4 **(a)** Single oxygen atoms called free radicals are produced during aerobic respiration in mitochondria. These combine with other molecules to form compounds that damage DNA, proteins and lipids. It is suggested that this ongoing damage leads to degenerative changes as organisms get older, putting a limit to the length of their lives.

Explain how damage to DNA **and** proteins could impair cell function.

DNA .....

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proteins .....

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.....[4]

(b) An experiment was carried out to investigate whether longer lifespan is associated with less damage due to free radicals. Two mammals of similar size but with different lifespans were compared. Table 4.1 gives information about their biology.

Table 4.1

	mouse *(Mus musculus)*	naked mole rat *(Heterocephalus glaber)*
length/cm	6.5–10	9–12
mass/g	12–22	30–35
normal lifespan/years	2–3	25–28
habitat	rests in burrows but emerges above ground to feed	entire life spent in underground burrows

It was hypothesised that the naked mole rat, since it lives longer, should show evidence of less free radical damage. Organisms remove free radicals with chemicals called antioxidants.

- The reduced form of an antioxidant binds to the free radical, becoming oxidised in the process.
- A high ratio of reduced to oxidised antioxidant is a sign of low free radical damage.

Fig. 4.1 shows the relative concentration of reduced and oxidised antioxidant in four-month-old mice and two-year-old naked mole rats, as measured **under laboratory conditions**.

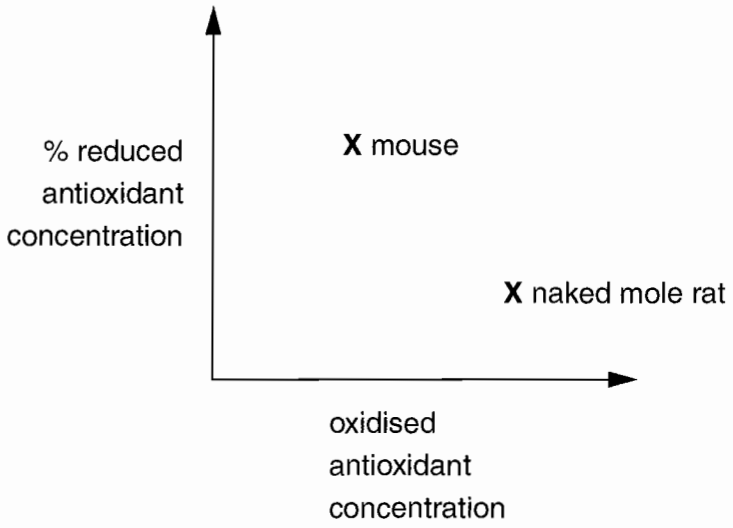

Fig. 4.1

(i) Explain whether the data shown in Fig. 4.1 supports the hypothesis that the longer lifespan of naked mole rats is due to their experiencing less free radical damage.

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.....[3]

(ii) From the information given, describe and explain **two** criticisms of the way this data was collected.

1 .....

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2 .....

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.....[4]

(c) Use the information about the habitat of naked mole rats given in Table 4.1 to draw in the likely position of the oxygen dissociation curve of naked mole rat haemoglobin on Fig. 4.2.

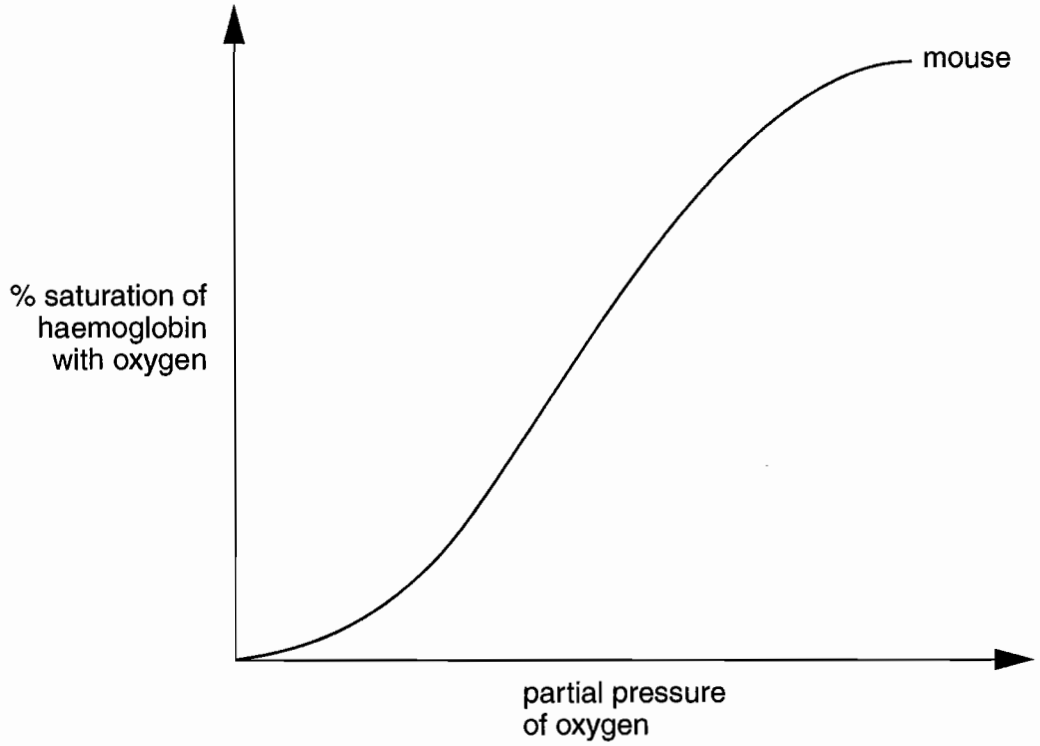

Fig. 4.2

[1]

[Total: 12]

END OF QUESTION PAPER