Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level
BIOLOGY

Paper 1

Monday 12 June 2017 Afternoon Time allowed: 2 hours

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All work must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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Answer **all** questions in the spaces provided.

0 1 . 1 Give the **two** types of molecule from which a ribosome is made.

[1 mark]

0 1 . 2 Describe the role of a ribosome in the production of a polypeptide. Do **not** include transcription in your answer.

[3 marks]

Do not write outside the box

0 1 . 3 **Table 1** shows the base sequence of part of a pre-mRNA molecule from a eukaryotic cell.

Complete the table with the base sequence of the DNA strand from which this pre-mRNA was transcribed.

[1 mark]

Table 1

									DNA
A	C	G	C	A	U	U	A	U	pre-mRNA

0 1 . 4 In a eukaryotic cell, the base sequence of the mRNA might be different from the sequence of the pre-mRNA.

Explain why.

[2 marks]

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7

Turn over for the next question

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0 2 In mammals, in the early stages of pregnancy, a developing embryo exchanges substances with its mother via cells in the lining of the uterus. At this stage, there is a high concentration of glycogen in cells lining the uterus.

0 2 . 1 Describe the structure of glycogen.

[2 marks]

0 2 . 2 During early pregnancy, the glycogen in the cells lining the uterus is an important energy source for the embryo.

Suggest how glycogen acts as a source of energy.

Do **not** include transport across membranes in your answer.

[2 marks]

Do not write outside the box

0 2 . 3 Suggest and explain **two** ways the cell-surface membranes of the cells lining the uterus may be adapted to allow rapid transport of nutrients.

[2 marks]

1 _____

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2 _____

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0 2 . 4 In humans, after the gametes join at fertilisation, every cell of the developing embryo undergoes mitotic divisions before the embryo attaches to the uterus lining.

- The first cell division takes 24 hours.
- The subsequent divisions each take 8 hours.

After 3 days, the embryo has a total volume of 4.2×10^{-3} mm^3.

What is the mean volume of each cell after 3 days? Express your answer in standard form.

Show your working.

[2 marks]

Answer = _____ mm^3

8

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0 3 . 1 Sodium ions from salt (sodium chloride) are absorbed by cells lining the gut. Some of these cells have membranes with a carrier protein called NHE3.

NHE3 actively transports one sodium ion into the cell in exchange for one proton (hydrogen ion) out of the cell.

Use your knowledge of transport across cell membranes to suggest how NHE3 does this.

[3 marks]

Do not write outside the box

0 3 . 2 Scientists investigated the use of a drug called Tenapanor to reduce salt absorption in the gut. Tenapanor inhibits the carrier protein, NHE3.

The scientists fed a diet containing a high concentration of salt to two groups of rats, **A** and **B**.

- The rats in Group **A** were **not** given Tenapanor (0 mg kg^{-1}).
- The rats in Group **B** were given 3 mg kg^{-1} Tenapanor.

One hour after treatment, the scientists removed the gut contents of the rats and immediately weighed them.

Their results are shown in **Table 2**.

Table 2

Concentration of Tenapanor / mg kg^{-1}	**Mean mass of contents of the gut / g**
0	2.0
3	4.1

The scientists carried out a statistical test to see whether the difference in the means was significant. They calculated a P value of less than 0.05.

They concluded that Tenapanor did reduce salt absorption in the gut.

Use all the information provided and your knowledge of water potential to explain how they reached this conclusion.

[4 marks]

Do not write outside the box

0 3 . 3 High absorption of salt from the diet can result in a higher than normal concentration of salt in the blood plasma entering capillaries. This can lead to a build-up of tissue fluid.

Explain how.

[2 marks]

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ANSWER IN THE SPACES PROVIDED

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0 4 . 1 Bacteria are often used in industry as a source of enzymes. One reason is because bacteria divide rapidly, producing a large number of them in a short time.

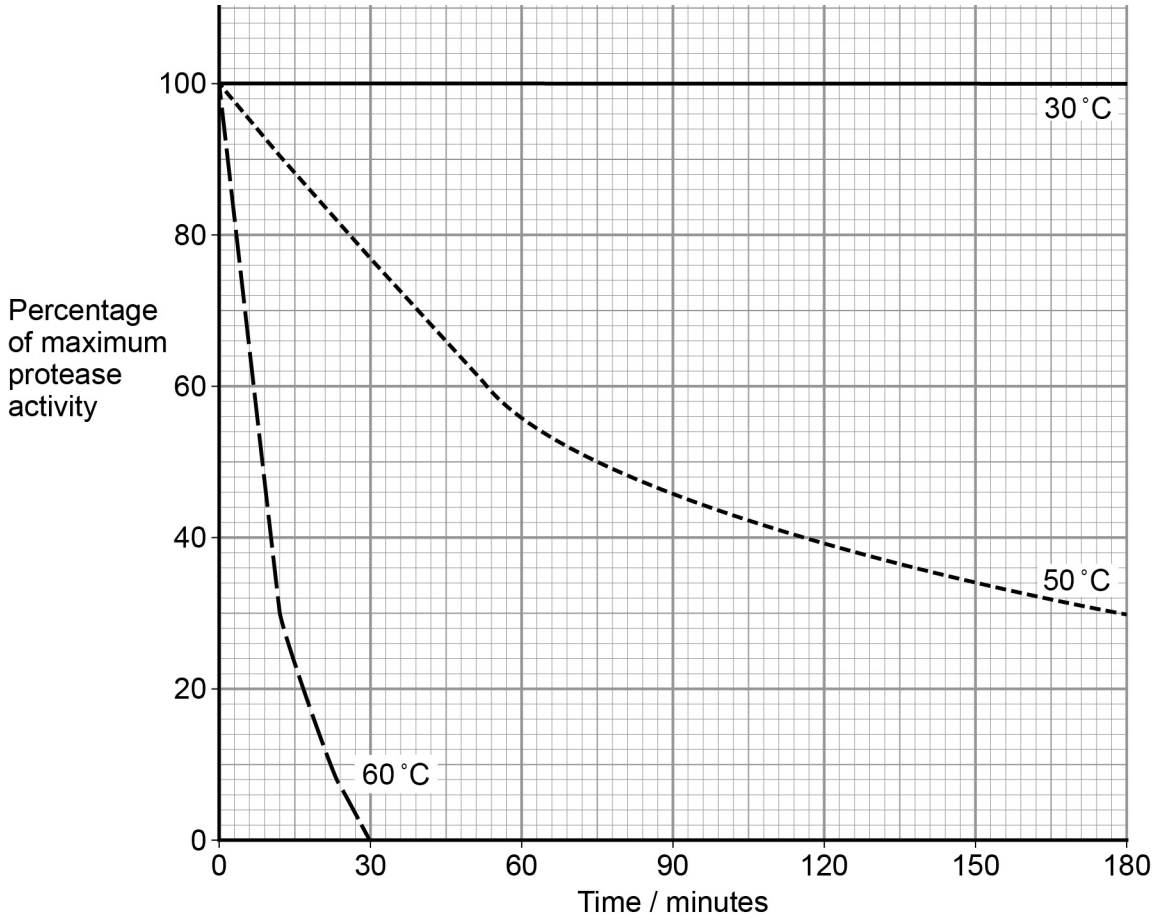
Describe how bacteria divide.

[2 marks]

0 4 . 2 Washing powders often contain enzymes from bacteria. These enzymes include proteases that hydrolyse proteins in clothing stains.

Figure 1 shows the effect of temperature on a protease that could be used in washing powder.

Figure 1



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Explain the shape of the curves at 50 °C and 60 °C.

[4 marks]

0 4 . 3 Some proteases are secreted as extracellular enzymes by bacteria.

Suggest **one** advantage to a bacterium of secreting an extracellular protease in its natural environment.

Explain your answer.

[2 marks]

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0 4 . 4 Mammals have some cells that produce extracellular proteases. They also have cells with membrane-bound dipeptidases.

Describe the action of these membrane-bound dipeptidases and explain their importance.

[2 marks]

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0 5 Scientists investigated treatment of a human bladder infection caused by a species of bacterium. This species of bacterium is often resistant to the antibiotics currently used for treatment.

They investigated the use of a new antibiotic to treat the bladder infection. The new antibiotic inhibits the bacterial ATP synthase enzyme.

0 5 . 1 Place a tick (✓) in the appropriate box next to the equation which represents the reaction catalysed by ATP synthase.

[1 mark]

$ATP \longrightarrow ADP + P_i + H_2O$ ☐

$ATP + H_2O \longrightarrow ADP + P_i$ ☐

$ADP + P_i \longrightarrow ATP + H_2O$ ☐

$ADP + P_i + H_2O \longrightarrow ATP$ ☐

0 5 . 2 The new antibiotic is safe to use in humans because it does **not** inhibit the ATP synthase found in human cells.

Suggest why human ATP synthase is not inhibited and bacterial synthase is inhibited.

[1 mark]

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Question 5 continues on the next page

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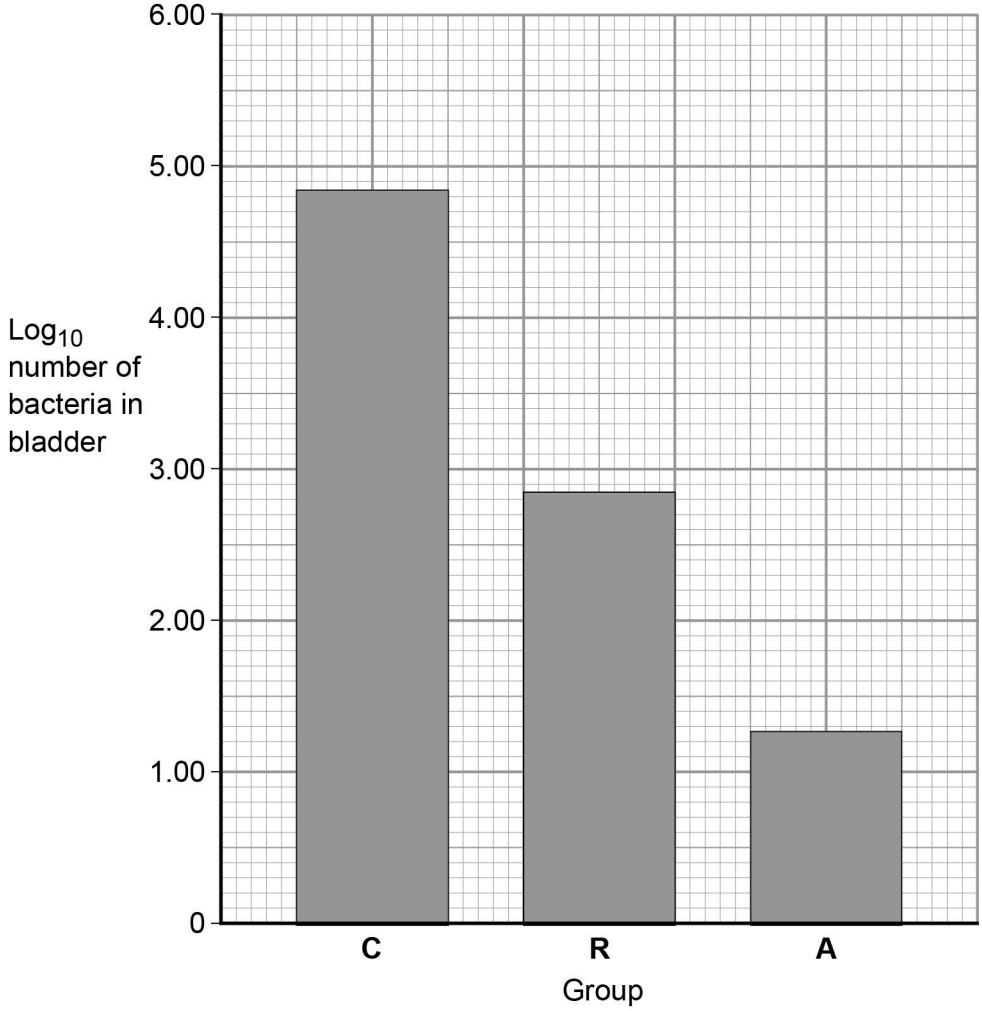
0 5 . 3 The scientists tested the new antibiotic on mice with the same bladder infection. They divided these mice into three groups, **C**, **R** and **A**.

- Group **C** was the control (untreated).
- Group **R** was treated with an antibiotic currently used against this bladder infection.
- Group **A** was treated with the new antibiotic.

They removed samples from the bladder of these mice after treatment and estimated the total number of bacteria in the bladder.

Their results are shown in **Figure 2**.

Figure 2



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The antibiotics were given to the mice at a dose of 25 mg kg^{-1} per day.

Calculate how much antibiotic would be given to a 30 g mouse each day.

Show your working.

[2 marks]

Answer = _____ mg

0 5 . 4 Calculate the percentage difference in actual numbers of bacteria in group **A** compared with group **R**. The actual number of bacteria can be calculated from the $\log_{10}$ value by using the 10^x function on a calculator.

Show your working.

[2 marks]

Answer = _____ %

Question 5 continues on the next page

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0 5 . 5 The scientists suggested that people newly diagnosed with this bladder infection should be treated with both the current antibiotic and the new antibiotic.

Explain why the scientists made this suggestion.

Use information from **Figure 2** and your knowledge of evolution of antibiotic resistance in bacteria in your answer.

[3 marks]

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0 6 2,4-D is a selective herbicide that kills some species of plants but not others. 2,4-D disrupts cell-surface membranes but the extent of disruption differs in different species.

Scientists investigated the effect of 2,4-D on wheat plants (a crop) and on wild oat plants (a weed).

They grew plants of both species in glasshouses. They put plants of each species into one of two groups, **W** and **H**, which were treated as follows:

- Group **W** – leaves sprayed with water
- Group **H** – leaves sprayed with a solution of 2,4-D.

After spraying, they cut 40 discs from the leaves of plants in each group and placed them in flasks containing 10 cm^3 de-ionised water. After 5 minutes, they calculated the disruption to cell-surface membranes by measuring the concentration of ions released into the water from the leaf discs.

Their results are shown in **Table 3**.

The lowest significant difference (LSD), is the smallest difference between two means that would be significant at $P \leq 0.05$

Table 3

Group	Treatment	Mean concentration of ions in water / arbitrary units	
		Wheat	Wild oats
W	Water	26	45
H	2,4-D	27	70
Lowest significant difference (LSD)		7	10

0 6 . 1 Give **three** environmental variables that should be controlled when growing the plants before treatment with the different sprays.

[2 marks]

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2 _____

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3 _____

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0 6 . 2 Evaluate the use of 2,4-D as a herbicide on a wheat crop that contains wild oats as a weed. Use all the information provided.

[4 marks]

Question 6 continues on the next page

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0 6 . 3 The scientists incubated the flasks containing the leaf discs at 26 °C and gently shook the flasks.

Suggest **one** reason why the scientists ensured the temperature remained constant and **one** reason why the leaf discs were shaken.

[2 marks]

Temperature _____

_____

_____

Shaken _____

_____

_____

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0 7 . 1 Describe how phagocytosis of a virus leads to presentation of its antigens.

[3 marks]

0 7 . 2 Describe how presentation of a virus antigen leads to the secretion of an antibody against this virus antigen.

[3 marks]

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0 7 . 3 Collagen is a protein produced by cells in joints, such as the knee.

Rheumatoid arthritis (RA) is an auto-immune disease. In an auto-immune disease, a person's immune system attacks their own cells. RA causes pain, swelling and stiffness in the joints.

Scientists have found a virus that produces a protein very similar to human collagen.

Suggest how the immune response to this viral protein can result in the development of RA.

[2 marks]

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Turn over for the next question

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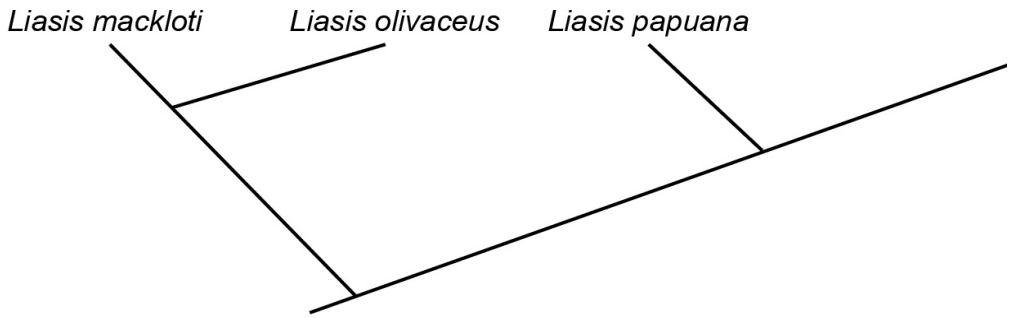
0 8 **Figure 3** shows two different ways of classifying the same three species of snake.

- Classification **X** is based on the frequency of observable characteristics
- Classification **Y** is based on other comparisons of genetic characteristics.

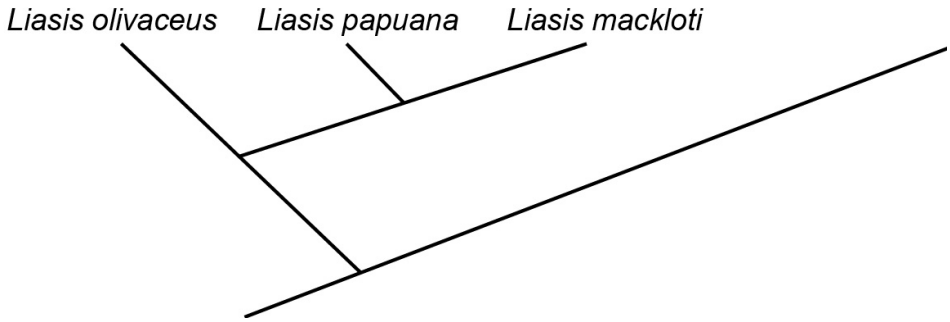
All three species of snake belong to the Python family.

Figure 3

Classification **X**



Classification **Y**



0 8 . 1 What do these classifications suggest about the evolutionary relationships between these species of snake?

[2 marks]

Classification **X** _____

_____

_____

_____

Classification **Y** _____

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0 8 . 2 Complete **Table 4** below to show the missing names of the taxa when classifying these snakes.

[1 mark]

Table 4

Taxon (hierarchical order)	Name
	Eukaryote
	Animal
	Chordata
	Reptilia
	Squamata
Family	Python

0 8 . 3 There is a debate about the name of one of these species of snake. Some scientists name it *Liasis papuana* and other scientists name it *Apodora papuana*.

Give the name of the taxon about which the scientists disagree.

[1 mark]

_____

_____

0 8 . 4 State **three** comparisons of genetic diversity that the scientists used in order to generate Classification **Y**.

[3 marks]

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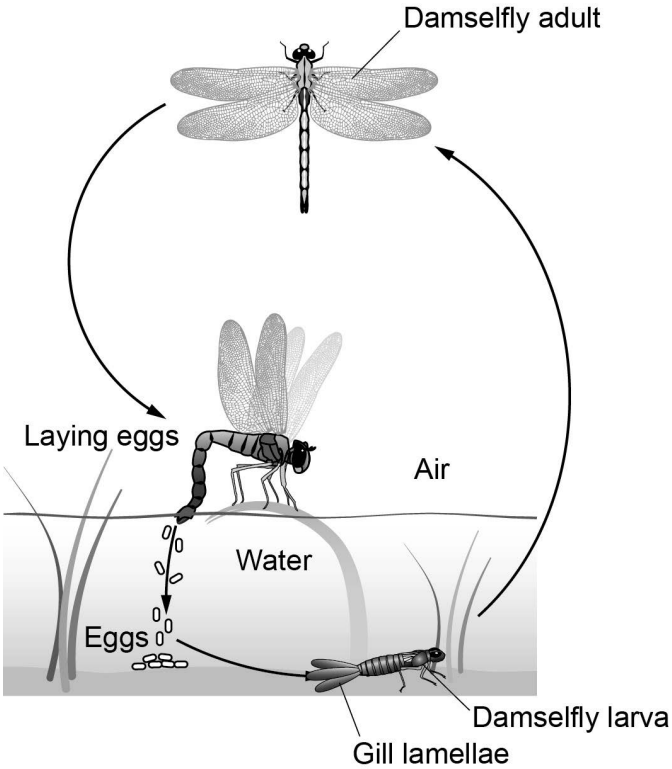
0 9 **Figure 4** shows the stages of development of an insect called a damselfly.

Figure 4



0 9 . 1 The adult damselfly uses a tracheal system for gas exchange.

Explain **three** ways in which an insect's tracheal system is adapted for efficient gas exchange.

[3 marks]

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0 9 . 2 The damselfly larva is a carnivore that actively hunts prey. It has gills to obtain oxygen from water.

Some other species of insect have larvae that are a similar size and shape to damselfly larvae and also live in water. These larvae do **not** actively hunt prey and do **not** have gills.

Explain how the presence of gills adapts the damselfly to its way of life.

[2 marks]

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0 9 . 3 A scientist measured the size of each gill lamella of the gills of 40 damselfly larvae. His results are shown in **Table 5**.

Table 5

Mean width / mm (± uncertainty / mm)	1.61 (± 0.19)
Mean length / mm (± uncertainty / mm)	6.12 (± 0.41)

Calculate the mean surface area of **one side** of one gill lamella. Assume that a gill lamella is rectangular and give your answer to an **appropriate number of significant figures**.

Include the percentage error (uncertainty) of surface area in your answer.
Show your working.

[3 marks]

Mean surface area = _____

Percentage error (uncertainty) of surface area = _____

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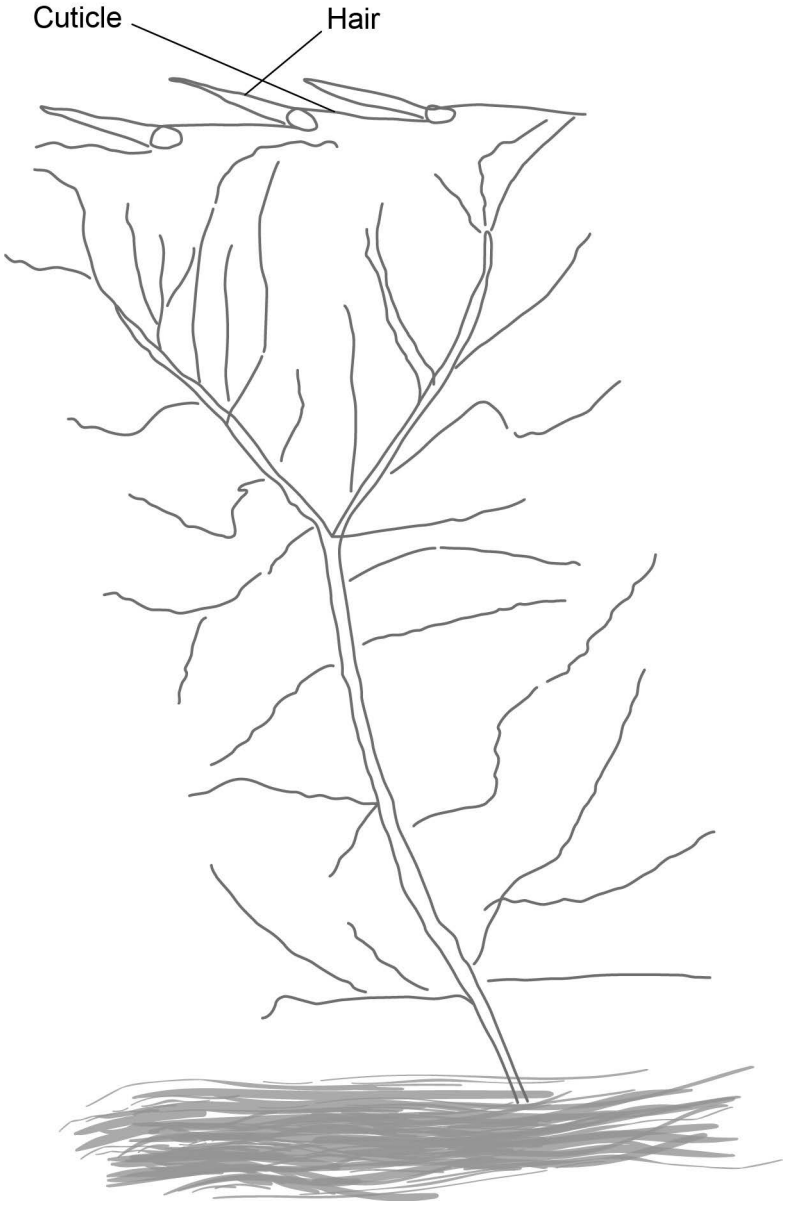
0 9 . 4 A student used an optical microscope to observe part of a damselfly larva gill.

Figure 5 shows the drawing the student produced.

Figure 5

Part of a damselfly larva's gill



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Suggest **two** ways the student could improve the quality of her scientific drawing of this gill.

[2 marks]

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Turn over for the next question

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1 0 . 1 Contrast how an optical microscope and a transmission electron microscope work **and** contrast the limitations of their use when studying cells.

[6 marks]

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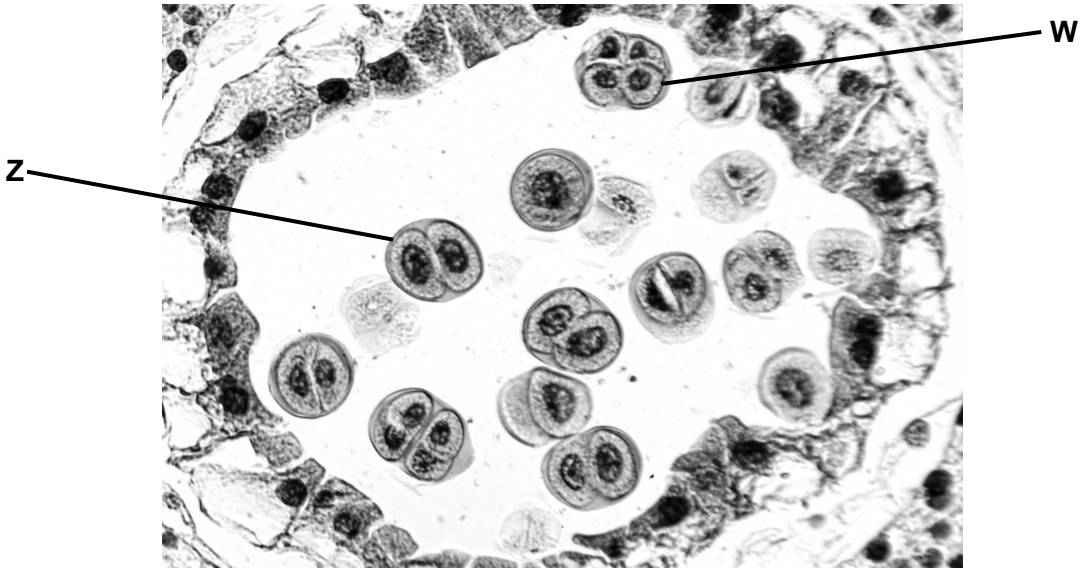
1 0 . 2 **Figure 6** shows an image from an optical microscope of meiosis occurring in a flower bud of a flowering plant. **W** and **Z** are undergoing meiosis.

Figure 6



Explain the appearance of **W** and **Z**.

[4 marks]

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1 0 . 3 An environmental scientist investigated a possible relationship between air pollution and the size of seeds produced by one species of tree.

He was provided with a very large number of seeds collected from a population of trees in the centre of a city and also a very large number of seeds collected from a population of trees in the countryside.

Describe how he should collect and process data from these seeds to investigate whether there is a difference in seed size between these two populations of trees.

[5 marks]

END OF QUESTIONS

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