Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3400UB0-1

Z22-3400UB0-1

TUESDAY, 17 MAY 2022 – MORNING

BIOLOGY – Unit 2:
Variation, Homeostasis and Micro-organisms

HIGHER TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**11**	
3.	**8**	
4.	**9**	
5.	**7**	
6.	**9**	
7.	**9**	
8.	**11**	
9.	**7**	
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 or correction fluid.

You may use 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 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.

Question **7**(b) is a quality of extended response (QER) question where your writing skills will be assessed.

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Answer **all** questions.

1. Biological control is used to reduce the numbers of a pest population through the introduction of another species. It has been used with varying success since the 19th century.

(a) (i) State **two** advantages of this method of control. [2]

Advantage 1

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Advantage 2

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(ii) State **two** disadvantages of this method of control. [2]

Disadvantage 1

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Disadvantage 2

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(b) The whitefly *(Trialeurodes vaporariorum)* is a pest which damages greenhouse crops such as tomatoes. Whitefly numbers can be reduced by using the biological control agent *Encarsia formosa*.

***Encarsia formosa* fact file**

- *E. formosa* is a tiny wasp that lays eggs inside developing whitefly.
- When the eggs hatch, the young wasps kill the developing whitefly from the inside.
- Optimal conditions for *E. formosa* are temperatures over 20°C.
- When daytime temperatures are less than 17°C, *E. formosa* activity is significantly reduced, making it less effective.

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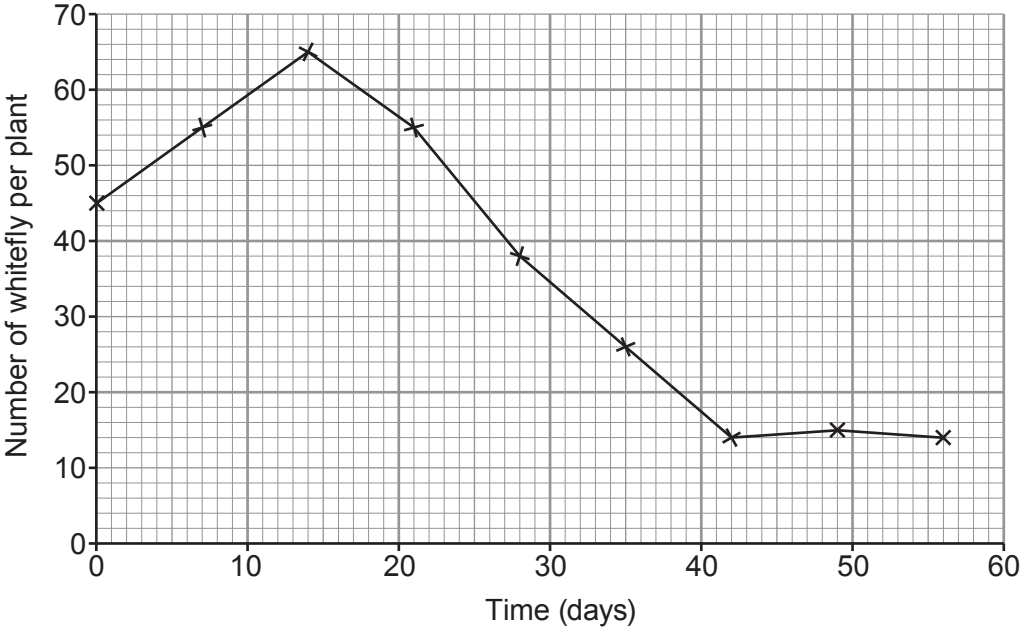
Graph 1.1 shows the number of whiteflies in a greenhouse containing tomato plants. *E. formosa* were introduced on day 7.

Graph 1.1



(i) I. The use of *E. formosa* to reduce the number of whiteflies is considered to be successful when there are 20 or fewer whiteflies per plant. Use **Graph 1.1** to determine how many days it took for the number of whiteflies to fall to 20 following the introduction of *E. formosa*. [2]

..... days

II. Suggest a reason why it took this long for the number to fall to 20. [1]

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(ii) Suggest **one** reason why this method of pest control would not be effective to use if whiteflies damaged wheat crops grown in Wales. [1]

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(iii) An alternative approach to reducing pest numbers is to use pesticide. State why it is not appropriate to use pesticide along with *E. formosa*. [1]

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2. Hair length in cats is controlled by a pair of alleles. The allele for short hair (**H**) is dominant to the allele for long hair (**h**).

(a) State what is meant by the terms:

(i) allele; [1]

.....

.....

(ii) dominant; [1]

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(iii) recessive. [1]

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(b) (i) A cat breeder crossed a homozygous short-haired cat with a long-haired cat. **Complete the Punnett square** to show the predicted genotypes of the offspring. Use the letters **H** and **h** for the alleles. [2]

Gametes		

(ii) State the **phenotype** of the offspring in the F1 generation. [1]

.....

(iii) **Complete the Punnett square** to show the possible genotypes of the offspring if two of the F1 offspring were crossed. [2]

Gametes		

(iv) Using the results from (b)(iii), state how many kittens would be predicted to be short-haired in a litter of 8 kittens. [1]

.....

(v) The cat breeder wanted to determine whether one of the short-haired cats was homozygous or heterozygous. She decided to breed the short-haired cat with a long-haired cat. Predict the phenotypes of the offspring you would expect if the short-haired cat was:

I. Homozygous [1]

.....

II. Heterozygous [1]

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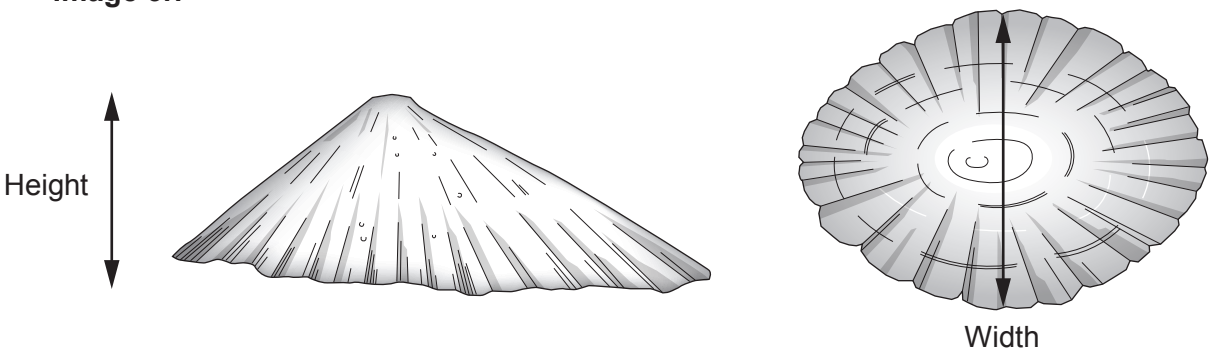
3. The common limpet *(Patella vulgata)* is found attached to rocks on most rocky shores in Wales. Limpets attach firmly to the rocks using a muscular foot. They also rotate their shell and grind it into rock to seal it into the rock. Limpets vary in height and width.

The common limpet

A survey was carried out to investigate the variation in the size of limpet shells on upper and lower shores in Cemlyn Bay, Anglesey in North Wales. The height and width of each shell were measured to the nearest mm as shown in **Image 3.1**.

Image 3.1



These measurements were used to calculate the height : width ratio.

$$\text{Ratio} = \frac{\text{height}}{\text{width}} : 1$$

(a) (i) State what is meant by the term variation. [2]

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(ii) State the type of variation shown in the size of the limpets. [1]

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Table 3.2

Limpet number	Limpet shell height : width ratio	
	Upper shore	Lower shore
1	1.35 : 1	0.38 : 1
2	1.53 : 1	0.36 : 1
3	1.47 : 1	0.41 : 1
4	1.80 : 1	0.28 : 1
5	3.11 : 1	0.44 : 1
6	3.00 : 1	0.57 : 1
7	2.56 : 1	0.58 : 1
8	2.45 : 1	0.37 : 1
9	2.00 : 1	0.27 : 1
10	2.42 : 1	0.30 : 1
Mean	2.17 : 1	..... : 1

(b) (i) Calculate the mean shell height : width ratio for limpets sampled on the lower shore. **Write your answer in Table 3.2.** [2]
Space for working

(ii) State the conclusion that can be made about the height to width ratios of limpets and their position on the shore. Suggest a reason for this. [2]

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(iii) State how the students could increase confidence in their results. [1]

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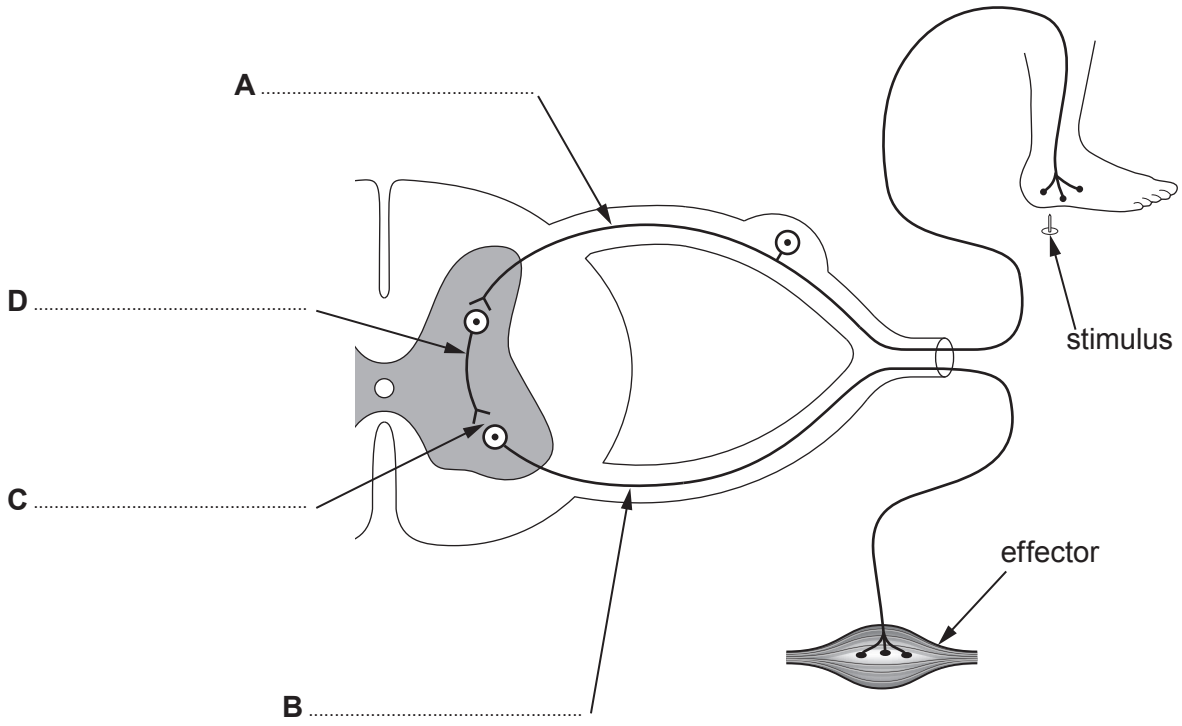
4. **Image 4.1** shows a reflex arc.



(a) (i) Label **A–D** on **Image 4.1**. [4]

(ii) State **two** properties of reflex actions. [1]

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(iii) The length of neurone **B** is 0.9 m. An electrical impulse can travel along a neurone at 75 m/s.

Use the following equation:

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

to calculate the time taken for the impulse to travel the length of neurone **B**. [2]

Time = ...s

(b) Motor neurone disease prevents motor neurones functioning effectively.
Explain why individuals with the disease find it difficult to walk. [2]

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5. The yellow crazy ant *(Anoplolepis gracilipes)* was introduced accidentally to northern Australia. Due to the ecological damage it has caused, it is on a list of "one hundred of the world's worst invasive species" produced by the International Union for Conservation of Nature (IUCN). The ants build super-colonies that disrupt native habitats.

Yellow crazy ants

(a) (i) State what is meant by the term invasive species. [1]

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(ii) State the genus of the yellow crazy ant. [1]

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(iii) Explain how the formation of super-colonies affects biodiversity. [1]

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(b) Female ants have a chromosome number of 34 and produce gametes through the process of meiosis.

(i) State how many gametes are produced from each mother cell. [1]

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(ii) Males develop from female eggs which have not been fertilised. Conclude the chromosome number in males and explain your answer. [2]

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(iii) State **one** function of mitosis in adult ants. [1]

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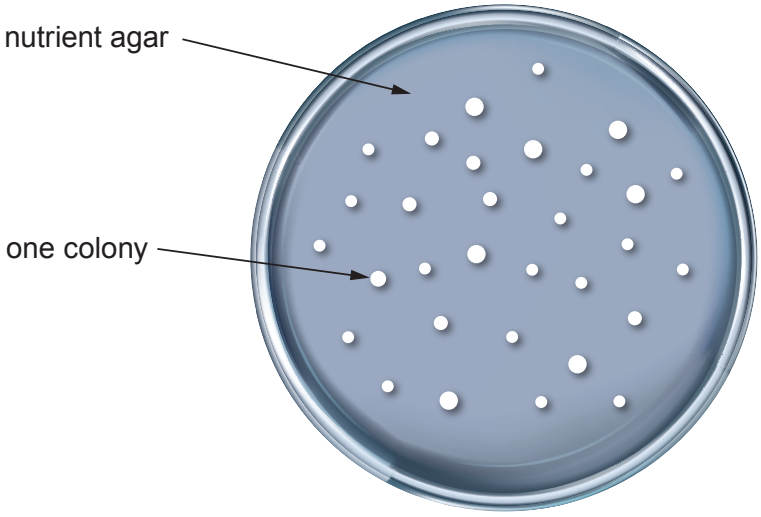
6. Environmental health officers estimated the number of bacteria in a milk sample from a cafe. The limit for the total number of bacteria in a sample of milk which is considered to be safe for human consumption is 1.0×10^5 bacteria per cm^3.

- Using aseptic techniques, they diluted the sample by a factor of 10 000.
- They plated 1 cm^3 of the diluted sample onto nutrient agar.
- The lid of the plate was secured with tape.
- The plate was incubated at 37 °C for 2 days.
- The result is shown in **Image 6.1**.

Image 6.1



(a) (i) State the assumption that must be made when calculating the number of bacterial cells present in the original sample. [1]

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(ii) I. Calculate the number of bacteria in 1 cm^3 of the original sample taken by the environmental health officers. **Write your answer in standard form.** [3]

Number of bacteria = ...

II. Conclude whether the milk sample was safe for human consumption. Explain your answer. [1]

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(b) Suggest why the plates were incubated at 37 °C. [1]

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(c) (i) State why the lids of the agar plates were secured with tape. [1]

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(ii) State **two** other precautions that should have been taken to ensure aseptic technique. [2]

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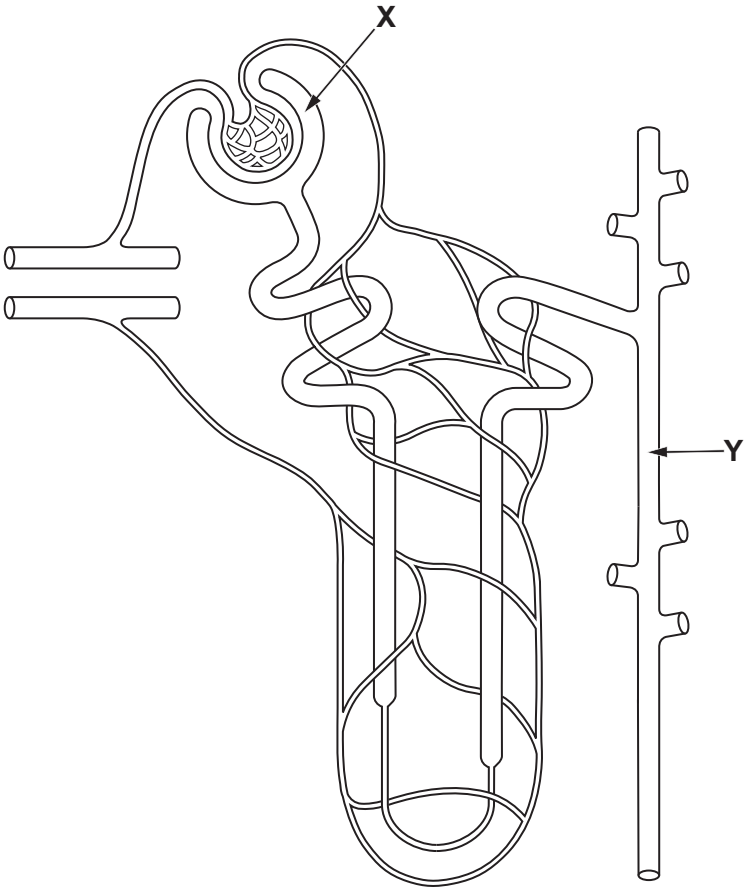
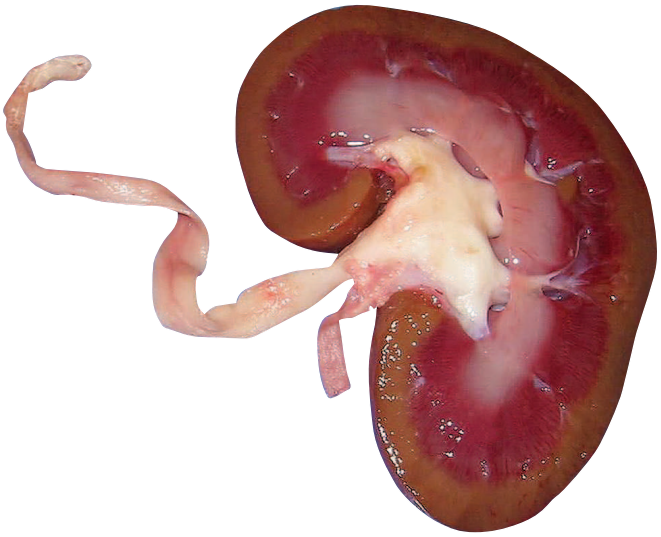
7. **Image 7.1** shows the structure of a nephron.

Image 7.1



(a) **Use a labelled line** to show the position of structure **X** (shown in **Image 7.1**) in the section through the kidney in **Image 7.2**. [1]

Image 7.2



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(b) The filtrate found at **X** in **Image 7.1** differs from the filtrate found at **Y** in **Image 7.1**. Describe and explain the composition of the filtrate at **X** and **Y**, identifying structures **X** and **Y** in your answer.
(No reference to ADH is required) [6 QER]

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(c) Protein is found in the blood in the capillary knot but is not found in the filtrate at **X**. Explain this observation. [2]

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8. There are many different types of cancer. One of the most common is breast cancer. In approximately 30% of breast cancers a high level of HER2 protein is present, this is due to a mutation in the HER2 gene. The high level of HER2 protein found on the surface of the cells causes them to grow and divide excessively.

(a) State what is meant by the term mutation. [1]

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(b) (i) In Wales, approximately 2 900 people are diagnosed with breast cancer each year. Calculate how many of those diagnosed would be expected to have a high level of HER2 protein present. [2]

Number of people = ...

(ii) Explain how the HER2 gene codes for the production of HER2 protein. [3]

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(c) Since 1985, approximately 100 different monoclonal antibodies have been developed and some are used in the treatment of breast cancer linked to the mutated HER2 gene. During chemotherapy a drug is attached to the monoclonal antibody to target these cancer cells directly.

Explain how the monoclonal antibody targets these cancer cells directly. [3]

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(d) State **two** other uses of monoclonal antibodies. [2]

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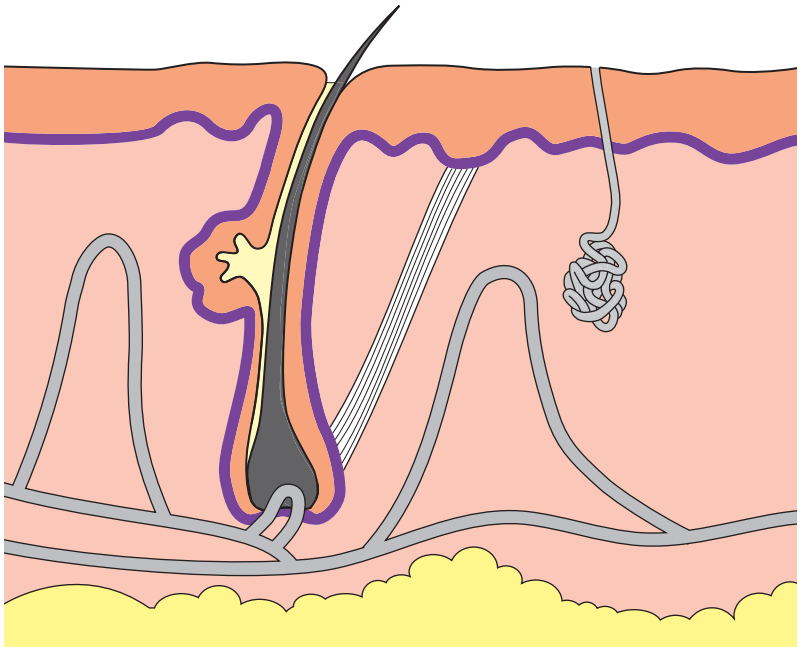
9. **Image 9.1** shows a section through human skin.

Image 9.1



(a) On **Image 9.1**, **draw labelled arrows to name and identify**:

(i) the structure where sweat is produced; [1]

(ii) a structure which transports blood. [1]

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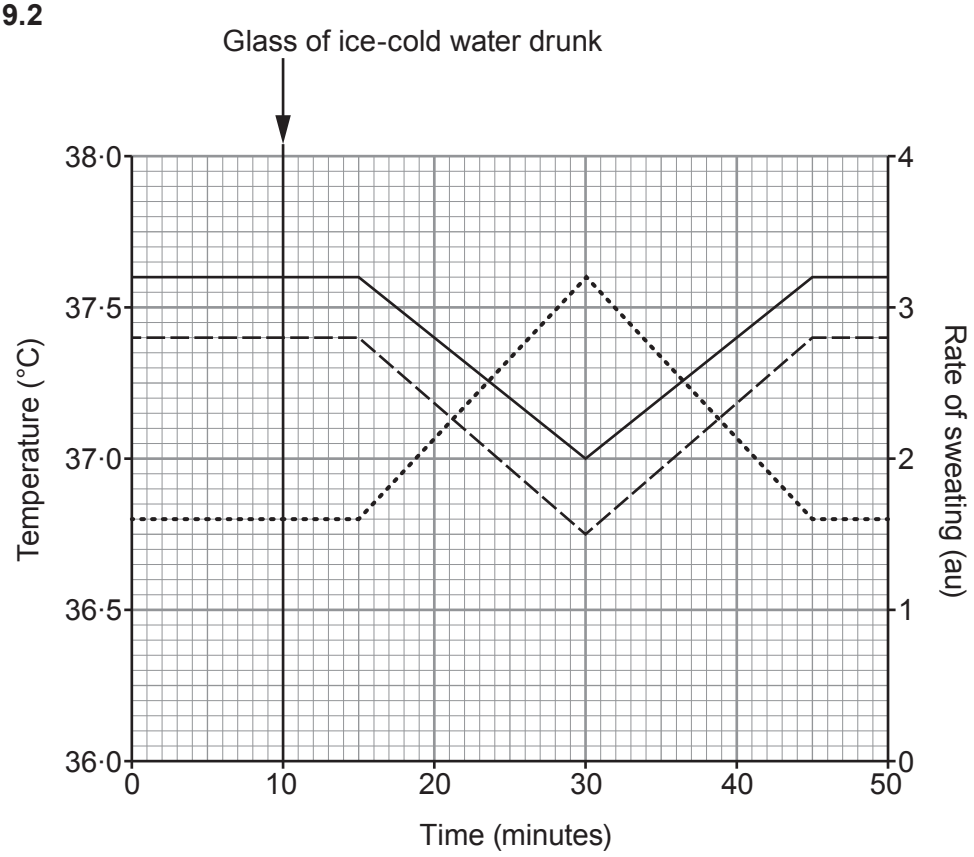
Gareth carried out an experiment to investigate homeostasis. He sat in a room heated to 50°C. His internal body temperature, rate of sweating and skin temperature were monitored.
After 10 minutes in the room, he drank a glass of ice-cold water. The results are shown in **Graph 9.2**.

Graph 9.2



Key:

——— Internal body temperature

– – – – – Rate of sweating

····· Skin temperature

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(b) Explain the effect that drinking the ice-cold water had on Gareth between 10 minutes and 30 minutes, as shown on **Graph 9.2**. [5]

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END OF PAPER

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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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