

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

BIOLOGY

2805/04

Microbiology and Biotechnology

Tuesday **31 JANUARY 2006** Afternoon 1 hour 30 minutes

Candidates answer on the question paper.

Additional materials:

Electronic calculator

Ruler (cm/mm)

Candidate Name	Centre Number	Candidate Number												
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TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Read each question carefully before starting your answer.

INFORMATION FOR CANDIDATES

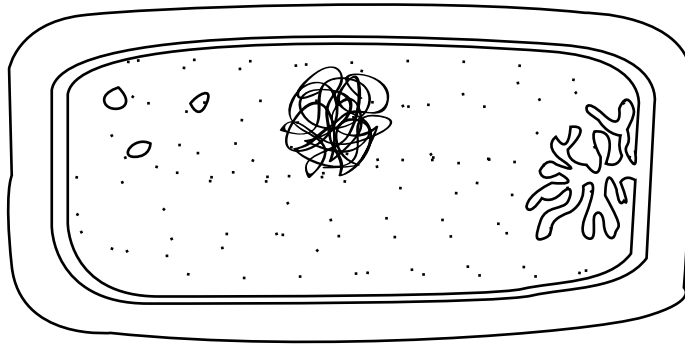
- The number of marks is given in brackets [] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	14	
2	20	
3	14	
4	6	
5	20	
6	16	
TOTAL	90	

This question paper consists of 16 printed pages.

Answer all the questions.

- 1 (a) Fig. 1.1 is a diagram taken from an electron micrograph of the bacterium *Escherichia coli*.



1 μm

Fig. 1.1

- (i) Calculate the magnification of the diagram.

Magnification = \times [1]

- (ii) On Fig. 1.1, add label lines and label each with the letter A, B or C to show:
- a site of polypeptide synthesis – label A
 - a structure that prevents cell lysis – label B
 - a structure that may carry advantageous genes – label C. [3]
- (iii) On Fig. 1.1, draw in and label a structure that would enable *E. coli* to move. [2]

(b) Gram staining can distinguish between Gram-positive and Gram-negative bacteria. Four stages in the Gram staining procedure are listed below. Give **one** reason for including each stage in the procedure:

(i) preparing a heat-fixed smear;

.....
.....[1]

(ii) flooding with crystal violet;

.....
.....[1]

(iii) adding alcohol (ethanol);

.....
.....[1]

(iv) adding safranin or carbol fuschin.

.....
.....[1]

(c) Penicillin is an antibiotic that is used to treat bacterial diseases caused by Gram-positive bacteria. It can be produced commercially in large fermenters by a fed-batch culture method.

(i) Explain why a continuous culture method would **not** be suitable for the manufacture of penicillin.

.....
.....
.....
.....[2]

(ii) Suggest why limited amounts of glucose are added at regular intervals to the culture medium during the fed-batch process.

.....
.....
.....
.....[2]

[Total: 14]

2 In an investigation into oxygen requirements for growth, a student obtained three different species of microorganism, **D**, **E** and **F**, each isolated from a different location.

The student prepared three sterile tubes half-filled with sterile nutrient broth. To each tube of broth, the student added small, equal amounts of:

- sterile agar
- thioglycolate
- resazurin.

Thioglycolate reduces the oxygen dissolved in the broth to water.

Resazurin is a dye that changes from colourless to pink in the presence of oxygen.

An equal volume of microorganism **D**, **E** and **F** was added, one to each tube, and incubated separately under the same controlled conditions. The results of the investigation are shown in Fig. 2.1.

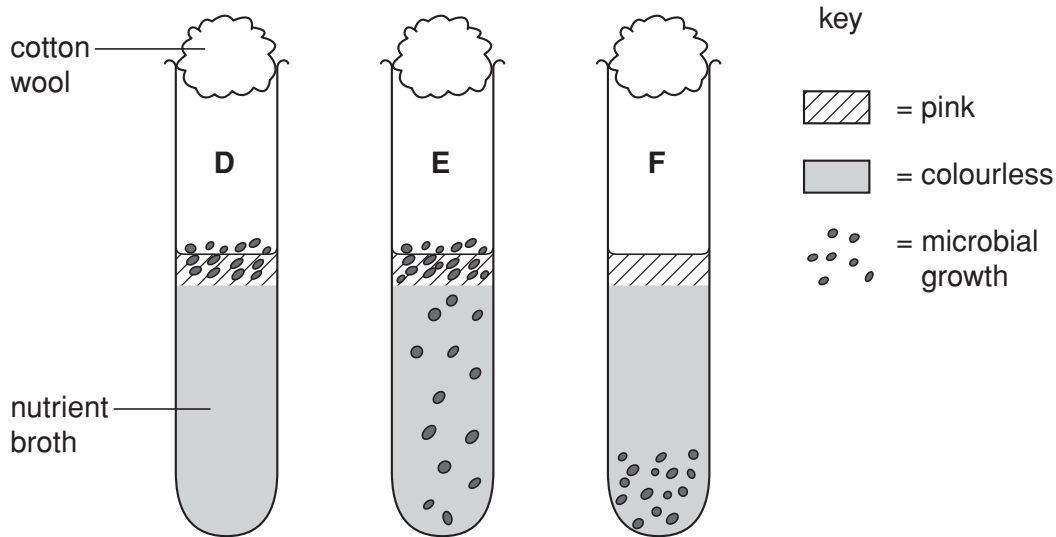


Fig. 2.1

(a) Explain why the student decided to add each of the substances, agar, thioglycolate and resazurin, to the tubes of broth.

agar

.....

thioglycolate.....

.....

resazurin.....

..... [3]

- 3 There has been considerable interest in recent years in the genetic manipulation of brewing yeasts.

In the fermenter, *Saccharomyces cerevisiae* uses various carbohydrates as energy sources. However, the yeast is unable to make use of starch that is still present as a result of its incomplete breakdown during the malting process. Brewers can add enzymes during the brewing process that will result in a higher alcohol yield, but this involves extra cost.

Saccharomyces diastaticus is a closely-related yeast species that possesses a gene coding for the extracellular digestive enzyme known as glucoamylase. This enzyme catalyses the breakdown of starch to reducing sugars. Unfortunately, *S. diastaticus* cannot be used as a brewing yeast because the beer that is manufactured has an unpleasant taste.

Researchers have been successful in producing a recombinant strain of *S. cerevisiae* that exhibits glucoamylase activity. The level of activity, as measured by the amount of starch that is converted to sugars, is considerably lower in the genetically modified *S. cerevisiae* than in the donor *S. diastaticus*.

- (a) Outline **two** potential benefits and **two** potential hazards of using genetically modified yeasts to brew beer.

benefits

1.....

.....

2.....

.....

hazards

1.....

.....

2.....

.....[4]

- (b) Suggest reasons for the observation that genetically modified *S. cerevisiae* exhibits lower levels of glucoamylase activity than *S. diastaticus*.

.....

.....

.....

.....[2]

- (c) Name a reducing sugar produced as a result of the digestion of starch by glucoamylase.

.....[1]

- (d) Yeast cells can be entrapped in alginate beads using the same methods as used for immobilising enzymes. A student performed an investigation to compare the glucoamylase activity of *S. diastaticus* with that of the genetically modified *S. cerevisiae*.

Fig. 3.1 is a diagram of the experiment.

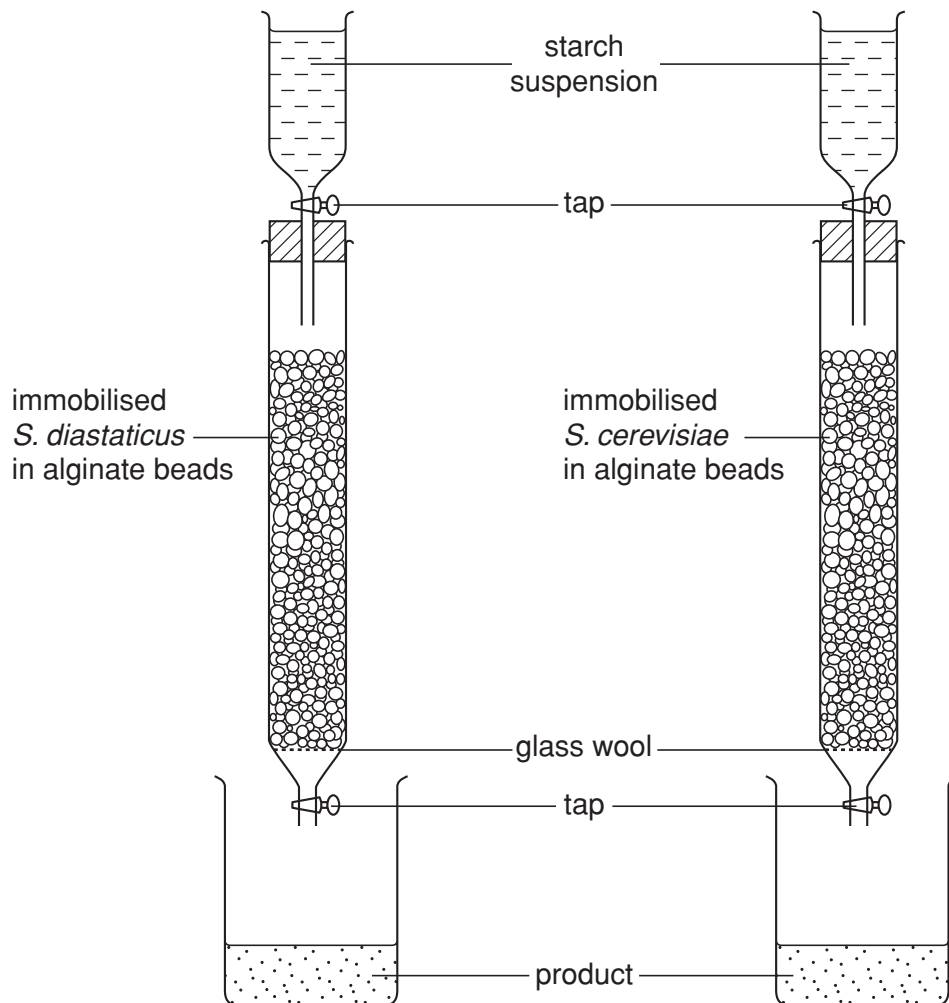


Fig. 3.1

(i) List **three** factors that would need to be controlled in this experiment in order to make valid comparisons.

1

2

3 [3]

(ii) Describe **one** method of measuring the concentration of reducing sugars in the products.

.....

.....

.....

..... [2]

(iii) The student expressed concerns that live yeast cells may be present in the product and that these cells would affect the results of the experiment.

Explain whether or not you agree with these concerns.

.....

.....

.....

..... [2]

[Total: 14]

- 4 Use the features stated in Table 4.1 to identify the group to which microorganisms **G** to **L** belong. Choose from the list below to complete the table.

viruses fungi protocista bacteria

Table 4.1

microorganism	features	group
G	cell wall, eukaryotic, photosynthetic	
H	unicellular, contractile vacuole, cilia	
I	enveloped, RNA as genetic material, capsid	
J	saprotrophic, filamentous, cell wall of chitin	
K	nitrogen-fixing, chemosynthetic, cell wall	
L	akaryotic, contractile sheath, no cell wall	

[6]

[Total: 6]

- 5 Somatic cell hybridisation involves the fusion of two cells to produce a single hybrid cell that contains the genetic information of both cells. In 1975, Köhler and Milstein, using this technique, successfully produced monoclonal antibodies from mouse cells.

(a) Explain the meaning of the term *monoclonal antibody*.

.....

.....

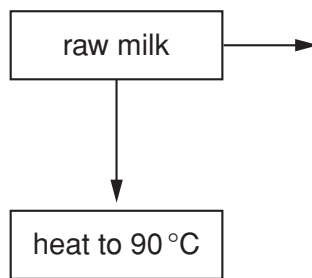
.....

..... [2]

- 6 This question is about the production of fruit yoghurt by a commercial producer in the UK.

The raw milk is tested to ensure that it is safe to use and is then heated to 90 °C and cooled to 45 °C. The starter culture of two different species of microorganism is added and the milk is then incubated at 32 °C for 12 hours. Fruit is sterilised and is then added to the yoghurt at the end of the incubation period. The final product is cooled to 4.5 °C, packed into yoghurt pots and stored at 2 °C awaiting delivery to the customers.

- (a) (i) In the space below, complete the flow chart to show the stages in the production of yoghurt. Use the information given above.



[5]

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