

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS****Advanced GCE****BIOLOGY****2805/04**

Microbiology and Biotechnology

Friday

**25 JUNE 2004**

Afternoon

1 hour 30 minutes

Candidates answer on the question paper.

Additional materials:

Electronic calculator

Ruler (cm/mm)

Candidate Name

Centre Number

Candidate  
Number

|  |   |  |  |  |  |  |   |  |  |  |  |  |
|--|---|--|--|--|--|--|---|--|--|--|--|--|
|  | <table border="1"> <tr> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> </tr> </table> |  |  |  |  |  | <table border="1"> <tr> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> </tr> </table> |  |  |  |  |  |
|  |   |  |  |  |  |  |   |  |  |  |  |  |
|  |   |  |  |  |  |  |   |  |  |  |  |  |

**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                  | 18        |      |
| 2                  | 16        |      |
| 3                  | 16        |      |
| 4                  | 18        |      |
| 5                  | 13        |      |
| 6                  | 9         |      |
| <b>TOTAL</b>       | <b>90</b> |      |

---

**This question paper consists of 15 printed pages and 1 blank page.**



- (b) Salt, sugar, alcohol and vinegar are used to preserve food. These substances create conditions that limit the growth of bacteria in food.

Table 1.1 shows the change in numbers of *Escherichia coli* over a 24-hour period in:

- a nutrient broth
- a nutrient broth containing 10% sodium chloride (salt) solution.

**Table 1.1**

| time / hours | <i>E. coli</i> / log of numbers per cm <sup>3</sup> |                                      |
|--------------|---|--------------------------------------|
|              | nutrient broth                                      | nutrient broth + 10% sodium chloride |
| 0            | 2.0   | 2.0                                  |
| 4            | 2.0   | 2.0                                  |
| 8            | 3.0   | 2.0                                  |
| 12           | 4.0   | 1.9                                  |
| 16           | 5.0   | 2.0                                  |
| 20           | 5.5   | 1.8                                  |
| 24           | 6.0   | 1.8                                  |

- (i) Use the data in Table 1.1 to compare the growth of *E. coli* in the two broths.

.....

.....

.....

.....

..... [3]

- (ii) State what happens to the water potential of a solution if the concentration of sodium chloride (salt) is increased.

..... [1]

- (iii) Explain, in terms of water potential, the effect of the 10% sodium chloride solution on the growth of *E. coli*.

.....

.....

.....

..... [3]

[Total: 18]

2 A family who lived on a farm and obtained their drinking water from a well, began to suffer from minor stomach upsets. The family were convinced that whilst ploughing a field, a sewage pipe had cracked and their water had become contaminated by bacteria.

A sample of water was taken from the well and sent for analysis.

A number of tests were carried out on the water, including:

- turbidimetry, which measures the cloudiness of a sample
- haemocytometry, which estimates the total number of cells in a sample.

(a) Explain why each of these methods would **not** give a clear idea of the danger of drinking this water.

turbidimetry .....

.....

.....

haemocytometry .....

.....

..... [2]

(b) Fig. 2.1 shows a haemocytometer slide.

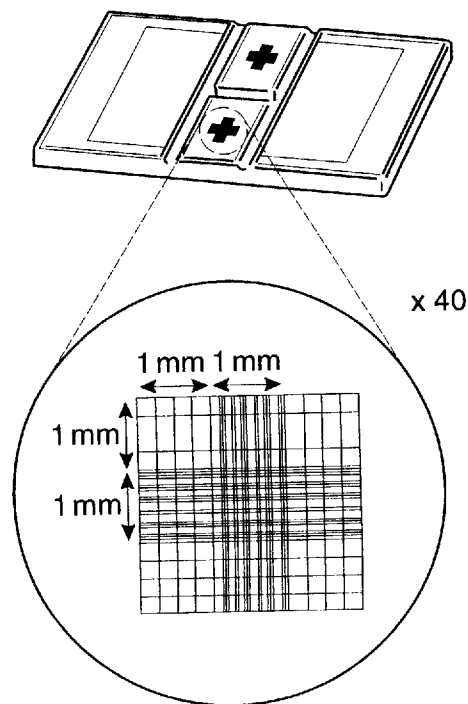


Fig. 2.1



- (c) After careful observations of the water from the well, the microorganisms found were described.

In each case, identify the group to which each microorganism belongs and give **one other** feature that would confirm your identification.

- (i) A single rod-shaped cell that is 2  $\mu\text{m}$  in length. A membrane encloses the cytoplasm but inside there is no evidence of a nucleus or any other organelle.

group .....

feature .....

..... [2]

- (ii) A single cell with a varying shape, often up to 0.2 mm long. Projections develop and the cytoplasm appears to flow into them.

group .....

feature .....

..... [2]

- (iii) An oval-shaped single cell, 6  $\mu\text{m}$  long, with a distinct wall. Most appear to be reproducing by forming buds.

group .....

feature .....

..... [2]

- (iv) A tiny structure, 250 nm long, only visible using an electron microscope. An outer coat is present made up of subunits.

group .....

feature .....

..... [2]

[Total: 16]



(b) A process called **cyclic fed-batch culture** has been developed to manufacture penicillin. Fresh nutrients are added slowly and some of the culture is removed during the process.

(i) Explain why it is necessary to continually limit the supply of nutrients to the fungus that produces penicillin.

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

(ii) In penicillin production, nutrients including **glucose**, **lactose** and a **yeast extract** are added to the fermenter.

Explain why each of these nutrients is needed.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [4]

(iii) The ideal pH for this process is 6.5. Describe how this pH is maintained.

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

[Total: 16]



- 4 (a) Fig. 4.1 shows a biosensor that can be used to measure the concentration of urea in blood or urine. The immobilised enzyme, urease, speeds up the reaction between urea and water to produce carbon dioxide and ammonium ions.

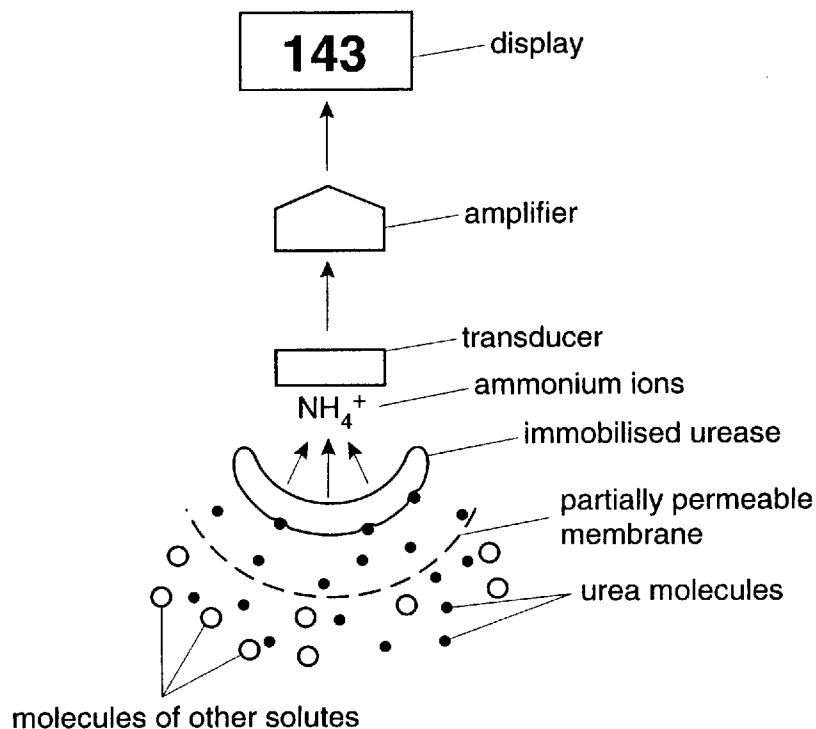


Fig. 4.1

- (i) State the function of the partially permeable membrane.

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

- (ii) Suggest a method that could be used to immobilise the enzyme.

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

- (iii) Describe the function of the transducer.

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

- (b) The biosensor was used to test two samples of urine. One was fresh from the body, the other had been stored in a refrigerator overnight at 4 °C.

Explain why it is important to ensure that the temperature of the solutions being tested is the same.

.....

.....

.....

.....

.....

.....

.....

..... [5]

- (c) In this question, one mark is available for the quality of written communication.

People with diabetes are encouraged to manage their condition. This requires them to test their blood regularly. They are able to do this using biosensors that are now readily available.

Discuss the advantages of using a biosensor to monitor blood glucose concentration for people with diabetes.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [8]

Quality of Written Communication [1]

[Total: 18]

5 (a) Yoghurt is produced by the action of microorganisms on milk. The milk is first tested to ensure that it does not contain any antibiotics or pathogenic bacteria.

(i) Suggest how milk may become contaminated with antibiotics **and** explain why it is important that such contaminated milk is not used to make yoghurt.

.....  
.....  
.....  
.....  
..... [3]

(ii) Explain why it would be a problem if the milk contained pathogenic bacteria.

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

- (b) When making yoghurt, milk is heated to 95 °C to kill any bacteria present. The milk is then cooled, a starter culture is added and the milk is incubated. Fig. 5.1 is an electron micrograph showing the two types of bacteria found in the starter culture.

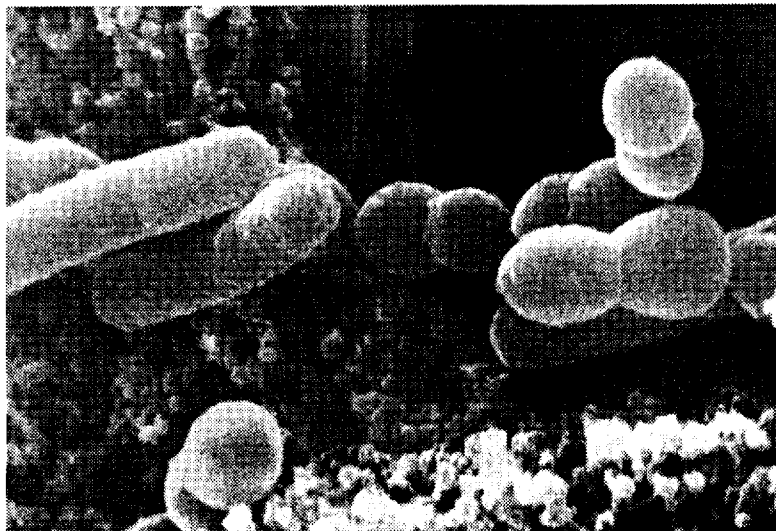


Fig. 5.1

- (i) Label Fig. 5.1 to identify and name the two types of bacteria. [2]
- (ii) Name **two** chemicals produced by these bacteria that give yoghurt its characteristic flavour. [1]
- .....
- ..... [1]
- (iii) Explain why the starter culture contains two different types of bacteria. [3]
- .....
- .....
- .....
- .....
- ..... [3]
- (iv) The pH of the milk changes during the incubation process. Explain why. [2]
- .....
- .....
- ..... [2]

[Total: 13]

- 6 (a) Sewage contains both human and industrial waste.

State **two** reasons for treating sewage rather than allowing it to pass directly into waterways.

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

- (b) Organic material in rivers provides nutrients for microorganisms. As the numbers of microorganisms increase, they use up much of the available oxygen in the river, which affects the other living things found there.

Explain how a modern sewage works reduces the amount of organic material in sewage by using the **activated sludge** process.

.....  
.....  
.....  
.....  
.....  
..... [4]

- (c) Sludge is the heavy material that falls to the bottom when sewage is allowed to rest in large tanks. The sludge may be passed into a digester, which contains bacteria. These bacteria produce methane if conditions are correct.

(i) Describe the conditions necessary for methane to be produced.

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

(ii) Suggest **one** use for the methane produced.

..... [1]

[Total: 9]

---

*Copyright Acknowledgements:*

Q.4                      Diagram of biosensor from *Microorganisms in Action*, by Freeland, published by Hodder & Stoughton Education.  
Q.5 Fig. 5.1            © Science Photo Library.

OCR has made every effort to trace the copyright holder of items used in this Question paper, but if we have inadvertently overlooked any, we apologise.