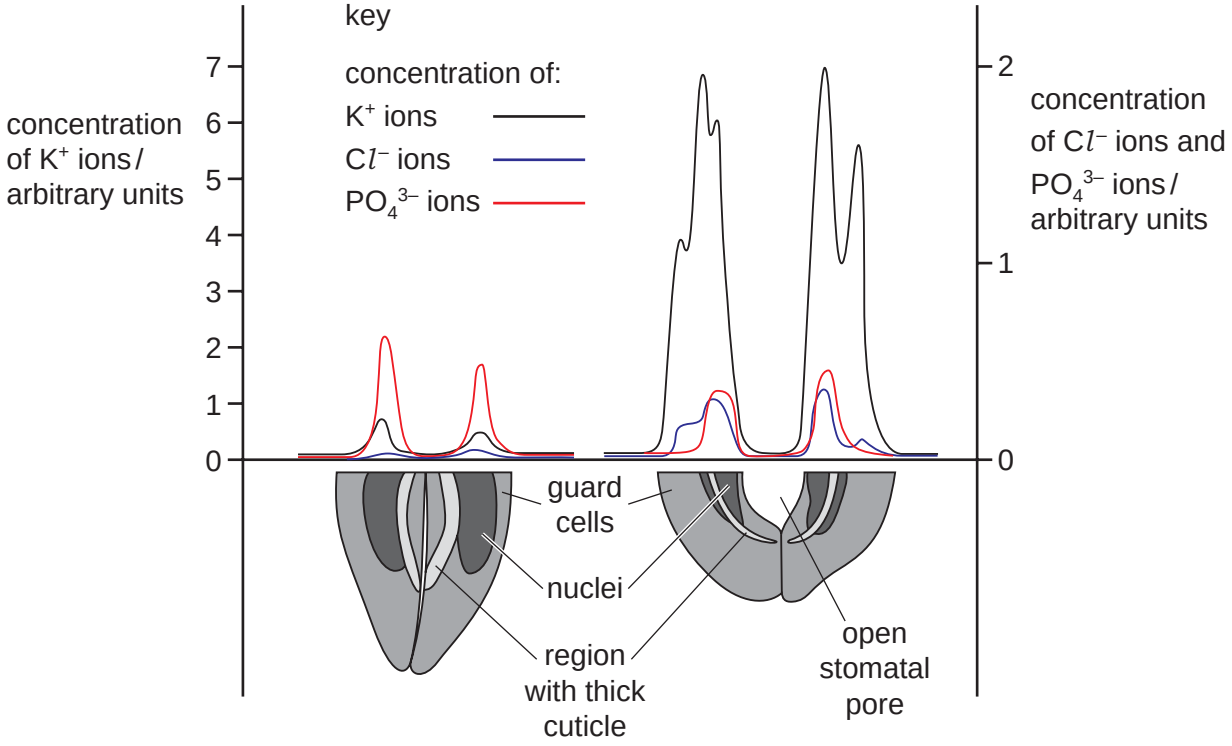


**Fig. 23.3**

**(b)** Suggest a possible mechanism, that can be supported by the data in Fig. 23.3, to account for the changes in stomatal aperture.

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**(c)** Many plant cells have cytoplasmic connections (plasmodesmata) between neighbouring cells, but these are absent from guard cells.

Explain how this helps guard cells function efficiently.

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**[Total: 10]**

**2** Fig. 25.1 shows a European starling, *Sturnus vulgaris*.

**Fig. 25.1**

**(a)** Outline the aspects of the biology of *S. vulgaris* that must be considered when describing the niche of this species.

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The relative contribution of individual species to the biodiversity of communities has been investigated for particular species. Fig. 25.2 shows the effect of different densities of the gastropod mollusc, *Littorina littorea*, on the number of species of algae in tidal rock pools on the Eastern seaboard of the USA. *L. littorea* grazes on algae.

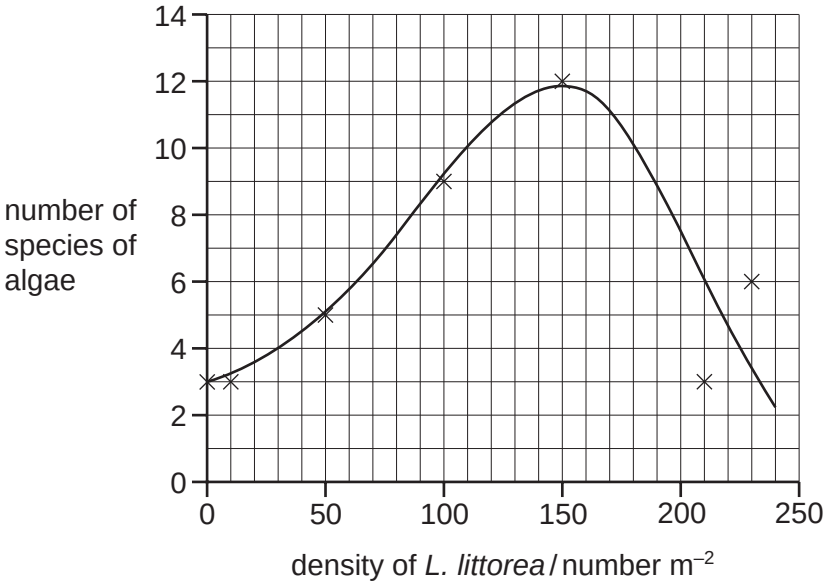


**Fig. 25.2**

**(b)** Describe the results shown in Fig. 25.2 and suggest how they could be explained.

[5]

The effects of removing all the individuals of a species of predatory starfish on a rocky shore community were investigated. Fig. 25.3 is part of a food web for this community and shows the changes that occurred. The minus symbol (–) indicates that the numbers of individuals in the species concerned decreased; the plus symbol (+) indicates that the numbers of individuals in the species concerned increased.

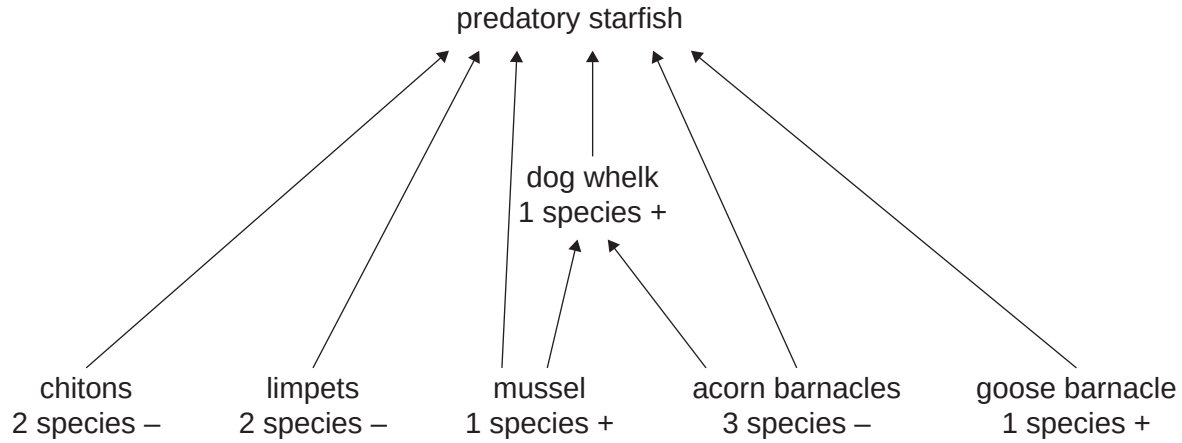


**Fig. 25.3**

**(c)** Explain how the results of the study support the idea that the predatory starfish is a keystone species.

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**[Total: 12]**

**3** The Mongolian gerbil, *Merionthes unguiculatus*, lives in semi-arid desert habitats in the steppes of northern Asia where much of the vegetation and drinking water has a high salt content.

A laboratory study was carried out to investigate the effect of supplying gerbils with drinking water with different concentrations of salt. Gerbils were divided into five groups and given equal volumes of either water or four different concentrations of sodium chloride solution for five days. The animals were kept under identical conditions and supplied with the same food.

The urine was collected each day and analysed. The volumes of urine collected on the fifth day and their concentrations of sodium ions are shown in Fig. 2.1.

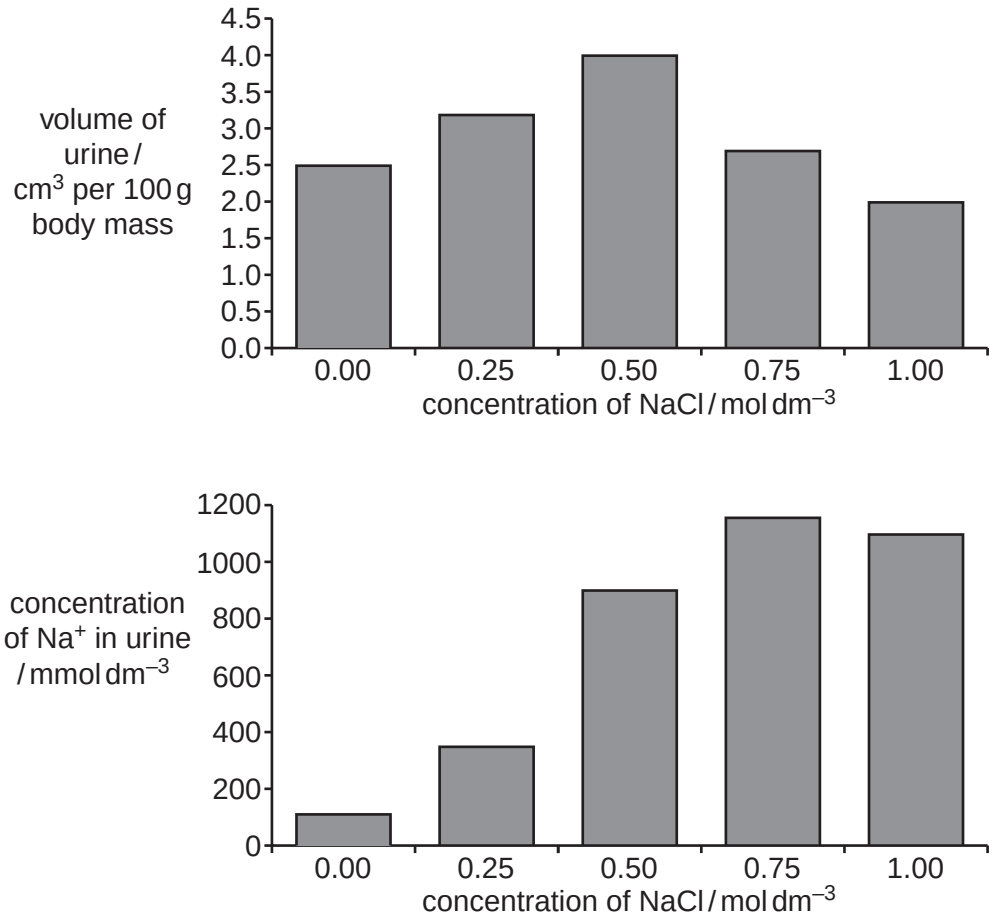


**Fig. 2.1**

**(a)** Describe **and** explain the results shown in Fig. 2.1.

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**(b)** Humans cannot survive if given a solution of 0.25 mol $dm^{-3}$ sodium chloride to drink over several days.

Explain how the kidneys of gerbils allow them to survive while drinking water with a high concentration of salt.

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**(c)** Another investigation found that gerbils given:

- 0.25 mol $dm^{-3}$ sodium chloride solution for five days had stores of ADH (antidiuretic hormone) in the posterior pituitary gland;
- 0.50, 0.75 and 1.0 mol $dm^{-3}$ sodium chloride solutions for five days had significantly less ADH in their posterior pituitary glands.

Suggest an explanation for these observations.

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**(d)** *M. unguiculatus* has both physiological and behavioural adaptations to its desert habitat.

Suggest examples of the physiological and behavioural adaptations that small mammals, such as *M. unguiculatus*, have for desert habitats.

Do **not** include the adaptations of the kidney.

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**[Total: 16]**

**4** The takahē, *Porphyrio hochstetteri*, is a flightless bird that is restricted to a small area of the South Island of New Zealand. It is one of only two remaining species of large, flightless, herbivorous birds from New Zealand. All the other species are extinct. The takahē was thought to be extinct, but a small population was discovered in 1948 in remote mountains of the South Island.

The takahē is a grassland specialist and lives in alpine grassland dominated by tussock grasses.

In order to conserve the takahē, some birds were transferred to four islands where the habitat is different from that in the mountains where they were found, but where there were fewer threats to their survival. Some ecologists argued that the takahē would not survive on these islands as their niche did not exist because the islands have pasture grasses rather than tussock grasses. The takahē populations on these four islands have survived, but have not thrived as well as those in the mountains.

**(a)** Explain why it has been possible for flightless birds, such as the takahē, to evolve in New Zealand.

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**(b)** Outline the threats to the remaining species of flightless birds of New Zealand.

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**(c)** Ecologists differentiate between *fundamental* and *realised* niches. The fundamental niche provides the conditions under which a species can in theory exist; the realised niche is the actual set of conditions under which it does exist.

Explain how knowledge of the fundamental niche and the realised niche of an endangered species, such as the takahē, may be used in making decisions about its conservation.

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**5** Reef-building corals are marine invertebrates found in shallow, clear, tropical oceans. The corals secrete an exoskeleton of calcium carbonate that becomes the underlying structure of the coral reef ecosystem.

Zooxanthellae are a group of unicellular algae from the genus *Symbiodinium* that live within the cells of reef-building corals. The relationship has been described as mutualistic since it is beneficial to both coral and zooxanthellae.

**(a)** Evidence shows that the mutualistic relationship between zooxanthellae and reef-building corals has evolved by free-living algae invading corals that did not contain algae.

**(i)** Corals that do not need zooxanthellae can live at a greater depth than reef-building corals.

Explain why this is so.

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**(ii)** Suggest the benefits **to the zooxanthellae** of their association with the corals.

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Under conditions of stress the relationship between the reef-building corals and the zooxanthellae can break down. Loss of zooxanthellae and the subsequent whitening that occurs, shown in Fig. 24.1, is known as coral bleaching. Coral bleaching can lead to death of the coral.

**Fig. 24.1**

**(b)** Suggest **one** reason why permanent loss of zooxanthellae can lead to death of the coral.

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**(c)** Increased sea temperature associated with global climate change is known to be an environmental stress that can cause coral bleaching. The temperature range for healthy survival of reef-building coral is 25 °C–29 °C.

**(i)** Explain why the areas of sea containing coral reefs are susceptible to increased temperature resulting from global climate change.

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**(ii)** Raw sewage released into the oceans can contain bacteria that cause disease in corals.

Suggest how global warming increases the rate of coral bleaching caused by bacterial disease.

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Recently, the International Union for Conservation of Nature (IUCN) has assessed over 47% of reef-building coral species as threatened, or near-threatened, with a global risk of extinction.

**(d)** Explain why the loss of reef-building corals has been described as an example of 'reduced biodiversity on a number of levels'.

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**(e)** Elkhorn coral, *Acropora palmata*, is one species of coral that is threatened. It has been suggested that elkhorn coral is a keystone species.

What are the features of a keystone species?

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[Total: 14]

## Part - B

**6** The hawksbill turtle, *Eretmochelys imbricata*, shown in Fig. 1.1, is classified as critically endangered by the International Union For Conservation of Nature (IUCN).

This turtle is slow-growing, with females only reaching breeding age at around 30 years old. Nesting sites are undisturbed tropical sandy beaches. It is omnivorous and its diet includes sea sponges that contain sharp crystals of silica. Many of these sponges contain toxins that are lethal to other animals. The turtle can also feed on venomous jellyfish, as it is resistant to the effects of the venom.

**Fig. 1.1**

**(a)** *E. imbricata* occupies a unique niche in its ecosystem. With reference to the information given, suggest **one** adaptation which enables it to survive successfully in this niche.

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**(b)** Suggest two factors which contribute to *E. imbricata* becoming a critically endangered species.

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**(c)** Explain why species become endangered when their population falls to very low numbers.

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**(d)** In recent years, marine biologists have begun to fit small satellite transponders to the shells of some sea turtles. This enables the biologists to track the movements of the turtles. Some turtles have been found to travel over 1000 km from the nest site where they hatched.

Explain the importance of this tracking in protecting sea turtles.

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**[Total: 8]**