AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 4.1.2.3

Stem cells

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**4**
Available paper years	**2018–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.1.2.3 Stem cells

Answer 01 · Mark scheme June 2018 | 8464/B/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **one** from: • meristem(s) • **tip** of shoot • **tip** of root	ignore stem and embryo	1	AO1 4.1.2.3 4.2.3.1
06.2	to produce large numbers of identical plants		1	AO1 4.1.2.3
06.3	6×10^{-12} (grams)		1	AO2 4.1.2.1 4.1.2.2
06.4	$\frac{28}{360} \times 15$ **or** 1.166666666(r) 1.17 (hours)	an answer of 1.17 (hours) scores **2** marks allow $\frac{7}{90} \times 15$ allow correct rounding allow 1.16 allow **1** mark for 1 hour 10 minutes **or** 1 and 1/6 hours **or** 70 minutes **only** if units given	 1 1	AO2 4.1.2.2

4.1.2.3 Stem cells

Answer 01 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5		**max 4** if correct sequence but no reference to stage numbers **max 4** marks if no stage numbers given ignore names of phases marks can be awarded for labelled diagrams		AO1 4.1.2.1 4.1.2.2
	stage 1 cell growth **or** increase in number of organelles	allow increase in named organelle eg ribosomes / mitochondria	1	
	DNA replicates **or** two copies of each chromosome form	allow DNA duplicates / doubles ignore genetic information replicates if this statement given as part of stage 2 allow **max 4** marks	1	
	stage 2 / mitosis one set of chromosomes moves to each end of cell	allow chromosomes separate or are pulled apart	1	
	nucleus divides	allow nucleus splits into two	1	
	stage 3 cytoplasm / cell membrane divides to form two (genetically) identical cells	allow cytokinesis	1	

4.1.2.3 Stem cells

Answer 01 · Mark scheme

June 2018 | 8464/B/1H | Original Q6

06.6	any **two** from: **advantages:** • may be used to cure / treat (current / future) diseases **or** cure medical conditions **or** produce replacement cells / tissues / organs • cells / tissues of any type could be produced • cells unlikely to be rejected by the patient • many cells produced • cells produced could be used for research • would reduce waiting time for organ transplants any **two** from: **disadvantages:** • potential life is killed / destroyed • shortage of donors / eggs • egg donation / collection has risks • do not yet know risks /side effects of the procedure on the patient • may transfer (viral) infection • poor success rate to produce viable eggs / embryo	ignore references to cost allow example eg diabetes / paralysis ignore used for medical treatments allow cells differentiate into many types ignore identical cells are produced unqualified ignore references to cost ignore unethical unqualified ignore references to religion / beliefs allow embryo is destroyed ignore cells destroyed or wasted allow may cause tumours / cancer	2 2	AO1 AO3 4.1.2.3 4.1.1.4 4.6.2.4
Total			**14**	

4.1.2.3 Stem cells

Answer 02 · Mark scheme

November 2021 | 8464/B/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	D		1	AO2 4.2.2.2
05.2	C		1	AO3 4.2.2.2
05.3	right atrium → right ventricle → pulmonary artery		1	AO1 4.2.2.2

4.1.2.3 Stem cells

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.		5–6	AO3
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.		3–4	AO3
	Level 1: Relevant points are made. They are not logically linked.		1–2	AO1
	No relevant content		0	
	Indicative content Advantages of statins • easy to take **or** not invasive (procedure) • decrease blood cholesterol • slow down build-up of fatty materials in arteries • maintain blood flow to heart muscle cells • low cost (compared to stent operation) Disadvantages of statins • might be side effects of drug eg muscle pain • effects take time to happen • drug will need to be taken long term • might forget to take drug Advantages of stent • blocked artery is held open • blood flow to heart muscle cells is increased • stent will remain in place for a long time • effect of stent is immediate • rapid recovery from operation Disadvantages of stent • risk of infection from operation • risk of surgery eg heart attack **or** bleeding • risk of thrombosis **or** blood clot For Level 3, arguments for and against **both** treatments are needed.			4.2.2.4

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Answer 02 · Mark scheme

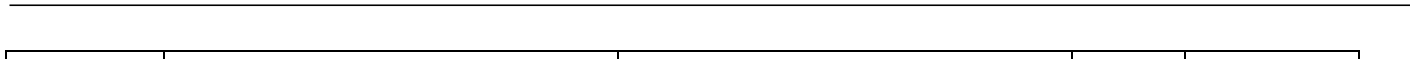
November 2021 | 8464/B/1H | Original Q5

05.5	heart (muscle) cannot contract / pump as effectively / powerfully (so) less blood pumped out of heart **or** to body (on each beat / contraction) (so) less oxygen (reaches cells / body) for (aerobic) respiration (so) breathing rate increases to supply more oxygen **or** (so) breathing rate increases to repay oxygen debt	allow heart (muscle) is not as strong ignore reference to rate of blood flow allow (so) more anaerobic respiration allow (so) breathing rate increases to break down lactic acid	1 1 1 1	AO2 4.2.2.2 4.2.2.4 4.4.2.1
05.6	stem cells are undifferentiated cells (therefore) can form heart (muscle) cells	allow stem cells can differentiate allow stem cells can develop into different types of cell ignore stem cells can become specialised ignore stem cells are not specialised allow (therefore) can form muscle cells	1 1	AO1 AO2 4.1.2.3 4.2.2.4
05.7	any **two** from: • cells will not be rejected • no risk of damage to embryo • adult can give consent	allow converse if clearly referring to embryonic stem cells allow no (potential) human life destroyed / damaged ignore unethical unqualified ignore religion unqualified	2	AO3 4.1.2.3
Total			**17**	

4.1.2.3 Stem cells

Answer 02 · Mark scheme

November 2021 | 8464/B/1H | Original Q5



4.1.2.3 Stem cells

Answer 03 · Mark scheme

June 2023 | 8464/B/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	any **one** from: • plasmid • chromosome • DNA / genes	 do **not** accept nucleus allow alleles allow genetic material	1	AO2 4.1.1.1 4.1.2.1 4.3.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	 no clear area (around C and E) (so) no bacteria killed (by antibiotic)	if no letters are given assume they are referring to antibiotics C and E allow (so) antibiotic did not work	 1 1	AO2 AO3 4.3.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	increased the concentration of antibiotic	allow increased the dose of antibiotic ignore increased the volume of antibiotic ignore left it longer ignore used a different temperature ignore used a different sized disc	1	AO3 AO2 4.3.1.8
	clear area seen (around disc) **or** bacteria (around disc) killed	mark dependent on describing a change to the method	1	

4.1.2.3 Stem cells

Answer 03 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	the treatment injected around the implant		1	AO2 4.1.2.3 4.3.1.3 4.3.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	any **one** from: (stem cells from fat tissue) • easier to obtain • less invasive	ignore reference to cost allow quicker to obtain allow fewer side effects allow less painful ignore reference to rejection	1	AO3 4.1.2.3 4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	by diffusion concentration of antibiotic lower inside cells than in solution **or** concentration of antibiotic higher in solution than inside cells	no marks if incorrect process selected allow 'it' for antibiotic allow correct reference to concentration gradient	1 1	AO2 4.1.1.2 4.1.2.3 4.1.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	0.09 to 0.31	allow 0.31 to 0.09	1	AO2 4.1.2.3 4.3.1.1 4.3.1.3 4.3.1.8

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Answer 03 · Mark scheme

June 2023 | 8464/B/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.8	any **two** from: **Pros:** stem cells containing antibiotic had: • smallest area of infection (**:** total tissue area) • small(est) range of results • no overlap with unreactive solution (suggesting significant effect)		2	AO3
	any **two** from: **Cons:** • only tested on 5 patients • some results for antibiotic treatment similar to stem cells containing antibiotic • some results for stem cell treatment similar to stem cells containing antibiotic • age / health of patients not controlled • only tested on one type of bacterium • only tested on one type of implant • only collected results after 7 days • may lead to antibiotic resistance (in *S. aureus* bacteria) • rejection of stem cells • need donors for stem cells • allergic reaction to antibiotic	allow small sample size ignore only tested on one infection ignore cost ignore religion ignore use of embryonic stem cells ignore references to viruses ignore side effects unqualified	2	AO3 AO2 4.1.2.3 4.3.1.1 4.3.1.3 4.3.1.8

Total Question 7	14

4.1.2.3 Stem cells

Answer 04 · Mark scheme

June 2025 | 8464/B/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **one** from: • high resolution • high magnification • 3D image • cilia can be seen in detail	 allow a high level of detail ignore subcellular structures can be seen	1	AO3 4.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	move / transport egg / embryo / ovum / mucus	ignore move / transport dust / bacteria / pathogens / sperm	1	AO2 4.1.1.3 4.3.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	*recall of equation* magnification = $\frac{\text{size of image}}{\text{size of real object}}$	ignore use of equation triangle	1	AO1
	rearrangement of equation size of real object = $\frac{\text{size of image}}{\text{magnification}}$		1	AO2
	substitution $\frac{6}{1.5 \times 10^3}$	allow $\frac{6}{1500}$ allow substitution of incorrectly converted value	1	AO2
	0.004 (mm)	allow answer using incorrectly converted value	1	AO2
	conversion 4 (µm)	allow conversion to µm at any stage	1	AO2 4.1.1.5

4.1.2.3 Stem cells

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	less oxygen (is transported) to cells / tissues / organs / muscles	allow less oxyhaemoglobin transported	1	AO2 4.2.2.3 4.4.2.1 4.4.2.2
	(so) anaerobic respiration produces lactic acid	ignore less aerobic respiration ignore reference to energy	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	*total amount of red blood cells* $(5 \times 10^5 \times 100\,000 =)$ $50\,000\,000\,000$	allow 5×10^{10}	1	AO2 4.2.2.3
	percentage calculation $\frac{50\,000\,000\,000}{100} \times 35$	allow $\frac{5 \times 10^{10}}{100} \times 35$ allow $5 \times 10^{10} \times 0.35$ allow a correctly calculated percentage calculation from an incorrectly calculated number of red blood cells	1	
	$17\,500\,000\,000$		1	
	standard form 1.75×10^{10}	allow correct standard form from an incorrectly calculated number of red blood cells	1	
		alternative route $\frac{35}{100} \times 100\,000 = 35\,000$ (1) $35\,000 \times 500\,000$ (1) $17\,500\,000\,000$ (1) 1.75×10^{10} (1)		

4.1.2.3 Stem cells

Answer 04 · Mark scheme

June 2025 | 8464/B/1H | Original Q6

Question	Answers	Mark	AO / Spec. Ref.
06.6	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO2
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3
	Level 1: Relevant points are made. They are not logically linked.	1–2	AO3
	No relevant content	0	4.1.2.3 4.2.2.3

Indicative content

Advantages of blood from stem cells:

- reduces the need for volunteer blood donors
- **only** a small sample of blood is required (to produce the necessary blood cells)
- can produce a large(r) quantity of red blood cells
- (blood cells are all new) so last longer in the patient
- no rejection **or** no need to tissue match
- no ethical objection to receiving blood (because it is from the patient)
- we can produce blood that is a rare / specific blood group / type
- less / no risk of infection (from contaminated blood)

- whole blood donation takes more time / processing to separate the blood into its parts

Disadvantages of blood from stem cells:

- a blood donation is still required
- not tried and tested **or** it is a (relatively) new technology
- white blood cells, plasma and platelets are not collected
- cannot use for other purposes as only red blood cells collected

Costs:

- red blood cells from donation are cheaper than blood from stem cells
- red blood cells from whole donation costs 61 / 62 pence per cm^3
  or
  red blood cells from whole donation costs £6.15 per 10 cm^3
- red blood cells from stem cells cost £1.50 per cm^3

- lab grown blood is 2 / 3 times more expensive than whole blood donation
- (470 cm^3 of red blood cells) from stem cells cost £705
- (211.5 cm^3 of red blood cells) from stem cells cost £317.25
- 211.5 cm^3 of red blood cells from whole donation costs £130

For **Level 3**, advantages and disadvantages for a treatment are needed **and** a reference to costs.
For **Level 2**, advantages / disadvantages for a treatment are needed **and** a reference to costs.
For **Level 1**, relevant points are made.

Total Question 6	**19**

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Answer 01 · Examiner comments

June 2018 | 8464/B/1H | Original Q6

Question 6 (standard, standard / high & high demand)

06.1 26% of students achieved the mark for saying stem cells are found in meristems or the tips of roots or shoots. A variety of incorrect organs or tissues were named, the most common being root, stem, xylem and embryo. Some students named parts of a cell, such as chloroplast or cytoplasm.

06.2 49% of students correctly identified producing a large number of identical plants as one economic use of plant stem cells. There was some confusion of genetic engineering and stem cell technology, as most other students selected to create genetically modified crops as their answer.

06.3 This question was targeted at grades 8–9. 4% of students correctly converted 6 picograms into grams and wrote the answer in standard form.

Some students did not understand the term standard form and gave a number written in decimal form. This value was usually an incorrect conversion of picograms to grams. Common incorrect attempts at writing the value in standard form included 6×10^{-6} or 6×10^{-9}

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Answer 01 · Examiner comments

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06.4 15% of students achieved both marks for calculating the number of hours the cell spent in mitosis and giving the answer to three significant figures. 20% of students achieved one mark because they rounded the number incorrectly or gave their answer in hours and minutes. Many students referred to both 28 and 15 but used an incorrect calculation or did not realise there are 360° in a circle.

06.5 14% of students achieved more than two marks. The majority of students gained a mark for stating that the cell would grow during stage 1, or two copies of each chromosome form. The latter of these events was often included in stage 2, rather than stage 1. This error, or if stage numbers were omitted, limited the response to a maximum of four marks.

Some very good descriptions of mitosis, including spindle formation, were seen. However, a lot of students did not mention the nucleus dividing. A few students gained the final mark for saying cytokinesis occurred in stage 3. Few gave the full description of the cytoplasm or membrane dividing to form two identical cells.

42% of students did not achieve any marks. This was usually because they described the process of IVF. Some confused the cell cycle with meiosis and fertilisation.

06.6 31% of students achieved two or more marks.

Marks were generally awarded for advantages, rather than disadvantages. Common correct advantages given included:

- how stem cells can be used in patients
- diseases stem cells can be used to treat, for example paralysis
- that the cells would not be rejected by patients.

The most common disadvantage mentioned was that an embryo or potential life was destroyed. Saying the cells were wasted was insufficient.

A lot of students confused the process with that of IVF.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.1.2.3 Stem cells

Answer 02 · Examiner comments

November 2021 | 8464/B/1H | Original Q5

Question 5 (standard/high and high demand)

This question assessed the understanding of blood flow through the heart and heart attacks. About a third of students identified the blood vessel that transported blood with the highest oxygen concentration into the heart, and a similar proportion identified the vessel which transports blood at the highest pressure. Almost half knew the route of blood flowing through the heart to the lungs.

05.4 was an extended response question, set at high demand, to evaluate the use of statins or a stent to reduce the risk of a heart attack. A quarter of students scored 1 or 2 marks, often stating blood flow to the heart muscle would increase. References to surgery being required for a stent was also seen. Both treatments had to be discussed to move above Level 1. Many students simply repeated the stem of the question, which did not gain any marks, or they mixed up the two treatments. Just over a quarter of students scored 3 marks or above. For Level 3, advantages and disadvantages of both treatments were needed, as well as a judgement.

Few students could explain why people who survive a heart attack get out of breath easily. Three-quarters of students scored zero for this question; a quarter scored 1 mark. This was usually for saying the heart is not as strong after a heart attack. Students did not include enough detail for the other marks, for example they did not link oxygen to respiration.

The last two items were about the use of stem cells to repair damaged heart tissue. Fewer than half the students scored any marks for **05.6**. Most did not understand the difference between differentiation and specialised cells. Just over half the students scored 1 mark for saying that stem cells made from the patient's own cells would be less likely to be rejected, or that they would not involve risking the life of an embryo.

Answer 03 · Examiner comments

June 2023 | 8464/B/1H | Original Q7

Question 7

07.1 Half of the students knew where mutations happen in a bacterial cell. In plasmids or in DNA were the most common responses. DNA was often described as a strand, loop or ball of DNA. The most common incorrect response was in the nucleus.

07.2 Almost half the students scored both marks and more than a third scored 1 mark. The first mark was for describing the evidence in the diagram that *S. aureus* oteNwas resistant to antibiotics C and E. Quite a lot of students did not give this evidence, but just said that no bacteria were killed to score the second mark.

07.3 This question was set at the highest level of demand. Only a fifth of students scored any marks and very few scored both marks. A suggestion of a change to the method had to be made in order to access any marks, although the change did not have to be creditworthy in order to access the second mark. For example, many students said leave the Petri dish for longer, or incubate it at

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a different temperature, which did not score marking point 1, but gave access to marking point 2. An increase in the concentration of the antibiotic was needed. The second mark was for how the change might show that *S. aureus* is not resistant to antibiotic E. A reference to a clear area then being seen, or that the bacteria would then be killed, was required. Simply saying the antibiotic would then work was insufficient.

07.4 Almost two thirds of students identified the independent variable in the investigation as the treatment injected around the implant. The most common incorrect response was the type of antibiotic used.

07.5 Two fifths of students gave a correct advantage of using stem cells from fat tissue, rather than from bone marrow. Saying the fat cells were easier or less painful to extract were common responses. Saying there was less risk was ignored, unless qualified. For example by saying less risk of damage to the patient. References to rejection were ignored.

07.6 The correct process for how the antibiotic entered stem cells was needed in order to score any marks. More than a third of students correctly identified diffusion as the process. A quarter of students scored 2 marks for also giving the reason, related to the concentration of antibiotic inside and outside the cells.

07.7 Three quarters of students interpreted the graph correctly and gave a range of 0.09 to 0.31. The most common error was to write 0.9 instead of 0.09.

07.8 Almost two thirds of students scored at least 1 mark. This was usually for one of the advantages of using stem cells containing antibiotic. A quarter of students scored 2 or more marks. The most common disadvantages given were that the stem cells might be rejected by the patient, or the bacterium might become resistant to the antibiotic.

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Answer 03 · Examiner comments

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.1.2.3 Stem cells

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evaluate' were often interpreted as 'state' or 'describe', leading to students missing out on marks. Question **06.6** was a notable example of this.

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4.1.2.3 Stem cells

Answer 04 · Examiner comments

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Question 1 (Standard demand)

01.1 This question was generally well answered. A significant proportion of students (48%) achieved both marking points, demonstrating strong understanding of the topic. Many responses showed accurate labelling and good recall of the key blood vessels associated with the heart.

Where only one mark was awarded, this was most commonly for the correct identification of the vena cava.

01.2 61% of students gained the mark for this question.

01.3 This question was generally well answered, with most students recognising the involvement of respiration. However, many did not explain that more energy was required, and the misconception that energy is 'produced' rather than 'released' in the mitochondria was common.

Only a small proportion demonstrated understanding that the heart muscle needs to contract, with few using this precise term. Confusion between the processes of respiration and breathing was common.

Overall, 35% of students achieved two or more marks, while only 7% gained full marks. Most gained partial credit for identifying respiration but struggled to explain how energy is used by the heart.

01.4 This question was well answered, with 71% of students gaining at least one mark. Tiredness and chest pain were the most frequently identified symptoms.

Some responses repeated the same idea using different wording, for example 'heart attack' and 'blood clot'. Terms such as 'heart murmur' or 'palpitations' were credited as irregular heartbeat, while 'heartburn' was not.
Descriptions of increased breathing rate were often too vague, and few students mentioned pale skin.

01.5 This question was generally well answered, with over 80% of students gaining at least one mark. Many correctly identified infection or rejection as valid risks, while fewer mentioned the risk from anaesthetic.

Weaker responses often rephrased the question, giving vague statements such as 'there is a risk from surgery', which were not creditworthy. Some students speculated about long-term outcomes, for example 'the heart tissue not growing' or 'the patch being too small'. These were outside the scope of the question and not accepted.

Answers referring to bleeding had to make clear that it resulted from the operation and involved a significant loss of blood, with terms such as 'heavy blood loss' being credited. General references to 'risk of disease' were also not sufficient.

Descriptions such as the heart being punctured or stopping were credited as examples of damage to the heart, but unqualified terms like 'harming the heart' or 'death' were not.

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Answer 04 · Examiner comments

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Question 2 (Standard demand)

02.1 This question was very well answered, with 95% of students correctly identifying touch or direct contact as a method of transmission. Many also referred accurately to coughing, sneezing, or droplets, which were credited.

Vague examples like hugging or playing together were not creditworthy, as they did not clearly imply skin-to-skin contact. In contrast, examples such as kissing, high fives, or transmission via contaminated surfaces like shared towels were accepted.

02.2 This question was very accessible, with many students correctly stating that antibiotics are used to treat bacterial infections.

A common misconception was the claim that chickenpox is not a virus, revealing a misunderstanding of the nature of the disease. References to 'it' were interpreted as referring to chickenpox and were credited where appropriate.

02.3 Many students correctly referred to dead pathogens, which was creditworthy. However, vague answers such as 'dead cells', 'dead disease', or 'dead chickenpox' were not accepted, as students needed to identify that it was the pathogen, not the disease itself, used in the vaccine.

Unqualified statements such as 'a small amount' were insufficient unless clearly linked to the dead pathogen or the antigen. Terms such as 'inert' or 'dormant' were accepted as synonymous with inactive when applied correctly to the pathogen.

02.4 This question was generally well answered, with 87% of students gaining at least two marks. Many demonstrated a clear understanding of the concepts being assessed.

Errors most often arose from repeating the same idea using different wording, for example stating that the drug was tested 'to check for toxicity' and 'to check for side effects'. These were treated as equivalent and not credited twice. References to allergic reactions were also accepted as side effects, and statements such as 'to check it doesn't kill the person' were credited as showing awareness of the ultimate risk.

Terms such as 'efficient' and 'effective' were accepted as equivalent to efficacy. However, references to 'reliability' or 'accuracy' were not sufficient, as they do not directly address whether the drug works as intended. Overall, this was an accessible question, though more precise language would have improved some responses.

02.5 This extended response question was assessed holistically. Many students demonstrated a clear understanding of the primary immune response, often describing in detail how white blood cells produce specific antibodies. These responses typically met the criteria for Level 2, with 50% of students achieving this level.

Fewer students were able to describe the secondary immune response in sufficient detail to reach Level 3, with only 10% achieving this. Stronger answers successfully linked features such as the faster production of antibodies and the role of memory cells in enabling a quicker, more effective response. High-level responses also referred to the production of complementary antibodies and explained how this led to a rapid destruction of pathogens. Statements such as antibodies being 'produced sooner' were creditworthy, while vague phrases such as pathogens being 'fought off quickly' were not.

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The function of white blood cells was generally well understood, and many students correctly described antibody production. However, credit for specificity required clarity that the antibodies produced were complementary or specific to the pathogen or its antigens. Simply stating that antibodies were produced was insufficient.

Confusion between antigens and antibodies was common and often affected the accuracy of responses. Overall, while the primary response was well described by most students, a lack of detail about the secondary immune response prevented many from progressing beyond Level 2. This question highlighted that the secondary immune response remains an area of weakness for many.

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4.1.2.3 Stem cells

Answer 04 · Examiner comments June 2025 | 8464/B/1H | Original Q6

0 2 . 5 Explain how a vaccine for chickenpox gives immunity against the disease.

You should refer to how the body responds to:

- the vaccine
- chickenpox pathogens that enter the body after vaccination.

[6 marks]

A Chickenpox Vaccine contains a dead or inert pathogen. This is then injected into the patients bloodstream. This causes the immune system to react to the new foreign pathogens. Lympho-cytes (White blood cells) ~~target~~ produce antibodies which are specific to the antigens on the surface of the pathogen and then memory cells remember what antibodies to produce for the particular antigens of the bacteria. Thus, if you are actually injected you can produce antibodies quicker and kill the pathogens

Extra Space

This response was awarded 4 marks but had the potential to reach 6 with slightly more detail. The initial explanation of what a vaccine is was ignored, as this was assessed in a previous question.
The student correctly states that white blood cells produce antibodies, which satisfies the requirements for Level 2 and earns 3 marks. They further add that the antibodies are specific to the antigens—this additional piece of indicative content increases the mark within Level 2.

Credit is given for the mention of memory cells, and the student continues by stating that antibodies are produced more quickly upon infection. While this begins to reference the secondary response, it lacks a second linked idea, such as explaining that pathogens are destroyed more rapidly. Had this been included, the response could have progressed into Level 3, with up to 6 marks awarded.

This example reflects a common pattern seen on the Higher Tier, students providing accurate information but not developing it fully enough to access the Level 3 marks.

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Answer 04 · Examiner comments

June 2025 | 8464/B/1H | Original Q6

Question 3 (High demand)

03.1 58% of students were awarded the mark for this question.

03.2 This question differentiated well between students of varying ability. Most were able to gain the first two marks by correctly selecting two distances from the graph that doubled and applying the inverse square law. A small number of students selected distances that did not double, such as 10 cm and 60 cm, which prevented them from achieving the calculation marks.

A few students used the incorrect formula 1/d rather than $1/d^2$, resulting in no credit. Others referred to the rate of oxygen production rather than calculating light intensity, which was also not credited. However, the majority used the correct formula and expressed their answers in an acceptable form.

Stronger answers correctly stated that light intensity 'decreases by a factor of four' or an equivalent phrase. Many, however, gave only vague statements such as 'light intensity decreases as distance increases', which were insufficient. A small number incorrectly stated that intensity 'reduced by 25%'.

03.3 This question was generally well answered, with 54% of students achieving at least one mark. Many correctly described that an increase in temperature leads to a higher rate of photosynthesis or faster oxygen production. Responses referring to the 'rate of bubble production' were credited, as the bubbles were identified as oxygen in the figure. However, answers that only mentioned an increase in oxygen volume or used vague terms such as 'rate of reaction' without linking this to photosynthesis were not sufficient.

Although many students described an 'increase of energy', It was often unclear what had more energy and vague statements about an energy increase for 'the plant' were not creditworthy. The idea of *more frequent* collisions was generally not well described. Responses that referred only to collisions, without further qualification did not gain credit.

Overall, most students gained at least one mark. However, only a minority demonstrated the particle-level understanding required to achieve full marks.

03.4 This question was challenging, with only 37% of students gaining at least one mark. References to other limiting factors, such as carbon dioxide, were not credited.

Many students correctly stated that high temperatures lead to less oxygen production, but only those who linked this to enzyme denaturation gained full marks. Responses that referred vaguely to cells or pondweed being denatured were not accepted.

Incorrect answers often suggested that oxygen production would increase or remain unchanged. Some students gave irrelevant points about experiment accuracy, which were not creditworthy.

Overall, while many achieved partial marks, few used precise biological terminology or explained the cause-and-effect relationship needed for full credit.

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Answer 04 · Examiner comments

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Question 4 (Standard and High demand)

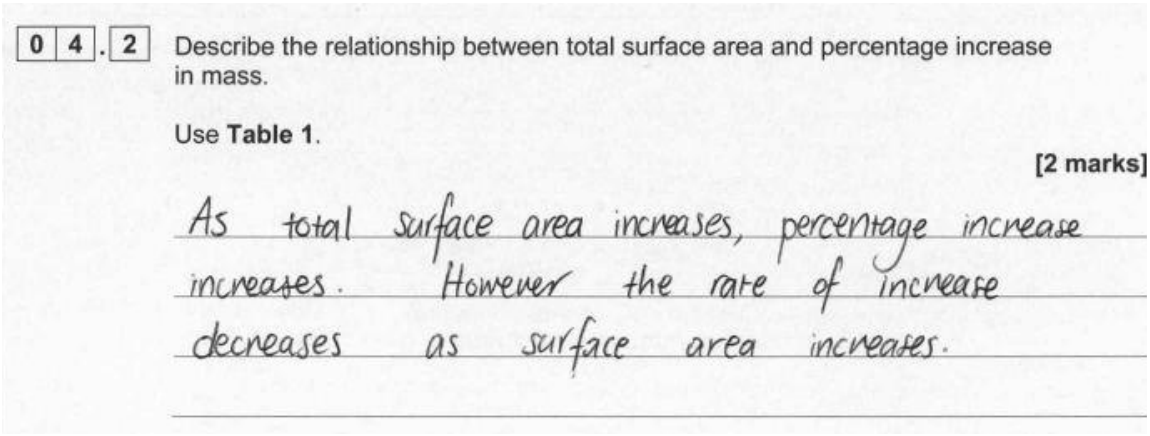
04.1 To gain credit, students needed to state that the potato pieces had different *starting* masses, making answers such as 'they have different mass', insufficient.

References to precision, accuracy, or comparability were not credited unless clearly linked to the variation in starting mass. Few students fully explained why using percentage change is more valid, with many giving vague responses such as 'more accurate' or 'more reliable'.

Some incorrectly attributed the use of percentage change to differences in surface area, which was not relevant. Others noted that it made results 'easier to compare', but did not go on to explain why.

04.2 This question was well answered, with 86% of students correctly identifying a positive correlation, stating that as surface area increases, the percentage increase in mass also increases.

A common error was the incorrect use of the term 'directly proportional', which was not credited as the relationship was not linear. Only 3% of students demonstrated higher-level understanding by noting that the rate of increase slowed, showing awareness of the diminishing trend in the data.



0 4 . 2 Describe the relationship between total surface area and percentage increase in mass.

Use **Table 1**.

[2 marks]

As total surface area increases, percentage increase increases. However the rate of increase decreases as surface area increases.

This is a rare response that was awarded 2 marks. The student successfully describes a decreasing rate, which meets the criteria for marking point 2. This level of detail and understanding was not commonly seen, as many students did not refer to the full pattern shown in the table.

04.3 To gain credit, students needed to state both the direction of water movement and name the process as osmosis. While most correctly identified osmosis, many omitted the direction of movement.

Explanations were credited if they described water moving from a high to low concentration of water, although this less precise wording often caused confusion. The preferred description was water moving from a dilute solution to a more concentrated solution across a partially permeable membrane. Statements referring to movement from low to high solute concentration were also accepted.

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4.1.2.3 Stem cells

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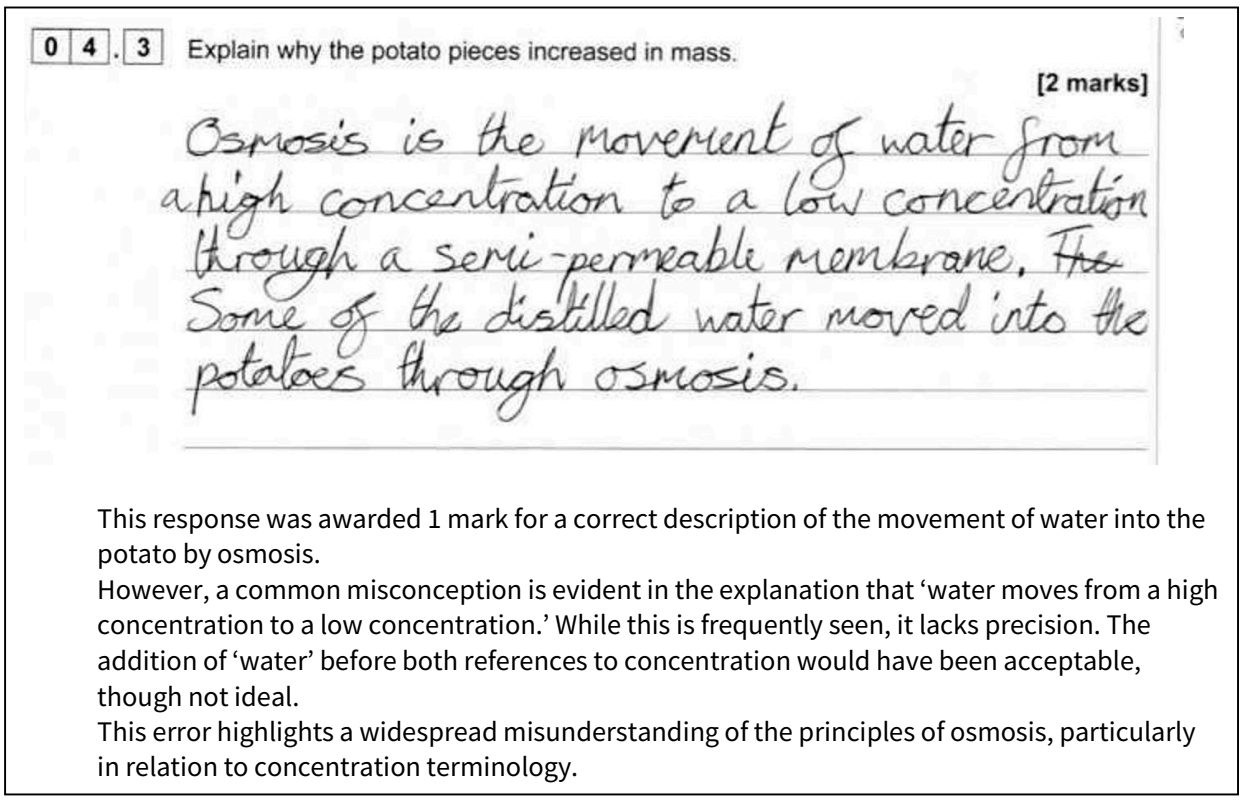
Confusion about concentration remained common, with many students not distinguishing between water and solute concentration. Although most could name osmosis, unclear explanations of the gradient and movement direction often prevented full marks.



0 4 . 3 Explain why the potato pieces increased in mass.

[2 marks]

Osmosis is the movement of water from a high concentration to a low concentration through a semi-permeable membrane. ~~The~~ Some of the distilled water moved into the potatoes through osmosis.

This response was awarded 1 mark for a correct description of the movement of water into the potato by osmosis.
However, a common misconception is evident in the explanation that 'water moves from a high concentration to a low concentration.' While this is frequently seen, it lacks precision. The addition of 'water' before both references to concentration would have been acceptable, though not ideal.
This error highlights a widespread misunderstanding of the principles of osmosis, particularly in relation to concentration terminology.

04.4 This question was particularly challenging, with only 4% of students gaining any marks. It required application of knowledge about osmosis in a broader context.

Few students recognised that all potato pieces would eventually reach the same percentage change in mass after 24 hours. Many incorrectly stated that the pieces would have the same mass, showing misunderstanding of what percentage change represents.

Credit was also given for identifying that it is the potato *cells*, not the whole pieces or the potato, that becomes turgid.

Common misconceptions included the belief that concentrations would equalise, and osmosis would stop, that percentage change would increase indefinitely, or that cells would burst. The role of the cell wall in preventing bursting was rarely acknowledged.

Overall, this question highlighted significant gaps in students' understanding of osmosis, particularly in distinguishing between plant tissues and plant cells.

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4.1.2.3 Stem cells

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04.5 This question was poorly answered, with only 8% of students meeting both criteria. Many responses lacked precision and failed to clearly describe how the method should be adapted. Few students stated that the independent variable should be different concentrations of salt solution. References to at least three concentrations and the use of units such as g/dm^3 clarified that solutions, not masses of salt, were being tested. Vague statements such as 'add some salt to water' were not credited. Many students also failed to recognise that surface area needed to be replaced as the independent variable, often attempting to include both variables in the same method.

For controlling surface area, responses needed to state that all potato pieces should have the same surface area and not just the 'same size' or 'same shape' which were too vague. Students could also gain credit by stating that the cylinders should not be cut further or should be cut into the same number of pieces, as this implied control of surface area. Very few students addressed this point at all.

Overall, most responses demonstrated confusion around the concept of concentration and lacked the clarity required to access the marks.

Describe how the student could change the method to investigate the effect of salt concentration on potato tissue.

[2 marks]

Cut 5 cylinders from one potato. Do not cut into different number of pices. Put each cylinder into different beaker containing solution of salt in distilled water with different concentrations: 0, 0.2, 0.4, 0.6, 0.8

This is a rare example of a 2-mark response. The student correctly refers to not cutting the pieces of potato, which demonstrates an understanding of the need to control the size and surface area of the samples. They also clearly state that different concentrations of salt solution were used, which shows an awareness of how to create the range of conditions needed to observe a pattern in mass change.

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Question 5 (Standard and High demand)

05.1 49% of students gained 1 mark on this question. 34% gained full marks for this question.

05.2 This question proved challenging, with 63% of students failing to achieve the mark. While many correctly identified the palisade layer, a wide range of incorrect responses was seen.

Common errors included confusing the palisade tissue with the upper epidermis, spongy mesophyll, or simply writing 'mesophyll', which was too vague to credit. Other incorrect answers suggested other plant tissues and sub-cellular structures.

Overall, the question highlighted that while some students had a good grasp of leaf anatomy, many lacked precise knowledge of the location and function of palisade tissue.

05.3 This question was challenging, with 62% of students failing to achieve any marks. It required understanding of the adaptations of palisade mesophyll tissue and how these relate to its role in photosynthesis. While some students identified one appropriate adaptation or function, few provided the full explanation needed for both marks.

Many students correctly stated that the cells contain many chloroplasts or a large amount of chlorophyll. However, common errors included mentioning a 'large surface area', omitting the quantifier 'many', or failing to link the adaptation to its function. Responses such as 'contains chloroplasts for photosynthesis' were too vague, whereas answers specifying that the many chloroplasts absorb light for photosynthesis were awarded full credit.

Some students incorrectly described the position of the palisade cells at the top of the leaf or referred to unrelated processes such as water absorption or gas exchange. Confusion between palisade and spongy mesophyll tissues was also frequent.

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4.1.2.3 Stem cells

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0 5 . 3 Explain how tissue **A** is adapted to its function.

[2 marks]

has many chloroplasts and so many chlorophyll so photosynthesis can take place ~~at a higher~~

0 5 . 3 Explain how tissue **A** is adapted to its function.

[2 marks]

contains lots of chloroplast wich contains chlorophyll to absorb the light thats why its on the top side of the leaf as thats where there is the highest light intensity

Two examples of responses that were both limited to 1 mark.

In the first example, the student is awarded for correctly stating that the cell contains many chloroplasts. However, further credit is not gained, as the response only references photosynthesis and does not specifically mention the absorption of light—an essential part of that marking point.

In the second example, the student is again awarded marking point 1 for correctly identifying the presence of many chloroplasts. This time, the student does mention light absorption but does not go on to link this to the process of photosynthesis.

In both cases, the students demonstrated partial understanding but did not provide enough detail to access full marks. This pattern was common across responses, where students often gave either the function (photosynthesis) or the mechanism (light absorption), but not both.

05.4 This question was challenging, with many students demonstrating only partial understanding. While 77% gained at least one mark, only 26% achieved three or more. Few were able to provide a full, coherent sequence of the pathway of water.

Most students gained credit for stating that water enters the root hair cells from the soil. However, answers that referred only to ‘roots’ or incorrectly described the process as active transport were not credited.

Fewer students successfully described water moving up the xylem, as many omitted the direction of flow or confused the xylem with the phloem, sometimes incorrectly referring to translocation instead of transpiration.

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References to water moving to the leaves were rare, with many responses diverting into discussions of photosynthesis, which was not relevant to the mark scheme.

Only a small number of students mentioned stomata or described their role in water leaving the leaf. Evaporation or transpiration as the final stage of water loss was more commonly stated, although it had to be correctly located to gain credit.

Overall, while the early and final stages of the process were better understood, students often lacked the precision and sequencing needed for full marks. This question highlighted persistent misconceptions about water transport and the role of specific plant structures.

Question 6 (High demand)

06.1 61% of students gained the mark for this question.

06.2 This question required students to apply their knowledge of ciliated cells in a new context. To gain credit, answers needed to describe the movement caused by the cilia (e.g. push, sweep, waft, pass through) and correctly identify what was being moved (e.g. egg, ovum, fertilised egg, or embryo). Phrases such as 'pass the egg through' were accepted, and incorrect references to the egg's destination were ignored. References to sperm were not credited.

Many students struggled, often confusing the roles of cilia and mucus. A common error was stating that cilia trap bacteria or pathogens, a function associated with mucus in the respiratory system rather than the oviduct.

06.3 Students generally performed well on this question, with 47% achieving full marks. Most were able to recall and correctly rearrange the equation, demonstrating strong mathematical skills.

The most common error was incorrect conversion from millimetres to micrometres, which prevented many from gaining the conversion mark. Some students also substituted values incorrectly, leading to an incorrect final answer.

Overall, performance was good, and many students showed confidence with both standard form and the calculation process. Clear working remains important, as it allows credit to be given for correct steps even when the final answer is incorrect. Students should also cross out incorrect attempts to make their reasoning clear.

06.4 This question proved difficult for many students, as it required clear application of knowledge about oxygen transport and respiration.

Many recognised that anaemia reduces oxygen transport but often used vague phrasing such as 'less oxygen is taken to the body', which was not credited. To gain the mark, answers needed to specify that oxygen was not reaching cells, muscles, or another specific destination. Irrelevant organs, such as the liver, and absolute statements like '*no* oxygen is taken to the cells' were not accepted.

Fewer students successfully identified the shift to anaerobic respiration and the associated production of lactic acid. Responses that referred only to 'less energy' or 'less aerobic respiration' were insufficient, and mentioning anaerobic respiration without lactic acid was also insufficient.

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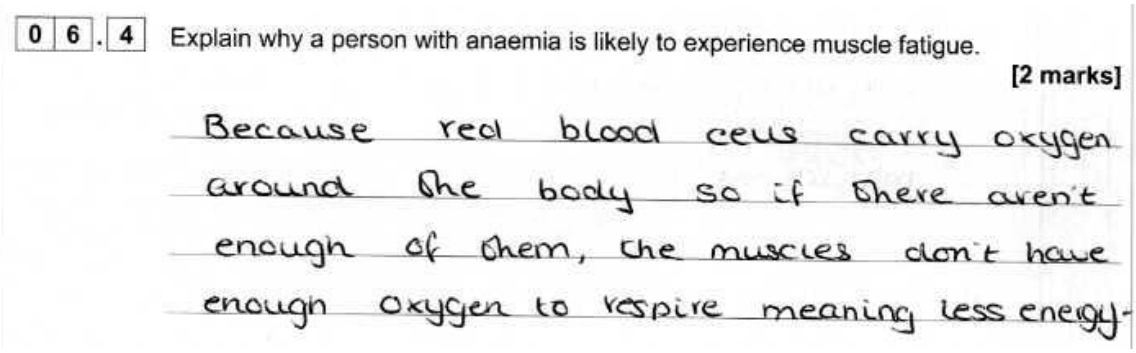
Overall, while many students understood the initial effect of reduced oxygen transport, few linked this to the physiological consequences of anaerobic respiration, revealing gaps in applying respiration knowledge in unfamiliar contexts.

0 6 . 4 Explain why a person with anaemia is likely to experience muscle fatigue.

[2 marks]



This response was awarded 1 mark. The student correctly identifies that less oxygen reaches the muscles. A more general statement such as 'less oxygen to the body' would not have been sufficient at this level.
However, the student does not mention anaerobic respiration or the production of lactic acid, both of which were required to achieve further credit. This reflects a common issue where students recognise the reduction in oxygen delivery but do not link it to the consequences on respiration.

06.5 This question was generally well answered, with 67% of students gaining full marks. Many demonstrated strong mathematical skills and successfully applied standard form.

The most common errors were in the percentage calculation, which led to incorrect final answers despite correct method or structure. Magnitude errors, often caused by misplacing zeros, were also frequent.
Students who made calculation errors but correctly expressed their answer in standard form were often able to gain partial credit.

06.6 Most students (83%) accessed Level 1 by identifying relevant points, 47% reached Level 2, but only 1% achieved Level 3. The question highlighted weaknesses in data interpretation, comparative reasoning, and structuring evaluations.

Many students correctly identified advantages of stem cell-derived red blood cells, including longer shelf life, smaller sample requirements, and lower risk of infection. Some gained credit by framing these as disadvantages of whole blood donation. However, many answers simply re-stated information from the table without comparison or explanation.

Disadvantages of stem cells were rarely mentioned. While cost was often noted, few students developed this point or compared it effectively with the lower cost of whole blood donation. Misconceptions were common, particularly references to ethical concerns about embryonic stem cells, which were not relevant in this context. Few students recognised benefits such as reduced risk of rejection or potential advantages for patients with rare blood types.

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You should refer to costs in your answer. **[6 marks]**

Red blood cells produced from stem cells are cheaper for smaller amounts at £15 per 10cm³ however it is largely more expensive than from a whole blood donation at the same volume, ~~#~~stem cells costing £705 for 470cm³ whereas whole blood donation only costs ~~£0~~£130 for 470cm³. A whole blood donation also allows the doctors to use other parts of the blood for different purposes like the white blood cells or plasmid ~~however~~ however this means that only 211.5cm³ of the 470cm³ taken is red blood cells meaning more blood has to be taken to get 470cm³ of red blood cells or more. Also, with stem cells, you can get a garanteed 120 days of working red blood cells compared to a whole blood donation where the can function from 1 day to 120 days with no garantee for lasting longer. Overall, I think that red blood cells produced from stem cells is better as it is moe effective despite the cost.

Extra Space

This is a rare example of a response that was awarded 5 marks.

The student correctly states that red blood cells produced from stem cells are more expensive and identifies the specific cost as £705, meeting two of the cost-related points.

They then note that whole blood donation includes other components, such as white blood cells, and despite the incorrect reference to plasma, this is accepted as being in line with the indicative content principles. The student also explains that these additional components can be used for different purposes. This was sufficient to award credit relating to the advantages of whole blood donation.

The response continues with an extended discussion about the lifespan of different types of blood cells. Although somewhat lengthy, the student eventually makes the point that red blood cells derived from stem cells last longer—earning credit for an advantage of stem cell blood.

In total, this response gained credit for cost-related points, advantages of whole blood donation, and an advantage of stem cell blood. Had the student included a further distinct advantage of stem cell blood, they would have been awarded the full 6 marks.

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Cost evaluation was key to higher marks. Many students performed calculations correctly, allowing progression beyond Level 1, but errors occurred when comparing unequal volumes. Correct intermediary calculations were still credited.

Overall, while most students identified some valid points, only a very small proportion produced well-developed evaluations supported by data analysis.

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4.1.2.3 Stem cells

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