PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

# BIOLOGY



## EXAM QUESTION PACK

TOPIC 4: EXCHANGE AND TRANSPORT

### TRANSPORT OF GASES IN THE BLOOD

| SCORE | PERCENTAGE |
| --- | --- |
| /59 | % |

STEMUP

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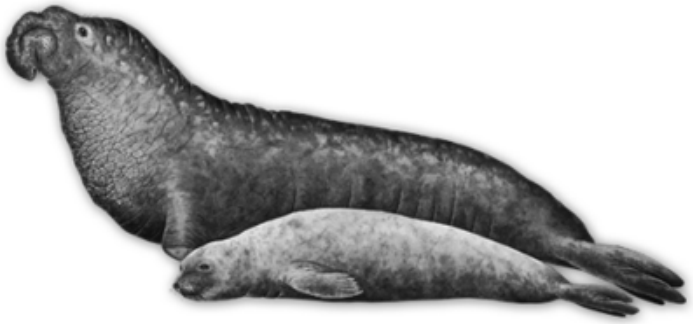
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Q1.

The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

Northern elephant seals are able to dive to great depths and hold their breath for up to two hours.

The tables show data for four diving mammals.

| Species | Maximum time holding breath / min | Maximum diving depth / m | Mass of animal / kg |
|---|---|---|---|
| bottlenose dolphin | 5 | 20 | 200 |
| harbour seal | 17 | 19 | 24 |
| Weddell seal | 82 | 400 | 400 |
| Northern elephant seal | 119 | 437 | 400 |

| Species | Volume of oxygen in body / $cm^3\ kg^{-1}$ | Concentration of haemoglobin in blood / $g\ dm^{-3}$ | Total blood volume / $cm^3\ kg^{-1}$ | Percentage of stored oxygen in different body tissues | | |
|---|---|---|---|---|---|---|
| | | | | lungs | blood | muscle |
| bottlenose dolphin | 36 | 14 | 71 | 34 | 27 | 39 |
| harbour seal | 57 | 21 | 132 | 13 | 54 | 33 |
| Weddell seal | 87 | 210 | 173 | 5 | 66 | 29 |
| Northern elephant seal | 97 | 216 | 207 | 4 | 71 | 25 |

(i) Calculate the total mass of haemoglobin in a Northern elephant seal.

**(3)**

Answer .....

* (ii) Analyse the data to explain how marine mammals are adapted for diving.

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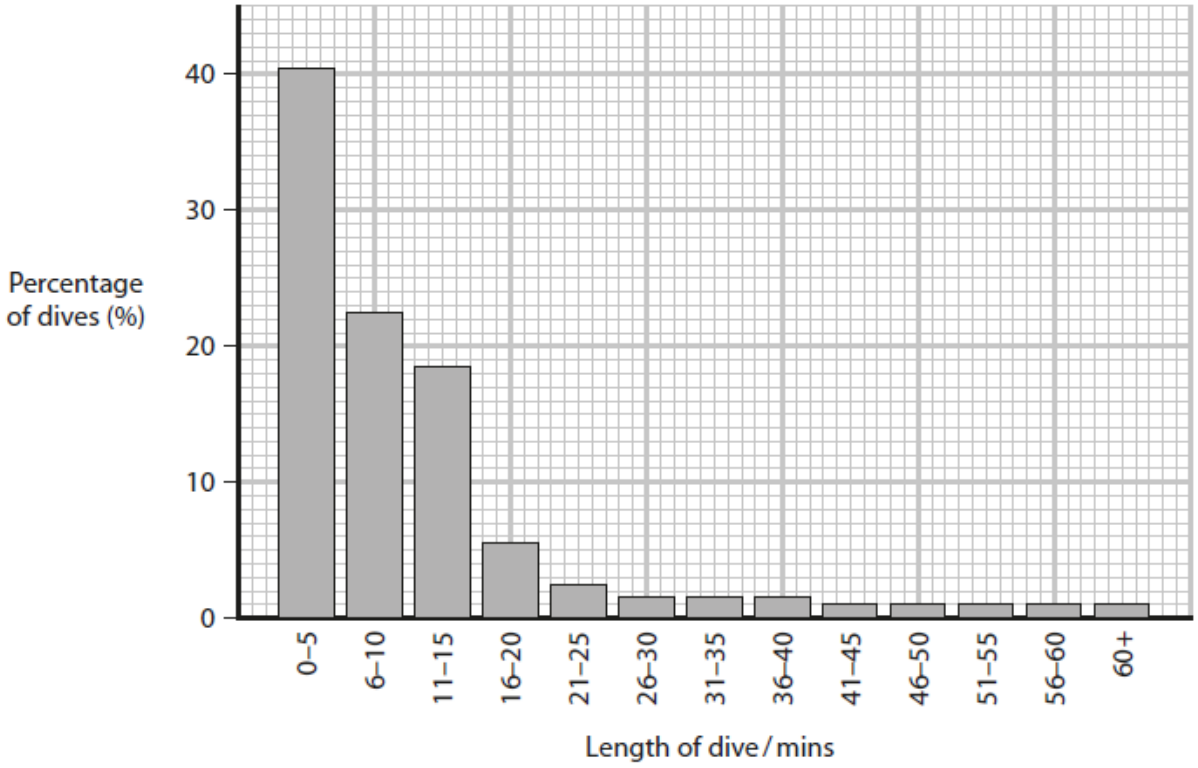
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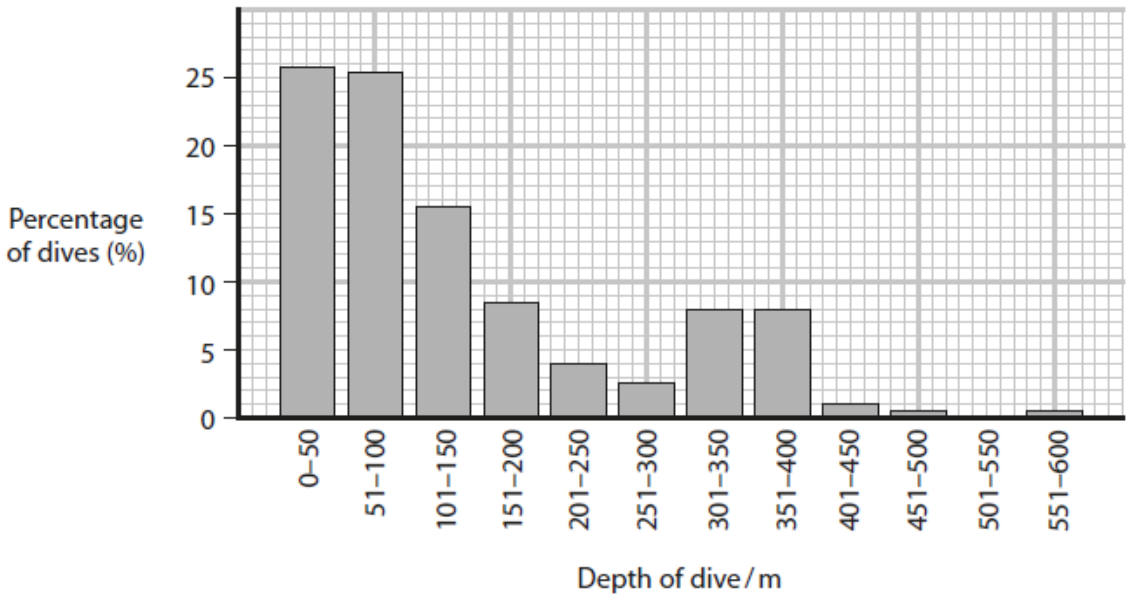
Q2.

Weddell seals spend a lot of their time swimming underwater, diving to find food and diving to avoid predators.

However, they do have to come to the surface to breathe.

The graphs give some information about dives by Weddell seals.




Comment on the conclusions that can be made about the dives of these seals.

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**(Total for question = 4 marks)**

Q3.

**Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

Weddell seals spend a lot of their time swimming underwater, diving to find food and diving to avoid predators.

However, they do have to come to the surface to breathe.

Weddell seals carry higher concentrations of oxygen in their bodies than humans.

(i) The haemoglobin of Weddell seals is adapted to carry higher levels of oxygen than the haemoglobin of humans, at each partial pressure of oxygen.

Which row of the table describes the haemoglobin of the Weddell seal?

**(1)**

| | Position of oxygen dissociation curve compared with human haemoglobin | Affinity for oxygen compared with human haemoglobin |
|---|---|---|
| ☒ A | to the left | higher |
| ☒ B | to the left | lower |
| ☒ C | to the right | higher |
| ☒ D | to the right | lower |

*(ii) The table shows how much oxygen is stored in different parts of the body of humans and Weddell seals.

| Part of body | Total oxygen stored / a.u. $kg^{-1}$ body tissue | |
|---|---|---|
| | humans | Weddell seals |
| lungs | 12 | 3 |
| blood | 10 | 58 |
| muscle | 2 | 23 |
| body fluids, other than in the blood | 2 | 2 |

Weddell seals also store erythrocytes in their spleen that are released into the bloodstream during deep dives.

Analyse the data to explain the differences between these two mammals.

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**(Total for question = 7 marks)**

Q4.

Malaria causes serious problems for pregnant women. They often suffer from a condition known as anaemia in which the ability of the blood to carry oxygen is significantly reduced.

Explain how malaria causes anaemia.

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**(Total for question = 2 marks)**

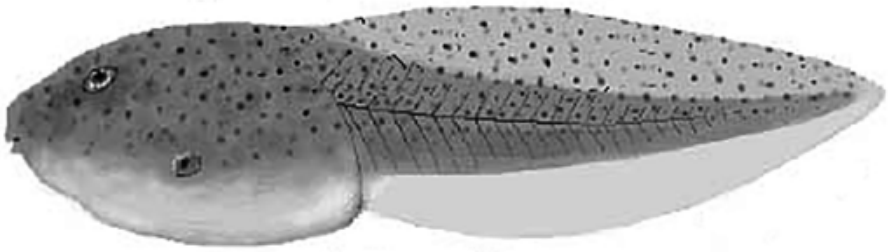
Q5.

The adult American bullfrog, *Rana catesbeiana*, can live in water or on land.

Adult frogs lay eggs in water where they are fertilised.

The fertilised eggs develop into tadpoles that live only in water.

The photograph shows a tadpole.



(i) Human activity can cause pollution that reduces the oxygen concentration in water.

Explain why a low oxygen concentration in the water would lower the pH of the blood of the tadpole.

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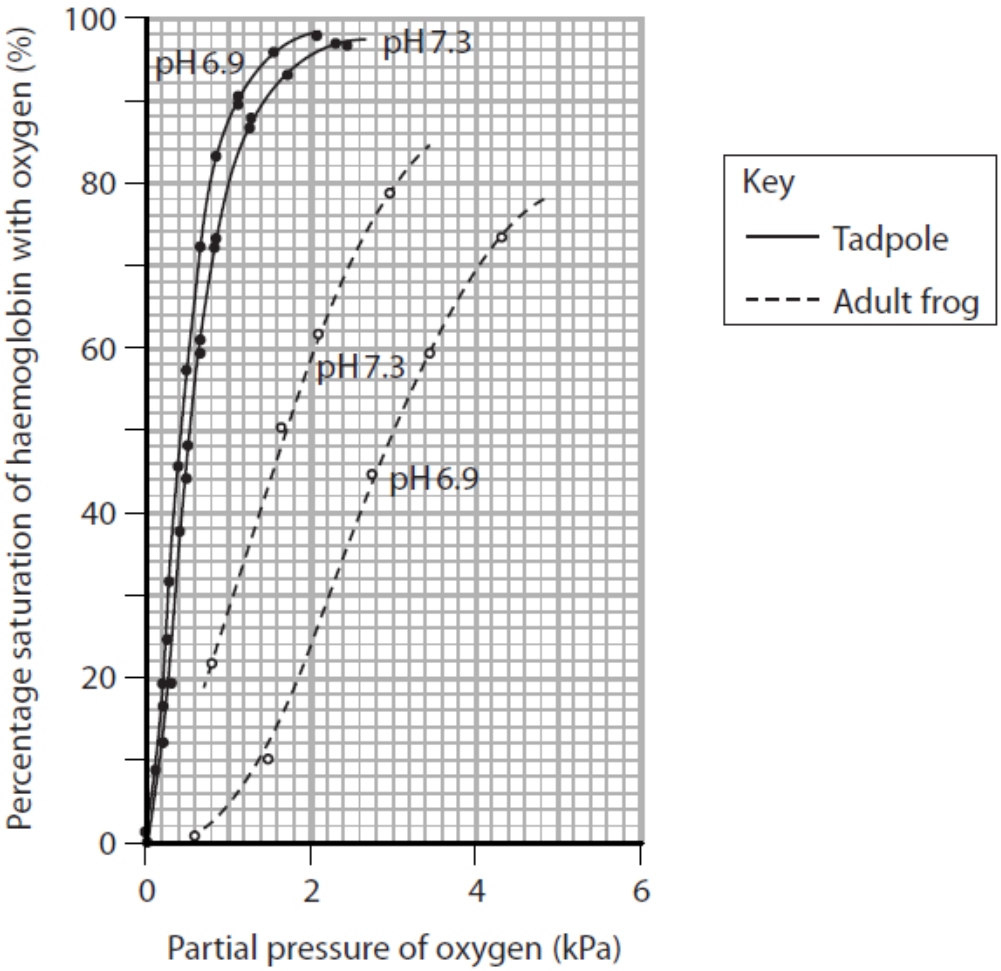
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*(ii) The graph shows the effect of pH on the oxygen dissociation curves of

haemoglobin for adult frog blood and tadpole blood.




The adult frog can either live on land or in water. The tadpole always lives in water.

Discuss how the shape and position of the dissociation curves reflect the habitat in which these animals live.

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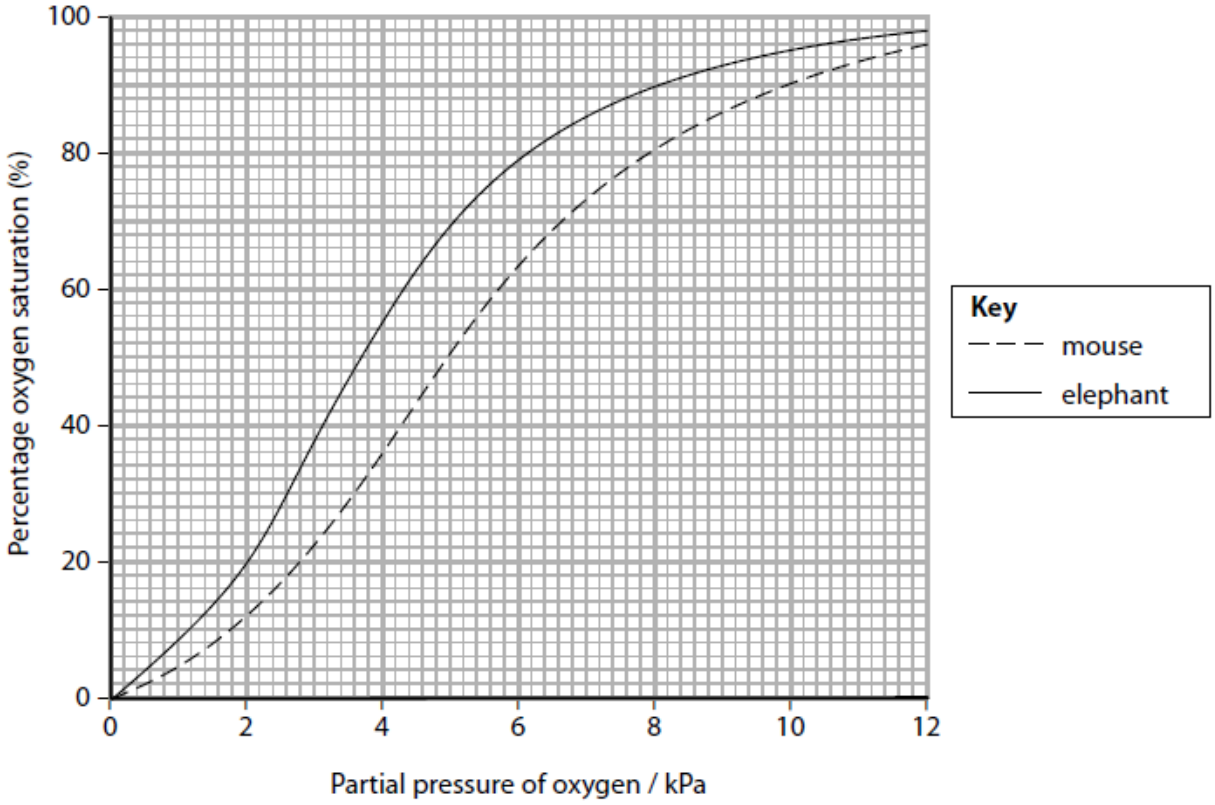
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**(Total for question = 12 marks)**

Q6.

The graph below shows the oxygen haemoglobin dissociation curves for a blood sample from an elephant and a mouse.




(a) Use the information in the graph to determine the difference in percentage saturation between elephant haemoglobin and mouse haemoglobin at a partial pressure of oxygen of 4 kPa.

**(1)**

Answer .....

*(b) Explain the effect that body size has on the metabolic rate of these two mammals.

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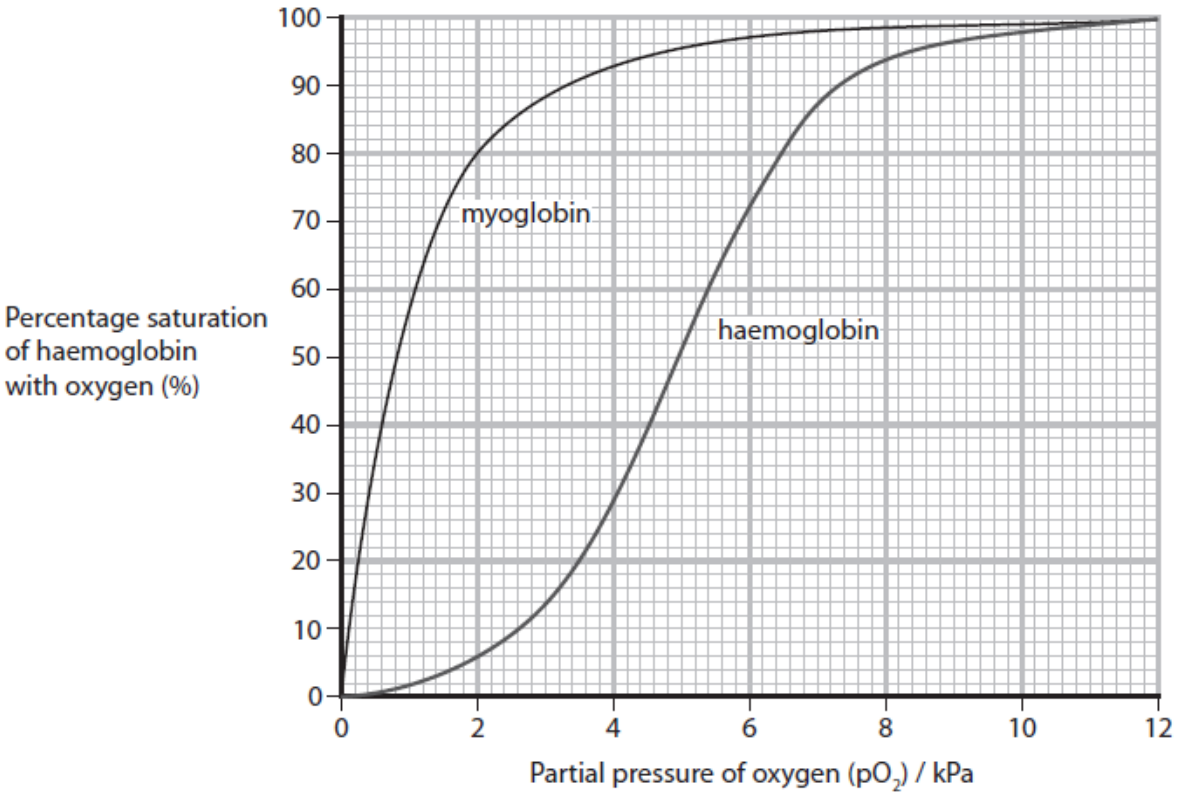
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**(Total for question = 7 marks)**

Q7.

The graph shows the oxygen dissociation curves of human haemoglobin and human myoglobin.




(i) Calculate the volume of oxygen bound to haemoglobin at a partial pressure of oxygen of 6 kPa in 100 $cm^3$ blood.

The concentration of haemoglobin is 15 g per $dm^3$ blood.

When fully saturated, there is 1.36 $cm^3$ oxygen per g of haemoglobin.

**(3)**

Answer .....

(ii) Explain why the oxygen dissociation curves for haemoglobin and myoglobin are different.

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**(Total for question = 7 marks)**

Q8.

The photograph shows a glacier that is melting. As the glacier gradually melts, it leaves behind bare rock.




(Source: © CHARLES D. WINTERS/SCIENCE PHOTO LIBRARY)

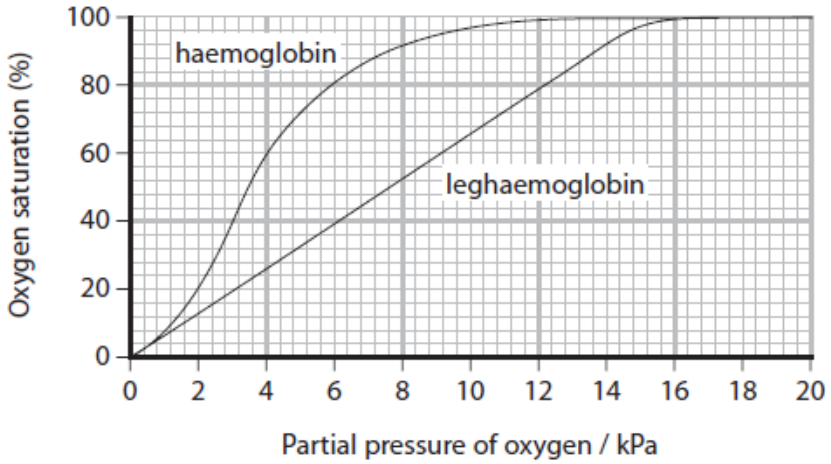
Scientists sampled the soil from areas that had been uncovered for different lengths of time after the glacier ice had melted.

The table shows the results from the samples.

| Length of time since glacier melted / years | Soil depth / cm | Mass of nitrate in soil / mg $m^{-2}$ | Mass of leaf litter that falls to ground each year / g $m^{-2}$ $yr^{-1}$ |
|---|---|---|---|
| 5 | 5.2 | 3.8 | 1.5 |
| 15 | 6.4 | 4.1 | 1.7 |
| 40 | 7.0 | 5.3 | 12.8 |
| 100 | 9.2 | 21.8 | 277.0 |
| 150 | 10.8 | 35.4 | 335.0 |
| 200 | 15.1 | 53.3 | 277.0 |
| 250 | 16.2 | 61.4 | 261.0 |

The roots of some of the plants growing around the glacier were found to contain an oxygen binding protein called leghaemoglobin.

The graph shows the oxygen dissociation curve for leghaemoglobin and the oxygen dissociation for haemoglobin.




(i) Leghaemoglobin is a protein that is similar in structure to myoglobin. Both of these proteins have one subunit.

Explain how the oxygen dissociation curve shows that the structure of leghaemoglobin is more similar to myoglobin than to haemoglobin.

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(ii) Explain how leghaemoglobin enables these plants to grow in waterlogged and compact soils.

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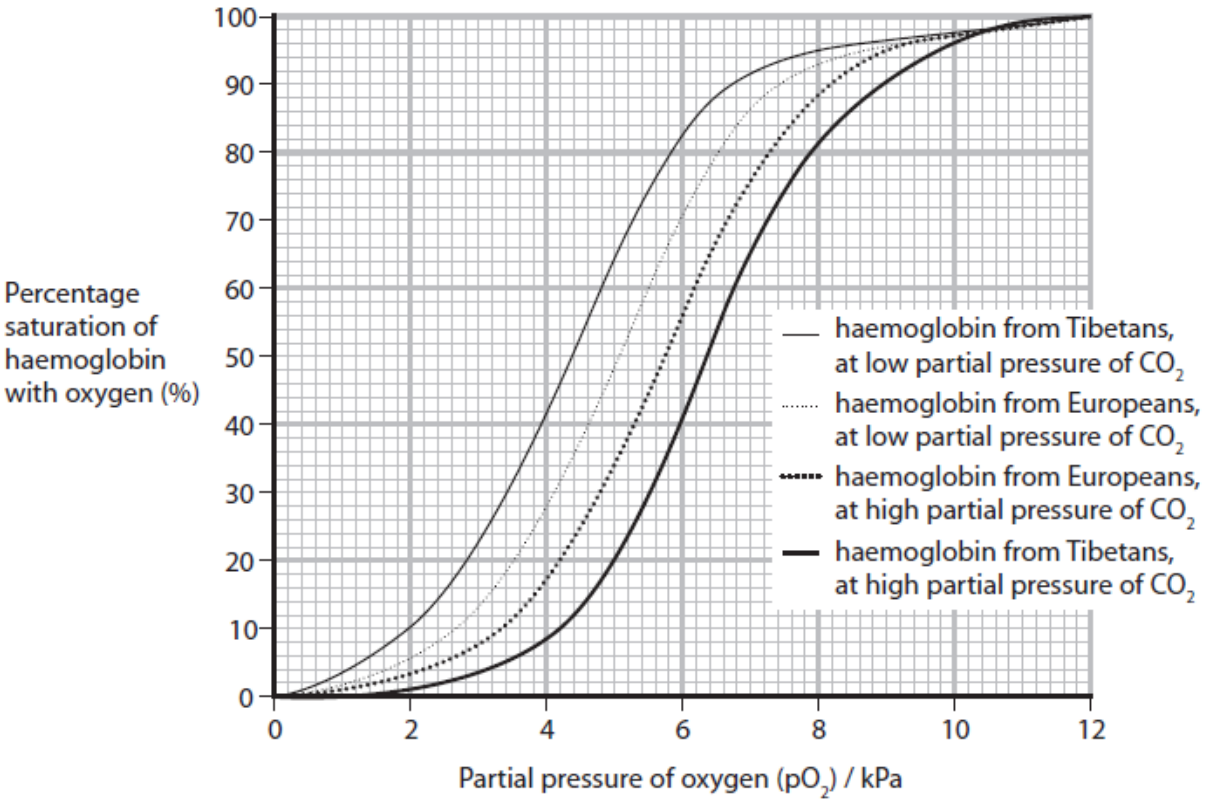
Q9.

In an investigation, the oxygen dissociation of haemoglobin from Tibetan people and European people was compared.

The Tibetan people were living at high altitude.

The European people were living at low altitude.

The graph shows the results of this investigation.




Comment on the oxygen dissociation curves of the Tibetan people.

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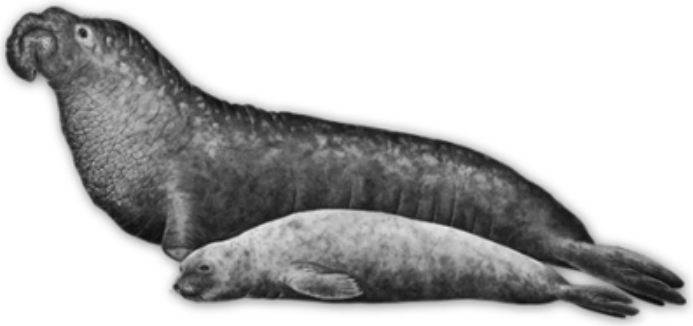
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**(Total for question = 4 marks)**

Q10.

The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

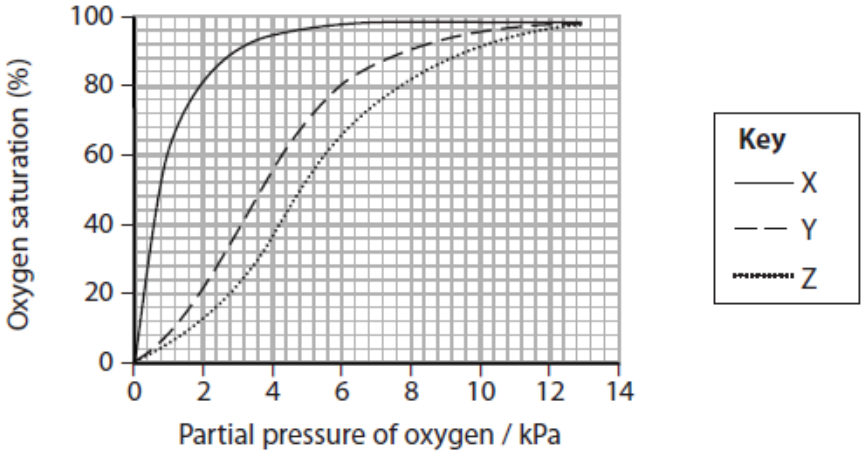
The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

Northern elephant seals have a high concentration of haemoglobin in their blood.

The graph shows the oxygen dissociation curves for myoglobin, adult haemoglobin and fetal haemoglobin.




Which of the rows correctly matches each curve with myoglobin, adult haemoglobin and fetal haemoglobin?

**(1)**

| | Myoglobin | Adult haemoglobin | Fetal haemoglobin |
|---|---|---|---|
| ☒ **A** | X | Y | Z |
| ☒ **B** | X | Z | Y |
| ☒ **C** | Y | Z | X |
| ☒ **D** | Z | X | Y |

**(Total for question = 1 mark)**