OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

BIOLOGY

Control, Genomes and Environment

F215

Candidates answer on the question paper.

OCR supplied materials:
None

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Thursday 27 January 2011
Morning

Duration: 1 hour 45 minutes

F215660111

F215

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Answer **all** the questions.
- Do **not** write in the bar codes.

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 **100**.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- 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.

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Answer **all** the questions.

1 **(a)** Human populations have herded cattle for milk for around 9 000 years. Artificial selection over this time has resulted in the modern dairy cow.

(i) State **three** phenotypic traits (characteristics) that have been selected for in dairy cows.

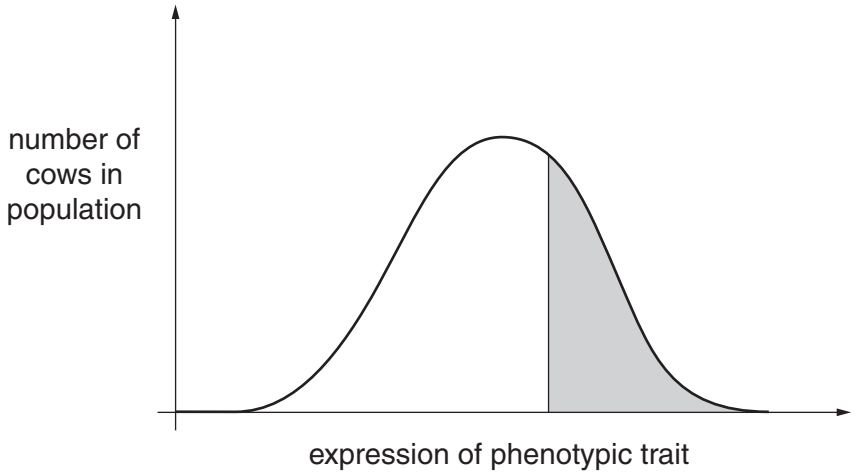
1 .....

2 .....

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

(ii) Fig. 1.1 shows the pattern of variation of a phenotypic trait in a herd of dairy cows. The shaded part of the graph indicates those cows that are chosen to breed.

Draw, **on Fig. 1.1**, a second curve to show the pattern of variation in the next generation.



[2]

Fig. 1.1

(iii) In recent years, artificial selection of dairy cows has been helped by modern reproductive technology.

Name **two** modern techniques or procedures that can be used in the selective breeding of dairy cows.

1 .....

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

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(b) Lactase is an enzyme that is necessary to digest lactose sugar in milk.

In some parts of the world, animals are not farmed for milk and no dairy products are eaten. Adult humans that are native to these parts of the world do not produce lactase.

In areas where animals are farmed for milk, native adult humans do produce lactase. In these populations, a new allele has arisen by gene mutation.

(i) State what is meant by gene mutation.

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

(ii) Over time, the frequency of this new allele increased in the gene pool of the human populations whose diet included milk.

Name the process by which this increase occurred.

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

(c) (i) All human babies produce the enzyme lactase. The genetic change that allows adults to produce this enzyme is thought to involve a mutation in a regulatory gene. This mutation causes the structural gene to be expressed in adults.

Distinguish between the terms 'regulatory gene' and 'structural gene'.

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(ii) Adult humans who cannot produce the enzyme lactase are described as lactose-intolerant and cannot drink milk without experiencing health problems. However, lactose-intolerant people can safely eat yogurt.

Yogurt is produced from milk that is fermented by bacteria. These bacteria perform anaerobic respiration, using carbohydrate as their respiratory substrate.

Suggest why yogurt is a suitable food for lactose-intolerant people.

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

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(d) The control of the expression of the *lac* operon genes, which allow uptake and digestion of lactose in the bacterium *Escherichia coli*, is well known.

Fig. 1.2 shows the arrangement of the elements of the *lac* operon.

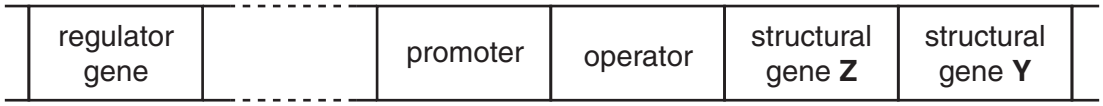


Fig. 1.2

Describe how genes **Z** and **Y** are switched on in bacteria that are moved to a nutrient medium that contains lactose.

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[Total: 16]

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2 This question is about types of muscle and how the nervous system and hormones control their activity.

(a) There are three types of muscle within the human body. These differ in their cellular structure and in their function.

Complete Table 2.1 to show how each type of muscle **differs from the other two** types.

Table 2.1

	voluntary (skeletal) muscle	involuntary (smooth) muscle	cardiac muscle
cellular structure			
function			

[6]

(b) The human thorax is the area between the base of the neck and the base of the rib cage. All three types of muscle can be found within this area.

For each type of muscle, identify where **in the thorax** this type of muscle may be found.

voluntary .....

involuntary .....

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

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(c) Fig. 2.1 shows a vertical section through the human brain.

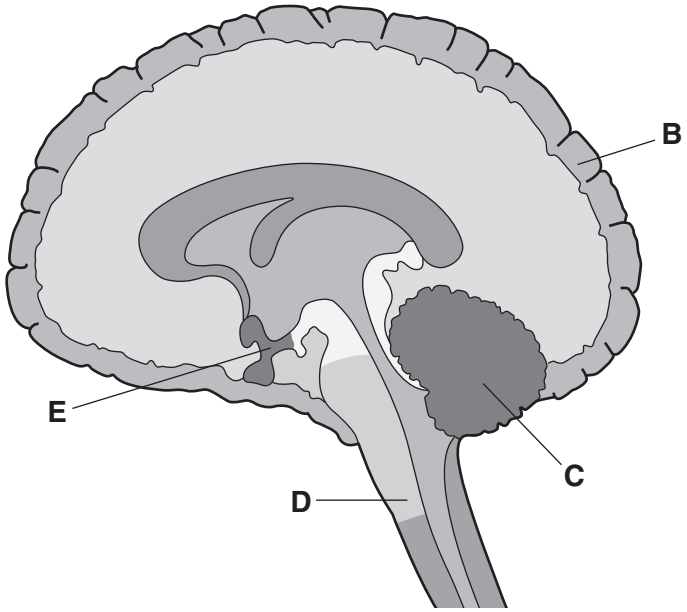


Fig. 2.1

Use Fig. 2.1 to state the letter (**B** to **E**) of the part of the brain that would be involved in the following:

adjusting the rate of contraction of cardiac muscle .....

clapping the hands together .....

automatically correcting balance when riding a bicycle ..... **[3]**

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(d) Movement disorders are conditions in which people lose the ability to control their body movements.

Scientists have discovered that inserting electrodes to stimulate parts of the brain can help to cure some movement disorders. This discovery has resulted from experimental work with monkeys, which has made the research controversial.

Suggest why monkeys rather than other laboratory animals, such as rats, were used for this work **and** comment on whether their use in this way is justified or not.

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QUESTION 2(e) STARTS ON PAGE 8

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(e) The 'fight or flight' response to threatening environmental stimuli is coordinated by the nervous and endocrine systems.

Describe and explain how the activation of the 'fight or flight' response affects voluntary, involuntary and cardiac muscle.



In your answer, for each type of muscle, you should give a named structure in which it is found and explain how the nervous and endocrine systems affect its response.

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[Total: 24]

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3 Total plant growth within an ecosystem depends on the light intensity, temperature and the supply of water and inorganic minerals to the ecosystem.

Table 3.1 shows the net primary production by plants in four different ecosystems.

Table 3.1

ecosystem	net primary production ($kJ\,m^{-2}\,year^{-1}$)
temperate grassland	9240
temperate woodland	11340
tropical grassland	13440
tropical rainforest	36160

(a) Discuss possible reasons for the differences in net primary production in these ecosystems.

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

QUESTION 3(b) STARTS ON PAGE 10

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(b) To calculate the net primary production figures in Table 3.1 in $kJ\,m^{-2}\,year^{-1}$, it is necessary to measure the energy content of the primary producers.

Outline how the energy content, in kJ, of a primary producer such as grass can be measured in the laboratory.

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(c) The efficiency with which consumers convert the food they eat into their own biomass is generally low.

Table 3.2 compares the energy egested, absorbed and respired in four types of animal.

Table 3.2

animal	percentage of energy consumed that is:			
	egested	absorbed	respired	converted to biomass
grasshopper, a herbivorous insect	63	37	24	13
perch, a carnivorous fish	17	83	61	
cow, a herbivorous mammal	60	40	39	
bobcat, a carnivorous mammal	17	83	77	6

(i) **Complete Table 3.2** to show the percentage of energy consumed that is converted into biomass in the perch and the cow.

You may use the space below for your working.

[2]

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(ii) Describe **and** explain, using the data from Table 3.2, how the trophic level of a **mammal** affects the percentage of its food energy that it is able to convert to biomass.

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(iii) Using the data from Table 3.2 and your knowledge of energy flow through food chains, suggest which of these four animals could be farmed to provide the maximum amount of food energy in $kJ\,m^{-2}\,year^{-1}$ for humans.

Explain the reasons for your choice.

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[Total: 14]

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4 The antibiotic penicillin is produced by batch culture of the fungus *Penicillium chrysogenum*.

(a) Fig. 4.1 shows the concentration of penicillin, lactose and ammonia as well as the fungal biomass over time when penicillin is being produced by batch culture.

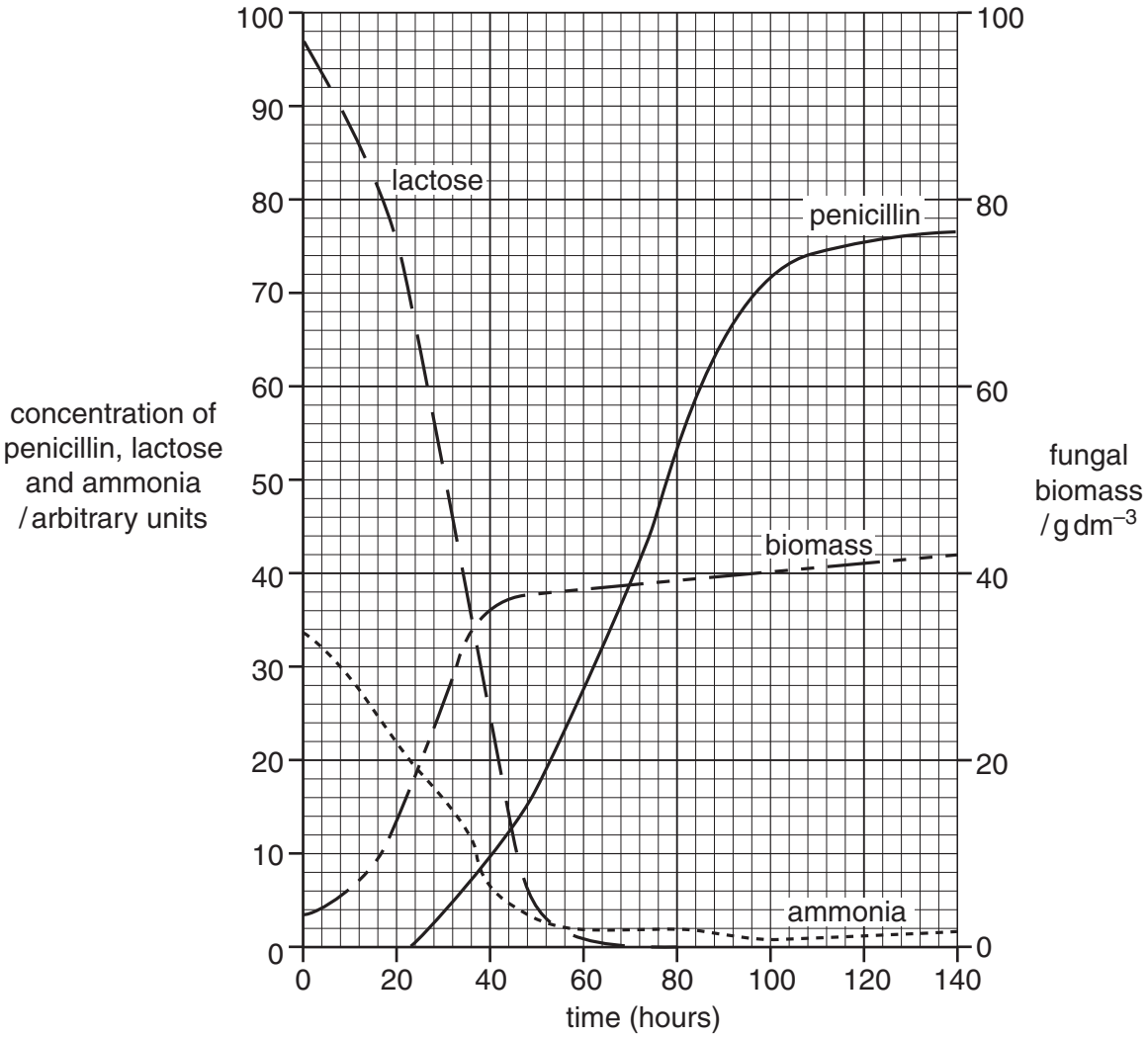


Fig. 4.1

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(i) With reference to Fig. 4.1, describe and explain the changes in concentration of lactose **and** ammonia.

description .....

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explanation .....

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(ii) A student incorrectly suggested that penicillin might be produced by continuous culture fermentation instead of by batch culture.

Suggest how the curves for lactose, ammonia and biomass on Fig. 4.1 might differ in continuous culture.

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(iii) A second student said that continuous culture would not be suitable, as penicillin is a secondary metabolite.

What evidence is there in Fig. 4.1 that penicillin is a secondary metabolite?

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(b) (i) Explain the importance of maintaining aseptic conditions in manufacturing penicillin by fermentation.

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(ii) State **three** physical or chemical factors within the fermenter, other than nutrient levels, that need to be monitored and controlled.

For each factor, explain **why** it must be controlled.

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[Total: 14]

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5 This question is about genetic engineering and the techniques used for making multiple copies of genes (gene cloning).

(a) Genetic engineering uses the following:

A an enzyme that synthesises new DNA
B an enzyme that cuts DNA at specific sequences
C an enzyme that reseals cut ends of DNA
D small circular pieces of DNA found in bacteria; these pieces of DNA have antibiotic resistance genes
E an enzyme found in some viruses with an RNA genome; this enzyme converts RNA into DNA.

Name **A** to **E**.

A .....

B .....

C .....

D .....

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

(b) Genes are cloned for a number of reasons. For example,

- one group of research scientists at a hospital wanted to sequence a disease-causing mutation to learn more about a human disease; these scientists started their research using white blood cells;

- another group of scientists at a biotechnology company wanted to clone the insulin gene in order to manufacture its protein product to treat diabetes; these scientists started their research using cells from the pancreas.

Suggest **and** explain the biological reasons why the two groups each started with a different cell.

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(c) A gene can be cloned *in vitro* (in a test-tube) by the polymerase chain reaction (PCR). Alternatively, a gene can be cloned *in vivo* (in living cells) by introducing the gene into bacterial host cells.

Table 5.1 identifies some of the key steps in each process.

Table 5.1

in vitro gene cloning (PCR)	*in vivo* gene cloning
At 95 °C, DNA extracted from a cell separates into two strands.	A library of gene fragments is produced and introduced into host bacteria.
At 50 °C, specially-made primer sequences attach to the ends of the desired gene only.	Bacteria are screened for antibiotic resistance to identify those with recombinant DNA.
At 72 °C complementary copies of both DNA strands are made.	A gene probe is used to select the bacterial colony containing the desired gene.
The cycle of temperature changes is repeated and more copies of the gene are made.	This colony is grown on in nutrient broth and the DNA is then purified.

Compare the two processes of gene cloning by explaining the advantages of each.



In your answer you should ensure that clear comparisons between the two processes are made and explained.

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6 **(a)** State the term used to describe:

(i) a directional growth response of a plant

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(ii) a signalling molecule that enables **plants** to respond to environmental change

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

(iii) plants that lose their leaves seasonally

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

(iv) the process of managing an ecosystem sustainably to protect biodiversity

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

(v) organisms that return inorganic minerals from the bodies of dead organisms to the abiotic environment

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

(vi) the conversion of nitrogen gas to ammonium compounds in the soil.

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

(b) Describe briefly **one** example of each of the following types of **animal** behaviour:

(i) habituation

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

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(ii) operant conditioning

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(iii) social behaviour in primates and its importance.

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[Total: 15]

END OF QUESTION PAPER

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ADDITIONAL PAGE

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