

OCR GCSE GATEWAY BIOLOGY A • J247

BIOLOGY



EXAM QUESTION PACK

M1 ARITHMETIC AND NUMERICAL COMPUTATION

SCORE

/55

PERCENTAGE

%

STEMUP

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Gateway Biology A (9-1)

Maths 1: Arithmetic and numerical computation

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname								
Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **55**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 A student uses a light microscope to see cheek cells.

One cell is shown in Fig. 16.1.

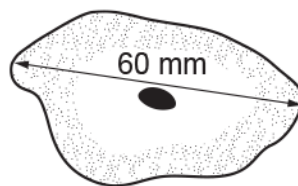


Fig. 16.1

- (i) The actual size of the cheek cell is 0.03 mm.

Calculate the magnification of the drawing.

Use the equation: magnification = measured size $\div$ actual size

Magnification = $\times$ [2]

- (ii) Which type of substance is used to make structures inside the cell easier to see when using a light microscope?

----- [1]

2 Some students investigate the effect of the surface area : volume ratio on the rate of diffusion in animal cells.

They use hydrochloric acid and gelatine cubes that have been stained blue using a pH indicator solution. The indicator will turn red in acidic conditions.

They put different sized cubes into 3 different test tubes of hydrochloric acid and time how long it takes for the cubes to completely change to red.

Fig. 21.1 shows the apparatus they use.

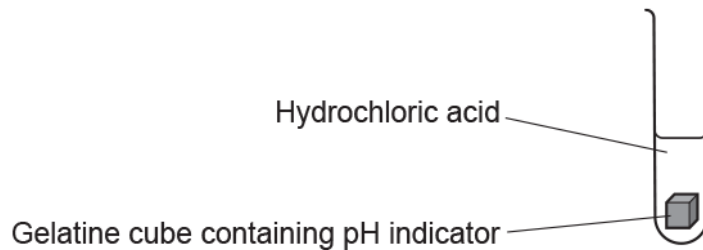


Fig. 21.1

The table shows the students' results.

Length of each side of the cube (mm)	surface area : volume ratio	Time to completely change colour (seconds)
2		32
4	3 : 2	61
6	1 : 1	170

(i) Calculate the surface area : volume ratio for the cube with sides of 2 mm.

surface area : volume ratio = ... [2]

(ii) What conclusion can be made about the effect of surface area : volume ratio on the rate of diffusion?

----- [1]

(iii) Emphysema causes some of the walls of alveoli in the lungs to break down. This produces a smaller number of larger air sacs.

Use the results to explain the effect of emphysema on oxygen diffusing into the blood.

----- [2]

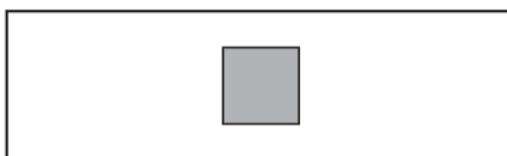
3 Fanconi anaemia is a genetic disorder. The disorder causes a decrease in the number of platelets in the blood.

Fanconi anaemia also causes a decrease in white blood cells and red blood cells.

The table shows ranges for blood components in people **without** Fanconi anaemia.

Blood component	Number per mm ³
red blood cell	4.5 million – 6.5 million
white blood cell	6.0 thousand – 16.0 thousand
platelet	0.15 million – 0.40 million

(i) The diagram shows a microscope slide containing blood from a patient.



The volume of blood under the slide is 0.1 mm³ and it contains 1000 white blood cells.

Calculate the number of white blood cells per mm³ of blood.

Number = ... per mm³ [2]

(ii) Does the blood sample provide evidence that the patient has Fanconi anaemia?

Use the table and your answer to part (i) to justify your answer.

----- [1]

4 Hypercholesterolemia (HC) is caused by a dominant allele on chromosome 19. This allele has mutations which cause a change in the order of DNA nucleotides.

One in 500 people are heterozygous for HC.

There are 66 000 000 people in the UK.

Calculate how many people in the UK are heterozygous for HC.

Number of people = ... [1]

5 Some students investigate the effect of the surface area : volume ratio on the rate of diffusion in animal cells.

They use hydrochloric acid and gelatine cubes that have been stained blue using a pH indicator solution. The indicator will turn red in acidic conditions.

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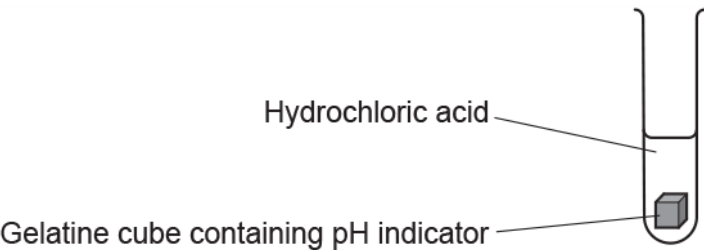


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surface area : volume ratio = ... [2]

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Use the results to explain the effect of emphysema on oxygen diffusing into the blood.

----- [2]

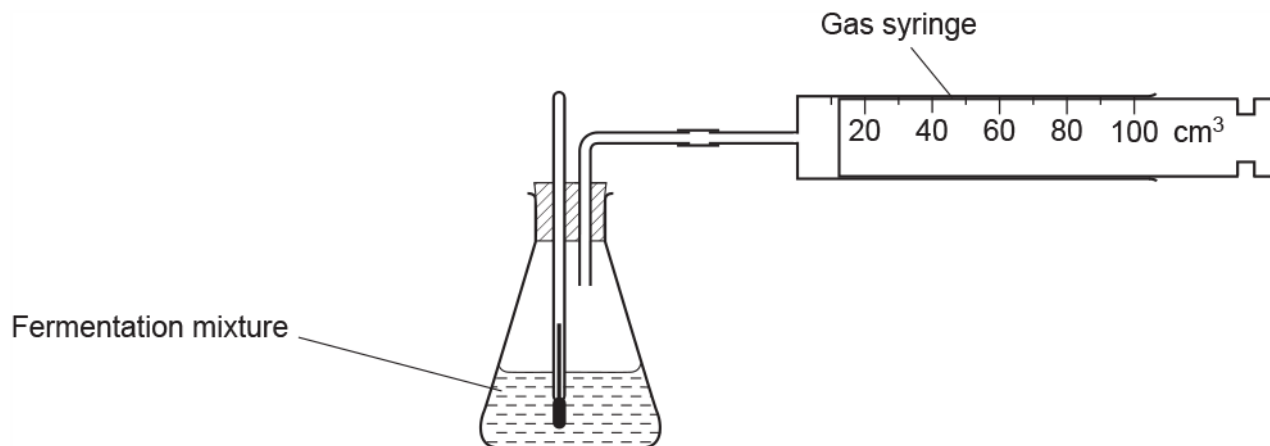
6 Fermentation involves enzymes that break down sugar releasing carbon dioxide gas.

The volume of carbon dioxide released can be used to measure how fast these enzymes are working.

A student investigates if fermentation works faster at 25 °C or 30 °C.

She measures the volume of carbon dioxide released in 10 minutes.

The diagram shows the apparatus she uses.



The student's results are shown in the table.

Temperature (°C)	Volume of carbon dioxide gas (cm ³) released in 10 minutes		
	Trial 1	Trial 2	Trial 3
25	23	25	22
30	34	27	33

(i) Calculate the **mean** rate of gas produced at 25 °C in cm³ / minute.

Give your answer to 1 decimal place.

Mean rate of gas produced at 25 °C = ... cm³ / minute [3]

(ii) The rate of gas produced at 30 °C is greater than at 25 °C.

Use ideas about enzymes to explain why.

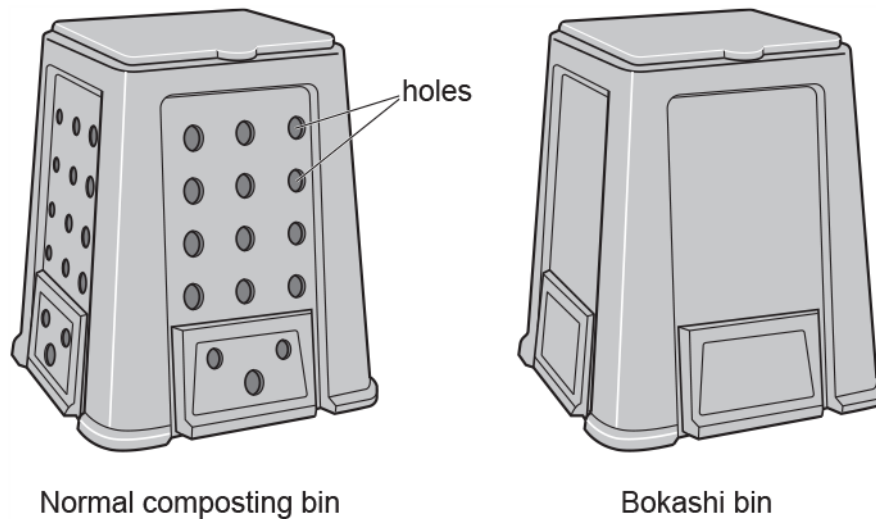
[3]

7(a) Gardeners often turn dead plant material from their garden into compost. They then add this compost to the soil where they are growing plants.

Compost can be made in a composting bin. In the bin **aerobic bacteria** turn dead plant material into compost.

Some people use a different way of making compost, called bokashi. In this process the compost is made **anaerobically**.

The drawings show a normal composting bin and a bokashi bin.



Explain the difference in the design of the two composting bins.

[2]

(b) Scientists investigate the two methods of making compost.

This is their method:

- Take one large pile of dead plant material
- Divide the material into two samples of equal mass
- Place one sample into the normal composter and place one sample into the bokashi composter
- Measure the temperature in each composter every 10 days
- After 40 days, measure the mass of the compost.

Write down **one** way that the scientists make sure that they can draw valid conclusions.

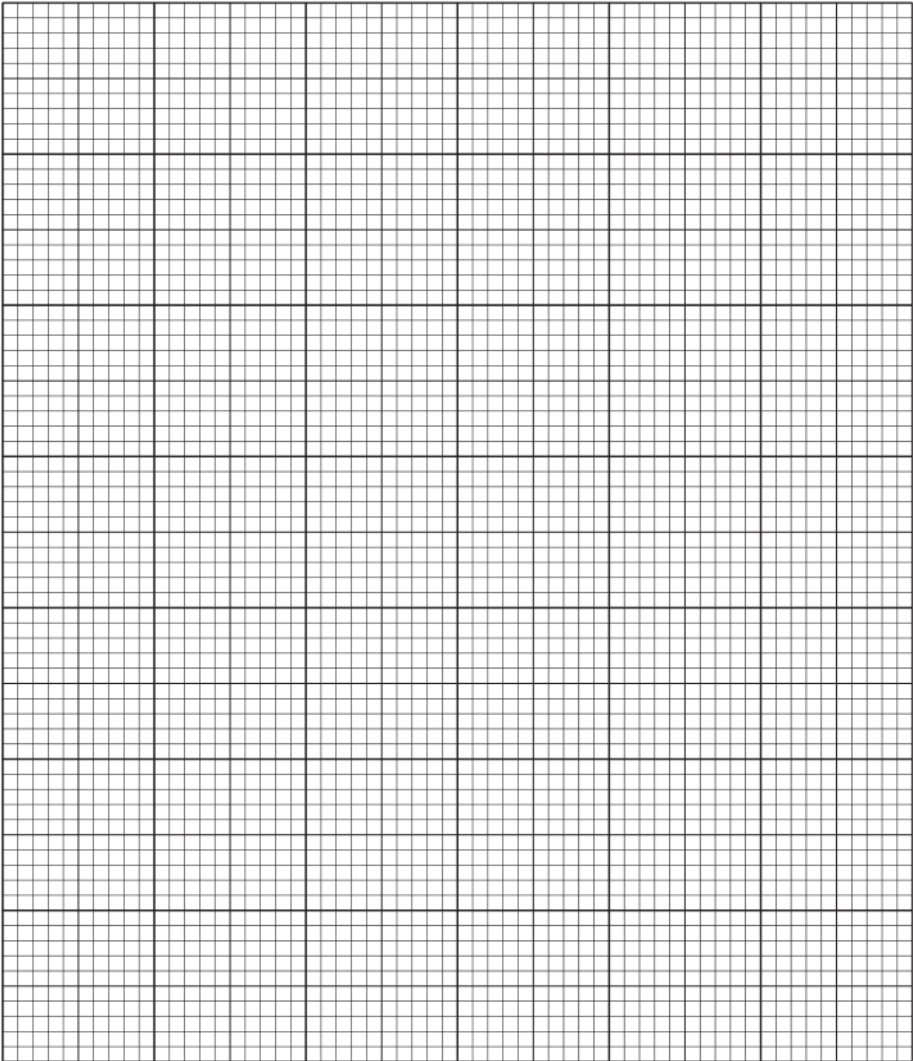
----- [1]

(c) Table 18.1 shows the scientists' temperature readings.

Time (days)	Temperature of the compost (°C)	
	normal compost	bokashi compost
0	26	26
10	70	27
20	53	29
30	42	31
40	28	28

Table 18.1

(i) Plot the scientists' results on the grid for normal and bokashi compost, and draw **two** curves of best fit.



[5]

(ii) Explain why the temperature of the compost in the **normal** bin changed as shown in the graph.

[2]

(iii) Explain the difference in the temperature changes between the aerobic normal compost and the anaerobic bokashi compost.

[2]

(d) **Table 18.2** shows the scientists' results for the mass of the compost.

	Normal compost	Bokashi compost
Mass at start (kg)	1500	1500
Mass after 40 days (kg)	750	1100

Table 18.2

A gas is given off in the formation of the compost. This causes most of the decrease in mass.

- (i) The percentage decrease in the mass of the normal compost is 50%.

Calculate the percentage decrease in the mass of the bokashi compost.

Give your answer to 2 significant figures.

Percentage decrease = ... % **[3]**

- (ii) The scientists concluded that the bokashi method of composting might be better for the environment.

Use your answer from part (i) to justify the scientists' conclusion.

[2]

8(a) Fanconi anaemia is a genetic disorder. It results in the bone marrow being destroyed.
This causes a decrease in the numbers of red blood cells, white blood cells and platelets.

Explain **two** possible symptoms of Fanconi anaemia.

1

2

[2]

(b) Table 19.1 shows normal ranges for blood components in people **without** Fanconi anaemia.

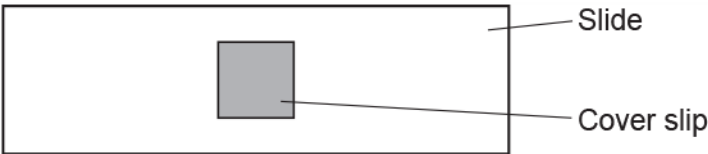
Blood component	Number per mm ³
red blood cell	4.5 – 6.5 × 10 ⁶
white blood cell	6.0 – 16.0 × 10 ³
platelet	1.5 – 4.0 × 10 ⁵

Table 19.1

(i) Suggest why there is such a wide range of white blood cell numbers.

[2]

(ii) The diagram shows a microscope slide containing blood from a patient.



The square cover slip is 10 mm wide and the thickness of the blood underneath is 0.001 mm.

Calculate the volume of blood under the cover slip.

Volume of blood = ... mm³ [1]

(iii) Under the cover slip are 1000 white blood cells.

Does the blood sample provide evidence that the patient has Fanconi anaemia?

Use **Table 19.1** and your answer to part (ii) to justify your answer.

----- [3]

(c) There are many different genetic disorders that can affect blood cells. Details of three of these are found in Table 19.2.

Name of disorder	Cause of disorder	Symptom
D-B anaemia	dominant allele	low red blood cell numbers
S-D syndrome	recessive allele	low white blood cell numbers
Fanconi anaemia	recessive allele	small numbers of all blood cells

Table 19.2

A blood smear from another patient shows that he has 3×10^6 red blood cells per mm^3 of blood. Neither of his parents have a blood disorder.

Use Table 19.1 and Table 19.2 to explain which blood disorder the patient could have.

Name of disorder

Explanation

[3]

9(a) Hypercholesterolemia (HC) is the result of a mutation in the genome. It is caused by a dominant allele on chromosome 19. The mutation involved causes a change in the DNA nucleotides.

Write the words **allele**, **chromosome**, **genome** and **nucleotide** in the boxes to show their size from smallest feature to largest feature.

Smallest feature

Largest feature

[1]

(b) One in 500 people are heterozygous for HC.

There are 66 000 000 people in the UK.

Calculate how many people in the UK are heterozygous for HC.

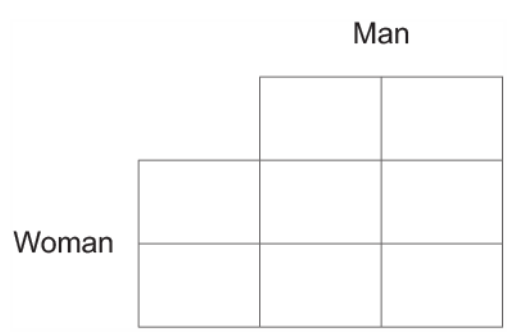
Number of people = ... [1]

(c) A woman who does not have HC and a man who is heterozygous are expecting a baby.

What is the probability of the baby having HC?

Complete the genetic diagram to explain your answer.

Use D for the dominant HC allele and d for the recessive allele.



Probability = ... [2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = (×) 2000 award 2 marks $60(\text{mm}) \div 0.03(\text{mm}) \checkmark$ $= (\times) 2000 \checkmark$	2 (AO2.2)	
		ii	(use of a) stain $\checkmark$	1 (AO1.2)	ALLOW named stain e.g. iodine / methylene blue / eosin ALLOW dye IGNORE colouring
			Total	3	
2		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3 : 1 award 2 marks $24 : 8 \text{ or } 3 \checkmark$ $3 : 1 \checkmark$	2 (AO2.2)	ALLOW answer in the table but answer on answer line takes preference
		ii	higher SA:V ratio faster rate of diffusion / ORA $\checkmark$	1 (AO3.2b)	ALLOW positive correlation ALLOW reference to less time instead of faster rate IGNORE they are directly proportional
		iii	reduces (total) SA of alveoli/air sacs / reduces SA : Vol ratio of alveoli/air sacs $\checkmark$ so diffusion (of oxygen) reduced $\checkmark$	2 (AO2 x 3.1a)	ALLOW harder for oxygen to diffuse IGNORE oxygen cannot diffuse into the blood in emphysema
			Total	5	
3		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10 000(per mm^3) award 2 marks $1000 \div 0.1 \text{ OR } 1000 \times 10 \checkmark$ $= 10\,000 \text{ (per } \text{mm}^3) \checkmark$	2 (AO2 x 2.2)	
		ii	no (no mark) (because 10 000) is in the normal range / levels / range without Fanconi anaemia $\checkmark$	1 (AO3.2a)	ALLOW ECF from (i) ALLOW 10 000 is between 6000 and 16000
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4			$66000000 \div 500 = 132\,000$ ✓	1 (AO2.2)	ALLOW 0.132 million or 132 thousand or 1.32×10^5
			Total	1	
5		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3 : 1 award 2 marks 24 : 8 or 3 ✓ 3 : 1 ✓	2 (AO2.2)	ALLOW answer in the table but answer on answer line takes preference
		ii	higher SA:V ratio faster rate of diffusion / ORA ✓	1 (AO3.2b)	ALLOW positive correlation ALLOW reference to less time instead of faster rate IGNORE they are directly proportional
		iii	reduces (total) SA of alveoli/air sacs / reduces SA : Vol ratio of alveoli/air sacs ✓ so diffusion (of oxygen) reduced ✓	2 (AO2 x 3.1a)	ALLOW harder for oxygen to diffuse IGNORE oxygen cannot diffuse into the blood in emphysema
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.3 (cm³ / min) award 3 marks $\frac{25+23+22}{3} = 23.3333333 \quad \checkmark$ $\frac{23.3 \times 10}{10} = 2.3333333 \quad \checkmark$ = 2.3 (cm³ / min) $\checkmark$	3 (AO1 x 1.2) (AO2 x 2.2)	ALLOW one mark for clear evidence of rounding incorrect answer correctly to one dp.
		ii	increased movement of molecules / increased kinetic energy $\checkmark$ therefore, more chance of substrate colliding with enzymes/active sites $\checkmark$ more chance of substrate entering active site $\checkmark$	3 (AO2 x 2.1)	increased KE of enzymes and substrates leads to more collisions = 2 marks ALLOW more enzyme-substrate complexes forming
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a		normal bin has holes to allow in air / oxygen ✓ (making normal compost) so aerobic respiration occurs ✓	2 (AO2.1) (AO1.1)	ALLOW converse arguments for bokashi bin ALLOW aerobic bacteria carry out respiration IGNORE bacteria work aerobically
	b		used the same pile of dead plant material for both composters / used same plant type / used equal mass in both composters ✓	1 (AO2.2)	ALLOW used the same time interval for both composters ALLOW used the same water/moisture content for both composters ALLOW idea of same external conditions e.g. put both in same place / external temperature kept the same / kept in the same environment IGNORE references to fair testing
	c	i	Axes – both correctly labelled, including units ✓ Axes - even scales occupying more than half of the grid ✓ Plotting - all points correctly plotted ✓ Line - lines labelled or a key ✓ Line - points with curve of best-fit lines ✓	5 (AO5 x 2.2)	Must have time on x-axis and temperature on y-axis ALLOW +/- half a square at least 8 points correctly plotted IGNORE extrapolated lines
		ii	temperature increased as compost decomposed / bacteria released heat by respiration ✓ temperature starts to drop as decomposition slows down/complete / bacterial respiration slows ✓	2 (AO2 x 2.1)	ALLOW rise in temperature due to energy released by respiration ✓ ALLOW bacterial activity slows (if respiration already mentioned) ALLOW temperature starts to drop as enzymes in respiration denature at high temperatures
		iii	idea that decomposition in bokashi (method) bin much slower ✓ anaerobic respiration releases less heat/energy than aerobic respiration ✓	2 (AO2 x 2.1)	Enter text here.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	d	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 27 (%) award 3 marks 400 / 1500 x 100 ✓ 26.6 (%) ✓ = 27 (%) ✓	3 (AO2.2) (AO2.2) (AO1.2)	If answer = 26.6 (%) award 2 marks ALLOW ECF for correct rounding
		ii	idea that the gas given off is carbon dioxide ✓ less greenhouse gas produced / less likely to result in global warming / less contribution to greenhouse effect ✓	2 (AO2.2) (AO3.1b)	ALLOW for 2 marks less carbon dioxide produced which is a greenhouse gas ALLOW correct formula ALLOW explanations of the greenhouse effect IGNORE references to environmental damage/not environmentally friendly/pollution/not good for the environment
			Total	17	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a		Any two from: anaemia / tiredness / lack of energy due to lack of red blood cells ✓ inability to fight off infections / prone to infections due to lack of white blood cells/WBC ✓ slow blood clotting due to lack of platelets ✓	2 (AO2 x 1.1)	DO NOT ALLOW incorrectly matched symptom to blood cell type ALLOW less immunity / reduced immune response / weakened immune system due to lack of white blood cells/WBC ALLOW (recurring) nosebleeds / bruise easily due to lack of platelets
	b	i	people may be ill with infection / have a pathogen / just recovering from infection ✓ therefore have produced more white blood cells to destroy the pathogen/produce antibodies ✓ OR weakened immune system/cancer/cancer treatment reducing white blood cell number so less white blood cells to defend against pathogens/produce antibodies	2 (AO2 x 2.1)	IGNORE fighting(off) pathogens
		ii	Area = $10 \times 10 = 100(\text{mm}^2)$ Volume = $100 \times 0.001 = 0.1 (\text{mm}^3)$ ✓	1 (AO2.2)	
		iii	No (no mark) $1000 \div 0.1$ OR 1000×10 ✓ number of white blood cells/mm^3 is 10×10^3 / 1.0×10^4 / 10000 ✓ within the range of $6.0 - 16.0 \times 10^3$ ✓	3 (AO2 x 2.2) (AO3.2b)	ALLOW ECF from (ii) ALLOW number of white blood cells /mm^3 = 10 000 ALLOW within the normal white blood cell range/ 6000 – 16000

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		(Fanconi anaemia) (no mark) (3 x 10 ⁶ is a) low red blood cell count ✓ must be Fanconi anaemia because: caused by recessive allele ✓ obtained from heterozygous/carrier parents who don't have a blood disorder ✓ OR cannot be D-B anaemia because: neither parents have a blood disorder ✓ it is caused by a dominant allele ✓	3 (AO3x3.2 b)	if incorrect disorder then no marks IGNORE low numbers of all cells
			Total	11	
9	a		smallest nucleotide allele chromosome genome largest	1 (AO1.1)	
	b		66000000 ÷ 500 = 132 000 ✓	1 (AO2.2)	ALLOW 0.132 million or 132 thousand
	c		man Dd d woman d d Dd dd ✓ 0.5 / 50(%)✓	2 (AO2.2) (AO3.1a)	ALLOW appropriate use of other lower/upper case letters ALLOW ECF ALLOW 1 in 2 / ½ / 1:1 ✓ DO NOT ALLOW 1:2
			Total	4	