A Level AQA Biology

24 Genetic technologies – answers

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td>01.1</td><td>classification;
medical diagnosis;
forensics / criminal investigations / paternity testing;
animal / plant breeding;</td><td>Accept disease (risk) analysis</td><td>2 max</td><td>AO1
3.8.4.3</td></tr>
<tr><td>01.2</td><td><table><tr><th>Stage</th><th>How is this achieved?</th></tr><tr><td>amplification of DNA</td><td>PCR</td></tr><tr><td>digestion / fragments produced</td><td>the use of restriction endonucleases</td></tr><tr><td>separation (of fragments)</td><td>electrophoresis</td></tr><tr><td>visualisation of banding patterns</td><td>hybridisation / radioactive probes / fluorescent probes</td></tr></table></td><td>One mark per correct row</td><td>4</td><td>AO1
3.8.4.1
3.8.4.3</td></tr>
<tr><td>01.3</td><td>fragments should not be placed at the anode / be placed at the cathode;
(because) DNA is negatively charged / moves towards the positive electrode;

idea that electrophoresis should not (necessarily) be run for two hours;
idea that electrophoresis needs to be stopped before fragments reach the anode;</td><td>Accept progress of electrophoresis should be monitored</td><td>4</td><td>AO3
3.8.4.3
AT g
PS 2.1</td></tr>
<tr><td>01.4</td><td>more variation in VNTRs;

idea of profiles more likely to be unique /differentiate;</td><td>Accept reverse argument: amino acid sequences have less variation</td><td>2</td><td>AO2
3.4.1
3.8.4.3</td></tr>
<tr><td>02.1</td><td>Hydrogen;
55 °C;

(free) nucleotides;</td><td>Accept any temperature value in the range 50–56 °C</td><td>3</td><td>AO1
3.8.4.1</td></tr>
</table>

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Spec reference</th></tr>
<tr><td>02.2</td><td>
<table>
<tr><th>Number of cycles</th><th>Number of fragments</th></tr>
<tr><td>4</td><td>16</td></tr>
<tr><td>6</td><td>2^6</td></tr>
<tr><td>8</td><td>256</td></tr>
<tr><td>11</td><td>$10^{3.3113}$</td></tr>
</table>
</td><td>Award one mark per correct box
Accept correct 2^n and $\log^{10}$ values (i.e. 2^4 and $10^{1.2}$) for row 1</td><td>4</td><td>AO2
3.8.4.1
PS 1.1
MS 0.5
MS 2.5</td></tr>
<tr><td>02.3</td><td>not enough primers;
not enough (free) nucleotides;
primers do not join;
temperature damage to fragment / template / strand;
strands fail to separate;</td><td>Accept alternative wording for ‘not enough’</td><td>2 max</td><td>AO2
3.8.4.1</td></tr>
<tr><td>03.1</td><td>(Taq) DNA polymerase;</td><td></td><td>1</td><td>AO2
3.1.5.2
3.8.3
3.8.4.1</td></tr>
<tr><td>03.2</td><td>idea of add solutions of each nucleotide (A, T, G, C) separately / one at a time;</td><td>Accept ensure each nucleotide produces a different wavelength / type of light</td><td>1</td><td>AO3
3.8.3</td></tr>
<tr><td>03.3</td><td>luciferin is the substrate;
(which is) complementary (in shape) to the active site of luciferase;
luciferin binds to active site;
induced fit;
enzyme-substrate / luciferase-luciferin complex;</td><td></td><td>4 max</td><td>AO2
3.1.4.2</td></tr>
</table>

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Question	Answers	Extra information	Mark	AO Spec reference
03.4	produce DNA / oligonucleotide probe; using PCR; complementary to known allele sequence (for disease/condition); probe is labelled with radioactive / fluorescent marker; anneal / hybridise probe and known sequence;		4 max	AO 3.8.4.2
03.5	*idea that* the best method will depend on the application / aim / research being conducted; *points supporting the student* (RS II) is quickest / has the shortest sequencing time; (RS II) can read the longest sequences; *points not supporting the student* (RS II) is the most expensive; (RS II) cannot read many bases per run compared to the Illumina methods; (RS II) has the highest error rate;		5 max	AO3 3.8.3
03.6	$\frac{(7 \times 10^8)}{(3.5 \times 10^8)} = 2$; $\frac{24 \text{ hours}}{2} =$ 12 hours;	If the final answer is incorrect, award one mark for correct working **OR** using error carried forward (using answer to step 1)	2	AO2 3.8.3 MS 0.2
04.1	(using) DNA ligase;		1	AO2 3.8.4.1
04.2	*idea of* to distinguish GM mosquitoes from normal / wild mosquitoes;		1	AO2 3.8.4.1

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Question	Answers	Extra information	Mark	AO Spec reference
04.3	stops transcription; prevents RNA polymerase from binding (to DNA promoter); *idea of* causes post-transcriptional (mRNA) editing;		2 max	AO2 3.8.2.2 3.8.4.1
04.4	males do not bite humans / females could bite humans;		1	AO2 3.8.4.1
04.5	*idea of* to allow GM males to develop and be released;		1	AO2 3.8.4.1
05.1	concentration of restriction enzyme / DNA solution; total volume / volume of buffer / DNA / restriction enzyme solution / water volume; source of DNA; temperature;		2 max	AO2 3.8.4.1 AT g PS 2.1
05.2	to maintain (constant) pH; to prevent enzyme denaturation / for optimal enzyme activity;		2	AO2 3.8.4.1 PS 2.1
05.3	DNA (solution), buffer (solution) and water (with no enzymes);		1	AO2 3.8.4.1 PS 2.4
05.4	restriction enzymes have different recognition sites; cut DNA in different places; different fragment lengths produced; fragments travel different distances based on mass / length;	Allow "restriction sites" instead of "recognition sites"	3 max	AO2 3.8.4.1 AT g

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<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td>06</td><td>
<table>
<tr><th>Enzyme</th><th>PCR</th><th>Genetic fingerprinting</th><th>Recombinant DNA technology</th></tr>
<tr><td>DNA polymerase</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>restriction endonucleases</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>DNA ligase</td><td></td><td></td><td>✓</td></tr>
</table>
</td><td>One mark per correct row</td><td>3</td><td>AO1
3.8.4.1
3.8.4.3</td></tr>
<tr><td>07</td><td>The following are suitable topic areas from the specification that could be used to describe the roles of enzymes in nucleotide biochemistry and gene technologies.

In order to fully address the question and reach the highest mark bands students must also include at least five topics in their answer, to demonstrate a synoptic approach to the essay.
<table>
<tr><th>Specification reference</th><th>Topic area</th></tr>
<tr><td>3.1.5.2</td><td>DNA replication</td></tr>
<tr><td>3.1.6</td><td>ATP</td></tr>
<tr><td>3.4.2</td><td>DNA and protein synthesis</td></tr>
<tr><td>3.8.2.2</td><td>Regulation of transcription and translation</td></tr>
<tr><td>3.1.5.1</td><td>Structure of DNA and RNA</td></tr>
<tr><td>3.8.3</td><td>Using genome projects</td></tr>
<tr><td>3.8.4.1</td><td>Recombinant DNA technology</td></tr>
<tr><td>3.8.4.2</td><td>Differences in DNA…</td></tr>
<tr><td>3.8.4.3</td><td>Genetic fingerprinting</td></tr>
</table>
</td><td></td><td>25</td><td>AO1
3.1.5.2
3.1.6
3.4.2
3.8.2.2
3.1.5.1
3.8.3
3.8.4.1
3.8.4.2
3.8.4.3</td></tr>
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Question	Answers	Extra information	Mark	AO Spec reference
	Students may be able to show the relevance of other topics from the specification. **Note:** other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.			

Skills box answers

Question	Answer
Years 9 and 13	0.412
Years 7 and 13	4.064