OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

BIOLOGY 2805/04

Microbiology and Biotechnology

Thursday **29 JANUARY 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

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	11	
2	16	
3	13	
4	16	
5	15	
6	19	
TOTAL	90	

This question paper consists of 19 printed pages and 1 blank page.

[Turn over

Answer **all** the questions.

1 In the early 1980s, it was noted that there was a decreased bacterial count in lakes and ponds where the water lily, *Nymphaea odorata*, grew. To find out whether the water lily was inhibiting the growth of bacteria, the following experiment was attempted.

A sample of water from a pond was made into a dilution series. One 0.5 cm^3 sample of each dilution was incubated on an agar plate with a 1 cm^3 sample of distilled water.

The number of bacteria present in the original sample of pond water can be estimated by counting the number of colonies that develop when incubated with distilled water.

Table 1.1 shows the number of colonies found in three sets of plates of different dilutions, incubated with distilled water.

Table 1.1

	dilution		
	10^{-5}	10^{-6}	10^{-7}
number of colonies	1900	98	7
	2000	94	3
	1800	99	5

(a) State **two** reasons for choosing the 10^{-6} dilution to estimate the number of bacteria in the original sample.

1 .....

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2 .....

..... [2]

For Examiner's Use

(b) The number of bacteria in the pond water was estimated as 194 000 000 per cm^3.

Explain how this number was calculated.

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(c) Another 0.5 cm^3 sample of each dilution was incubated on an agar plate with a 1 cm^3 sample of water lily extract. The extract was prepared by liquidising some leaves.

State what results you would expect when the bacteria in the pond water are incubated with an extract of water lily leaves.

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..... [1]

(d) The bacteria that were thought to be affected by the presence of *Nymphaea odorata* included *Escherichia coli*, a Gram-negative bacterium, and *Bacillus cerus*, a Gram-positive bacterium.

Complete the table below to show the differences between the cell wall structures of these two bacteria. Use the words '**present**' or '**absent**'.

	E. coli	*B. cerus*
capsule		
lipopolysaccharide outer membrane		
murein wall		
cell surface membrane		

[4]

[Total: 11]

2 Fig. 2.1 shows a diagram of a bacteriophage.

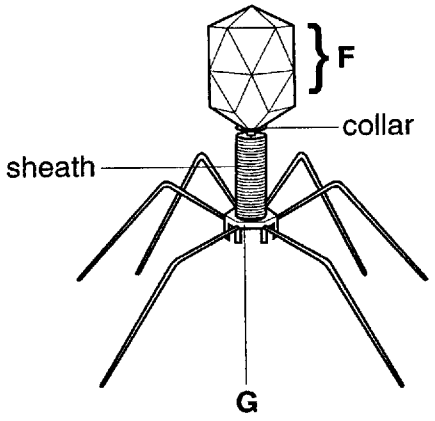

Fig. 2.1

(a) Name the group of microorganisms which include bacteriophages.

..... [1]

(b) Identify the structures labelled **F** and **G** on Fig. 2.1.

F .....

G .....

[2]

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

Fig. 2.2 shows the life cycle of a bacteriophage.

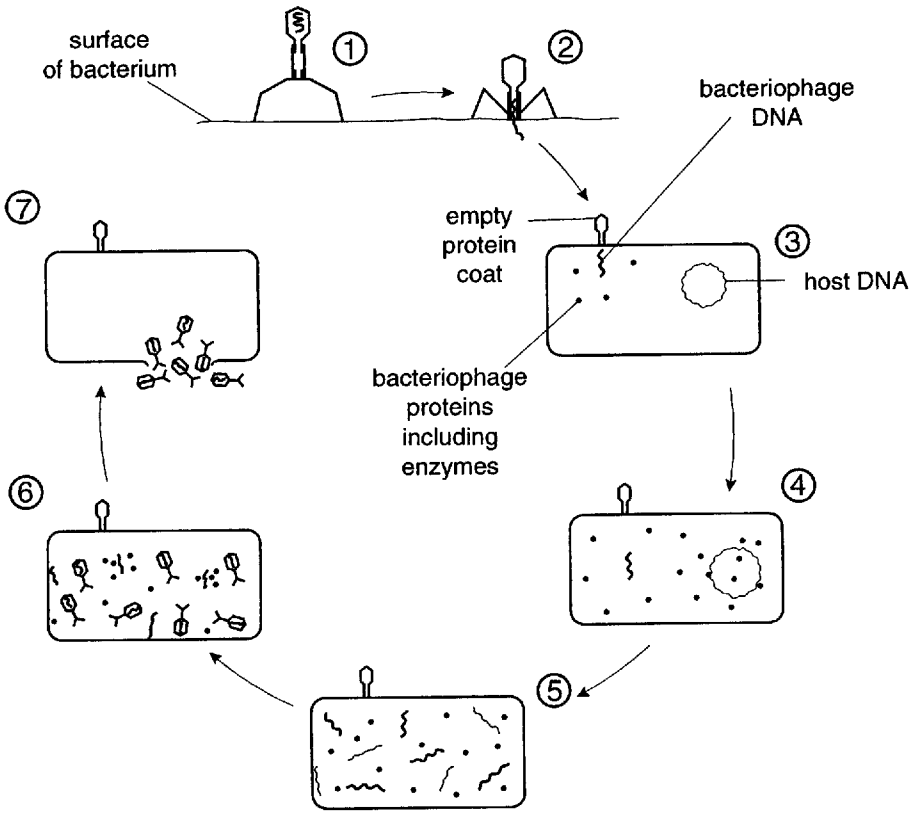

Fig. 2.2

For Examiner's Use

Describe the life cycle of the bacteriophage shown in Fig. 2.2.

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Quality of Written Communication [1]

(d) Describe

(i) **one** use of bacteriophages in industrial processes;

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(ii) **one** hazard of bacteriophages in industrial processes.

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[4]

[Total: 16]

3 Fig. 3.1 is a diagram showing a large-scale fermenter that is used in the production of mycoprotein.

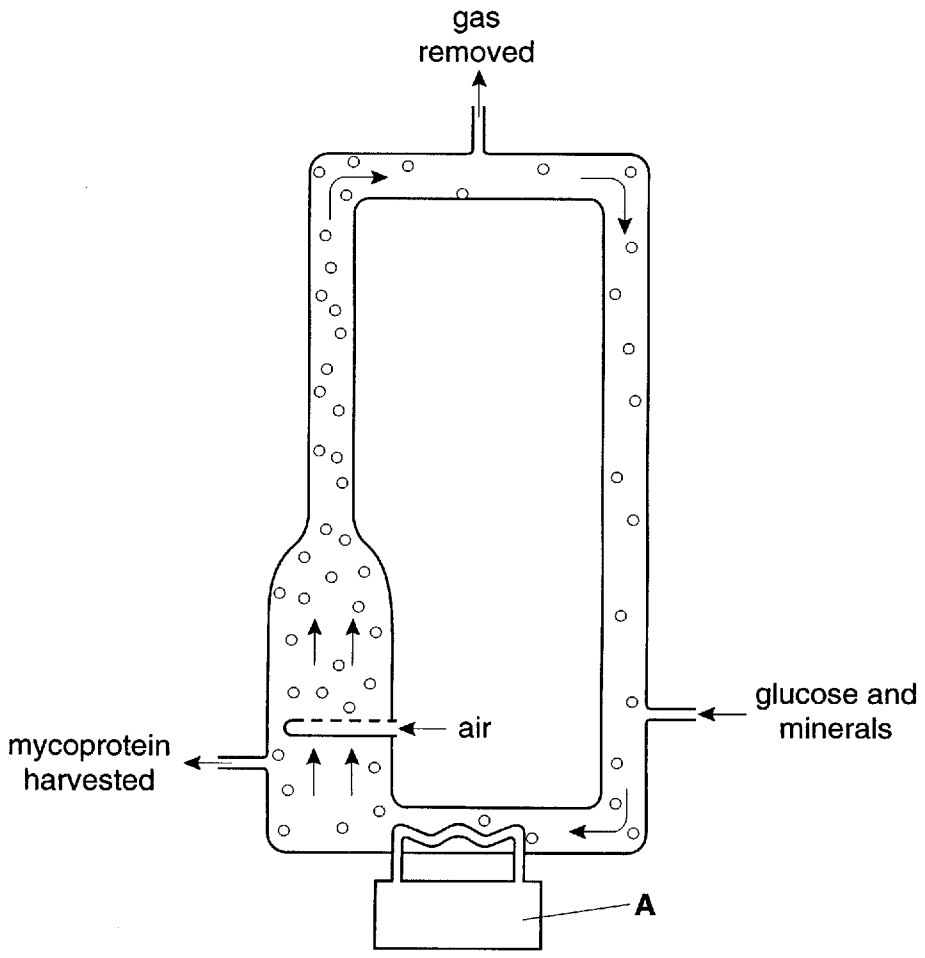

Fig. 3.1

(a) **(i)** Name the part of the fermenter labelled **A** and explain why it is necessary.

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..... [2]

(ii) One of the outlets removes a gas that is produced inside the fermenter.

Name the gas and the process that produces it.

name .....

process ..... [2]

(iii) State **one** reason why air is added to the fermenter.

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..... [1]

(b) Mycoprotein is used to make Quorn™, a substance that is used as a meat substitute in foods.

Outline the processing of the mycoprotein that takes place **after harvesting** from the fermenter to convert the mycoprotein into Quorn™.

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(c) Table 3.1 shows the nutritional contents of freshly harvested Quorn™ mycoprotein and that of beef.

Table 3.1

nutrient	mass in mycoprotein / g per 100 g	mass in beef / g per 100 g
protein	11.80	23.10
dietary fibre	4.80	0.00
fat	3.50	15.20
carbohydrate	2.00	0.00
sodium	0.24	0.32
cholesterol	0.00	0.08
water	75.00	59.10

With reference to the data in Table 3.1, explain the **advantages** of including mycoprotein in the human diet as a meat substitute.

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[Total: 13]

4 When cows are milked, lactic acid bacteria living on the skin of these animals enter the milk. These microorganisms are responsible for the natural formation of cheese. Now that we can identify specific microorganisms and understand what they do, we are better able to control the production of cheese.

Fig. 4.1 shows the major steps in the production of cheese.

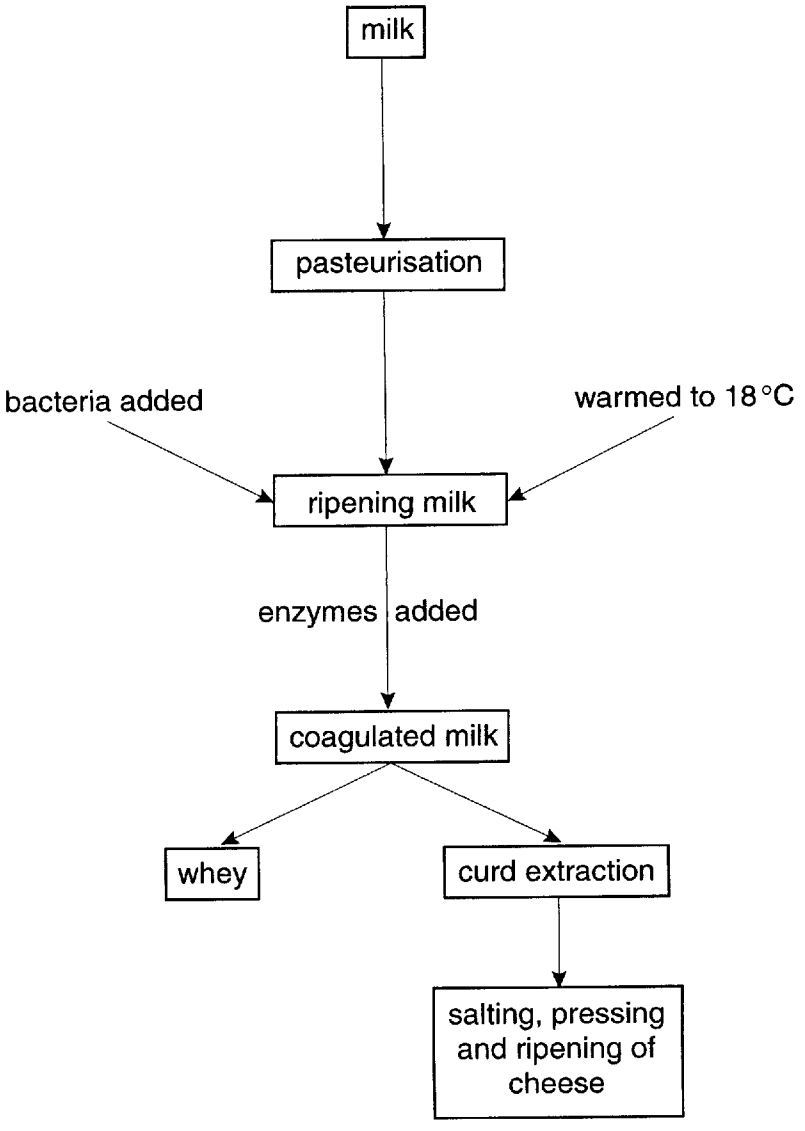

Fig. 4.1

For Examiner's Use

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

With reference to Fig. 4.1, explain the roles of microorganisms and enzymes in the production of cheese.

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Quality of Written Communication [1]

(b) The increasing worldwide demand for cheese is causing problems with the supply of some of the enzymes used in its production. In the past, one of these enzymes was obtained from the stomachs of slaughtered calves.

Recently, however, a strain of yeast, *Kluyveromyces lactis*, has been genetically modified to express the gene that codes for this enzyme.

(i) Suggest **two** advantages of using genetic engineering to produce this enzyme.

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2 .....

..... [2]

(ii) Outline how a strain of *K. lactis* may be genetically engineered to produce the required enzyme.

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..... [5]

[Total: 16]

For Examiner's Use

5 Fig. 5.1 shows an antibody molecule that consists of four polypeptide chains that fold to form a Y-shaped structure. The variable region forms the binding site that recognises a specific antigen or a specifically shaped molecule, which complements it.

Fig. 5.1

(a) Describe how the structure of protein molecules makes it possible to produce antibodies with many different binding sites.

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(b) All the molecules of one type of monoclonal antibody have the same binding sites.

Outline how monoclonal antibodies are produced.

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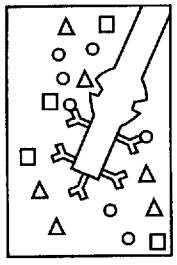
Question 5 continues on page 16

(c) Monoclonal antibodies are used in pregnancy testing kits. Some kits contain a sampler stick or 'dipstick', which uses two different monoclonal antibodies and an enzyme for the detection of pregnancy.

Fig. 5.2 summarises the steps involved in using such a kit.

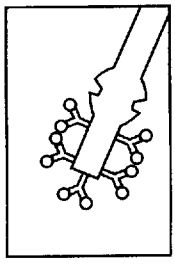
A the sampler stick with first monoclonal antibody attached is held in the urine stream



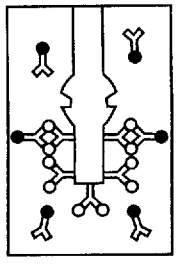
key:

- monoclonal antibody to hormone
- hormone
- other compounds in urine
- enzyme
- enzyme substrate

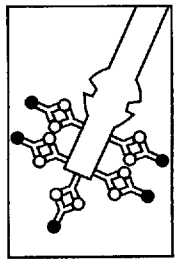
B the sampler stick is rinsed under the tap



C the sampler stick is dipped into second monoclonal antibody with enzyme attached



D the sampler stick is rinsed again in tap water



E the sampler stick is dipped into enzyme substrate

the end of the sampler stick turns blue

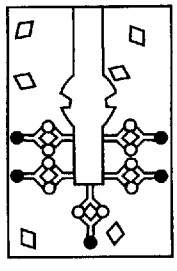


Fig. 5.2

Using the information in Fig. 5.2,

(i) explain why the test is carried out on urine;

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(ii) state the role of the first antibody;

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(iii) state the role of the second antibody;

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..... [1]

(iv) state the function of the enzyme.

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..... [1]

(d) Monoclonal antibodies can also be used to carry drugs to specific target sites in the treatment of some human diseases. However, there are very few such treatments available. Most monoclonal antibodies are produced using cells from animals, such as mice.

Suggest why the use of animals, such as mice, in the production of monoclonal antibodies limits the usefulness of these antibodies in human therapy.

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[Total: 15]

For Examiner's Use

6 **(a)** As the price of oil increases, alternative fuel products are becoming more attractive. Gasohol is used as a fuel in some countries and is produced by mixing ethanol with another flammable chemical.

(i) Name the flammable chemical that is mixed with ethanol to make gasohol.

..... [1]

(ii) Name **two** carbohydrates that are used to produce ethanol.

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..... [2]

(b) Ethanol is an organic chemical that is also used as a solvent and in alcoholic drinks. A new method of producing ethanol involves immobilising microorganisms and then pouring a substrate over them.

(i) State what is meant by *immobilisation* in this context.

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..... [1]

(ii) Describe a method of immobilising microorganisms or enzymes.

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(iii) Explain the **advantages** of using immobilised enzymes in industry.

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(iv) Explain the **advantages** of immobilising a whole microorganism rather than an enzyme.

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(c) *Zygomonas* is a fungus that is now commonly used in the production of ethanol. This has a smaller mean cell size than *Saccharomyces*, the fungus that was originally used. The fermentation rate of *Zygomonas* is faster than that of *Saccharomyces*.

(i) Suggest why the smaller mean cell size of *Zygomonas* may be responsible for its faster fermentation rate.

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..... [3]

(ii) Suggest **two** features of a microorganism, **other than a fast fermentation rate**, that would increase its productivity.

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2 .....

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[Total: 19]

END OF QUESTION PAPER