Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
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TOTAL	

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2014

Biology BIOL2

Unit 2 The variety of living organisms

Monday 2 June 2014 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.

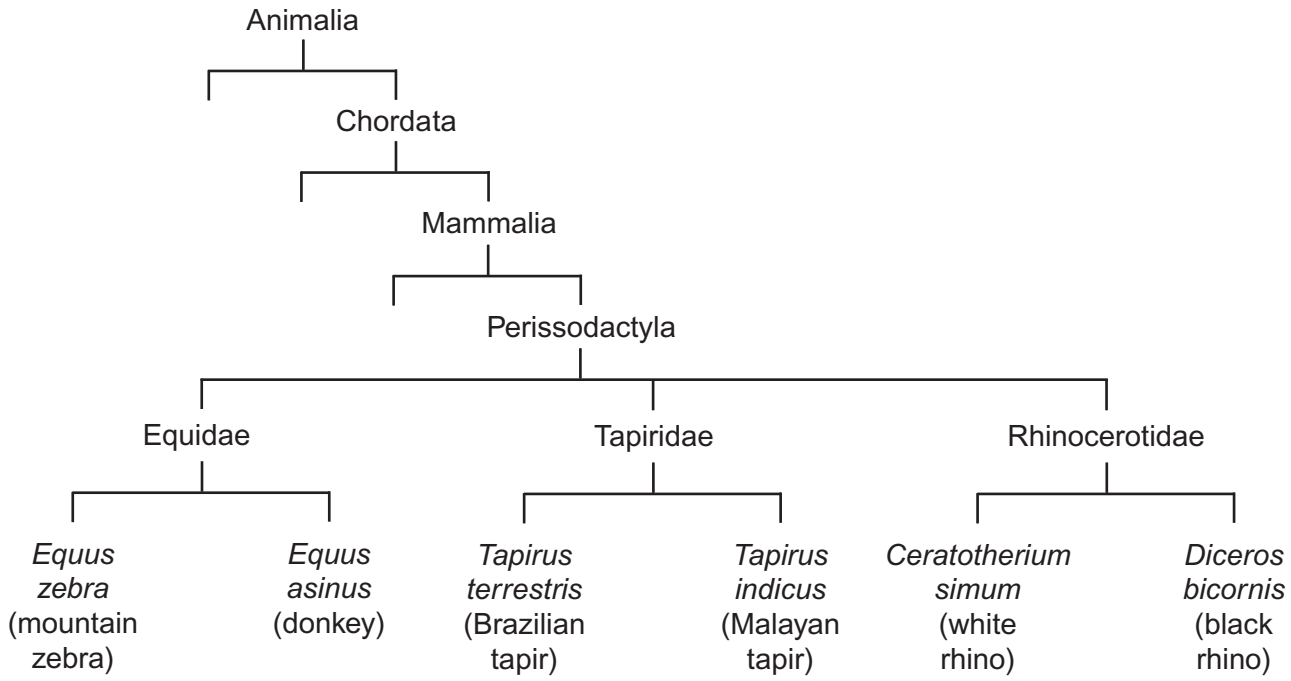
Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise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

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

1 **Figure 1** shows how some animals with hooves are classified.

Figure 1



1 (a) This type of classification can be described as a phylogenetic hierarchy.

1 (a) (i) What is meant by a **hierarchy**?

[2 marks]

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1 (a) (ii) How many different families are shown in **Figure 1**?

[1 mark]

1 (a) (iii) To which phylum does the white rhino belong?

[1 mark]

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1 (b) (i) Explain the role of independent segregation in meiosis.

[2 marks]

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1 (b) (ii) A zeedonk is the offspring produced from breeding a mountain zebra with a donkey.

- The body cells of a mountain zebra contain 32 chromosomes.
- The body cells of a donkey contain 62 chromosomes.

Use this information to suggest why zeedonks are usually infertile.

[2 marks]

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2 (a) (i) What is **selective breeding**?

[1 mark]

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2 (a) (ii) Explain **one** potential problem that can be caused by selective breeding.

[2 marks]

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2 (b) Heritability is a measure of how much of the variation in a population is due to genetic factors. Values for the heritability of a feature range from 0 to 1. A value of 0 means that there is no influence of genetic factors. A value of 1 means that the feature is completely due to genetic factors.

The Large Munsterlander and Pudelpointer are two breeds of hunting dog. **Table 1** shows the mean heritability values and standard deviations for two features of these two breeds of hunting dog.

Table 1

Feature	**Mean heritability value (± standard deviation)**	
	Large Munsterlander	**Pudelpointer**
Tracking	0.80 ± 0.10	0.17 ± 0.06
Searching	0.19 ± 0.11	0.12 ± 0.08

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2 (b) (i) If a dog breeder wishes to use selective breeding for one of these features, which **one** should he choose? Use information in **Table 1** to explain your answer.

[2 marks]

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2 (b) (ii) What do the standard deviations suggest about the differences in heritability values for searching between the two breeds of hunting dog?

[2 marks]

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Turn over for the next question

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3 (a) The oxygen dissociation curve for haemoglobin shifts to the right during vigorous exercise. Explain the advantage of this shift.

[3 marks]

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3 (b) Weddell seals are diving mammals that live in cold environments. A Weddell seal is shown in **Figure 2**.

Figure 2



3 (b) (i) Explain how the body shape of a Weddell seal is an adaptation to living in a cold environment.

[2 marks]

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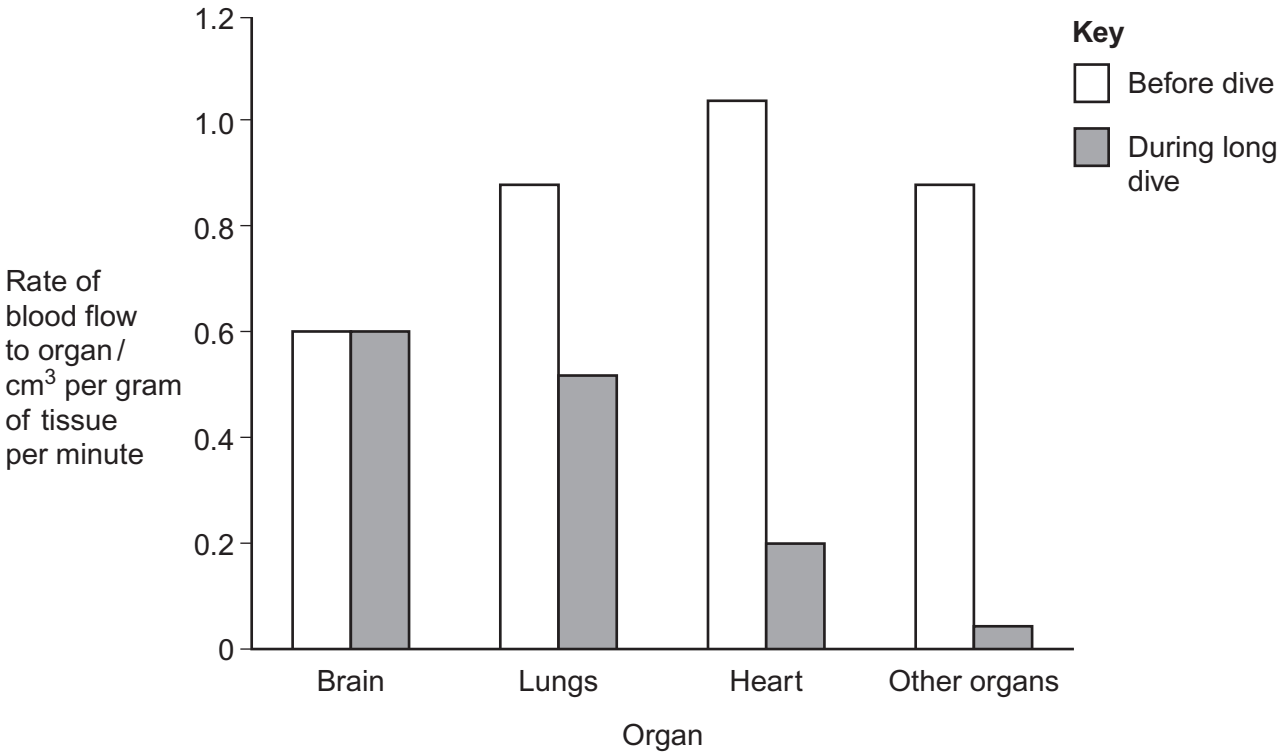
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3 (b) (ii) Weddell seals can remain underwater for long periods of time. **Figure 3** shows the rate of blood flow to different organs of a Weddell seal before a dive and during a long dive.

Figure 3



Describe and explain the changes in the rate of blood flow to the different organs during a long dive.

[3 marks]

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4 (a) Describe and explain how the countercurrent system leads to efficient gas exchange across the gills of a fish.

[3 marks]

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4 (b) Amoebic gill disease (AGD) is caused by a parasite that lives on the gills of some species of fish. The disease causes the lamellae to become thicker and to fuse together.

AGD reduces the efficiency of gas exchange in fish. Give **two** reasons why.

[2 marks]

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4 (c) **Table 2** shows some features of gas exchange of a fish at rest.

Table 2

Volume of oxygen absorbed by the gills from each dm^3 of water / cm^3	7
Mass of fish / kg	0.4
Oxygen required by fish / $cm^3\ kg^{-1}\ hour^{-1}$	90

4 (c) (i) Calculate the volume of water that would have to pass over the gills each hour to supply the oxygen required by the fish. Show your working.

[2 marks]

..... dm^3

4 (c) (ii) The volume of water passing over the gills increases if the temperature of the water increases. Suggest why.

[1 mark]

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5 (a) Genes for antibiotic resistance can be transmitted between bacteria. **Table 3** shows features of gene transmission.

Complete **Table 3** by putting a tick in the box if the statement is correct for vertical or horizontal gene transmission.

[2 marks]

Table 3

Statement	**Vertical gene transmission**	**Horizontal gene transmission**
Gene is replicated		
Gene can be passed to other species of bacteria		
Involves conjugation		

5 (b) (i) The antibiotic tetracycline binds to ribosomes in bacterial cells.

Explain how this causes the death of bacterial cells.

[2 marks]

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Question 5 continues on the next page

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Scientists determined the amino acid sequences of two forms of a protein, **A** and **B**, found in two types of the same species of bacterium. They used these amino acid sequences to find the DNA base sequences that code for these proteins.

Table 4 shows their results for the same region of proteins **A** and **B**.

Table 5 shows DNA triplets that code for different amino acids.

Table 4

Protein A							
Amino acid sequence	Lys	Ser	Pro	Cys	Leu	Gly	Ala
DNA base sequence	TTT	TCA	GGT	ACG	GAA	CCA	CGA

Protein B							
Amino acid sequence	Lys	Ser	Pro	Trp	Pro	Trp	Cys
DNA base sequence	TTT	TCA	GGT				

Table 5

Amino acid	**DNA bases that code for this amino acid**
Trp	ACC
Pro	GGT or GGA
Cys	ACA or ACG

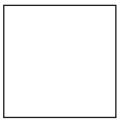
The amino acid sequence of protein **B** was the result of a mutation. A single base was added within the DNA sequence coding for protein **A**.

5 (b) (ii) Use the information provided to complete the DNA base sequence that codes for protein **B**.

[1 mark]

5 (b) (iii) Complete the box to show which DNA base was added.

[1 mark]



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5 (b) (iv) Tetracycline can enter a bacterium through protein **A**. This protein is found in the plasma membrane.

Suggest how a change in the amino acid sequence of this protein could make a bacterium resistant to tetracycline.

[2 marks]

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Turn over for the next question

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6 Evolutionary relationships between different primates can be found by comparing their proteins and DNA.

6 (a) All primates produce a species-specific type of haemoglobin. An antibody against human haemoglobin could be used to compare the evolutionary relationships between different primates. Describe and explain how.

[3 marks]

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6 (b) Scientists used DNA hybridisation to determine the evolutionary relationships between five species of primate.

The temperature at which a molecule of double-stranded DNA separates into two single strands is the separation temperature.

The scientists recorded the mean separation temperature of DNA in which both strands were from the same species.

The scientists then recorded the mean decrease in separation temperature of DNA in which one of the strands was from another species.

Their results are shown in **Table 6**.

Table 6

Primate	**Mean decrease in separation temperature / ºC**				
	Human	Chimpanzee	Gorilla	Orang-utan	Gibbon
Human					
Chimpanzee	1.7				
Gorilla	2.3	2.3			
Orang-utan	3.6	3.6	3.5		
Gibbon	4.8	4.8	4.7	4.9	

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6 (b) (i) These data suggest that gibbons are the most distantly related to humans. Explain how.

[2 marks]

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6 (b) (ii) There were differences in separation temperature of DNA formed from single-stranded DNA of the **same** species of primate. Suggest why.

[1 mark]

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6 (b) (iii) The scientists assumed that the decreases in separation temperatures are directly proportional to the time since the evolutionary lines of these primates separated. Gorillas are thought to have separated from orang-utans 20 million years ago.

Use this information to calculate how long ago the evolutionary lines of humans and chimpanzees separated. Show your working.

[2 marks]

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7 (a) What **two** measurements are needed to calculate an index of diversity?

[2 marks]

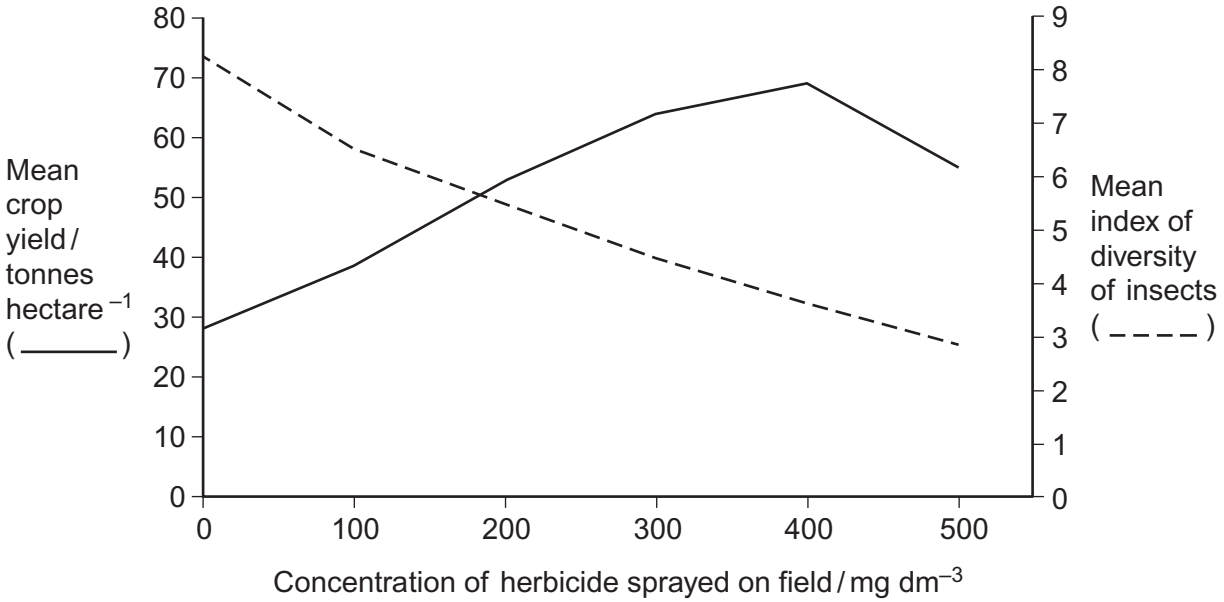
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7 (b) A herbicide is a chemical used to kill weeds. Ecologists investigated the effect of a herbicide on crop yield and the diversity of insects. They sprayed different fields with the same volume of different concentrations of the herbicide. At harvest, the ecologists determined the mean crop yield and the mean index of diversity of insects for fields that had received the same concentration of the herbicide.

Figure 4 shows their results.

Figure 4



7 (b) (i) Some fields acted as controls. They were sprayed with a solution that did not contain the herbicide. Explain the purpose of these control fields.

[1 mark]

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7 (b) (ii) Suggest an explanation for the relationship between the concentration of herbicide and the mean crop yield.

[2 marks]

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7 (b) (iii) Explain the relationship between the concentration of herbicide and the mean index of diversity of insects.

[3 marks]

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Turn over for the next question

Do not write outside the box

8 (a) Explain how the structure of DNA is related to its functions.

[6 marks]

[Extra space]

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Scientists investigated three genes, **C**, **D** and **E**, involved in controlling cell division. They studied the effect of mutations in these genes on the risk of developing lung cancer.

The scientists analysed genes **C**, **D** and **E** from healthy people and people with lung cancer.

- If a person had a normal allele for a gene, they used the symbol N.
- If a person had two mutant alleles for a gene, they used the symbol M.

They used their data to calculate the risk of developing lung cancer for people with different combinations of N and M alleles of the genes. A risk value of 1.00 indicates no increased risk. **Table 7** shows the scientists' results.

Table 7

Gene C	Gene D	Gene E	Risk of developing lung cancer
N	N	N	1.00
M	N	N	1.30
N	N	M	1.78
N	M	N	1.45

N = at least one copy of the normal allele is present
M = two copies of the mutant allele are present

8 (b) What do these data suggest about the relative importance of the mutant alleles of genes **C**, **D** and **E** on **increasing** the risk of developing lung cancer? Explain your answer.

[3 marks]

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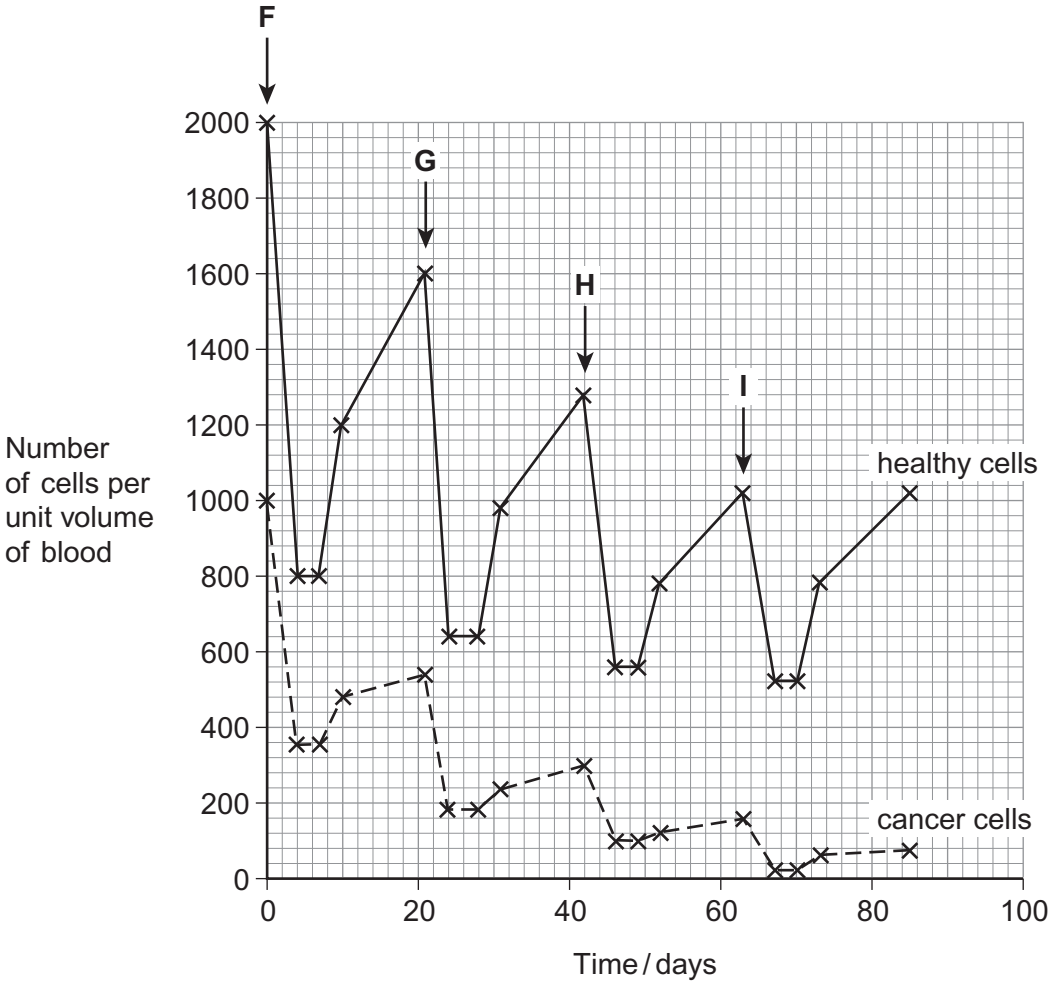
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Question 8 continues on the next page

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Chemotherapy is the use of a drug to treat cancer. The drug kills dividing cells. **Figure 5** shows the number of healthy cells and cancer cells in the blood of a patient receiving chemotherapy. The arrows labelled **F** to **I** show when the drug was given to the patient.

Figure 5



8 (c) Calculate the rate at which healthy cells were killed between days 42 and 46.

[1 mark]

..... cells killed per unit volume of blood per day

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8 (d) Describe similarities and differences in the response of healthy cells and cancer cells to the drug between times **F** and **G**.

[3 marks]

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8 (e) More cancer cells could be destroyed if the drug was given more frequently.

Suggest why the drug was **not** given more frequently.

[2 marks]

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Turn over for the next question

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9 Nicotine is the addictive substance in tobacco. When nicotine reaches the brain, it binds to a specific protein. This causes the release of chemicals that give a feeling of reward to the smoker. This reward is part of the reason why people find it difficult to stop smoking.

Scientists have developed a vaccine against nicotine to help people stop smoking. They set up an investigation, which involved a large number of volunteers. Once a month for 5 months, one group of volunteers was given the vaccine and the other group was given a placebo.

At regular intervals, the scientists measured the concentration of antibodies to nicotine in the blood of each group of volunteers. They also calculated the percentage of volunteers who had stopped smoking from months 2 to 6 of the investigation.

9 (a) (i) In this investigation, neither the volunteers nor the scientists knew if a particular volunteer was receiving the vaccine or a placebo.

Suggest **two** reasons why this made the scientists' results more reliable.

[2 marks]

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9 (a) (ii) The scientists measured the concentration of nicotine in the blood of two volunteers who smoked the same number of cigarettes per day.

Suggest **two** reasons why the concentration of nicotine in the blood of these smokers might be different.

[2 marks]

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9 (b) (i) Suggest how this vaccine could help people to stop smoking.

[3 marks]

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9 (b) (ii) Some people have suggested that this vaccine should **not** be given free to smokers on the National Health Service (NHS). Evaluate this suggestion.

[3 marks]

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The scientists measured the concentration of antibodies to nicotine in the blood of the volunteers for 12 months after the first vaccination. As a result of these measurements, they divided the volunteers who received the nicotine vaccine into three groups:

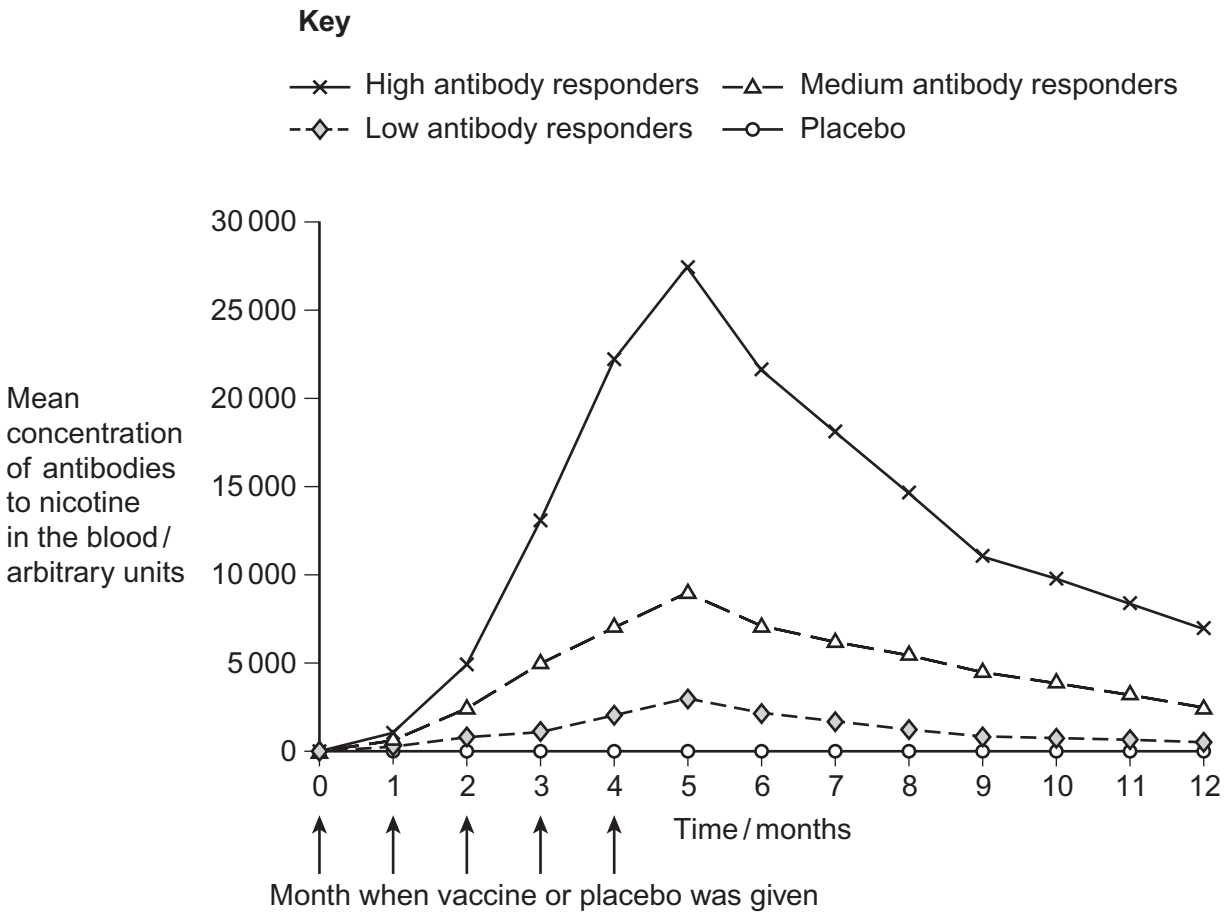
- high antibody responders
- medium antibody responders
- low antibody responders.

Figure 6 shows their results.

The scientists also recorded the number of volunteers who had stopped smoking from months 2 to 6 of the investigation.

Table 8 shows these results.

Figure 6



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Table 8

Group	Percentage of volunteers who had stopped smoking from months 2 to 6 of the investigation
High antibody responders	56.6
Medium antibody responders	38.1
Low antibody responders	32.1
Placebo	31.3

9 (c) A journalist reported that this vaccine is a major breakthrough in helping people to stop smoking. Do these data support this statement? Explain your answer.

[5 marks]

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END OF QUESTIONS

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Figure 2 Daisy Gilardini/Photodisc/Getty Images

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