OCR
RECOGNISING ACHIEVEMENT

**ADVANCED GCE** **2806/01**

**BIOLOGY**

Unifying Concepts in Biology

**FRIDAY 13 JUNE 2008** Afternoon

Time: 1 hour 15 minutes

Candidates answer on the question paper.
**Additional materials:** Electronic calculator
Ruler (cm/mm)

*CUP/T42410*

| Candidate Forename | | Candidate Surname | |
|---|---|---|---|

| Centre Number | | | | | | Candidate Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|

**INSTRUCTIONS TO CANDIDATES**

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

**INFORMATION FOR CANDIDATES**

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

| FOR EXAMINER'S USE | | |
|---|---|---|
| **Qu.** | **Max.** | **Mark** |
| **1** | **15** | |
| **2** | **21** | |
| **3** | **12** | |
| **4** | **12** | |
| **TOTAL** | **60** | |

This document consists of **16** printed pages and an Insert.



**[Turn over**

Answer **all** the questions.

**1** This question is about mammals found on the island of Ireland and factors that have affected their survival and evolution.

Fig. 1.1, **on the insert**, shows the islands of Great Britain and Ireland at the time of the last ice age, 12 000 years ago. The shaded area represents the mass of solid ice that joined the two islands to the continental land mass of Europe.

Fig. 1.2 shows the occurrence of some mammal species in Ireland over the last 12 000 years. Lemmings and reindeer now occur further north than Great Britain and Ireland.

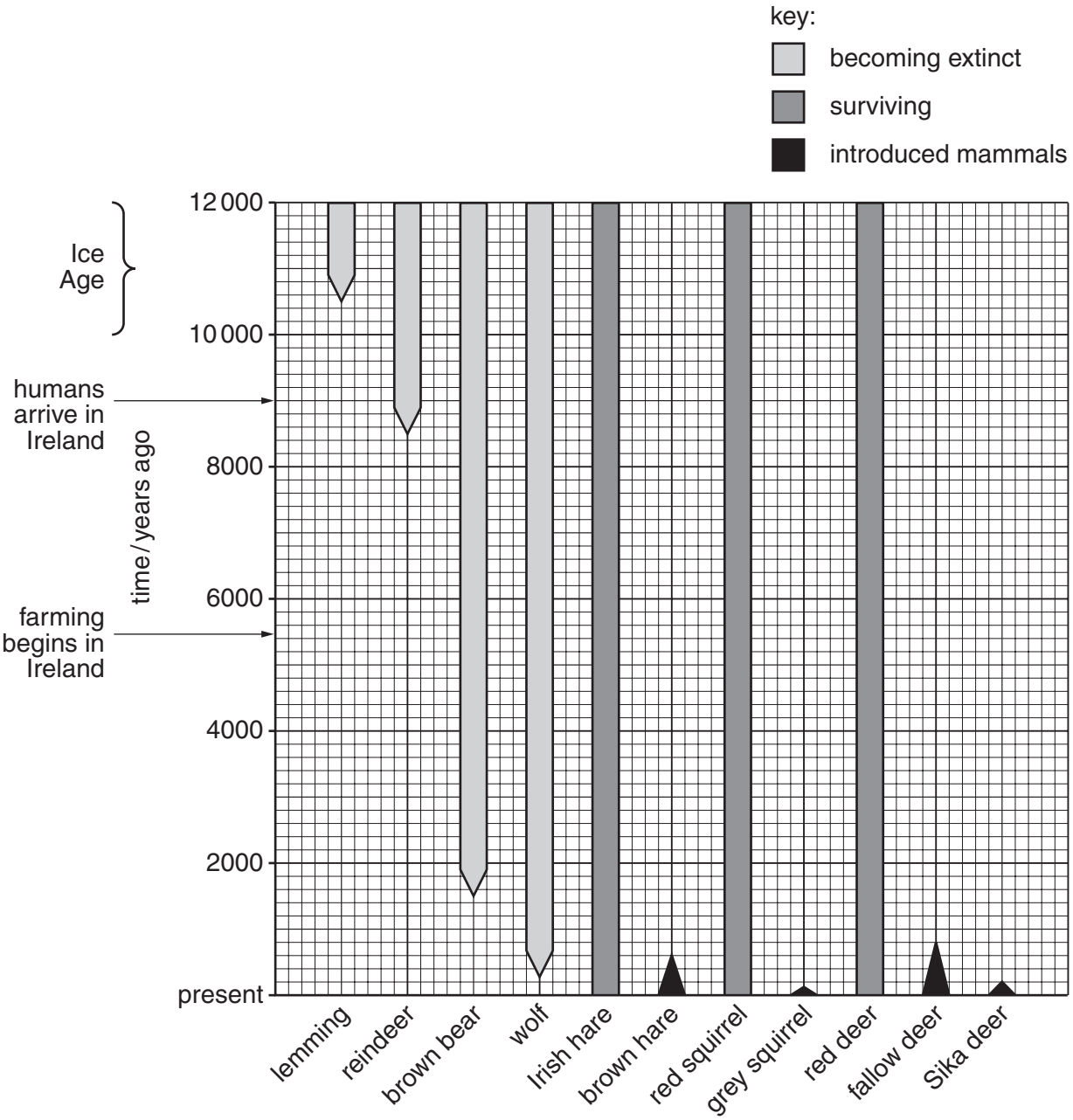


**Fig. 1.2**

**(a)** Use the information in Fig. 1.2 to suggest the name of a mammal species that:

may have become extinct in Ireland due to climate change .....

may have become extinct in Ireland due to human activity .....

may be threatened by competition from a recently introduced species .....[3]

**(b)** The population in Ireland of red deer, *Cervus elephas,* survived the introduction of fallow deer, *Dama dama,* 800 years ago. However, scientists are concerned that the introduction of Sika deer, *Cervus nippon,* is altering the gene pool of the red deer population.

Use your knowledge of taxonomy to explain why the Sika deer population may directly affect the red deer gene pool while the fallow deer population does not.

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Fig. 1.3 shows the number of species of different types of terrestrial mammals in Ireland compared to the neighbouring island of Great Britain.

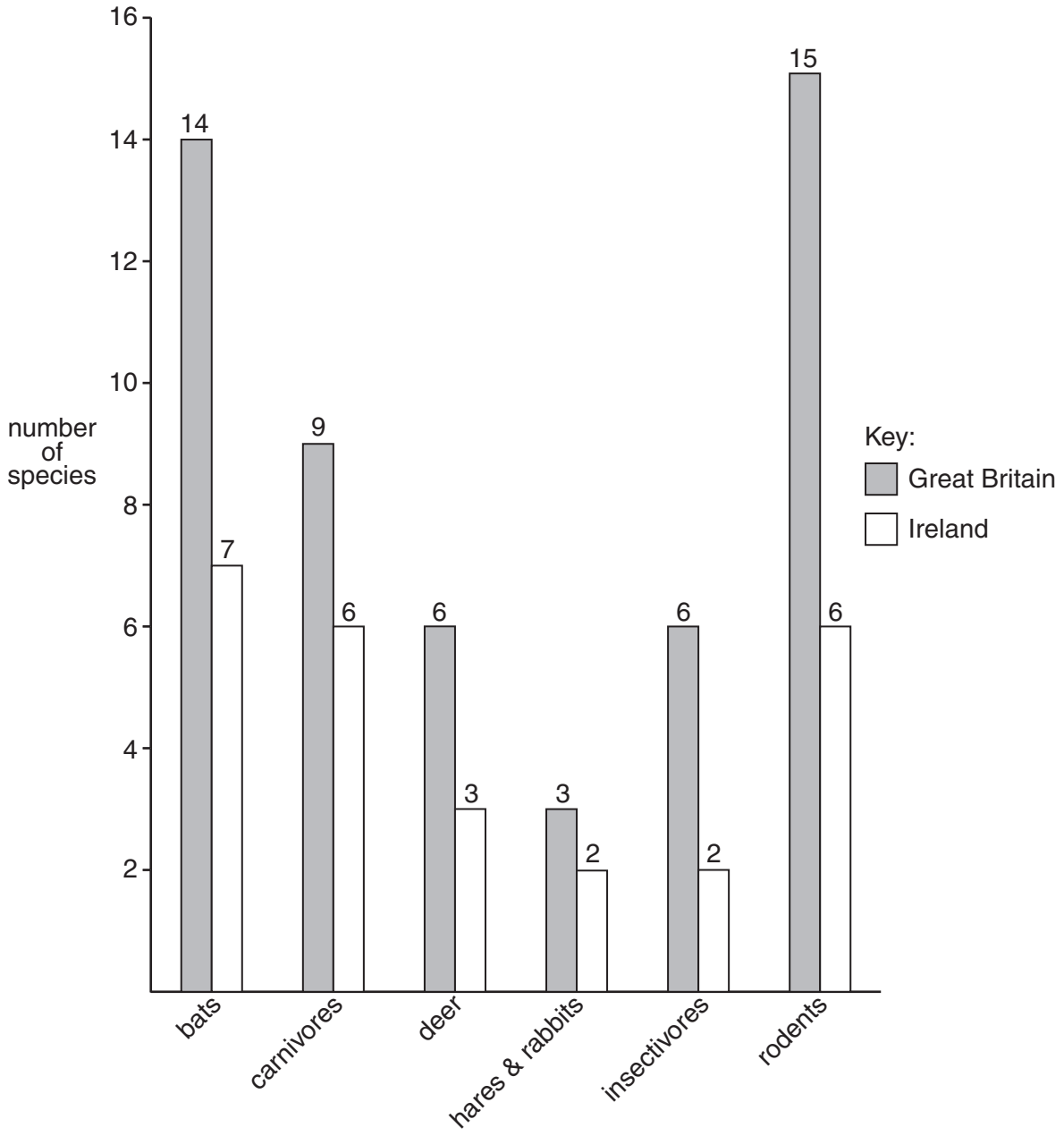


**Fig. 1.3**

**(c)** Calculate the number of mammal species in Ireland as a percentage of the number of species in Great Britain. Show your working and give your answer to the **nearest whole number**.

Answer = .....% [2]

**(d)** Use the information given in Fig. 1.1 **and** Fig. 1.3 to suggest why Ireland has fewer mammal species than Great Britain.

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**(e)** One sub-species of hare is found only in Ireland. The Irish hare differs in small ways from the brown hare species found in Great Britain and elsewhere.

The Irish hare, *Lepus timidus hibernicus,* and the brown hare, *Lepus europaeus,* are shown **on the insert** in Fig. 1.4.

Describe **two** differences, **visible in Fig. 1.4**, between the two hare species.

1.....

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2.....

.....[2]

**(f)** Suggest how distinct subspecies of some mammals like the hare could have evolved in Ireland.

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.....[3]

[Total: 15]

**2** Table 2.1 shows the percentage of men and women in the UK classified as underweight, of acceptable weight, overweight and obese in the period 1993 to 2003.

**Table 2.1**

| | 1993 | 1995 | 1997 | 1999 | 2001 | 2003 |
|---|---|---|---|---|---|---|
| **men** | | | | | | |
| underweight | 5 | 4 | 4 | 4 | 4 | 4 |
| acceptable | 38 | 37 | 34 | 33 | 28 | 29 |
| overweight | 44 | 44 | 45 | 44 | 47 | 44 |
| obese | 13 | 15 | 17 | 19 | 21 | 23 |
| **women** | | | | | | |
| underweight | 7 | 7 | 7 | 7 | 6 | 6 |
| acceptable | 44 | 43 | 40 | 39 | 38 | 37 |
| overweight | 32 | 33 | 33 | 33 | 33 | 33 |
| obese | 17 | 18 | 20 | 21 | 23 | 24 |

**(a)** Describe the trends shown in Table 2.1 that are common to **both** men and women. Suggest explanations for these trends.

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**(b)** Being overweight or obese is the main risk factor for type 2 (non-insulin dependent) diabetes.

Explain why the data in Table 2.1 indicate that in 2003 men were more at risk of developing diabetes than women.

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.....[2]

**8**

The spice cinnamon comes from the bark of trees of the genus *Cinnamomum*. Recent research indicates that cinnamon may be useful in the treatment of type 2 diabetes.

An experiment monitored the effects of cinnamon on glucose, triglyceride and cholesterol concentrations in the blood of sixty people with type 2 diabetes. The people were divided into six groups of ten. Each group received a different treatment regime over a 40 day period.

The results of this experiment are shown in Table 2.2.

**Table 2.2**

| daily treatment regime | mean percentage change in concentration in blood after 40 days | | |
|---|---|---|---|
| | glucose | triglyceride | cholesterol |
| 1 g cinnamon | –25 | –30 | –12 |
| 3 g cinnamon | –18 | –27 | –26 |
| 6 g cinnamon | –29 | –23 | –12 |
| 1 g placebo | +2 | +8 | 0 |
| 3 g placebo | +2 | 0 | 0 |
| 6 g placebo | +1 | –1 | +3 |

**(c) (i)** The placebo consisted of measured doses of wheat flour.

Explain why half of the experimental subjects were given a placebo.

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.....[2]

**(ii)** Individual results for mean percentage change in blood glucose concentration varied about the mean by plus or minus 2.

Explain why the researchers concluded that 'no significant changes in blood glucose were seen in the placebo groups'.

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**(iii)** Suggest why the researchers measured blood cholesterol concentrations.

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.....[2]

**(d)** In this question, one mark is available for the quality of spelling, punctuation and grammar.

Further investigation showed that the compound in cinnamon responsible for the changes shown in Table 2.2 is a water-soluble polymer called MHCP. A second experiment was carried out to investigate the action of MHCP.

- Fat storage cells from rats were incubated *in vitro* (in test tubes) with either MHCP or insulin.
- It was found that MHCP activated the insulin receptors on the cell surface (plasma) membranes of the fat storage cells.

Use the results in Table 2.2 and the results of the *in vitro* experiment to explain how MHCP can help treat diabetes.

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Quality of Written Communication [1]

[Total: 21]

**3** **(a)** Fig. 3.1 shows a type of virus called a T2 phage. It consists of a protein coat enclosing a DNA molecule. T2 infects bacteria by attaching to the surface of a bacterium and injecting phage DNA into its cytoplasm. This DNA causes the bacterial cell to make new copies of the T2 phage. The protein coat of the phage is left loosely attached to the surface of the bacterium.

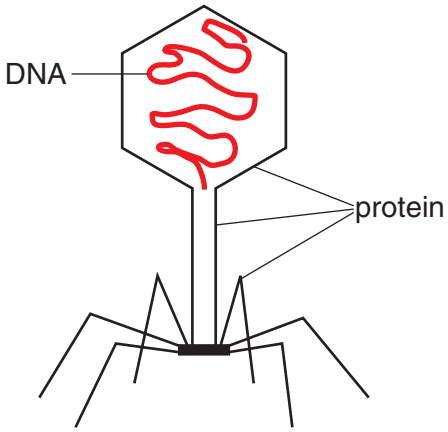


**Fig. 3.1**

**(i)** State **two** ways in which the structure of the protein coat of T2 differs from the structure of its DNA.

1 .....

2 .....[2]

**(ii)** A bacterium is a prokaryotic cell. List **three** features of a bacterium that T2 **does not** share.

1 .....

2 .....

3 .....[3]

T2 phages were used in experiments in 1952 to find out whether protein or DNA is the genetic material responsible for inheritance. The protein molecules in the coat were labelled with a radioactive isotope of sulphur, $^{35}S$, and the DNA inside was labelled with a radioactive isotope of phosphorus, $^{32}P$.

**(b)** **(i)** Name the bond in protein that joins two sulphur atoms.

.....[1]

**(ii)** Name the part of the DNA nucleotide to which phosphorus atoms are bonded.

.....[1]

**(c)** The experiments proceeded as shown in Fig. 3.2, **on the insert**.

**(i)** Explain why the isotopes of phosphorus and sulphur used in this experiment had to be radioactive.

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**(ii)** Explain how the two experiments demonstrate that DNA, not protein, is the genetic material of the T2 phage.

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[Total: 12]

**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**.

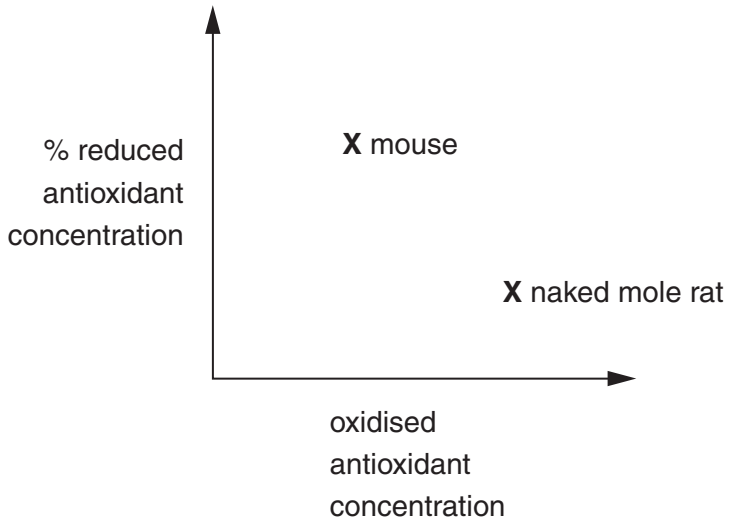


**Fig. 4.1**

**(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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**(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.

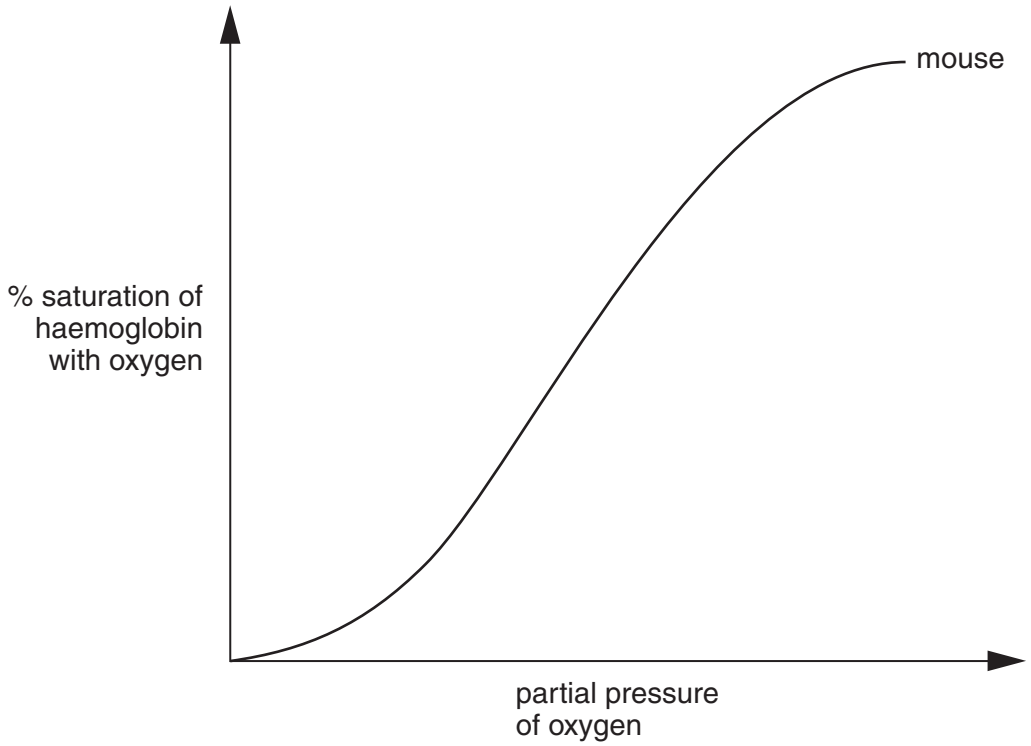


**Fig. 4.2**

[1]

[Total: 12]

**END OF QUESTION PAPER**