AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 4.6.3.4

Resistant bacteria

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**4**
Available paper years	**2018–2023**

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.

4.6.3.4 Resistant bacteria

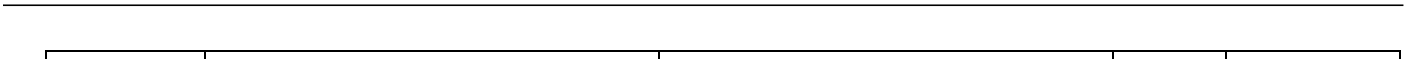
Answer 01 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
02	**Level 3:** Relevant points (advice / reasons) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (advice / reasons) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO2 AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content **precautions with reasons** • do not prescribe fluroquinolone / antibiotics for mild infections • because they will get better due to the body's normal immune system • do not prescribe fluroquinolone / antibiotics for viral infections / colds / flu • because antibiotics do not kill viruses • if you do prescribe fluroquinolone / antibiotics make sure the patient finishes the course • because any bacteria left may develop resistance, survive and reproduce rapidly (due to lack of competition) • only prescribe fluroquinolone if the patient has the new strain • because routine use would lead to an increase in resistant bacteria **other relevant content** • doctors and nurses in the practice / hospital should be using antibacterial / alcohol hand wash between each patient **and / or** disinfectant to clean wards • to kill (resistant) bacteria • doctors should isolate patients with this strain of bacteria • to prevent other patients getting the resistant infection		4.6.3.4 4.3.1.8
Total		**6**	

4.6.3.4 Resistant bacteria

Answer 01 · Mark scheme

June 2018 | 8464/B/2H | Original Q2



4.6.3.4 Resistant bacteria

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	the variety of all the different <u>species</u> (of organisms) on Earth **or** the variety of all the different <u>species</u> (of organisms) in a habitat / area / ecosystem		1	AO1 4.7.3.1
03.2	any **one** from: • compost • burning **or** as a fuel	allow to improve soil (texture / drainage / quality) allow to grow food / crops / plants ignore farming unqualified ignore as fertiliser	1	AO1 4.7.3.3
03.3	decay / burning of peat releases carbon dioxide (into the atmosphere) which is increasing global warming	do **not** accept peat bogs release carbon dioxide into the atmosphere allow a description of global warming or consequences if no other mark awarded allow removal of a carbon sink / store for 1 mark	1 1	AO1 4.7.3.3 4.7.3.5

4.6.3.4 Resistant bacteria

Answer 02 · Mark scheme

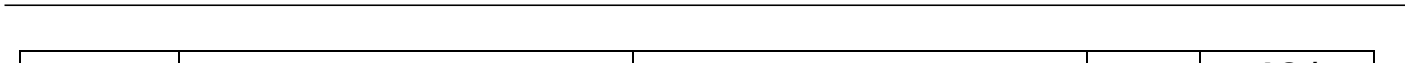
November 2020 | 8464/B/2H | Original Q3

03.4	any **two** from: • takes minerals from the soil as crops are harvested / removed • leads to soil erosion • farmers have to use fertilisers which pollute water / streams / lakes • burning crop waste produces carbon dioxide • using large farm machinery causes soil compaction	ignore nutrients allow burning crop waste causes global warming allow using large farm machinery releases carbon dioxide	2	AO3 4.7.3.2 4.7.3.3 4.7.3.5 4.7.3.6
03.5	antibiotic passed into the environment in animal faeces / urine / sewage **or** antibiotic in animal faeces / urine / sewage flows into rivers		1	AO2
	bacteria in water / land become antibiotic resistant	allow named water or land pathogen such as typhoid / cholera / E coli	1	AO2
	some of these bacteria are human pathogens		1	AO3
	(so) cause (human) diseases which now cannot be cured because they are antibiotic resistant	If no other marks awarded allow 1 mark for mention of antibiotics in milk / meat being consumed by humans.	1	AO3 4.6.3.4 4.7.3.2
Total			**10**	

4.6.3.4 Resistant bacteria

Answer 02 · Mark scheme

November 2020 | 8464/B/2H | Original Q3



4.6.3.4 Resistant bacteria

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	

4.6.3.4 Resistant bacteria

Answer 03 · Mark scheme

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

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

4.6.3.4 Resistant bacteria

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

4.6.3.4 Resistant bacteria

Answer 04 · Mark scheme

June 2023 | 8464/B/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	humans have not found evidence of every species		1	AO3 4.6.3.2 4.6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	fossils	allow fossil record allow remains of organisms allow DNA do **not** accept fossil fuels	1	AO1 4.6.3.1 4.6.3.2 4.6.3.3

4.6.3.4 Resistant bacteria

Answer 04 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
02.3	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO2
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content **Methods of reducing rate of evolution and linked explanation** • doctors should not prescribe antibiotics inappropriately ○ so fewer *C. difficile* are exposed to antibiotic(s) • do not use antibiotics to treat mild (bacterial) infection ○ because the immune system can respond (to mild bacterial infection) • do not use antibiotics to treat (any) viral infections ○ because antibiotics do not kill viruses • patients should complete their course of antibiotics ○ so (more likely that) all *C. difficile* are killed ○ so none survive to mutate (and form resistant strains) • the agricultural use of antibiotics should be restricted ○ so fewer *C. difficile* are exposed to antibiotic(s) • hand washing after going to toilet ○ will reduce spread of *C. difficile* • people with diarrhoea / *C. difficile* should stay away from school / work ○ to reduce spread of *C. difficile* • develop new antibiotic against *C. difficile* ○ so all *C. difficile* are killed ○ so none survive to mutate and form (another) resistant strain • develop vaccine against *C. difficile* ○ would decrease the use of antibiotics For **Level 3**, answers must refer to method(s) and linked explanation(s).		4.6.3.4 4.6.3.1 4.6.2.2

Total Question 2	8

4.6.3.4 Resistant bacteria

Answer 01 · Examiner comments

June 2018 | 8464/B/2H | Original Q2

Question 2 (standard demand)

02 This was an 'extended response' question, marked using a holistic 'levels of response' mark scheme. Students were asked to explain the advice that doctors should be given to prevent the spread of a new strain of *Pseudomonas*. They were told that infections caused by the strain occurred in hospitals and that they could only be treated with one antibiotic, fluroquinolone.

Most students who took this paper showed good appreciation of how best to prevent the spread of such an infection and achieved at least a level 2 mark (47% of students). There were some excellent answers which easily accessed the highest award within level 3 (2% of students).

Many students failed to supply good biological explanations for the precautions they gave and so restricted themselves to the level 2 criteria of attempted logical linking and a not fully clear account. Common examples of this were references to bacteria becoming 'immune' to the antibiotic, or even the patient becoming immune to the antibiotic and the bacteria becoming 'stronger' if they were not all killed. Basic hygiene rules to 'stop the spread' as given in the stem were restricted to level 1. Many students gave no relevant content (0 marks) because they suggested that all hospital patients, or everyone in the world, should be given the new antibiotic. Many thought that it should be used as a vaccine to immunise everyone.

There were several misunderstandings:

- The question asked for advice that should be given to doctors. Answers based on advice to patients rarely gained above level 1. Doctors are not responsible for developing vaccines, so answers that focused on this alone could not be given credit.
- Answers that suggested that 'everyone should be given antibiotics' because they are a protective, preventative measure were inappropriate.
- Bacteria may develop resistance to an antibiotic but not 'immunity'. Some students also implied that that any bacteria remaining after use of antibiotics might simply be 'stronger'.
- Some students believed that the 'patient' developed resistance to the antibiotic or that the 'antibiotic became resistant to the bacteria', as opposed to the resistance being developed 'by the bacteria' and 'against the antibiotic'.
- Some students thought that antibiotic resistance only developed 'over time' and, therefore, suggested that antibiotics should only be administered for short periods. Others believed that dosage was significant and argued for either small or large doses of antibiotics to be given.

4.6.3.4 Resistant bacteria

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

4.6.3.4 Resistant bacteria

Answer 03 · Examiner comments June 2023 | 8464/B/1H | Original Q7

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.

4.6.3.4 Resistant bacteria

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.

4.6.3.4 Resistant bacteria

Answer 04 · Examiner comments

June 2023 | 8464/B/2H | Original Q2

Question 2 (Standard demand)

02.1 In this question students were asked to identify why the percentage of species that are extinct is only an estimate. Over 95% of students gave the correct answer.

02.2 Most students could state that fossils or DNA are used as evidence to study species that have become extinct. References to fossil fuels were seen and did not gain credit. A few students misread the question and gave details of the reasons why species become extinct instead.

02.3 This was an 'extended response' style of question. Such questions are marked holistically. There are overall generic descriptions for the three levels of response at the top of the scheme, giving a hierarchy of response. Within each level there are 2 marks.

In this question, students were asked to explain how the evolution of an antibiotic-resistant bacterium could be slowed down. As students were asked to explain how this could be done, it was necessary to link suggested actions with reasons in order to achieve higher level marks.

The question was not asking how antibiotic resistant bacteria evolve in the first place and neither was it about genetic engineering.

Students achieving Level 1 gave simple unconnected but appropriate suggestions such as 'isolation of infected people' or 'don't use antibiotics when not necessary'. To enter Level 2 there had to be evidence of at least an attempt at linking an idea with the underlying reason(s) behind it together with some limited but additional relevant information. To enter Level 3 students had to make several appropriate points as well as show at least one clear, logical link.

The most frequently seen suggestion was that patients should complete courses of antibiotics. This was often correctly linked with the need to kill all *C. difficile* but fewer answers then went on to say that none would therefore (survive and) mutate to form resistant strains.

Simple rewording of the question did not gain credit. Answers that simply said 'so the bacteria would not be able to evolve and become antibiotic resistant' added nothing else to be credited.

Other points that were commonly made included references to isolation of patients and to hand washing. The question context here was of infection of the digestive system by *C. difficile* and, therefore, suitable qualification of hand washing, such as 'after going to the toilet' or 'before preparing food' was required in order for a strong, reasoned link to be credited. Vague answers relating to 'good hygiene' only were insufficient. Some students thought that diet and exercise would kill the bacteria.

Several students made references to doctors not prescribing antibiotics inappropriately but few students went on to explain why. Similarly, the reason for not using antibiotics for mild infections – 'the body's own immune system can respond effectively' – was rarely seen. Students do seem to appreciate, though, that antibiotics cannot kill viruses and so a mention of this linked to no antibiotics being used in such cases often gained credit.

4.6.3.4 Resistant bacteria

Answer 04 · Examiner comments June 2023 | 8464/B/2H | Original Q2

Some answers suggested that new antibiotics might be developed but the idea that antibiotics can be made 'stronger' is incorrect. As with the point about completing courses of antibiotics, the advantage of a new antibiotic would need to be linked to 'all *C. difficile* being killed' or 'none could survive to mutate' in order to gain credit for a linked statement.

Some students commented on developing a vaccine against *C. difficile* but very few then managed to link this to an explanation.

The indicative content in the mark scheme can never cover all ideas that are worthy of credit, but are there to guide examiners. Other ideas such as 'Treatment with several antibiotics at the same time to kill all of them' was another appropriate method with linked explanation.

Many students referred to 'it' in their answer. Sometimes this meant antibiotics and other times this meant bacteria. We always read for context to make sense of the term 'it'.

'Immune bacteria' was not an acceptable alternative to resistant bacteria. It was assumed that bacteria referred to in a response meant *C. difficile*.

0 7 . 3 A bacterium called *Clostridioides difficile* (*C. difficile*) can infect the human digestive system.

C. difficile can multiply and produce toxins. The toxins cause diarrhoea.

Doctors are concerned that new strains of *C. difficile* may evolve.
Antibiotics may **not** be able to kill these new strains.

Explain how the evolution of antibiotic resistant *C. difficile* can be slowed down.

[6 marks]

the evolution of the antibiotic resistant C. difficile can be slowed down by getting people who have it on the antibiotics instantly and make sure they take the full course correctly. Another way to stop the evolution from happening so quick is by quarantining people who have it or have been near someone who had it to stop it spreading and developing fast. also staying out/away from lots of heat as that lets bacteria multiply faster.

The student (from a Foundation tier paper) has given bullet point 7 and then linked bullet points 14 and 15 from the indicative content. This exceeds the minimum requirement to meet the Level 2 descriptor, but does not meet the Level 3 descriptor, therefore 4 marks were awarded.

4.6.3.4 Resistant bacteria

Answer 04 · Examiner comments June 2023 | 8464/B/2H | Original Q2

0 2 . 3 A bacterium called *Clostridioides difficile* (*C. difficile*) can infect the human digestive system.

C. difficile can multiply and produce toxins. The toxins cause diarrhoea.

Doctors are concerned that new strains of *C. difficile* may evolve.
Antibiotics may **not** be able to kill these new strains.

Explain how the evolution of antibiotic resistant *C. difficile* can be slowed down.

[6 marks]

Evolution of antibiotic resistant C. difficile can be slowed down if the overuse of the antibiotics used to treat this bacterial disease, is reduced by taking precautions. These might be ~~that's~~ making ~~the~~ the rules for its prescription more strict and actually having the regulations properly in place.
Another way is to encourage people to use full course of their antibiotic treatment even if the symptoms are relieved, because ~~they~~ when it is not used fully, ~~antibiotics~~ bacteria that's left alive can reproduce and develop resistance to the drug which is what ~~it~~ might cause it to evolve.
Also for lighter symptoms, if it is not serious, it might be better for the body to overcome the bacteria by itself to not introduce ~~enter~~ the drug to the bacteria.

The student (from a higher paper) has given bullet point 1 from the indicative content. They link bullet points 7 and 8. In the final paragraph they link bullet points 3 and 4. This exceeds the minimum required for the Level 3 descriptor, therefore 6 marks were awarded.