# 2014 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 3or 7near 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.

**Part Two: Marking Instructions for each Question**

**Section A**

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

**Section A**

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

**Section B**

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **1** | **(a)** | **(i)** | Prokaryotes have a single circular chromosome, eukaryotes have multiple linear chromosomes<br>**OR**<br>Eukaryotes have exons and introns, prokaryotes have no introns | **1** | |
| **1** | **(a)** | **(ii)** | prevents dessication/phagocytosis by macrophages | **1** | |
| **1** | **(a)** | **(iii)** | antibiotic resistance | **1** | |
| **1** | **(b)** | | peptidoglycan<br>positive | **1** | |
| **1** | **(c)** | | Eukaryotes have other membrane bound organelles (example), prokaryotes do not/prokaryotes always unicellular, eukaryotes maybe uni- or multicellular<br><br>Both have ribosomes/cell membrane/any other suitable | **2** | Must mention both prokaryotes and eukaryotes |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **2** | **(a)** | | Example from:<br><br>Skin, nasal hair, lysozyme in tears<br>physical barrier, traps microbes, kills microbes (any other relevant example and description).<br>**OR** macrophages carry out phogocytosis | **2** | |
| **2** | **(b)** | **(i)** | Antigens | **1** | |
| **2** | **(b)** | **(ii)** | Production of (specific) antibodies by β-lymphocytes | **1** | |
| **2** | **(c)** | **(i)** | Artificial active | **1** | |
| **2** | **(c)** | **(ii)** | Some of the lymphocytes persist as memory cells (**1**) which will respond rapidly to future exposure to the same antigen and produce antibodies quickly enough to prevent illness (**1**) | **2** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **3** | **(a)** | | Starch = Carbon source for building **OR** energy source<br><br>Nitrate = Nitrogen for protein synthesis or nucleotides/DNA | **2** | |
| **3** | **(b)** | | To remove competition for space, nutrients…etc | **1** | |
| **3** | **(c)** | | Both Gram positive and negative are inhibited, but all extracts inhibit Gram positive whereas only some inhibit Gram negative | **1** | |
| **3** | **(d)** | **(i)** | Extract 3 | **1** | |
| **3** | **(d)** | **(ii)** | Can inhibit both | **1** | |
| **3** | **(e)** | **(i)** | Each extract was tested four times | **1** | |
| **3** | **(e)** | **(ii)** | Calculating average values reduces the effects of extreme results | **1** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **4** | **(a)** | **(i)** | Micrococcus | **1** | |
| **4** | **(a)** | **(ii)** | (make fixed smear), (gram) stain both bacteria and view under microscope<br><br>Enterococcus will appear round in shape, Lactobacillus will be rod shaped | **2** | |
| **4** | **(a)** | **(iii)** | Flagellum | **1** | |
| **4** | **(b)** | | Heat to > 100°C and test for further growth / endospore stain | **1** | |
| **4** | **(c)** | | Tube 1 | **1** | |
| **4** | **(d)** | **(i)** | Glycolysis | **1** | |
| **4** | **(d)** | **(ii)** | two | **1** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **5** | **(a)** | | Axis correctly drawn and labelled<br>Bars plotted correctly and labelled | **2** | |
| **5** | **(b)** | | Approximately 6 times more cases in Holland than in Norway, but about 1 in 10 die in Holland compared to 1 in 5 in Norway ie Holland has a lower fatality rate | **2** | |
| **5** | **(c)** | **(i)** | 69 cases in 2012 | **1** | |
| **5** | **(c)** | **(ii)** | Incorrect recording of causes of disease or death / non-reporting of probable cases / any other suitable | **1** | |
| **5** | **(d)** | **(i)** | Erythromycin<br><br>Penicillin is ineffective against gram negative bacteria because they have low peptidoglycan which is the target for penicillin, Erythromycin will kill Legionella by inhibiting protein synthesis | **2** | |
| **5** | **(d)** | **(ii)** | Expose bacterial culture to Erythromycin, remove sample of bacteria to new medium, test for growth | **2** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **6** | **(a)** | | Hybrid | **1** | |
| **6** | **(b)** | | Unfused cells will grow and take over the culture/ use up nutrients<br>**OR**<br>unable to differentiate between fused and unfused cells | **1** | |
| **6** | **(c)** | | May prevent growth factor from getting to non-cancerous cells/may prevent non-cancer cells dividing | **1** | |
| **6** | **(d)** | | Pregnancy testing/research tool/identifying ineffective agents | **1** | |
| **6** | **(e)** | **(i)** | Stainless steel<br>Can tolerate steam sterilisation/does not corrode | **1** | |
| **6** | **(e)** | **(ii)** | Paddles<br>Used to stir contents | **1** | |
| **6** | **(e)** | **(iii)** | Message from probe to computer system, inject cold water through the water jacket (**1**), when temperature returns to normal no more cold water added (**1**) | **2** | |
| **6** | **(f)** | | Column chromatography | **1** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| 7 | (a) | | Lab model | 1 | |
| 7 | (b) | | **Intracellular invertase** – breakdown of cell walls (with enzymes or detergents) and purification (or named) of enzyme **(1)**<br><br>**Extracellular invertase** – remove cells and purify (by column chromatography) enzyme from medium **(1)** | 2 | |
| 7 | (c) | (i) | 8g | 1 | |
| 7 | (c) | (ii) | 30g sucrose / 38g total growth media components × 100 = 79%<br>**Or** 30/38·4 × 100 = 78%/78.13% | 1 | |
| 7 | (d) | (i) | Name – Bonding, adsorption, entrapment<br><br>Describe – enzyme covalently bonded to matrix / non-covalent bonding of enzyme and matrix / entrapment within gel-type matrix | 2 | |
| 7 | (d) | (ii) | Enzymes can be recycled, easier to separate enzyme and product, can stabilise enzymes, reduces problems with dealing with effluent waste | 2 | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **8** | **(a)** | | Growth of both strain Y and strain Z decreases as mercury concentration increase **(1)**, but at 50μM and above strain Y is completely inhibited whereas there is still some growth of strain Z at these concentrations **(1)** | **2** | |
| **8** | **(b)** | | Strain Z is able to convert mercury into a non-toxic compound/strain Z is able to contain the mercury in a way that makes it non-toxic to the cell | **1** | |
| **8** | **(c)** | **(i)** | 20 | **1** | |
| **8** | **(c)** | **(ii)** | 1 : 3 | **1** | |
| **8** | **(d)** | | Prediction – increase<br><br>Explanation – the cells of strain Z have taken up the mercury and so when the cells are removed from the medium the mercury is also removed and so strain X can then grow | **1** | |
| **8** | **(e)** | | Bioremediation | **1** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **9** | **(a)** | **(i)** | Cellulase/amylase | **1** | |
| **9** | **(a)** | **(ii)** | Simple carbohydrates can be utilised more easily by the cells | **1** | |
| **9** | **(b)** | **(i)** | Downstream processing | **1** | |
| **9** | **(b)** | **(ii)** | Because it has a greater surface area | **1** | |
| **9** | **(c)** | | By trapping the proteins in capsules they become heavy and sink to the bottom of the container | **1** | |
| **9** | **(d)** | | To kill off any remaining yeast | **1** | |
| **9** | **(e)** | | ***MARKING INSTRUCTIONS REMOVED DUE TO COPYRIGHT ISSUES*** | **2** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **10** | **(a)** | **(i)** | They contain a monkey gene/gene from another species | **1** | |
| **10** | **(a)** | **(ii)** | Either DNA profiling or look for the antiviral protein with an antibody | **1** | |
| **10** | **(b)** | **(i)** | Eggs bisected at two cell stage<br>Each half is transplanted back into the cat results in 2 kittens | **2** | |
| **10** | **(b)** | **(ii)** | Infect the transgenic cats with the HIV-like virus<br>Monitor to see if they develop the infection | **2** | |
| **10** | **(c)** | **(i)** | Expensive large scale production vessels<br>The bacteria cannot add sugar residues to the protein so it may not be functional | **1** | |
| **10** | **(c)** | **(ii)** | Owners will not need to keep vaccinating the cats/genes passed onto the next generation so litters will all be transgenic too/cats will live longer and healthier lives/other reasonable<br>**Any 2** | **1** | |

**Section C**

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **1** | **A** | **a** | 1. dilute liquid culture to appropriate number for counting<br>2. description of step-wise transfer<br>3. aseptic technique/prevention of contamination<br><br>**Any 2 from 3** | **2** | |
| **1** | **A** | **b** | 4. plate known volume from serial dilution<br>5. spread plate (or description)<br>6. viable (living) cells will produce colonies after incubation<br>7. plate count description including range<br>8. too many not accurate, too few not reliable<br>9. calculate no. of cells using volume and dilution factor<br><br>**Any 4 from 6** | **4** | |
| **1** | **A** | **c** | 10. plaque assay counts phage/viruses<br>11. mix virus and bacteria<br>12. transfer known volumes to plates<br>13. count areas of clearing/plaques<br>14. plaques formed by lysis of cells by virus<br>15. 1 plaque = 1 virus particle<br><br>**Any 4 from 6** | **4** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **1** | **B** | **a** | 1. sterilisation by autoclaving – including time and temp<br>2. check sterilisation with Brownes tubes/test strips<br>3. description of appropriate safety checks/seal intact/water in autoclave<br>4. materials not suitable for autoclaving<br>5. require alternative sterilisation technique (or named)<br><br>**Any 3 from 5** | **3** | |
| **1** | **B** | **b** | 6. cool medium to 45-55°C (within range)<br>7. slopes set at an angle (or description of)<br>8. slopes in screw-top vessel (or named example)<br>9. sterile zone for pouring<br>10. aseptic technique (or description)<br>11. suitable plates are smooth, flat, dry (all 3)<br>12. check for contamination before using<br><br>**Any 5 from 7** | **5** | |
| **1** | **B** | **c** | 13. description of selective medium – inhibits growth of some organisms, allows growth of others<br>14. description of differential medium – show differences between organisms<br>15. any named example<br><br>**Any 2 from 3** | **2** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **2** | **A** | | 1. name stages – lag, log, stationary, death/decline<br>2. in correct order (or labelled on graph)<br>3. (description of lag phase) increase in cell size but no division<br>4. bacteria adapt to growth conditions/metabolically active<br>5. (description of log phase) bacteria number increases exponentially/growth rate constant/bacteria reproduce at maximum rate<br>6. (description of stationary phase) no overall increase in cell numbers/number of cells dying = number of cells being produced<br>7. due to nutrient depletion/build up of toxins/waste<br>8. (description of death phase) cells die exponentially/number dying > number being produced<br>9. Temp, $O_2$, pH, availability of nutrients, pressure, space, presence of toxins affect growth (**at least 3 factors for 1 mark**)<br>10. $O_2$ essential for growth of aerobes/may be toxic to anaerobes<br>11. pH affects protein structure/function<br>12. high temp denatures proteins/damages DNA/lipids<br><br>**Any 8 from 12**<br><br>**Coherence mark** –<br>1 mark for coherence – at least 5 pieces of relevant information and related information must be grouped together and divided into paragraphs or under subheadings<br><br>**Relevance mark** –<br>1 mark for relevance at least 5 pieces of relevant information and no more than 2 irrelevant | **10** | |

| Question | | | Expected Answer/s | Max Mark | Additional Guidance |
|---|---|---|---|---|---|
| **2** | **B** | | 1. cDNA synthesised from (template) mRNA<br>2. reverse transcriptase (enzyme) used<br>3. forms DNA-RNA hybrid<br>4. RNA removed by alkali<br>5. DNA polymerase used to make double stranded DNA<br>6. vectors can be plasmid or phage<br>7. vectors must have antibiotic resistance/means of replication in host/lac operon or similar for control<br>8. (1 or 2 for 1 mark, 3 for 2 marks)<br>9. vector cDNA cut with same restriction enzyme and joined with ligase<br>10. engineered vector inserted into host cell = transformation<br>11. only cells with vector will grow in selective medium<br>12. transformed bacteria scaled up = cloning<br><br>**Any 8 from 12**<br><br>**Coherence mark** –<br>1 mark for coherence – at least 5 pieces of relevant information and related information must be grouped together and divided into paragraphs or under subheadings<br><br>**Relevance mark** –<br>1 mark for relevance – at least 5 pieces of relevant information and no more than 2 irrelevant | **10** | |

[END OF MARKING INSTRUCTIONS]