RECOGNISING ACHIEVEMENT

JUNE 2002

ADVANCED GCE UNIT

MARKING SCHEME

MAXIMUM MARK: 90

Syllabus / Component: 2805/04

Options in Biology: Microbiology and Biotechnology

Paper Set Date: 20/06/02

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

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

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. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   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 part question should be indicated in the margin provided on the right hand side of the page. The mark total 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. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

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 and 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.

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 A = accept AW = alternative wording ora = or reverse argument

Question **Expected Answers** **Marks**

1 (a)

	Salmonella tetani (Gram +ve)	*Escherichia coli* (Gram –ve)
Add crystal violet, wash with Gram's iodine, then wash with alcohol	Purple / violet / lilac NOT blue	Remains colourless / violet washed out R normal colour
Add safranin	(Remains) purple / violet / lilac Must be same colour	red

award one mark for each column **2**

(b) **A** – murein / peptidoglycan / mucopeptide, (wall); **R** cell wall support/correct reference to osmotic potential; **R** protection
B – plasma / cell surface / cell / phospholipid membrane/plasmalemma / phospholipid bilayer; **R** phospholipid unqualified
selective /partial / semi permeable; **R** allow materials in and out / controls diffusion **4**

(c) capsule / mucus layer;
murein wall / peptidoglycan / mucopeptide, (wall);
plasma membrane / cell surface / cell / phospholipid membrane / plasmalemma / phospholipid bilayer;
wall bigger than shown in figure 1.1; **4**

(d) outer membrane present in gram-negative, (but not gram-positive bacteria) / lipopolysaccharide present;
extra physical barrier;
alternative suggestion appropriate to context; e.g. does not reach wall
description of effect on wall synthesis;
R not as many layers **max 2**

[Total: 12]

Question	Expected Answers	Marks
2 (a)	<u>disease</u> causing; **R** harmful	1
(b)	1. use sterilised petri dish; 2. flame mouth of molten agar flask; 3. to destroy microbes (allow ref once); 4. only lift lid slightly / use lid as umbrella; 5. to avoid <u>air</u> contamination; (related to '4' or '6') 6. use transfer chamber / near a Bunsen burner / UV light; 7. use of disinfectant to wash hands / bench / discarded glass ware; **R** antiseptic 8. heat loop/sterilise syringe / sterilise pipette; 9. dip loop into sample/description of collecting sample; 10. raise lid off petri dish <u>a little</u> to allow loop inside; 11. streak surface of agar / description; 12. tape across dish to avoid escape; 13. incubate upside down;	max 7
	QWC – clear, well organised, using specialist terms;	1
		max 8
(c)	*amino acids* – protein / polypeptide / peptide / enzyme synthesis; **R** for growth / repair *vitamins* – components of enzyme / cofactor / coenzymes / required for specific pathways / name vitamin function / prosthetic group; **(I)** micronutrients *purines and pyrimidines* – nucleic acid synthesis / components of DNA or RNA ;	3
(d)	only (reproduce) inside (living) cells; **R** survive or live inside cells	1
(e)	<u>serial dilution</u>; detail of how to do so; detail of high each plated; e.g. mix known volume with agar incubate; count colonies; use plate with sensible numbers (30-300); each colony represents one microorganism; calculate number in original sample; replicates;	max 4
		[Total: 17]

Question	Expected Answers	Marks
3 (a) (i)	cooling jacket needed / no need for heater; mixer or respiration of microorganism produces heat / surface area less so less heat lost; air added must be sterile / fermenter must be sealed / air lock needed; avoids contamination by other microorganisms / contamination costly; immobilise microorganisms; to reduce contamination of product / reduce loss of microorganism; fermenter made of stainless steel; easier to clean; electric mixer associated with excess, electricity/heat/energy use; increased aeration to mix;	4
(ii)	pH; temperature; oxygen concentration; nutrient / substrate concentration; end product concentration / carbon dioxide concentration;	max 2
(b)	**A** – (lag phase) synthesis of enzymes; little (cell) division / (cells) grow / increase in size/mitosis; germination of spores; **R** adjusting to the environment **B** – (log / exponential phase) exponential division of cells / log or exponential growth; more division than death; mitosis / binary fission; no limiting factors; **R** ref to more birth than death/rapid division of cells **C** – (stationary phase) number of cells produced equal numbers of cells dying; cells not dividing as rapidly; correct named limiting factors / toxic waste build up / lack of nutrients; **D** – (decline / death phase) more cells dying than are being produced; (comparative) correct named limiting factors; (if not mentioned before)	max 8
(c) (i)	add materials 'continuously'; balance product removal; remove toxins/metabolites regularly;	max 2

(ii) *advantages*

smaller vessel;
greater productivity / exponential growth maintained;
no need to clean out fermenter;
recycle low yield;
no build up of waste;
R no need to shut down / save time

disadvantages

difficult to monitor;
difficult to control conditions;
tubes get blocked;
will not produce secondary metabolites;
foaming / clumping;
costly if breaks down; **max 4**

[Total: 20]

Question	Expected Answers	Marks
4 (a)	*accept each point for Benedict's or the biosensor, but not for both*	

Benedict's	*Biosensor*
colour change not easy to distinguish/	no problem with colour confusion;
qualitative / semi-quantitative / not easy to make quantitative /	quantitative;
inaccurate / reacts to all reducing sugars /	accurate / specific to glucose;
not reusable /	reusable;
larger sample needed /	smaller sample needed;
not easily portable /	portable; **R** quicker / reliable / no heat necessary

max 4

(b)
1. selectively permeable membrane;
2. immobilised enzyme;
3. glucose oxidase;
4. specific to, substrate / glucose;
5. enzyme substrate complex formed/binds with enzymes;
6. one product is hydrogen peroxide;
7. reaction reduces oxygen concentration;
8. (platinum oxygen) electrode;
9. transducer;
10. produces an electric current/converts chemical to electrical;
11. amplified;
12. scale of current, is graduated / calibrated;
13. related to concentration of glucose;

Alternative if candidate uses microchip:

1. microchip contains;
2. immobilised enzyme;
3. glucose oxidase;
4. positive charge on chip surface produced;
5. due to gluconic acid production;
6. energy flow / potential difference;
7. generates electric current in chip;

Note: do not mix and match both alternatives **max 7**

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

max 8

[Total: 12]

Question	Expected Answers	Marks
5 (a)	yeast / *Saccharomyces*; starter culture; AW anaerobic (respiration) / fermentation; up to max. two substrates;; e.g. sucrose, fructose, maltose, maltotriose **R** sugar producing, ethanol / ethyl alcohol / correct formula; carbon dioxide;	**max 4**
(b)	more than one enzyme required; multistep reaction / ref to named stages; self replicating / microorganisms make more enzymes; adds flavour / taste / vitamins;	**max 2**
(c)	pH less than 7 / acidic; increased pH allows faster fermentation; but produces unwanted, by-products / off flavours; temperature related to type of yeast; sensible suggestion of temperature / allow ref up to 25 ^{o}C oxygen needed so yeast can replicate; and synthesise fatty acids / sterols; no oxygen needed if provided with, oleic / olenoic acid; **R** anaerobic unqualified	**max 4**
(d) (i)	select / isolate gene; AW (remove) using restriction enzyme; add to vector; using ligase; insert into, yeast cell / bacterium; clone;	**max 4**
(ii)	ferments at lower temperature; **R** temperature tolerant/ferments at higher temperatures tolerant to higher alcohol concentration/higher yield/more product; alternative suggestions appropriate to context;; e.g. use different substrates shorter generation time;	**max 2**
(e)	genetically engineered, bacteria / microorganisms / plants, escape; cross-pollination / horizontal transfer (of gene) to other species; specific example; (e.g. pathogenic bacteria become antibiotic resistant / herbicide resistant weeds) specific unintended effect; (e.g. toxicity of product / allergic reactions / killing useful insects / activate existing gene) accept other appropriate answers e.g. competition between gm plants and existing species **R** passing to humans / passing down food chains / causing mutations	**max 2**
		[Total: 18]

Question	Expected Answers	Marks
6 (a)	*any two of the following for one mark* bacillus or bacteria *Nitrosomonas* *Nitrobacter* *Pseudomonas* protozoan or ciliate or *Vorticella* fungi; **R** aerobes	**1**
(b)	oxygen; carbon dioxide; respiration; **R** anaerobic respiration	**3**
(c)	stir / agitate;	**1**
(d)	low level of organic pollution in liquid; no pathogens in liquid; dilution effect; microorganisms in river or sea; complete breakdown of effluent;	**max 2**
(e)	anaerobic; *Methanobacterium* / bacterium; breaks down / metabolises, organic matter; produces methane; used to heat digester / produce electricity / biogas;	**max 4**
		[Total: 11]