Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Biology B

Advanced Subsidiary

Paper 2: Core Physiology and Ecology

Tuesday 7 June 2016 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
8BI0/02

You may need a ruler, a pencil and a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 4 9 8 3 2 A 0 1 3 6

PEARSON

Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Cholera is a disease caused by a bacterial infection that affects the absorption of water in the small intestine.

(a) The photograph shows part of one epithelial cell from the wall of the small intestine.

This cell is adapted to absorb substances by active transport.

State what is meant by the term **active transport**.

(2)

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(b) The bacteria that cause cholera release a toxin.

This toxin affects the CFTR protein found in the membrane of intestinal epithelium cells.

The toxin causes the CFTR protein to pump more chloride ions out of these cells into the intestine. This causes a lot of water to be lost in the faeces.

Explain how the toxin causes this water loss.

(3)

(c) The CFTR protein is also found in the membrane of epithelial cells in the lungs.

Cystic fibrosis is a recessive genetic condition caused by mutations of the allele for the CFTR protein.

This can result in the production of thick, highly viscous mucus in the bronchioles and bronchi.

Explain why the blood of people with cystic fibrosis has a low oxygen concentration.

(2)

(d) There is a high frequency of mutated CFTR alleles in some human populations.

In an experiment, three groups of genetically modified mice were infected with cholera bacteria.

The relative volume of water in their faeces was measured.

The results are shown in the table.

Group	Relative volume of water in faeces
Mice with two normal CFTR alleles	1.0
Mice with one normal and one mutated CFTR allele	0.5
Mice with two mutated CFTR alleles	0.1

Use the information in the table to explain why the mutated CFTR allele has a high frequency in some human populations.

(3)

(Total for Question 1 = 10 marks)

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2 The rate of transpiration in plants can be measured using a potometer.

(a) (i) Explain why the stem of a plant should be cut under water before it is inserted into a potometer.

(2)

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(ii) Which combination of the following factors would increase the rate of transpiration the most?

(1)

☒ **A** high wind speed, low humidity, high temperature

☒ **B** low wind speed, low humidity, high temperature

☒ **C** high wind speed, high humidity, high temperature

☒ **D** high wind speed, low humidity, low temperature

(b) Which of the following shows the order of the structures a water molecule would pass through as it moves from the soil along the symplastic pathway in a root?

(1)

☒ **A** cell wall only

☒ **B** cell wall, cell membrane, cytoplasm

☒ **C** cytoplasm only

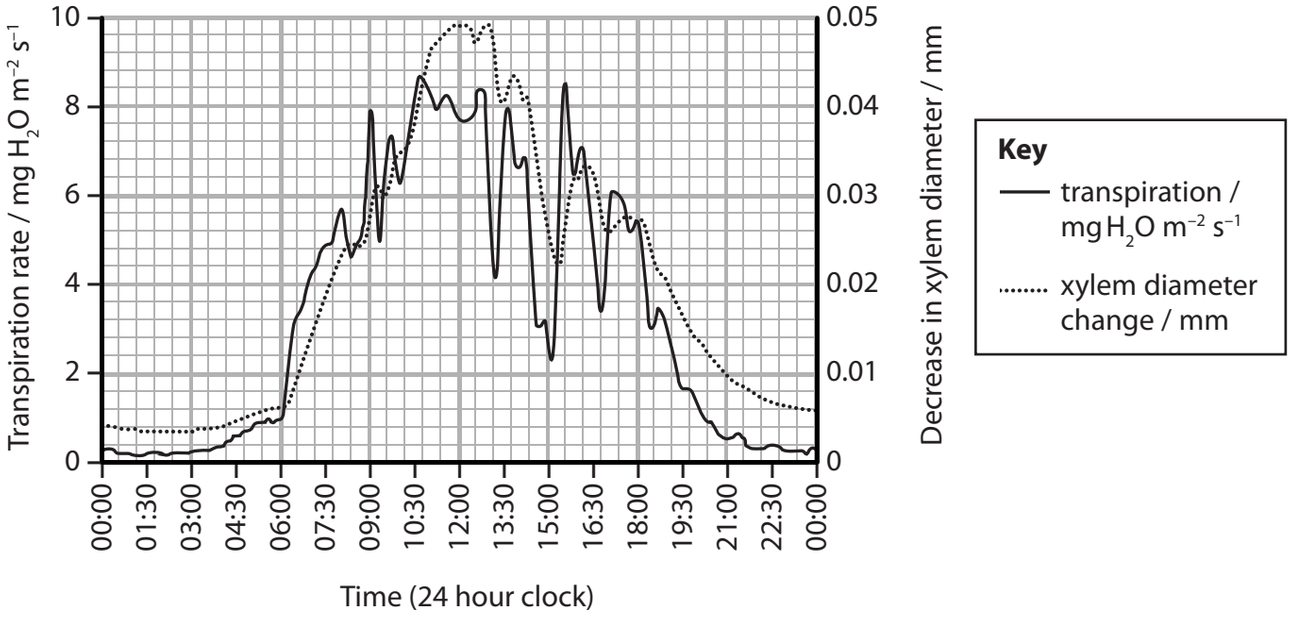
☒ **D** cell membrane, cytoplasm, cell wall

*(c) Scientists investigated the transpiration of pine trees over a 24-hour period.

The mass of water lost per second and the total area of the leaves were measured.

The decrease in diameter of xylem vessels was also measured over the same 24 hours.

The results are shown in the graph.



Using your knowledge of cohesion-tension theory, explain the changes in xylem diameter and transpiration rate over the 24-hour period.

(6)

(Total for Question 2 = 10 marks)

3 Organic farming does not use artificial insecticides, herbicides or fertilisers, all of which are used in conventional farming.

Students investigated the effect of organic farming on the species diversity of butterflies.

They compared fields used for growing crops on an organic farm and on a conventional farm.

Butterflies were sampled three times on both farms during July. They were collected by walking around the fields using a sweep net. On each sampling exercise, the butterflies were collected until no more butterflies were seen.

Sampling was only carried out when the temperature exceeded 25 °C and the wind speed was low.

The results are shown in the table.

Species of butterfly	Number of butterflies	
	Organic farm	Conventional
Cabbage white	22	44
Common blue	12	0
Large skipper	4	0
Monarch	3	0
Painted lady	11	0
Peacock	14	5
Red admiral	35	6
Small copper	2	0
Swallowtail	14	4

(a) (i) The index of diversity for the conventional farm is 1.54

Use the formula to calculate the index of diversity for the organic farm.

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

N = total number of organisms of all species
n = total number of organisms of a particular species

(2)

Answer .....

(ii) Explain why the organic farm has a higher index of diversity than the conventional farm.

(3)

(iii) Criticise the method used by the students to obtain these results.

(4)

(b) Some conventional farms have converted to organic farming.

A further experiment was carried out to investigate the effect on species diversity of how long the farms have used organic methods.

(i) Butterflies and plant species were sampled from a range of farms that had used organic farming methods for different lengths of time.

The number of plant species and the number of butterfly species were recorded.

The results are shown in the table.

Years of organic farming	Number of plant species	Number of butterfly species
0	17	4
1 to 5	38	12
6 to 15	42	14
16 to 25	39	12

Explain how the number of years of organic farming affects the biodiversity of butterfly species.

(3)

(ii) Creeping thistle is considered to be a weed.

Creeping thistle has a deep root system and takes many years to be completely removed by organic farming methods.

The moth population and the number of creeping thistle plants were counted.

The results are shown in the table.

Years of organic farming	Number of moth species	Number of creeping thistle plants
0	15	10
1 to 5	27	235
6 to 15	20	74
16 to 25	10	14

Explain the changes in the number of moth species.

(2)

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(Total for Question 3 = 14 marks)

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4 The mammalian circulatory system transports materials to and from cells.

(a) (i) State how the double circulatory system of mammals ensures a higher hydrostatic blood pressure than a single circulatory system.

(1)

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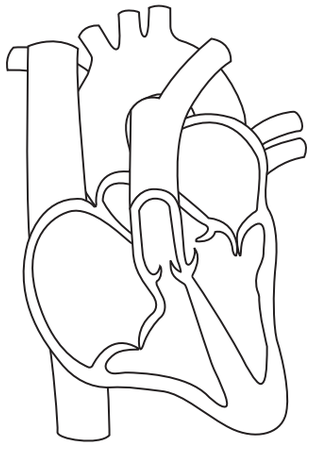
(ii) The diagram shows a section through a mammalian heart during part of the cardiac cycle.



Which of the following statements is true for this stage in the cardiac cycle?

(1)

☒ **A** the pressure in the aorta is higher than the pressure in the left ventricle

☒ **B** the atrioventricular valves are open and the semilunar valves are closed

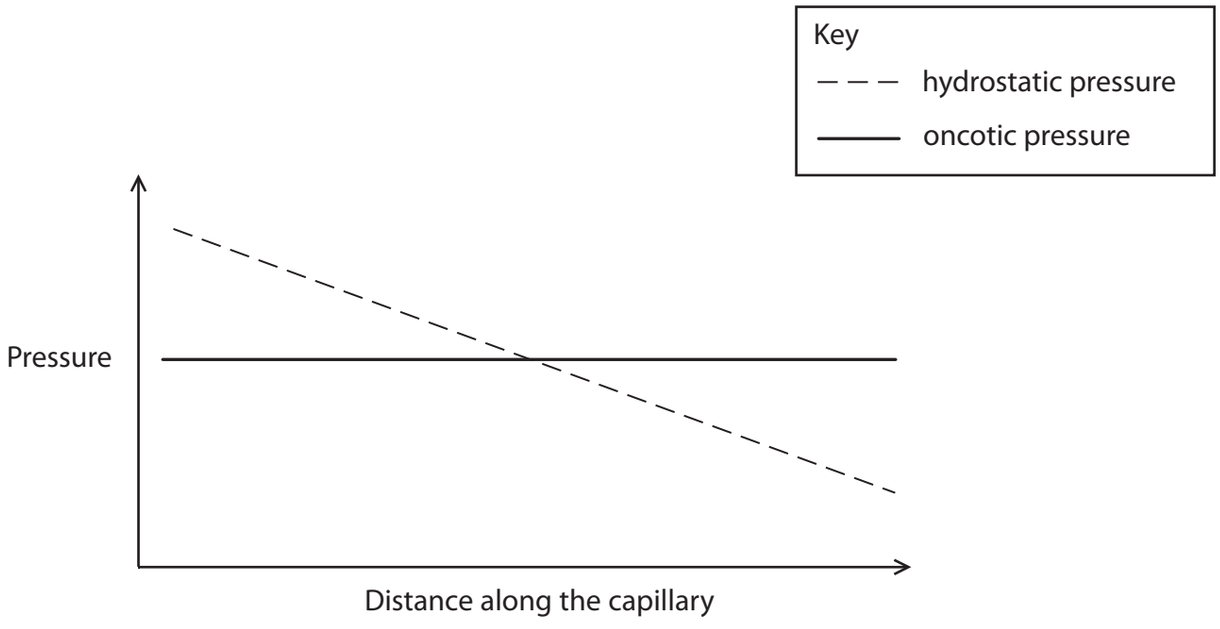
☒ **C** the pressure in the left ventricle is higher than the pressure in the left atrium

☒ **D** the atrioventricular node is about to send an impulse along the bundle of His

(b) Lymphoedema is a condition that causes severe swelling of body tissues due to the accumulation of tissue fluid.

This occurs when lymphatic ducts are blocked.

The diagram shows how the hydrostatic blood pressure and oncotic plasma pressure vary along the length of a capillary.



(i) With reference to the diagram, explain how tissue fluid is produced and reabsorbed by the capillaries.

(4)

(ii) Lymphatic ducts remove proteins that are secreted by cells.

Explain how a blockage of a lymphatic duct could lead to lymphoedema.

(2)

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(Total for Question 4 = 8 marks)

5 Blood contains a variety of cells, plasma and clotting factors.

Smoking can increase the risk of blood clot formation.

An investigation was carried out to determine the effects of smoking on the contents of blood plasma.

In the first part of the investigation, blood samples were taken from male smokers and non-smokers aged between 35 and 50. All males were matched for health status, body mass and diet.

The concentration of fibrinogen in their blood plasma was measured.

The results are shown in the table.

Number of cigarettes per day	Sample size	Mean blood plasma concentration of fibrinogen / mg 100 cm^{-3}	Standard deviation
0	30	241.8	± 3.0
1 to 10	10	329.0	± 7.4
11 to 20	22	361.0	± 4.7
> 20	8	376.9	± 6.6

In the second part of the investigation, blood samples were taken from men aged between 35 and 50 just after waking.

Another blood sample was taken just after the men had smoked their first cigarette.

The concentration of thrombin present in both blood samples was measured.

The concentration of thrombin present in the blood of the non-smokers was also measured.

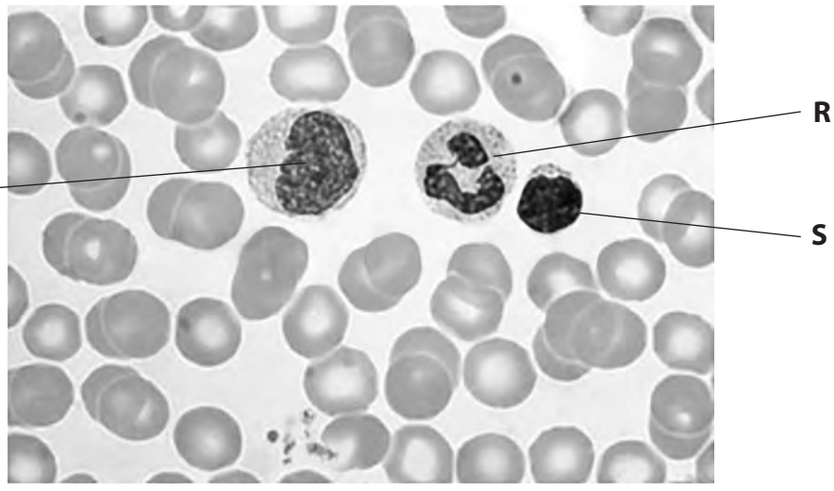
The results are shown in the table.

Group	Sample size	Mean thrombin concentration / arbitrary units	Standard deviation
Non-smokers after waking	9	56	± 1
Smokers after waking	10	121	± 47
Smokers after first cigarette	10	365	± 76

(a) Analyse the data to explain why smoking can increase the risk of blood clot formation.

(4)

(b) The diagram below shows some of the cells found in blood.



(i) Which row of the table correctly identifies the cells labelled **Q**, **R** and **S** ?

(1)

		Q	R	S
☒	**A**	erythrocyte	monocyte	neutrophil
☒	**B**	neutrophil	lymphocyte	monocyte
☒	**C**	monocyte	neutrophil	erythrocyte
☒	**D**	monocyte	neutrophil	lymphocyte

(ii) Describe the function of a neutrophil in defence.

(2)

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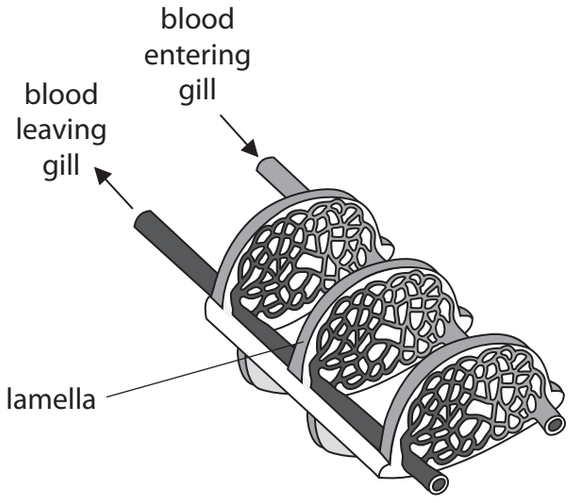
(Total for Question 5 = 7 marks)

6 Gills are the site of gas exchange in fish.

(a) The diagram shows some of the gill lamellae from a bony fish.

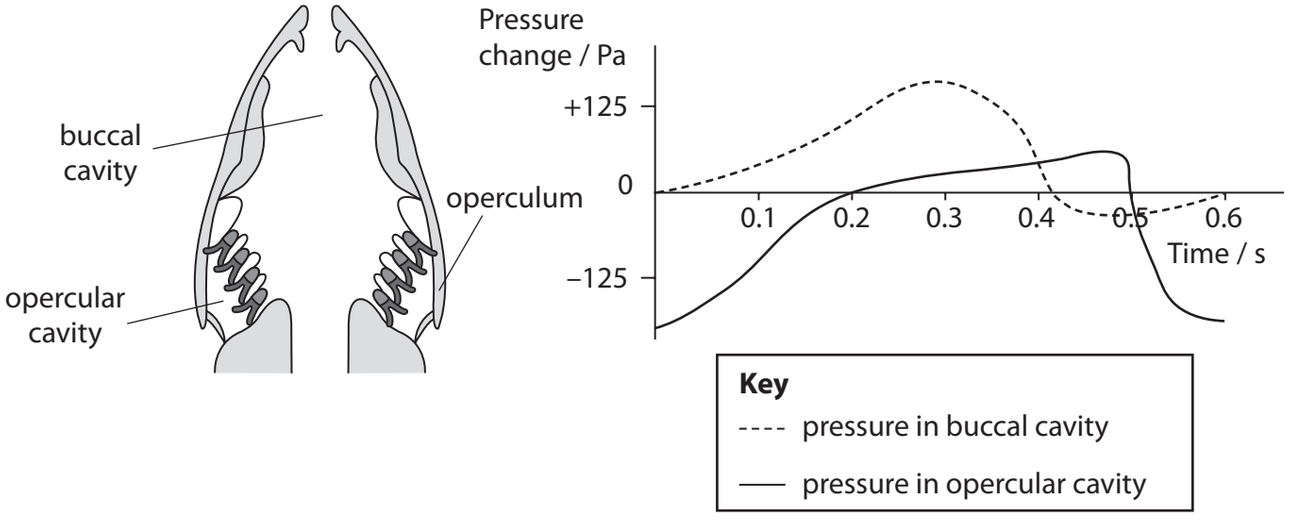


Draw **one** arrow on the diagram to show the direction of water flow across the lamellae.

(1)

(b) The diagram shows a section through the head of a bony fish.

The graph shows the pressure changes in the buccal cavity and opercular cavity during ventilation.



The operculum will be closed between

(1)

☒ **A** 0.4 s and 0.5 s

☒ **B** 0.0 s and 0.4 s

☒ **C** 0.4 s and 0.6 s

☒ **D** 0.2 s and 0.4 s

(c) The table shows some information for five species of fish.

Fish species	Activity level	Surface area of gill lamellae / mm^2	Mass of fish / g	Comparison of surface area to mass / $cm^2 g^{-1}$
toadfish	low	46 055	305	1.51
butterfish	medium	120 321	261	4.61
sheepshead	medium	254 048	544	4.67
mullet	high	252 500	250	
mackerel	high	235 040	226	10.40

(i) The comparison of surface area to mass of mullet is

(1)

☒ **A** 1010 $cm^2 g^{-1}$

☒ **B** 10.10 $cm^2 g^{-1}$

☒ **C** 1.01 $cm^2 g^{-1}$

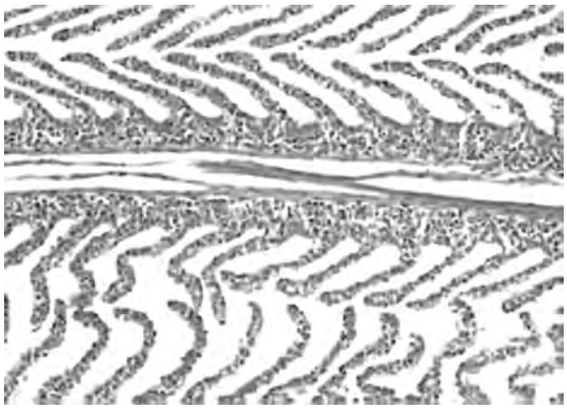
☒ **D** 0.99 $cm^2 g^{-1}$

(ii) Analyse the data to explain the difference in the activity levels of these fish species.

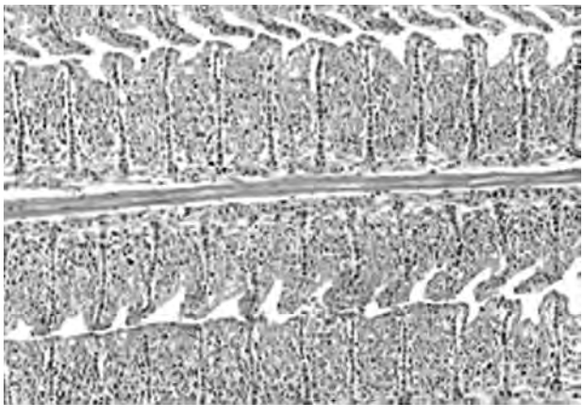
(3)

(d) Water polluted with heavy metal ions can cause the death of fish.

The photographs show cross-sections of the lamellae from a fish caught in unpolluted water and from a fish caught in water polluted with heavy metal ions.



Gill lamellae from a fish in unpolluted water



Gill lamellae from a fish in water polluted with heavy metal ions

Use the photographs to explain why fish die in water polluted with heavy metal ions.

(2)

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(Total for Question 6 = 8 marks)

7 There are currently only three surviving species of elephant:

- Asian elephant, *Elephas maximus*
- African bush elephant, *Loxodonta africana*
- African forest elephant, *Loxodonta cyclotis*

(a) Complete the table showing the classification of the African bush elephant.

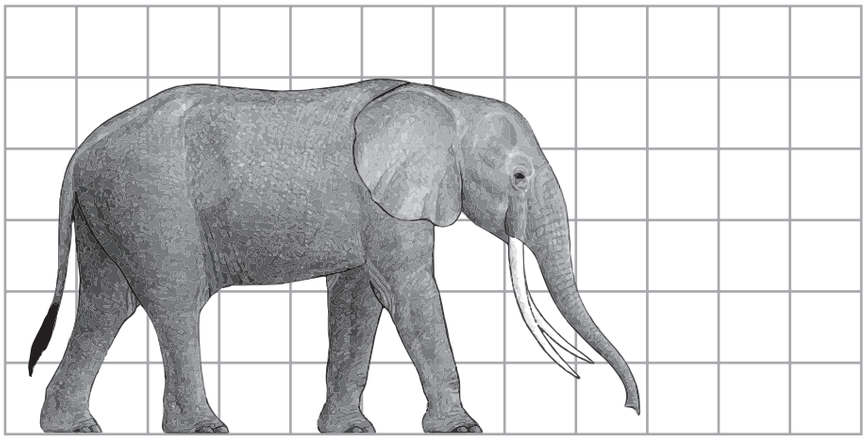
(2)

Domain	.....
Kingdom	Animalia
Phylum	Chordata
.....	Mammalia
Order	Proboscidae
Family	Elephantidae
Genus	.....
Species	.....

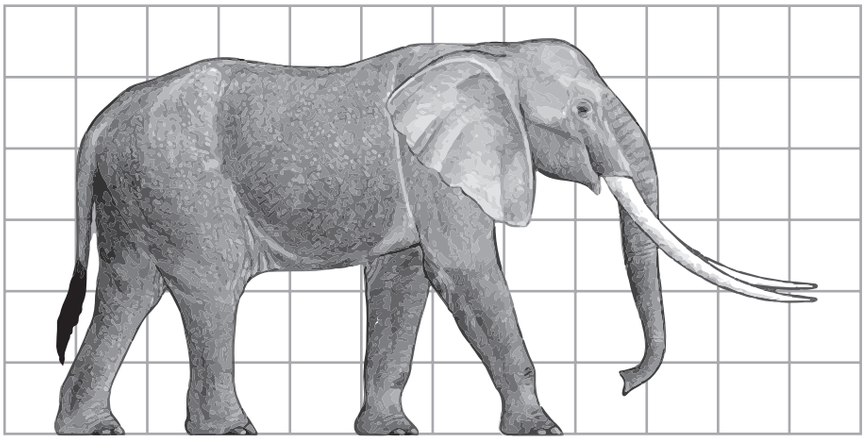
(b) All African elephants used to be classified as a single species.

Recent comparisons of African elephants demonstrated that they are two separate species.

The diagrams show the appearance and locations of the two African elephant species.



African bush elephant



African forest elephant

(i) Give one reason why scientists used to classify African elephants as a single species.

(1)

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(ii) Scientists agreed to separate the African elephants into two species based on new evidence from DNA sequencing.

State how scientists reach agreement on new evidence.

(1)

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(c) Recently, scientists extracted mitochondrial DNA from a frozen Arctic mammoth.

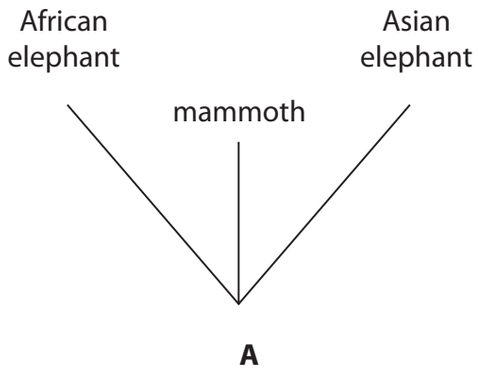
This DNA was sequenced and compared with the mitochondrial DNA from the Asian elephant and from the African bush elephant.

The percentage similarities in the DNA sequences are shown in the table.

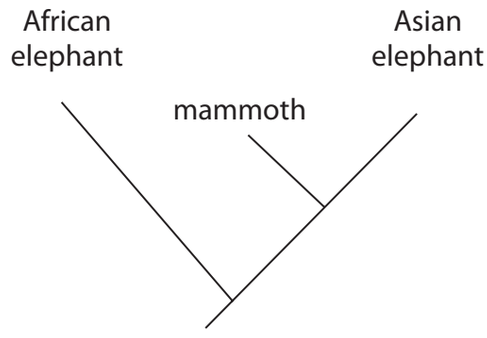
Species	Percentage similarity in DNA sequence (%)		
	Mammoth	Asian elephant	African bush elephant
Mammoth	100	98	96
Asian elephant	98	100	95
African bush elephant	96	95	100

Which diagram shows the correct evolutionary relationship for these three species, based on the data in the table?

(1)



A



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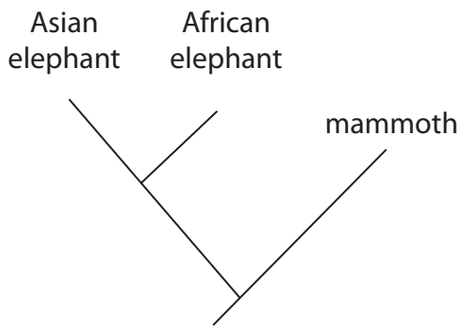

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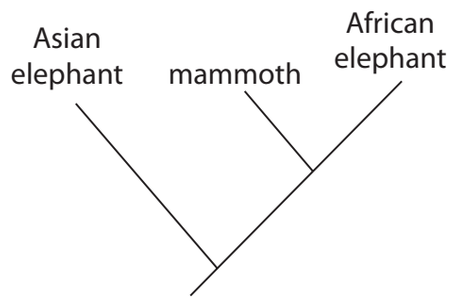
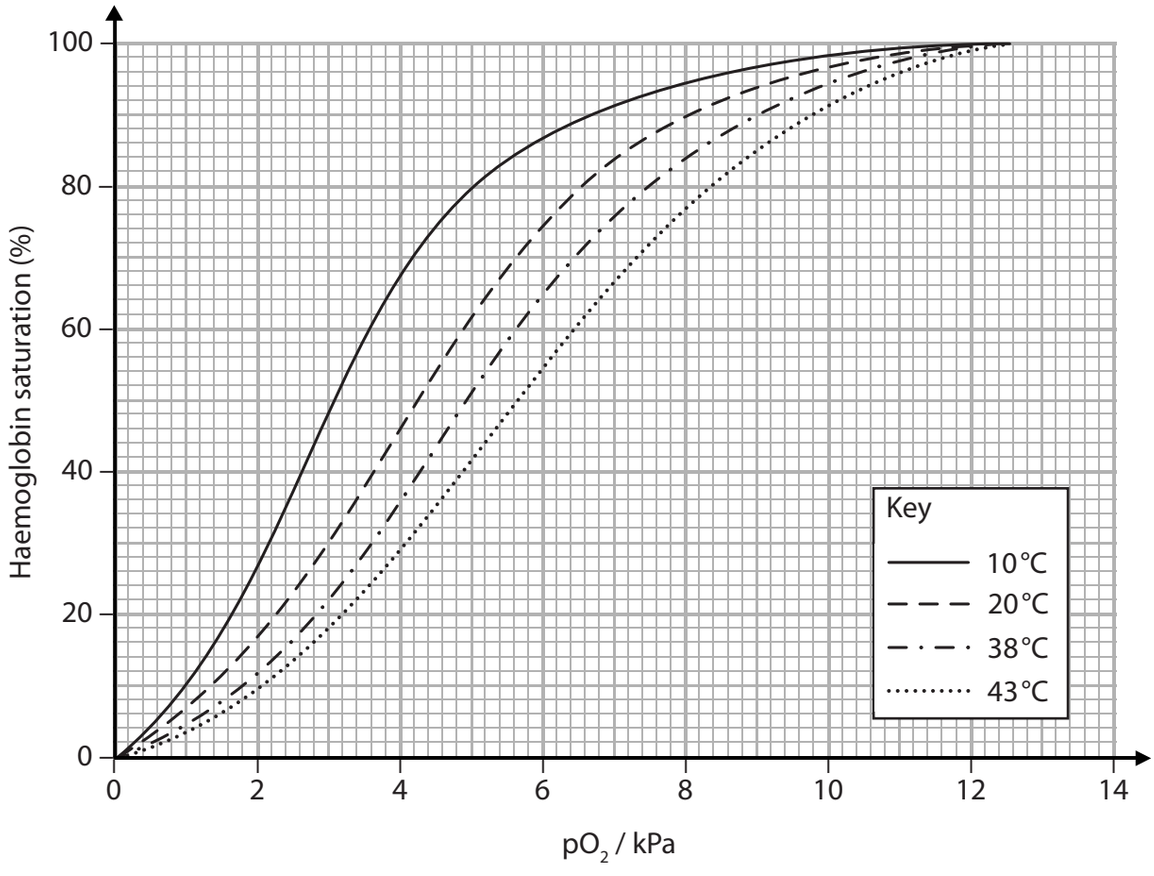


D

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(d) Scientists also investigated the effect of temperature on the percentage saturation of haemoglobin with oxygen, using blood from an Asian elephant.

The oxygen dissociation curves are shown in the graph.



(i) In the alveolar capillaries, the partial pressure of oxygen is 12 kPa at a temperature of 38 °C and haemoglobin is fully saturated with oxygen.

In active muscle tissue, the partial pressure of oxygen is 2 kPa at a temperature of 43 °C.

Use the graph to determine the percentage saturation of haemoglobin in active muscle tissue.

(1)

Answer ..... %

(ii) When 1g of haemoglobin is fully saturated it carries 1.3 cm^3 of oxygen.

Calculate the volume of oxygen released by 1 g of haemoglobin to this active muscle tissue.

Show your working.

(2)

Answer .....

(iii) Scientists extracted the genes for mammoth haemoglobin and used them to produce mammoth haemoglobin.

The oxygen dissociation curve for mammoth haemoglobin at 38 °C was found to be the same as for the Asian elephant at 38 °C.

Lowering the temperature did not shift the oxygen dissociation curve.

Explain how these observations show that this haemoglobin enabled mammoths to be adapted for life in cold Arctic regions.

(3)

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(Total for Question 7 = 11 marks)

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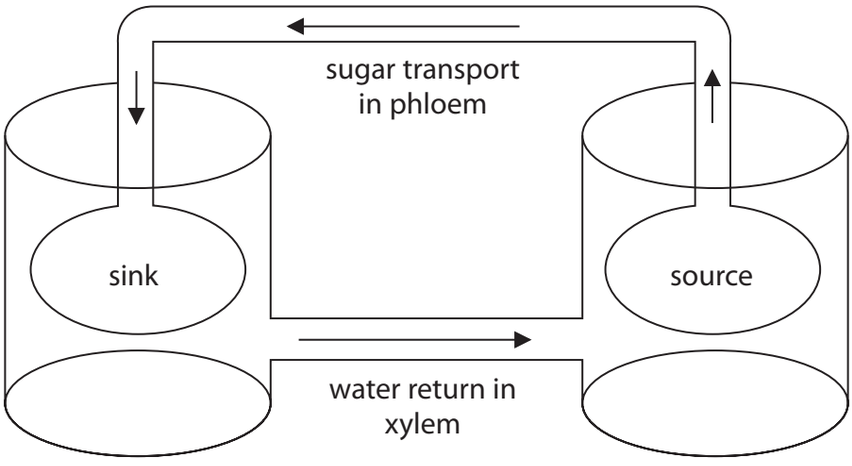
8 Sucrose is synthesised and transported through plants.

The diagram represents the mass-flow hypothesis for sucrose transport in a plant.

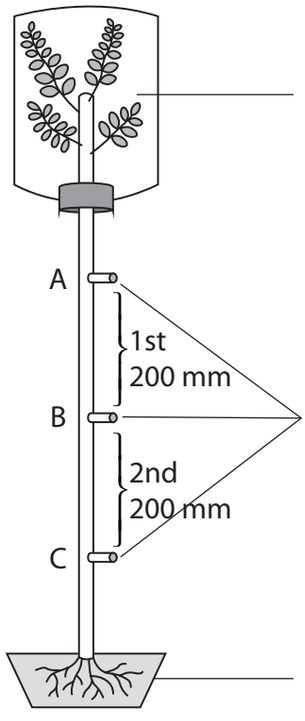


(a) Which row in the table shows the conditions present in the sink and the source of a plant carrying out rapid photosynthesis?

(1)

	Sink		Source	
	Sucrose concentration	**Water potential**	**Sucrose concentration**	**Water potential**
☒ **A**	high	low	high	low
☒ **B**	high	low	low	high
☒ **C**	low	high	high	low
☒ **D**	low	high	low	high

(b) The effect of root temperature and oxygen on the movement of sucrose through a plant was investigated using the apparatus shown in the diagram.



Plant leaves placed into a sealed glass chamber with an atmosphere consisting of radioactive carbon dioxide ($^{14}CO_2$) and air

Three small tubes, **A**, **B** and **C**, 200 mm apart, penetrating the phloem vessels of the stem

Plant roots in a thermostatically controlled water bath

The water bath was set at 10 °C and a solution from each of the small tubes was collected. The time taken for radioactive sucrose to travel the first 200 mm and the second 200 mm was recorded.

The experiment was repeated at 20 °C and 30 °C.

The whole experiment was then repeated replacing the air with nitrogen gas (N_2).

The results are shown in the table.

Glass chamber containing	Temperature of roots / °C	Time taken for sucrose to travel 200 mm / hr			Mean rate of sucrose transport / mm hr^{-1}
		From A to B	From B to C	Mean	
$^{14}CO_2$ + air	10	3.25	3.50	3.38	59.17
$^{14}CO_2$ + air	20	2.35	2.45	2.40	83.33
$^{14}CO_2$ + air	30	1.75	1.83		
$^{14}CO_2 + N_2$	10	6.50	6.25	6.38	31.35
$^{14}CO_2 + N_2$	20	6.25	6.10	6.18	32.36
$^{14}CO_2 + N_2$	30	6.45	6.11	6.28	31.85

(i) Calculate the mean rate of sucrose transport when the plant is kept in $^{14}CO_2$ + air whilst at 30 °C.

Show your working.

(1)

Answer ..... mm hr^{-1}

(ii) Analyse the data in the table to explain the effect of temperature and oxygen on sucrose transport.

(4)

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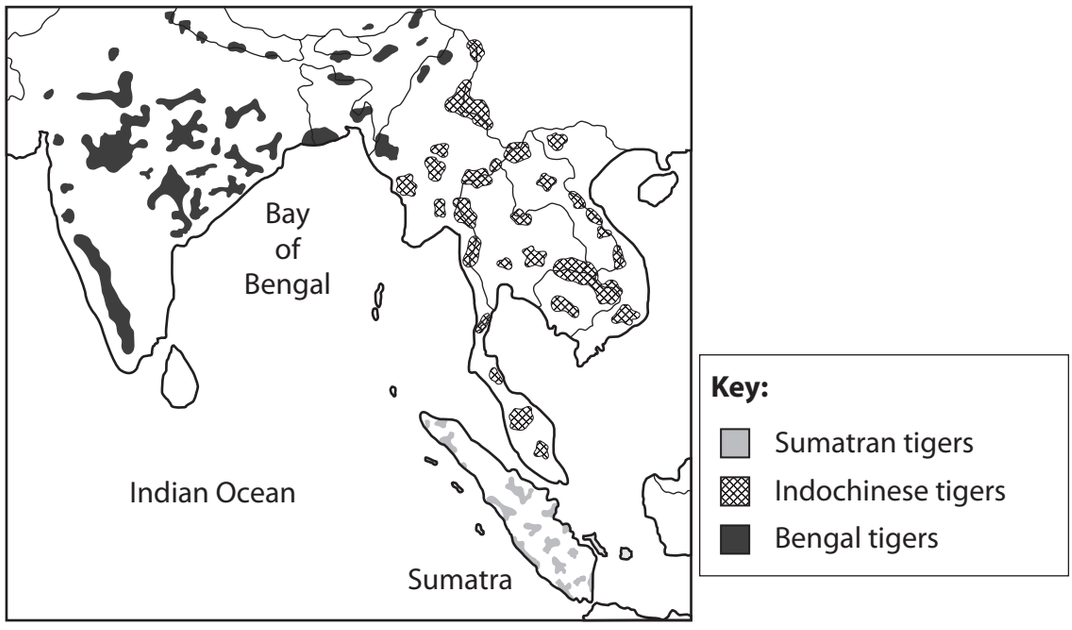
(Total for Question 8 = 6 marks)

9 Before the twentieth century, tigers were once widespread across the whole of South and South East Asia. Over the last hundred years, their geographical distribution has been reduced by over 90%. The diagram shows the current distribution of three varieties of tiger.



(a) Use the map to explain how the different varieties of tiger may eventually become separate species.

(4)

(b) The development of palm oil plantations in Sumatra has removed areas of forest that provided the natural habitat for these tigers.

Many tigers in Sumatra suffer from inherited disorders.

Explain why planting strips of trees to link the remaining patches of forest would have an effect on the frequency of genetic disorders in these tigers.

(2)

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(Total for Question 9 = 6 marks)

TOTAL FOR PAPER = 80 MARKS

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