Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS/A LEVEL

2400U20-1

Z22-2400U20-1

THURSDAY, 9 JUNE 2022 – AFTERNOON

BIOLOGY – AS unit 2
Biodiversity and Physiology of Body Systems

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**12**	
3.	**14**	
4.	**15**	
5.	**18**	
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 or correction fluid.

You may use a pencil for graphs and diagrams only.

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(s) 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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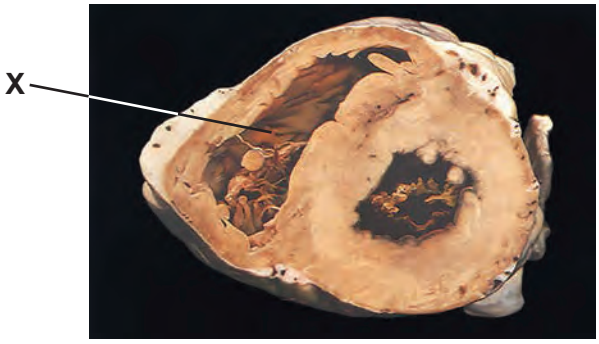
Answer **all** questions.

1. **Image 1.1** shows a transverse section though a mammalian heart.

Image 1.1



(a) (i) Identify the chamber of the heart labelled **X**. [1]

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(ii) Explain your answer to (a)(i). [1]

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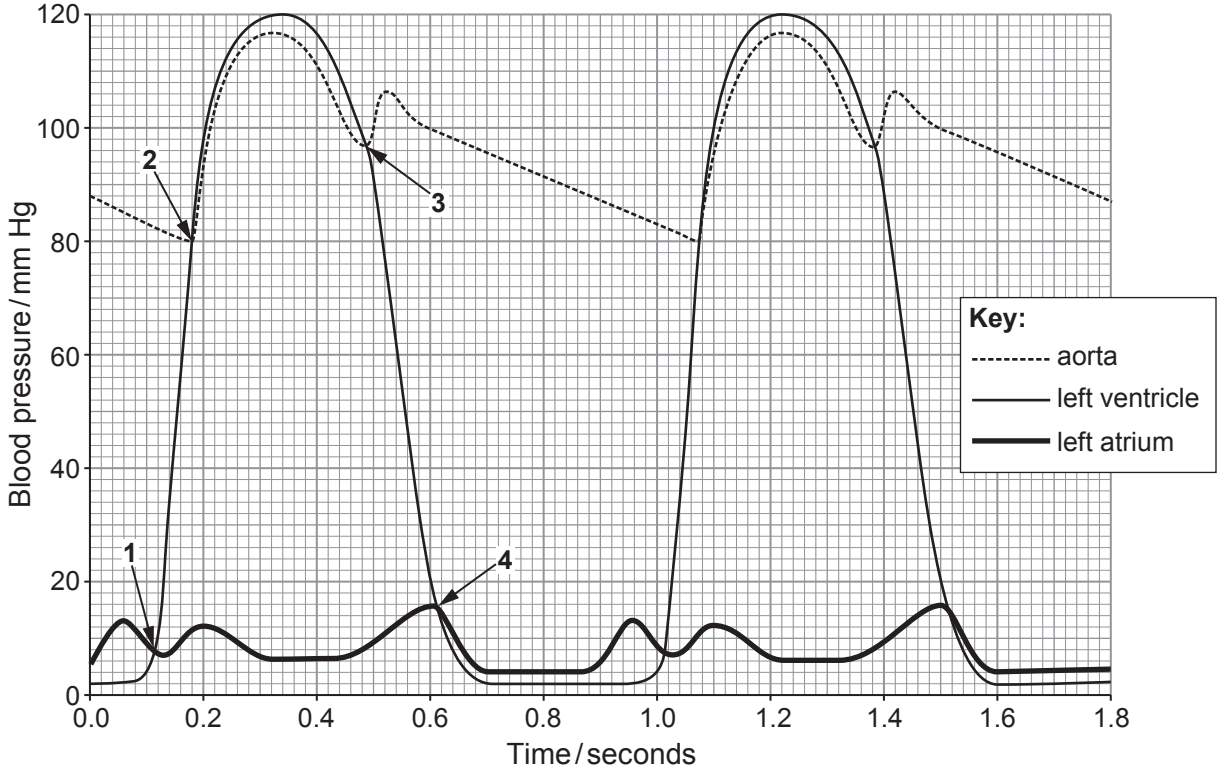
(b) **Graph 1.2** shows pressure changes in the aorta, left ventricle and left atrium of an adult individual at rest.

Graph 1.2



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(i) On **Graph 1.2 mark with a Y** a point at which blood is flowing from the left ventricle into the aorta. [1]

(ii) The numbers on **Graph 1.2** indicate the points at which valves in the heart are either opening or closing. Complete the table below to show the name of the valve and state whether the valve is opening or closing. [2]

Number	Name of valve	Opening or closing
1	.....	.....
3	.....	.....

(iii) Calculate the resting heart rate, in beats per minute, for this individual. [1]

Heart rate = ... beats per minute

2400U201 03

(c) The volume of blood expelled from the left ventricle during each cardiac cycle is known as stroke volume. A person's cardiac output is calculated by multiplying the stroke volume by the heart rate, as shown in the equation below.

Cardiac output = heart rate × stroke volume

Calculate the stroke volume for an individual whose heart rate was 75 bpm and cardiac output was 5.25 dm^3 min^{-1}. [2]

Stroke volume = ... cm^3

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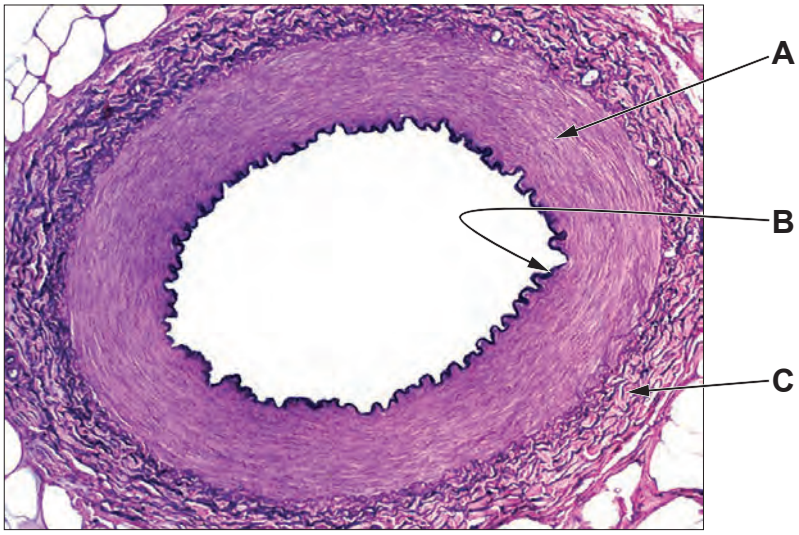
(d) **Image 1.3** shows a transverse section through the aorta. The specimen has been stained to provide contrast.

Image 1.3



(i) Name the tissue layers labelled **A**, **B** and **C**. [2]

A .....

B .....

C .....

(ii) Although the pressure in the left ventricle drops almost to zero during diastole in the cardiac cycle, the pressure in the aorta remains relatively high. With reference to **Image 1.3**, explain how high pressure is maintained in the aorta. [2]

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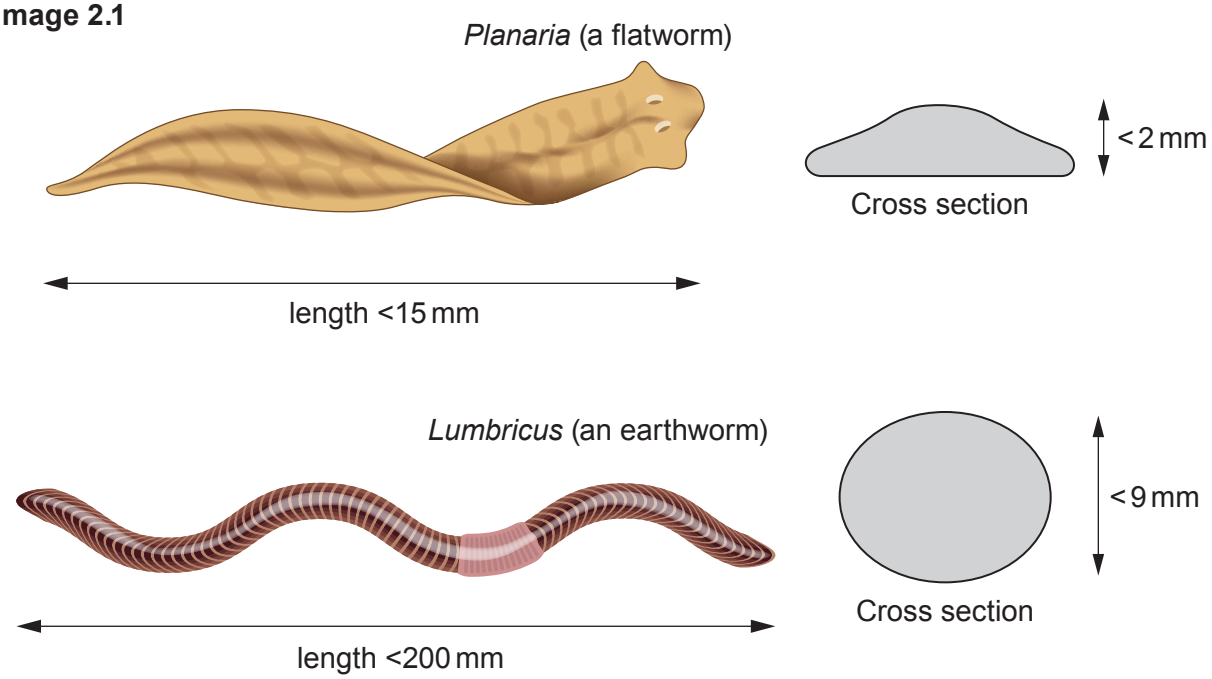
2. *Planaria* and *Lumbricus* are both multicellular animals that use their body surface for gas exchange. These are shown in **Image 2.1**.

Image 2.1



(a) (i) The body surface of both animals is adapted for gas exchange by being thin, moist, and permeable to gases. State **one** other feature of the body surface that these organisms have in common. [1]

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(ii) *Planaria* does not require a circulatory system. Explain why *Lumbricus* does require a circulatory system. [3]

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(iii) Locusts are large insects. Explain how they ensure an efficient supply of oxygen to their tissues. [2]

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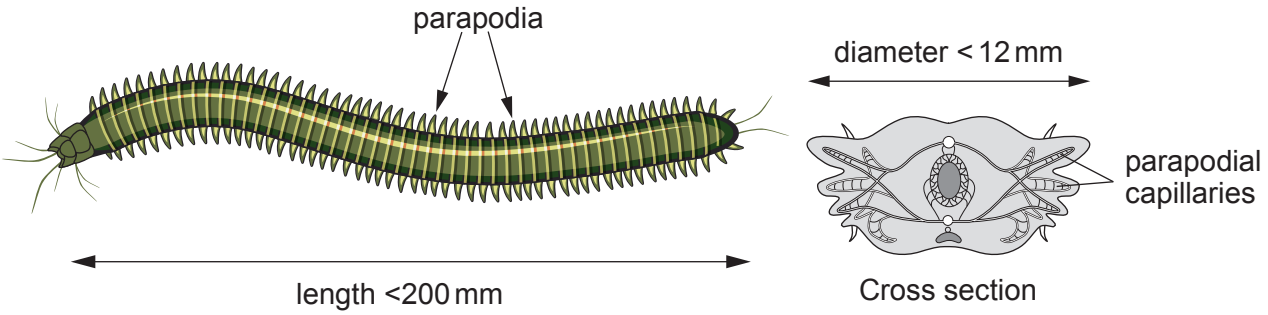
(b) The animal shown in **Image 2.2** is *Nereis* (a ragworm).

Image 2.2



Nereis also uses its body surface for gas exchange and, like *Lumbricus*, has a closed circulatory system and blood containing haemoglobin. *Lumbricus* is slow-moving and burrows in damp soil feeding on decaying organic matter. *Nereis* is a fast-moving, marine predator and uses its parapodia to crawl and swim.

(i) Suggest **how** parapodia are also adapted to increase the efficiency of gas exchange. [1]

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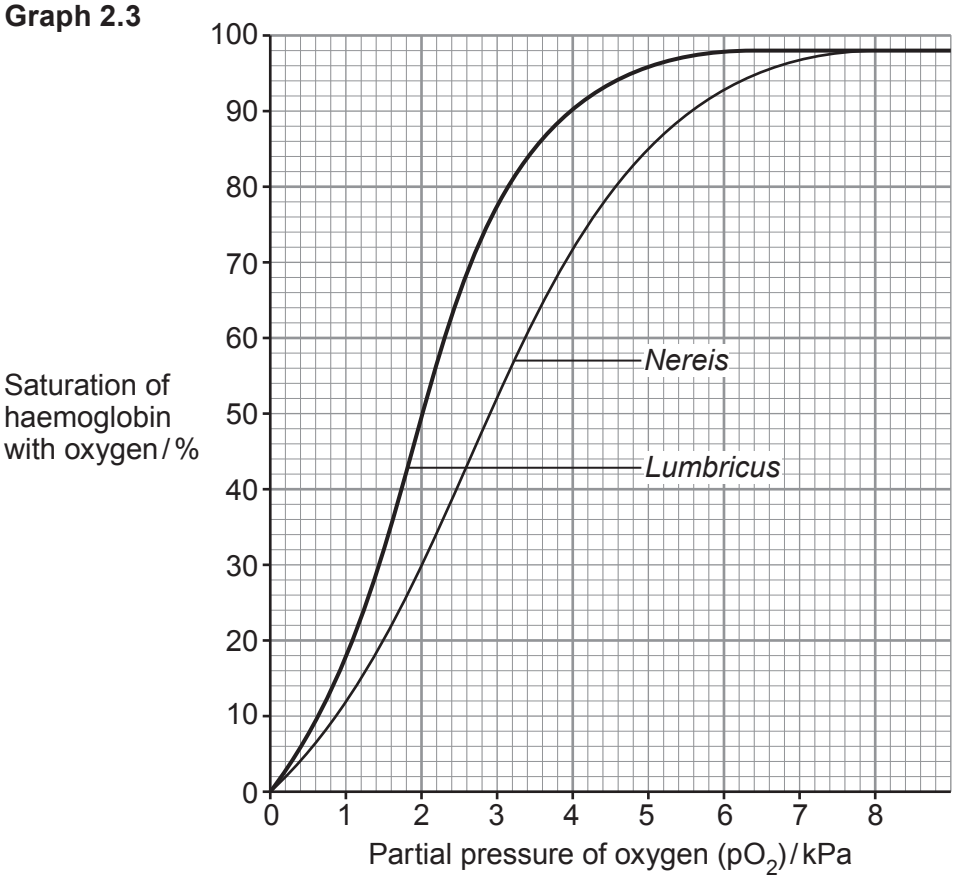
Graph 2.3 shows the oxygen haemoglobin dissociation curves for *Lumbricus* and *Nereis* haemoglobin.

Graph 2.3



(ii) Use the information provided to explain how the difference in the positions of the dissociation curves for *Lumbricus* and *Nereis* haemoglobin reflects their method of feeding. [5]

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3. All mammals, including humans, are examples of holozoic heterotrophs. Once food has been ingested, it undergoes both mechanical and chemical digestion.

(a) Describe what is meant by the terms mechanical digestion and chemical digestion. [2]

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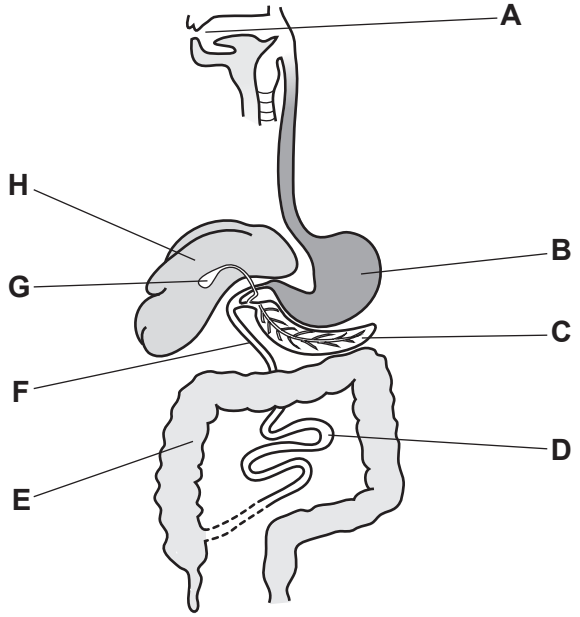
(b) **Image 3.1** shows the human alimentary canal and associated organs.

Image 3.1



(i) Using the letters from **Image 3.1**, identify the organs where lipase and bile are synthesised. [1]

Lipase: .....

Bile: .....

(ii) Bile is composed of bile salts and HCO_3^- ions. Explain the importance of the HCO_3^- ions in the small intestine. [2]

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2400U201 09

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(c) An experiment was carried out to determine the effect of bile salts on the digestion of lipids. The student used full fat milk as it contains a relatively high concentration of lipids. Each test tube was set up as shown in **Table 3.2**; all solutions were maintained at 37 °C throughout the investigation.

Table 3.2

Tube	Volume / cm^3					
	Full fat milk (3.5% fat content)	Sodium carbonate solution (0.05 mol dm^{-3})	Lipase solution (5%)	Bile salts solution (3%)	Phenolphthalein (1%)	Distilled water
A	5.0	1.0	0.5	0.0	0.2	1.0
B	5.0	1.0	0.5	1.0	0.2	0.0
C	5.0	1.0	0.0	1.0	0.2	0.5

Phenolphthalein was used as an indicator. It is pink in solutions with a pH above 10 and colourless in solutions below pH 8.3.

(i) Explain why it was important that sodium carbonate solution was added to each of the test tubes. [1]

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(ii) Explain why it was important that different volumes of water were added to each of the test tubes. [1]

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(d) The student recorded the time taken for the phenolphthalein to turn colourless. The results are shown in **Table 3.3**.

Table 3.3

Tube	Time taken for phenolphthalein to turn colourless / s			
	Trial 1	Trial 2	Trial 3	Mean
A	247	283	266	265
B	111	87	109	102
C	*	*	*	*

* No colour change was recorded in test tube **C** even after 900 seconds.

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(i) Explain the results shown in test tubes **A** and **B**. [4]

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(ii) Explain why bile salts were included in test tube **C** but lipase was not. [1]

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(iii) Suggest **one** source of inaccuracy with this investigation and suggest **one** possible way in which it could be improved. [2]

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2400U201 11

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4. The Hawaiian archipelago is a group of tropical volcanic islands that formed within the last 30 million years. They are located in the middle of the Pacific Ocean, almost 2300 miles away from the closest continent, North America. There are 351 different bird species on the islands, of which 59 species are endemic (found only on the Hawaiian Islands). The UK has 635 different bird species, of which only one species is endemic.

(a) (i) Calculate the percentage of bird species that are endemic to Hawaii. [1]

..... %

(ii) Less than 0.2% of UK bird species are endemic. Suggest **one** reason for the difference in the percentage of endemic species between the UK and Hawaii. [1]

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(b) Hawaiian honeycreepers are a group of birds endemic to Hawaii. At least 56 species are known to have existed, however 38 species are now extinct. **Image 4.1** and **Table 4.2** show one species, called apapane (*Himatione sanguinea*), and part of its classification.

Complete Table 4.2, to show the full classification of apapane. [3]

2400U201 13

Image 4.1

Table 4.2

Domain	.....
Kingdom	Animalia
Phylum	Chordata
Class	Aves
.....	Passeriformes
.....	Fringillidae
Genus	.....
Species	.....

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(c) Scientists have debated the identity of the ancestor of the honeycreepers. Morphological and behavioural data have suggested several possibilities. One group of scientists carried out DNA hybridisation to compare the DNA of apapane with other bird species. They include the orchard oriole (*Icterus spurius*), the palm tanager (*Thraupis palmarum*) and the purple finch (*Carpodacus purpureus*). This technique involves:

- Heating the extracted DNA from apapane to break the hydrogen bonds, causing the two strands to separate.
- Mixing the separated strands with single DNA strands from a different species.
- Cooling the mixture to allow hydrogen bonds to form between complementary base pairs to produce hybrid DNA (with one strand from apapane and the other strand from the different species).

When the hybrid DNA is then reheated the strands will separate at a lower temperature. This is because fewer hydrogen bonds will be present than in non-hybrid DNA from apapane. The difference in temperature indicates how similar the DNA sequences are.

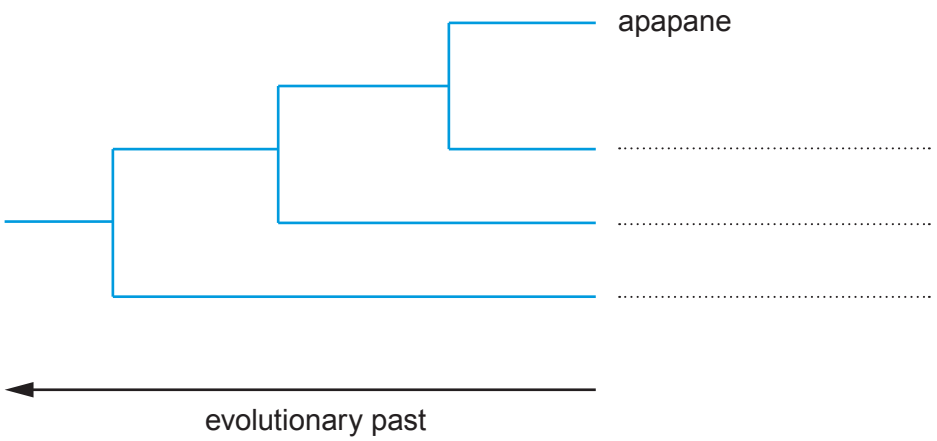
The results are shown in **Table 4.3**:

Table 4.3

DNA	Temperature required to separate hybrid strands / °C
apapane – apapane	92.0
apapane – oriole	84.9
apapane – tanager	84.5
apapane – finch	87.8

(i) Use the results to **complete the phylogenetic tree in Image 4.4**. [2]

Image 4.4



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(ii) Use the information provided to explain how the technique allows the evolutionary relationships between the species to be determined. [3]

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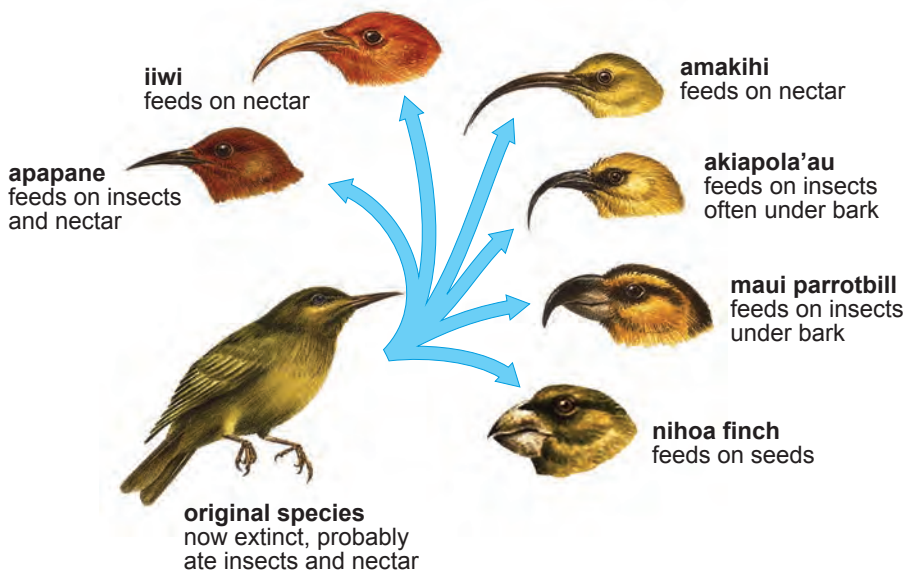
(d) Since the arrival of the common ancestor in Hawaii, the honeycreepers have diversified into many different species. **Image 4.5** shows some of these with information regarding their food source.

Image 4.5



(i) The apapane and iiwi are found in similar habitats and have similar diets. Explain why they are regarded as separate species. [1]

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(ii) Using the information provided, describe and explain the evolutionary change illustrated by **Image 4.5**. [4]

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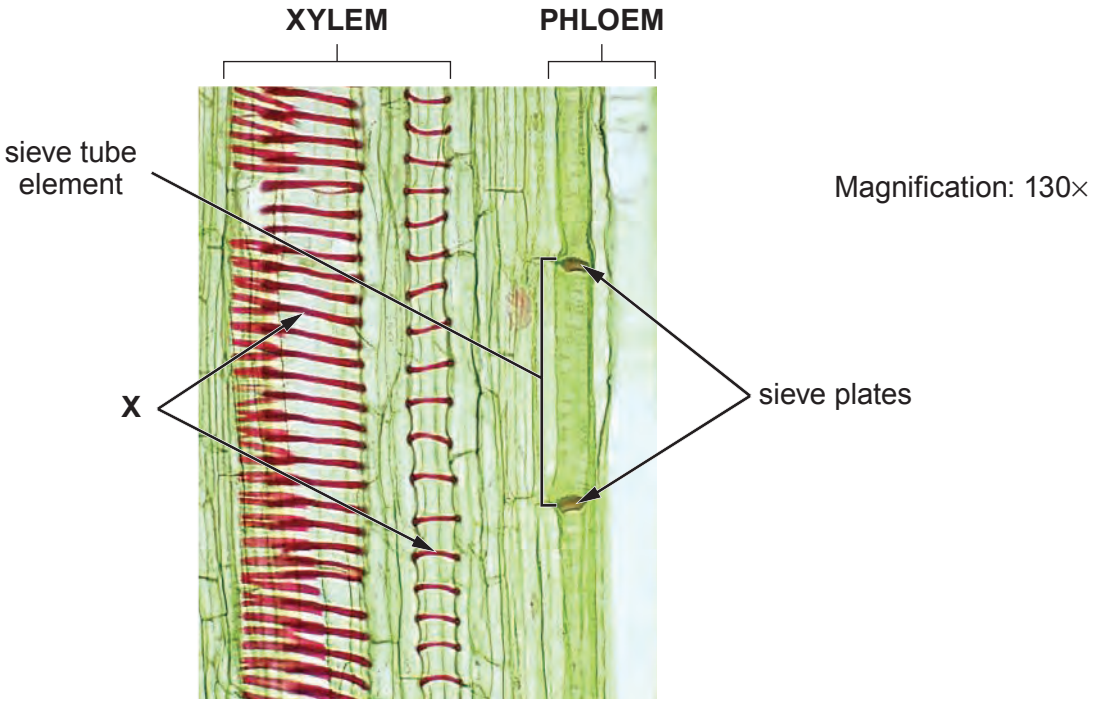
5. **Image 5.1** shows a longitudinal section through a vascular bundle of a marrow (*Cucurbita*) stem.

Image 5.1



(a) (i) State the main chemical found in the structures labelled **X** in **Image 5.1** and explain the importance of these structures in the functioning of xylem. [2]

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(ii) Calculate the length of the sieve tube element shown in **Image 5.1** in micrometres (μm). Show your working. [2]

Length = ... μm

(iii) Use your answer to (ii) to calculate the length of time, in seconds, that it would take for a molecule of sucrose to travel between the sieve plates labelled in **Image 5.1**, if the flow rate of phloem contents was $0.28\,mm\,s^{-1}$. Show your working. [3]

Time = ... seconds

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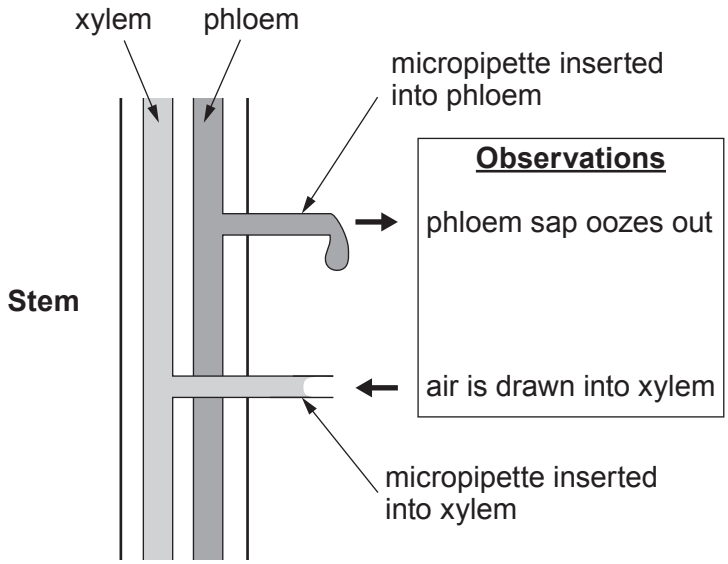
(b) In an investigation into the mechanisms of transport, fluid filled micropipettes were inserted into xylem vessels and sieve tube elements. **Image 5.2** shows the observations made.

Image 5.2



Using your knowledge of plant transport, explain the observations shown in **Image 5.2**.

[4]

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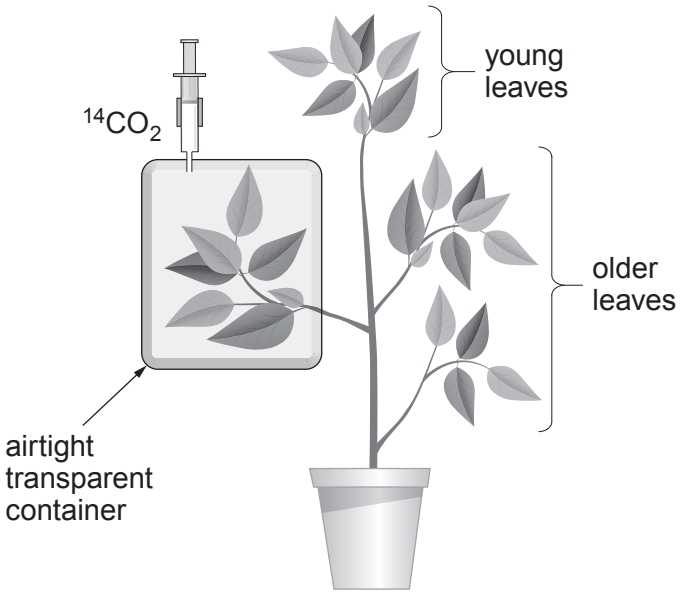
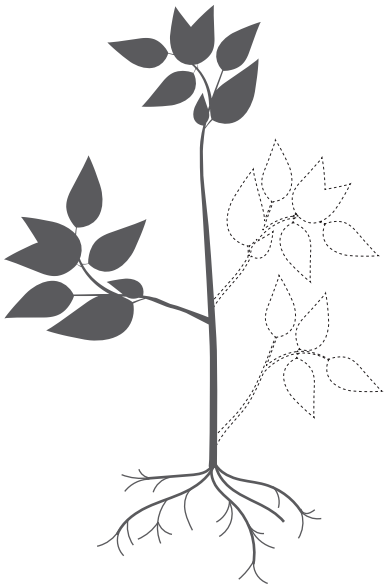
(c) In an experiment, some leaves of a plant were supplied with radioactively labelled carbon dioxide ($^{14}CO_2$) and allowed to photosynthesise, as shown in **Image 5.3**. The leaves used $^{14}CO_2$ to produce sucrose. The sucrose was then transported from the leaves by the phloem.

Image 5.3



After 24 hours exposure to $^{14}CO_2$ the plant was removed from the pot, dried, and then laid on photographic film in the dark. Radioactivity exposes the film turning it black. **Image 5.4** represents an autoradiograph showing the location of compounds containing ^{14}C.

Image 5.4



(i) Other than sucrose, name **one** type of compound containing ^{14}C that may be transported in phloem. [1]

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(ii) State the conclusions that can be drawn from the distribution of radioactivity in the **leaves** of the plant. [4]

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(iii) The autoradiograph shows that radioactivity is also found in the roots. State the additional information that this provides about transport in phloem. [1]

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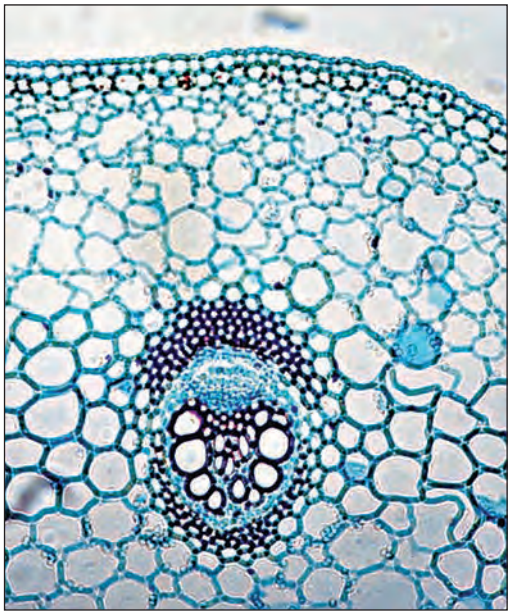
(iv) **Image 5.5** shows a transverse section of part of the stem of this plant.

Image 5.5



Using a single arrow, indicate **one** region on **Image 5.5** in which radioactivity would be found. [1]

18

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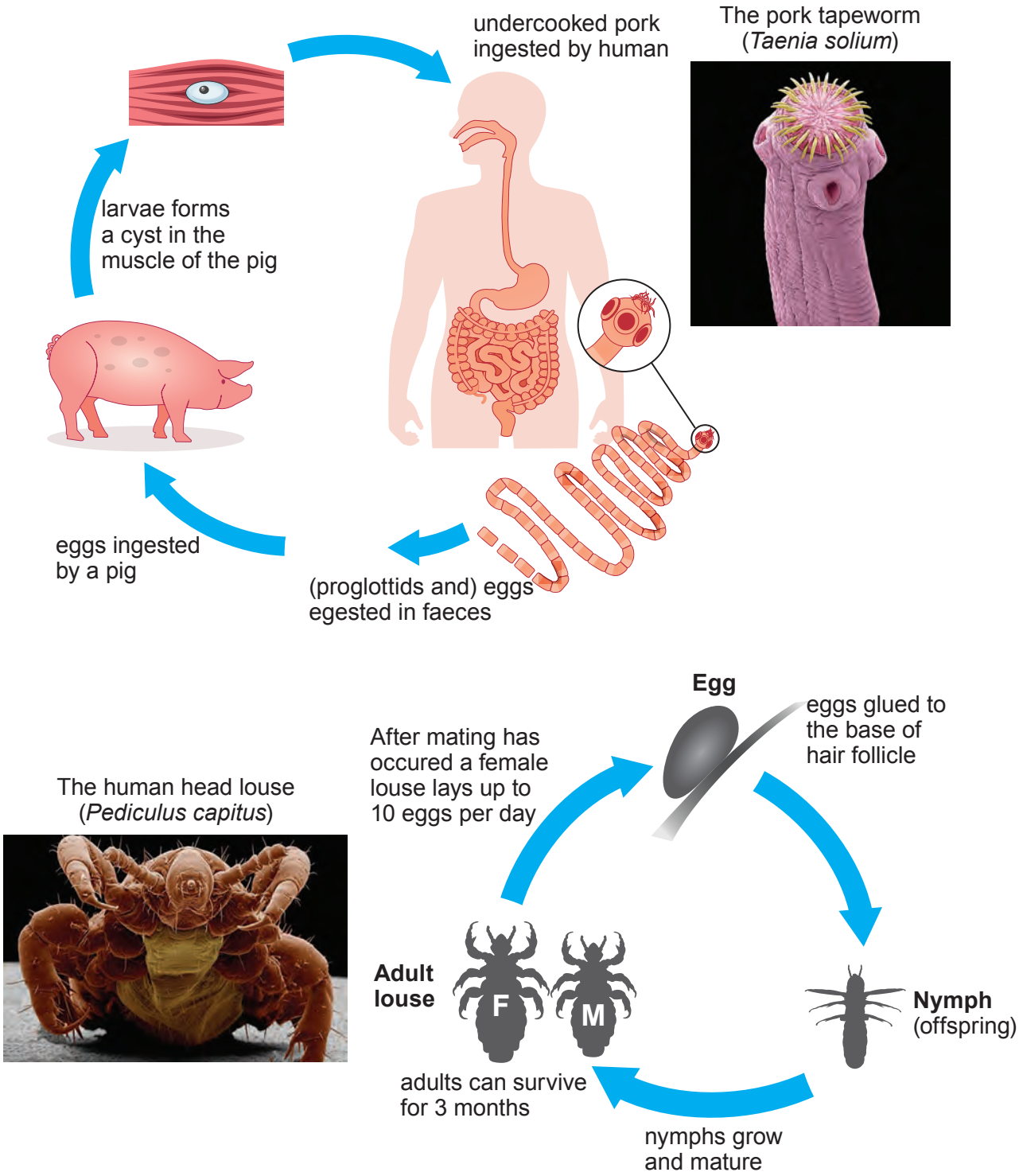
6. **Image 6.1** shows two human parasites, the pork tapeworm (*Taenia solium*) and a head louse (*Pediculus capitus*). The diagrams illustrate the life cycles of these parasites. The diagrams are not to scale.

Image 6.1



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Using the information given in **Image 6.1** and your own knowledge, describe the general adaptations shown by **both** organisms to a **parasitic mode of life** and explain the **specific adaptations** of *Taenia* and *Pediculus*. [9 QER]

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