OCR
Oxford Cambridge and RSA

Monday 17 June 2019 – Morning

A Level Biology A

H420/03 Unified biology

Time allowed: 1 hour 30 minutes

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number						Candidate number				

First name(s) ____________________

Last name ____________________

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **24** pages.

Turn over

Answer **all** the questions.

1 Sago pondweed is an underwater plant that grows in many regions of the world.

Fig. 1.1 shows a transmission electron micrograph of a sago pondweed cell.

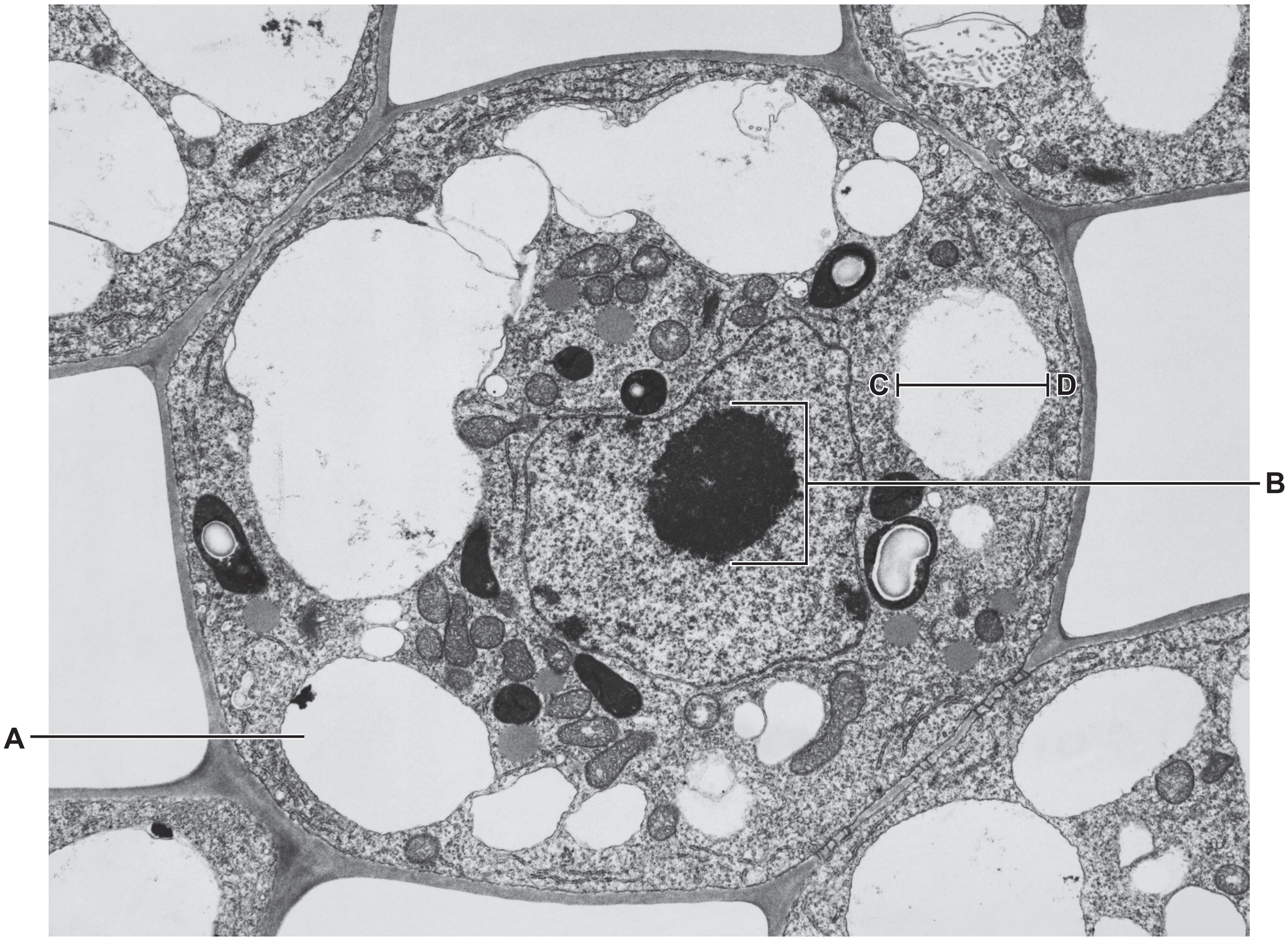

Fig. 1.1

(a) (i) Identify the **cellular components** shown at **A** and **B**.

A ....

B ....

[2]

(ii) The real size of the line between **C** and **D** on Fig. 1.1 is 1.4×10^{-6} m.

Calculate the magnification that was used to produce the image in Fig. 1.1.

Give your answer to **2 significant figures**.

magnification = ... **[2]**

(iii) Fig. 1.2 shows a student's drawing of another sago pondweed cell, which was observed under a light microscope. The student used a sharp pencil but did not label the drawing.

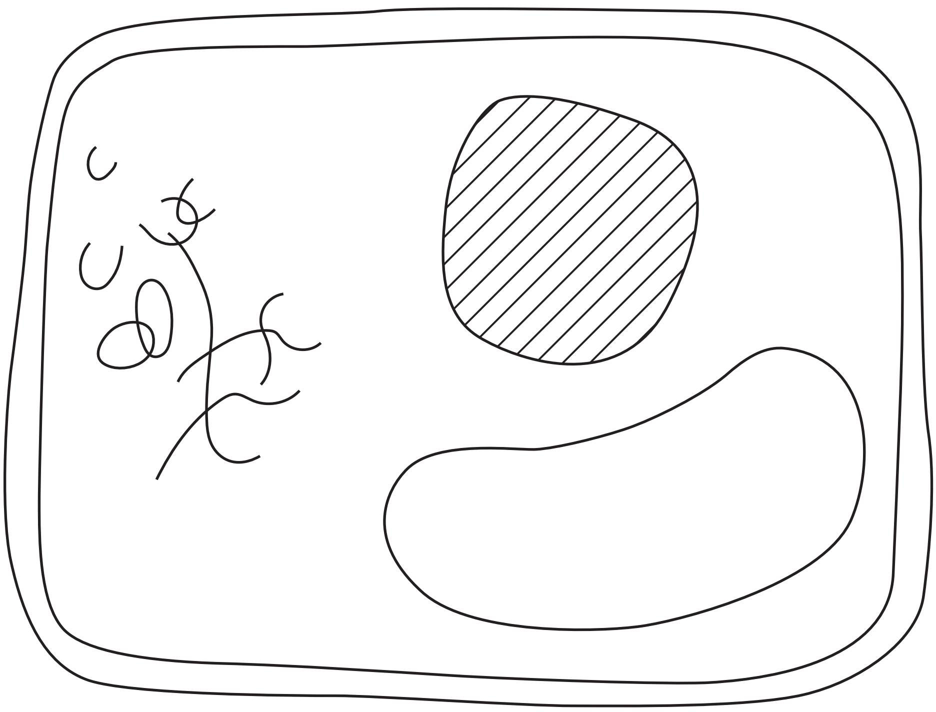

Fig. 1.2

Describe **two other** ways in which the drawing could be improved.

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.... **[2]**

(iv) The student stained a sago pondweed sample to improve the contrast between cellular components when viewed under a microscope.

The student used the following procedure to stain the sample:

- Use forceps to place the sample on a glass slide.
- Use a pipette to place two drops of the stain in the centre of the sample.
- Carefully lower a cover slip onto the sample, ensuring that the cover slip is parallel with the slide as it is lowered.

Describe **two** improvements the student should make to their staining procedure.

1 ....

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2 ....

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[2]

(b) Sago pondweed has evolved many adaptations to its aquatic environment. Three such adaptations are described below.

Explain the advantage of each adaptation.

Adaptation 1: No waxy cuticle

Advantage ....

....

Adaptation 2: Stem tissue that contains air spaces

Advantage ....

....

Adaptation 3: A thin, flexible stem

Advantage ....

....

[3]

2 Fig. 2.1 shows a naked mole rat, *Heterocephalus glaber*.

Fig. 2.1

The naked mole rat is a mammal. However, it has several features that are unusual for mammals.

(a) Naked mole rats regulate their temperature in a way that is different from most mammals.

(i) Some features of thermoregulation in naked mole rats are listed below:

- They live in complex underground tunnel systems, which tend to have a stable temperature of 30–32 °C. However, sometimes the environmental temperature can increase or decrease outside this range.
- In experiments that examine environmental temperature changes, the core body temperature of naked mole rats remains close to that of the environmental temperature.
- When tunnel temperature increases they often move to cooler parts of the tunnel system.
- When tunnel temperature decreases they often lie together in large groups.

Outline **two** ways in which thermoregulation in naked mole rats is different from thermoregulation in most mammals.

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.... **[2]**

(ii) In humans, when core body temperature falls below 35 °C, positive feedback causes this decrease in core body temperature to continue. This process is known as hypothermia.

Explain how positive feedback could accelerate the process of hypothermia.

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.... **[4]**

(iii) Mammals, including naked mole rats, have temperature receptors that play a role in thermoregulation.

The table below lists four statements about mammalian temperature receptors.

Write either 'true' or 'false' in the empty boxes to indicate whether each statement is true or false.

Statement	True or False?
Peripheral temperature receptors detect the temperature of internal organs	
Receptors in the hypothalamus detect core body temperature	
Blood temperature is detected by the receptors in the hypothalamus	
Temperature receptors send impulses to the medulla oblongata, which regulates body temperature	

[2]

(b) Another unusual characteristic of naked mole rats is their tolerance of pain.

Acid causes pain responses in most mammals. Naked mole rats are tolerant of the pain caused by acid.

This tolerance can be explained by the type of pain receptor found in naked mole rats.

Fig. 2.2 shows a representation of the ion channels present in the pain receptors of naked mole rats and other mammals.

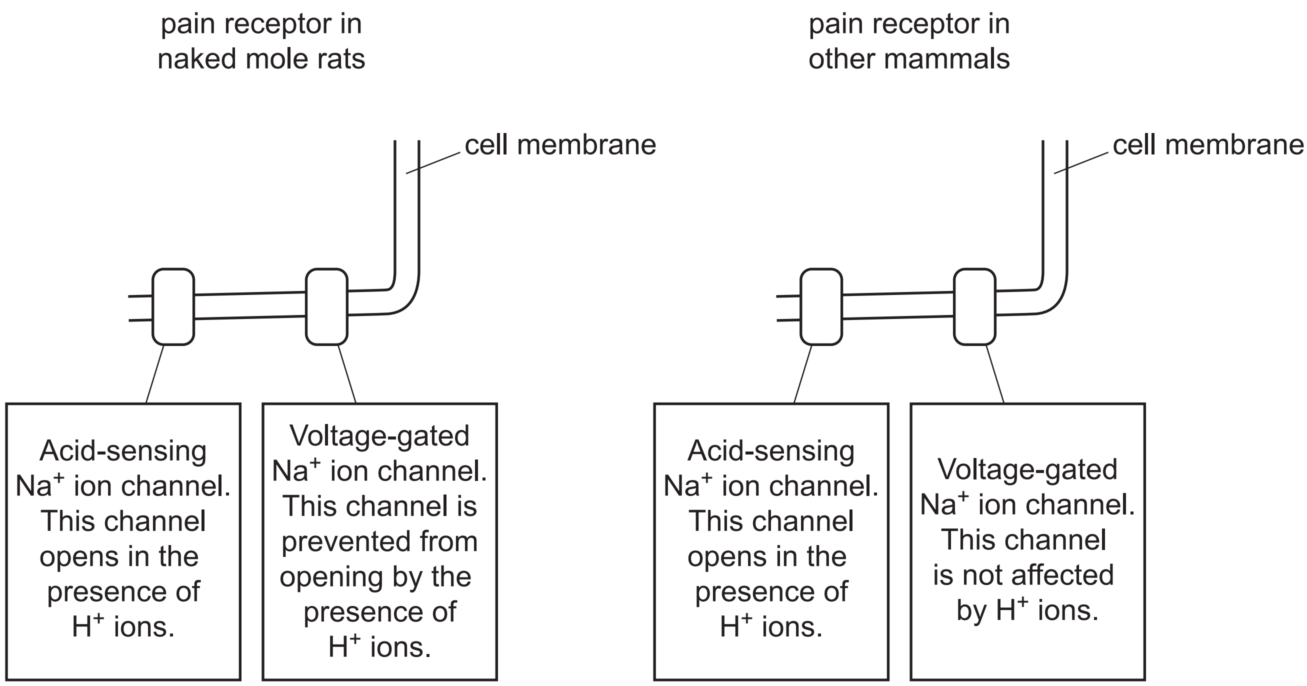

Fig. 2.2

(i) Use the information in Fig. 2.2 to suggest why naked mole rats do not feel pain when exposed to acid.

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.... **[2]**

(ii) Explain how a pain receptor is an example of a transducer.

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.... **[1]**

(c) Fig. 2.3 shows the relationship between body mass and lifespan in a range of mammal species.

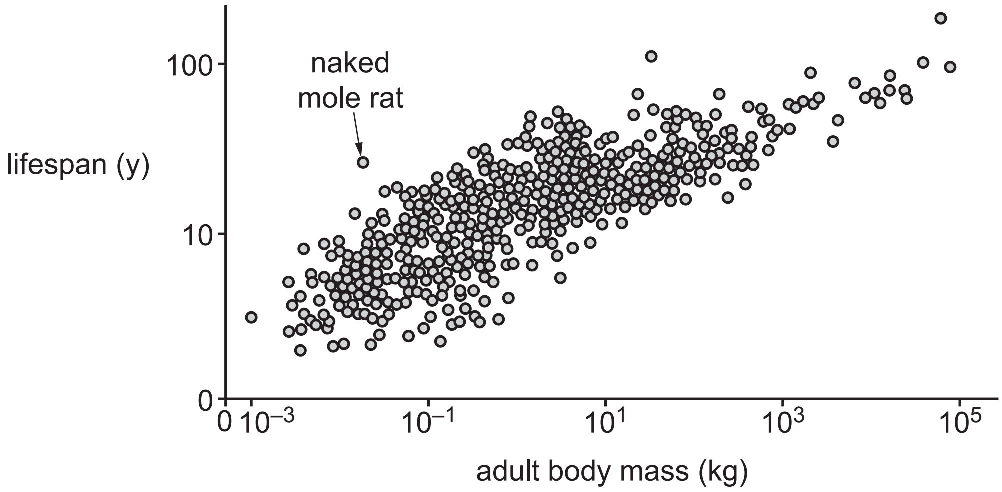

Fig. 2.3

(i) Describe the relationship between body mass and lifespan shown in Fig. 2.3.

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.... **[1]**

(ii) What conclusion can you draw from Fig. 2.3 about the lifespan of naked mole rats in comparison to other mammals?

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.... **[1]**

(d) Naked mole rats can survive without oxygen for up to 18 minutes. This is several times longer than other mammals of a similar size.

The following information might help to explain how naked mole rats can survive without oxygen for a long time:

- In normal glycolysis, the enzymes needed to convert glucose to triose phosphate may be inhibited by lactate.
- Naked mole rats can use fructose as a respiratory substrate.
- Fructose is converted to triose phosphate.
- Triose phosphate can then enter the glycolysis pathway.

(i) Suggest why the use of fructose allows naked mole rats to survive without oxygen for a long time.

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.... **[2]**

(ii) Suggest **one** other aspect of the physiology of naked mole rats that explains how they are able to survive without oxygen for a long time.

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.... **[1]**

3 Icefish live in very cold water.

Icefish contain biological molecules that allow them to tolerate cold temperatures.

(a) Adaptations can be grouped into three general categories.

Which category of adaptation is represented by cold-tolerant molecules?

.... **[1]**

(b) One example of a cold-tolerant molecule present in icefish is a modified form of the protease enzyme trypsin.

Fig. 3 shows how trypsin is converted from a molecule called trypsinogen. This conversion occurs in the lumen of the small intestine.

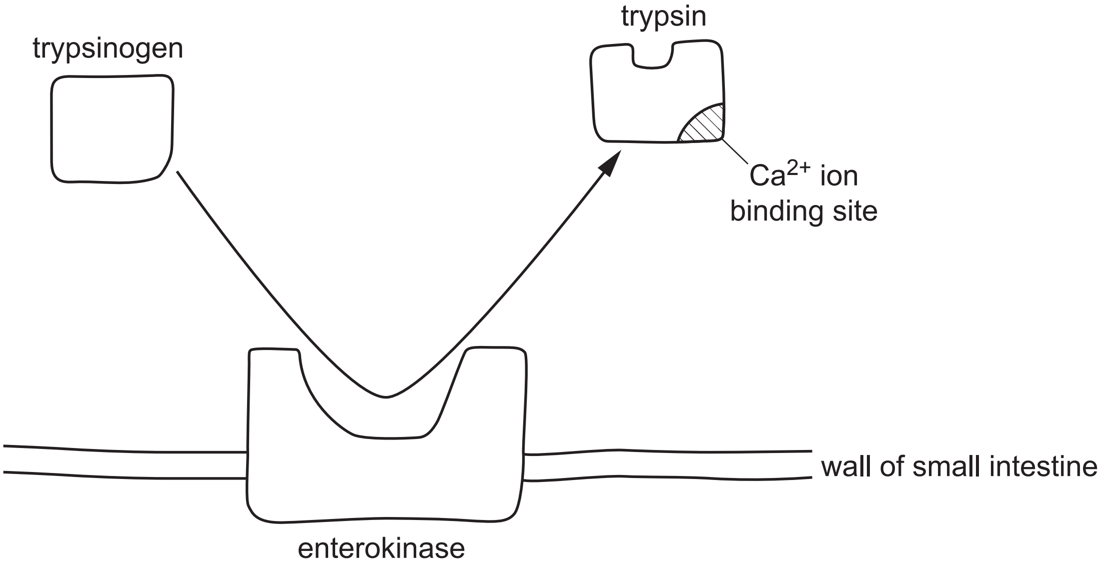

Fig. 3

State **two** conclusions that can be drawn from Fig. 3 about the roles of the molecules and ions that affect how trypsin functions.

1 ....

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2 ....

.... **[2]**

(c) A group of students investigated the effect of temperature on the activity of two forms of trypsin: human trypsin and icefish trypsin.

Part of their method is shown below:

- use 10 cm^3 of 5% trypsin solution for all trials
- measure enzyme activity at 10, 20, 30, 40 and 50 °C for both enzymes
- carry out each trial in the same pH buffer
- repeat the experiment 5 times at each temperature
- measure enzyme activity by recording the area of gelatine on a photographic film that is broken down over a set time period
- calculate the rate of enzyme activity at each temperature.

(i) Suggest **and** explain two improvements that would increase the validity of the students' investigation.

Improvement ....

Explanation ....

....

Improvement ....

Explanation ....

.... **[4]**

(ii) Suggest appropriate units to use to represent the rate of enzyme activity in this investigation.

.... **[1]**

(iii) The students recorded the temperature that produced the fastest reaction rate in each of the five replicates. These results are shown in Table 3.

Replicate	**Temperature that produced the fastest reaction rate (°C)**	
	Human trypsin	**Icefish trypsin**
1	40	20
2	10	10
3	30	20
4	40	30
5	40	30
Mean =	32.0	22.0
Mode =	40	20 and 30
Median =	40	20

Table 3

One of the students made the following statement:

I think the mean is a more accurate measure than the median or mode for these results.

Evaluate the student's statement.

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.... **[2]**

(iv) The students wanted to know whether there was a difference between the reaction rates of the two forms of trypsin at 30 °C.

They performed a statistical test on the mean of the five replicates for human trypsin and the five replicates for icefish trypsin.

Suggest the most appropriate statistical test for the students to use **and** explain why this test is appropriate.

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.... **[2]**

4 **(a)** An individual's immune responses can change throughout their lifetime.

Fig. 4.1 shows one person's immune response to the influenza virus when they were first infected and when they were infected two years later by a new, mutated strain of the virus.

The influenza virus has many antigens to which the immune system can respond. Fig. 4.1 shows the response to four of these antigens (A–D).

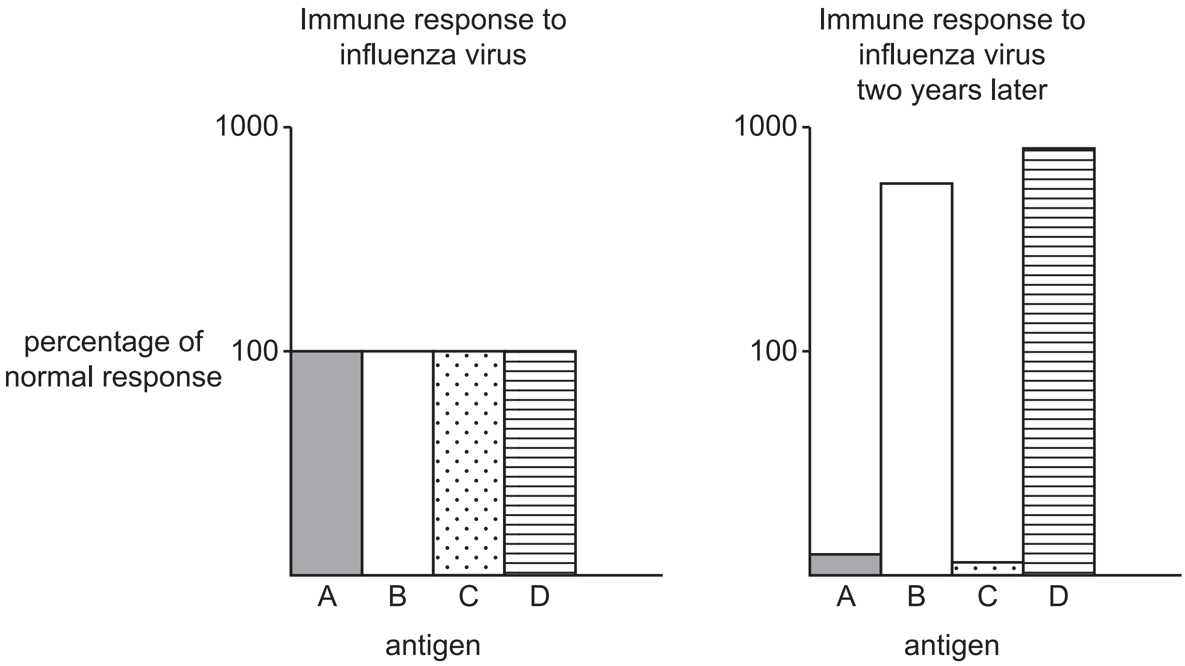

Fig. 4.1

Explain the differences in the person's initial immune response to the influenza virus with their immune response two years later.

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.... **[2]**

(b)* The specific immune response involves B and T lymphocytes.

There is variation in specific immune responses between individual animals.

Variation between immune responses can be influenced by genes and the environment.

Using examples, explain how both genes and environment can cause animals to vary in their specific immune responses.

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.... **[6]**

Additional answer space if required.

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(c) It is possible to manufacture antibodies to treat certain diseases. These are known as synthetic antibodies.

DNL-Fab3, shown in Fig. 4.2, is an example of a synthetic antibody.

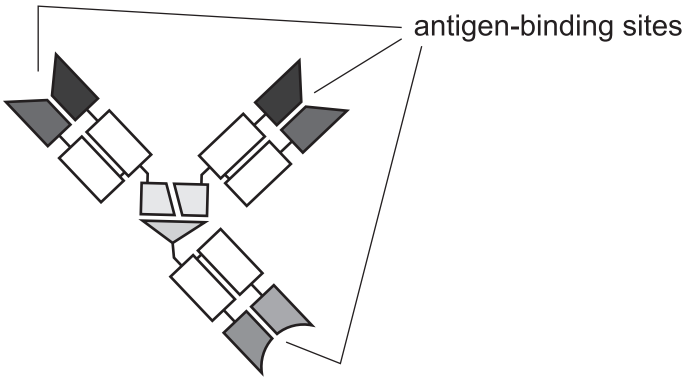

Fig. 4.2

State **two** conclusions that can be drawn from Fig. 4.2 about the differences between the way DNL-Fab3 functions and the functioning of normal antibodies.

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2 ....

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.... **[2]**

5 All organisms exchange gases with their environment.

(a) Organisms can use simple diffusion to exchange gases when the diffusion pathway is less than 1 mm.

A beet armyworm larva:

- has a cylindrical shape
- is 15 mm long
- has a volume of 30 mm^3.

Calculate the diffusion pathway of the larva and state whether it **could** or **could not** rely on simple diffusion across its external surface to meet its gas exchange requirements.

Use the formula: Volume of a cylinder = $\pi r^2 l$

diffusion pathway = ... mm

larva .... rely on simple diffusion

[2]

(b) Beet armyworm larvae eat a variety of plants, including tomato plants.

Scientists wanted to investigate how effective a chemical called methyl jasmonate was in stopping beet armyworm larvae from eating plants. They sprayed tomato plants with different concentrations of methyl jasmonate and recorded the final biomass of the plants.

The results are shown in Fig. 5.1.

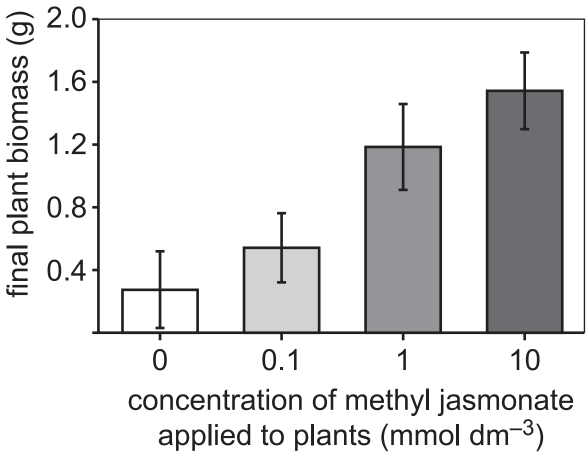

Fig. 5.1

The scientists wrote the following hypothesis:

Plants use methyl jasmonate as a defence against herbivory.

(i) What additional information do the scientists need to confirm their hypothesis?

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.... **[2]**

(ii) Suggest **one** valid conclusion it is possible for the scientists to draw from the results in Fig. 5.1.

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.... **[1]**

(iii) The scientists also recorded the level of cannibalism amongst the beet armyworm larvae. Cannibalism was measured as the number of beet armyworm larvae eaten by other beet armyworm larvae.

The results are shown in Fig. 5.2.

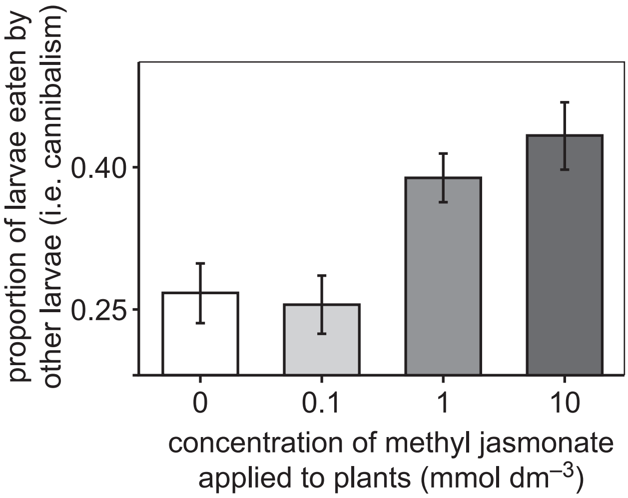

Fig. 5.2

Suggest **one** valid conclusion it is possible for the scientists to draw from their results shown in Fig. 5.2.

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.... **[1]**

6 Bacteria and fungi can be used to make food for human consumption. The use of microorganisms in food production creates fewer ethical issues than the use of animals.

(a) (i)* Using examples, describe and explain some **other** advantages of using microorganisms to produce food for human consumption.

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.... **[6]**

Additional answer space if required.

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(ii) On an industrial scale, microorganisms can be cultured using either batch fermentation or continuous fermentation.

The table below lists statements about industrial culturing of microorganisms.

Place ticks (✓) in the table to indicate whether each statement applies to batch or continuous fermentation.

Statement	Batch	Continuous
Waste is removed during the fermentation process		
A fixed volume of nutrient medium is used		
Secondary metabolites are more likely to be produced		
The growth rate tends to be faster		
The culture is grown for a fixed period of time		

[3]

(b) **(i)** Serial dilutions can be used to estimate the size of a bacterial population in a culture.

A scientist used 20 cm^3 of a bacterial culture that contained 1.0×10^6 bacterial cells.

- 5% of the 20 cm^3 culture was transferred to a new test tube and made up to 10 cm^3 with water.
- An additional ten-fold dilution was carried out, which produced a final 10 cm^3 solution.
- 0.1 cm^3 of the final 10 cm^3 solution was transferred to an agar plate.

Each colony that developed on the agar plate was assumed to represent a single bacterial cell in the bacterial culture.

Estimate the number of colonies that you would expect to develop on the agar plate.

number of colonies = ... **[3]**

(ii) A student carried out a different serial dilution to estimate the size of another bacterial population.

The serial dilution resulted in four colonies developing on an agar plate.

Explain why the student's estimation of this bacterial population is likely to be inaccurate.

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.... **[1]**

(c) Some microorganisms can be used by humans in industry. Some microorganisms are pathogenic.

Pathogenic microorganisms are transmitted in various ways.

Complete the following passage about the transmission of pathogenic microorganisms using the most appropriate terms.

Some pathogens are carried between host organisms by animals, which are often insects.

These animals suffer no symptoms of the disease and are known as ....

Other pathogens, such as *P. infestans* that causes potato blight, produce reproductive structures

called .... , which can be carried on air currents to infect other hosts.

[2]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).