AQA GCSE Biology | 8461

SPECIFICATION POINT 4.6.2.4

Genetic engineering

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**24**
Available paper years	**2007–2025**

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.

4.6.2.4 Genetic engineering

Answer 01 · Mark scheme March 2007 | BLY1B | Original Q1 | Legacy

One	**A**	black skin	**4**
	B	small ears	**2**
	C	thick fur	**3**
	D	white fur	**1**

Answer 02 · Mark scheme March 2007 | BLY1B | Original Q6 | Legacy

Six	**A**	A cloned human could have an identical twin 30 years younger than	**4**
	B	Many cloned animals have died early in their lives.	**3**
	C	The first scientist to clone a human will be famous.	**2**
	D	The techniques needed to clone humans could be used to produce human	**1**

	A	**B**	**C**	**D**

Answer 03 · Mark scheme June 2007 | BLY1B | Original Q6 | Legacy

Six	**1**	**2**	**1**	*****

Answer 04 · Mark scheme November 2007 | BLY1B | Original Q6 | Legacy

Six	**1**	**2**	**4**	**2**

4.6.2.4 Genetic engineering

Answer 05 · Mark scheme

Question 8

	answers	extra information	mark
(a)(i)	chromosomes	allow DNA ignore nucleus	1
(a)(ii)	enzymes		1
(b)	asexual reproduction / no gametes / no fusion / only one parent cells all contain same genetic information / same genes (as parent) / same DNA	ignore clones	1 1
(c)	can spray crop with herbicide – <u>only weeds</u> killed	crop survives herbicide insufficient	1
(d)	any **one** from: • fears / lack of knowledge about effects of GM food on health • crop plants may pass on gene to wild plants • encourages use of herbicides	allow 'think that GM food is bad for health' ignore not natural **or** against religion	1
total			6

4.6.2.4 Genetic engineering

Answer 06 · Mark scheme March 2008 | BLY1BP | Original Q4 | Legacy

Four	**3**	**2**	**4**	**3**

Answer 07 · Mark scheme November 2008 | BLY1BP | Original Q6 | Legacy

Six	**3**	**4**	**2**	**3**

Answer 08 · Mark scheme March 2009 | BLY1BP | Original Q7 | Legacy

Seven	**3**	**2**	**4**	**4**

Answer 09 · Mark scheme June 2009 | BLY1BP | Original Q4 | Legacy

Four	**2**	**2**	**1**	**3**

4.6.2.4 Genetic engineering

Answer 10 · Mark scheme

June 2009 | BLY1H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	any **three** from: • greenhouse gas • causes global warming / changes weather patterns • absorbs energy / infrared light / heat (radiated) from Earth • re-radiates (some) of this energy	ignore references to ozone layer accept absorbs radiation from Earth do **not** accept absorbs energy from Sun / sunlight allow reflects energy back to Earth	3
6(b)(i)	any **three** from: • remove gene • use of enzymes • from plant with high sugar production • insert gene into rye grass	ignore references to other methods eg tissue culture and embryo transplantation allow from bacteria	3
6(b)(ii)	any **two** from eg • concern about effect on (health) of cow • concern about effects on human (health) • concern about food chain effects **or** effects on ecosystem • effect on gene pool	ignore not natural **or** cost ignore ethical / religious arguments if no other marks awarded 'we don't know the long term effects' = 1 mark	2
Total			**8**

4.6.2.4 Genetic engineering

Answer 10 · Mark scheme June 2009 | BLY1H | Original Q6 | Legacy

BLY1H

Answer 11 · Mark scheme June 2010 | BLY1BP | Original Q4 | Legacy

No matching mark scheme was available in the supplied archive for this question.

Answer 12 · Mark scheme November 2010 | BLY1BP | Original Q3 | Legacy

Three	**2**	**3**	**2**	**4**

Answer 13 · Mark scheme March 2011 | BLY1BP | Original Q4 | Legacy

Four	**3**	**4**	**3**	**2**

Answer 14 · Mark scheme March 2011 | BLY1BP | Original Q9 | Legacy

Nine	**1**	**1**	**3**	**3**

Answer 15 · Mark scheme June 2011 | BLY1BP | Original Q4 | Legacy

Four	**2**	**4**	**3**	**4**

Answer 16 · Mark scheme November 2011 | BLY1BP | Original Q4 | Legacy

Four	**4**	**3**	**2**	**1**

4.6.2.4 Genetic engineering

Answer 17 · Mark scheme

June 2012 | BL1HP | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6 (a)	(jellyfish) gene(s) cut out		1
	ref to enzymes (at any stage)		1
	(gene) transferred to zebra fish at early stage of development / embryo / egg	ignore removal of zebra fish genes	1
6 (b)	any **two** from: • could transfer gene to other (fish) species • effects on food chains • effects on zebra fish themselves, eg may out compete non GM zebra fish	ignore unethical / religious / unnatural accept effects on other species / humans who eat them	2
Total			**5**

4.6.2.4 Genetic engineering

Answer 17 · Mark scheme

June 2012 | BL1HP | Original Q6 | Legacy

BL1HP

Answer 18 · Mark scheme

June 2014 | BL1HP | Original Q8 | Legacy

8(a)	any **three** from: • (gene) cut out • (gene / cut out) from (bacterial) chromosome / DNA • ref to enzymes (at any point) • (gene spliced) into maize chromosome / DNA • (gene added) at an early stage of development	accept (gene / cut out) from (bacterial) plasmid	3	AO1 1.7.2d, e
8(b)	any **four** from: • justification based on comparison of the relative merits of at least one advantage and one disadvantage Advantages: • less effort for farmer **or** less likely to harm farmer • (pesticide) always there **or** doesn't wash away • less insects to eat crop / maize **or** carry disease • so greater crop production / yield Disadvantages: • (toxin) kills other insects • so (some) crops don't get pollinated / (sexually) reproduce • possible harm when eaten by humans / animals • damage to food chains • gene may spread to other species	max **3** marks if only advantages or disadvantages given ignore ref to cost allow examples eg no need to spray allow pesticide doesn't contaminate water courses ignore ref to cost allow maize not pollinated allow may have unpleasant taste allow reduced biodiversity	4	AO3 1.7.2e, f
Total			**7**	

4.6.2.4 Genetic engineering

Answer 19 · Mark scheme

June 2016 | BL1HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)	0.67(%)	allow $0.\dot{6}$ or 0.7 allow **1** mark for evidence of $(2 \times 10^6) \div (3 \times 10^8)$ **or** allow **1** mark for 0.0067 or 0.6	2	AO2 1.1.2
6(b)(i)	idea that food chains start with plants / producers idea that these make food (for other organisms in the chain)	allow food chains do not start with animals **or** larvae are consumers allow idea that plants / producers photosynthesise **or** plants / producers get energy from the sun allow mosquito larvae do not make food / photosynthesise **or** mosquito larvae do not get energy from the sun	1 1	AO1 1.5.1a

4.6.2.4 Genetic engineering

Answer 19 · Mark scheme

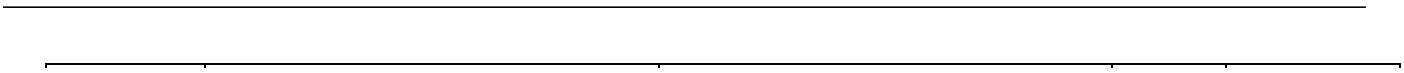
June 2016 | BL1HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(b)(ii)	any **four** from: • reasoned argument for **or** against release *advantages:* • fewer mosquitos biting **or** spreading malaria • fewer people get / die from malaria • lower medical costs (for those infected **or** for treatment) **or** less healthcare needed • better economically for developing / tropical countries. *disadvantages:* • fewer crops reproduce • poorer crop yield • possible starvation (of people) • high cost of GM production / mosquito release • less food for bats / birds **or** bats / birds die • gene could 'escape' into other wildlife / species	must refer to at least one advantage and one disadvantage. max **3** marks for either only advantages **or** only disadvantages allow people won't get / die from malaria allow fewer crops pollinated allow disruption to food chain / ecosystem **or** reduction of biodiversity ignore into plants	4	AO3 1.7.2f
6(b)(iii)	any **three** from: • gene from bacteria cut out • ref to enzymes (anywhere in process) • (gene) transferred to chromosome of mosquito • at an early stage of development	allow allele for gene allow at any point in process, ie in cutting or in splicing allow DNA for chromosome allow egg / embryo	3	AO1 1.7.2d/e
Total			**11**	

4.6.2.4 Genetic engineering

Answer 19 · Mark scheme

June 2016 | BL1HP | Original Q6 | Legacy



4.6.2.4 Genetic engineering

Answer 20 · Mark scheme

June 2016 | BL3HP | Original Q9 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
9(a)(i)	fewer cows any **one** from: • less methane • less CO_2 in the atmosphere because of less deforestation **or** less plants consumed.	 do **not** allow CH^4 allow less CO_2 released into the atmosphere because less fuel used e.g. to heat cowsheds **or** to transport meat do **not** allow CO^2	1 1	AO2/3 3.4.2c 3.4.3a
9(a)(ii)	any **two** from: • could be mass produced to feed an increasing population • disease free meat • no / low fat • no harm to animals or less intensive farming • antibiotic free meat • more land available for farming crops	 allow (may be) suitable for vegetarians allow no energy loss along a food chain	2	AO3 3.4.4a/b
9(b)	 fungus / *Fusarium* with glucose (syrup) in aerobic conditions **or** in presence of oxygen mycoprotein is harvested / purified	ignore stirring / mixing and temperature ignore air allow ammonia added (as source of nitrogen)	 1 1 1 1	AO1 3.4.4d
Total			**8**	

4.6.2.4 Genetic engineering

Answer 21 · Mark scheme

June 2019 | 8461/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	**Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		3–4	AO1 AO2
	Level 1: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.		1–2	
	No relevant content		0	
	Indicative content • use of quadrat • (quadrat) of given area / dimensions – eg 0.25 m^2 or 1 m × 1 m • quadrats are placed randomly • method of obtaining randomness – eg random coordinates from a calculator **or** throw over shoulder **or** throw with eyes closed • suitable number of quadrats (10 or more **or** a large number) • count number of plants (in each quadrat) • calculation of mean per quadrat or per unit area • determination of area of field (length × width) • population = mean per m^2 × area of field			4.7.2.1
07.2	more bacteria so more divisions / reproduction (per unit time)		1	AO2 4.1.1.6
07.3	any **three** from: • add (more) sugar • add (more) amino acids / protein • add (more) oxygen • increase temperature • remove toxins / waste **or** maintain pH • stir the culture	if neither point given, allow add (more) nutrients allow in range 26 °C to 40 °C allow maintain optimum temperature if no other mark awarded allow **1** mark for add more food	3	AO3 4.1.1.6 4.4.2.3 4.7.2.3 4.7.4.3 4.7.5.4

4.6.2.4 Genetic engineering

Answer 21 · Mark scheme

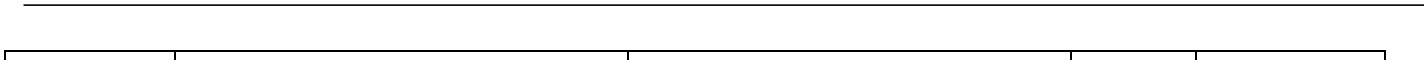
June 2019 | 8461/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		an answer in the range of 2.9 to 3.4 scores **4** marks an answer in the range of 2.08 to 3.77 scores **3** marks		AO2 4.1.1.6 4.6.2.4
	tangent drawn to the curve at 12 hours	do **not** accept if there is an incorrect tangent at 7 hours	1	
	calculation of rate at 7 hours $\frac{\Delta y}{\Delta x}$	allow an answer that correctly rounds to a value in range 10.0 to 11.7	1	
	calculation of rate at 12 hours $\frac{\Delta y}{\Delta x}$	allow an answer that correctly rounds to a value in range 3.1 to 4.8	1	
	3.3	allow in range 2.9 to 3.4 if both rates are in the correct ranges	1	
07.5	can use the glyphosate / weed killer to kill weeds but not kill / affect crop	allow **only** kills weeds	1	AO1 4.6.2.4 4.7.1.3 4.7.5.4
	(so) less competition for light / water / minerals / ions	allow less competition for nutrients ignore food / carbon dioxide / space	1	AO2
	(so) crops have high(er) yield	allow crops grow better / well	1	AO1
Total			**15**	

4.6.2.4 Genetic engineering

Answer 21 · Mark scheme

June 2019 | 8461/2H | Original Q7



4.6.2.4 Genetic engineering

Answer 22 · Mark scheme

November 2020 | 8461/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	$\frac{6.0}{1.6}$ 3.75	allow a range of 5.9 to 6.1 for 6.0 do **not** accept if a unit is given if no other marks awarded, allow a correct answer using a value of 5.8 or 6.2 for **1** mark	1 1	AO2 4.7.3.2
02.2	$\frac{2.5 - 1.6}{50}$ 0.018 (billion per year)	allow $\frac{0.9}{50}$	1 1	AO2 4.7.3.2
02.3 view with Figure 2	suitable extrapolation line on Figure **2** reading taken at 2050 from student's line	allow straight extrapolation allow a tolerance of ± ½ small square allow **1** mark for 10 billion if no extrapolation drawn	1 1	AO2 4.7.3.2
02.4	fewer fish caught **or** limit the number of fish caught (remaining fish) can reproduce	allow a method of doing this, eg increase mesh size **or** do not catch young fish allow more fish (survive to) reproduce	1 1	AO1 4.7.5.1 4.7.5.3

4.6.2.4 Genetic engineering

Answer 22 · Mark scheme

November 2020 | 8461/2H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.5	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	4-6	AO1 4.7.3.1 4.7.3.2 4.7.3.3 4.7.3.4 4.7.3.6 4.7.3.5 4.7.5.1 4.7.5.2
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–3	
	No relevant content	0	
	Indicative content **human land use** • increasing population requires more food • crops / livestock for food • farming crops for biofuels • peat use as compost • peat use as fuel • increased use of pesticide / insecticide / herbicide / fertilisers • use of free-range / organic methods increases land use (for same yield) **link to biodiversity** • deforestation • monocultures • loss of hedgerows (to make fields larger) • loss of habitat • consequence of loss of habitat eg (change in) migration • fertiliser run off polluting water • use of pesticide / insecticide / herbicide reduces insects / plants which damages food chains • more soil erosion **link to atmospheric pollution** • more carbon dioxide (from farm animals / machinery) • more methane (from cows) • climate change **or** global warming • example of impact on biodiversity • acid rain • desertification Answers referring to only land use or only biodiversity are level 1		

4.6.2.4 Genetic engineering

Answer 22 · Mark scheme

02.6	golden rice has improved nutritional value		1	AO1 4.7.5.4
02.7	any **one** from: • gene may contaminate / enter other breeds / species • reduction / extinction of population of wild / traditional rice • reduction / extinction of population of flowers / insects • high cost of seeds • may have too much vitamin A (in diet)	ignore references to religious beliefs allow decrease in biodiversity allow decrease in gene pool allow may harm (human) health allow may cause side effects (on humans) ignore may harm humans unqualified	1	AO3 4.6.2.4
Total			**16**	

4.6.2.4 Genetic engineering

Answer 22 · Mark scheme

November 2020 | 8461/2H | Original Q2

4.6.2.4 Genetic engineering

Answer 23 · Mark scheme

June 2024 | 8461/2H | Original Q9

Question 9

Question	Answers	Mark	AO / Spec Ref.
09.1	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.2.3.2 4.4.1.1 4.4.1.3 4.6.2.4 4.7.1.1 4.7.2.4 4.7.5.4
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • glyphosate kills weeds but does not harm GM soya • (so) less competition for light / water / ions / (named) minerals / (named) salts / space • more light / water for photosynthesis o (so) more glucose produced • more glucose for o respiration for energy o cellulose for cell walls o starch for stored energy / glucose (in soya beans) o protein for cell structure / storage (in soya beans) o lipids for energy storage (in soya beans) • more water for o turgor / support o transport o medium for reactions o hydrolysis / digestion of (stored) organic substances • more magnesium o for chlorophyll • more nitrate o for amino acids / proteins • more phosphate o for DNA For **Level 3**, answers must include detail of factors that increase the yield of GM maize.		

4.6.2.4 Genetic engineering

Answer 23 · Mark scheme

June 2024 | 8461/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec Ref.
09.2	any **two** from: • do not know effects on animals / humans (when eaten) • gene / allele may be transferred to other (wild) plants • reduce biodiversity • increased cost of seed (for farmers) **or** increased cost to consumer (for product) • may affect flavour / taste (of product)	ignore reference to ethical concerns or religion allow do not know side effects on animals / humans (when eaten) ignore cost unqualified	2	AO2 4.6.2.4

Total Question 9	8

4.6.2.4 Genetic engineering

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	ADH **or** antidiuretic hormone	allow other correct pituitary hormone eg FSH / LH / TSH ignore functions of hormones	1	AO1 4.5.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	any **one** from: • (it would) be digested to amino acids • (it would) be digested by protease • (it would) be digested (by enzymes) in the stomach • (it would) be digested (by enzymes) in the small intestine • (it would) be digested so (hGH is) not absorbed	allow 'broken down' for digested throughout	1	AO2 4.2.2.1 4.5.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	isolate (hGH) gene from human DNA / chromosome	allow cut (hGH) gene from human DNA / chromosome	1	AO1 4.6.2.4
	join (hGH) gene to (cut) <u>plasmid</u>		1	
	put plasmid (containing gene) into bacteria		1	
	enzyme used at a suitable stage: to cut (hGH) gene from human DNA **or** to insert / join (hGH) gene to plasmid	allow reference to named enzyme used in genetic engineering allow to insert / join (hGH) gene to bacterial DNA	1	

4.6.2.4 Genetic engineering

Answer 24 · Mark scheme

June 2025 | 8461/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	any **two** from: • (hGH) easier to isolate / purify / extract • made in larger quantities • no / less chance of immune reaction • no / less chance of passing on disease / pathogens (from animals to humans) **or** no / less chance of infection (of humans) • no / less chance of containing antibiotics / urea / drugs • it is the specific human hormone so may be more effective (in human body)	allow converse if clearly referring to GH ignore reference to speed of production allow no / less chance of rejection ignore reference to side effects allow named (animal) disease eg BSE allow animal GH may not be the correct shape ignore ethical / religious reasons ignore reference to cost	2	AO3 4.6.2.4

Total Question 4	8

4.6.2.4 Genetic engineering

Answer 22 · Examiner comments

November 2020 | 8461/2H | Original Q2

Question 2 (standard demand)

The question was about human population increase and the problem of provision of sufficient food. For the calculation in **09.2**, both of the values required were given in the information, so it was not necessary to determine figures from the graph. Despite this, many students did attempt to, often incorrectly. For those who did show the correct numbers in their calculations, a large proportion used them incorrectly, often adding them and very few did the necessary calculation of dividing the difference by 50. Some just left the value at '0.9'. Others calculated the mean of the two given values rather than the mean annual increase. Fewer than half of the students were completely successful.

In **02.3** most students attempted to draw some sort of extrapolation on the graph; however, this was sometimes not linked to the trend shown by the line, rising a little, then plateauing or even taking a downturn. Students could still gain the second mark for reading the correct value from their own line. This was often not done accurately, particularly by students who continued their extrapolation beyond 2050 and read off the final population value. It was clear that students who simply read the scale, and gave answers such as '10' had not considered the implication that their answer of a human population of only 10, rather than 10 billion, is unlikely.

In **02.4** students showed some understanding of the term 'quota' and described limiting fishing in one way or another. However, this was as far as some got as they omitted the idea that the remaining fish would be able to reproduce, in order to maintain stocks. Lower-attaining students often suggested that a quota referred to the amount of fish that people could buy or eat. In **02.5** most students successfully linked the need for more farmland to an increasing population needing more food. References to the use of chemicals to enhance growth were only given very occasionally. In terms of reduced biodiversity, few students went beyond deforestation and habitat loss, although some suggested that the latter might result in migration of animals to find new habitats. There were only occasional references to methane and carbon dioxide production and an association of these with global warming. The question differentiated between students well.

4.6.2.4 Genetic engineering

Answer 23 · Examiner comments

June 2024 | 8461/2H | Original Q9

Question 9 (standard/high and high demand)

09.1 This was an extended response question and was set mainly at high demand, thus, considerable detail and the linking of ideas was required to gain access to higher marks. Two thirds of students did not gain any marks.

Many students were confused as to what 'herbicides' do (specification ref 4.6.2.4), often believing that they contain 'fertiliser', plant 'hormones', 'kill insects', 'kill bacteria' or, very commonly, 'kill herbivores'. These students almost inevitably struggled to gain any marks as their descriptions failed to refer to why GM plants produce higher yields, only that they were not damaged or could 'use the fertiliser to grow more'.

Those students who did know that herbicides kill plants were usually able to state that weeds would be killed, but the GM soya plants would not be. However, some seemed to believe that farmers might plant a mixture of non-GM soya and GM soya, just so that some could be killed by glyphosate.

Many students who got this far, were then able to describe the reduced competition for some named resource. However, getting further than this was not at all common and a significant number of students filled all the available space simply repeating these ideas.

Less than 10% of students gained credit beyond Level 1 and were able to show detailed understanding by linking ideas of increased availability of a named resource and how this enhanced growth (and thus yield) of the GM soya. The most commonly described routes were of the GM soya having access to more light for photosynthesis to produce glucose or for more access to a named mineral ion and its role in plant growth (commonly magnesium and/or nitrate).

One significant misunderstanding of what was required was by those students who often used at least half the available space describing how genetic modification is carried out, for no credit, as this had not been requested.

Those students who used the information along with their own knowledge generally scored high marks, but there were very many who failed to score more than one mark.

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4.6.2.4 Genetic engineering

Answer 23 · Examiner comments

09.2 This was the last question on the paper and students might reasonably expect it to be set at high demand and thus the need for them to give details in their responses. Over half of students were able to give at least one reason why some people are concerned about the use of GM soya bean plants.

Whilst many referred to 'effects', either short-term or long-term, a significant proportion of these students omitted to link this to who, or what, might be affected. A reference to 'animals' or 'humans' was required to gain credit here, rather than potential effects on the plants themselves. Thus, terms such as 'when consumed' were sufficient if linked to effect, to gain credit.

A few students referred to possible changes to the taste of the GM beans, whilst others described a reduction of biodiversity. However, on this latter point, a 'reduction in variation' was not credited, often also being linked incorrectly to the idea that all crops could be wiped out by a single pathogen. Students should be aware of the difference between 'variation' (differences within a species) and biodiversity (the range of different species in a habitat).

Simply 'increased cost' was also insufficient to gain credit, students needed to indicate what that cost might be, either for purchasing seeds or the cost of the product to consumers. It was rare for students to refer to ethical concerns or to religion which had been excluded by the rubric, although some students did refer to the use of GM foods as being 'not natural'.

It should be noted that the question did not refer to the use of glyphosate, only to GM soya, thus, descriptions of polluting effects of glyphosate or the potential for it to be toxic when consumed, were ignored.

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4.6.2.4 Genetic engineering

Mark Ranges and Award of Grades

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

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Answer 24 · Examiner comments

Question 4 (Standard/high demand)

04.1

Almost all students attempted this question, with just over 80% of gaining the mark. ADH and FSH were the most common creditworthy answers seen. Common incorrect answers, although seen relatively rarely, included adrenaline, thyroxine, and progesterone.

04.2

Only a third of students gained credit in this question. Whilst many students were able to begin their answer to this question, a number did not give sufficient detail at this level of demand to gain the mark. Stronger responses often covered several marking points in one succinct sentence e.g. 'The hGH would be digested by protease into amino acids within the stomach and so would not be absorbed into the blood', whilst those that were less successful did not refer to either what would break down the hGH, or where this breakdown would occur.

A significant proportion of students cited the stomach acid as breaking down the protein, with many going on to refer to denaturation of enzymes. A number also referred incorrectly to the hGH 'dissolving', rather than being digested.

Some students misunderstood the question and wrote about the hormone taking longer to get into the blood stream if taken orally, rather than focussing on the hormone being digested as a protein. Other less successful responses correctly recognised that the hormone would be digested but implied that the products of this digestion would work in the same way as the undigested hormone when later absorbed into the bloodstream. The idea of lack of absorption because the hormone was 'too big' was also seen relatively frequently.

04.3

This question differentiated well, with the full range of marks awarded. While a quarter of students scored no marks, a third of students were able to gain 3 or 4 marks. High level responses often went beyond the scope of the specification, using terminology such as recombinant DNA, restriction enzymes / endonucleases and DNA ligase in the correct contexts. 'Sticky ends' also featured frequently with some good descriptions of how these were used within the process. Some students confused 'ligase' with 'lipase' which meant that they were unable to earn credit for mark point 4.

A very small minority of students answered the question in relation to production of insulin rather than hGH, but a number of responses detailed parts of the process of adult cell cloning, rather than genetic engineering.

Some students found explaining the process of genetic engineering difficult and used only the information provided in the question. Reference to plasmids as vectors for mark point 3 and the sweeping statement 'using enzymes and plasmids' were not creditworthy without further qualification as this information was given to them in the question.

Less successful responses often confused the role of the hormone and the enzymes in the process, with the enzyme occasionally being inserted into the plasmid, or the hGH hormone itself (rather than the gene) being cut out, or placed into the plasmid/bacteria.

04.4

50% of students scored no marks on this question. Students are reminded that when answering 'compare' style questions they should make it absolutely clear to what they are referring when writing in the converse and to be mindful when using the word 'it'. In the

4.6.2.4 Genetic engineering

Answer 24 · Examiner comments June 2025 | 8461/2H | Original Q4

context of this question, 'it' referred to the hormone produced by genetic engineering as this was the subject of the question and therefore, an answer of 'it might spread infection' is incorrect. There was a significant number of responses where marks could not be awarded due to this lack of clarity.
Bullet points 2, 3 and 4 were the most commonly awarded, although for bullet point 4, a lack of qualification relating to the disease being passed on or spreading to humans (rather than the disease just being present in urine) meant this bullet point could not be awarded.
A number of uncreditworthy responses referred to the difficulties in physically collecting the urine from the animal, as well as ideas that the recombinant hormone is simply 'cheaper', 'easier', 'safer' or 'quicker'. A significant proportion of students described recombinant production in purely hygienic terms (e.g. 'cleaner' or 'more sanitary') without recognising it is easier to purify.
Only a very small number of students were able to access bullet point 6, often due to a lack of precision with their wording; many students did state that it was a 'specific human hormone' but often neglected to go on to relate this to effectiveness.