1. March/2023/Paper_ 9700/42/No.10

(a) The passage in Fig. 10.1 is about biodiversity.

Complete the passage by using the most appropriate scientific terms.

Biodiversity within an area can be assessed at different levels, including the species diversity, genetic diversity and ecological diversity.

Species diversity can be assessed by determining the number of different species and the relative ..... of different species in a given area. From this information, species diversity can be estimated using ..... index of diversity.

Organisms of the same species can show much genetic diversity even though they share the same ..... . This is because they can have different combinations of ..... .

The greater the genetic diversity, the greater the ability of a species to ..... to a changing environment.

Ecological diversity is a measure of the number and range of different ecosystems and ..... within a given area.

Fig. 10.1

[6]

(b) The International Union for Conservation of Nature (IUCN) Red List of Threatened Species is updated regularly.

Table 10.1 shows the numbers of endangered animal species counted every three years between 2007 and 2019.

Table 10.1

year	number of endangered species
2007	7851
2010	9618
2013	11212
2016	12630
2019	14234

(i) Calculate the rate of increase in the number of endangered species between 2007 and 2019.

Show your working.

Give your answer to the nearest whole number.

rate of increase = ... per year
[2]

(ii) More species of fish were listed as endangered in 2019 than species of mammals.

Suggest reasons why more fish species than mammal species are endangered.

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[Total: 12]

2. June/2023/Paper_ 9700/41/No.2

The natural **ecosystem** on Hawadax Island in Alaska was disrupted in the 1780s when brown rats, *Rattus norvegicus*, swam to the island from a sinking ship and then rapidly increased their population size.

The rats occupied a new **niche** on the island as predators. The rats ate the eggs and chicks of birds such as the black oystercatcher, *Haematopus bachmani*, and the glaucous-winged gull, *Larus glaucescens*. These birds make nests, lay eggs and rear their chicks on the beaches of the island.

(a) Define the terms ecosystem and niche.

(i) ecosystem

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(ii) niche

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..... [1]

Conservation ecologists carried out a project to try to restore the natural ecosystem of Hawadax Island. In 2008, they removed all rats from the island.

Before removing the rats, the ecologists measured the abundance of birds, invertebrates and seaweeds on eight of the island's beaches. Seaweeds are large algae that grow attached to rocks on the beach. The ecologists repeated these measurements in 2013 and in 2019, so that they could calculate the percentage change in abundance from 2008.

(b) To measure the abundance of invertebrates and seaweeds, the ecologists used this method:

- They laid 30 m tapes from high-tide mark to low-tide mark on the beach.
- They placed quadrats at 5 metre intervals next to the tapes.
- They took a photograph of each quadrat.
- They analysed the photographs to calculate the percentage cover of seaweeds and the percentage cover of invertebrates such as mussels and sea snails.

(i) State the name of the sampling technique used.

..... [1]

(ii) Biodiversity can be assessed at a number of different levels.

Identify the levels of biodiversity:

- that were assessed by this sampling technique
- that were **not** assessed by this sampling technique.

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(c) Table 2.1 shows the percentage change in abundance of some of the seaweeds, invertebrates and birds found on the beaches of Hawadax Island.

Table 2.1

organism	percentage change from 2008 to 2013	percentage change from 2008 to 2019
seaweeds	+2	+49
mussel, *Mytilus*	–94	–99
sea snail, *Littorina*	–47	–91
black oystercatcher, *Haematopus bachmani*	+400	+800
glaucous-winged gull, *Larus glaucescens*	+126	+191

(i) Use Table 2.1 to state the **genus** name of **one** organism that has **increased** in abundance.

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(ii) Seaweeds were once thought to be plants but are now classified in the kingdom Protoctista.

Outline the features of the kingdom Protoctista that are shown by **seaweeds**.

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(d) To evaluate the success of the Hawadax Island restoration project, the ecologists obtained data from other islands near to Hadawax Island.

- Some islands had never been occupied by rats (rat-free islands) and had a healthy ecosystem.
- Some islands were still occupied by rats (rat-occupied islands) and had a disrupted ecosystem.

Table 2.2 shows the percentage differences in the abundance of organisms in rat-free islands compared with rat-occupied islands.

Table 2.2

organism	percentage difference in rat-free islands compared to rat-occupied islands
seaweeds	+68
mussel, *Mytilus*	–97
sea snail, *Littorina*	–83
black oystercatcher, *Haematopus bachmani*	+883
glaucous-winged gull, *Larus glaucescens*	+914

With reference to Table 2.1 and Table 2.2, suggest **and** explain how removing rats has restored the ecosystem on Hawadax Island.

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[Total: 14]

(a) Warfarin is a poison used to kill rats. Some rats are resistant to warfarin and can survive the effects of the poison. Warfarin resistance is due to a mutant dominant allele at a single gene locus.

Researchers investigated the population of brown rats on a large island where there are no predators of rats. On this island, warfarin is used to try to control the rat population.

The researchers found that 40% of the population of rats was resistant to warfarin.

(i) Use Hardy–Weinberg equation 1 and equation 2 to calculate the percentage of the population of rats on the island that is heterozygous for warfarin resistance.

equation 1 $p + q = 1$

equation 2 $p^2 + 2pq + q^2 = 1$

Show your working.

answer ..... % [3]

(ii) In natural populations, it is usual to find that only some of the conditions of the Hardy–Weinberg principle are met.

Suggest **and** explain which of the conditions of the Hardy–Weinberg principle are most likely to be met for the island population of brown rats.

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(b) Dominant advantageous alleles and recessive advantageous alleles both naturally occur in populations.

Explain why, when a new **dominant** advantageous allele occurs, its frequency increases more quickly in the population than when a new **recessive** advantageous allele occurs.

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[Total: 10]

4. June/2023/Paper_ 9700/42/No.10

(a) Many zoos around the world are involved in captive breeding programmes for endangered species.

Outline the role of zoos in the conservation of endangered species, **other than** captive breeding programmes.

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(b) Chester Zoo, in the United Kingdom, controls the European captive breeding programme for the eastern black rhinoceros, *Diceros bicornis michaeli*.

Fig. 10.1 shows an eastern black rhinoceros.

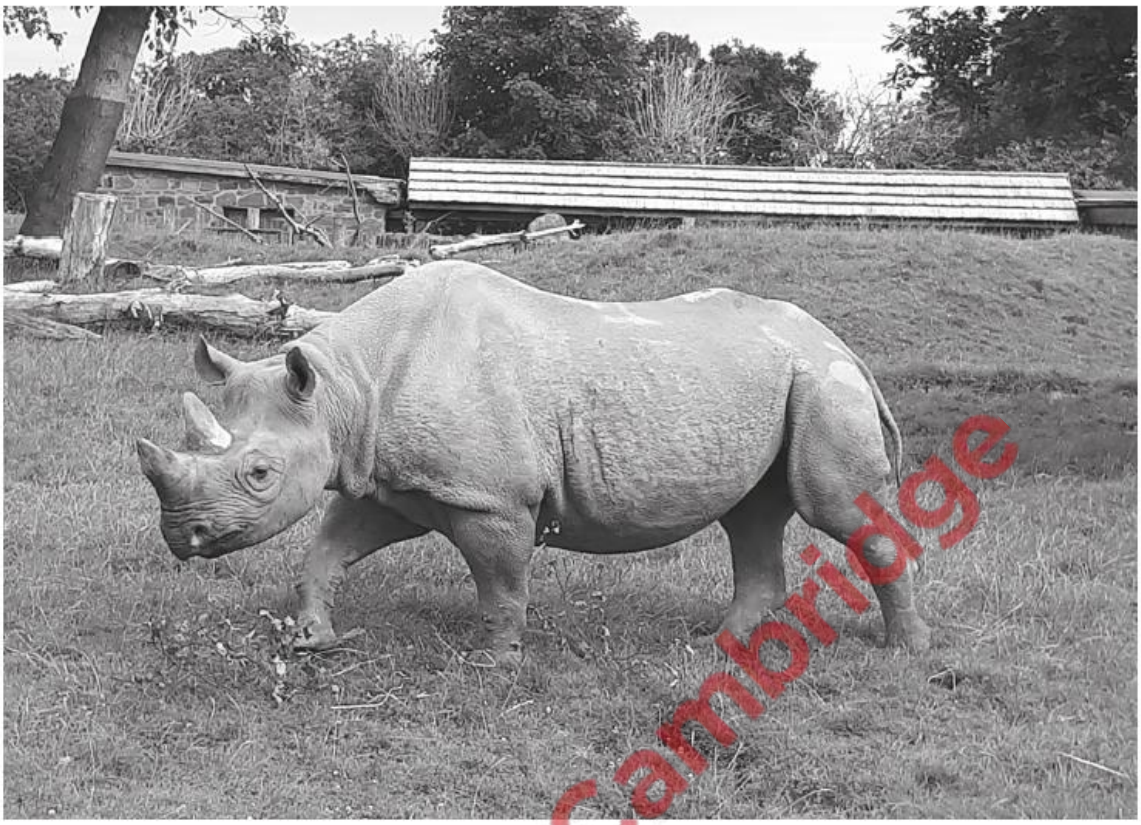

Fig. 10.1

In the captive breeding programme for the eastern black rhinoceros, 15.8% of females breed each year while in the wild 23.7% of females breed each year.

Suggest reasons why fewer females breed in captivity than in the wild.

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(c) Sometimes assisted reproduction is used in captive breeding programmes for the eastern black rhinoceros.

Fig. 10.2 outlines the process of IVF that is used in these programmes.

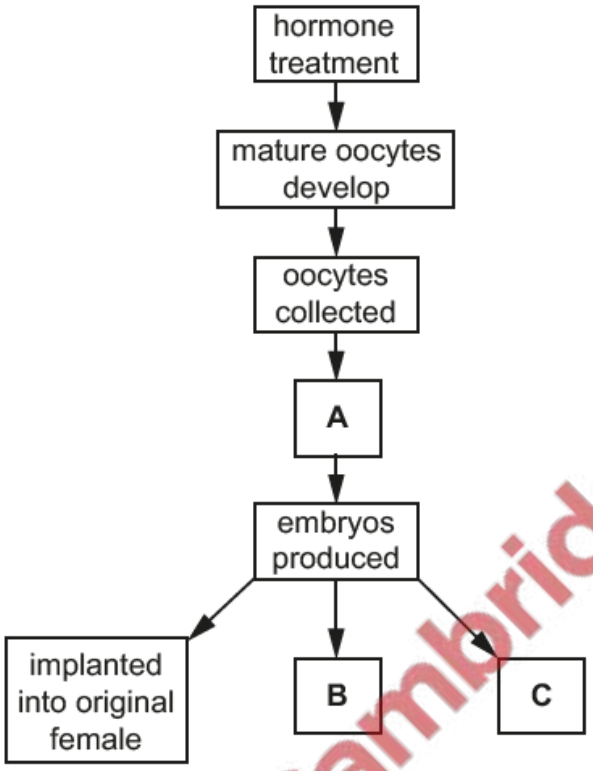

Fig. 10.2

Outline:

- the event **A** that occurs in the production of the embryos
- the **two** other possible outcomes, **B** and **C**, for the embryos that have been produced.

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[Total: 10]

(a) The moose, *Alces alces*, is a large member of the deer family. It lives in temperate forests in North America and northern Europe, where snow is present for large parts of the year.

Fig. 10.1 shows an adult male moose feeding in a lake.

Fig. 10.1

The moose feeds on a plant in the lake called watermilfoil, *Myriophyllum aquaticum*.

The moose and the watermilfoil belong to the domain Eukarya, which includes the kingdoms Animalia and Plantae.

Describe the main differences between the kingdom Animalia and the kingdom Plantae.

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(b) Measurements of the surface temperature of land and oceans can be taken from locations around the world. The mean global surface temperature for land and ocean combined can be calculated for a fixed time period.

Scientists calculated:

- the mean global temperature for the twentieth century
- the mean global temperature for each decade (ten years) from 1880 to 2020.

The mean temperature for each decade was compared to the mean for the twentieth century. For each decade, the difference in temperature was calculated.

The calculated differences are shown in Fig. 10.2.

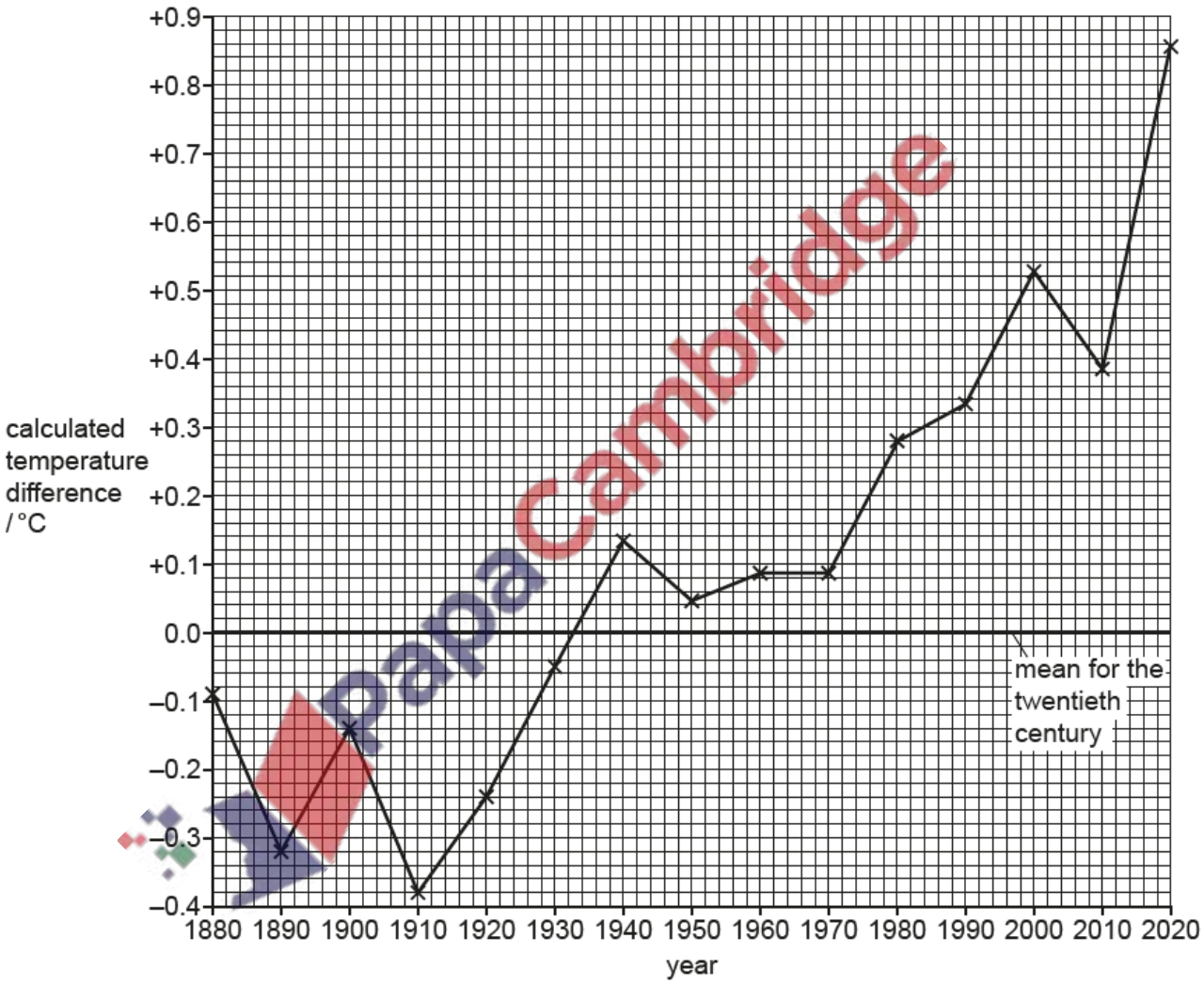

Fig. 10.2

(i) Calculate the rate of increase in temperature per **decade** between 1980 and 2020.

Show your working.

Write your answer to **two** decimal places.

answer ..... °C per decade [2]

(ii) Moose populations have decreased in North America since 1980.

Suggest **and** explain reasons for the decrease in moose populations.

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[Total: 9]