Oxford Cambridge and RSA

Friday 15 October 2021 – Morning

A Level Biology B (Advancing Biology)

H422/02 Scientific literacy in biology

Time allowed: 2 hours 15 minutes

You must have:
- a clean copy of the Advance Notice Article (inside this document)

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 **100**.
- 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.

© OCR 2021 [601/4720/9]
DC (CJ/FC) 300220/3
OCR is an exempt Charity

Answer **all** the questions.

1 This question is based on the Advance Notice article **'Do Pathogens Gain Virulence as Hosts Become More Resistant?'** on the **Insert**.

(a) The myxoma virus (MYXV) is a pathogen that causes myxomatosis in its hosts.

(i) Describe how a virus replicates.

.....

.....

.....

.....

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

(ii) Explain why myxomatosis could not be described as endemic in Australia before 1950.

.....

.....

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

(iii) Explain why the myxomatosis outbreak in the 1950s could be described as an epidemic.

.....

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

(b) HIV is a retrovirus but MYXV is not.

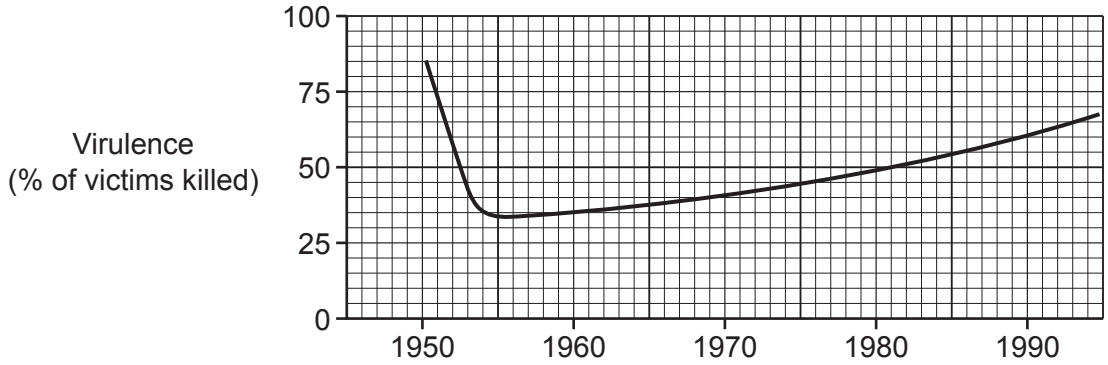
Use this information and your knowledge to complete the following table by placing a tick (✓) if the feature is found in HIV or MYXV.

Feature	**HIV**	**MYXV**
Genetic material is RNA		
Virus particle contains reverse transcriptase		
Virus has a protein capsid		

[3]

© OCR 2021

(c) The graph shows how the virulence of MYXV changed over the period from 1950 to 1990.



Describe how the virulence of MYXV strains varied during the period 1950 to 1990.

.....

.....

.....

.....

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

(d) The article describes the interactions between pathogen virulence and host resistance to infection.

(i) Explain how immunological and genetic factors would allow a population of wild rabbits to become more resistant to infection by MYXV.

.....

.....

.....

.....

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

© OCR 2021

(ii) The article discusses how resistance to infection can be affected by two common agricultural practices: vaccination and selective breeding.

Explain how vaccination is used to protect poultry against pathogens such as Marek's disease virus (MDV).

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(iii) Explain why vaccination might **not** prevent epidemics of Marek's disease in poultry.

.....

.....

.....

.....

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

© OCR 2021

(iv) Evaluate the suggestion that birds should be bred for susceptibility to MDV rather than resistance.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

© OCR 2021

2 **(a)** The faecal occult blood test (FOBT) is a screening method that is now used routinely in people over the age of 65 years.

The presence of blood in faeces (a positive result) is thought to be caused by chronic inflammation of the gut and indicates an increased risk of developing colorectal cancer (CRC).

A Scottish study looked at 133 921 individuals who were tested with FOBT and then followed for up to 16 years.

- 131 207 had a negative FOBT
- 2714 had a positive FOBT

(i) Outline a method that a doctor could use to confirm that a person with a positive FOBT has CRC.

.....

.....

.....

.....

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

© OCR 2021

BLANK PAGE

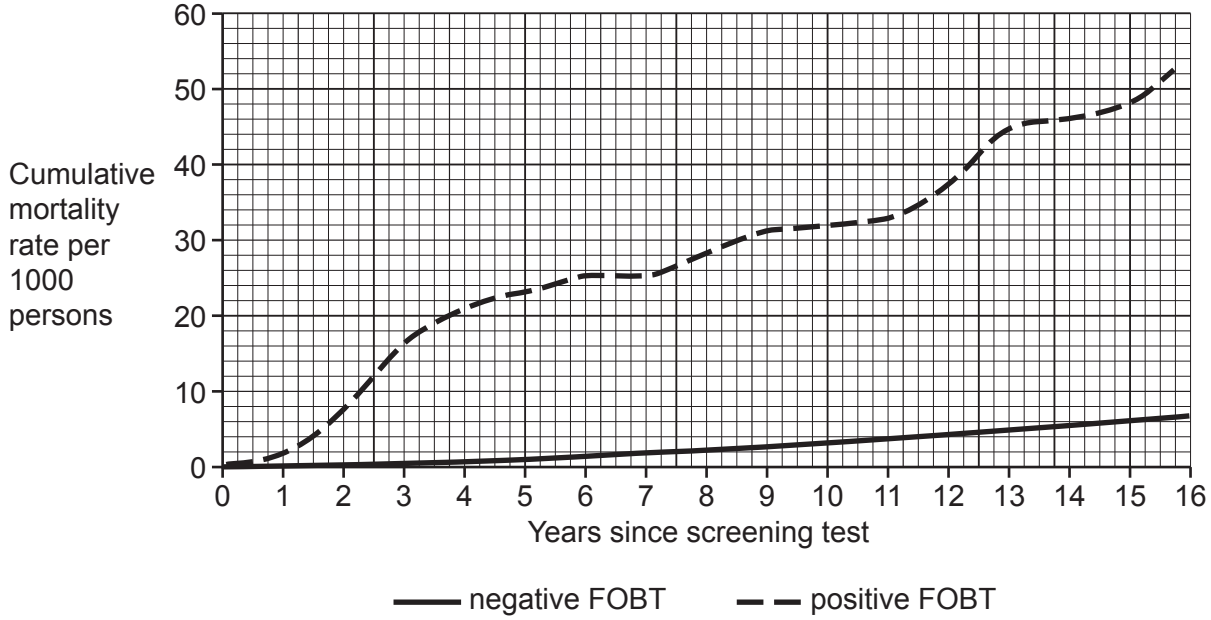
PLEASE DO NOT WRITE ON THIS PAGE

Question 2(a)(ii) begins on page 8

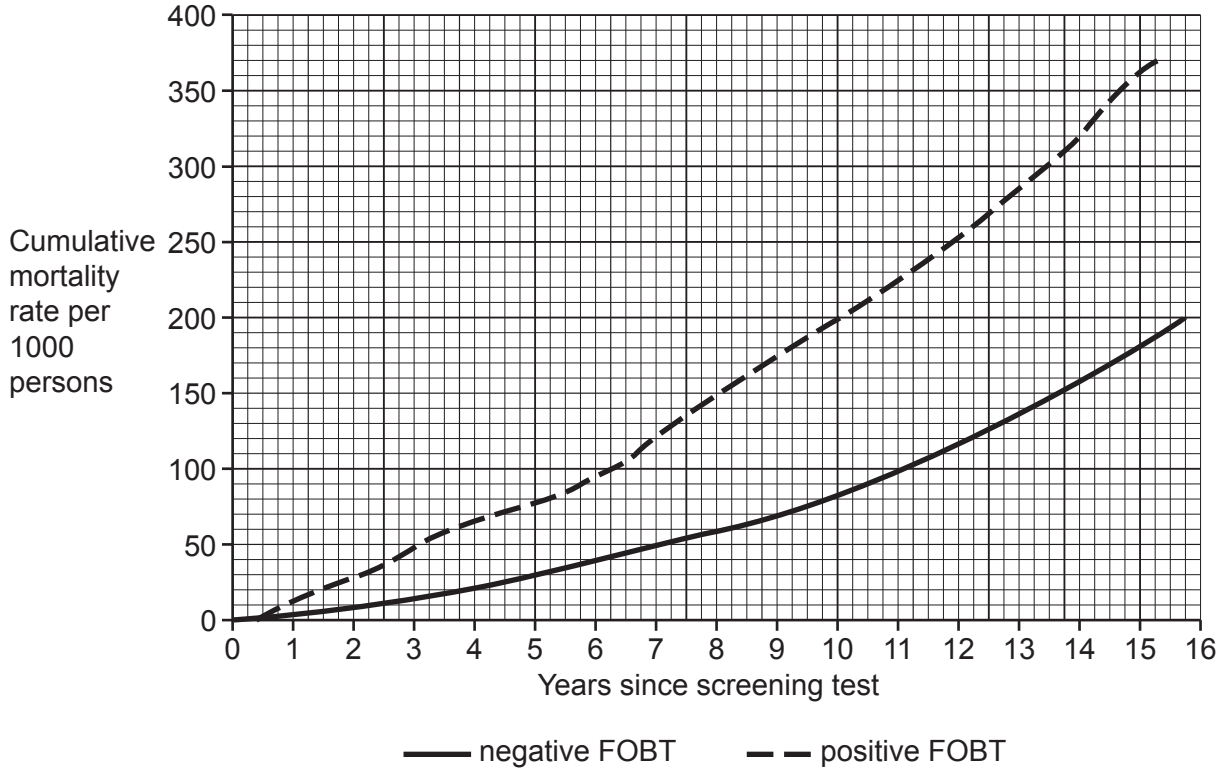
© OCR 2021

(ii) The graphs show cumulative mortality rate from CRC and cumulative mortality rate from all causes except CRC in the two groups studied over the 16-year period.

Cumulative mortality rate from CRC



Cumulative mortality rate from all causes except CRC



© OCR 2021

The scientists who carried out this study concluded that a positive FOBT was an indicator of increased risk of death from other (non-cancerous) diseases linked to inflammation of the gut.

Explain whether the data in the graphs support their conclusion.

.....

.....

.....

.....

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

(iii) An FOBT kit is sent to everyone in England between 60 and 74 years of age.

Using your own knowledge and the data in the graphs, evaluate the effectiveness of FOBT in screening for CRC.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

© OCR 2021

(b)* CRC is one of more than 100 forms of cancer.

Describe, with examples, how mutations in genes that control cell division can lead to cancer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

Additional answer space if required.

.....

.....

.....

.....

.....

© OCR 2021

3 **(a)** **Fig. 3.1** is a diagram of a section through the human brain.

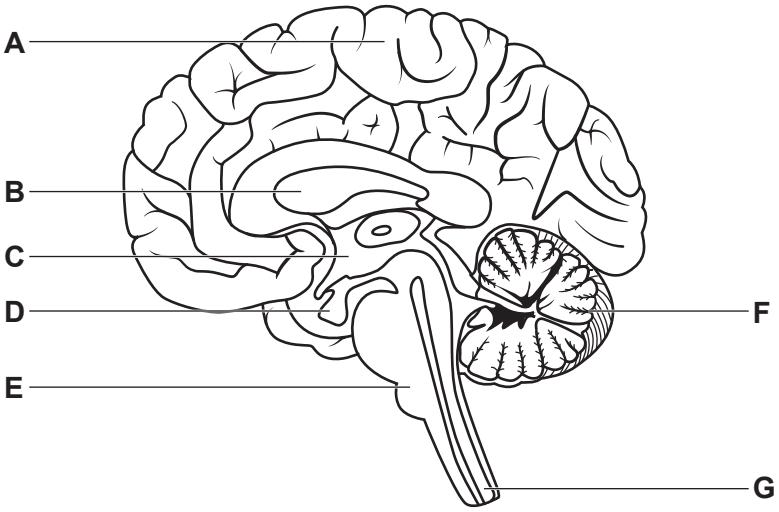


Fig. 3.1

The following table contains statements about areas of the brain shown in **Fig. 3.1**.

Complete the table using the most appropriate letter from **Fig. 3.1**. Each letter may be used once, more than once, or not at all.

Statement	Letter
fMRI shows this area of the brain to be active when playing a musical instrument.	
Temperature-sensitive neurones are located in this area of the brain.	
Traumatic injury to this area can lead to over- or under-production of sex hormones.	
This region of the brain controls heart rate and breathing rate.	
Stroke affecting part of this area of the brain could cause loss of conscious control of muscles in the arms or legs.	

[4]

© OCR 2021

(b) The brain contains the structures responsible for coordination of the control of body temperature.

An 80-year-old man was found in an unheated room when the outside temperature was below 0º C. The man had a weak pulse. A paramedic measured the man's core body temperature as 34.2 ºC.

(i) Explain how the paramedic could obtain an accurate measurement of core body temperature.

.....

.....

.....

.....

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

© OCR 2021

(ii)* The paramedic concluded that the man was suffering from hypothermia.

Describe the biological processes that lead to hypothermia and the treatment for hypothermia.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

Additional answer space if required.

.....

.....

.....

.....

.....

© OCR 2021

(c) **Fig. 3.2** shows monthly data for the treatment of cases of hypothermia (**Fig. 3.2a**) and hyperthermia (**Fig. 3.2b**) in the United States over a two-year period.

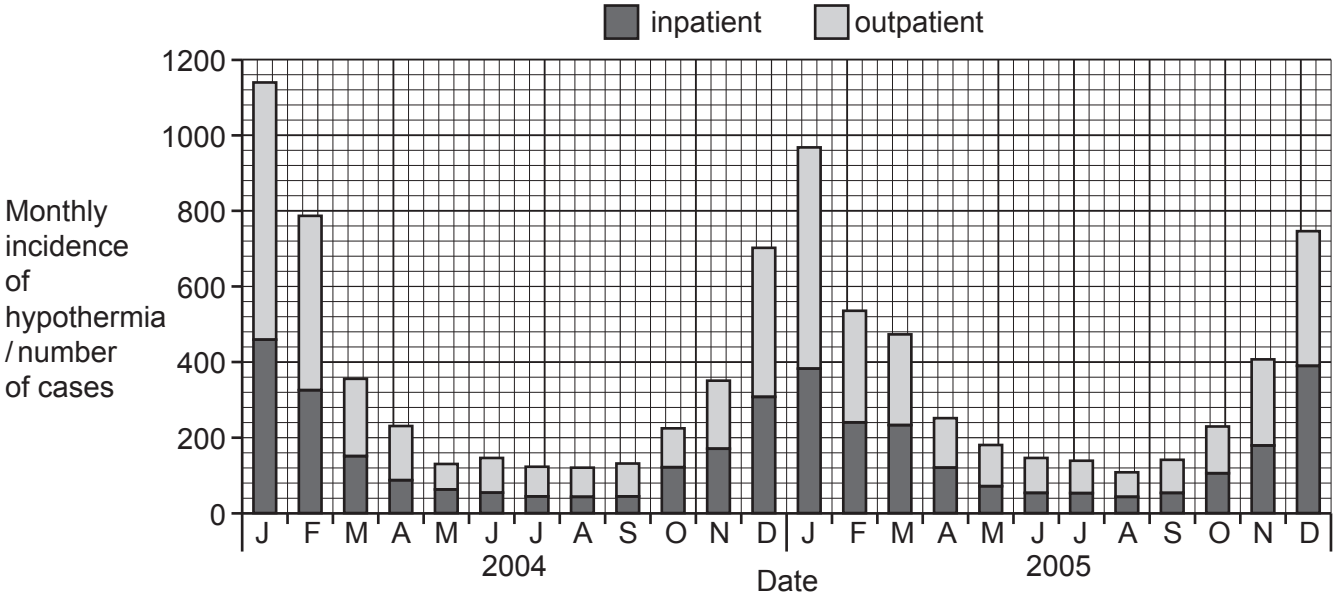


Fig. 3.2a

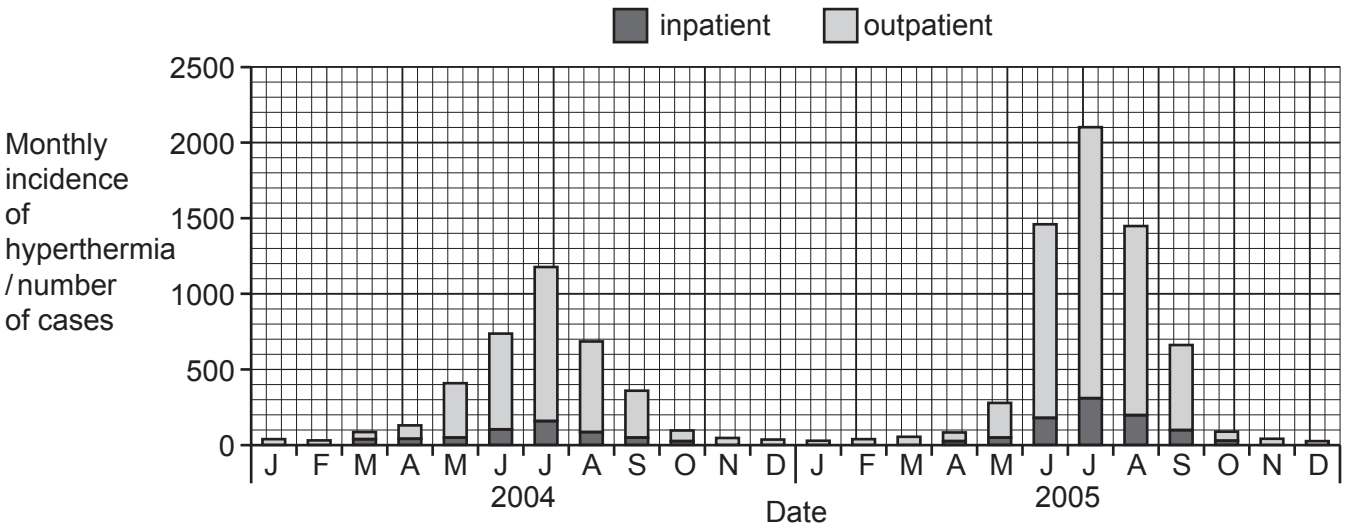


Fig. 3.2b

Some patients were treated as outpatients in a clinic or Emergency Department. Others required admission to hospital as inpatients.

© OCR 2021

(i) Describe and explain the seasonal trends shown in the two graphs in **Fig. 3.2**.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(ii) Suggest why the proportion of inpatient hospital admissions was different for hypothermia and hyperthermia.

.....

.....

.....

.....

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

(iii) A student looked at the data for hyperthermia and concluded that this was evidence for climate change.

Discuss the student's conclusion.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2021

4 **(a)** **Fig. 4.1** shows a graph of rate of reaction plotted against substrate concentration for an enzyme that converts a colourless substrate into a coloured product.

V_{max} represents the maximum rate of reaction.

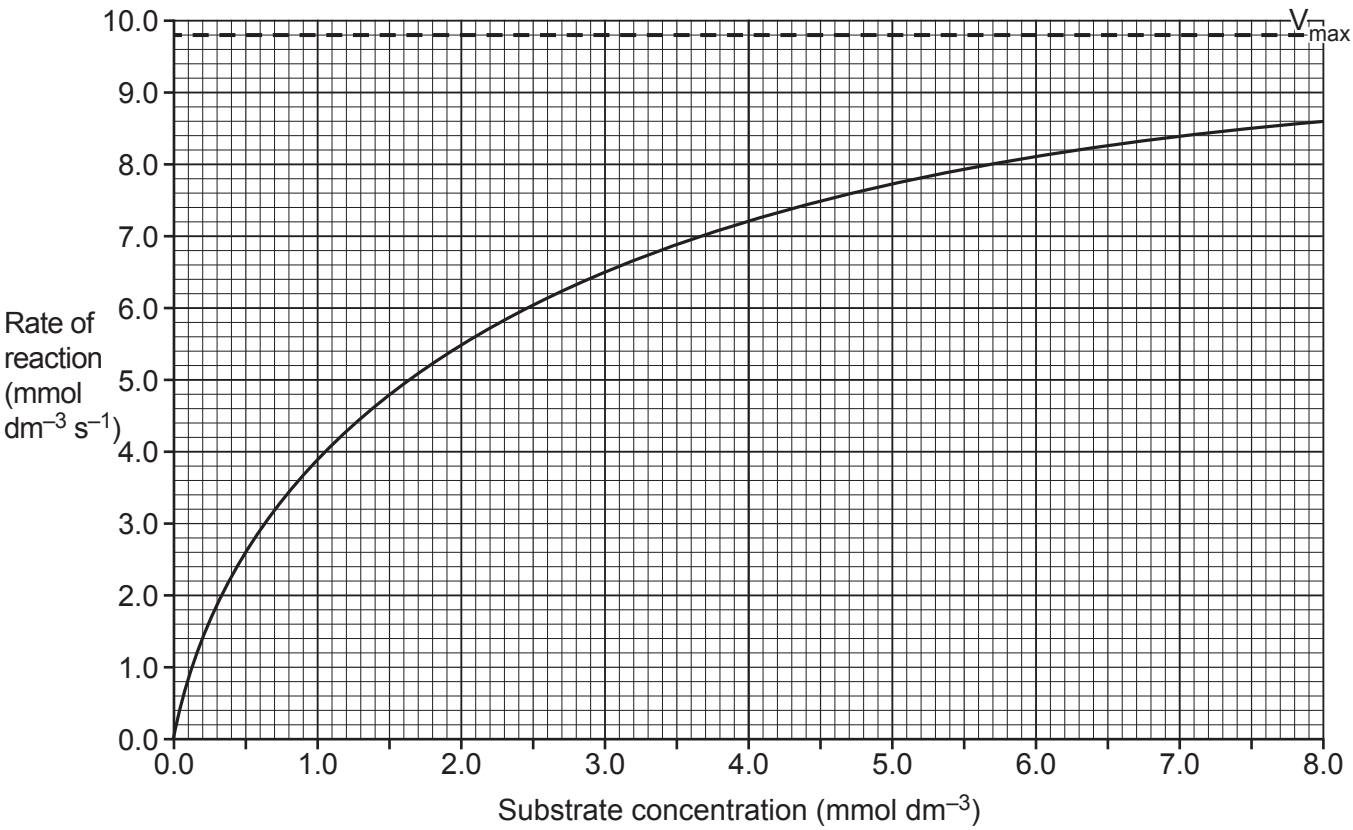


Fig. 4.1

(i) Describe how you could obtain the data for this graph.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2021

(ii) Explain why the experiments you have described should be carried out with excess enzyme.

.....

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

(iii) The Michaelis constant, K_M, is defined as the substrate concentration that gives half the maximum reaction rate ($\frac{1}{2}$ V_{max}).

Use **Fig. 4.1** to obtain a value for K_M for this enzyme, including units.

K_M = ... units ..... **[2]**

(iv) Suggest why it is often difficult to determine a value for V_{max} experimentally.

.....

.....

.....

.....

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

© OCR 2021

(b) Because of the difficulty in determining a value for V_{max}, a double reciprocal plot can be used instead.

To prepare this plot, the rate of reaction, V, is measured at different substrate concentrations, [S].

Then, a plot of 1 / V against 1 / [S] is made, as shown in **Fig. 4.2**.

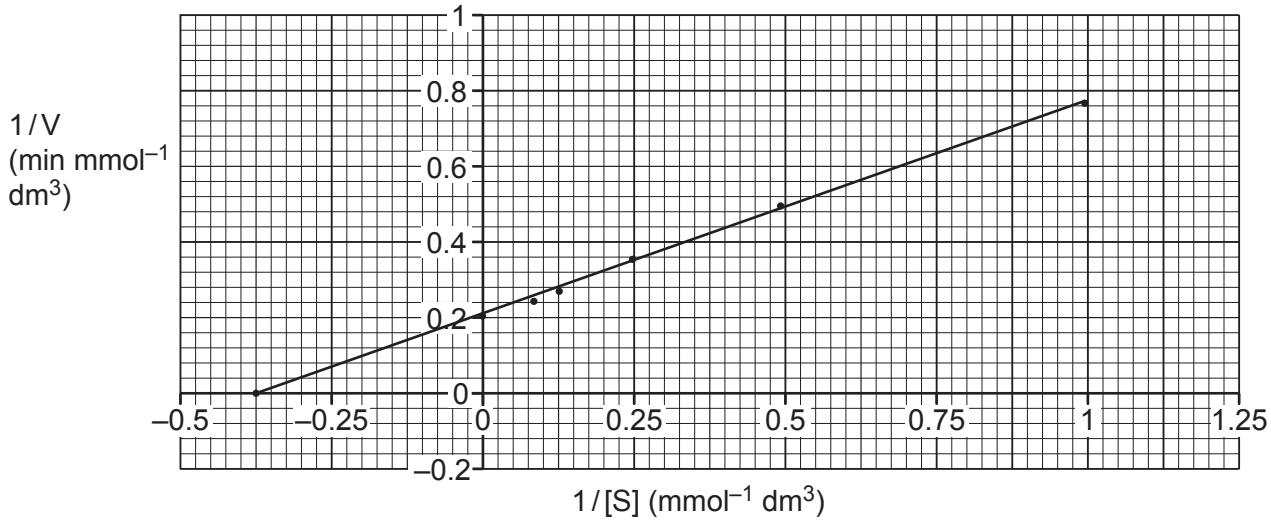


Fig. 4.2

The equation for the graph in **Fig. 4.2** is:

$$\frac{1}{V} = \frac{K_M}{V_{max}} \times \frac{1}{[S]} + \frac{1}{V_{max}}$$

This equation is of the form $y = mx + c$ where

- 1 / V represents y
- K_M / V_{max} represents m
- 1 / [S] represents x
- $1 / V_{max}$ represents c

The double reciprocal plot therefore produces a straight line graph.

(i) Use **Fig. 4.2** to determine the gradient of the line.

Gradient = ... **[1]**

© OCR 2021

(ii) Write an expression that connects the gradient of the line, K_M and V_{max}.

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

(iii) A student used **Fig. 4.2** to determine that $V_{max} = 5$.

Use this value and your answer to part **(i)** to determine K_M for this enzyme.

K_M = ... (units not required) **[2]**

© OCR 2021

5 **(a)** The following passage describes aspects of epigenetics.

Complete the passage using the most appropriate terms.

A mutation causes a change in the nucleotide sequence of DNA. Epigenetic changes do not change the nucleotide sequence. Instead, they change the extent to which genes are …….. .

One epigenetic mechanism involves acetylation of ……., which makes the genes more accessible. Another mechanism involves ……. of the DNA. Some epigenetic changes can be inherited if they are present in …….. . **[4]**

(b) Twenty zebrafish were exposed to hypoxia (oxygen deprivation) by keeping them in water with a low oxygen concentration for 4 weeks.

All the offspring of these fish had greater resistance to hypoxia than offspring whose parents were kept in well-oxygenated water.

The researchers concluded that this showed evidence for inheritance of epigenetic changes rather than being the result of a mutation.

Evaluate this conclusion.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2021

(c) *Drosophila simulans* and *Drosophila mauritiana* are two closely related species of fruit fly.

The *OdsH* gene in Drosophila is described as a speciation gene. It causes epigenetic changes to the DNA that regulates the condensation of chromosomes.

(i) Name the stage of the cell cycle in which condensation of chromosomes occurs.

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

(ii) The *OdsH* gene causes male sterility in *D. simulans* – *D. mauritiana* hybrids.

Based on the information provided, suggest how the *OdsH* gene has caused *D. simulans* and *D. mauritiana* to become and remain separate species.

.....

.....

.....

.....

.....

.....

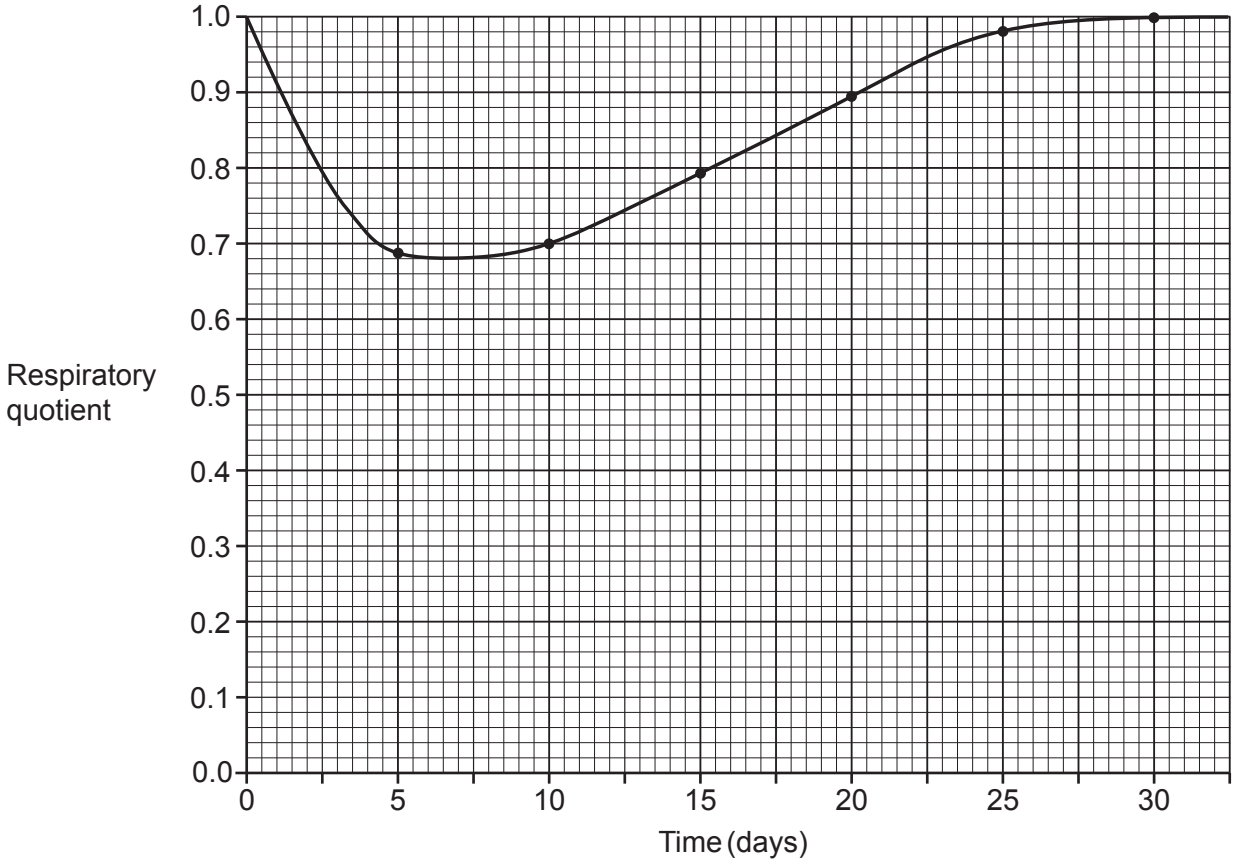
.....

..... **[3]**

© OCR 2021

6 **(a)** Barley is a widely grown cereal in the UK. The production of barley malt involves germinating the barley grains (seeds) and then drying them.

The graph shows the results of an investigation into changes in respiratory quotient (RQ) of barley seeds during the first 30 days of germination.



(i) Name the apparatus that could have been used to measure RQ in this investigation.

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

(ii) Barley grains contain about 12% by mass of storage proteins. A student stated that the graph was evidence that these proteins are used as respiratory substrates throughout germination.

Suggest whether the student's statement is likely to be correct.

.....

.....

.....

.....

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

© OCR 2021

(iii) Describe how you could extend this experiment to test the student's hypothesis.

.....

.....

.....

.....

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

(iv) What can you conclude from the graph about the respiratory substrates, other than protein, that are used during germination?

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2021

(b) After being used in brewing, spent grain can be used as an animal feed.

Approximately 50% by mass of the fatty acids in spent grain are linoleic acid, $C_{18}H_{32}O_2$.

(i) Calculate the respiratory quotient, RQ, of linoleic acid when respired aerobically.

RQ = ... **[2]**

(ii) State the effect on RQ if the linoleic acid were respired by a mixture of aerobic and anaerobic respiration. Explain your answer.

.....

.....

.....

.....

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

© OCR 2021

7 **(a)** Immunity can be categorised as

- active or passive
- natural or artificial.

Complete the following table by putting ticks (✓) in the correct boxes to show whether each example is active or passive **and** natural or artificial.

Example	**Active**	**Passive**	**Natural**	**Artificial**
Snake antivenoms consist of sheep or horse antibodies to snake venom proteins. They are given to treat snake bite.				
A mixture of proteins purified from the *Haemophilus influenzae* virus is used to reduce the risk of a person getting the flu.				
Following infection by a pathogen, a person develops memory T and B cells.				
A calf receives antibodies from its mother in colostrum.				

[4]

© OCR 2021

(b) Scientists investigated the link between breastfeeding in mice and the risk of offspring developing asthma.

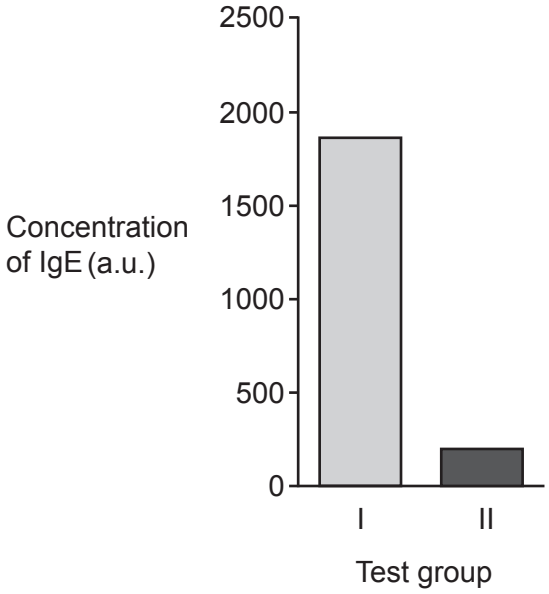
They used a model system of asthma called allergic airway disease (AAD).

Two groups of mice were compared:

- Group I: mice who were born to normal mothers (no AAD) and then breastfed by their own mothers.
- Group II: mice who were born to normal mothers but then breastfed by foster mothers with AAD.

After 4 weeks the offspring were exposed to a protein to induce AAD.

The concentration of IgE in the blood of the offspring was determined. IgE is a type of antibody that increases in concentration during allergic reactions. The results are shown in the graph.



(i) Name a statistical test the scientists could have used to compare the results of the two groups. Give a reason for your choice.

.....

.....

.....

.....

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

© OCR 2021

(ii) State which group of offspring showed more AAD. Give a reason for your choice.

.....

.....

.....

.....

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

(iii) The statistical analysis showed there was a significant difference in the concentrations of IgE antibodies in the two groups.

Breastfeeding is associated with a reduced risk of asthma in children.

Explain whether the results support the conclusion that breastfeeding could reduce the risk of asthma in children.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

END OF QUESTION PAPER

© OCR 2021

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).

OCR
Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2021