2013 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 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.

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.

Part Two: Marking Instructions for each Question

Section A

Question			Expected Answer/s	Max Mark	Additional Guidance
1			B		
2			D		
3			C		
4			A		
5			D		
6			C		
7			B		
8			A		
9			D		
10			A		
11			D		
12			B		
13			C		
14			D		
15			B		

Section A (cont.)

Question			Expected Answer/s	Max Mark	Additional Guidance
16			D		
17			B		
18			A		
19			D		
20			B		
21			C		
22			A		
23			B		
24			C		
25			A		
26			C		
27			C		
28			C		
29			A		
30			D		

Section B

Question			Expected Answer/s	Max Mark	Additional Guidance
1	**a**		Capsule	**1**	
1	**b**	**i**	Rod-shaped	**1**	
1	**b**	**ii**	Purple	**1**	
1	**b**	**iii**	Retains the crystal violet stain due to the thick layer of peptidoglycan in its cell wall (>40%)	**1**	"Retains crystal violet" not sufficient
1	**b**	**iv**	Poorly fixed = no bacteria to view on slide/ not destaining properly = artificial positive result/ too much destaining = artificial negative result/ too much bacteria = artificial positive result, or not able to distinguish shape.	**1**	
1	**c**		Pathogenic	**1**	Accept pathogen(s)
1	**d**		$14 \times 7.5 \times (1 \times 10^6) = 1.05 \times 10^8$	**1**	
1	**e**	**i**	15mm ÷ 2 = 7.5mm Accept between 7-8mm 7.5mm ÷ 2000 = 0.00375mm = 3.75 μm	**1**	Answer within range 3.5 → 4.0 μm
1	**e**	**ii**	Into a container of disinfectant	**1**	

<table>
<tr><th colspan="3">Question</th><th>Expected Answer/s</th><th>Max Mark</th><th>Additional Guidance</th></tr>
<tr><td>2</td><td>a</td><td></td><td>Operon</td><td>1</td><td></td></tr>
<tr><td>2</td><td>b</td><td>i</td><td>Doesn’t waste energy or materials if proteins are not needed</td><td>1</td><td></td></tr>
<tr><td>2</td><td>b</td><td>ii</td><td>mRNA/messenger RNA</td><td>1</td><td></td></tr>
<tr><td>2</td><td>b</td><td>Iii</td><td>Cytoplasm</td><td>1</td><td></td></tr>
<tr><td>2</td><td>c</td><td></td><td>Met-Lys-Pro-Val</td><td>1</td><td></td></tr>
<tr><td>2</td><td>d</td><td></td><td>Deletion</td><td>1</td><td></td></tr>
<tr><td>2</td><td>e</td><td></td><td><table><tr><th>RNA Polymerase binds to operator?</th><th>Lactose metabolised?</th></tr><tr><td>Yes</td><td>Yes</td></tr><tr><td>No</td><td>No</td></tr></table></td><td>2</td><td>1 mark per row</td></tr>
</table>

Question			Expected Answer/s	Max Mark	Additional Guidance
3	**a**		46.70 ÷ 100 × 62kg = 28.95kg	**1**	Rounding up allowed
3	**b**	**i**	Higher percentage of protein produced	**1**	
3	**b**	**ii**	Add cellulose to Candida growing on molasses/other substrate and compare with growth without cellulose to see if growth improves	**1**	
3	**c**	**i**	Budding	**1**	
3	**c**	**ii**	Cells produced from budding are genetically identical, those from sexual reproduction are not	**1**	Must have 'genetically identical'
3	**d**		Brewing/baking	**1**	
4	**a**		1:8	**1**	
4	**b**	**i**	Artificial active	**1**	
4	**b**	**ii**	If a person is naturally exposed to the bacterium they should produce antibodies against the toxin which would protect them against further disease	**1**	Need natural exposure **and** antibody production
4	**c**		(Passive immunity) from antibodies in breast milk	**1**	Also accept antibodies via placenta

Question			Expected Answer/s	Max Mark	Additional Guidance
5	**a**	**i**	Inhibition of growth by the antibiotic/no growth of the bacteria	**1**	Accept sensitivity to/ effectiveness of antibiotic
5	**a**	**ii**	Sulphafurazole	**1**	
5	**b**		Any of: • concentration of antibiotic • diameter of disks • thickness of lawn	**1**	
5	**c**		Add antibiotic to a growing culture of bacteria, then transfer a sample to fresh media to see if further growth occurs If biocidal, no further growth, if biostatic, growth occurs	**1** **1**	
5	**d**		Enumerating bacteriophage/ plaque assay	**1**	Accept viable count

Question			Expected Answer/s	Max Mark	Additional Guidance
6	**a**		Using a spectrophotometer/colorimeter/haemocytometer	**1**	
6	**b**	**i**	Increasing CO_2 concentration inhibits growth of all 3 bacteria **(1)** CO_2 has a greater inhibitory effect on Acinetobacter than on Pseudomonas or Alteromonas **(1)**	**2**	
6	**b**	**ii**	Prediction – growth would be further inhibited Reason – because the inhibition effect does not appear to be decreasing as CO_2 concentration increases	**1**	Accept – decrease Less O_2 available/ bacteria needs O_2
6	**b**	**iii**	15%	**1**	
6	**c**		Because they are still able to grow at high CO_2 concentration	**1**	
6	**d**	**i**	Measurements are taken 10 degrees apart – optimum temperature may be between the time points used eg 35°C	**1**	
6	**d**	**ii**	20%	**1**	

Question			Expected Answer/s	Max Mark	Additional Guidance
7	**a**		Lactose – carbon source/ energy source Agar – solidifying agent/ solid surface	**1**	Not 'nutrient'
7	**b**		Selective because it selects for the growth of these 2 bacteria and inhibits E.coli Differential because colonies of Shigella and Salmonella will appear different colours and so it is possible to tell the difference between the 2 species.	**1** **1**	
7	**c**		37 ^{o}C	**1**	
7	**d**	**i**	Filtration/ ultrafiltration	**1**	
7	**d**	**ii**	Disinfect bench Work with blue flame/in sterile zone Flaming neck of bottle **2 marks for 3** **1 mark for 2**	**2**	Also accept 'not putting lids on bench'
7	**d**	**iii**	Cool to 45-55°C before pouring	**1**	

Question			Expected Answer/s	Max Mark	Additional Guidance
8	**a**		Entrapment	**1**	
8	**b**	**i**	Increased productivity **(1)** continuous supply of product **(1)**	**2**	Accept - less down time/ no need to continuously clean fermenter
8	**b**	**ii**	Nutrients continually added **(1)** product continually removed **(1)**	**2**	Accept - waste continually removed
8	**c**		To clarify fruit juice/ clear/ release juice	**1**	
8	**d**		• Urokinase to dissolve blood clots • Cellulase to manufacture feedstock • Lysozyme to disrupt bacterial and yeast cells	**1**	

Question			Expected Answer/s	Max Mark	Additional Guidance
9	**a**	**i**	Scale and label correct **(1)**	**2**	
9	**a**	**ii**	Points plotted and joined correctly **(1)**		
9	**b**		Hydrocarbon concentration starts to drop after the bacteria start to grow **(1)** (use of numbers to quantify**(1)**) Update as per marked up version	**2**	Relationship = 1 mark Quantifying = 1 mark
9	**c**	**i**	Using a water jacket	**1**	
9	**c**	**ii**	pH / sample volume/ O_2 concentration	**1**	
9	**d**		There is a filter on the air inlet to sterilise the air going in to the fermenter and to prevent contaminants entering **(1)** There is no filter on the sampling port as this would remove the bacteria from the culture **(1)**	**2**	
9	**e**	**i**	Bioremediation	**1**	
9	**e**	**ii**	The bacteria may cause pollution problem of their own / bacteria may not grow if other nutrients are not available	**1**	

Question			Expected Answer/s	Max Mark	Additional Guidance
10	**a**		(Crystalline) protein	**1**	
10	**b**		Insects that <u>eat</u> the plant ingest the protein/product which acts as a toxin and <u>kills the</u> caterpillars	**1**	
10	**c**	**i**	Spraying the plants with the bacteria instead of incorporating the gene.	**1**	
10	**c**	**ii**	You can wash the bacteria off the surface of the plant whereas you would ingest the transgenic gene product.	**1**	Accept – 'Fear' of GM crops, environmental issues…etc
10	**d**		Wheat plants with the gene produce a protein that degrades and detoxifies the glyphosate **(1)** Weeds do not have the gene and will die in the presence of glyphosate **(1)**	**2**	

Question			Expected Answer/s	Max Mark	Additional Guidance
11	**a**		Agrobacterium tumifaciens	**1**	
11	**b**	**i**	Removal of cell wall with cellulase.	**1**	
11	**b**	**ii**	Allows uptake of plasmid/plasmids could not enter the cell if cell wall was present	**1**	For cells to fuse together is NOT sufficient
11	**c**	**i**	Antibiotic	**1**	
11	**c**	**ii**	Only plant cells that have taken up the plasmid have the antibiotic resistance gene	**1**	
11	**d**		Produces genetically identical plants / produces large numbers / pathogen free / growth independent of seasons	**1**	
11	**e**	**i**	60 000 daltons – 62 500 daltons	**1**	
11	**e**	**ii**	Trials 1 and 3 because they contain the least waxy protein	**1**	

Section C

Question			Expected Answer/s	Max Mark	Additional Guidance
1	**A**	**a**	1. viruses have no cellular structure 2. contain (nucleic acid which is) either DNA or RNA 3. surrounded by a protein coat / capsid 4. may have an outer covering called an envelope. **i. any 3 from 4**	**3**	
1	**A**	**b**	5. virus/viral nucleic acid enters cell 6. alters host cell metabolism 7. replication of viral nucleic acid 8. production of viral protein (coats) 9. assembly of new viral particles 10. lysis/bursting of cells to release virus 11. some viruses can incorporate their DNA into host cells chromosome. **i. any 5 from 7**	**5**	
1	**A**	**c**	12. viruses are used for the production of vaccines 13. named example eg smallpox, polio rubella 14. used for cloning vectors/in genetic engineering. **i. any 2 from 3**	**2**	
1	**B**	**a**	1. DNA has a double helix structure 2. sugar – phosphate backbone 3. made up of nucleotides containing deoxyribose sugar, phosphate and a base 4. base pairing occurs between adenine – thymine and cytosine – guanine 5. held together with H-bonds 6. strands are antiparallel – one runs 3' to 5', the other 5' to 3' 7. eukaryotic DNA has exons (coding regions) and introns (non-coding). **i. any 5 from 7**	**5**	

Question			Expected Answer/s	Max Mark	Additional Guidance
1	**B**	**b**	8. helix unwinds/unzips 9. semiconservative replication (or description) 10. DNA polymerase catalyses addition of/adds nucleotides 11. nucleotides added only to 3' end of strand **i. any 3 from 4**	**3**	
1	**B**	**c**	12. RNA is single stranded 13. made of nucleotides similar to DNA except uracil in place of thymine 14. and ribose sugar in place of deoxyribose **i. any 2 from 3**	**2**	
2	**A**		1. <u>downstream processing</u> for extraction and purification of products 2. extraction of cells solvents, solute 3. flocculation/precipitation of cells 4. filtration of yeast in alcohol production 5. centrifugation to remove cells 6. freeze-drying of cells 7. solvent extraction of penicillin 8. distillation of alcohol 9. citric/lactic acid precipitation with lime or chalk 10. protein purification using column chromatography 11. on basis of size, charge or shape **i. any 8 from 11** **Coherence mark** – • writing must be under sub-headings or divided into paragraphs • related information must be grouped together • at least 5 relevant points **Relevance mark** – • no more than 2 irrelevant points • at least 5 relevant points	**10**	

Question			Expected Answer/s	Max Mark	Additional Guidance
2	**B**		1. vaccines produced by genetic engineering 2. hepatitis vaccine produced in yeast cells 3. viral surface antigen purified and used as a vaccine 4. monoclonal antibodies produced by fusing B-lymphocytes with cancer cells to produce hybrid cells 5. selection and cloning of hybrid cells which produce desired antibody 6. uses – named use of monoclonals 7. transgenic animals for production of named therapeutic protein eg interferon, blood clotting factors, AAT 8. genome of animal altered by recombinant DNA technology 9. secretion of required protein in milk of animal 10. stem cells produced by embryo cloning 11. uses in treatment of disease and potential organ production **i. any 8 from 11** **Coherence mark** – • writing must be under sub-headings or divided into paragraphs • related information must be grouped together • at least 5 relevant points **Relevance mark** – • no more than 2 irrelevant points • at least 5 relevant points	**10**	

[END OF MARKING INSTRUCTIONS]