Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
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7	
8	
9	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Biology BIOL2

Unit 2 The variety of living organisms

Monday 1 June 2015 1.30 pm to 3.15 pm

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

Time allowed
- 1 hour 45 minutes

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.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

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

1 (a) What is the function of the coronary arteries?

[2 marks]

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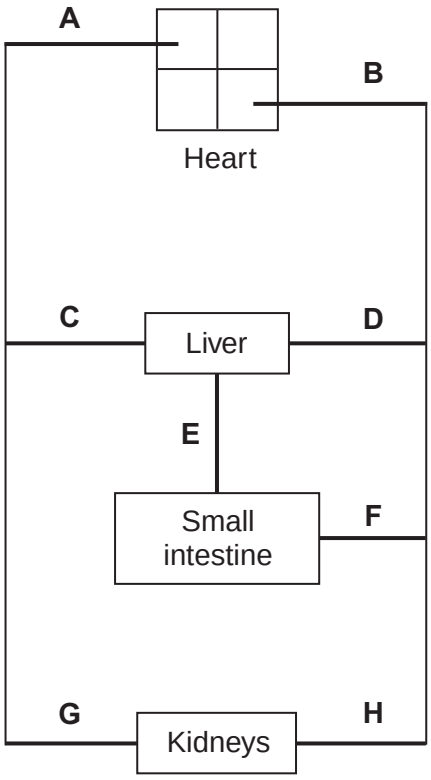
1 (b) **Figure 1** shows some of the large blood vessels in a mammal.

Figure 1



1 (b) (i) Which of the blood vessels **A** to **H** is the vena cava?

[1 mark]

1 (b) (ii) Which of the blood vessels **A** to **H** is the renal artery?

[1 mark]

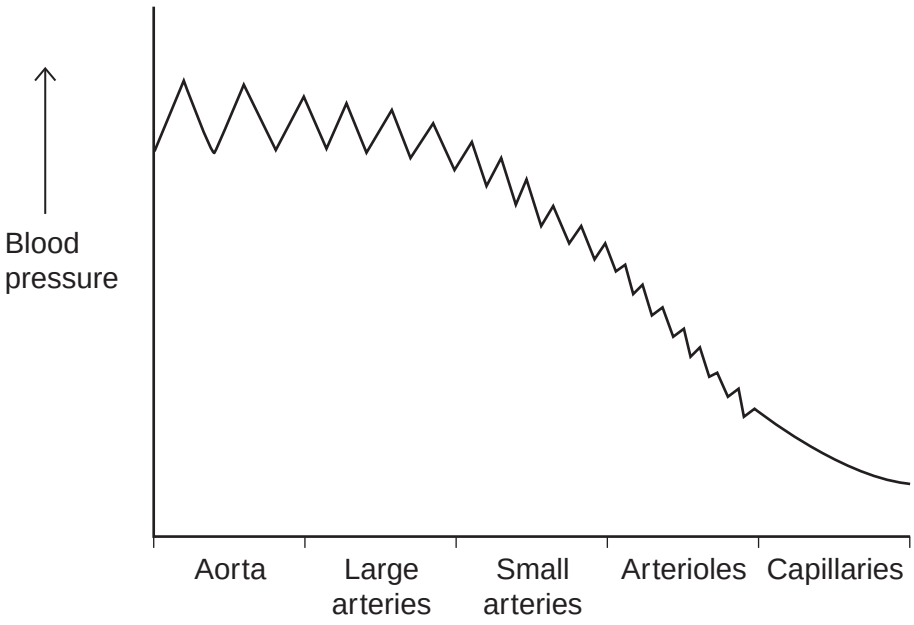
1 (b) (iii) Which of the blood vessels **A** to **H** is the hepatic portal vein?

[1 mark]

Question 1 continues on the next page

1 (c) **Figure 2** shows how the blood pressure changes as blood travels from the aorta to the capillaries.

Figure 2



The rise and fall in blood pressure in the aorta is greater than in the small arteries. Suggest why.

[3 marks]

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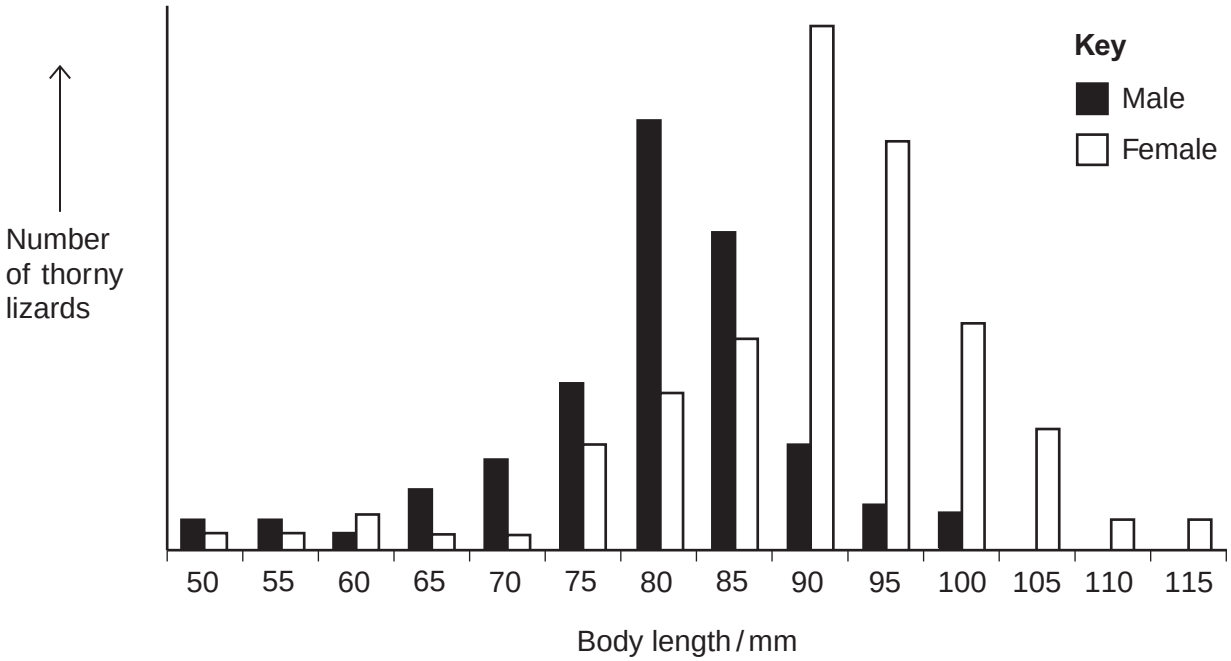
2 (a) Ecologists measured the body lengths of male and female thorny lizards living in the same habitat. The ecologists measured the body lengths to the nearest 5 mm. **Figure 3** shows how they presented their results.

Figure 3



Give **two** differences in the variation in body length of male and female thorny lizards.

[2 marks]

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Question 2 continues on the next page

2 (b) Another group of ecologists investigated biodiversity of lizards in a woodland area.

Table 1 shows their results.

Table 1

Lizard species	Number of individuals
Dominican giant anole	5
Hispaniolan green anole	11
Hispaniolan stout anole	22
Bark anole	91
Hispaniolan grass anole	13
Cope's galliwasp	5
Cochran's least gecko	8
Peninsula least gecko	1

The index of diversity can be calculated using the formula

$$d = \frac{N(N-1)}{\Sigma\, n(n-1)}$$

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

2 (b) (i) Use the formula to calculate the index of diversity of lizards in the woodland area.
Show your working.

[2 marks]

Answer = ...

2 (b) (ii) The ecologists also determined the index of diversity of lizards in an oil palm plantation next to the woodland area. They found fewer species of plant in the oil palm plantation. Lizards feed on plants and insects.

Explain why fewer species of plant would lead to fewer species of lizard in the oil palm plantation.

[3 marks]

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[Extra space] .....

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7

Turn over for the next question

3 (a) (i) Give **two** ways in which the structure of starch is **similar** to cellulose.

[2 marks]

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2 .....

3 (a) (ii) Give **two** ways in which the structure of starch is **different** from cellulose.

[2 marks]

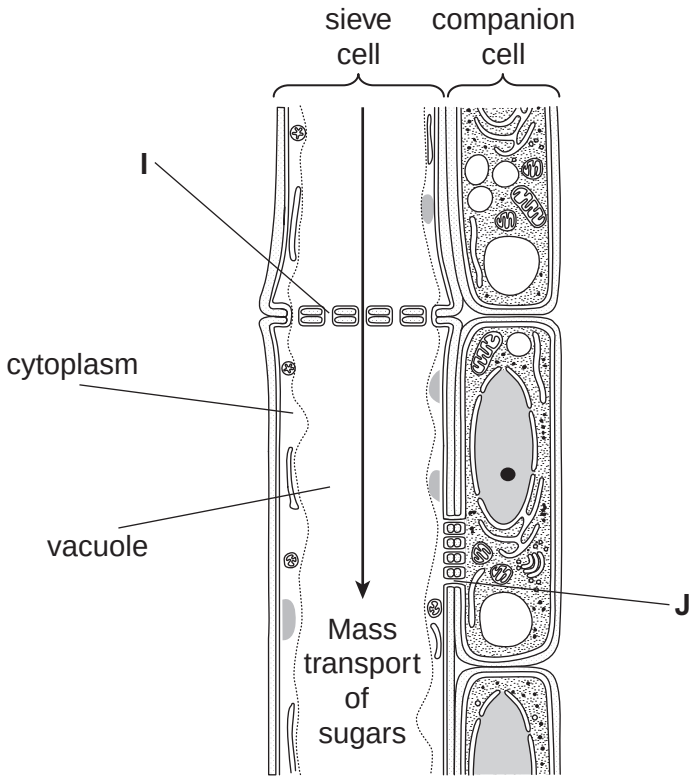
1 .....

2 .....

3 (b) In plants, mass transport of sugars takes place through columns of sieve cells in the phloem. Other cells, called companion cells, transport sugars into, and out of, the sieve cells.

Figure 4 shows the structure of phloem.

Figure 4



Structures **I** and **J** allow the transport of sugars between cells.

3 (b) (i) Using **Figure 4**, suggest and explain **one** other way in which sieve cells are adapted for mass transport.

[2 marks]

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3 (b) (ii) Using **Figure 4**, suggest and explain **one** other way in which companion cells are adapted for the transport of sugars between cells.

[2 marks]

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Turn over for the next question

4 (a) (i) Describe the role of DNA polymerase in DNA replication.

[1 mark]

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4 (a) (ii) Other than being smaller, give **two** ways in which prokaryotic DNA is different from eukaryotic DNA.

[2 marks]

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2 .....

4 (b) **Table 2** shows the percentage of each base in the DNA from three different organisms.

Table 2

Organism	Percentage of each base in DNA			
	Adenine	Guanine	Thymine	Cytosine
Human	30.9	19.9	29.4	19.8
Grasshopper	29.4	20.5	29.4	20.7
Virus	24.0	23.3	21.5	31.2

4 (b) (i) Humans and grasshoppers have very similar percentages of each base in their DNA but they are very different organisms.

Use your knowledge of DNA structure and function to explain how this is possible.

[2 marks]

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4 (b) (ii) The DNA of the virus is different from that of other organisms.

Use **Table 2** and your knowledge of DNA to suggest what this difference is.
Explain your answer.

[2 marks]

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Turn over for the next question

5 (a) Give **three** ways in which courtship behaviour increases the probability of successful mating.

[3 marks]

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Male field crickets produce a courtship song by vibrating their wings. The natural song contains seven low-pitched 'chirps' followed by two high-pitched 'ticks'.

Scientists recorded this song and used a computer program to change the number of chirps and ticks. Different versions of the song were then played back continuously to females in the presence of a male. This male had previously had one wing removed so he could not produce a courtship song. The scientists determined the percentage of females that showed courtship behaviour within 5 minutes of hearing each recorded song.

Table 3 shows the results of the scientists' playback experiments.

Table 3

Version of recorded song played	Number of chirps	Number of ticks	Percentage of females that showed courtship behaviour within 5 minutes
K	No song played		30
L (natural)	7	2	83
M	7	0	70
N	0	2	65
O	7	1	83
P	7	4	82

5 (b) The scientists wanted to know if the recorded natural song was less effective than the natural song in stimulating courtship behaviour.

Suggest how the scientists could determine if the recorded natural song (**L**) was less effective than the natural song.

[2 marks]

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5 (c) A student concluded from **Table 3** that the number of chirps and ticks is essential for successfully stimulating courtship behaviour.

Do these data support this conclusion? Explain your answer.

[4 marks]

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6 (a) The events that take place during interphase and mitosis lead to the production of two genetically identical cells. Explain how.

[4 marks]

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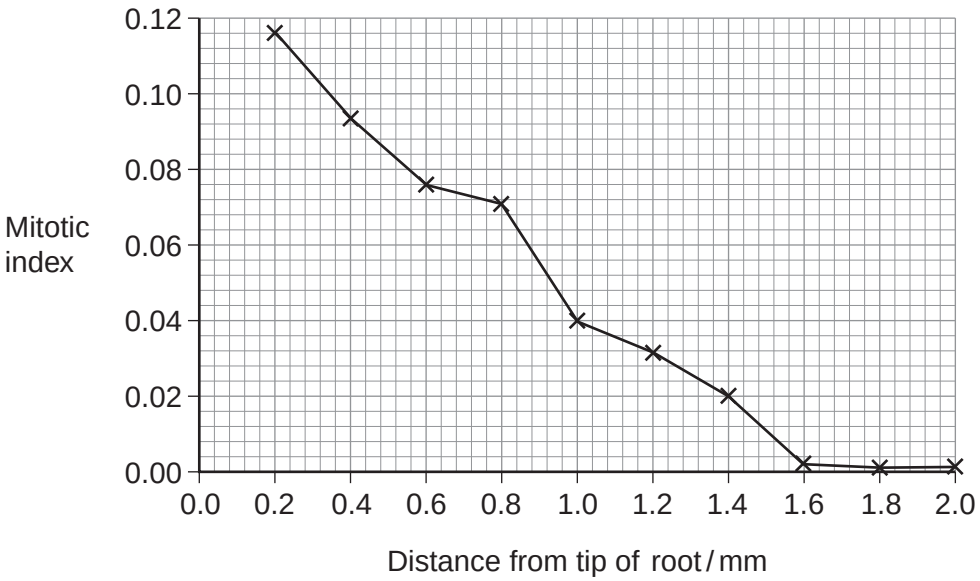
6 (b) A student cut thin sections of tissue at different distances from the tip of a root. She stained the sections and viewed them with an optical microscope.

For each section, the student counted the number of cells in mitosis and the total number of cells in each field of view. She then calculated a **mitotic index** for each section using the equation:

$$\text{mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}}$$

Figure 5 shows the student's results.

Figure 5



6 (b) (i) The student cut thin sections of tissue to view with an optical microscope.
Explain why it was important that the sections were thin.

[2 marks]

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6 (b) (ii) What does **Figure 5** show about the growth of roots?
Use the data to explain your answer.

[2 marks]

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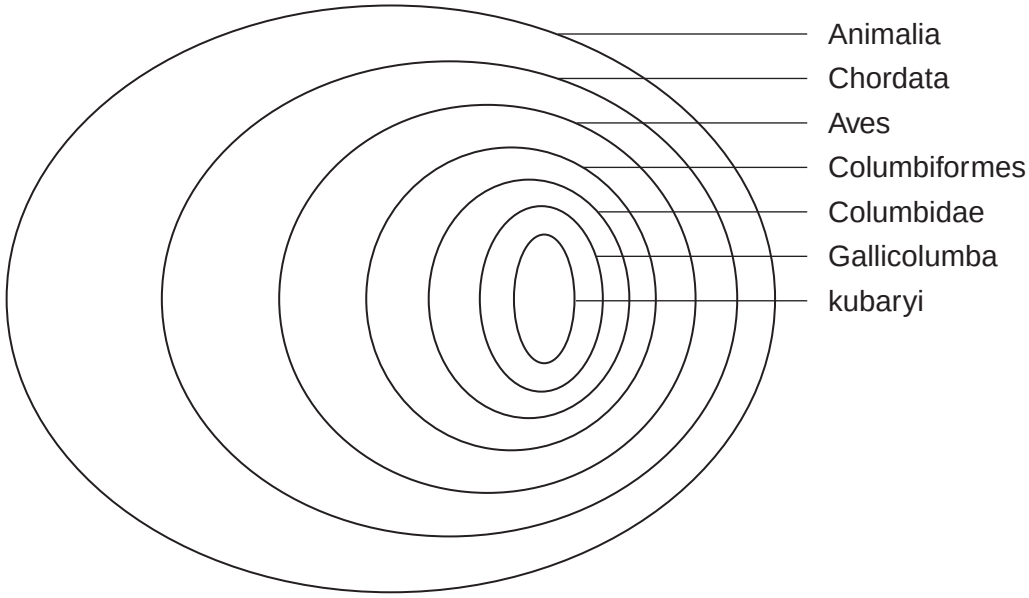
ANSWER IN THE SPACES PROVIDED

7 (a) Micronesia is a group of islands in the Pacific Ocean. The white-fronted ground dove is a bird found on these islands.

Figure 6 shows how the white-fronted ground dove is classified.

Figure 6



7 (a) (i) To which class does the white-fronted ground dove belong?

[1 mark]

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7 (a) (ii) Give the scientific name for the white-fronted ground dove.

[1 mark]

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7 (a) (iii) This classification system consists of a hierarchy as there are small groups within larger groups.

Give **one** other feature of a hierarchy that is shown in **Figure 6**.

[1 mark]

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Question 7 continues on the next page

7 (b) Pingelap is a small island in Micronesia. About 200 years ago, a large storm killed most of the population, leaving only 20 people alive on the island. One of these survivors carried a faulty allele for a genetic disease that causes complete colour blindness. There are approximately 3000 people living on Pingelap today and nearly all of them are descended from the 20 survivors.

Table 4 shows the frequencies of complete colour blindness and the approximate populations of Pingelap and the USA.

Table 4

Region	Frequency of complete colour blindness	Approximate population
Pingelap	1 in 10	3000
USA	1 in 33 000	318 000 000

7 (b) (i) Complete colour blindness occurs at a higher frequency on Pingelap than in the USA.

Use the information provided to explain why.

[3 marks]

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7 (b) (ii) Use **Table 4** to calculate the ratio of the number of people who have complete colour blindness in the USA to the number of people who have complete colour blindness on Pingelap.

Show your working.

[2 marks]

Answer = ... : 1

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Turn over for the next question

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8 (a) A mutation can lead to the production of a non-functional enzyme. Explain how.

[6 marks]

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Question 8 continues on the next page

Scientists investigated the effect of a specific antibiotic on two strains of the same species of bacterium.

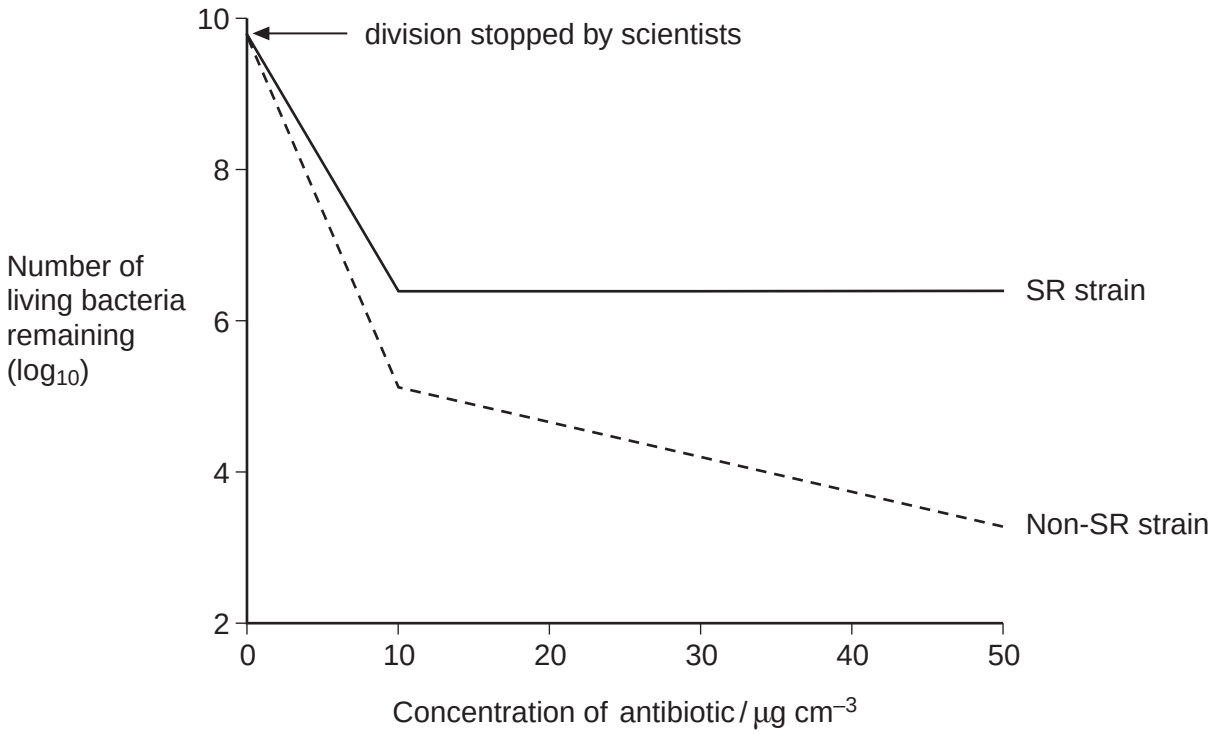
- One strain, SR, shows a **stringent response** in the presence of this antibiotic. Part of this response involves stopping cell division. This gives this strain a greater resistance to the effects of this antibiotic.

- The other strain, non-SR, cannot carry out a stringent response.

The scientists grew cultures of the SR strain and the non-SR strain containing the same number of bacterial cells. They then stopped each strain from dividing and exposed them to different concentrations of the antibiotic. After a fixed time, the scientists estimated the number of living bacteria remaining in the cultures.

Figure 7 shows their results.

Figure 7



8 (b) Describe differences in the effect of increasing the concentration of antibiotic on the SR strain and the non-SR strain.

[2 marks]

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8 (c) One way in which the stringent response gives resistance to this antibiotic is by stopping cell division.

The scientists concluded that stopping cell division is not the **only** way in which the stringent response gives resistance to this antibiotic.

Explain how **Figure 7** supports this conclusion.

[2 marks]

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Question 8 continues on the next page

8 (d) The stringent response involves a number of enzyme-catalysed reactions.

Explain how scientists could use this knowledge to design drugs that make the treatment of infections caused by the SR strain more successful.

[2 marks]

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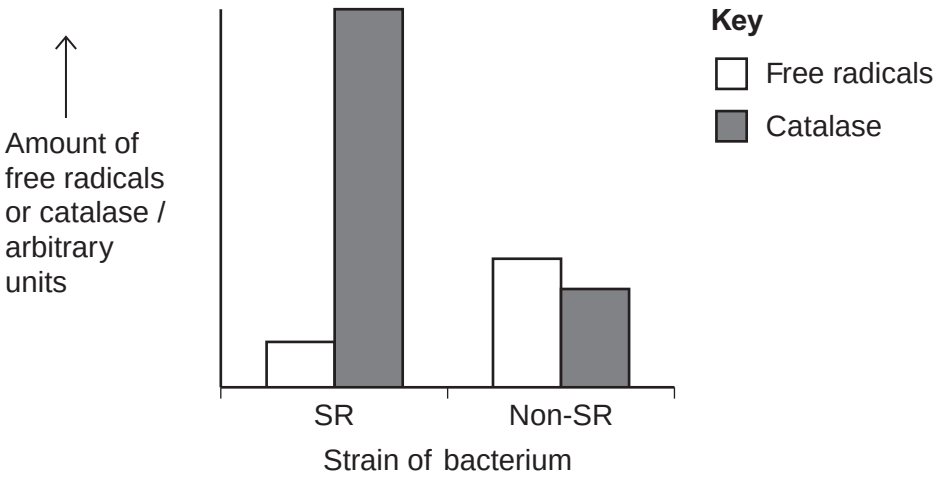
The antibiotic damages the bacterium by causing the production of substances called free radicals.

The scientists exposed the SR strain and the non-SR strain to the antibiotic. They then measured the amounts of free radicals and an enzyme called catalase in both strains.

Figure 8 shows their results.

Figure 8



8 (e) Use the information provided and **Figure 8** to suggest an explanation for the greater resistance of the SR strain to this antibiotic.

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Turn over for the next question

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9 Oestrogen is a substance produced by the enzyme aromatase. In females, the main source of oestrogen is the ovaries but aromatase is produced by many other organs in the body, including the lungs. Oestrogen can stimulate the development of some lung tumours. In these tumours, binding of oestrogen to cell-surface receptors stimulates cell division.

Scientists investigated whether two drugs could prevent lung tumours in female mice. First, they removed the ovaries from these mice. They then injected the mice with a tumour-causing chemical found in tobacco twice a day for 4 weeks. The mice were then randomly allocated to one of four groups. Each group contained 10 mice.

- Group **Q** was given a placebo. This placebo did not contain either drug.
- Group **R** was given the drug anastrozole. This inhibits the enzyme aromatase.
- Group **S** was given the drug fulvestrant. This binds to oestrogen receptors.
- Group **T** was given both anastrozole and fulvestrant.

The mice were given these drugs each week during weeks 5–15 of the investigation.

9 (a) The scientists removed the ovaries from the mice for the investigation. They also gave the mice injections of the substrate of aromatase each day.

Explain why these steps were necessary.

[2 marks]

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9 (b) The scientists predicted that fulvestrant would be more effective when given with anastrozole than when given alone.

Use the information provided to suggest why they predicted this.

[2 marks]

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Question 9 continues on the next page

At week 15, the lungs of the mice were removed and examined. The scientists then determined the number of tumours present and the mean tumour area for each group.

Figure 9 and **Figure 10** show the scientists' results.

Figure 9

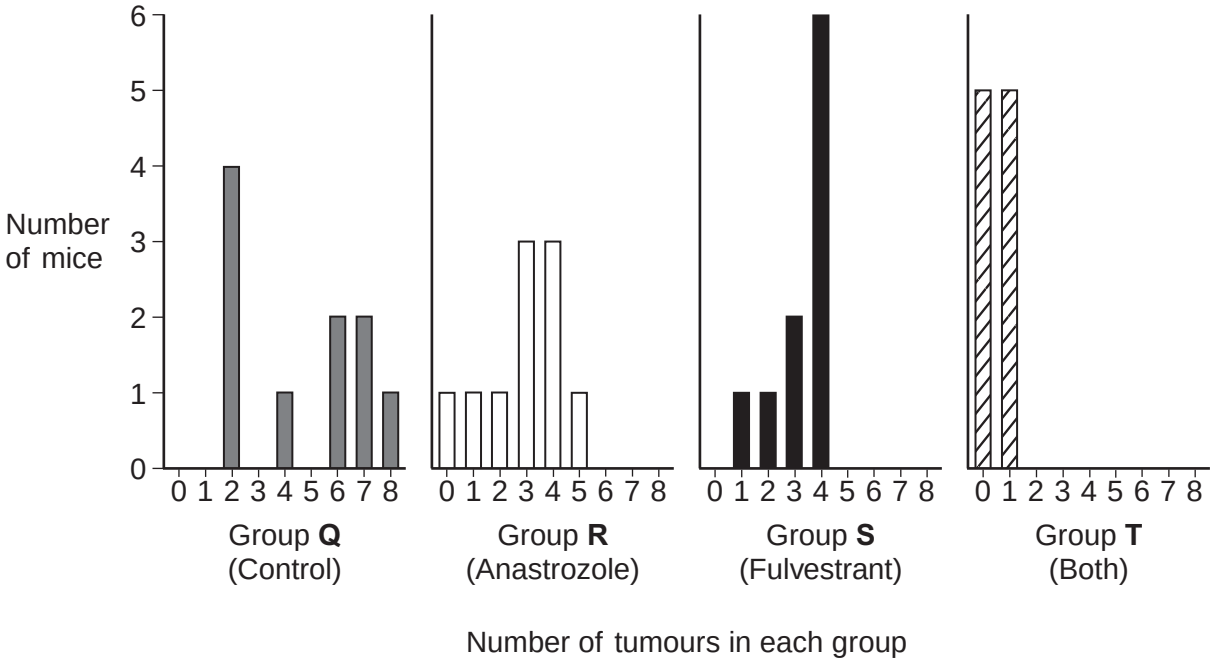
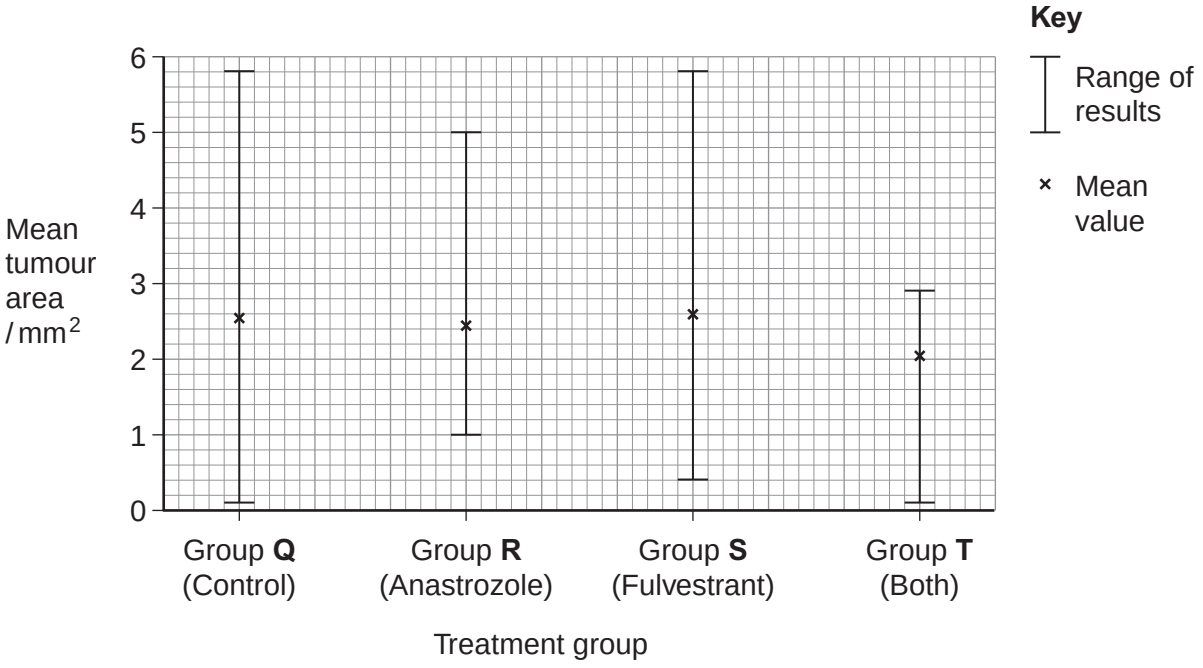


Figure 10



9 (c) The scientists concluded that both drugs should be used together to reduce the risk of lung cancer in women exposed to tobacco products.

Do you agree? Explain your answer.

[5 marks]

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Question 9 continues on the next page

9 (d) The scientists used tumour area as an indicator of tumour size.

Explain why tumour area may **not** be the best indicator of tumour size and suggest a more reliable measurement.

[2 marks]

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9 (e) The scientists repeated the investigation but this time they did not give the drugs until week 9.

Suggest why they gave the drugs at week 9, rather than at week 5.

[2 marks]

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9 (f) Another group of scientists is currently using these drugs in human trials. However, the control group is **not** being given a placebo.

Suggest why a placebo is **not** being given and what is being given to this group instead.

[2 marks]

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END OF QUESTIONS

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