OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

BIOLOGY 2805/04

Microbiology and Biotechnology

Friday **23 JUNE 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

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 calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	10	
2	12	
3	12	
4	20	
5	20	
6	16	
TOTAL	90	

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

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 **(a)** Give the term that corresponds to the definitions in **(i)** to **(vi)** below.

(i) Large pressure cooker used to steam-sterilise equipment.

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(ii) Subunit of outer protein coat of a virus.

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(iii) Microorganism with an optimum growth temperature above 40 °C.

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(iv) Population phase in which the number of bacterial cells being produced equals the number of bacterial cells dying.

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(v) Device that uses biological products, such as enzymes or hormones, together with electronics, to provide accurate detection of substances, such as blood glucose concentration.

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(vi) Alternative energy source made from a blend of 10% ethanol and 90% petrol.

..... [6]

(b) Fig. 1.1 shows a laboratory fermenter (bioreactor) used by a student to batch culture microorganisms.

Fig. 1.1

Explain how the student could modify the fermenter for continuous fermentation .

If you wish, you may add annotations to Fig. 1.1 to help you in your answer.

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..... [4]

[Total: 10]

2 **(a)** A **mixed** culture of **two** types of lactic acid bacteria, *Lactobacillus* and *Streptococcus*, was isolated from a cheese sample. A student was asked to determine the number of **live** *Lactobacillus* and the number of **live** *Streptococcus* in the sample.

Initially, the student chose a haemocytometer to obtain separate estimates of the number of each bacterial type, but later used a dilution plating method instead.

(i) Suggest how the student could distinguish between *Lactobacillus* and *Streptococcus* using a haemocytometer.

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(ii) Explain whether you support the student's decision to change to the dilution plating method.

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..... [4]

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[Turn over

(b) In the dilution plating method, a ten-fold serial (decimal) dilution was carried out to obtain the tubes shown in Fig. 2.1.

Two 0.1 cm^3 samples from each tube were separately transferred to sterile Petri dishes containing sterile agar. Each plate contained a culture medium, specific for the growth of either Lactobacillus or Streptococcus .

The agar plates were incubated for 48 hours and then the colonies were counted. The results are shown in Fig. 2.1.

A diagram has been removed due to third party copyright

Details: A diagram showing the results when agar plates were incubated for 48 hours

Fig. 2.1

Use the information in Fig. 2.1 for the questions that follow.

(i) State **one** plate, **A** to **E**, that the student could choose to give a valid estimate of the number of *Lactobacillus* in 1 cm^3 of the **undiluted** sample.

Give reasons for this choice of plate.

plate .....

reasons .....

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..... [3]

(ii) Calculate the number of *Lactobacillus* in 1 cm^3 of the **undiluted** sample.

Show the steps in your calculation.

Answer = ... [2]

(iii) Suggest why there are such low numbers of *Streptococcus* compared to *Lactobacillus* in the cheese sample.

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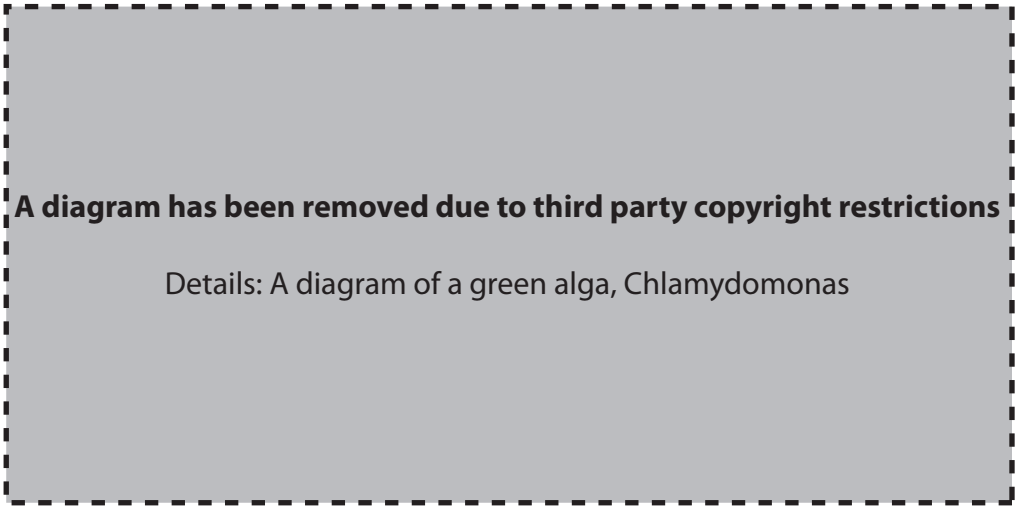
..... [3]

[Total: 12]

3 (a) In this question, one mark is available for the quality of spelling, punctuation and grammar.

Fig. 3.1 shows a green alga, Chlamydomonas , and a cyanobacterium, Microcystis .

Chlamydomona s



Microcystis

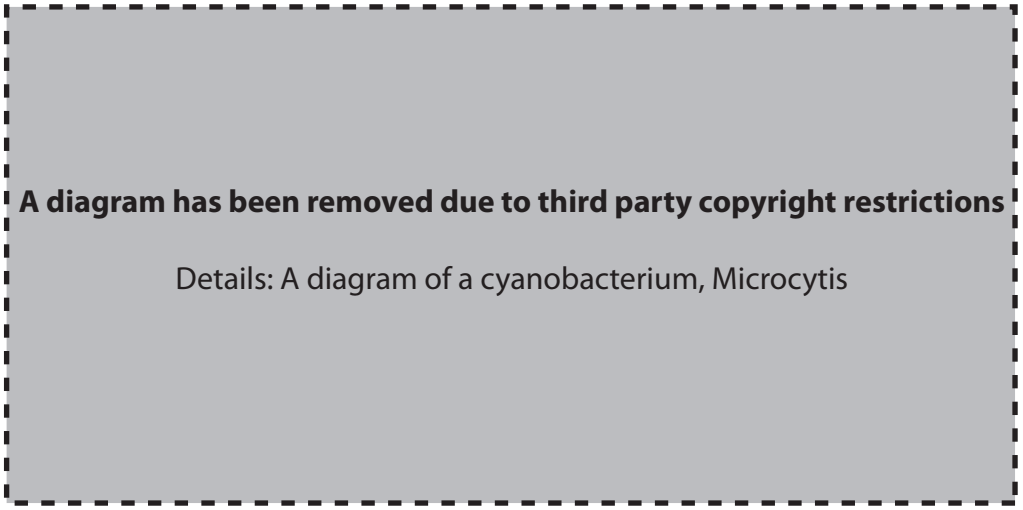


Fig. 3.1

Green algae and cyanobacteria (blue-green bacteria) were once classified in the Kingdom Plantae. As more information became available, taxonomists re-classified these organisms into separate kingdoms. The green algae are now in the Kingdom Protoctista. Although cyanobacteria and green algae share certain structural and functional features, they are placed in different kingdoms.

Suggest why the green algae and cyanobacteria were originally considered to be plants **and** explain why taxonomists decided to re-classify them into **separate** kingdoms.

Use the information given in Fig. 3.1 and the box on page 8 to help you. You may annotate Fig. 3.1 if you wish.

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Quality of Written Communication [1]

(b) For each of the following pairs of named organisms, state the major group to which the microorganisms belong and give one **structural** difference between the two.

Differences in size will **not** be credited.

(i) bacteriophage lambda (λ) and HIV.

group .....

difference .....

.....

(ii) *Saccharomyces cerevisiae* and *Penicillium notatum*.

group .....

difference .....

..... [4]

[Total: 12]

4 **(a)** Laminar air flow hoods are used in laboratories that carry out plant tissue culture techniques.

Air from the laboratory is drawn into the unit and passed through a pre-filter to the high efficiency particulate air (HEPA) filter. This has the ability to remove at least 99.997% of particles of 0.3 μm diameter or greater. The clean air then flows over the whole work surface in parallel (laminar) lines at a constant velocity and out through the open front of the unit, where the worker is positioned.

(i) Describe the advantage of using laminar air flow hoods in plant tissue culture.

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..... [2]

(ii) Suggest why purified air flowing out through the open front of the unit is of benefit to the plant tissue culture procedure.

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..... [2]

(iii) Explain why this type of laminar air flow hood would not be safe to use in laboratories where pathogens, such as *Mycobacterium tuberculosis*, are subcultured.

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(iv) Suggest why room ventilation units and vacuum cleaners containing HEPA filters are sometimes recommended for use in the homes of asthma sufferers.

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..... [2]

[Turn over

(b) State **three** advantages of plant tissue culture.

1 .....

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2 .....

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3 .....

..... [3]

(c) Human growth hormone can be produced commercially in industrial fermenters. In common with many microbiology laboratories, the areas in which the fermenters are situated are designed with safety as a top priority.

Apart from using HEPA filters, state **one** feature of the **fermenter area**, which would prevent contamination of workers and the environment. Explain the significance of this feature.

feature .....

explanation .....

..... [2]

(d) In this question, one mark is available for the quality of use and organisation of scientific terms.

Describe the sequence of steps that can be used to produce a protein of medical importance, such as human growth hormone (HGH), on a large scale.

Include in your answer details of how

- a microorganism can be genetically modified to produce such a protein
- large amounts of the protein can then be produced.

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Quality of Written Communication [1]

[Total: 20]

5 This question is about the treatment of domestic and industrial waste.

Fig. 5.1 shows the main stages in the treatment of sewage and waste water in a modern sewage treatment works that uses the activated sludge process.

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Details: A diagram showing the main stages in the treatment of sewage and waste water in a modern sewage treatment works that uses the activated sludge process

Fig. 5.1

(a) The following processes occur during the treatment of sewage, as shown in Fig. 5.1. Indicate the stage, A to F, where each of these processes occur.

(i) inoculum of Zoogloea added .....

(ii) anaerobic digestion occurring .....

(iii) removal of grit .....

(iv) chemical treatment ..... [4]

(b) Name the gas produced from the secondary treatment that is 'used for power'.

..... [1]

(c) The biochemical oxygen demand (BOD) of waste products can be measured before and after microbial action in a sewage works. The BOD represents the quantity of dissolved oxygen taken up by microorganisms as they metabolise the organic material. The British recommendation for BOD of water discharged from sewage works to rivers and lakes is less than 25 mg O_2 dm^{-3}.

Table 5.1 shows some values of BOD for wastes at different sewage works.

Table 5.1

sewage works	waste	BOD / mg O_2 dm^{-3}	
		before secondary treatment	after secondary treatment
1	domestic sewage with pig sty slurry	820	41
2	domestic sewage with brewery discharge	480	24
3	domestic sewage with cheese production outflow	2600	
4	domestic sewage from urban estate	200	

Following secondary treatment using an activated sludge process, the BOD of wastes can be reduced by 95%.

(i) Calculate the BOD of the waste products from sewage works **3** and **4** after secondary treatment. Write your answers in the last column of Table 5.1.

You may use the space below for any working.

[2]

(ii) Using the information in the completed Table 5.1, state which **two** sewage works would be advised to implement a further (tertiary) treatment process before discharge of treated water to a local river.

..... [1]

(iii) Name the waste product from cheese-making that is responsible for the high BOD value.

..... [1]

[Turn over

(d) The activated sludge ecosystem consists of a highly complex food web, where the organisms are directly affected by their treatment environment.

Use the information below to draw a food web to show the feeding relationships of the organisms found in the activated sludge ecosystem.

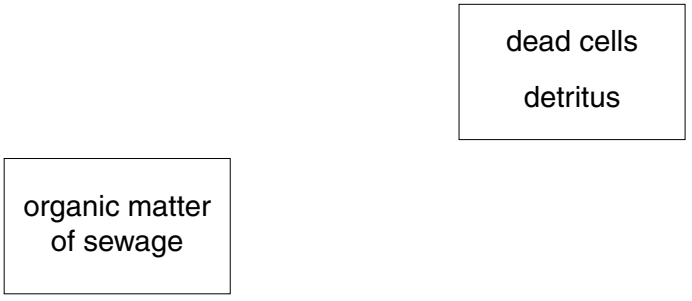
Two parts of the food web have been drawn in for you.

Bacteria, such as *Pseudomonas*, use the organic matter of sewage for their growth and reproduction and can be found forming part of the floc or existing free around the floc.

Some ciliates, such as *Vorticella*, attach to the biomass, and others, like *Paramecium*, move around. These ciliates feed on the bacteria. Ciliates are protozoa belonging to the Kingdom Protoctista.

Tubifex, or sludge worms, feed on bacteria, dead cells and detritus, while *Euchlanis*, a rotifer (microscopic animal), is an omnivore and can feed on detritus, bacteria or protozoa.

Insect larvae feed on the protozoa and rotifers.



[4]

(e) The number of species of microorganism entering the activated sludge tank is greater than the number that is present at the end of the process.

Outline the biological and physical factors that could lead to a decrease in the number of species in the activated sludge ecosystem.

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(f) In some countries, raw sewage passes directly into lakes and rivers. One of the outcomes of this is an increase in the turbidity of water caused by the suspended solids.

Suggest the likely consequences to the river ecosystem of an increase in turbidity of the water.

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[Total: 20]

Turn over for question 6

6 Beer is produced from the fermentation of a liquid extract prepared mainly from malted (germinated) barley. Fig. 6.1 represents the main stages involved in the commercial manufacture of beer.

malting

kilning

milling

mashing

boiling

cooling

fermentation

filtration

pasteurisation

packaging

A diagram has been removed due to third party copyright restrictions

Details: A diagram of the main stages involved in the commercial manufacture of beer

Fig. 6.1

(a) Name the liquid extract, **X**.

..... [1]

(b) Give **one** use for the surplus yeast, **Y**.

..... [1]

(c) State the environmental conditions necessary for the germination of the barley seeds during malting.

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..... [2]

(d) Describe the sequence of events that occurs in the germination of a barley seed during malting.

You should include in your answer reference to changes in the seed as well as to any plant growth regulators and enzymes that are involved.

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(e) Suggest why germination needs to be stopped during the kilning stage.

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..... [2]

(f) The kilning stage involves drying followed by heating. Although most enzymes are denatured during this process, some are 'inactivated'. During mashing, these malt enzymes are reactivated to bring about an increase in the quantity of monosaccharides and amino acids available for yeast metabolism during the fermentation stage.

(i) Suggest why denaturation of these malt enzymes does not occur during the kilning process.

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..... [1]

(ii) Suggest why hot, rather than cold, water is used during mashing.

..... [1]

(iii) State and explain the likely outcome to the brewing process of having an increased 'quantity of monosaccharides and amino acids'.

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..... [3]

[Total: 16]

END OF QUESTION PAPER