AQA GCSE Biology | 8461

SPECIFICATION POINT 4.7.5.4

# Role of biotechnology

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Higher** |
| Question groups | **11** |
| Available paper years | **2008–2020** |

## 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.

4.7.5.4 Role of biotechnology

Answer 01 · Mark scheme



**Question 7**

| question | answers | extra information | mark |
|---|---|---|---|
| (a)(i) | ref. access of fungus to reactants / food / oxygen<br>**or**<br>maintain even temperature throughout<br>**or**<br>prevents sedimentation of fungus | | 1 |
| (a)(ii) | any **two** from:<br>• maintain constant / suitable / optimum temperature<br>• prevent denaturation of enzymes / prevent death of microorganisms<br>• microorganisms release / produce heat / energy<br>**or** respiration releases / produces heat / energy | ignore 'to cool' – needs qualification re. reason for cooling<br>do **not** allow death of enzymes **or** denaturation of microorganisms | 2 |
| (b)(i) | 66 – 72 | | 1 |
| (b)(ii) | glucose concentration falls first | allow falls faster | 1 |

**continued…**

4.7.5.4 Role of biotechnology



**BLY3H**

**Question 7 continued…**

| question | answers | extra information | mark |
|---|---|---|---|
| (b)(iii) | description: | | |
| | glucose concentration falls as biomass / fungus / Cephalosporium increases | | 1 |
| | Cephalosporin C increases after biomass increase | must imply after | 1 |
| | explanation: | | |
| | glucose used in respiration / as source of energy for Cephalosporium **or** glucose used as material to make cells / to make hyphae | **not** just 'used for growth' | 1 |
| | Cephalosporin C is a product from Cephalosporium (so Cephalosporium must be present to produce it) **or** Cephalosporium not produced until growth has ceased | | 1 |
| total | | | 9 |

**4.7.5.4 Role of biotechnology**

**Answer 02 · Mark scheme** June 2008 | BLY3H | Original Q6 | Legacy

| question | answers | extra information | mark |
|---|---|---|---|
| **6**(a) | any **five** from:<br><br>description:<br><br>• (at low protein conc / at first) increased protein gives increased growth / gives steep line<br>• at medium protein conc rise is less steep<br>• at high protein conc / later increased protein gives no change<br>• appropriate use of number eg levels off at 16.4 (million bacteria per $cm^3$)<br>**or** levels off at 5 (g per $dm^3$ protein)<br>**or** 6 (million bacteria) at 0 protein conc.<br>**or** 12-12.4 (million bacteria)<br>**or** 0.8-1 protein conc.<br><br>explanation:<br><br>• protein is the limiting factor at low conc. / at first<br>**or** not enough protein at low concentration<br>• something else is limiting at high conc. / later<br>**or** not enough named example at high concentration<br>• growth rate equals death rate at high concentration / accept birth rate equals death rate<br>• protein is used to make cell structures | if no reference to protein conc allow **1** mark for description of line in 2 or 3 stages<br>eg goes up and levels off **or** goes up sharply, goes up less steeply and levels off<br><br>allow between 16.3 and 16.5<br><br>accept named example: temperature / glucose / mineral element / etc<br><br>do **not** accept growth unqualified | 5 |

**Question 6 continued on next page...**

4.7.5.4 Role of biotechnology



**COMPONENT NUMBER: BLY3H**

**COMPONENT NAME: Biology**

**STATUS: Final**

**DATE: June 2008**

**Question 6 continued...**

| question | answers | extra information | mark |
|---|---|---|---|
| **6**(b) | 0.5–5 ( g per $dm^3$) | allow any number in range | 1 |
| | below this – lower growth rate | allow most / greatest amount of bacteria at 5 | 1 |
| | above 5 – no improvement in growth rate / waste of resources / waste of money<br>**or**<br>above 0.5 < 5 slower improvement in growth rate / waste of resources / waste of money | do **not** allow just 'graph levels off'' | 1 |
| **Total** | | | **8** |

4.7.5.4 Role of biotechnology

Answer 02 · Mark scheme

June 2008 | BLY3H | Original Q6 | Legacy

**COMPONENT NUMBER: BLY3H**

**COMPONENT NAME: Biology**

**STATUS: Final**

**DATE: June 2008**

### 4.7.5.4 Role of biotechnology

**Answer 03 · Mark scheme** June 2008 | BLY3H | Original Q7 | Legacy

| question | answers | extra information | mark |
|---|---|---|---|
| **7**(a) | circulation / mixing / described<br>**or**<br>temperature maintenance | | 1 |
| | supply <u>oxygen</u><br>**or**<br>for <u>aerobic</u> conditions<br>**or**<br>for <u>faster</u> respiration | do **not** allow oxygen for anaerobic respiration | 1 |
| **7**(b) | any **one** from:<br>• energy supply / fuel<br>**or** use in respiration<br>• <u>material</u> for growth<br>**or** to <u>make</u> mycoprotein | do **not** allow just food / growth<br>ignore reference to aerobic / anaerobic | 1 |
| **7**(c) | (heat / energy) from <u>respiration</u> | allow <u>exothermic</u> reactions<br>allow description eg <u>breakdown</u> of glucose / catabolism<br>ignore metabolism<br>ignore aerobic / anaerobic | 1 |
| **7**(d)(i) | any **one** from:<br>• compete (with Fusarium) for food / oxygen<br>**or** reduce yield of Fusarium<br>• make toxic waste products<br>**or** they might cause disease / pathogenic<br>**or** harmful to people / Fusarium | do **not** allow harmful unqualified | 1 |

**Question 7 continued on next page...**

**COMPONENT NUMBER: BLY3H**

**COMPONENT NAME: Biology**

**STATUS: Final**

**DATE: JUNE 2008**

**Question 7 continued...**

| question | answers | extra information | mark |
|---|---|---|---|
| 7(d)(ii) | any **two** from:<br>• steam / heat treat / sterilise fermenter (before use)<br>• steam / heat treat / sterilise glucose / minerals / nutrients / water (before use)<br>• filter / sterilise air intake<br>• check there are no leaks | **not** just clean<br>allow sterilisation unqualified for **1** mark<br>**not** just use pure glucose | 2 |
| 7(e) | any **three** from:<br>• beef is best **or** beef is better than mycoprotein<br>• mycoprotein <u>mainly</u> better than wheat<br>• more phenylalanine in wheat than in mycoprotein<br>• but no information given on other amino acids / costs / foods<br><br><u>overall conclusion</u>:<br>statement is incorrect<br>**or**<br>it would be the best source for vegetarians<br>**or**<br>for given amino acids, beef is the best source<br>**or**<br>three foods provide insufficient data to draw a valid conclusion | allow equivalent numerical statements | 3<br><br>1 |
| **Total** | | | **11** |

4.7.5.4 Role of biotechnology

Answer 04 · Mark scheme

June 2009 | BLY3H | Original Q6 | Legacy

## Question 6

| question | answers | extra information | mark |
|---|---|---|---|
| **6**(a) | sucrose → smaller (molecules)<br><br>**or** it gives simple sugars / glucose / fructose<br><br>(products) can be absorbed / taken in | <br><br><br><br>if answer refers to digestion, assume reference is to products | 1<br><br><br><br>1 |
| **6**(b)(i) | only small increase in yield at 25%<br><br>**or** not much difference in yield at 25%<br><br>extra cost / less economic if using 25% fungus | <br><br><br><br> | 1<br><br><br><br>1 |

**Question 6 continues on the next page…**

**BLY3H**

**Question 6 Continued**

| question | answers | extra information | mark |
|---|---|---|---|
| **6**(b)(ii) | any sensible suggestion plus explanation eg<br><br>• increased oxygen → increased respiration rate<br>• less substrate available for making enzyme / toxic product made<br>**or**<br>• more respiration occurs which releases heat (1)<br>• (increase in temperature) reduces amount of enzyme(1)<br>**or**<br>• anomalous result(1)<br>• suggestion why eg zero error on instrument (1)<br>**or**<br>• initial aeration limiting factor (1)<br>• later something else is limiting (1)<br>**or**<br>• 1.0 optimum fungus growth (1)<br>• higher concentrations oxygen becomes toxic / inhibits growth of fungus (1)<br>**or**<br>• aeration at 2.0 too vigorous / damages fungus (1)<br>• less fungus remains to make enzyme (1)<br>**or**<br>• higher aeration causes cooling (1)<br>• less growth / enzyme production if cooler (1)<br>**or**<br>• air contaminated with microorgamisms (1)<br>• microorganism compete **or** make toxin (1) | suggestion<br><br>explanation<br><br>must mention heat or temperature | 1<br><br>1 |
| **Total** | | | **6** |

### 4.7.5.4 Role of biotechnology

**Answer 04 · Mark scheme**

June 2009 | BLY3H | Original Q6 | Legacy

**BLY3H**

4.7.5.4 Role of biotechnology

Answer 05 · Mark scheme

January 2019 | BLY3H | Original Q7 | Legacy

## Question 7

| question | answers | extra information | mark |
|---|---|---|---|
| **7**(a)(i) | to mix in oxygen / air<br>**or**<br>to allow aerobic respiration / prevent anaerobic | allow stops olive oil separating out | 1 |
| **7**(a)(ii) | so *Fusarium* not limiting<br>**or**<br>so can see effect of protein / oil (concentration) | | 1 |
| **7**(b)(i) | 300 | correct answer with or without working = **2** marks<br>$\frac{(8000-800)}{24}$ **or** $\frac{7200}{24}$<br>if one error only eg<br>**or** $\frac{8000-1000}{24}$<br>allow **1** mark | 2 |
| **7**(b)(ii) | cannot tell how accurate / precise / reliable the values are<br>**or**<br>there may be a wide range<br>results may overlap with values for other conditions<br>**or**<br>may not be significantly different from other conditions | do **not** allow – to make it more accurate / precise / reliable<br>allow suitable reference to anomalies | 1<br>1 |

**Question 7 continues on the next page...**

**BLY3H**

**Question 7 continued**

| question | answers | extra information | mark |
|---|---|---|---|
| **7**(c)(i) | <u>description</u>: | each point made must compare *Fusarium* growth **and** lipase production | |
| | *Fusarium* grows (mainly) before lipase production starts | allow correct use of figures | 1 |
| | as *Fusarium* growth slows lipase production speeds up | | 1 |
| **7**(c)(ii) | <u>explanation</u>:<br>any **two** from:<br>• need sufficient growth of *Fusarium* before it can release / make / produces (detectable) lipase<br>• initial *Fusarium* growth uses protein (from reaction mixture) **or** protein more important than lipid for *Fusarium* growth<br>• later *Fusarium* growth uses lipid / oil (from reaction mixture) | allow no lipase production until 'nutrients' used up / limiting | 2 |
| **Total** | | | **10** |

4.7.5.4 Role of biotechnology

Answer 06 · Mark scheme

January 2011 | BLY3H | Original Q6 | Legacy

## Question 6

| question | answers | extra information | mark |
|---|---|---|---|
| 6(a) | maintain / constant / suitable / optimum temperature **or** to prevent overheating | ignore to cool (= question) | 1 |
| | high temperature denatures enzymes / proteins / high temperature kills microorganisms / fungus | do **not** allow death of enzymes / denatures microorganisms | 1 |
| | microorganisms / fungus / respiration release energy | allow release heat | 1 |
| 6(b) | any **four** from:<br>• very little / no measurable fungus / biomass before 20 h<br>• need fungus present to make protease enzyme **or** protease is a product from the fungus **or** protease not made until the fungus is made<br>• protease not made until glucose is used<br>• glucose needed for energy / respiration **or** glucose as material for growth / to make more fungus<br>• equipment not sensitive enough to measure low concentrations | allow spores take about 20 h to start growth<br>allow protease increases as glucose decreases | 4 |

**Question 6 continues on the next page**

**BLY3H**

**Question 6 continued**

| question | answers | extra information | mark |
|---|---|---|---|
| **6(c)** | 40 (no mark)<br><br>any **two** from:<br><br>• (40) gives the highest yield / activity of enzyme per g glucose<br><br>• (40) gives highest yield / activity of enzyme per g fungus produced.<br><br>• (40) is more economic / saves money | if neither point made allow **1** mark for (40) gives the highest yield / activity of enzyme | 2 |
| **Total** | | | **9** |

### 4.7.5.4 Role of biotechnology

**Answer 06 · Mark scheme**

January 2011 | BLY3H | Original Q6 | Legacy

**BLY3H**

4.7.5.4 Role of biotechnology

Answer 07 · Mark scheme

June 2011 | BLY3H | Original Q6 | Legacy

## Question 6

| question | answers | extra information | mark |
|---|---|---|---|
| 6(a) | any **one** suitable product: eg<br>• penicillin / antibiotic / other named antibiotic<br>• mycoprotein / described / quorn<br>• lactic acid / yoghurt<br>• enzymes<br>• ethanol / alcohol / beer / wine<br>• hormones / insulin / GH / somatotrophin<br>• blood-clotting protein / factor VIII<br>• methane / biogas<br>• vaccines | | 1 |
| 6(b)(i) | otherwise too many colonies <u>to count</u> **or** too many bacteria <u>to count</u> **or** make it easier to count | | 1 |
| 6(b)(ii) | a colony is <u>many</u> bacteria **or** cannot see one bacterium<br><br>each bacterium produces one colony | | 1<br><br>1 |

**Question 6 continues on the next page**

**Question 6 continued**

| question | answers | extra information | mark |
|---|---|---|---|
| **6(c)** | correct answer: 8 800 000 / 8.8 million / $8.8 \times 10^6$ | correct answer gains **2** marks with or without 1st two lines<br><br>if answer incorrect, 1 error in calculation<br>eg 88 000 / 880 000 gains **1** mark<br><br>**or**<br><br>allow error carried forward from incorrect 1st line for **1** mark | 2 |
| **6(d)(i)** | on graph:<br><br>line starts at x and decreases<br><br>downward sloping s – shaped curve not reaching zero before 30 hours | | <br><br>1<br><br>1 |
| **6(d)(ii)** | (graph **A**) rises:<br><br>because glucose <u>is used</u> for reproduction / growth / cell division / multiplication<br><br>(graph **A**) falls:<br><br>less / no glucose available **or** glucose is limiting<br><br>causes some bacteria to die | <br><br><br><br><br><br>allow food for glucose<br><br>must relate to previous point | <br><br>1<br><br><br><br>1<br><br>1 |
| **6(d)(iii)** | method B counts living and dead bacteria / includes dead bacteria | | 1 |
| **Total** | | | **12** |

**The AQA UMS Conversion Calculator** is available on the Results statistics page of the AQA Website

### 4.7.5.4 Role of biotechnology

**Answer 08 · Mark scheme** June 2014 | BL1HP | Original Q8 | Legacy

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

4.7.5.4 Role of biotechnology

Answer 09 · Mark scheme

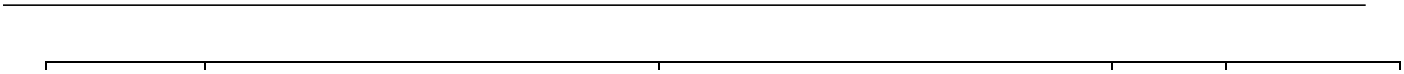
June 2015 | BL3HP | Original Q1 | Legacy

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 1(a)(i) | fungus | | 1 | AO1<br>344d |
| 1(a)(ii) | oxygen / $O_2$ | accept air<br>accept $O_2$<br>do **not** allow $O^2$/ O / O2 | 1 | AO2<br>344d |
| 1(a)(iii) | glucose (syrup) | allow carbohydrate / sugar<br>ignore food / starch<br>allow oxygen if oxygen / air not given in (a)(ii) | 1 | AO1<br>344d |
| 1(b) | any **two** from:<br>• quicker<br>• suitable for vegetarians<br>• cheaper<br>• more efficient **or** less land / methane | ignore high in protein<br>ignore sustainability unqualified<br>ignore less pollution unqualified<br>allow less animals harmed / killed<br>allow food chain is shorter **or** has less trophic levels<br>allow less energy lost (from the food chain)<br>do **not** allow no energy lost<br>allow low(er) in calories (than some meat)<br>allow low(er) in fat / healthier (than some meat)<br>allow source of fibre / prevent constipation | 2 | AO3<br>344a/d |
| **Total** | | | **5** | |

### 4.7.5.4 Role of biotechnology

**Answer 09 · Mark scheme**

June 2015 | BL3HP | Original Q1 | Legacy



4.7.5.4 Role of biotechnology

Answer 10 · Mark scheme

June 2016 | BL3HP | Original Q9 | Legacy

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

4.7.5.4 Role of biotechnology

Answer 11 · Mark scheme

November 2020 | 8461/2H | Original Q2

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

4.7.5.4 Role of biotechnology

Answer 11 · 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<br>4.7.3.1<br>4.7.3.2<br>4.7.3.3<br>4.7.3.4<br>4.7.3.6<br>4.7.3.5<br>4.7.5.1<br>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**<br><br>**human land use**<br>• increasing population requires more food<br>• crops / livestock for food<br>• farming crops for biofuels<br>• peat use as compost<br>• peat use as fuel<br>• increased use of pesticide / insecticide / herbicide / fertilisers<br>• use of free-range / organic methods increases land use (for same yield)<br><br>**link to biodiversity**<br>• deforestation<br>• monocultures<br>• loss of hedgerows (to make fields larger)<br>• loss of habitat<br>• consequence of loss of habitat eg (change in) migration<br>• fertiliser run off polluting water<br>• use of pesticide / insecticide / herbicide reduces insects / plants which damages food chains<br>• more soil erosion<br><br>**link to atmospheric pollution**<br>• more carbon dioxide (from farm animals / machinery)<br>• more methane (from cows)<br>• climate change **or** global warming<br>• example of impact on biodiversity<br>• acid rain<br>• desertification<br><br>Answers referring to only land use or only biodiversity are level 1 | | |

4.7.5.4 Role of biotechnology

Answer 11 · Mark scheme

November 2020 | 8461/2H | Original Q2

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

4.7.5.4 Role of biotechnology

Answer 11 · Mark scheme

November 2020 | 8461/2H | Original Q2

Answer 11 · 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.