Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A Level

2400U20-1 – **NEW AS**

S16-2400U20-1

BIOLOGY – Unit 2
Biodiversity and Physiology of Body Systems

P.M. TUESDAY, 7 June 2016

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**8**	
3.	**14**	
4.	**14**	
5.	**8**	
6.	**13**	
7.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. Where the space is not sufficient for your answer, continue at the back of the book, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question 7.

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Answer **all** *questions.*

1. *(a)* The table below shows the relationship between length, surface area and volume for three different organisms.

Organism	Length	Surface area (m^2)	Volume (m^3)	Surface area to volume ratio
amoeba	1µm	6×10^{-12}	1×10^{-18}	6000000 : 1
housefly	10mm	6×10^{-8}	1×10^{-12}	
dog	1m	6×10^{0}	1×10^{0}	6 : 1

The housefly is an organism adapted to a terrestrial mode of life, possessing an internal tracheal system for gas exchange.

(i) Calculate the surface area to volume ratio of the housefly. [1]

Surface area to volume ratio = ...

(ii) Give **one** advantage and **one** disadvantage of the tracheal system. [2]

Advantage: ....

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Disadvantage: ....

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(b) Use the table to explain why an amoeba does not need a specialised gas exchange surface or circulatory system. [3]

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(c) State how mammals maintain the concentration gradient at their gas exchange surface. [2]

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(d) Suggest why cellular demand for oxygen is lower in a fish compared to a dog of the same size. [2]

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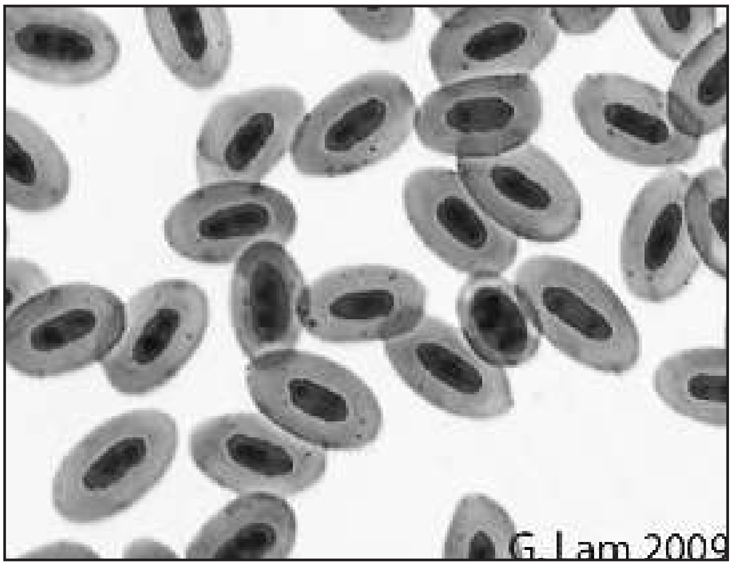
(e) Mammals evolved in the Triassic period when levels of oxygen in the atmosphere were 50% lower than now. Birds evolved much later, in the Jurassic period, when oxygen levels in the atmosphere approached present day levels.

The red blood cells of birds are elliptical in shape and have a nucleus.

Mammalian red blood cells are biconcave in shape, do not have a nucleus and are much smaller than the red blood cells of birds.



Red blood cells from birds

How do you account for the difference in size and structure of bird and mammalian red blood cells? [4]

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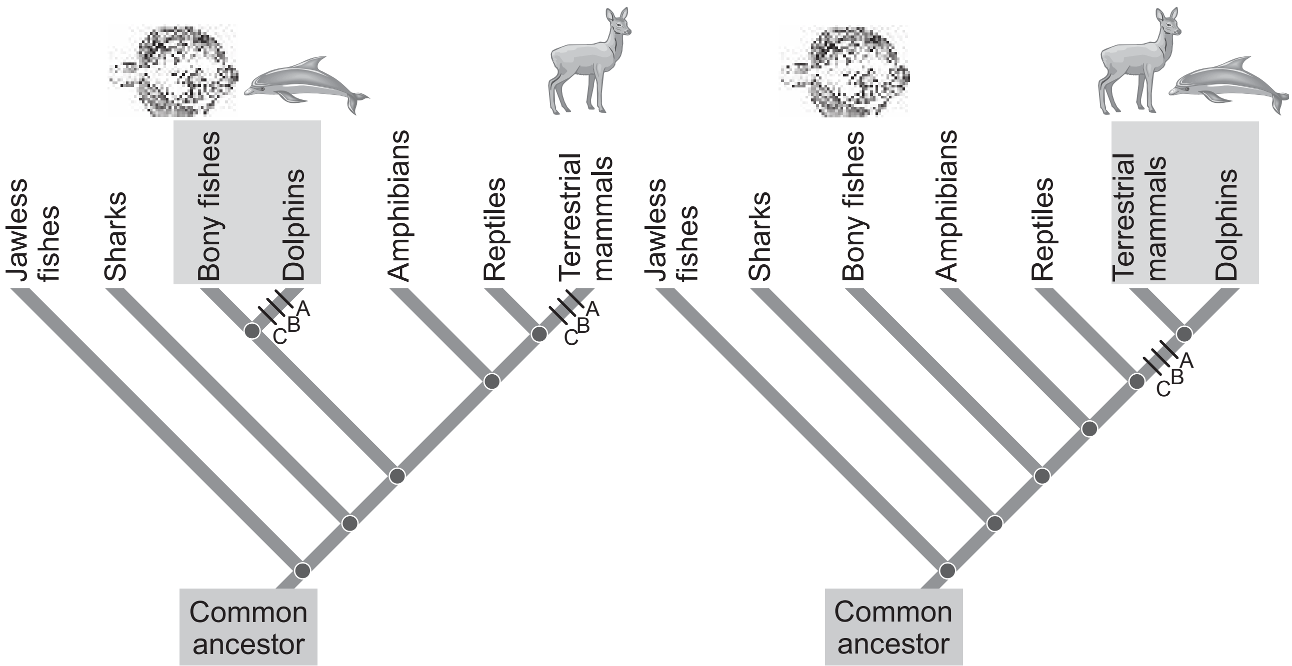
2. *(a)* Phylogenetic trees are used to show alternative possible evolutionary relationships between organisms. Mutation is an evolutionary event that can result in the formation of a new species. By assessing the likelihood of different mutations occurring they can be used to identify the most likely pattern of evolution.

The diagrams below show two possible phylogenetic trees for the evolution of dolphins.



Hypothesis 1: Dolphins and bony fishes are close relatives.

Hypothesis 2: Dolphins and terrestrial mammals are close relatives.

Key to the mutations required to form the new species.
A = Hair formation
B = Development of mammary glands
C = Development of middle ear bones

(i) Which phylogenetic tree represents the more probable hypothesis? Give a reason for your answer. [1]

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(ii) Explain how analysis of protein could be used to confirm your answer. [2]

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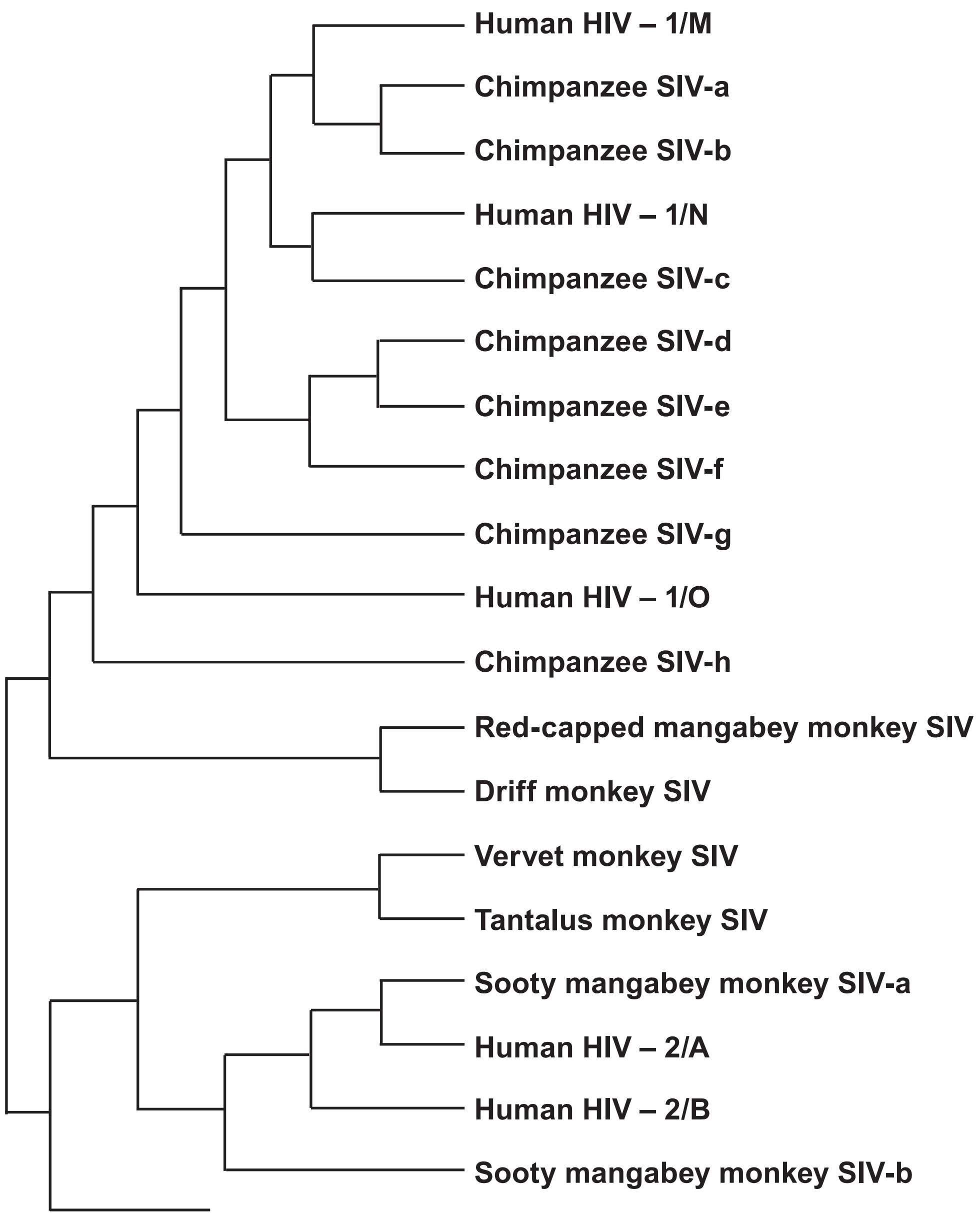
(b) AIDS was first described in humans in 1981, but the virus (HIV) which causes it, has been present in human populations since the beginning of the 19th century.

It has been found that there are two main forms of this virus: HIV1, and the more virulent HIV2. It is believed that HIV1 and HIV2 appeared due to mutations of a virus (SIV) found in monkeys and chimpanzees; these mutations have enabled them to infect humans.

Scientists have analysed the molecular similarities between HIV from infected humans and similar viruses which are found in monkeys and chimpanzees.

The diagram below shows the possible evolutionary history of HIV.



Key: SIV = Simian Immunodeficiency Virus.

HIV = Human Immunodeficiency Virus.

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(i) What conclusions can be made from the diagram regarding the evolution of both forms of human HIV? [3]

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(ii) Scientists have been able to calculate the mean rate of mutation in the virus which causes HIV. What use can scientists make of this information? [1]

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(iii) Evidence shows a high similarity between one strain of HIV2 and a virus found in Sooty Mangabey monkeys. It was unclear if the virus had originally evolved in humans or in the monkeys. Further analysis showed that there was more genetic variation in the monkey virus than in the human virus.

Explain why it is now believed that the virus originated in the **Sooty Mangabey monkey**. [1]

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3. *(a)* A group of students investigated the effect of pollution on species diversity in a stream. They sampled an unpolluted stream and a polluted stream and recorded the number of individuals of different species present in each.

(i) Identify the dependent and independent variables in their study. [2]

Dependent variable = ...

Independent variable = ...

(ii) Identify **one** possible source of error when investigating the biodiversity of animals. [1]

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(iii) The results for the unpolluted stream are given in the table below.

Species. Common name with description	***n***	***(n-1)***	***n(n-1)***
Water boatman. Surface living, fast swimming.	4	3	12
Mayfly nymph. Bottom dwelling, fast swimming.	30	29	870
Freshwater shrimp. Bottom dwelling, fast moving.	70	69	4 830
Water louse. Bottom dwelling, fast moving.	34	33	1 122
Bloodworm. Bottom dwelling in mud. Slow moving.	10	9	90
Sludgeworm. Bottom dwelling in mud. Slow moving.	2	1	2
	N = ...		∑n(n-1) = ...
	N (N – 1) = ...		

N = total number of individual animals of all species.
n = number of individuals per species of each species.
∑ = sum of

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Use the formula given below to calculate the Diversity Index for the unpolluted stream. Give your answer to 2 dp. [3]

$$\text{Diversity Index} = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

(iv) The diversity index of the polluted stream was 0·1. What can you conclude from this figure? [1]

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(v) One student calculated the diversity index in one section of a stream to be 10.24. Explain what can be concluded from this result. [2]

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(b) The banded snail *(Cepaea nemoralis)* is found in a variety of habitats, such as grassland, heathland, sand dunes and the base of hedges. The shell colour can vary:

- yellow (which appears green with the animal inside)
- brown
- pink
- white

The shell can be unbanded or have up to five bands.

(i) These morphologically different snails are all the same species. Explain why *Cepaea nemoralis* is an example of 'genetic polymorphism'. [2]

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The students made the following observations over a period of time:

- the main predator of the banded snail is the thrush
- fewer yellow shelled snails are eaten in summer than in winter but this is the opposite for banded snails
- in habitats such as tangled, dense hedges, dark banded snails are not eaten but large numbers of yellow snails are
- very few yellow snails are eaten from grassland or sand dunes but banded are

(ii) Explain how genetic polymorphism is maintained in banded snail populations. [3]

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4. All terrestrial plants lose water from their leaves by a process called transpiration.

(a) A student used a potometer to estimate the transpiration rate of a leafy shoot over a twenty-four hour period.

(i) Explain why the water uptake from the potometer gives an estimate of the transpiration rate and not its true value. [1]

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(ii) Give **three** other variables that would need to be controlled when using a potometer to investigate the difference in transpiration rates of leafy shoots of **two** different plant species at the same light intensity and temperature. [3]

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(b) The table shows the average density and distribution of stomata on the leaves of oak and wheat.

Plant	**Density of Stomata (number mm^{-2})**	
	Upper leaf surface	**Lower leaf surface**
Wheat	50	40
Oak	0	340

Explain the distribution of stomata in wheat and oak. [2]

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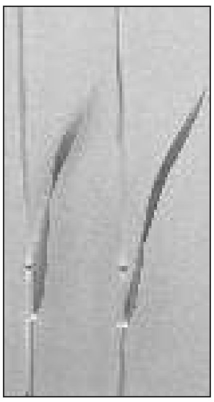
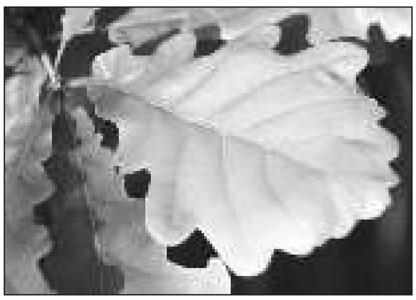


Wheat *(Triticum aestivum)*



Oak *(Quercus robur)*

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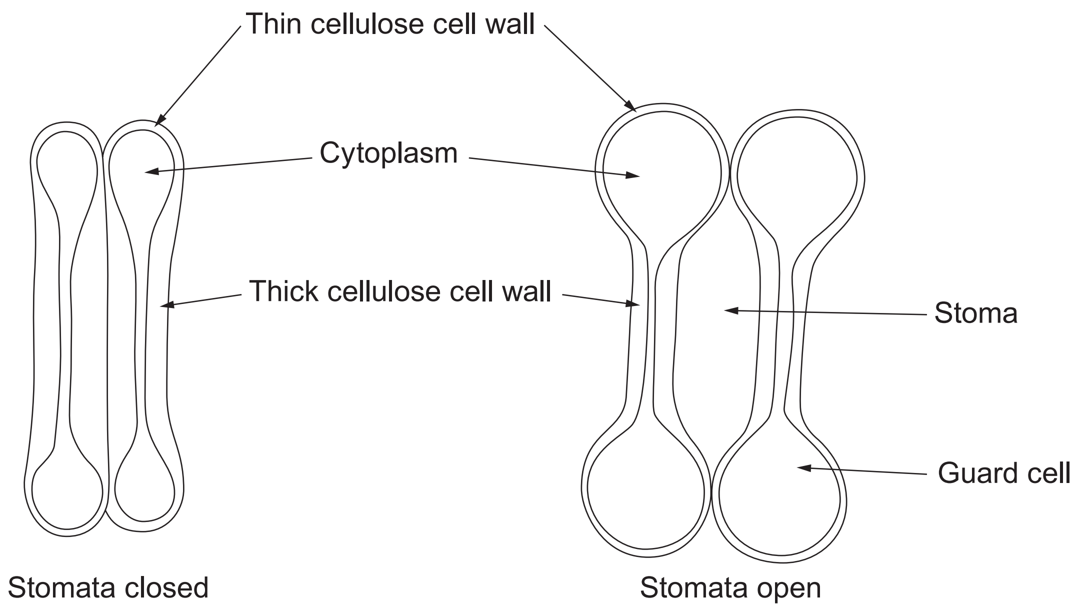
(c) The diagrams below show the arrangement of guard cells in a leaf of wheat under two different environmental conditions.



Stomata open when potassium ions are actively transported into the guard cells. Explain how this would cause wheat stomata to open. [5]

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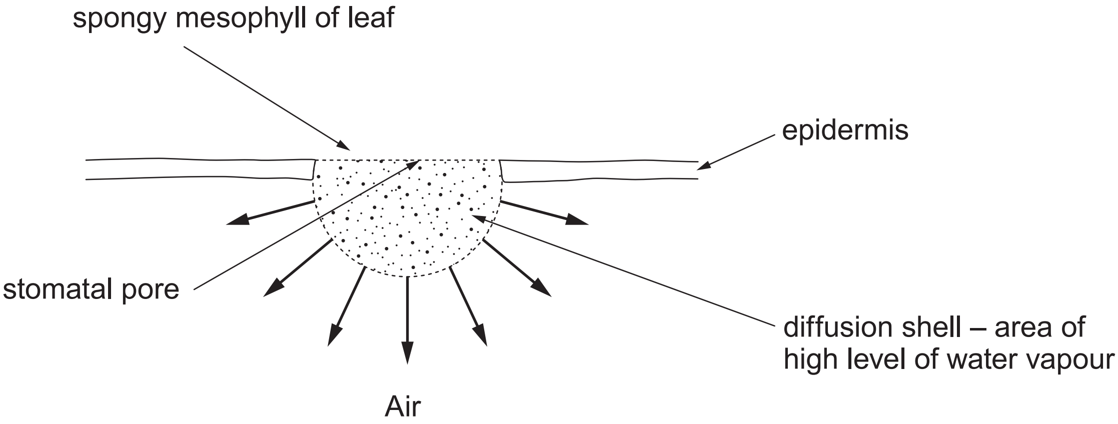
(d) Water is lost through stomata by transpiration. This results in a shell of water vapour forming over the stomatal pores as shown.



Water molecules from the edges of stomatal pores evaporate more readily into the air.

The stomatal density and the diameter of the stomatal pores were recorded for the leaves of two species of plant. The stomatal pores were circular and the total area of the pores was approximately the same in both plants.

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Plant species	**Density of stomata (number mm^{-2})**	**Mean diameter of stomatal pore (µm)**	**Total circumference of stomata (µm mm^{-2})**
A	110	8	2760
B	423	4	

Circumference of a circle = $2\pi r$
r = radius of circle
π = 3.14

(i) Calculate the total circumference of the stomatal pores for species **B**. Give your answer to three significant figures. [2]

Circumference = ...

(ii) Use these figures to identify which plant species, **A** or **B**, has the higher transpiration rate. Explain your answer. [1]

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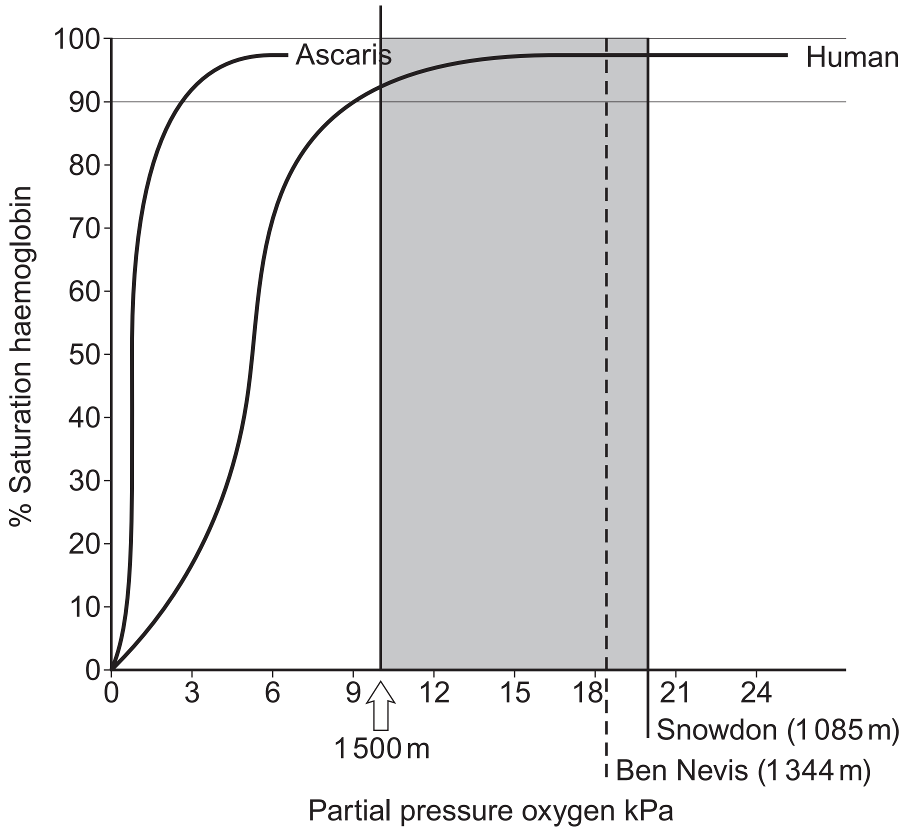
5. *(a)* The oxygen dissociation curves for human haemoglobin and for a parasitic worm (*Ascaris lumbricoides)*, which lives in the gut of humans, are shown below.



People live at altitudes between sea level and approximately 5 000 m. Human health is not affected until the percentage haemoglobin saturation falls below 95%.

(i) Explain the advantage to humans of the oxygen dissociation curve in the shaded region of the graph. [1]

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(ii) Suggest how people become adapted to living at very high altitudes. [1]

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(iii) Explain why the parasitic worm *Ascaris lumbricoides* has an oxygen dissociation curve as shown. [2]

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(b) Crustaceans, such as crabs, have a molecule called haemocyanin in their blood which is used to transport oxygen from the respiratory surface to the respiring cells. It has similar properties to haemoglobin but contains copper instead of iron.

(i) Haemoglobin and haemocyanin can be described as an example of convergent evolution. State what is meant by this term. [2]

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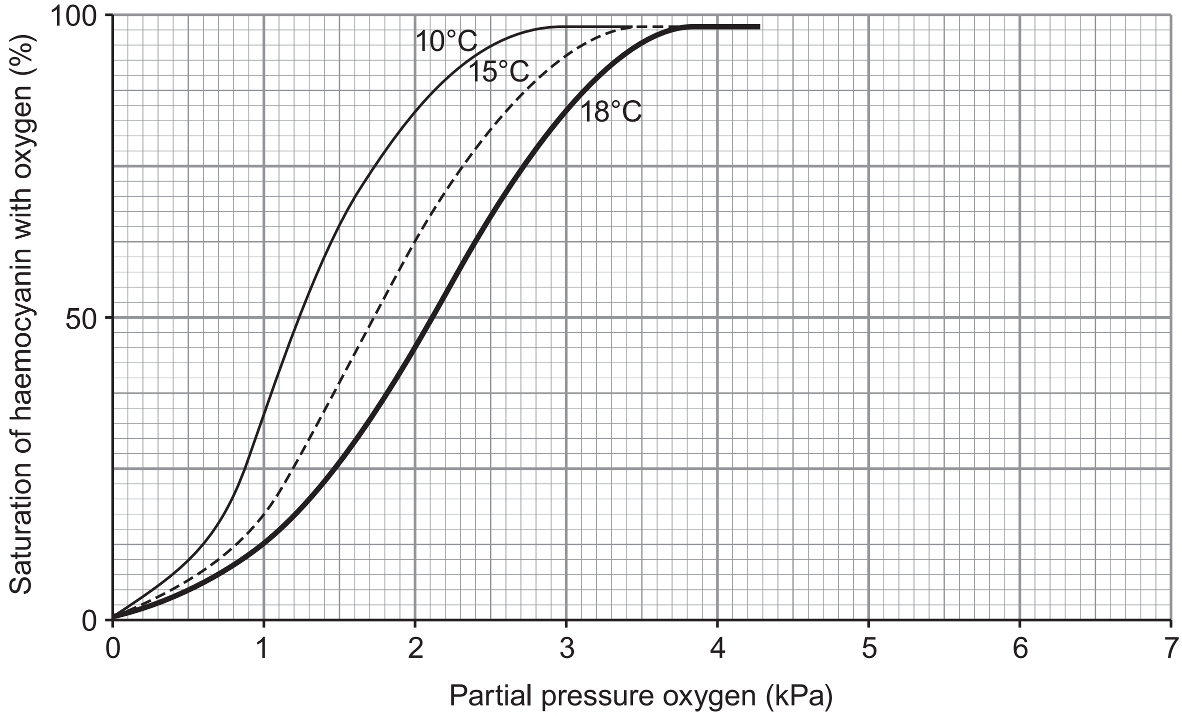
The graph shows the effect of temperature on the dissociation of haemocyanin.



Crabs are often found in rock pools along the Welsh coast. In the Summer, water temperatures in rock pools can increase from 5 to 20°C during the day which reduces the oxygen content of the water. The body temperature of crabs varies with that of their surroundings.

(ii) What effect does an increase in temperature have on the partial pressure of oxygen at which the haemocyanin becomes 96% saturated? [1]

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(iii) The crab is living in water with a partial pressure of oxygen of 4 kPa and the partial pressure of oxygen in its tissues is 2.5 kPa. State an advantage to the crab when the temperature rises from 10°C to 18°C. [1]

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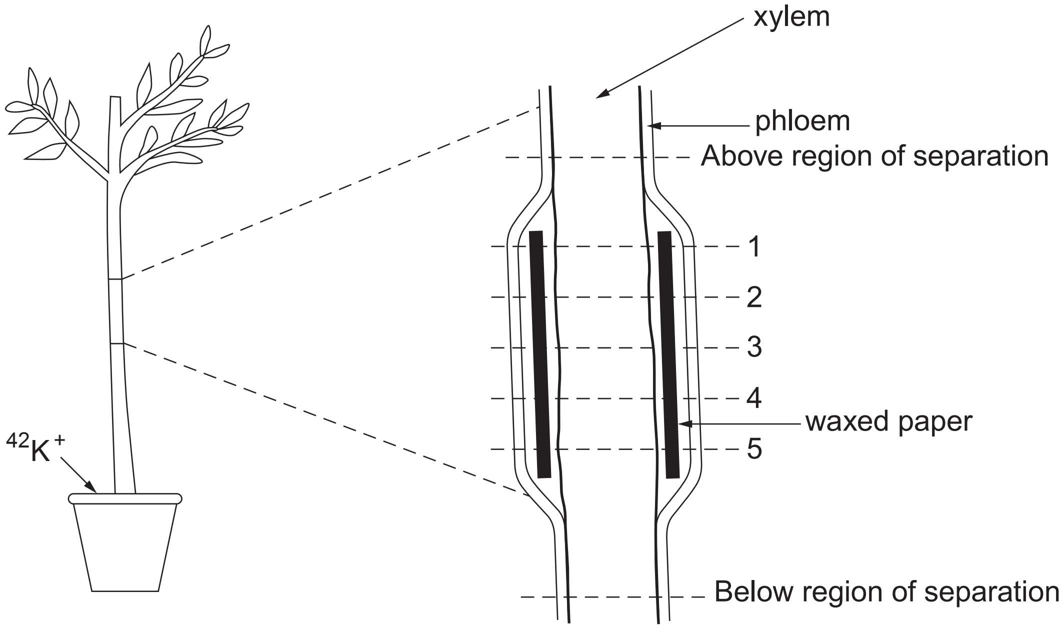
6. *(a)* The apparatus below was set up to study the upward transport of mineral ions from the soil. The mineral ion used was radioactive potassium, $^{42}K^{+}$.

In one region of the stem, the xylem was separated from the phloem and waxed paper was inserted between the xylem and phloem to act as a barrier between the tissues. This is illustrated in the simplified diagram below.



The plants were allowed to absorb $^{42}K^{+}$ for five hours. After this period, the distribution of $^{42}K^{+}$ in the xylem and phloem at points above and below the region of separation, and at points 1 to 5 within the region of separation, were measured. The results are shown in the table.

Sampling point	**Radioactivity (ppm $^{42}K^{+}$)**	
	phloem	**xylem**
Above	53	55
1	11	119
2	0.3	122
3	0.4	112
4	0.3	110
5	0.3	108
below	56	59

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(i) What conclusion can be made from these results about the transport of $^{42}K^{+}$ in the xylem and phloem? [2]

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(ii) A suitable control for this experiment would be to separate the xylem and phloem but not to insert waxed paper.

Suggest why this would be a suitable control and explain how the results could be used to support your conclusion. [2]

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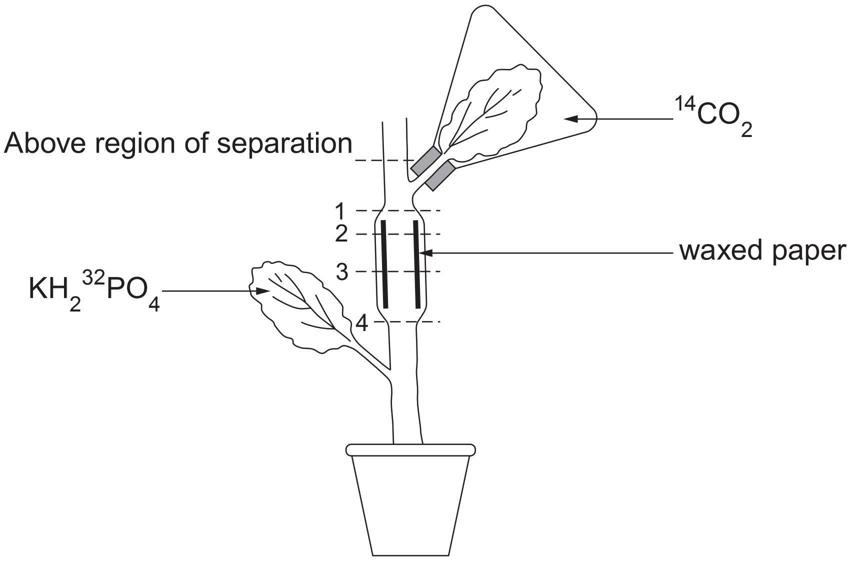
(b) In a similar experiment $^{14}CO_2$ was applied to an upper leaf and $KH_2{}^{32}PO_4$ to a lower leaf. After fifteen hours, the levels of both radioactive isotopes ^{14}C and ^{32}P were analysed. The results are shown in the table.



	Radioactivity (ppm)			
	^{14}C		**^{32}P**	
Sample site	**phloem**	**xylem**	**phloem**	**xylem**
Above	6 500	0	98	0
1	3 480	0	103	0
2	3 030	0	116	0
3	2 380	0	125	0
4	2 300	0	185	0

(i) What conclusions can be made from these results about transport of ^{14}C in xylem and phloem? [2]

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(ii) Describe how you would refine the experiment to determine the direction of transport of ^{32}P. [2]

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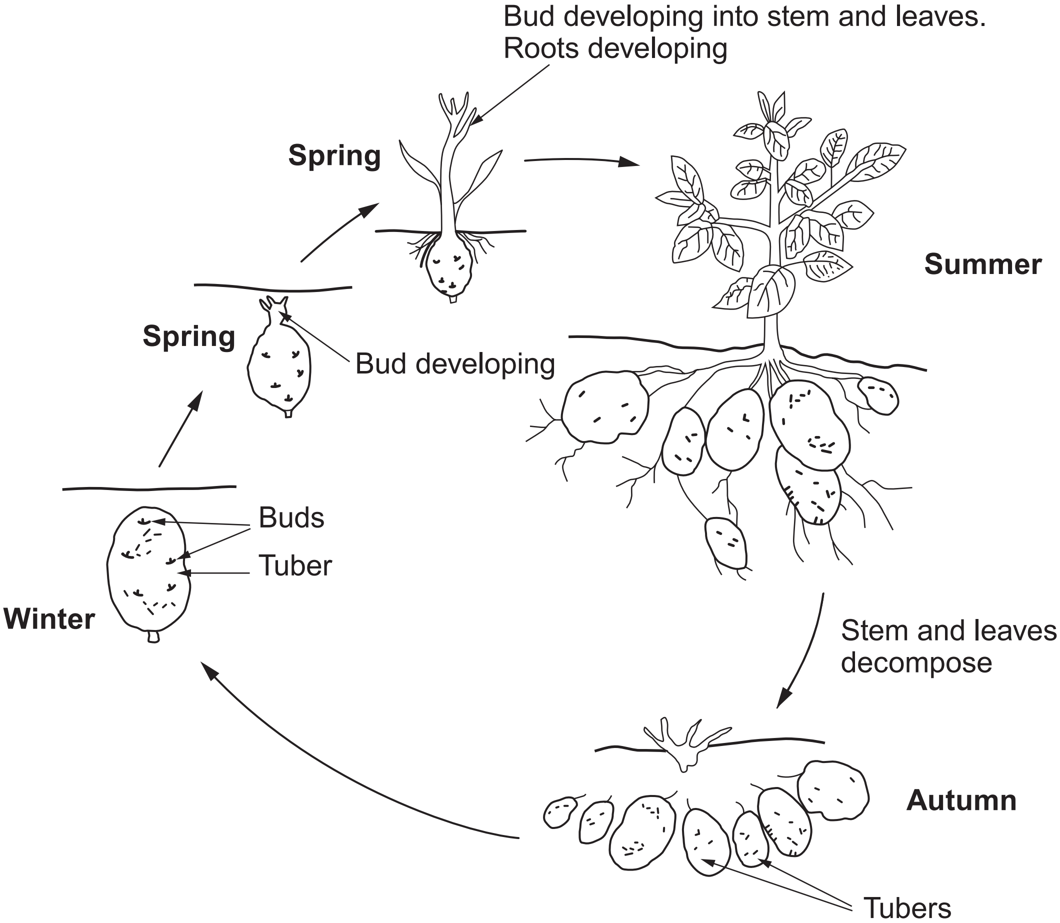
(c) Organic molecules such as sucrose move through a plant in the phloem by mass flow.



The diagram shows the life-cycle of a potato plant. During the summer months the potato tuber acts as a sink and stores starch. In Spring the tuber acts as a source and supplies sugars to the new shoots and roots. Use the mass flow model to explain how the sugars are transported to the potato tuber to be stored as starch and explain the advantage of the tuber acting as a source in Spring. [5]

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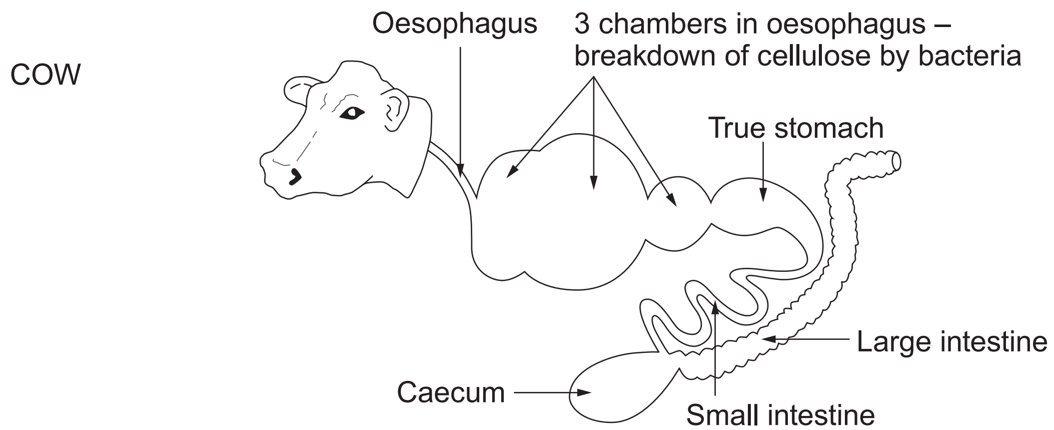
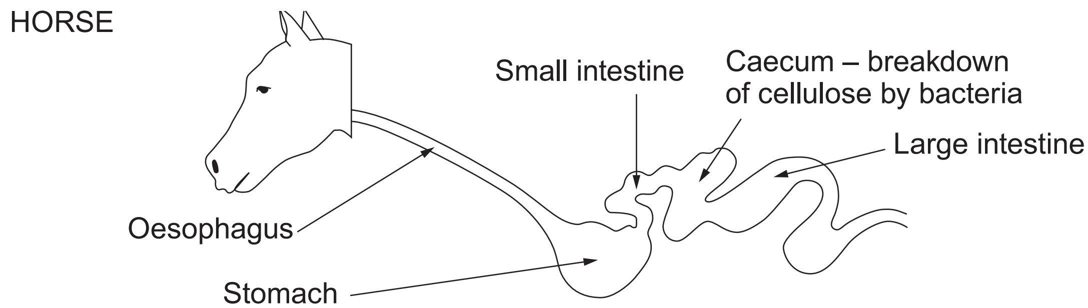
7. All animals need a source of amino acids for growth and repair of tissues. Bacteria, found in the gut of herbivores, can break down cellulose into energy rich molecules; these can be absorbed and used by the herbivore.

Cows produce a large volume of saliva which contains urea. The urea provides a source of nitrogen that bacteria use to make proteins.

Horses need a diet which is much richer in protein than the diet required by a cow.

Manure from horses contains 3 times as much organic nitrogen as cow manure.





Describe how proteins are digested and made available to the muscles of the herbivore. Using the diagrams of the gut of a cow and a horse, account for the difference in the protein requirement of a horse and a cow and the difference of organic nitrogen in the manure of both animals.

[9 QER]

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