2011 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 **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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Marking Scheme

Section A

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

Section B

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
1 (a)	Endoplasmic reticulum labelled	**1**		
(b)	Q: Mitochondrion: Production/synthesis of ATP/aerobic respiration R: Plasmid: carries (non-essential) genes/ DNA/genetic information (for antibiotic resistance)/used as cloning vector	**1** **1**	Production of energy Carries antibiotic resistance	
(c)	Ribosome/cell membrane/cell wall	**1**		
(d)	Staphylococcus aureus	**1**		
(e)	H – granum/grana J – lamella/lamellae K – stroma **2 correct = 1 mark**	**2**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
2 (a)	Virus that infects/targets bacteria	**1**		
(b)	x = <u>protein</u> coat/capsid y = nucleic acid/DNA <u>or</u> RNA/DNA	**1**	RNA	
(c)	DNA/Nucleic acid replication:– uses host nucleotides/enzymes/ATP Protein synthesis:– uses host ribosomes/ amino acids/ATP **ATP may be used as an answer once only** **4 answers = 2 marks** **2/3 answers = 1 mark**	**2**		
(d)	Bacteriophage cause cell to rupture/to burst/lysis	**1**		
(e)	120 per 2 µl= **60 per µl**	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
3 (a)	Glycolysis	**1**		
(b)	3/2 × 3C	**1**		
(c)	Joins with 4-carbon compound (**1**) to form citric acid/6 carbon compound (**1**)	**2**		
(d) (i)	Decrease in oxygen/anaerobic	**1**		
(ii)	Distillation	**1**		
(e) (i)	NAD/NADH/FAD/coenzyme	**1**		
(ii)	Oxygen	**1**		
(f)	Any named ATP-requiring process	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
4 (a) (i)	92 – 72 = <u>20 mm</u> **must include units**	**1**		
(ii)	Gel X	**1**		
	Greater distance between fragments		"Travels further"	
(iii)	76 – 78 mm	**1**		
(b) (i)	0.24	**1**		
(ii)	(DNA is) negatively charged	**1**		
(iii)	Time run for (**1**) voltage/current (**1**)	**2**	'charge'	
(c) (i)	1 – 270-275 2 – 450-460 3 – 580-600	**1**		
(ii)	Once	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
5 (a)	Tip of root/shoot	**1**	Top of shoot/end of shoot	
(b)	Washed with/dipped in alcohol/bleach	**1**	"Alcohol"/"bleach"	
(c)	Source of energy/building block (for organic molecules)/because plants in culture photosynthesise less	**1**		
(d)	Promote cell differentiation/cell division	**1**	'promote growth'	
(e)	Cytokinin/auxin/IAA	**1**		
(f)	**Two of** Vitamins/salts/water/agar/nitrates/phosphate	**1**		
(g)	To produce pathogen free plants/conserve genetic traits/produce many (genetically) identical copies	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
6 (a)	(lac) operon	**1**		
(b)	Lactose Regulator gene Operator Structural gene **Three or two correct – 1 mark**	**2**		
(c)	Regulator gene encodes repressor (**1**) repressor binds to operator (**1**) prevents <u>transcription/mRNA</u> production (of structural genes) (**1**) no enzyme/β-galactosidase produced (**1**) **Any 3 for 3 marks** <u>Note</u> if answer to (b) transposed but (c) is consistent with answer given to (b), award marks for part (c)	**3**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
7 (a)	To allow a comparison to be made (with the antibiotic)	**1**		
(b) (i)	600	**1**		
(ii)	62.5%	**1**		
(c)	RA1 causes a <u>greater decrease</u> in protein synthesis <u>than erythromycin</u> (**must be comparison**)	**1**		
(d)	<u>mRNA</u> and <u>translation</u>	**1**		
(e)	Cells carry antibiotic resistance genes/ prevent erythromycin entering cell/ attaching to ribosome/breaks down erythromycin (or acceptable)	**1**		
(f)	2200	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
8 (a) (i)	$\underline{2.6 \times 10^8}$/260,000,000	**1**		
(ii)	$\underline{1.3 \times 10^5}$/$\underline{130000}$ **Mark correct if consistent with answer to (a) (i)**	**1**	1.36×10^5/136000 or 1.37×10^5/137000	
(b) (i)	To regulate pH/maintain constant pH	**1**		
(ii)	To prevent cells sinking to the bottom of the bioreactor/to keep the contents evenly distributed/to mix contents	**1**		
(c)	The production of hormone would decrease; animal cells would die/proteins would be denatured	**1**		
(d)	To establish optimum conditions for cell growth/product formation	**1**		
(e)	(the industrial fermenter would have) a water jacket	**1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
9 (a)	Scales and units 1 Each plot 1	**2**		
(b)	11 J : 4 K	**1**		
(c)	Patients of a similar age, patients are the same sex, similar medical history	**2**		
(d)	To show that it was the vaccine and not the adjuvant that triggered the production of antibody	**1**		
(e) (i)	Vaccine stimulates HPV-vcp antibody production in Patient J/Antibody levels in Patient J fall to the same level as that of Patient K/antibody levels increase one month after vaccination/other reasonable	**2**		
(ii)	<u>Vaccinate</u> more patients <u>and</u> larger control group	**1**	'use more people'	
(f)	No chance of new viruses forming so it is considered safer/no danger of infection	**1**	'safer'/'cheap'	

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
10 (a) (i)	When the bacteria sporulate	**1**		
(ii)	(crystalline) protein	**1**		
(b) (i)	Using a plasmid (vector)	**1**		
(ii)	Absence of cell wall makes the transfer possible	**1**	'protoplast lacks cell wall'	
(iii)	Transgenic/genetically modified	**1**		
(c)	Advantage: no need to use chemicals/ inherited characteristic Disadvantage: cross-pollination/spread of resistance	**1** **1**		

Question	Acceptable Answer	Mark	Unacceptable answer	Negates
11 (a)	Microinjection or viral infection	**1**		
(b)	Surrogate (mother)	**1**		
(c)	So that blood clotting factor/protein/is secreted in milk (**1**)/can be easily purified (**1**) or gene can be inherited	**1**		
(d)	Bacteria cannot carry out post-translational modifications/proteins non-functional (**1**)	**1**		
(e)	Egg bisected at two cell stage	**1**		

Section C

1 A Give an account of the identification of bacteria under the following headings:

Gram staining method

1 Differentiates Gram positive or Gram negative
2 fix bacteria (smear) to slide (or described)
3 add crystal violet and iodine
4 destain (or named) and counterstain (or named or colour described)
5 Gram positive = purple and gram negative = pink
6 Gram positive has >40% peptidoglycan (and Gram negative has less)

4 from 6

Shape and structures

7 Bacillus or rod/coccus or round/spirillum or spiral
8/9 flagellum/capsule or endospore (any 2)

2 from 3

Biochemical tests

10 growth on (diagnostic) media/agar containing starch/casein/gelatin/fat
11 indicates production of extracellular (or secreted) enzymes
12 fermentation of carbohydrate
13 production of gas/acid
14 hydrogen peroxide for catalase
15 cytochrome C for oxidase

4 from 6

10 marks

Section C

1 B Give an account of the handling of microorganisms in the laboratory under the following headings:

Purpose of risk assessment

1 to identify hazard and risk
2 (hazard:) source of risk/potential harm
3 (risk:) probability of harm being realised

2 from 3

Types of risk assessment

4 simple: (hazard familiar and) control methods well known
5 generic: uses authoritative source of advice/code of practice
6 novel: from first principles for new/unfamiliar task

Name + correct description – 2 marks

or

6a names only with no/wrong description (**1**)

or

6b 2 descriptions unnamed/wrongly named (**1**)

4 from 6

Control measures

7 choice of organism/source of organism
8 choice/selection of medium
9 growth conditions/method of culture
10 choice of handling procedure:
11 scale of operation/degree of containment
12 protective equipment/named example

4 from 6

10 marks

Section C

2 A Describe the production and purification of enzymes from batch culture.

1 Batch culture is closed system/nothing added or taken away
2 organism multiplies and changes conditions/makes conditions unfavourable
3 uses up nutrients/produces waste
4 useful for/selects for production of secondary metabolites/eg penicillin
5 and 6 **two advantages from**
short fermentation time
ease of control
allows all stages of growth
7 Downstream processing is recovery/purification/isolation of product
8 isolate cells by flocculation/centrifugation/filtration
9 intracellular enzyme – burst cells
10 protein purification by precipitation/column chromatography
11 described (size/charge/shape)
12 extracellular enzyme – purify from medium

Maximum 8 marks

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

Coherence (min 5 points to apply)
1 The writing must be under sub-headings or divided into paragraphs.
2 Related information must be grouped together eg batch culture/intracellular enzymes/extracellular enzymes.

Both must apply for the coherence mark.

Relevance (min 5 points to apply)
1 No more than two irrelevant points.

This must apply for relevance mark.

Section C

2 B Describe the detection and removal of environmental pollution using biotechnology.

1 detection (of pollution) by biosensor
2 consists of transducer
3 which contains enzyme/antibody/cell
4 that reacts with material to be detected
5 signal is electrical/dye/luminescence
6 signal picked up by detector/signal strength proportional to level of pollution
7 Removal by bioremediation
8 uses microorganisms
9 to degrade/detoxify/accumulate (pollution)
10/11 can treat contaminated soil/oil spilage/other (any 2)
12 advantage – eg treat *in situ*/natural process

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 – biosensor/bioremediation with at least **five** relevant points made.

Both of these 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]