A Level OCR Biology

21 Cellular control – answers

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>Mutation</th><th>Number of triplet codes that are changed</th></tr>
<tr><td>substitution of guanine</td><td>1</td></tr>
<tr><td>deletion of the initial cytosine base</td><td>3</td></tr>
<tr><td>insertion of cytosine after the first adenine base</td><td>3</td></tr>
<tr><td>insertion of three cytosine bases before guanine</td><td>1</td></tr>
</table>
</td><td>One mark per correct box
The 2nd triplet (CCC) and the 4th triplet (AAA) remain the same
The 1st triplet and 2nd triplet (CCC) remain the same

Only CTG is changed (to CTC and CCG). Although the sequence of triplets will change, AAA and ATT remain the same.</td><td>4</td><td>AO2
6.1.1(a)</td></tr>
<tr><td>1(b)(i)</td><td>C to T on (original) 22nd base ✓
A to T on 12th base ✓
A to T on 10th base ✓</td><td></td><td>3</td><td>AO2
6.1.1(a)</td></tr>
<tr><td>1(b)(ii)</td><td>deletion of the eight nucleotides GATTATGG (originally bases 14-21) ✓</td><td></td><td>1</td><td>AO2
6.1.1(a)</td></tr>
<tr><td>1(c)(i)</td><td>change in DNA triplet code / base sequence of DNA / mRNA codon (sequence) ✓
different primary structure of protein / order of amino acids in polypeptide ✓
different tertiary protein structure ✓</td><td></td><td>3</td><td>AO1
2.1.2(m)
2.1.3(g)
6.1.1(a)</td></tr>
<tr><td>1(c)(ii)</td><td>(mutation in) non-coding DNA / intron ✓
point / substitution mutation AND same amino acid produced (by a different triplet) ✓
idea that new primary structure / change in an amino acid has little / no effect on tertiary structure ✓</td><td></td><td>3</td><td>AO1
6.1.1(a)</td></tr>
</table>

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<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
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<tr><td>2(a)(i)</td><td>U / uracil instead of A / adenine (in mRNA) ✓</td><td></td><td>1</td><td>AO2
2.1.3(a)
2.1.3(g)</td></tr>
<tr><td>2(a)(ii)</td><td>(valine and glutamic acid have) different R groups ✓
(which can) form different hydrogen bonds / hydrophobic interactions / ionic bonds (with other polypeptide chains) ✓</td><td></td><td>2</td><td>AO2
2.1.2(m)</td></tr>
<tr><td>2(b)</td><td>Any two from:
epigenetic change / modification / gene silencing ✓
RNA polymerase cannot bind ✓
to promoter ✓</td><td></td><td>2 max</td><td>AO2
2.1.3(g)
6.1.1(b)</td></tr>
<tr><td>2(c)(i)</td><td>more DNA triplets affected / changed ✓
idea of greater change to protein structure ✓</td><td>Accept more likely to cause frameshifts</td><td>2</td><td>AO1
6.1.1(a)</td></tr>
<tr><td>2(c)(ii)</td><td>homozygous recessive AND heterozygous ✓</td><td>Accept letters to represent alleles (e.g., cc and Cc)</td><td>1</td><td>AO2
6.1.2(b)(i)</td></tr>
<tr><td>3(a)</td><td>
<table>
<tr><th>Level</th><th>Control mechanism</th><th>Description</th></tr>
<tr><td>transcription</td><td>transcription factors</td><td>idea of molecules bind to DNA to either increase or decrease transcription</td></tr>
<tr><td rowspan="2">post-transcription</td><td>mRNA processing to produce mature mRNA</td><td>introns removed from (immature) mRNA</td></tr>
<tr><td>(m)RNA editing</td><td>nucleotides are deleted, added, or substituted</td></tr>
<tr><td>post-translation</td><td>protein modification</td><td>protein folding / addition of (named) non-protein groups / protein shortening / activation by cAMP</td></tr>
</table>
</td><td>One mark per correct box</td><td>4</td><td>AO1
6.1.1(b)</td></tr>
</table>

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Question	Answers	Extra information	Mark	AO Spec reference
3(b)	Any five from: lac operon ✓ lactose binds to repressor protein ✓ repressor changes shape ✓ stops repressor binding to operator ✓ promoter not covered (by repressor) / available ✓ RNA polymerase binds to the promoter ✓ mRNA transcribed from structural gene(s) (for enzymes) ✓	Accept alternative wording	5 max	AO1 6.1.1(b)
4(a)(i)	Any three from: (control) body plan development ✓ regulate where and when genes are expressed / switched on ✓ (code for) homeodomains / transcription factors ✓ regulate mitosis / apoptosis ✓ idea of ensuring structures develop the correct positions ✓	Accept alternative wording for regulate	3 max	AO1 6.1.1(c)
4(a)(ii)	*idea of* ensuring (body) structures develop at the correct time / in the correct position ✓		1	AO2 6.1.1(c)
4(a)(iii)	Hox genes are a subset of homeobox genes ✓ (that are) found only in animals ✓	Accept alternative wording for subset	2	AO1 6.1.1(c)
4(b)	Any two from: *idea that* we need to define what is meant by complexity ✓ *(agree)* vertebrates have more (homeobox) genes than invertebrates ✓ *(disagree)* humans have fewer (homeobox) genes than other animals ✓		2 max	AO3 6.1.1(c)
5(a)	mitosis increases cell numbers / allows growth of tissues ✓ apoptosis removes unwanted cells / shapes the structures ✓	Accept alternative wording	2	AO2 6.1.1(d)

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Question	Answers	Extra information	Mark	AO Spec reference
5(b)	Any two from: phagocytes ✓ engulf apoptotic bodies / vesicles / cell fragments ✓ digests / breaks down cell fragments ✓		2 max	AO2 4.1.1(e)(i) 6.1.1(d)
5(c)	Any two from: *in apoptosis* (hydrolytic) enzymes are not released ✓ (it is a) controlled process ✓ vesicles are formed (to contain cell fragments) ✓		2 max	AO2 6.1.1(d)
6	**Level 3 (5–6 marks)** Describes the use of mitosis **and** apoptosis in development in detail, using examples. *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 2 (3–4 marks)** Describes some aspects of mitosis **and** apoptosis in development, using examples. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1–2 marks)** Describes the use of mitosis **or** apoptosis in development. *The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.* **0 marks** No response or no response worthy of credit.	**Indicative content**: • Patterns of mitosis and apoptosis are controlled by homeobox genes. *Mitosis* • Cell division • Growth of tissues • Reference to control by hormones or growth factors *Apoptosis* • Programmed cell death • Controlled removal of cells • Forms specific shapes of tissues and organs *Examples* • Digits • Various organs • Neurones	6	AO1 6.1.1(c) 6.1.1(d)

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Question	Answers	Extra information	Mark	AO Spec reference
7	**Level 3 (5–6 marks)** Describes the control of gene expression before **and** after transcription, with few or no errors or omissions. *There is a well-developed line of reasoning, which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 2 (3–4 marks)** Describes the control of gene expression before **and** after transcription, with some errors or omissions. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1–2 marks)** Describes the control of gene expression before **or** after transcription, with errors and omissions. *The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.* **0 marks** No response or no response worthy of credit.	**Indicative content**: *Before transcription* • Transcription factors • Mechanistic details, roles, and examples of transcription factors Credit the inclusion of information that is not mentioned in the specification (e.g., structural changes in chromatin, epigenetic changes, and eukaryotic operons) *After transcription* • mRNA processing (e.g., removal of introns) • mRNA editing • control of mRNA binding the activation of proteins by cyclic AMP (post-translational level)	6	AO1 2.1.3(g) 6.1.1(b)

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Skills box answers

Question	Answer
1	87 $q^2 = \frac{1}{2000} = 0.000\,5$, therefore $q = 0.022\,4$, and $p = (1 - 0.022\,4) = 0.977\,6$ $2pq = 1 - (0.022\,4)^2 - (0.977\,6)^2 = 0.043\,5$ In a population of 2000, $2pq = 0.043\,5 \times 2000 = 87$. Therefore, if there is one sufferer of cystic fibrosis in a population of 2000, there will be 87 carriers
2	10.9%. $p + q = 1$, therefore $q = 1 - 0.942 = 0.058$ $p^2 + 2pq + q^2 = 1$ Therefore $2pq = 1 - q^2 - p^2 = 1 - (0.058)^2 - (0.942)^2$ $= 0.109\,4$ So the frequency of the heterozygous genotype ($2pq$) = 0.109 To calculate the frequency of $2pq$ as a percentage of the population = $0.109 \times 100 = 10.9\%$