THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

BIOLOGY

Microbiology and Biotechnology

2805/04

OCE/10336

Candidates answer on the Question Paper

OCR Supplied Materials:
None

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)

Monday 25 January 2010
Afternoon

Duration: 1 hour 30 minutes

2805045

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **90**.
- 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.
- This document consists of **20** pages. Any blank pages are indicated.

Examiner's Use Only:			
1			
2			
3			
4			
5			
6			
Total			

DC (SHW/SW 00417 3/09) 10336/3

Answer **all** the questions.

1 Fig. 1.1 shows part of a student's account about microorganisms.

The information provided is all correct **except** for the second sentence, which is shown in **bold type**.

Read Fig. 1.1 before answering **(a)** to **(d)**.

Viruses, fungi, bacteria and protoctists are four groups of microorganism. **They all have cell surface (plasma) membranes, store their genetic material as DNA, use ATP energy and are pathogens.**

Cyanobacteria are in the same kingdom as bacteria because they both have the same organisation and structure of their genetic material. Bacteria belonging to the order Enterobacteriales are rod-shaped, facultative anaerobes, which have cell walls that stain red using the Gram staining technique. Good examples are bacteria in the genus *Salmonella*. All bacteria within the phylum Actinobacteria have cell walls that stain purple with the Gram staining technique and include the aerobic, rod-shaped pathogenic species known as *Mycobacterium tuberculosis*.

Algae such as the unicellular *Chlamydomonas* are protoctists that have cellulose cell walls and can carry out photosynthesis. Other protoctists are heterotrophic, and a good example is the protozoan carried by the *Anopheles* vector.

Organisms of the kingdom Fungi used to be placed in the Plant kingdom but they don't have chloroplasts or the same type of cell wall.

Fig. 1.1

(a) Comment on the accuracy of the sentence in **bold type** in Fig. 1.1.

.....

.....

.....

.....

.....

.....

.....

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

(b) The classification of bacteria is based on a hierarchical system; each level of classification is known as a taxon (plural: taxa) and members of each taxon share characteristic features.

(i) In addition to 'kingdom', four other bacterial taxa are referred to in Fig. 1.1. Write the names of the taxa below, in the **correct hierarchical order**.

The first one has been done for you.

kingdom
……

……

……

……

……

[2]

(ii) State the kingdom to which cyanobacteria and bacteria belong.

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

(iii) Describe the organisation of the genetic material in cyanobacteria and bacteria.

.....

.....

.....

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

(iv) Suggest why *Escherichia coli* is more likely to be a member of the Enterobacteriales than the Actinobacteria.

.....

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

(c) (i) State the name of the pathogenic protoctist carried by *Anopheles* **and** give the name of the disease that is caused by the protoctist.

name .....

disease ..... **[1]**

(ii) State **one** reason why *Chamydomonas* is classified as a protoctist rather than as a plant.

.....

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

(d) Describe the distinguishing features of members of the kingdom Fungi.

.....

.....

.....

.....

.....

.....

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

(e) Some viruses kill their host cell soon after infection. This is in contrast to viruses such as bacteriophage lambda (λ) and the human immunodeficiency virus (HIV). These are viruses that can exist in their host cell and not cause cell death.

For **either** λ **or** HIV, outline the steps that occur after virus infection of a host cell that lead to the virus remaining in the cell, but **not** causing the death or lysis of the cell.

Details of the recognition, binding and entry of the virus into the host cell are **not** required.

virus chosen (λ or HIV) .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

[Total: 18]

2 **(a)** Table 2.1 shows the main stages in the production of yoghurt. The stages are not in sequence. Complete the second column by writing the correct stage number in the sequence for yoghurt production.
The first stage, number 1, has been completed for you.

Table 2.1

description of production stage	stage number in yoghurt production
milk is heated to 90 °C	
cooling to 4.5 °C occurs	
incubation occurs at 32 °C	
raw milk arrives from the supplier	1
milk is cooled to 45 °C	
a sample of raw milk is tested	
the starter culture is added	

[3]

(b) The starter culture, used by many yoghurt producers, contains two different bacterial populations, *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Some producers also add *Bifidobacterium*, a naturally-occurring inhabitant of the human gut, as it is thought to have health benefits.

(i) Explain why the different bacterial populations in the starter culture can be described as showing a 'mutualistic' interaction.

.....

.....

.....

.....

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

(ii) There is some evidence that yoghurt containing live *Bifidobacterium* can lead to a lower concentration of blood cholesterol. Suggest **one** health risk to the consumer of a high concentration of blood cholesterol.

.....

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

(iii) Suggest why foods made from fermented milk, such as yogurt and cheese, can be stored for a long time without spoiling.

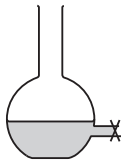
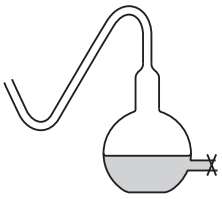
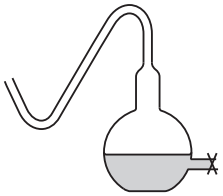
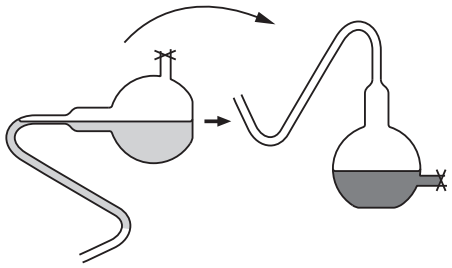
.....

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

[Total: 9]

3 Table 3.1 summarises an investigation into the growth of microorganisms. The investigation is based on Louis Pasteur's original experiments.

Table 3.1

step	procedure	results
1	Nutrient broth powder was mixed with water in a long-necked flask. The flask had a side arm and tap to withdraw samples.	
2	The neck of the flask was heated in a burner and shaped to create a 'swan-neck'.	
3	The flask and contents were autoclaved.	
4	The flask was left for two weeks with the end of the swan-neck open to the atmosphere. The appearance of the contents was recorded.	 contents remain clear
5	After **step 4**, a sample of the contents was removed for: (i) examination under the light microscope; (ii) plating out onto sterile nutrient agar in a sterile Petri dish.	(i) nothing visible under the light microscope (ii) no growth of microorganisms
6	The flask was tipped so that the contents moved into the swan-neck. The flask was then placed upright again and left for three days. The appearance of the contents was recorded.	 contents turbid (cloudy)
7	After **step 6**, a sample was removed for: (i) examination under the light microscope; (ii) plating out onto sterile nutrient agar in a sterile Petri dish.	(i) bacteria and fungal cells observed under the microscope (ii) growth of bacteria and fungi

(a) State the conclusion(s) that can be drawn from this investigation **and** discuss the evidence that you used to draw your conclusion(s).

conclusion(s) .....

.....

.....

.....

discussion .....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[7]**

(b) State **two** methods that could have been used during **step 6** of the procedure to estimate microorganism numbers.

1 .....

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

(c) Suggest, with **one** reason, what results would have been obtained in **step 7** if sterile water had been used instead of nutrient broth in **step 1**.

.....

.....

.....

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

(d) **Outline** the procedure you would use in **step 7**(ii) to show growth of any microorganisms present.

Assume that you are working in a sterile area with a Bunsen burner and are provided with a sample of the flask contents in a small jar with a screw-top.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[5]**

(e) Describe **two** differences in **appearance** between the bacterial and fungal growth that you would expect to see in **step 7**(ii).

.....

.....

.....

.....

.....

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

[Total: 18]

4 Mycoprotein is a food source for human consumption and is derived from a fungus. A continuous fermentation method in an airlift loop fermenter is used for the large-scale production of fungal biomass. There are a number of important factors that need to be considered for the efficient production of mycoprotein.

(a) Suggest why inefficient production of mycoprotein can result from the nutrient media being added to the fermenter at too high or too low a flow rate.

.....

.....

.....

.....

.....

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

(b) The environment around the fermenter must be kept as clean and free from contamination as possible.

Explain why this is important **and** outline how this could be achieved.

.....

.....

.....

.....

.....

.....

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

(c) In a pilot production of mycoprotein, using a new design of an airlift loop fermenter, a constant time was achieved for one complete flow cycle (the time taken for the culture and medium to circulate once around the fermenter).

The time taken for 20 complete flow cycles was recorded as 10 minutes. In this time, 0.05 g of new fungal biomass was formed per gram of existing fungal biomass.

(i) Calculate the time in minutes taken to produce 1.0 g of new fungal biomass per gram of existing biomass.

Answer = ... minutes **[1]**

(ii) Calculate the number of flow cycles that would need to be completed to produce 1.0 g of new fungal biomass per gram of existing biomass.

Answer = ... flow cycles **[1]**

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

- Describe the large-scale production of mycoprotein using an airlift loop fermenter **and**
- discuss the advantages of using a continuous fermentation method rather than a batch fermentation method to produce mycoprotein.

Details of downstream processing are **not** required.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[8]**

Quality of Written Communication **[1]**

[Total: 18]

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

5 **(a)** **(i)** Explain what is meant by the term 'biogas'.

.....

.....

.....

.....

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

(ii) Outline **two** benefits of using biogas fermenters (biogas digesters).

.....

.....

.....

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

(b) Biogas fermenters have been used for many years by families in developing countries.

State the important features in the design of a simple biogas fermenter, explaining **briefly** why each design feature is important.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

In recent years, research has been undertaken to design large-scale biogas fermenters. Table 5.1 shows the results of an investigation into the commercial production of methane.

Two different variables were investigated:

- temperature inside the fermenter,
- the retention time (the length of time the inoculum and the waste organic matter remain in the fermenter).

Table 5.1

temperature / °C	mean volume of methane produced / $m^3 day^{-1}$		
	7 days retention time	14 days retention time	21 days retention time
15	0.0	1.8	1.8
20	0.0	2.2	2.2
25	1.4	4.0	3.2
30	6.2	4.3	3.4
35	8.0	4.9	3.5
40	9.0	5.2	3.8

(c) The investigation was carried out using the same biogas fermenter each time.

State **one other** variable that would need to be kept constant in the investigation.

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

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

With reference to Table 5.1, describe **and** explain the results of the investigation.

You should also comment on the role of the microorganisms involved in the investigation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[8]**

Quality of Written Communication **[1]**

[Total: 17]

6 **(a)** Monoclonal antibodies and biosensors are two examples of biotechnology in medicine.

State the term that corresponds to the definitions given in **(i)** to **(v)** below.

(i) The events occurring in the body of a mammal after the introduction of an antigen **for the first time** that result in the production of a clone of specific B lymphocytes.

.....

(ii) The name of the type of cell produced from the fusion of an antibody-producing cell and a myeloma cell.

.....

(iii) The name of the antigen that binds to the coloured mobile monoclonal antibody in a pregnancy testing strip.

.....

(iv) The part of the glucose biosensor to which the immobilised glucose oxidase molecules are attached.

.....

(v) The name of the **product** of the reaction catalysed by glucose oxidase that is detected by the transducer in some glucose biosensors.

.....

[5]

(b) Human growth hormone (HGH), insulin and factor VIII are examples of proteins of medical importance that can be obtained by genetic engineering.

(i) For any **one** of these three proteins, state how the gene coding for the product is obtained.

protein .....

.....

.....

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

(ii) Suggest why only **proteins** of medical importance can be produced directly by genetic engineering.

.....

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

(c) *Escherichia coli* is an example of a host cell that can be genetically engineered to produce large quantities of HGH and insulin for medical use.

Explain briefly **two** advantages of using microorganisms in the production of HGH and insulin.

.....

.....

.....

.....

.....

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

[Total: 10]

END OF QUESTION PAPER

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

PLEASE DO NOT WRITE ON THIS PAGE