2015 Biotechnology

Higher

Finalised Marking Instructions

Part One: General Marking Principles for: Biotechnology Higher

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor.

(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

GENERAL MARKING ADVICE: Biotechnology Higher

The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments and course assessments.

1. There are no **half marks**. Where three answers are needed for two marks, normally one or two correct answers gain one mark.

2. In the mark scheme, if a word is **underlined** then it is essential; if a word is (**bracketed**) then it is not essential.

3. In the mark scheme, words separated by / are **alternatives**.

4. There are occasions where the second answer negates the first and no marks are given. There is no hard and fast rule here, and professional judgement must be applied. Good marking schemes should cover these eventualities.

5. Where questions on data are in two parts, if the second part of the question is correct in relation to an incorrect answer given in the first part, then the mark can often be given. The general rule is that candidates should not be penalised repeatedly.

6. If a numerical answer is required and units are not given in the stem of the question or in the answer space, candidates must supply the units to gain the mark. If units are required on more than one occasion, candidates should not be penalised repeatedly.

7. Clear indication of understanding is what is required, so:

- if a description or explanation is asked for, a one word answer is not acceptable
- if the questions ask for **letters** and the candidate gives words and they are correct, then give the mark
- if the question asks for a word to be **underlined** and the candidate circles the word, then give the mark
- if the result of a calculation is in the space provided and not entered into a table and is clearly the answer, then give the mark
- **chemical formulae** are acceptable eg CO_2, H_2O
- contractions used in the Arrangements document eg DNA, ATP are acceptable
- words not required in the syllabus can still be given credit if used appropriately eg metaphase of meiosis

8. Incorrect **spelling** is given. Sound out the word(s),

- if the correct item is recognisable then give the mark
- if the word can easily be confused with another biological term then **do not** give the mark eg ureter and urethra
- if the word is a mixture of other biological words then **do not** give the mark, eg mellum, melebrum, amniosynthesis.

9. Presentation of Data:

- if a candidate provides two graphs or bar charts (eg one in the question and another at the end of the booklet), mark both and give the higher score
- if the question asks for a line graph and a histogram or bar chart is given, then do not give the mark(s). Credit can be given for labelling the axes correctly, plotting the points, joining the points either with straight lines or curves (best fit is rarely used)
- if the *x* and *y* data are transposed, then do not give the mark
- if the graph used less than 50% of the axes, then do not give the mark
- if 0 is plotted when no data is given, then do not give the mark (ie candidates should only plot the data given)
- no distinction is made between bar charts and histograms for marking purposes. (For information: bar charts should be used to show discontinuous features, have descriptions on the *x* axis and have separate columns; histograms should be used to show continuous features; have ranges of numbers on the *x* axis and have contiguous columns.)
- where data is read off a graph it is often good practice to allow for acceptable minor error. An answer may be given 7.3 $\pm$ 0.1.

10. Extended response questions: if a candidate gives two answers where there is a choice, mark both and give the higher score.

11. Annotating scripts:

- put a 0 in the box if no marks awarded – a mark is required in each box
- indicate on the scripts why marks were given for part of a question worth 3 or 2 marks. A ✓ or ✗ near answers will do.

12. Totalling scripts: errors in totalling can be more significant than errors in marking:

- enter a correct and carefully checked total for each candidate
- do not use running totals as these have repeatedly been shown to lead to more errors.

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Part Two: Marking Instructions for each Question

Section A

Question	Expected Answer(s)	Max Mark
1.	D	**1**
2.	C	**1**
3.	B	**1**
4.	C	**1**
5.	C	**1**
6.	C	**1**
7.	D	**1**
8.	C	**1**
9.	B	**1**
10.	A	**1**
11.	B	**1**
12.	A	**1**
13.	B	**1**
14.	D	**1**
15.	D	**1**

Question	Expected Answer(s)	Max Mark
16.	C	**1**
17.	C	**1**
18.	B	**1**
19.	A	**1**
20.	D	**1**
21.	D	**1**
22.	B	**1**
23.	A	**1**
24.	D	**1**
25.	B	**1**
26.	A	**1**
27.	C	**1**
28.	D	**1**
29.	A	**1**
30.	A	**1**

Section B

Question			Expected Answer(s)	Max Mark	Additional Guidance
1.	**(a)**		Bacillus	**1**	
1.	**(b)**		Staph is Gram positive whereas E coli and Pseud are Gram negative, penicillin is more effective against gram positive than gram negative bacteria	**2**	
1.	**(c)**	**(i)**	100 − 97·6 = 2·4% alive 2580000 × 5/100 × 2·4 = 309600	**1**	
1.	**(c)**	**(ii)**	Two from – pH, O_2 levels, pressure, nutrient supply	**1**	
1.	**(d)**		97·6% (or any number similar to Staph)	**1**	Must be closer to Staph, not half way between Staph and other species
1.	**(e)**		Do a viable count at start and end of experiment **(1)**, compare both counts **(1)**	**2**	
2.	**(a)**		Operon	**1**	
2.	**(b)**		When lactose is absent the repressor molecule binds to the operator preventing transcription from the structural gene **(1)** when lactose is present it binds to the repressor molecule stopping it from binding to the operator (so transcription can occur) **(1)**	**2**	
2.	**(c)**		The activity is low to start with and gradually increases as the gene is switched on and the enzyme is produced **(1)**, after about 100 minutes enzyme activity at a maximum as production of the enzyme is at its maximum **(1)**	**2**	One mark**(1)** for description of trend using numbers from graph
2.	**(d)**		Add X gal to the agar **(1)** if the gene is switched on then the enzyme will break it down and produce a blue colour **(1)**	**2**	

Question			Expected Answer(s)	Max Mark	Additional Guidance
3.	**(a)**		Has sequence <u>complementary</u> to target sequence **(1)** Is labelled (named labelling) **(1)**	**2**	
3.	**(b)**		A change of a base in the DNA sequence will affect the codon in the mRNA, **(1)** this could then affect the amino acid it codes for in the protein sequence **(1)**	**2**	
3.	**(c)**		25,674 or 25600	**1**	
3.	**(d)**		The monoclonal antibody is specific to the cancer cells **(1)** This allows the drug to be targeted to the cancer cells **(1)**	**2**	
3.	**(e)**		Introns	**1**	
4.	**(a)**		To combat the severe rise in cases that was seen that year	**1**	
4.	**(b)**		To stimulate a higher level of antibody production/produce memory cells	**1**	
4.	**(c)**		Because their immune system is not well developed/does not respond as well as adults or older children	**1**	
4.	**(d)**		Test for antibodies to the measles virus	**1**	
4.	**(e)**		Artificially acquired: by injection/not by natural methods **(1)** Active: the body produces its own antibodies against the antigen **(1)**	**2**	

Question			Expected Answer(s)	Max Mark	Additional Guidance
5.	**(a)**		It contains undifferentiated cells/cells that are capable of producing all types of tissue/meristem cells are virus free	**1**	
5.	**(b)**		Explants 5:1 plantlets	**1**	
5.	**(c)**	**(i)**	The smaller the size of the explant, the higher the percentage of virus free plants produced	**1**	
5.	**(c)**	**(ii)**	Safrane – produced most virus free plantlets and had highest survival rate	**1**	
5.	**(d)**	**(i)**	More plants from 0·5 mm explants are virus free therefore less chance of disease and greater survival rate	**1**	
5.	**(d)**	**(ii)**	Prediction – number would reduce further or number would level off **(1)** Justification – still some infected plants which may die or plants that are likely to die would have done so by 4 weeks **(1)**	**2**	
5.	**(e)**	**(i)**	To promote cell differentiation/formation of roots and shoots	**1**	
5.	**(d)**	**(ii)**	At stage 1 the explants is not photosynthesising therefore cannot fix carbon **(1)**, at stage 4 photosynthesis will be taking place therefore C source not needed **(1)**	**2**	
5.	**(f)**		To produce a large number of genetically identical plants	**1**	

Question			Expected Answer(s)	Max Mark	Additional Guidance
6.	**(a)**		$0{\cdot}5 \times 0{\cdot}5 \times 0{\cdot}2 = 0{\cdot}05$ mm^3 $10/0{\cdot}05 = 200 \times 24$ (cells in square) = 4800 or $4{\cdot}8 \times 10^3$	**1**	
6.	**(b)**		Overlapping cells not counted/cells counted more than once or not at all/miscounting cells/ culture not mixed properly so cell distribution uneven	**1**	
6.	**(c)**		Equal numbers of living and dead cells in the culture	**1**	
6.	**(d)**		The number of live cells are important as fermentation requires live cells	**1**	
6.	**(e)**	**(i)**	Put on ppe, cover spillage with absorbent material, pour on disinfectant, leave time for disinfectant to work clear up, disinfect/autoclave debris and equipment **(at least 3 for 1, 5 for 2)**	**2**	
6.	**(e)**	**(ii)**	Into a container of disinfectant	**1**	
6.	**(e)**	**(iii)**	Production of aerosols	**1**	
7.	**(a)**	**(i)**	Autoclaving/moist heat sterilisation **(1)** 126°C for 10 mins/121°C for 15 mins **(1)**	**2**	
7.	**(a)**	**(ii)**	Using Browne's tubes – colour change (from red to green), or test strips – colour change	**1**	
7.	**(b)**		Penicillin would be destroyed/inactivated by the high temperature	**1**	
7.	**(c)**		1 in 20 dilution = 1 + 19 = 10 cm^3 stock solution + 190 cm^3 agar	**1**	
7.	**(d)**		Molten agar in bottles put at an angle to allow agar to set **(1)** – labelled diagram acceptable	**1**	

Question			Expected Answer(s)	Max Mark	Additional Guidance
8.	**(a)**	**(i)**	Row 1 – non-identical & share half genetic material **(1)** Row 2 – identical **(1)**	**2**	
8.	**(a)**	**(ii)**	Two cell	**1**	
8.	**(a)**	**(iii)**	Embryo manipulation	**1**	
8.	**(b)**	**(i)**	Viral infection or microinjection	**1**	
8.	**(b)**	**(ii)**	Increased yield/production of therapeutic proteins (or specific example)	**1**	
9.	**(a)**		One mark for each set of points correctly plotted and lines distinguished	**2**	
9.	**(b)**		To prove that it was the bacteria that was producing the enzyme	**1**	
9.	**(c)**		To obtain a more accurate cell number at the particular time point	**1**	
9.	**(d)**	**(i)**	As it was detected in the growth media/ didn't need to extract it from the cells	**1**	
9.	**(d)**	**(ii)**	Filtration or centrifugation to remove cells **(1)** followed by protein purification via column chromatography **(1)**	**2**	
9.	**(e)**		The enzyme is more active at 4°C than 25°C	**1**	Must use numbers not just "high temperature" and "low temperature"

Question			Expected Answer(s)	Max Mark	Additional Guidance
10.	**(a)**	**(i)**	Continuous flow culture	**1**	
10.	**(a)**	**(ii)**	Nutrients/fresh medium added and product harvested throughout the process **(1)** Optimum (named) conditions maintained throughout **(1)**	**2**	
10.	**(a)**	**(iii)**	Increased productivity/ less down time (for cleaning) between cultures	**1**	
10.	**(b)**		The bacteria in a mixed culture may have different growth requirements/any other reasonable	**1**	
11.	**(a)**		Protoplasts, cell wall, cellulase **(2 for 1 mark, all 3 for 2 marks)**	**2**	
11.	**(b)**	**(i)**	Only plants which have taken up the plasmid will grow **(1)** which means they carry the herbicide resistance gene also **(1)**	**2**	
11.	**(b)**	**(ii)**	50	**1**	
11.	**(c)**		Gene encodes a protein which degrades and detoxifies the herbicide (all info required)	**1**	
11.	**(d)**		Could pass herbicide resistance to other plants/breed resistance in other organisms	**1**	

Section C

Question			Expected Answer(s)	Max Mark	Additional Guidance
1.	**A**	**a**	1. Lab model is small volume culture (in flask/small fermenter) 2. Used to determine optimum conditions 3. For example – oxygen requirements, pH, temperature (at least 2) 4. Determination of MGT 5. Range of substrates used 6. Rate at which nutrients are used up 7. Stage at which product produced **Any 5 from 7**	**5**	
1.	**A**	**b**	1. Scaling up from lab model – pilot plant – industrial fermenter 2. Factors to take into account include – cost 3. Technical specification 4. Containment of microorganisms 5. Exclusion of contaminates 6. Control systems for temp/pH/maintaining fluid volume &7. (3 for 2, 2 for 1) **Any 5 from 7**	**5** **(10)**	

Question			Expected Answer(s)	Max Mark	Additional Guidance
1.	**B**	**a**	1. DNA fingerprinting 2. Samples of DNA treated with endonucleases/restriction enzymes 3. DNA digested/cut into fragments 4. DNA fragments separated by electrophoresis 5. Lengths/sizes of fragments determined 6. Used to identify individuals 7. Also used to detect genetic diseases **Any 5 from 7**	**5**	
1.	**B**	**b**	1. Biosensors detect pollution 2. Consist of transducer plus either antibody, enzyme or cell 3. React with material to be detected 4. Signal produced is either electrical, dye or luminescent (at least 2) 5. Bioremediation to remove/degrade/detoxify/accumulate contaminating chemicals 6. Used for soil contamination 7. Oil spills **Any 5 from 7**	**5** **(10)**	

Question			Expected Answer(s)	Max Mark	Additional Guidance
2.	**A**		Prokaryotes 1. Single circular chromosome not within nucleus/membrane bound 2. Cell wall (made of peptidoglycan) for shape/support 3. Cell membrane controls entry & exit of substances 4. Ribosomes for protein synthesis 5. May have – capsule, attachment or protection 6. Flagellum for motility 7. Plasmid – extra chromosomal DNA carrying advantageous genes **Any 4 from 7** Eukaryotes 1. Cell membrane (as above – credit marks only once) 2. Membrane bound nucleus containing genetic material/DNA 3. ER with ribosomes attached for protein synthesis 4. Golgi for processing and packaging of proteins 5. Mitochondria for energy production 6. Lysosome contains enzymes to digest worn out organelles etc 7. May have – chloroplasts for photosynthesis **Any 4 from 7** **Coherence** – divided into paragraphs/section, must have at least 2 points from each section **Relevance** – no more than 2 irrelevant points eg examples of cell types or uses of cells, must have at least 2 points from each section	**10**	

Question			Expected Answer(s)	Max Mark	Additional Guidance
2	**B**		1. Aerobic respiration in presence of oxygen 2. Names of 3 processes – glycolysis, Krebs cycle, cytochrome system 3. Locations correctly assigned – cytoplasm, matrix of mitochondrion, cristae 4. Glycolysis – glucose to pyruvate net production of 2ATP 5. Krebs – acetyl CoA combines with 4C to give 6C then cyclical breakdown to produce 4C 6. Release of CO_2 and H 7. H picked up by coenzyme and taken to cytochrome system 8. Cytochrome system – transfer of electrons/H 9. Produces large quantities (38 molecules) ATP for each glucose 10. Aerobic final products CO_2 and H_2O 11. Anaerobic in absence of oxygen 12. Only glycolysis occurs 13. Pyruvic acid then converted to ethanol and CO_2 14. Produces less ATP than aerobic (or numbers) **Any 8 from 14** **Coherence** – divided into paragraphs/sections, must have at least 2 points from each section **Relevance** – no more than 2 irrelevant points, must have at least 2 points from each section	**10**	

[END OF MARKING INSTRUCTIONS]