Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3400UA0-1

S18-3400UA0-1

BIOLOGY – Unit 1:
Cells, Organ Systems and Ecosystems

HIGHER TIER

MONDAY, 11 JUNE 2018 – MORNING

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**10**	
3.	**7**	
4.	**13**	
5.	**10**	
6.	**9**	
7.	**10**	
8.	**11**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this paper you may 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. If you run out of space, use the additional page at the back of the booklet, 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.

Question **8***(c)* is a quality of extended response (QER) question where your writing skills will be assessed.

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Answer **all** *questions.*

1. *(a)* What is meant by the term selectively permeable membrane? [1]

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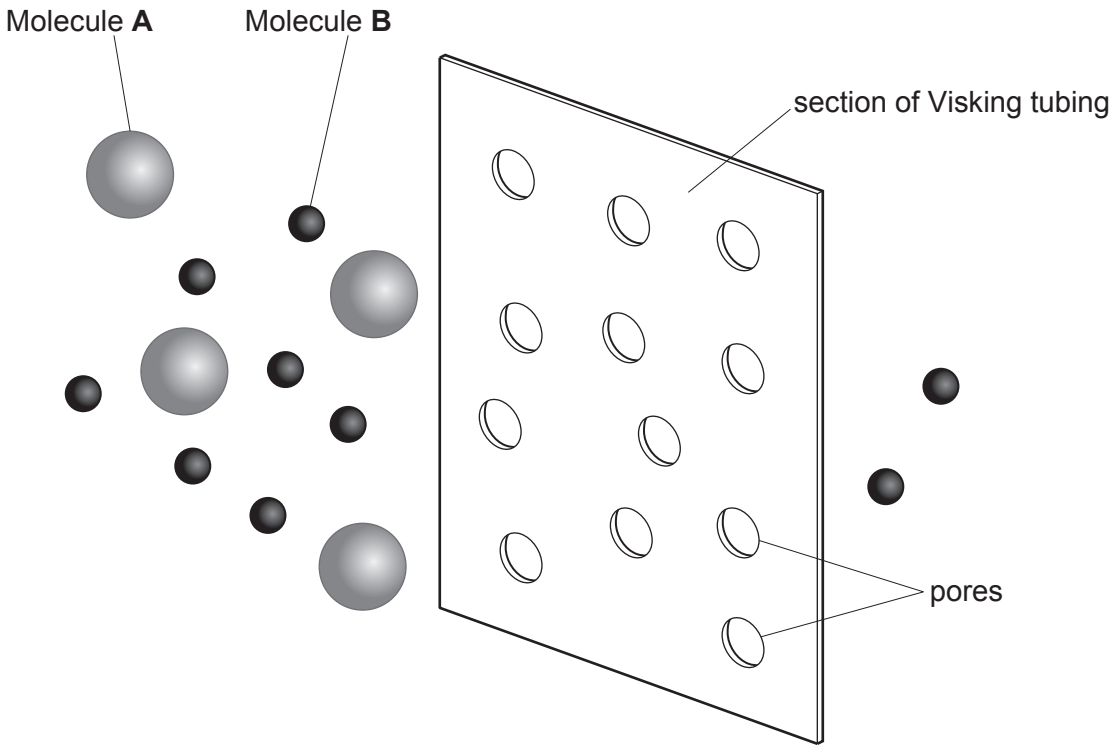
Visking tubing can be used as a model of the cell membrane.

The diagram below shows a section of Visking tubing working in the same way as a selectively permeable membrane.



Use the diagram above and your own knowledge to answer the following:

(b) (i) State the process by which molecules could pass through the Visking tubing. [1]

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(ii) Identify which molecules pass through the Visking tubing. Explain your answer. [2]

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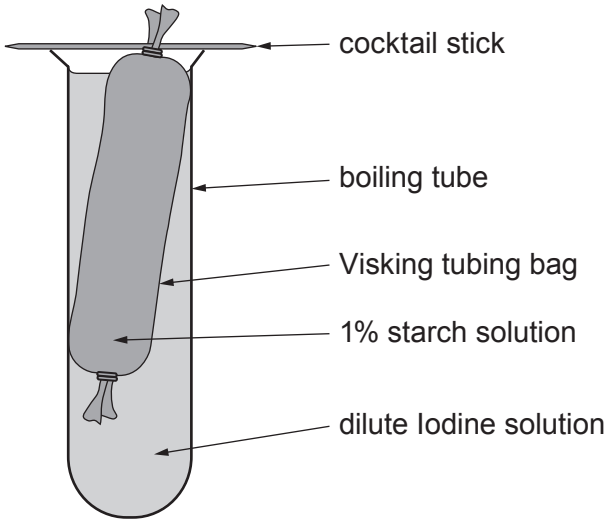
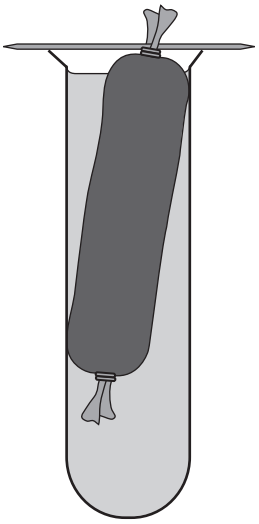
(c) Students were instructed to set up the following apparatus.



The appearance of the apparatus after 15 minutes is shown below.



(i) Explain why the colour of the contents inside the Visking tubing turned blue black. [3]

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(ii) Explain why the colour of the Iodine solution in the boiling tube did not change. [2]

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(d) Name **one** substance required for respiration that would pass into a cell. [1]

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2. *(a)* (i) Write the **word** equation for photosynthesis. [2]

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(ii) State the name of the pigment present in plant cells which absorbs light. [1]

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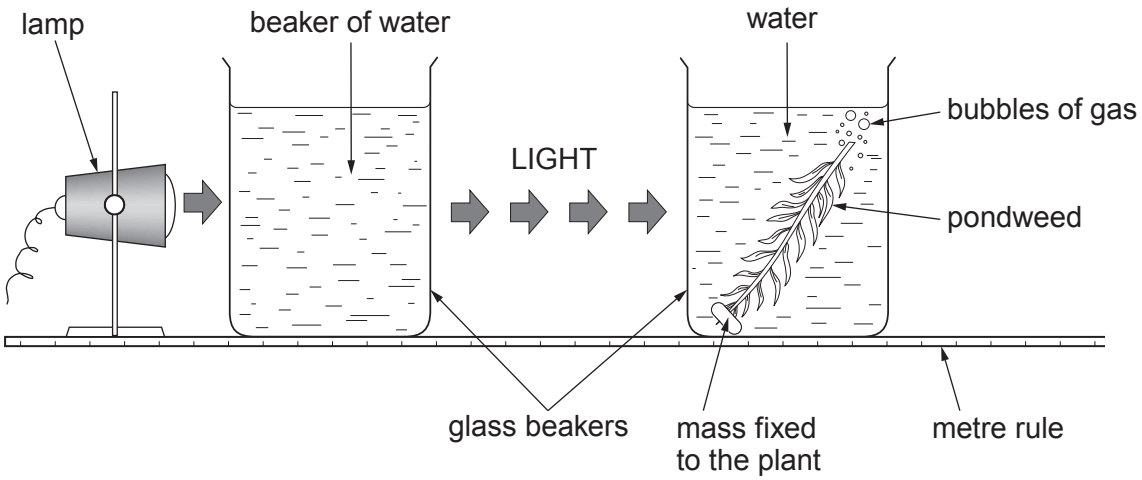
Phoebe and Adam used the apparatus below to study the rate of photosynthesis in the pondweed *(Elodea sp.).*



The number of gas bubbles per minute produced by the pondweed was counted at different distances from the light.

The experiment was carried out three times at each distance.

The results are shown below. Means were calculated to the nearest whole number.

Distance of lamp from pondweed (cm)	Number of bubbles per minute			
	Test 1	Test 2	Test 3	Mean
10	19	32	25	25
20	14	20	20	18
30	11	15	17	.....
40	7	10	13	10
50	5	9	11	8

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(b) **Complete the table** opposite by calculating the mean number of bubbles for a distance of 30 cm. **Write your answer in the table.** [2]

(c) State the relationship between the distance of the lamp from the pondweed and number of bubbles produced per minute. Explain your answer. [3]

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(d) Explain why a beaker of water was placed between the lamp and the pondweed. [1]

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(e) State how you could improve the accuracy of this investigation. [1]

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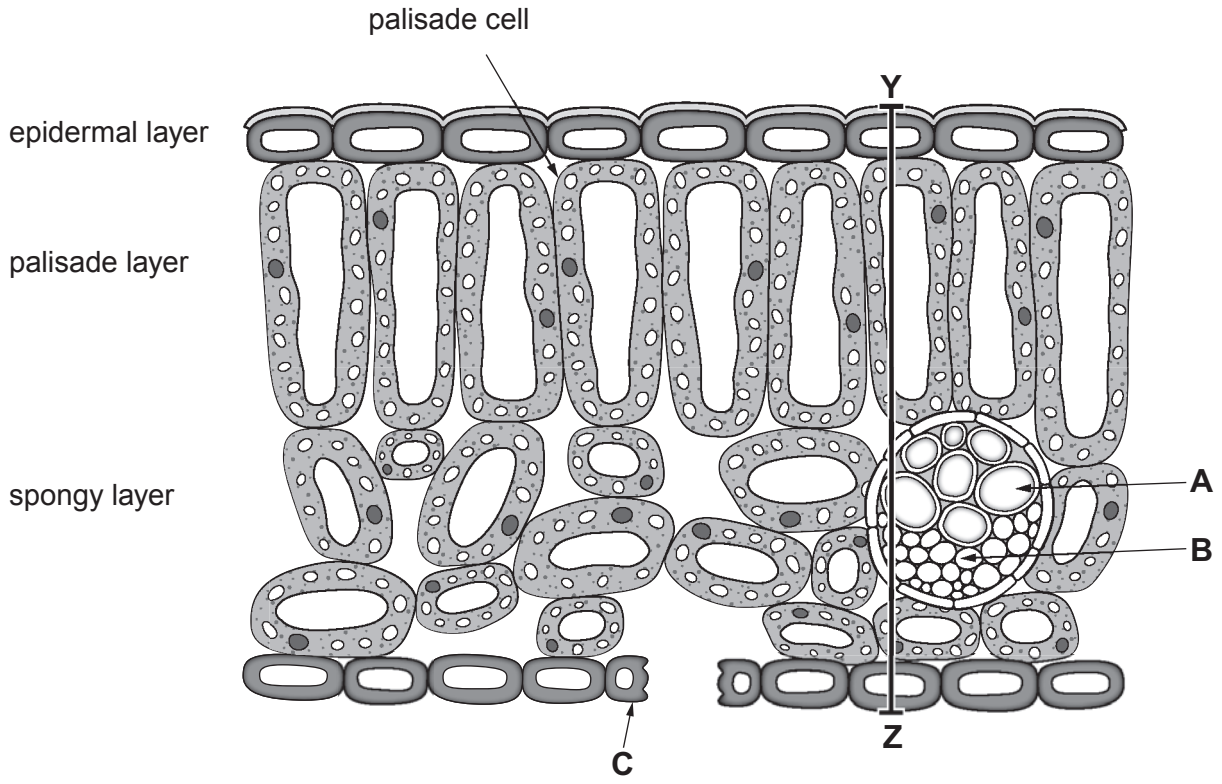
3. The diagram below shows a section through a leaf of a sunflower *(Helianthus sp.)*.



(a) State the name of structures **A**, **B** and **C**. [2]

A .....

B .....

C .....

(b) (i) The palisade cell is an example of a specialised cell.
What is the advantage to the plant of having specialised cells? [1]

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(ii) The leaf is considered to be an organ of the plant. What is meant by this statement? [1]

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(c) (i) Measure the length of line **Y – Z** on the drawing. [1]

Length = ... mm

(ii) The actual length of **Y – Z** on the diagram opposite is 225 µm.
Calculate the magnification of the drawing. [2]
(1 mm = 1000 µm)

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4. *(a)* State what is meant by a double circulatory system. [2]

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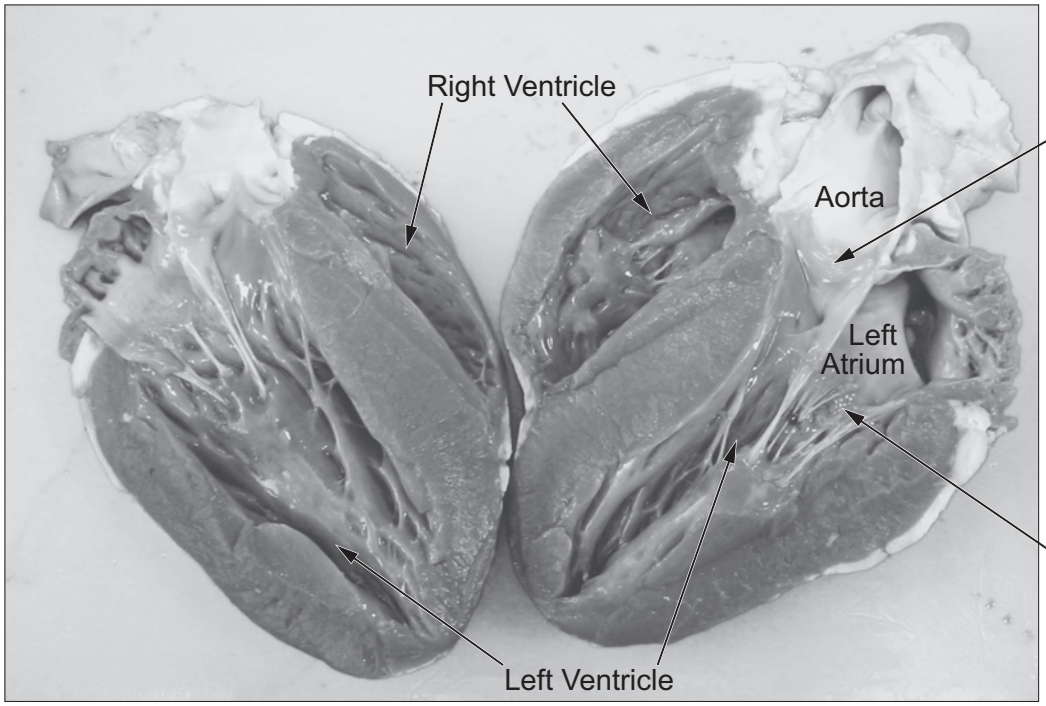
The photograph below shows a section through the heart.



(b) Use the picture above and your own knowledge to identify valve **A**. [1]

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(c) Explain how the semi-lunar valve, shown in the photograph, helps to ensure a one-way flow of blood through the heart. [3]

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(d) The walls of the left ventricle are thicker than the walls of the right ventricle. Explain the significance of this difference. [2]

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In 2016, a research group at Imperial College London reported that weekly exercise seemed to increase the thickness of the walls of the ventricles. This effect could be mistaken for serious heart disease even though the individuals are healthy.

(e) Suggest an explanation for the effect of exercise on the thickness of the walls of the ventricles. [2]

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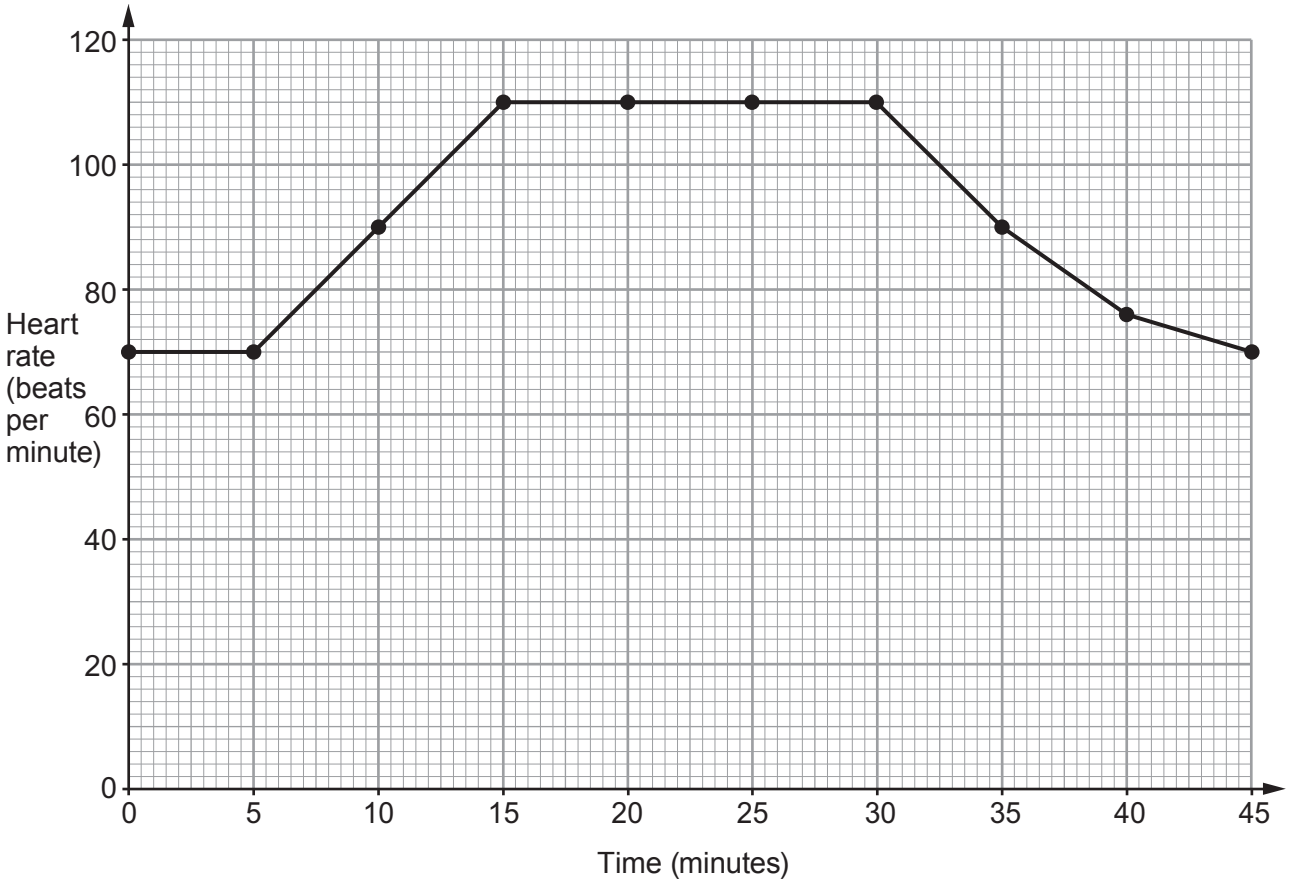
(f) Cardiac output is a measurement of the volume of blood pumped by a ventricle in one minute. It can be calculated as follows:

Cardiac output = volume of blood in ventricle × heart rate

The volume of blood in a ventricle of an average adult human is 70 cm^3.

The graph below shows the heart rate of an individual before, during and after a session on an exercise bike.



(i) Calculate the cardiac output at 5 minutes and 20 minutes. [1]

5 minutes = ... cm^3/min

20 minutes = ... cm^3/min

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(ii) Calculate the percentage increase in cardiac output between 5 and 20 minutes. [2]

percentage increase in cardiac output = ... %

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5. The following article appeared on the BBC news website on the 13th of April 2010.

A "perfect storm" of nutrients from sewage effluent and unusual weather conditions has been blamed for a 2009 outbreak of toxic algae in a lake.

Llyn Padarn at Llanberis was closed to leisure users for much of last summer.

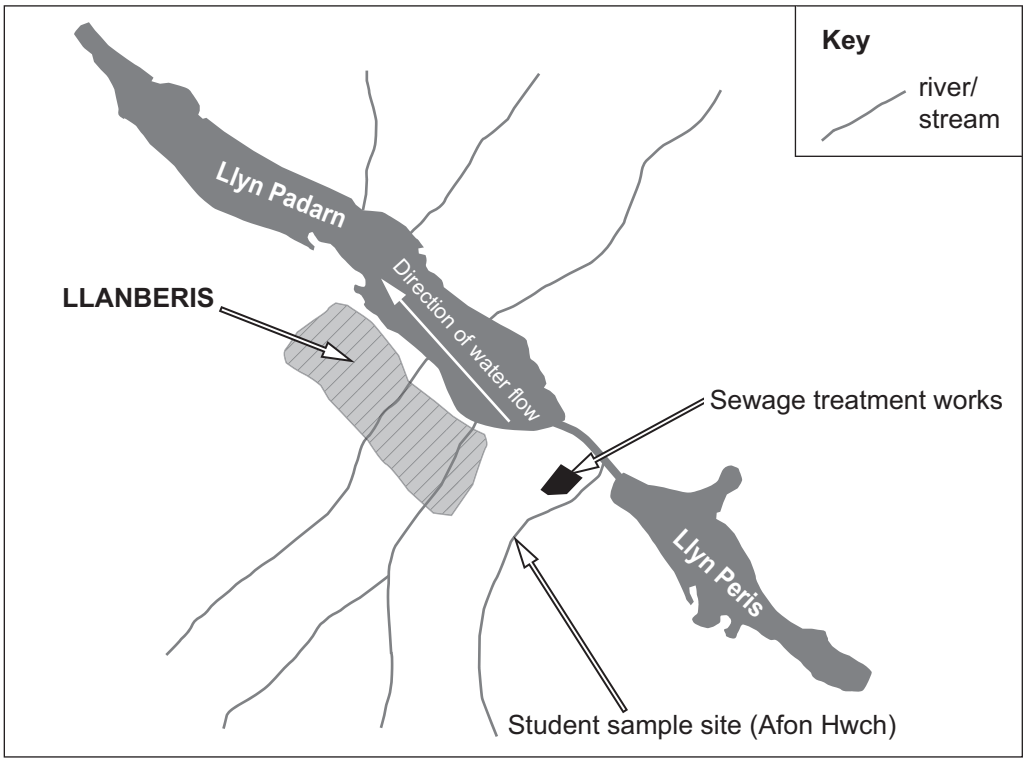
A report commissioned by Environment Agency Wales calls for stricter limits on effluent discharged from the local sewage treatment works.

The report by Professor Glen George described the warm spring, followed by a still June and a wet July and August as "the perfect storm".

He said the weather conditions, combined with nutrients in the lake, not only created the right conditions for the algal bloom to form but also meant it continued through the summer.

His report makes a number of recommendations for further scientific studies of the lake and more work to find out how the management of the sewage treatment works in Llanberis is affected by heavy rain.

The map below shows Llyn Padarn and the surrounding area.



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Llyn Padarn is also home to a rare breed of fish called the Arctic char fish *(Salvelinus alpinus)*. The char feeds on insects found on the water's surface, fish eggs and snails found on the lake bottom.

(a) Explain how the **unusual weather** conditions in 2009 referred to in lines 4 and 5 contributed to the outbreak of algae. [2]

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(b) Explain why the local fishermen thought that the algal blooms could lead to a decrease in the population of the arctic char. [3]

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Students from a local school carried out a survey on the Afon Hwch, a river that flows into Llyn Padarn, during July of 2009. The site of the survey is shown on the map on page 14. The results are recorded below:

Number of organisms						
stonefly nymph	mayfly nymph	caddis fly larvae	blood worm	leeches	sludge worms	rat tailed maggot
3	17	7	0	5	0	0

The following table can be used to assess the condition of the water.

Organism present	Levels of pollution	Oxygen concentration
no visible life	very high	no oxygen
rat tailed maggot	high	low
sludge worm		
leeches	moderate	moderate
blood worm		
caddis fly larvae	low	moderate to high
mayfly nymph	none	high
stonefly nymph		

(c) (i) State the scientific term which is used to describe organisms that are used to detect levels of pollution. [1]

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(ii) Consider the information provided to describe the water conditions in the Afon Hwch. [2]

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(iii) It was recommended that further scientific studies were needed to show that the algal blooms were not caused by fertilisers used on the land around the lake. Describe how students could extend their survey to test this idea. [2]

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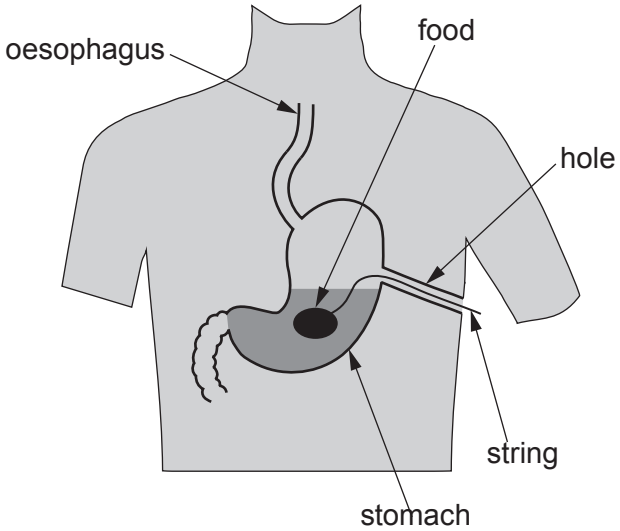
6. On June 6, 1822 Alexis St. Martin, was accidentally shot in the stomach from close range. Dr. William Beaumont treated his wound, but expected Alexis to die from his injuries. Alexis survived, but with a hole through his abdomen wall into his stomach that never fully healed.

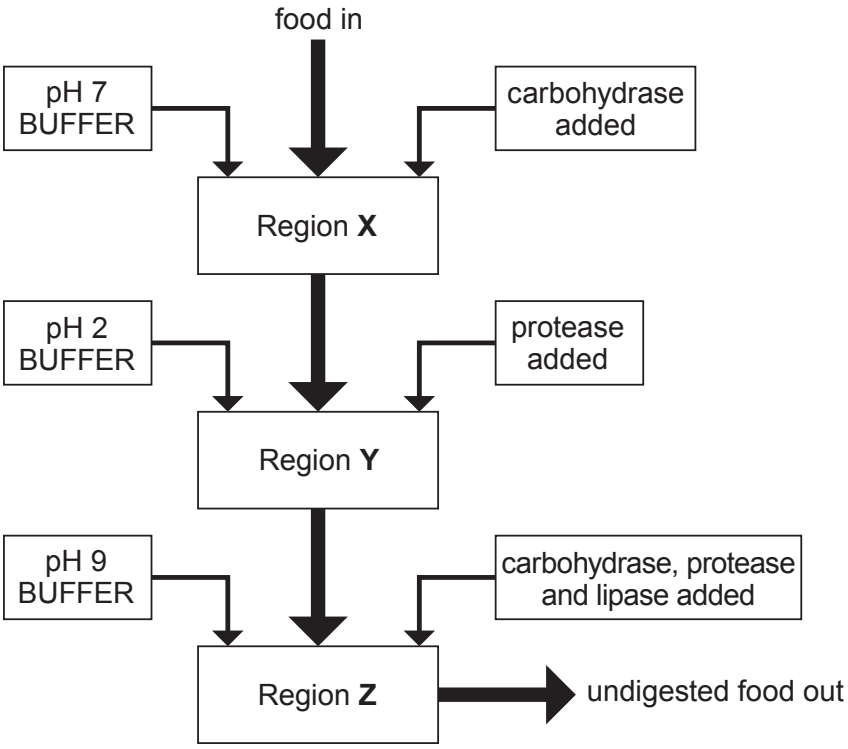
Dr. Beaumont began to carry out experiments on digestion by tying a piece of food to a string and inserting it through the hole into Alexis' stomach. Every few hours, Beaumont would remove the food and assess how much digestion had happened. Beaumont also extracted a sample of gastric juice from the stomach. Analysis showed that the gastric juice was acidic.

Fig 1 – Diagram showing Dr. Beaumont's experiment



Scientists can now follow the digestion of food in detail by using an artificial gut. The diagram below shows how an artificial gut works. (Note: a pH buffer is a chemical that keeps pH constant.)

Fig 2 – Flow chart of an artificial gut



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(a) (i) State the region of the artificial gut that represents the stomach. [1]

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(ii) Explain why the pH of each region needs to be different. [2]

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(iii) State **one** *other* factor that would need to be controlled to ensure valid results from an artificial gut. [1]

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(iv) State the role of lipase in region **Z**. [1]

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(b) One of Dr. Beaumont's experiments involved inserting meat on a piece of string through the hole in Alexis' stomach and observing the time taken for the meat to disappear.

Explain why the meat disappeared. [2]

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(c) Suggest **two** reasons why scientists prefer to use an artificial gut rather than using human trials. [2]

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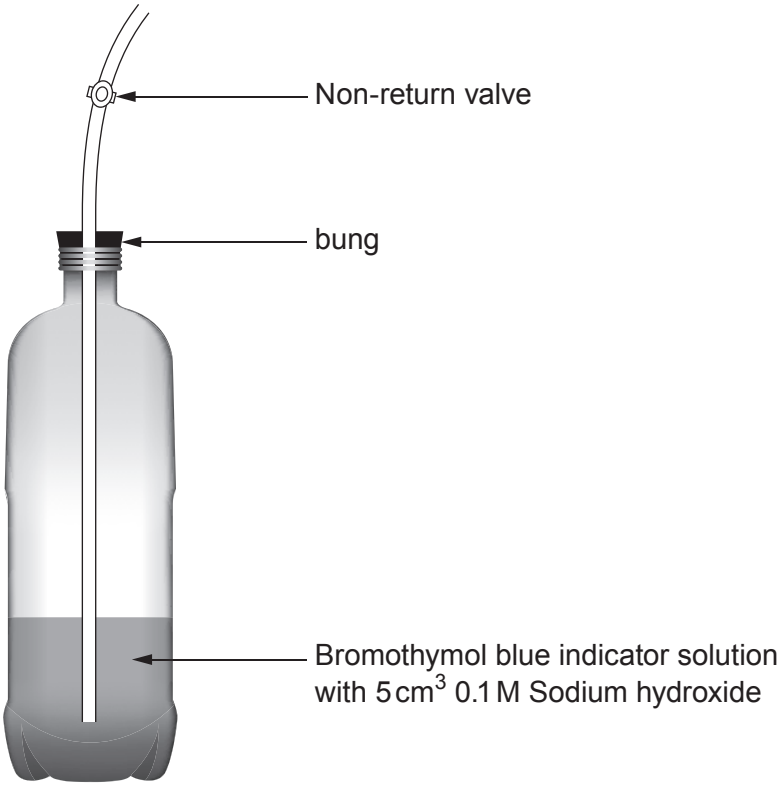
7. A respirometer is a device used to measure the rate of respiration of a living organism by measuring its rate of exchange of oxygen and/or carbon dioxide. A simple respirometer used in a school laboratory is shown below. It can be used to estimate the volume of carbon dioxide in exhaled air.



Fact file

- Bromothymol blue indicator is green when neutral and blue when alkali.
- 5.6 cm^3 of carbon dioxide will neutralise the sodium hydroxide in the respirometer.

The following equation can be used to calculate the volume of carbon dioxide produced per minute.

Volume of carbon dioxide per minute = breathing rate × volume of carbon dioxide in one breath
(cm^3/minute) (breaths/minute) (cm^3/breath)

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Use the information from the fact file opposite to answer the following questions.

(a) (i) Alun wanted to investigate the effect of exercise on the volume of carbon dioxide breathed out. While resting, he takes 5 breaths over a period of 25 seconds to change the colour of the Bromothymol indicator from blue to green. Use the equation given in the fact file to calculate the volume of carbon dioxide produced per minute. [3]

volume of carbon dioxide per minute = ... cm^3/minute

(ii) Suggest a possible source of error in the experimental method that could lead to inaccurate results. [1]

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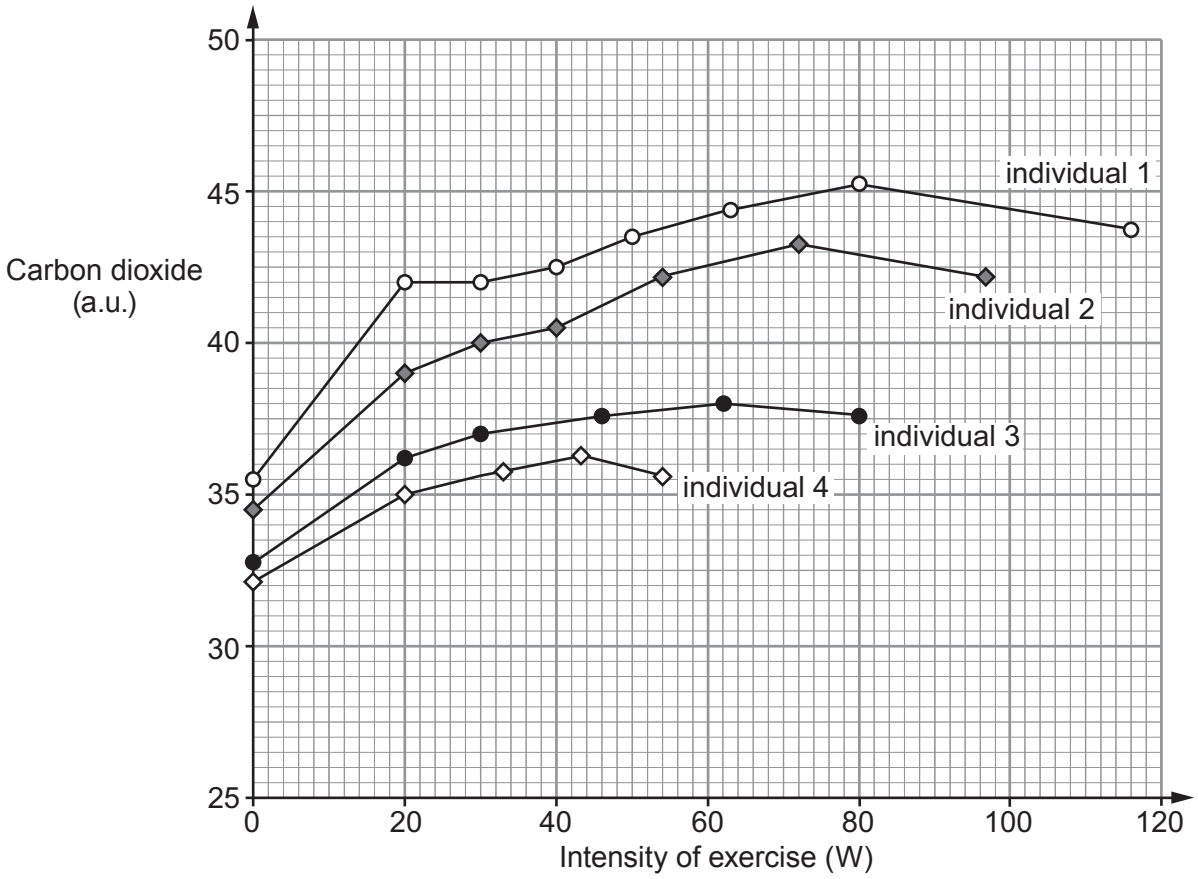
(b) A group of scientists monitored the proportion of carbon dioxide expired in 4 individuals. The individuals were tested on an exercise bike. They were allowed to rest for 4 minutes, and then exercised at an intensity of 20 watts for 4 minutes. After this time the intensity was increased 1 watt every 6 seconds. Individuals stopped exercising when they suffered cramp in their leg muscles. A gas analyser was used to get an accurate measurement of the expired carbon dioxide level per breath.

The results of the investigation are shown below.



(i) Explain the increase in carbon dioxide levels between an intensity of exercise 0 W and 20 W for all the individuals. [2]

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(ii) The decrease in carbon dioxide levels for all individuals at a higher intensity of exercise was linked to cramp in the muscles. Suggest an explanation for this. [2]

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(iii) Suggest which individual is the least fit. Give a reason for your answer. [1]

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(c) State why sports scientists working with athletes would measure oxygen consumption as well as carbon dioxide production. [1]

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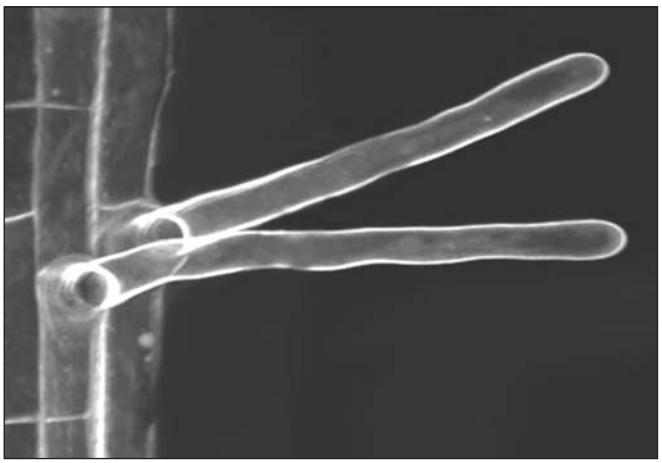
8. The pictures below show a young bean seedling *(Vicia faba)* root and an electron micrograph of root hair cells.

Root with root hairs (left) and magnified view of root hairs (right)



(a) State how the root hair cell is adapted for its function. [1]

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(b) Describe how water moves from the soil into a root hair cell. [4]

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The following is an extract from a UK government report from 2016:

"During the period from mid-December 2013 through until early February 2014 the UK suffered a spell of extreme weather, with a series of very large winter storms battering the country. Much of the UK suffered from extensive flooding during January 2014; this period saw the highest rainfall on record. The floods impacted on the agricultural sector through damage to or loss of established crops."

Soil becomes waterlogged when water builds up and is unable to drain away. This reduces the oxygen levels available to root hair cells.

(c) Explain why reduced oxygen levels for the root hair cells results in poor growth and yellowing of the leaves. [6 QER]

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.	Examiner only

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