2805/04   Microbiology and Biotechnology

June 2004

Mark Scheme

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme.
    <u>You are advised to destroy all draft versions.</u>

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. <u>No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.</u>

x	=	incorrect response (errors may also be underlined)
^	=	omission mark
bod	=	benefit of the doubt (where professional judgement has been used)
ecf	=	error carried forward (in consequential marking)
con	=	contradiction (in cases where candidates contradict themselves in the same response)
sf	=	error in the number of significant figures

4. The marks awarded for each <u>part</u> question should be indicated in the margin provided on the right hand side of the page. The mark <u>total</u> for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Examiners will be expected to use their professional judgment in marking answers that contain more than the number required. Advice about specific cases will be given at the standardisation meeting.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct <u>and</u> answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

Mark Scheme

Abbreviations, annotations and conventions used in the Mark Scheme	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	R	=	reject
	( )	=	words which are not essential to gain credit
	___	=	(underlining) key words which **must** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question	Expected Answers	Marks

1 (a) (i) axes correct way around (x time / y number - indicated by either label) ;
axes labelled time and (log of density) number of microorganisms ;
      R 'population of microorganisms' unless qualified
sigmoid curve ; *treat death phase as neutral*   **3**

(ii) *allow each phase if indicated on curve with a letter and identified correctly in (iii)*
lag phase ;
log / exponential phase ;   **R** growth phase
stationary phase ;
decline / death phase / senescence ;   **4**

(iii) cells synthesising DNA *or* protein / enzymes being made / no cell division / switching
      on genes ; **R** making organelles
(rapid) division of cells / division faster than death ;
reproduction rate = death rate / cell number or population number stable ;
      R links to growth or 'birth' rate
ref limiting factors / build up of waste / lack of nutrients / lack of space / lack of oxygen ;
death rate exceeds reproduction rate / cell number falls ;   **4**

(b) (i) *broth*
increase in numbers ;
by 10 000x ;   **R** 3x
exponentially / log growth ;   **R** 3x
sodium chloride
no increase / a decrease in numbers / remains in lag phase ;
use of figures / use two numbers e.g. 2 to 1.8 ;   **max 3**

(ii) decreases / becomes more negative ;   **1**

(iii) water moves, from high to low water potential / down water potential gradient / by
      osmosis ;   *ecf from (ii)*
water leaves the cell ;   *ecf from (ii)*
plasmolysed or flaccid cells / cells do not grow / enzymes not mobilised *or* cannot
      move / ref to physiological effect ;   **R** enzymes are denatured   **3**

[Total: 18]

Question	Expected Answers	Marks

2 (a) *look for two different reasons, ignore repetition*

turbidimetry includes, particles / dust / cell fragments / dead cells ;
haemocytometry includes dead cells ;
cannot identify bacteria / no measure of 'pathogenicity' ;   **max 2**

(b) 1 place cover slip over central section ;
2 dilute a sample ;   **A** ref to serial dilution
3 'inject' fluid / sample drawn under cover slip by capillarity ;
4 leave to settle ;
5 view the slide under microscope ;
6 select the appropriate dilution to count ;
7 (central section of) slide etched with, grid / squares ;
8 cells in a number of squares counted (min 5 if number quoted) ;
9 random selection of the squares to use ;
10 only cells overlapping top and left counted (any 2 sides) ;
11 chamber under cover slip is of known depth (0.1mm) ;
12 a set volume of liquid (0.004mm^3) is over each square ;
13 mean value calculated ;
14 multiply by dilution factor (to calculate the number in original sample) ;
15 ref Newton's rings ;   **max 6**

(c) (i) Prokaryotae / Monera / bacteria / bacillus ;
murein *or* peptidoglycan cell wall / flagella / capsule / slime layer / 70S ribosomes /
  pili / plasmid(s) / mesosome(s) / circular DNA ;   **2**

(ii) Protoctista / protozoa / protista ;
food vacuoles / contractile vacuole ;   **2**

(iii) Fungi ;   *treat yeast as neutral*
chitin cell wall ;   **2**

(iv) virus ;
nucleoid / inner core of DNA / RNA / single *or* double strand of DNA / ref CD
  receptors ;   **2**

                                                    [Total: 16]

Question			Expected Answers	Marks

3 **(a)**
1. stirrer / impeller / paddles / sparger / bubbler ;
2. ensure that microorganisms and nutrients come into contact ;
3. water jacket ;
4. <u>cool</u> contents ;
5. (named) monitors / probes ;
6. (monitor) changes of environmental conditions / named examples e.g. temperature, pH, oxygen ; **R** 'to control conditions'
7. input tube for, acid / alkali ;
8. maintain correct pH ;
9. input tube for (sterile) air ;
10. oxygen supply for <u>aerobic</u> respiration ;
11. AVP ; e.g. venting gases / smooth surface of fermenter / stainless steel
12. AVP ; further explanation **max 7**

QWC – legible text with accurate spelling, punctuation and grammar; **1**

(b) (i) penicillin is, secondary / intermediate, metabolite ;
under these conditions stationary phase is, reached faster / maintained ;
most rapid production of antibiotic ; **max 2**

(ii) *glucose*
is a carbon source ; **R** carbohydrate source
encourages growth / energy source / respiratory substrate ;

lactose
not present normally ;
enzyme to metabolise it has to be synthesised / β galactosidase not present ;
competition / 'stress' induced ;
lactose encourages more penicillin production ;
yeast extract
is a nitrogen source ;
for amino acid / protein synthesis / enzymes / DNA / RNA ; **max 4**

(iii) monitor pH using a probe / AW ;
add buffer ;
which adds or removes H^+ ;
R add acid / alkali **max 2**

[Total: 16]

Mark Scheme

Question	Expected Answers	Marks

4 **(a)** **(i)** only allows urea to pass to the recognition layer / other <u>solutes</u> do not pass ;
        R only allows urea to combine with recognition layer   **1**

      (ii) collagen matrix / gel entrapment / (polymer) microspheres / cellulose fibres / alginate
          (beads) / agarose / sepharose ;   **1**

    (iii) converts, ammonium ion / chemical energy ;
into, an electrical signal / a current / electrical energy ;

award max one for
converts one form of energy into another ;   **2**

  (b) *accept ora in this question*

enzyme-controlled reaction ;
at a higher temperature there would be a faster rate / ref Q_{10} ;
higher kinetic energy / molecules moving more ;
more collisions between enzyme and substrate / more enzyme-substrate complexes
       formed ;
more, product / ammonium ions ;
higher electrical signal ;
greater reading / higher urea value recorded ;   **max 5**

  (c) **1** specificity of biosensor / only glucose measured ;
     2 only glucose reacts with enzyme / no other reducing sugar will react ;
     3 enzyme is glucose oxidase ;
     4 quantitative value obtained ; **A** 'level of glucose'
     5 important to calculate the insulin dose ;
     6 can be linked to pump for insulin injection ;
     7 blood colour not a problem ;
     8 only a small sample (of blood) needed ;
     9 portable / simple / easy to <u>use</u> (at home) / do not need to visit hospital ;
   10 reusable ;
   11 rapid result ; **A** immediate if qualified, **R** 'instant'
   12 AVP ; e.g. sensitivity / cost effective / cheaper   **max 8**

QWC – clear, well organised using specialist terms;   **1**

                                                [Total: 18]

Question	Expected Answers	Marks

5 **(a)** **(i)** antibiotic used to treat cattle ;
gets from blood into milk ;
inhibits the growth of bacteria / kills bacteria ;
  treat as neutral any ref to effect on starter culture
(so stops growth of bacteria) used to make yoghurt ;
ref to development of antibiotic resistance ; **max 2**

(ii) competition with, starter culture / yoghurt-making bacteria / named bacteria ;
cause disease ; **R** vague refs to illness
AVP ; e.g. detail of disease / TB
  contaminate milk factory
  contaminate production line **max 2**

(b) **(i)** *labelled on Fig. 5.1*

Lactobacillus (bulgaricus) is rod shape ;
Streptococcus (thermophilus) is spherical shape ; **2**

(ii) acetaldehyde / ethanal **and** lactic acid / lactate **or** formic acid / methanoic acid ; **1**

(iii) they are <u>symbiotic</u> / <u>mutualistic</u> ;
Lactobacillus breaks down protein into peptides ;
Streptococcus produces, methanoic acid / formic acid ;
produce conditions which encourages the <u>growth</u> of the other ; **max 3**

(iv) *treat as neutral refs to [H$^+$] / acidity changing*

(Streptococcus produces) methanoic acid ;
(Lactobacillus produces) lactic acid ;
(more acid therefore) pH falls ;
to pH 4.4 ; **max 3**

[Total: 13]

Question	Expected Answers	Marks

6 **(a)** *treat refs to pollution / contamination as neutral*

remove, pathogens / harmful organisms ;
removes, specific component e.g. organic matter / solids / smells ;
    A prevents eutrophication / fall in oxygen levels / rise in BOD in river   **2**

(b) bubble air through the tank ;
aerobic condition / high oxygen levels ;
increase population of, microorganisms / bacteria / fungi / protozoans / nematodes ;
(which digest the organic material) produce, inorganic compounds / ions / named
    ions ;
making them available for recycling ;
floc formation ;   **max 4**

(c) **(i)** anaerobic ;
temperature above 15 ^{o}C ;   **A** up to 30 ^{o}C
pH between 6 – 8 ;   **max 2**

    (ii) *treat as neutral - energy source / gasohol / produce energy / biogas*

fuel source / powers sewage works / heats digester *or* community *or* buildings *or*
    swimming pool ;
    R fuel for cars / power for power stations   **1**

           [Total: 9]