Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL

2400U20-1

S18-2400U20-1

BIOLOGY – AS unit 2
Biodiversity and Physiology of Body Systems

MONDAY, 4 JUNE 2018 – AFTERNOON

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**17**	
2.	**10**	
3.	**11**	
4.	**18**	
5.	**15**	
6.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

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 continuation pages 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.

The assessment of the quality of extended response (QER) will take place in question **6**.

The quality of written communication will affect the awarding of marks.

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Answer **all** *questions.*

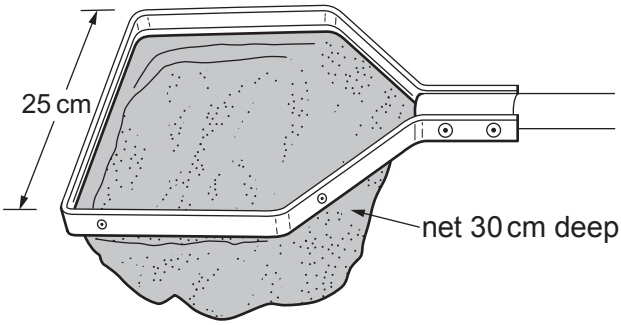
1. In Wales, 12 000 out of 24 000 km of rivers are estimated to be acidified (having a pH of less than 5.6).

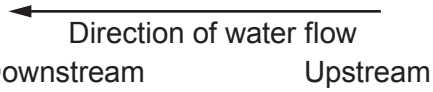
Forests capture acidic pollutants from the atmosphere and release them into stream water.

A group of students investigated the effect of acidification on the biodiversity of freshwater invertebrates in streams in Mid Wales.

Kick sampling was used to compare the biodiversity of a moorland stream (pH = 6.5) and a forest stream (pH = 5.0).

The diagrams below give the dimensions of a "D net" and its use when sampling.





The kick sampling method used by the students is described below:

- Place the bottom edge of the net on the stream bed on the downstream side of the sampling point.
- Kick into the stones just upstream of the net, allowing the disturbed material to drift downstream and be caught in the net.
- Empty the contents of the net into a tray containing stream water.
- Identify and count the invertebrates.
- Return the invertebrates gently to the stream.

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(a) (i) Both streams were sampled in shallow, fast flowing regions. The samples were taken from areas of the same width and water depth, with similar stony stream beds.

Suggest **two** other variables that would need to be as similar as possible between the two streams. [2]

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(ii) When kick sampling, state **two** factors that need to be controlled to ensure standardisation of sampling. [2]

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(iii) To improve the accuracy of species identification it was suggested that the specimens collected could be preserved in alcohol and taken back to the laboratory for closer examination. Discuss why this was considered to be unethical. [2]

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(b) Five kick samples were obtained from each stream. The results are shown below.

Species of invertebrate (common names)	Total number of organisms of each species	
	Moorland stream (pH = 6.5)	Forest stream (pH = 5.0)
Caddisfly larva	8	1
Stonefly nymph	10	37
Wandering snail	3	0
Swimming beetle larva	2	8
Freshwater shrimp	39	0
Mayfly nymph	22	2
Total	84	48

(i) The students collected invertebrates at sites chosen at random. Explain the importance of the sites being chosen at random. [1]

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(ii) Suggest **two** reasons why the values obtained using this technique might be an underestimate of the actual numbers of species at the kick sample sites. [2]

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(iii) Use the following table and the formula to calculate Simpson's Diversity Index for the moorland stream. [3]

Species of invertebrate (common names)	*n*	*(n–1)*	*n(n–1)*
Caddisfly larva	8	7	56
Stonefly nymph	10	9	90
Wandering snail	3	2	6
Swimming beetle larva	2	1	2
Freshwater shrimp	39	38	1482
Mayfly nymph	22	21	462
	$N = 84$		$\Sigma n(n-1) =$ .....
	$N(N-1) =$		

N = total number of individuals of all species
n = number of individuals per species of each species
Σ = sum of

Simpson's Diversity Index $D = 1 - \dfrac{\Sigma n(n-1)}{N(N-1)}$

= .....

(iv) The Diversity Index for the forest stream is 0.4. With reference to the results table on page 4, explain how you could deduce that the forest stream was less diverse than the moorland stream without needing to calculate the Diversity Indices. [2]

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(c) The students concluded that forests reduced species diversity in streams.

(i) Explain how the confidence in this conclusion could be improved. [2]

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(ii) Suggest how forest managers could use this information to increase diversity in forest streams. [1]

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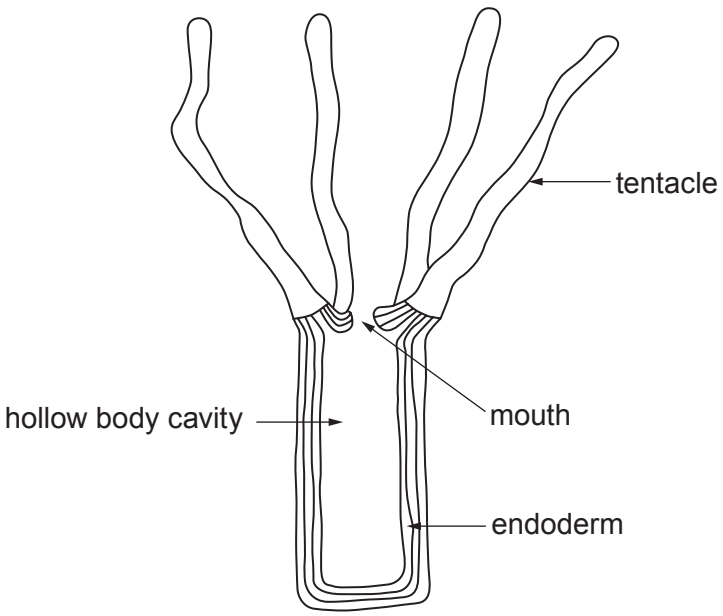
2. Nutrition is the term used to describe how living organisms obtain the molecules from which they build up their organic compounds. A major difference between many types of living organism is their method of nutrition.

(a) The diagram below illustrates the structure of *Hydra viridis*.



Hydra viridis is a simple, multicellular, freshwater animal that uses its tentacles to capture small organisms and transfer them through the mouth into the hollow body cavity. Gland cells in the endoderm secrete enzymes which digest the prey. The products of digestion are absorbed and indigestible remains are egested through the mouth.

(i) State the method of nutrition, exemplified by *Hydra*, where food is ingested and then digested internally. [1]

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(ii) The endodermal cells of *Hydra viridis* contain cells of the green alga *Chlorella*. This is called mutualism which is a relationship between two different species where each individual benefits from the activity of the other. Explain how both *Hydra* and *Chlorella* may benefit from this relationship. [2]

Hydra: .....

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Chlorella: .....

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(b) *Nostoc commune* and *Nitrosomonas europaea* are bacterial species that can be found in soil. Both species use simple inorganic molecules to build up their organic compounds. Chlorophyll pigments are found in the cells of *Nostoc* but not in the cells of *Nitrosomonas*.

What conclusions can be made about the methods of nutrition in these two species? [3]

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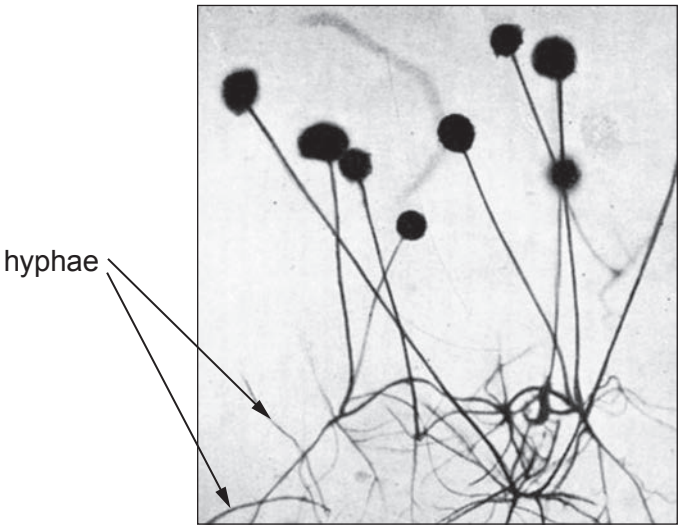
(c) The photograph illustrates the structure of a fungus belonging to the genus *Rhizopus*. All *Rhizopus* species have a similar structure.



Two species of this genus are *Rhizopus stolonifer* and *Rhizopus oryzae. R. stolonifer* is commonly found on bread surfaces and rotting fruit. *R. oryzae* can cause a rare and potentially life-threatening infection of humans called mucormycosis.

What conclusions can be made about the methods of nutrition in these two species? [4]

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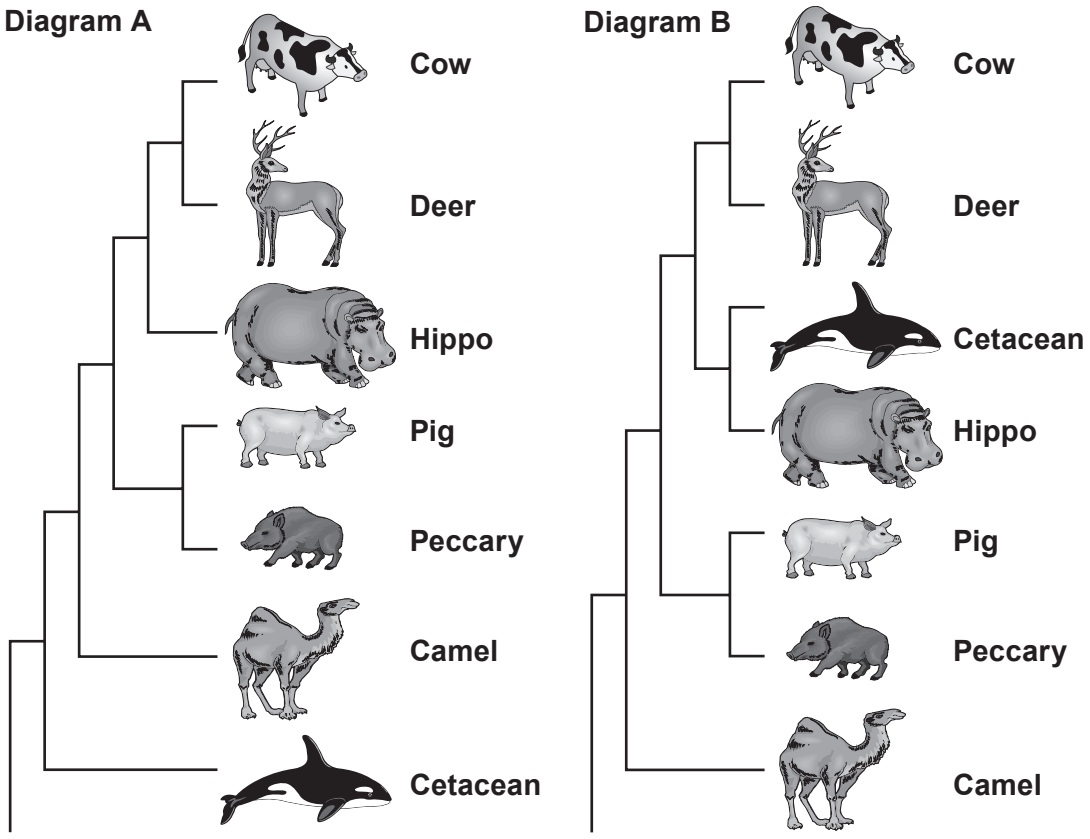
3. Whales and dolphins belong to a single group of carnivorous, marine mammals called the cetaceans (order Cetacea). Cetaceans are comprised of three sub-orders: Odontoceti (toothed whales including sperm whales and dolphins), Mysticeti (baleen whales), and Archaeoceti (the extinct ancestors of modern whales).

There have been a number of theories regarding the closest living relative to the cetaceans.

The diagrams below illustrate two of these theories. With the exception of the cetacean, all the mammals shown belong to the order Artiodactyla.



(a) State the term used to describe diagrams such as those shown above. [1]

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(b) The values given in the following table show the number of differences in the nucleotide sequence of the gene coding for the synthesis of the milk protein casein in different mammals.

Sperm whale	3						
Dolphin	3	2					
Hippo	4	3	3				
Cow	9	8	8	8			
Camel	12	11	11	12	14		
Deer	11	10	10	10	4	16	
Pig	11	10	10	11	13	14	13
Peccary	14	12	13	14	16	16	18	7
	Baleen whale	Sperm whale	Dolphin	Hippo	Cow	Camel	Deer	Pig

(i) Use the information in the table to explain whether **Diagram A** or **Diagram B** represents the currently accepted theory regarding the closest living relative to the cetaceans. [3]

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(ii) Modern taxonomic classification combines Cetacea and Artiodactyla into a single order, the Cetiartiodactyla. Explain how this illustrates the "tentative nature" of biological classification. [2]

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(c) Both the common bottlenose dolphin *(Tursiops truncates)* and the killer whale *(Orcinis orca)* belong to a smaller taxonomic group of the sub-order Odontoceti called the Delphinidae. Name the group in the taxonomic hierarchy to which the Delphinidae belong. [1]

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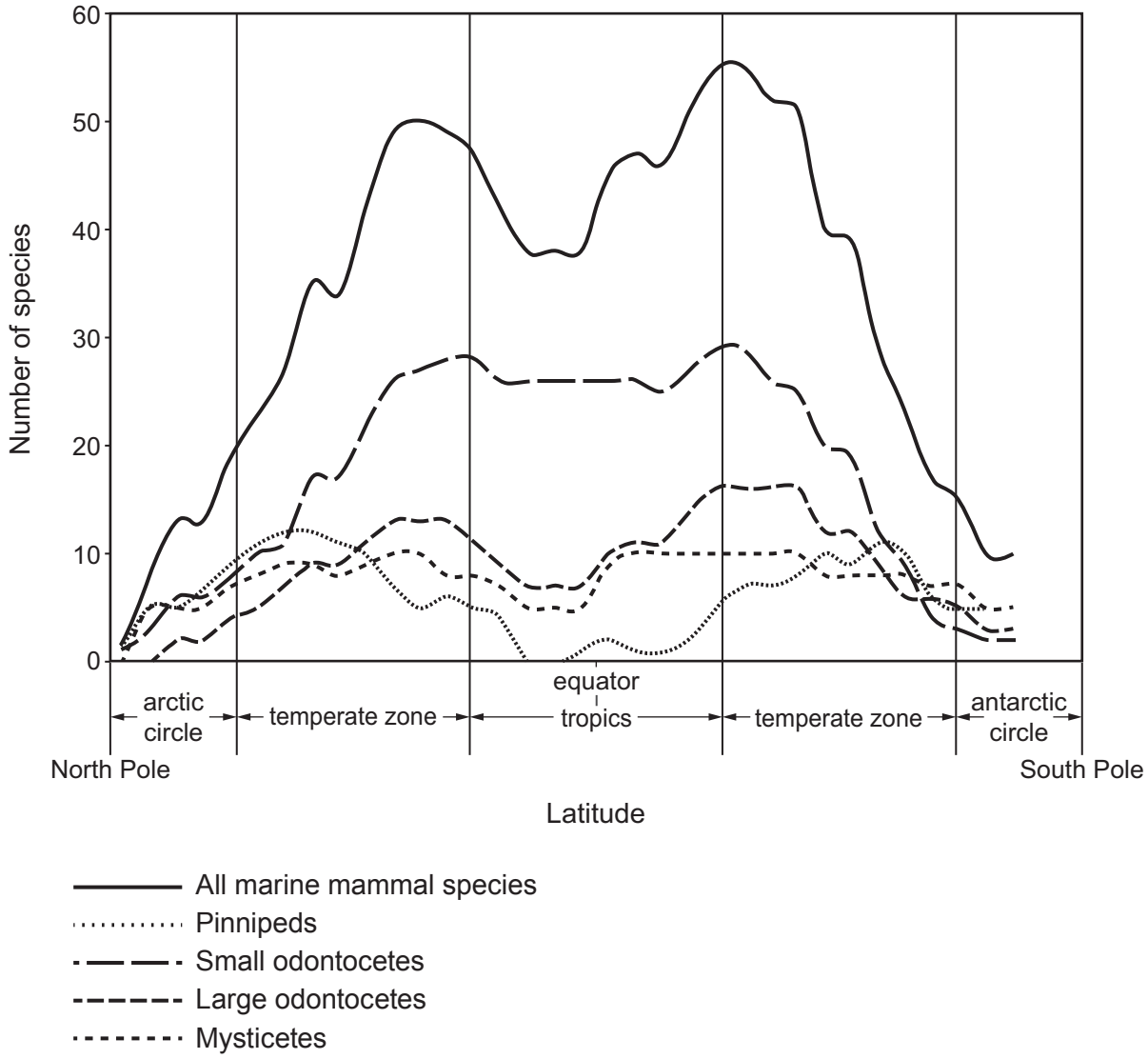
(d) In 2011, an international group of researchers used sightings from three oceanic surveys to predict patterns in the global distribution of marine mammals. The table lists the mammalian groups included in the survey.

Mammalian group	Examples
Pinnipeds	seals and sea lions
Small odontocetes	dolphins
Large odontocetes	sperm whales and killer whales
Mysticetes	baleen whales

The following graph shows the predicted number of species by latitude.



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(i) Describe the effect of latitude on the number of species of small odontocetes from the **antarctic circle** to the **tropics**. [2]

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(ii) State the environmental factor that is **most** likely to explain the distribution of all marine mammal species. [1]

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(iii) Why is the curve for **all marine mammal species** described as showing a bimodal distribution? [1]

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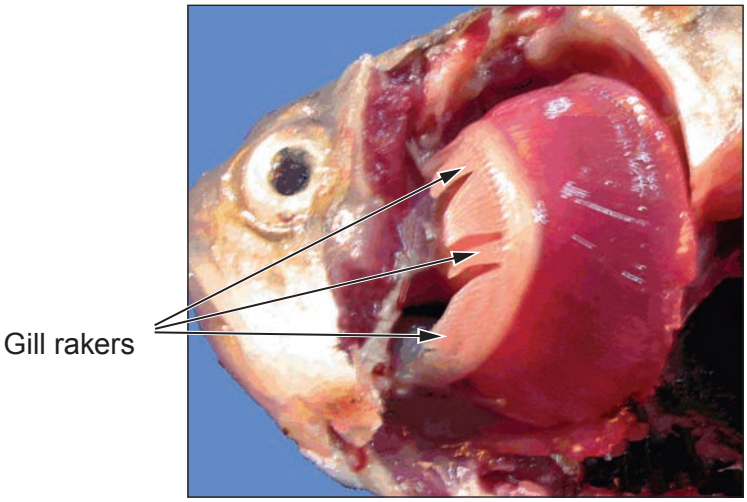
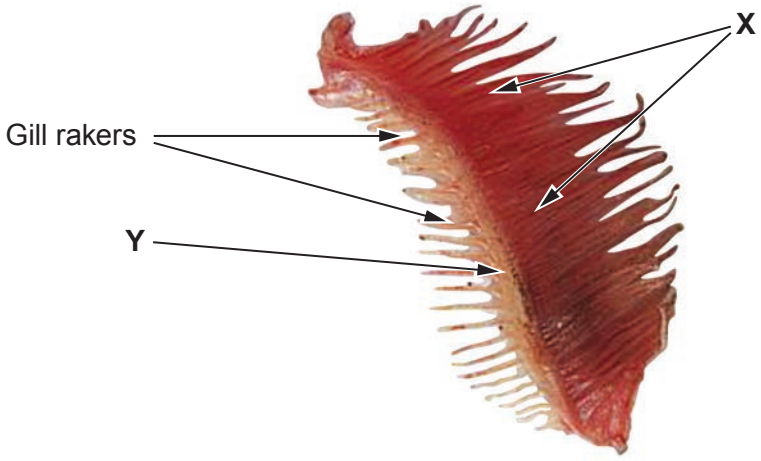
4. **Photograph A** shows a freshly dissected bony fish with the operculum removed to show the gills.
Photograph B shows a single gill 30 minutes after having been removed from the fish.

Photograph A



Photograph B



(a) (i) Identify the structures labelled **X** and **Y** in **Photograph B**. [1]

X .....

Y .....

(ii) Suggest the function of the gill rakers. [1]

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(iii) Use the photographs, and your knowledge, to explain why fish suffocate when out of water. [4]

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(b) Gas exchange in bony fish uses the countercurrent flow mechanism, where blood flows through the capillaries of the gill lamellae in the opposite direction to water flowing across them. In parallel flow, blood flows through the capillaries of the gill lamellae in the same direction as water flowing across them. Explain the advantages of the countercurrent flow mechanism compared to the parallel flow mechanism. [4]

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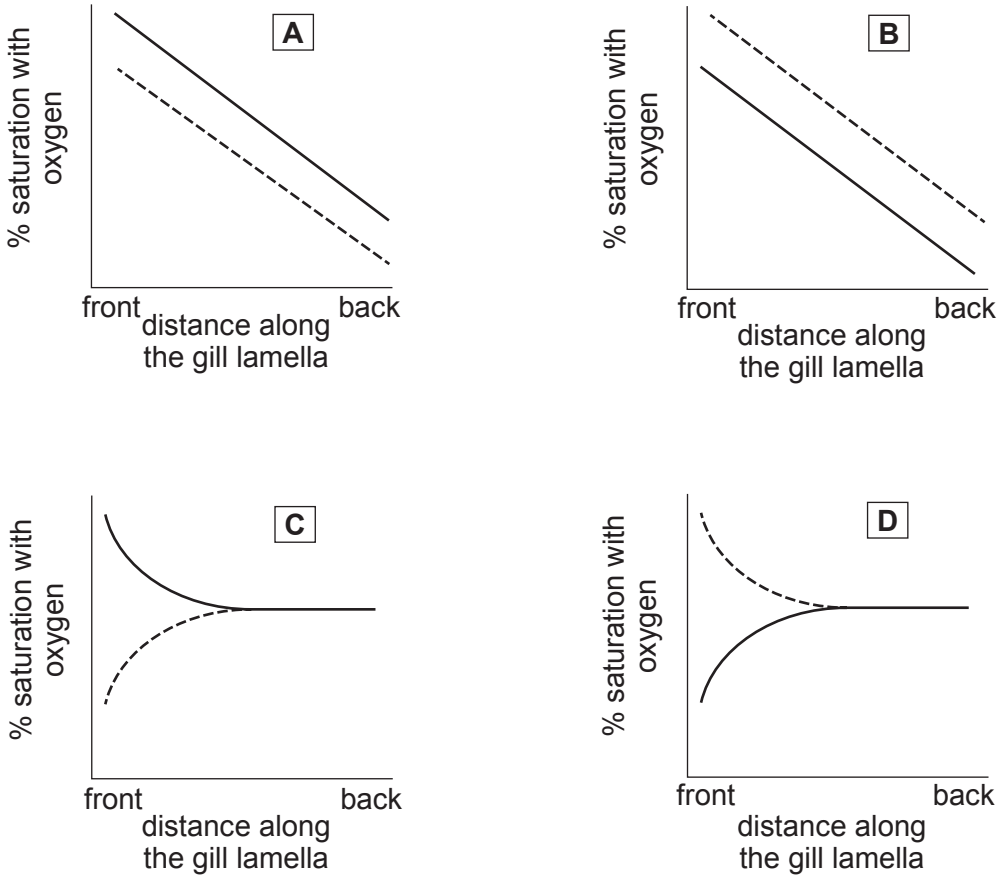
(c) The graphs below show representations of changes in oxygen concentration as water flows across the gill lamellae.



Key: ———— = water; ---------- = blood

(i) Identify which graph illustrates parallel flow and which graph illustrates countercurrent flow. [1]

Parallel flow ..... Countercurrent flow .....

(ii) **Clearly** insert arrows on the graph which represents countercurrent flow to show the direction of blood flow **and** of water flow. [1]

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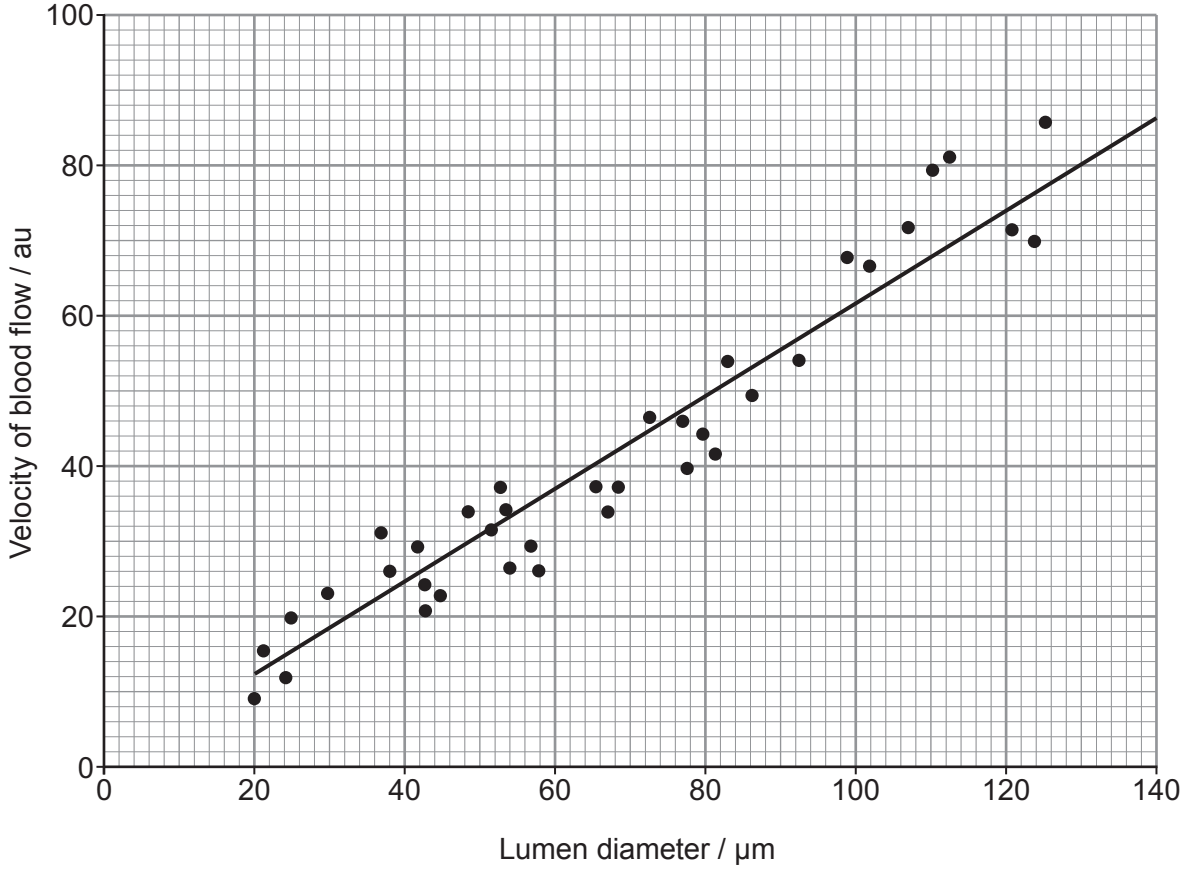
(d) The scatter diagram below shows the relationship between blood vessel lumen diameter and velocity of blood flow.



(i) State the type of correlation between the two variables shown on the scatter diagram. [1]

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(ii) Use the graph to determine the gradient of the line of best fit. [2]

gradient = ...

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(iii) The equation for a straight line is:

$$y = mx + c$$

where:

m = gradient
y = velocity of blood flow
x = lumen diameter
c = y-intercept of the graph

On this graph, $c = 0$. Calculate the velocity of blood flow in a vessel with a lumen diameter of 160 µm using your calculated value of m and the equation above. [1]

Velocity of blood flow = ... au

(iv) In the single circulatory system of a fish, oxygenated blood leaves the capillaries of the gill lamellae and passes to the systemic circulation. Explain the importance of the relationship shown by the graph in the return of deoxygenated blood through veins to the fish's heart. [2]

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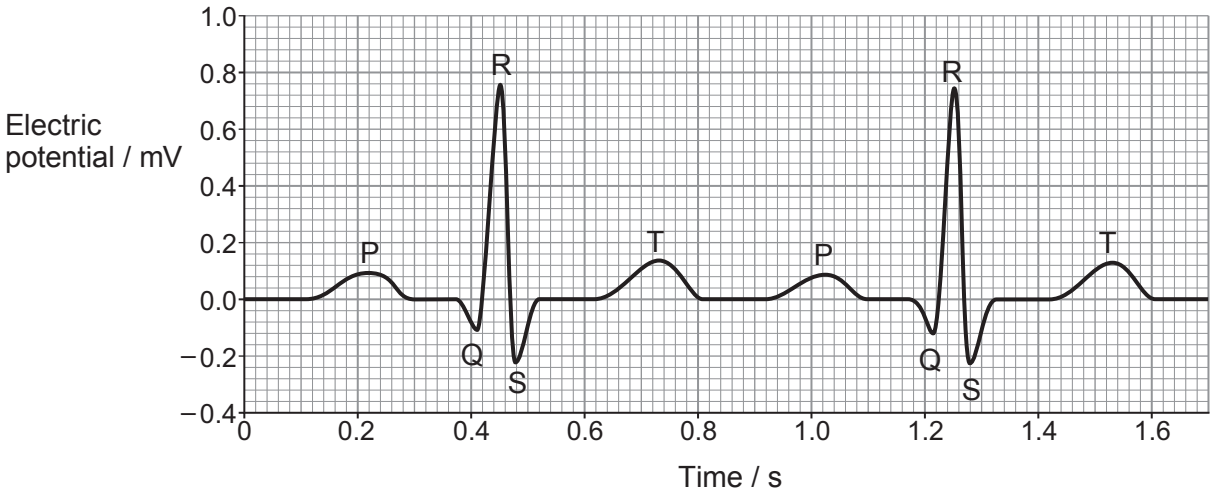
5. An ECG is a test that can be used to check the heart's rhythm and electrical activity. Sensors attached to the skin are used to detect the electrical signals produced by the heart each time it beats. The graph below shows part of a trace from a healthy person at rest.



(a) (i) What does the abbreviation ECG represent? [1]

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(ii) Calculate the heart rate of the person in beats per minute (bpm). [1]

Heart rate = ... bpm

(iii) Explain the events occurring during;

I. The P wave. [3]

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II. The QRS complex. [3]

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III. The T wave. [2]

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(b) During exercise there is little change to the lengths of the P wave, QRS complex, or T wave. Describe and explain how the distance between consecutive P waves would differ in a person taking exercise. [2]

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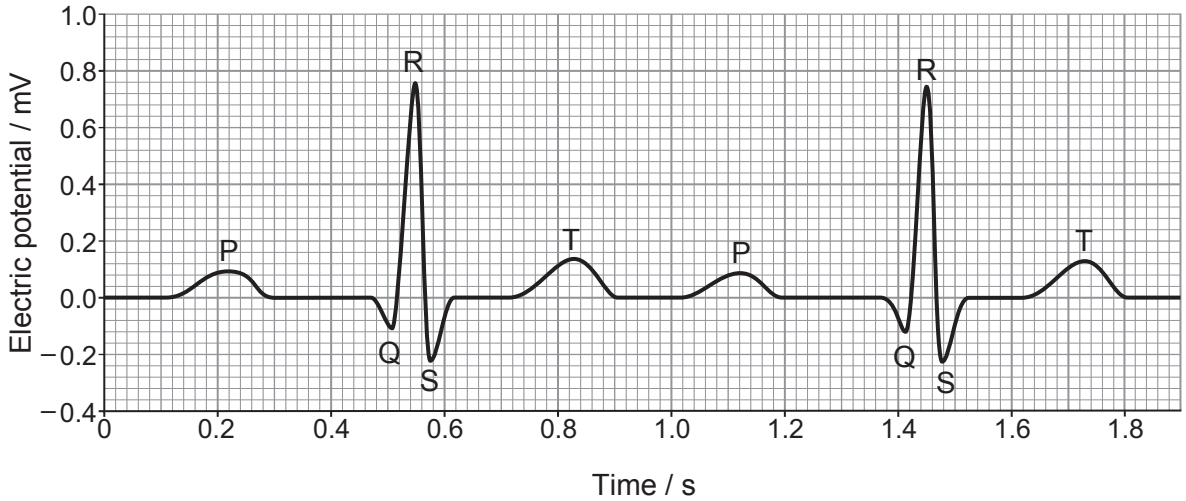
(c) The ECG trace below illustrates an abnormality known as a First Degree Heart Block.



(i) On the graph above **circle one** region of the ECG where this abnormality occurs. [1]

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(ii) Conclude which region of the conducting tissue of the heart is affected by a First Degree Heart Block. [1]

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(iii) Suggest the effect that a First Degree Heart Block would have on the functioning of the heart. [1]

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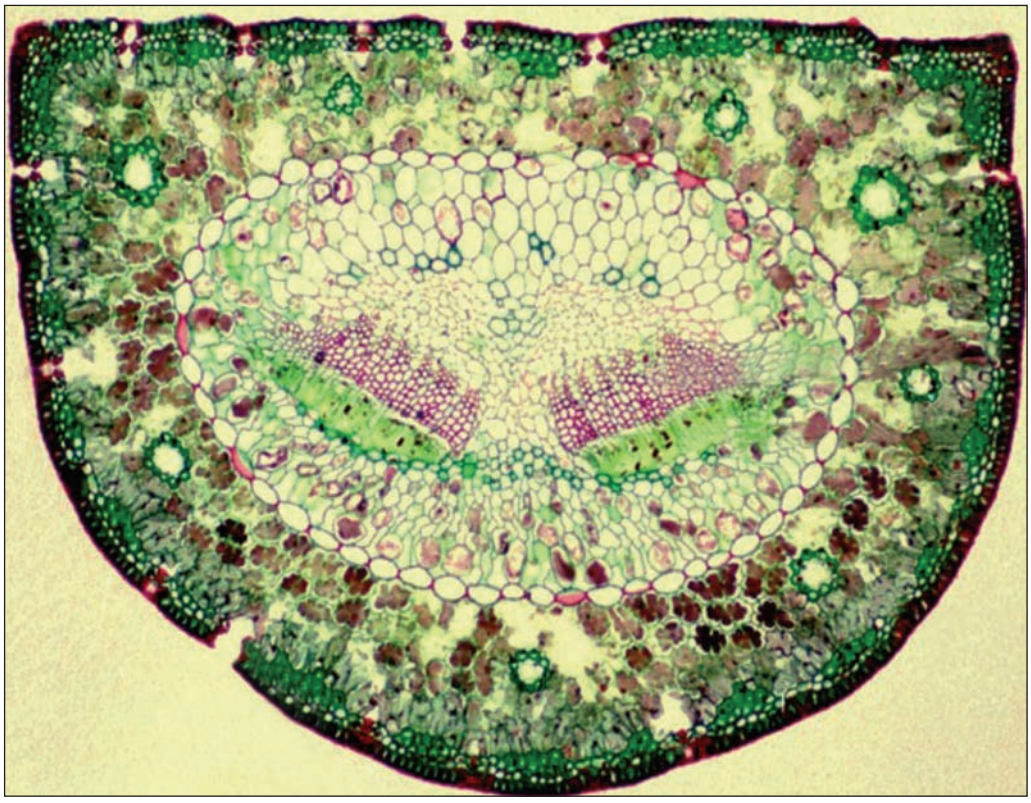
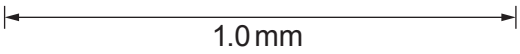
6. Many plants such as *Quercus* (oak), *Ligustrum* (privet) and *Narcissus* (daffodil), are mesophytes. However, other plants can be classified as xerophytes or hydrophytes.

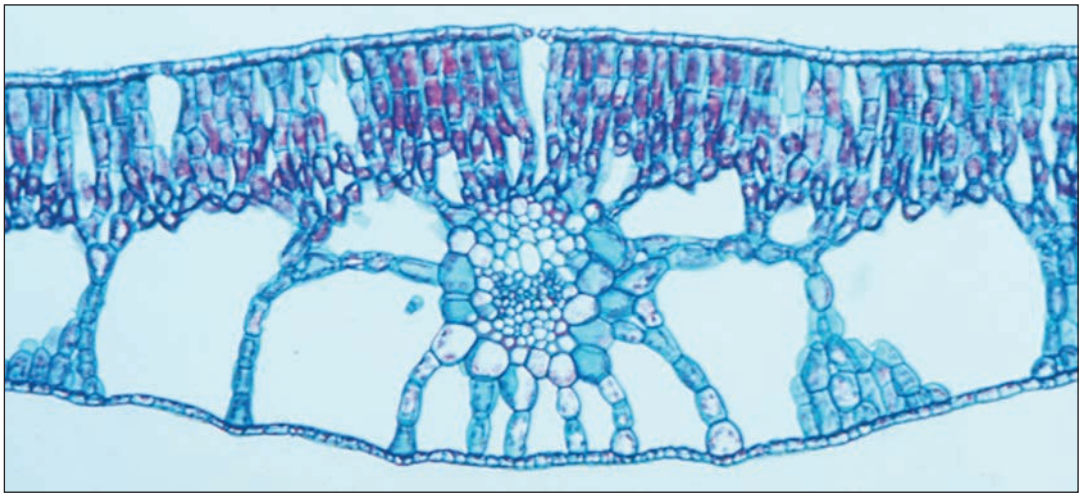
The photomicrographs below show transverse sections through the leaves of *Pinus* (pine) and *Potamogeton* (pondweed).

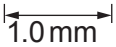
***Pinus* (pine) – a xerophyte.**





***Potamogeton* (pondweed) – a hydrophyte.**





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Explain what is meant by the terms mesophyte, xerophyte and hydrophyte.

For both *Pinus* and *Potamogeton* describe and explain how their leaf structure enables them to survive in their respective environments. [9 QER]

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

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