2009 Biotechnology

Higher

Finalised Marking Instructions

GENERAL MARKING ADVICE: BIOTECHNOLOGY

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 <u>**underlined**</u> 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 ± 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.

2009 Biotechnology Higher

Marking Scheme

Section A

1.	D		16.	D
2.	C		17.	A
3.	A		18.	C
4.	B		19.	B
5.	D		20.	B
6.	B		21.	C
7.	A		22.	B
8.	C		23.	C
9.	D		24.	D
10.	A		25.	D
11.	B		26.	C
12.	A		27.	C
13.	A		28.	A
14.	D		29.	D
15.	B		30.	B

Section B

	Question		Acceptable Answer	Mark	Unacceptable answer	Negates
1	**(a)**	**(i)**	Budding/asexual	**1**		
		(ii)	1: ADP + Pi 2/3: CO_2 water **2 answers = 1 mark, 1 answer = 0 marks**	**2**	ADP only (no Pi)	
		(iii)	Facultative anaerobes	**1**		
		(iv)	Two	**1**		
	(b)	**(i)**	9	**1**		
		(ii)	$9 \times 10 \times 10^4 = 9 \times 10^5$ Allow candidates answer to part i $\times 10^5$	**1**		

Question		Acceptable Answer	Mark	Unacceptable answer	Negates
2	**(a)**	(DNA) ligase	**1**		
	(b)	Control of/to allow expression of foreign gene/allow foreign DNA to be transcribed	**1**		
	(c)	To allow the plasmid to replicate	**1**		
	(d)	Fast growing/easy to manipulate/easy to transform	**1**		
	(e) (i)	Plate Y contains ampicillin/bacteria on plate Y are ampicillin/antibiotic resistant (**1**) Only *E.coli*/bacteria/colonies that have taken up plasmid/vector can grow (**1**)	**2**		
	(ii)	Isolated and grown	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
3 **(a)** **(i)**	Patient X has prior immunity (or inferred) (Patient Y has not) (**1**) Therefore produces more antibodies/antibodies faster/longer lasting response/secondary response (or converse for patient Y) (**1**)	**2**		
(ii)	4 : 3	**1**		
(iii)	six times	**1**		
(b)	Artificial – Passive Natural – Passive Natural – Active Artificial – Active 3 correct – **2 marks** 2 correct – **1 mark**	**3**		

	Question	Acceptable Answer	Mark	Unacceptable answer	Negates
4	**(a) (i)**	Autoclave $\quad$ 121°C $\quad$ 15 min $\qquad\qquad$ 126°C $\quad > \quad$ 10 min	**1**		
		Oven/dry heat $\quad$ 160 - 180°C 2 hours	**1**		
	(ii)	Brownes tubes/test strips	**1**		
	(b) (i)	Filtration	**1**		
	(ii)	20 stock $\qquad$ 80 water	**1**		
	(c) (i)	The probability of harm being realised	**1**		
	(ii)	Follows an established/authoritative/published code of practice	**1**		
	(iii)	Any **two** acceptable relating to choice of organism, choice of medium growth conditions, handling procedures etc	**2**		

	Question		Acceptable Answer	Mark	Unacceptable answer	Negates
5	**(a)**	**(i)**	4 to 5 hours	**1**		
		(ii)	Exponential/log **and** stationary	**1**	Lose mark if death/senescent mentioned	
		(iii)	2.5 hours/150 minutes	**1**		
	(b)		There is no increase in cell number (**1**) because of (named) limiting factor (**1**) build up of toxins (**1**) Any **two**	**2**		
	(c)		Enzymes/biochemical reactions more efficient at 30	**1**	Cells are at their optimum temperature	

Question		Acceptable Answer	Mark	Unacceptable answer	Negates
6	**(a)**	2002 – 2003	**1**		
	(b)	20% (180 to 216 – increase of 36)	**1**		
	(c)	Predict: Number of cases will continue to decrease/number of cases will level off Reason: Increasing uptake of new procedure/ uptake of new procedure reached saturation point	**1**		
	(d)	54 cases (30% of 180)	**1**		
	(e)	<u>Percentage</u> of cases caused by *Clostridium* increased <u>Percentage</u> of cases caused by *Staphylococcus* remain level	**1**		
	(f)	New procedure has had great effect/has reduced number of cases (or numbers)/ New procedure more effective against *Staphylococcus* (than *Clostridium*)	**1**		
	(g)	Spores are difficult to kill/more resistant to disinfectants	**1**		

	Question		Acceptable Answer	Mark	Unacceptable answer	Negates
7	**(a)**		Description of agar preparation/sterilise agar (**1**); set agar at angle (**1**)	**2**		
	(b)	**(i)**	Dry, flat, smooth, uncontaminated – 3 points required	**1**		
		(ii)	Different bacteria show different growth characteristics/different effect on medium	**1**		
	(c)	**(i)**	Synthetic	**1**		
		(ii)	Buffer	**1**		

Question			Acceptable Answer	Mark	Unacceptable answer	Negates
8	**(a)**	**(i)**	They are antibody secreting cells/produce antibodies	**1**		
		(ii)	To select for (cell producing) <u>desired</u> antibody/ protein	**1**		
	(b)		Monoclonal antibody attaches to cancer cell (**1**) Anti-cancer drug destroys cancer cell (**1**)	**2**		

	Question	Acceptable Answer	Mark	Unacceptable answer	Negates
9	**(a)**	Scale (**1**) Plots (**1**) each	**3**	Plots not distinguished (-1 mark)	
	(b) (i)	Cells grow better/longer with <u>serum</u>/cells require <u>serum</u> for growth (or converse)	**1**		
	(ii)	Between days 4 and 5	**1**		
	(c)	Sterilise equipment/bioreactors; use sterile medium; large volume of inoculum; pure inoculum	**2**		
	(d)	It is a control	**1**		
	(e) (i)	Closed system/fixed volume/nothing added or removed	**1**		
	(ii)	Short fermentation time/ease of control/ allows all stages of growth to occur/secondary metabolites produced	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
10 (a) (i)	Centrifugation/flocculation/filtration/precipitation	**1**		
(ii)	Size/charge/shape (**two required**)	**1**		
(b)	Less chance of infection/guaranteed source of supply/higher yield/reason why it is ethically more acceptable	**1**	Cheaper/easier to produce/safer/ethical	
(c)	(yeast eukaryotic therefore) perform post translational modification/describes post-translational process	**1**		
(d)	Cost/technical specification/containment of microorganisms, exclusion of contaminants/ control systems Any **two**	**2**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
11 (a)	Blastocyst	**1**		
(b)	Cells are implanted into surrogate (or equivalent)	**1**		
(c)	Mouse R is clone of/genetically identical to embryo removed from Mouse P	**1**	Mouse R is genetically identical to/clone of mouse P	
(d)	Similarity: produces clones/involve nuclear transfer/surrogate mother used Difference: different sources of DNA (must mention both types of cloning)	**2**		
(e)	To conserve desired features for future generations/rapid production of desired characteristics/(multiple) clones of <u>genetically identical</u> individuals	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
12 (a)	Bioremediation	1		
(b)	90%	1		
(c)	1 500	1		
(d)	Media contains pollutant (**1**). Plate out bacteria on media and examine plate for growth (**1**)	2		

Section C

1 A   Discuss the applications of biotechnology in agriculture under the following headings:

Production of transgenic plants and animals

1   Use of *Agrobacterium tumefaciens*
2   Foreign DNA carrying desired genes inserted into bacterial plasmid
3   Plant cell protoplasts incubated with bacteria containing plasmid
4   Selection using medium which allows only growth of those plant cells
     which have taken up the foreign DNA
5   Use of fertilised egg
6   Use of microinjection/infection

Maximum 4 marks

Crop protection

7   Spray plants with *Bacillus thuringiensis*
8   Which during sporulation
9   Produces (crystalline) protein toxin
10   Which selectively kills Gypsy Moth caterpillars
11   Gene for bacterial toxin
12   Transferred into plants
13   Plants transformed with genes
14   That code for protein to degrade/detoxify herbicide

Maximum 6 marks

Section C

1 B   Give an account of the application of immobilised enzymes in biotechnology under the following headings:

Methods for immobilising enzymes

1   Bonding, adsorption, entrapment
2   (Bonding:) covalent attachment to matrix/surface/support/structure
3   (Adsorption:) non-covalent attachment to matrix
4   Entrapment within matrix (or described)

Maximum 3 marks

Advantages of immobilising enzymes

5   Enzyme recycled
6   Cost reduction/cheaper
7   Ease of separation of enzyme and product
8   Increased productivity/stability

Maximum 2 marks

Therapeutic and industrial applications

9   PECTINASE   fruit juice clarification
10   UROKINASE   fibrin clot removal
11   CELLULASE   feedstock manufacture from waste material/breaks
                     down plant/cell walls
12   LYSOZYME   disruption of yeast and bacterial cells
13   LACTASE/   removing lactose from milk
     β galactosidase
14/15 1 mark for 2 names of enzymes (no description)
      2 marks for 4 names of enzymes (no description)

Maximum 5 marks

Section C

2 A   Prokaryotes and eukaryotes both carry out transcription (synthesis of mRNA) and translation (synthesis of protein). Describe the similarities and differences between prokaryotes and eukaryotes in the way they carry out the processes.

Similarities

1   DNA encodes mRNA encodes protein
2   Both use enzyme/RNA polymerase for transcription
3   Both use ribosomes (plus tRNA) for translation
4   Both use ATP

Differences

Eukaryotes
5   Transcription occurs in nucleus
6   (pre-) mRNA contains introns and exons
7   splicing/removal of introns required
8   mRNA leaves nucleus for cytoplasm
9   ribosomes free or attached

Prokaryotes
10   Transcription occurs in cytoplasm
11   mRNA entirely coding sequences/no introns or exons
12   all ribosomes free

Maximum 8 marks

1 mark for relevance and 1 mark for coherence = 10 marks

Coherence
1   The writing must be under sub-headings or divided into paragraphs.
2   Related information must be grouped together.
    Similarities grouped together/differences grouped together **or** account of one group followed by account of second group noting similarities and differences.
    In either case, at least **five** relevant points must be made.

Both must apply for the coherence mark.

Relevance
1   Essay requires candidates to highlight **similarities and differences** in processes, not to describe processes in great detail, therefore should not contain excessive detail on mechanism of transcription or translation.
2   Must refer to similarities **and** differences in transcription **and** translation in prokaryotes **and** eukaryotes.

Both must apply for the relevance mark.

Section C

2 B   Give an account of the purification and fragmentation of DNA, and the separation of the fragments produced.

        1   Release of DNA from cell by breakdown of cell wall/membrane
        2   Removal of protein

        3   Cut DNA with <u>restriction</u> enzymes/endonucleases
        4   DNA cut at specific sites (to produce fragments)

        5   Fragments separated using gel electrophoresis
        6   Agarose gel used
        7   Concentration of agarose affects migration of fragments
        8   Fragments move towards positive electrode/anode
        9   Because DNA negatively charged
        10   Smallest fragments move furthest
        11   DNA visualised by staining

Maximum 8 marks

1 mark for relevance and 1 mark for coherence = 10 marks

Coherence
1   The writing must be under sub-headings or divided into paragraphs.
2   Related information must be grouped together – Purification/restriction/electrophoresis with at least **five** relevant points made.
3   Account should flow, purification to restriction to electrophoresis to staining, with at least **five** relevant points included.

Two of these three must apply for the coherence mark.

Relevance
1   Essay should contain no more than **two** irrelevant points.

This must apply for relevance mark.

[END OF MARKING INSTRUCTIONS]