OCR
Oxford Cambridge and RSA

Thursday 9 June 2022 – Afternoon

AS Level Biology A

H020/02 Depth in biology

Time allowed: 1 hour 30 minutes

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

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. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*****).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

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Answer **all** the questions.

1 The cells in beetroot contain a red pigment called betalain. The plasma membrane of the beetroot cell is impermeable to betalain.

A group of students set out to investigate how temperature affects the structure and permeability of the plasma membrane of beetroot cells. The method they used is shown below.

- Cut some pieces of beetroot.
- Place them in a flask containing 100 cm^3 of distilled water.
- Stand this flask in a water bath and increase the temperature at 10 °C intervals.
- Take a sample of water from the flask 5 minutes after each new temperature is reached.
- Measure the absorbance of the water samples taken using a blue filter in the colorimeter.

(a) A second group of students made improvements to this method. One of the improvements they made was to carry out two further trials at each temperature.

Suggest **two** further improvements they could have made **and** give a reason for the improvements you have suggested.

Improvement and reason 1

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Improvement and reason 2

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(b) Name the independent variable in this investigation.

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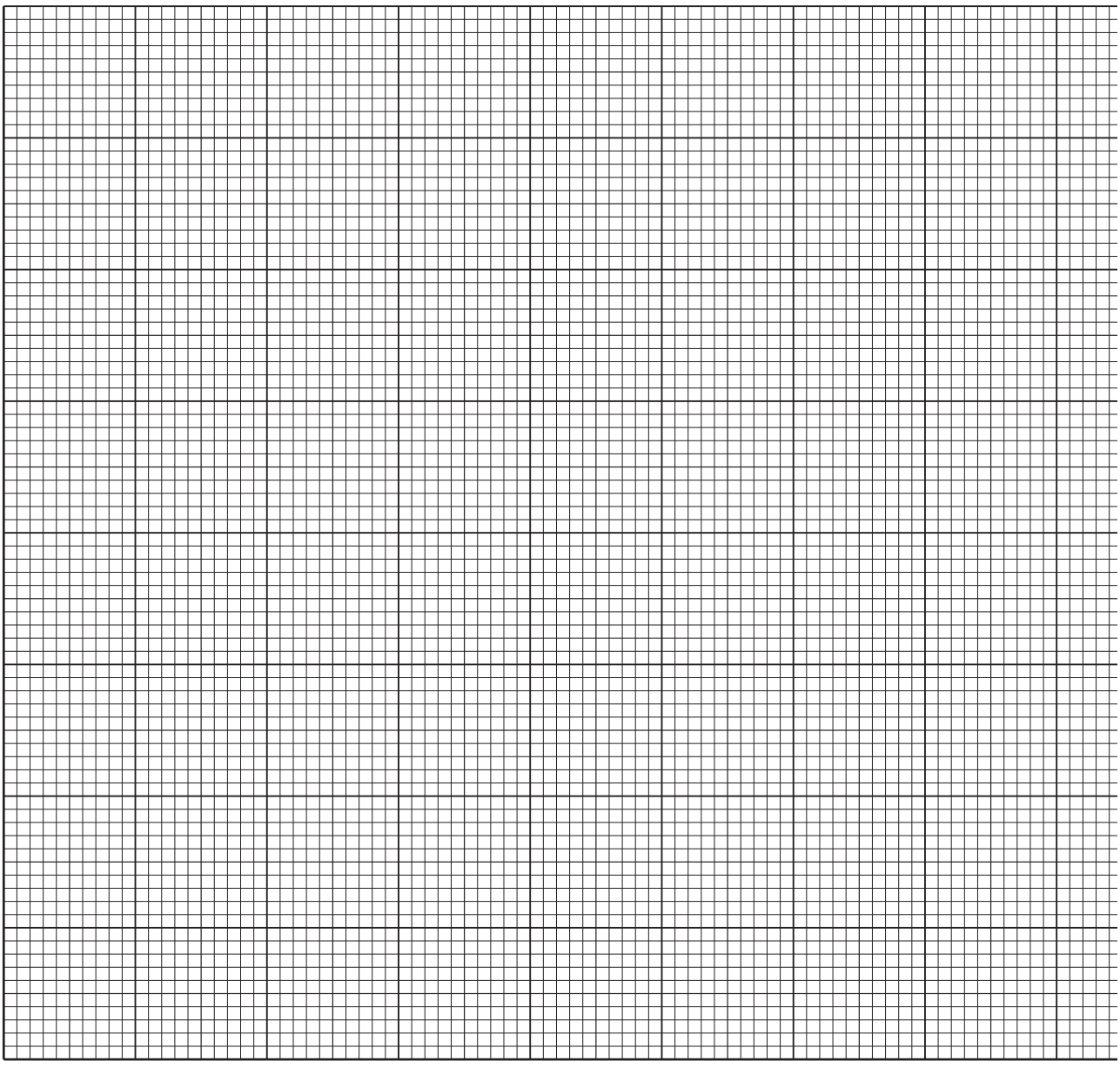
(c) (i) The table shows the results obtained by the second group of students.

Temperature (°C)	Absorbance (%)			
	Trial 1	**Trial 2**	**Trial 3**	**Mean**
10	0	0	0	0.0
20	0	0	0	0.0
30	2	3	2	2.3
40	6	5	7	6.0
50	9	7	7	7.7
60	46	45	47	46.0
70	78	78	80	78.7

Plot a graph of the results from the table on the grid.



[3]

(ii)* Explain the results between 20 °C and 70 °C using your knowledge of the structure and properties of phospholipid molecules in the plasma membrane.

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Additional answer space if required.

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(d) In a second experiment, students followed the same method but used pieces of beetroot that had been frozen for several days and then defrosted. They were surprised when their results differed from the students that had been given fresh beetroot.

Suggest how their results would **differ** from those given in the table **and** provide an explanation.

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..... **[2]**

2 **(a)** **Fig. 2.1** shows the larva of a European stag beetle, *Lucanus cervus*.

Fig. 2.1

These larvae can live for up to six years, feeding and growing in decaying wood. During this time, the cells in the larvae undergo mitosis to produce genetically identical cells.

Mitosis is part of the cell cycle. The cell cycle is shown in **Fig. 2.2**.

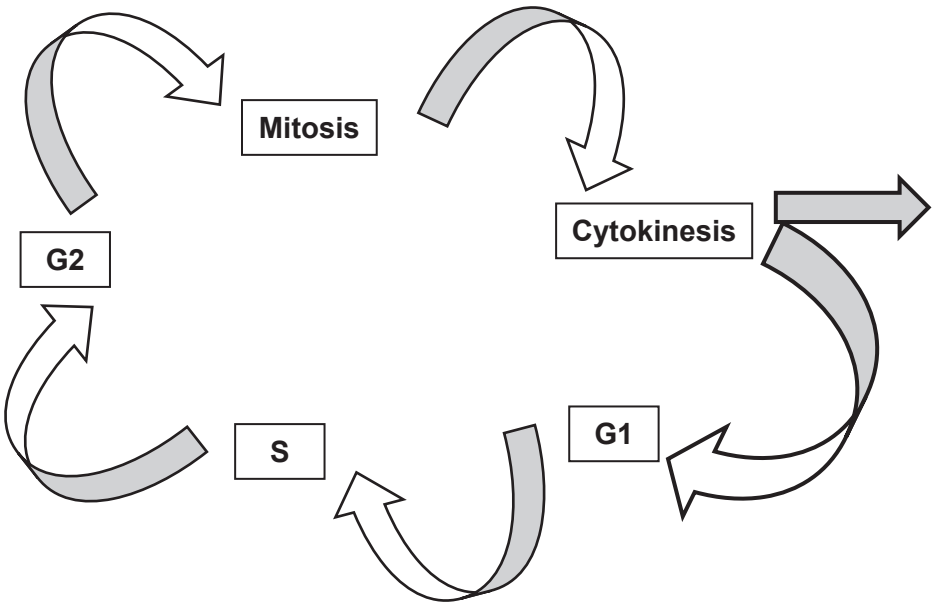

Fig. 2.2

(i) The size of the cell increases during stage **G2** in the cell cycle.

State **one** other process that takes place during stage **G2**.

..... **[1]**

The length of a stag beetle larva was measured at yearly intervals and some of the data plotted onto the graph shown in **Fig. 2.3**.

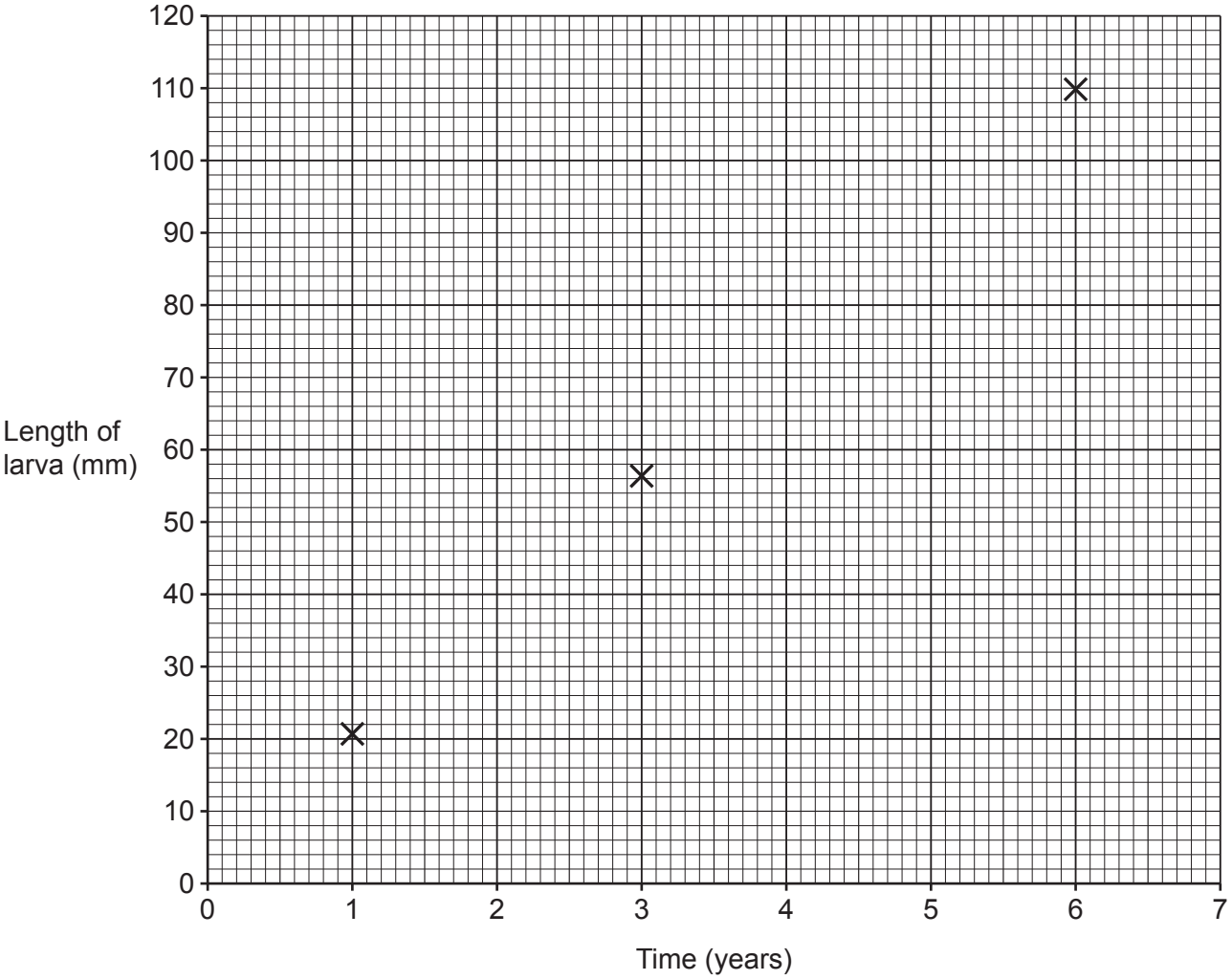

Fig. 2.3

(ii) Assuming that the growth of the larva follows a relationship of y = mx + c, use **Fig. 2.3** to determine the length of the larva at 0 years, when it emerges from the egg.

Length of larva = ... mm **[1]**

(iii) Calculate the growth rate of the larva.

Growth rate = ... mm year^{-1} **[2]**

(b) A group of students were investigating mitosis. They examined cells from onion root tip squashes that had been prepared using acetic orcein stain. Chromosomes appear a purple red colour when this stain is used.

Fig. 2.4 shows a light micrograph of one of these cells. A student stated that this cell was at metaphase.

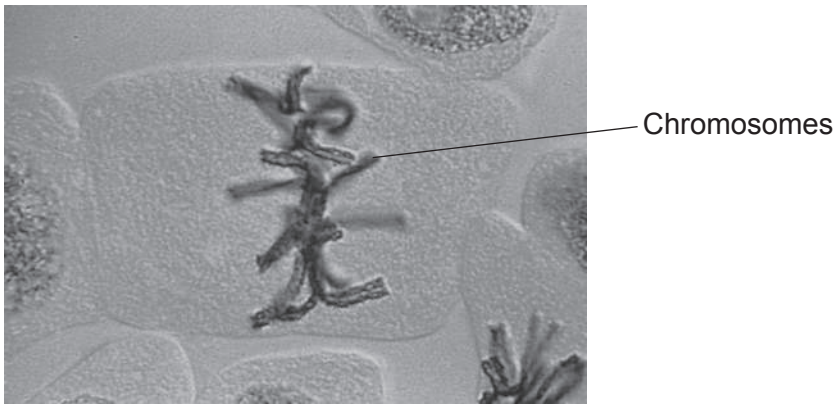

Fig. 2.4

(i) Describe how **Fig. 2.4** shows the importance of differential staining for observing cells undergoing mitosis.

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(ii) Identify one piece of evidence that would have led the students to conclude that the cell in **Fig. 2.4** is at metaphase.

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(iii) Three students were studying onion root tip squashes under the microscope. They recorded the number of cells at each stage of mitosis. A record of their observations is shown below.

Student 1:	Metaphase 1 cell
	Anaphase 3 cells
	Prophase 3 cells
Student 2:	Anaphase 4 cells
	Prophase 5 cells
	Telophase 1 cell
Student 3:	Telophase 3 cells
	Metaphase 5 cells
	Prophase 2 cells

In the space below draw an appropriate table to present the students' observations.

Include the headings for the columns. You are **not** required to enter any of the results into your table.

[2]

(c) Compare prophase in mitosis with prophase in meiosis.

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3 **(a)** Congenital lactose intolerance is where a person is born without the enzyme lactase needed to digest lactose in milk. The use of enzyme technology has allowed lactose free milk to be widely available in shops and supermarkets.

Fig. 3.1 shows a technique used to produce lactose free milk.

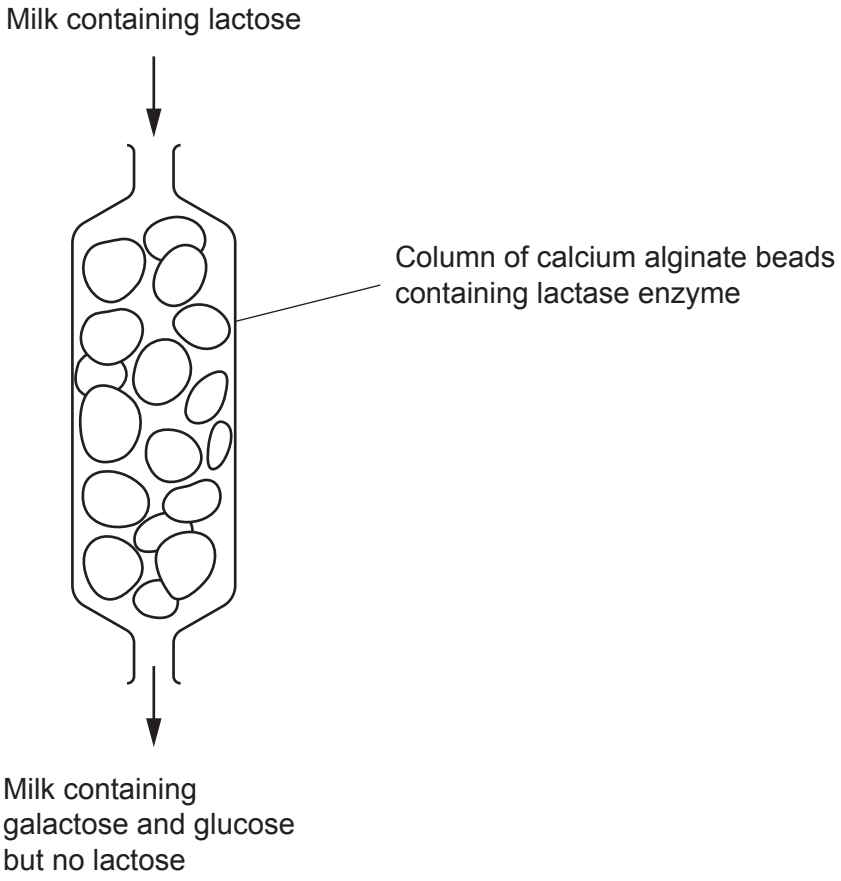

Fig. 3.1

(i) Name the type of bond broken by the enzyme lactase **and** describe what happens when this bond is broken.

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(ii) A common symptom of lactose intolerance in adults is the creation of extra fluid in the large intestine.

Suggest why this occurs.

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(b) Research indicates that reducing dietary intake of saturated triglycerides and cholesterol can reduce potential risk of developing cardiovascular disease (CVD) in later life.

Fig. 3.2 shows the structure of a saturated triglyceride.

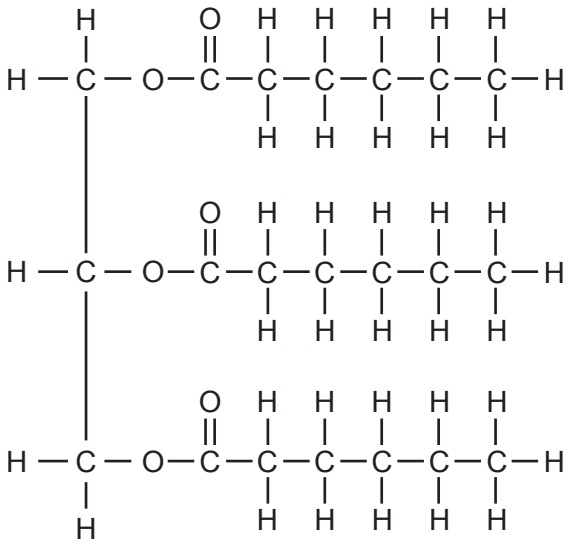

Fig. 3.2

(i) Describe how the structure of a polyunsaturated triglyceride molecule would **differ** from the molecule shown in **Fig. 3.2**.

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..... **[1]**

(ii) Hypercholesterolemia is a condition in which an individual has a high blood cholesterol level.

Studies were carried out in the USA over several decades, looking at the overall death rates from cardiovascular disease (CVD) and the percentage of the population with hypercholesterolemia in different age groups.

Fig. 3.3 shows data from these studies.

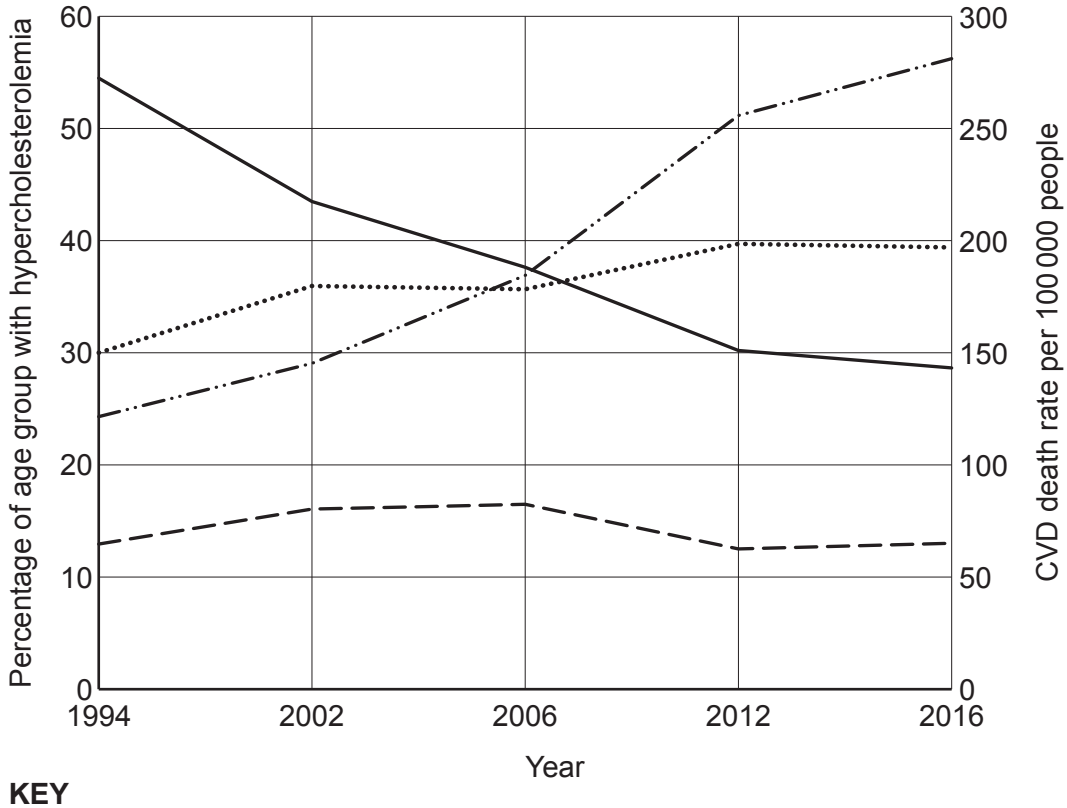

Fig. 3.3

A student looking at this data made the following statement:

‘A fall in death rate from cardiovascular disease is due to a reduction in the percentage of people with hypercholesterolemia.’

With reference to the **20–44 age group** in **Fig. 3.3**, discuss whether the student’s statement is correct.

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(c) **Fig. 3.4** shows the changes in pressure in the left side of the heart and aorta during one cardiac cycle.

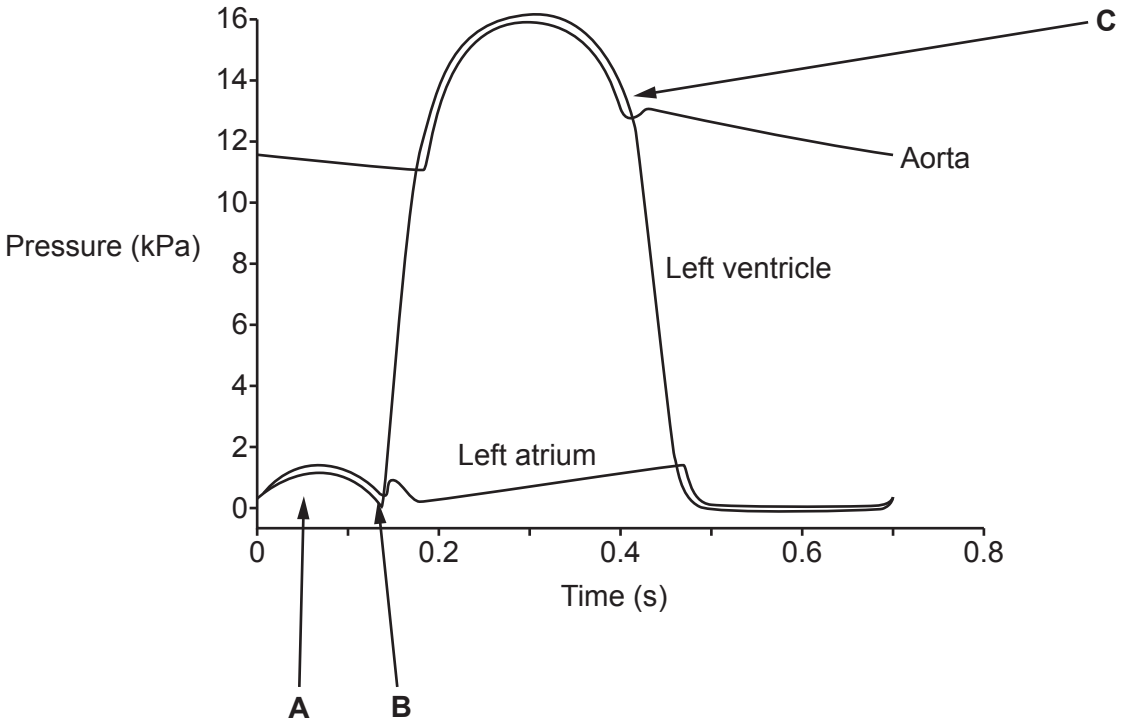

Fig. 3.4

A student described the events shown in **Fig. 3.4**.

'At **A**, the muscles in the wall of the atrium are contracting. This is caused by a wave of electrical excitation that starts at the atrio ventricular node (AVN).

At **B**, the muscles in the wall of the ventricle are contracting. The atrioventricular valve opens and the pressure in the aorta falls. The ventricular pressure rises above that of the aorta.

At **C**, the muscles in the walls of the ventricle are relaxing. The semilunar valve opens. The pressure in the ventricle drops.'

Identify **three** errors in the student's description and write the correction for each error.

Error and correction 1

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Error and correction 2

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Error and correction 3

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[3]

4 **(a)** **Fig. 4.1** shows a light micrograph of cells in the blood.

Cell **X** plays a role in the immune response.

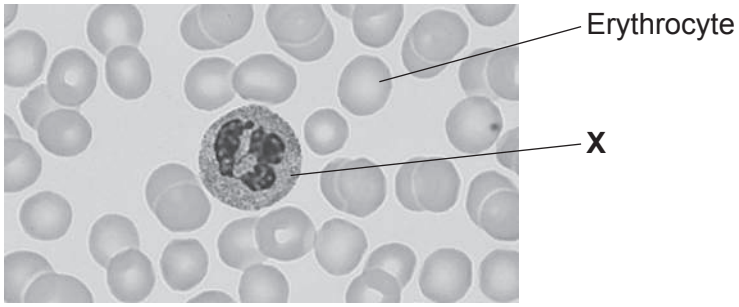

Fig. 4.1

(i) Name cell **X**.

..... **[1]**

(ii) The magnification of the microscope used to observe the cells in **Fig. 4.1** was ×950.

Calculate the diameter of cell **X** in **Fig. 4.1**.

Give your answer in micrometres.

Diameter = ... μm **[2]**

(iii) Using **Fig. 4.1**, explain why blood is described as a tissue and not an organ.

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..... **[1]**

(b) Every winter a large proportion of the population are given a vaccine against the disease influenza.

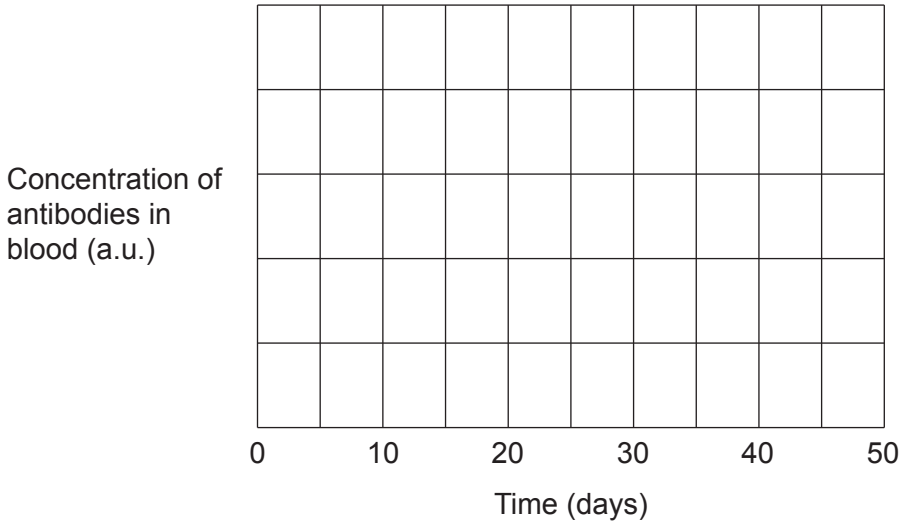
(i) Identify the type of immunity given by an influenza vaccine.

..... **[1]**

(ii) A patient was participating in influenza vaccination trials.

- On day 5 of the trial the patient was injected with antigens extracted from the influenza virus.
- On day 25 the patient was exposed to the influenza virus.
- The response of their immune system was monitored by regular blood tests to determine the quantity of antibodies in their blood.

Sketch a graph on the axes to show the possible primary **and** secondary immune response for this patient. Label **both** responses on your graph.



[2]

(iii) Outline the role of B memory cells in the secondary immune response.

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(c) Outline the roles of phagosomes and lysosomes in phagocytosis.

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(d) Most of the oxygen in blood is transported bound to haemoglobin.

Haemoglobin also plays an important role during the transportation of carbon dioxide by acting as a buffer and preventing a lowering of the pH in the erythrocytes.

(i) Explain how haemoglobin acts as a buffer.

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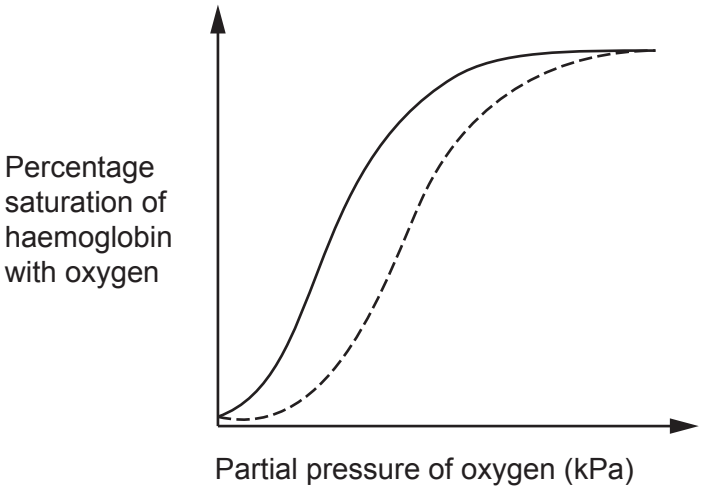
(ii) **Fig. 4.2** shows the shape of oxygen dissociation curves for haemoglobin for a person at rest and during exercise.

The changes to the dissociation curve at different carbon dioxide concentrations is known as the Bohr effect.



KEY

——— At rest

– – – – During exercise

Fig. 4.2

With reference to **Fig. 4.2** explain why the Bohr effect is important during exercise.

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5* A teacher set up the apparatus shown in **Fig. 5.1** to demonstrate ventilation in mammals to a group of students.

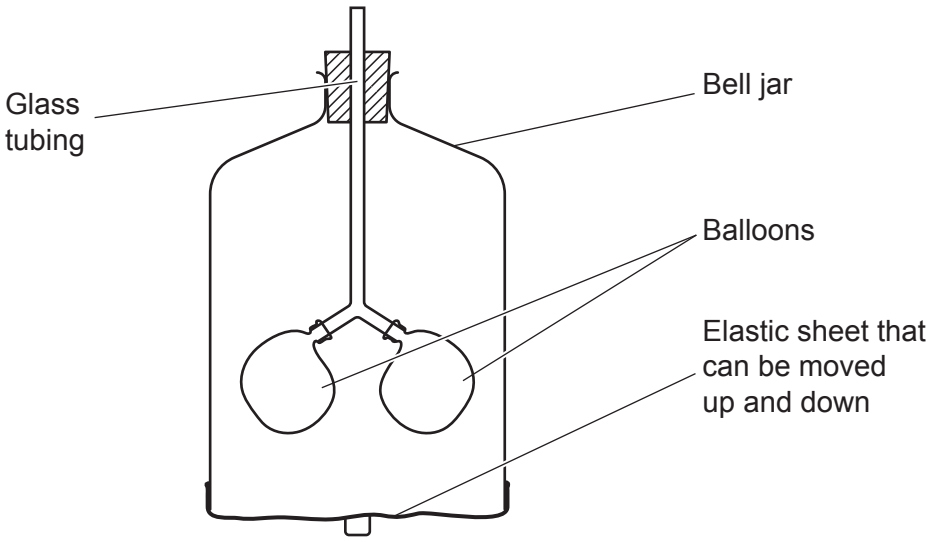

Fig. 5.1

Describe how the apparatus in **Fig. 5.1** can be used to model the changes that take place during inspiration in mammals.

In your answer comment on how appropriate the apparatus is in demonstrating inspiration.

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Additional answer space if required.

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6 **(a)** **Fig. 6.1** shows a larva of the gum-leaf skeletoniser moth, *Uraba lugens*, found in Australia and New Zealand.

- The larva has an exoskeleton.
- The exoskeleton is the external skeleton that supports and protects the soft tissues and organs of the larva. It is shed periodically to allow the larva to grow.
- Each time it sheds its exoskeleton, the exoskeleton head remains attached to its body and these old exoskeleton heads stack up on top of each other.
- The larva is given the name mad hatterpillar because of this unusual adaptation.

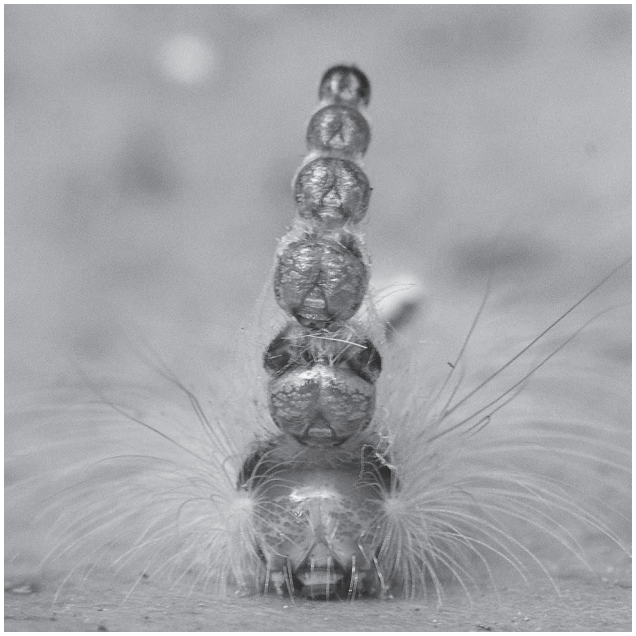

Fig. 6.1

(i) With reference to **Fig. 6.1**, suggest a purpose for the adaptation of attaching and stacking the old exoskeleton heads.

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..... **[1]**

(ii) Name the genus of the gum-leaf skeletoniser moth.

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(iii) The table shows some taxonomic descriptions for the gum-leaf skeletoniser moth. They are **not** in the correct hierarchical sequence.

Complete the table to show the correct hierarchical sequence. Use the numbers 1 to 4. One row has been completed for you.

Taxonomic description	Hierarchical position
Phylum Arthropoda	
Order Lepidoptera	
Kingdom Animalia	1
Class Insecta	

[1]

(b) The peppered moth, *Biston betularia*, has two forms, a pale form and a dark form, both shown in **Fig. 6.2**.

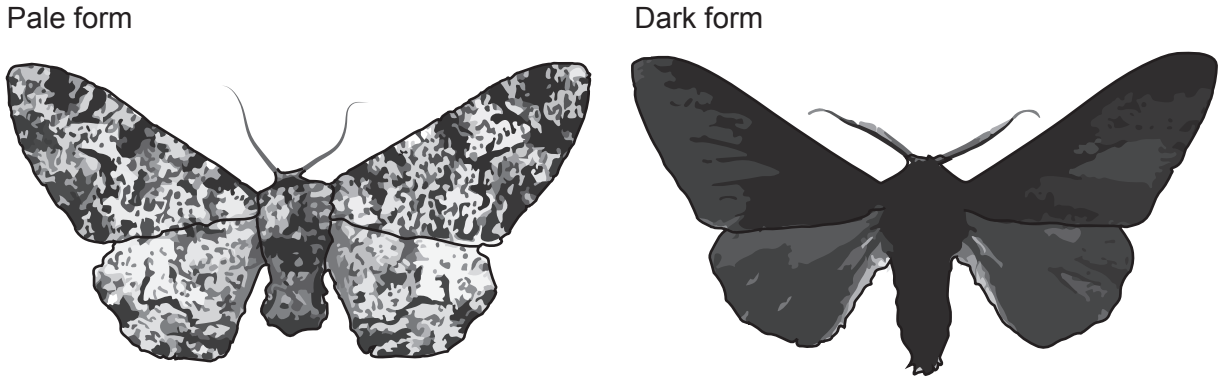

Fig. 6.2

Predators of the peppered moth include birds such as the robin and nuthatch. Peppered moths avoid these predators by flying at night and resting on tree trunks during the day. Many trees have light coloured lichens growing on them. However, many lichens are unable to tolerate high levels of air pollution. Without lichens the bark of trees appears darker.

The dark form of the peppered moth first appeared in Britain during the industrial revolution.

Various surveys have shown that the percentage of the dark form of the peppered moth population is higher in parts of England where there is a lot of heavy industry compared with more rural areas.

Explain how the process of natural selection has resulted in this distribution of the two forms of the peppered moth.

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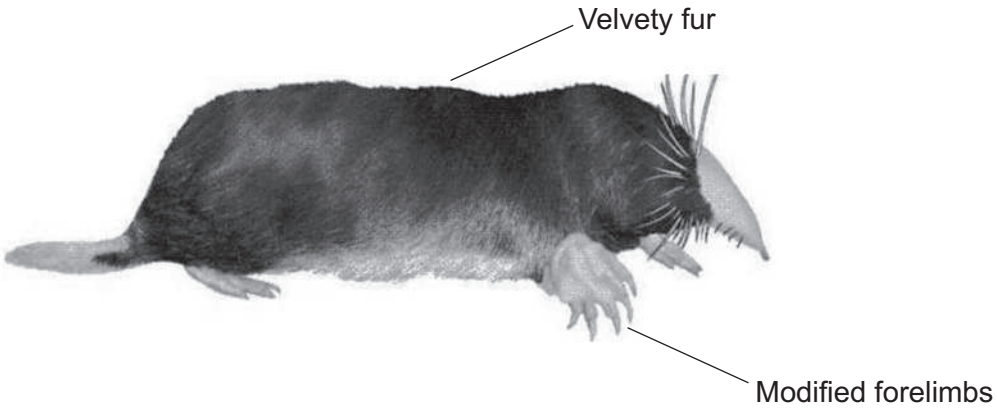
(c) **Fig. 6.3** shows two types of mole and some information about each type.

Placental mole family *Talpidae*

Found in: North America, Asia and Europe
Habitat: Lives in burrows in soft soil
Food: Grubs and worms



Marsupial mole family *Notoryctidae*

Found in: Australia
Habitat: Lives in burrows in soft soil
Food: Grubs and worms

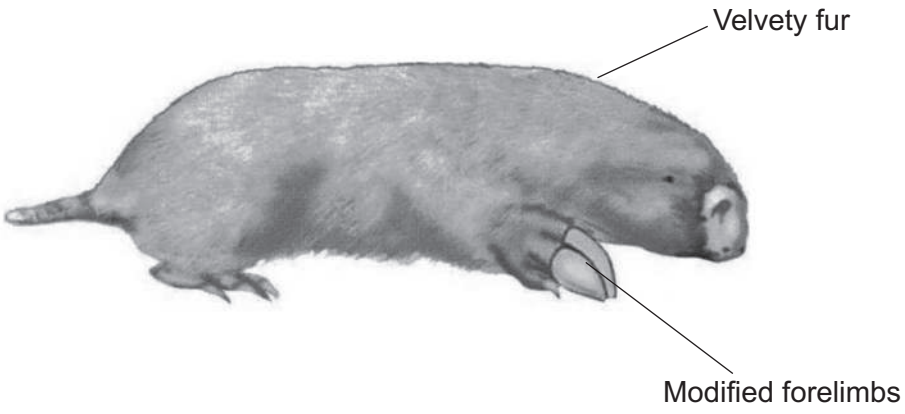


Fig. 6.3

Explain how **Fig. 6.3** supports the theory of convergent evolution.

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..... **[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).