FOR OFFICIAL USE

Total for Sections B and C

X008/201

NATIONAL QUALIFICATIONS 2008

WEDNESDAY, 21 MAY 1.00 PM – 3.00 PM

BIOTECHNOLOGY INTERMEDIATE 2

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

SECTION A (25 marks)

Instructions for completion of **Section A** are given on page two.

For this section of the examination you must use an **HB pencil**.

SECTION B AND SECTION C (75 marks)

1 (a) All questions should be attempted.

(b) It should be noted that in **Section C** questions 1 and 2 each contain a choice.

2 The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, **and must be written clearly and legibly in ink**.

3 Additional space for answers will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the invigilator and should be inserted inside the **front** cover of this book.

4 The numbers of questions must be clearly inserted with any answers written in the additional space.

5 Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written. If further space is required, a supplementary sheet for rough work may be obtained from the invigilator.

6 Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.

SECTION A

Read carefully

1 Check that the answer sheet provided is for **Biotechnology Intermediate 2 (Section A)**.

2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.

3 Check that the answer sheet you have been given has **your name**, **date of birth**, **SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

Do not change any of these details.

4 If any of this information is wrong, tell the Invigilator immediately.

5 If this information is correct, **print** your name and seat number in the boxes provided.

6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).

7 There is **only one correct** answer to each question.

8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.

9 At the end of the exam, put the **answer sheet for Section A inside the front cover of this answer book**.

Sample Question

Which of the following foods contains a high proportion of fat?

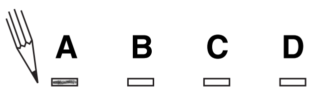
A Butter

B Bread

C Sugar

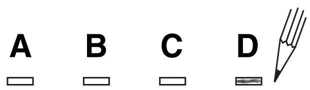
D Apple

The correct answer is **A—**Butter. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).



Changing an answer

If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.



SECTION A

All questions in this Section should be attempted.

Answers should be given on the separate answer sheet provided.

1. Which structure removes excess water in the protozoa *Paramecium*?

A Contractile vacuole

B Flagellum

C Nucleus

D Cell wall

2. Which line in the table correctly describes the composition and activity of enzymes?

	Composition	*Enzyme activity*
A	carbohydrate	specific
B	protein	specific
C	carbohydrate	non-specific
D	protein	non-specific

Questions 3 and **4** refer to the following table.

	Groups of compounds
A	carbohydrates
B	lipids
C	proteins
D	vitamins

3. Which group of compounds includes chitin, cellulose and starch?

4. Which group of compounds is built up from amino acids?

5. A culture of yeast cells contained 100 000 cells at the start of an experiment. Yeast cells divide asexually once every 15 minutes.

Calculate the number of yeast cells which would be present after 1 hour.

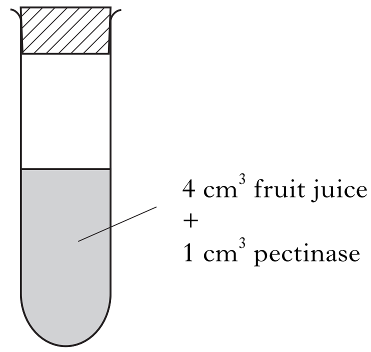
A 200 000

B 400 000

C 800 000

D 1 600 000

6. An experiment was set up to demonstrate that the enzyme pectinase makes cloudy fruit juice clear.



Which line in the table below shows the correct contents of a control tube for this experiment?

	Volume of fruit juice (cm^3)	*Volume of pectinase* (cm^3)	*Volume of water* (cm^3)
A	0	1	4
B	4	1	1
C	4	0	0
D	4	0	1

7. In the nitrogen cycle, nitrification is the conversion of

A ammonia to nitrate

B nitrogen to nitrate

C ammonia to nitrogen

D nitrogen to protein.

8. The micro-organism involved in the process of nitrogen fixation is

A *Acetobacter*

B *Rhizobium*

C *Saccharomyces*

D *Zygomonas*.

[Turn over

9. Micro-organisms can be stained with a vital stain.

One of the reasons for using a vital stain is to

A fix the micro-organisms

B kill the micro-organisms

C view live micro-organisms

D make the micro-organisms divide.

10. The loop transfer of micro-organisms from solid to liquid medium is the transfer of bacteria from

A an agar plate to nutrient broth culture

B an agar plate to an agar plate

C a nutrient broth culture to an agar plate

D a nutrient broth culture to nutrient broth culture.

Questions 11 and **12** refer to the following steps in good laboratory practice in a biotechnology laboratory.

W Putting on and fastening a lab coat

X Tying back long hair

Y Swabbing the bench surface with disinfectant

Z Washing and drying hands

11. Which of the following steps is **not** part of the preparation of a person in good laboratory practice in a biotechnology laboratory?

A W

B X

C Y

D Z

12. Which of the following is the correct order of these steps before starting work in a biotechnology laboratory?

A Y ⟶ X ⟶ Z ⟶ W

B X ⟶ Z ⟶ W ⟶ Y

C W ⟶ Y ⟶ Z ⟶ X

D Z ⟶ X ⟶ W ⟶ Y

13. Which of the following combinations of microscope lenses provides the **lowest** power total magnification?

	Eyepiece lens magnification	*Objective lens magnification*
A	4x	20x
B	8x	20x
C	10x	10x
D	15x	10x

Questions 14, **15** and **16** refer to the following information about oxygen production by algae.

An experiment was set up to investigate the effect of various factors on oxygen production in four flasks of algae (W, X, Y and Z). The table below shows the results of this experiment.

Flask	W	X	Y	Z
Carbon dioxide concentration (units)	5	1	5	5
Temperature (°C)	25	25	25	20
Light (lux)	0	5	10	5
Oxygen production (units)	0	5	20	10

14. Which flasks should be compared to show the effect of light on oxygen production?

A Flasks W and X

B Flasks Y and Z

C Flasks W and Z

D Flasks W and Y

15. The percentage increase in oxygen production in flask Y compared to flask X is

A 4%

B 15%

C 75%

D 300%.

16. Which flask would produce the largest increase in biomass?

A W

B X

C Y

D Z

17. The raw materials used in photosynthesis are

A water and glucose

B glucose and carbon dioxide

C oxygen and carbon dioxide

D carbon dioxide and water.

18. The fungus *Aspergillus* is used in the industrial production of

A acetic acid

B citric acid

C ethanol

D penicillin.

19. A technique used in the identification and location of genes on chromosomes is

A genome mapping

B selective breeding

C tissue culture

D genetic modification.

[Turn over

20. In saprophytic nutrition, food is obtained from dead or decaying organisms.

This type of nutrition involves the following sequence of events.

A extracellular enzymes ⟶ internal digestion ⟶ absorption of food

B absorption of food ⟶ external digestion ⟶ extracellular enzymes

C extracellular enzymes ⟶ external digestion ⟶ absorption of food

D absorption of food ⟶ extracellular enzymes ⟶ internal digestion

21. Which line in the table correctly identifies the benefit to the plant and the micro-organism from a mycorrhizal association?

	Plant obtains	*Micro-organism obtains*
A	Nitrate	Carbohydrate
B	Carbohydrate	Protein
C	Carbohydrate	Nitrate
D	Nitrate	Protein

Questions 22 and 23 refer to the following information.

The tables below show the results from an experiment set up to look at the preservation of peas at room temperature. If the peas become spoiled, micro-organisms cause the solutions to turn cloudy.

Concentration of sodium chloride (%)	*Cloudiness of preservative solution*
0·1	+++
1·0	+++
10·0	++

Concentration of potassium sorbate (%)	*Cloudiness of preservative solution*
0·1	+++
1·0	++
10·0	+

Key:

+++ very cloudy
++ cloudy
+ slightly cloudy

22. What is the variable under investigation in this experiment?

A Volume of preservative solution

B Type of preservative solution

C Cloudiness of preservative solution

D Temperature of preservative solution

23. A valid conclusion from these results is that

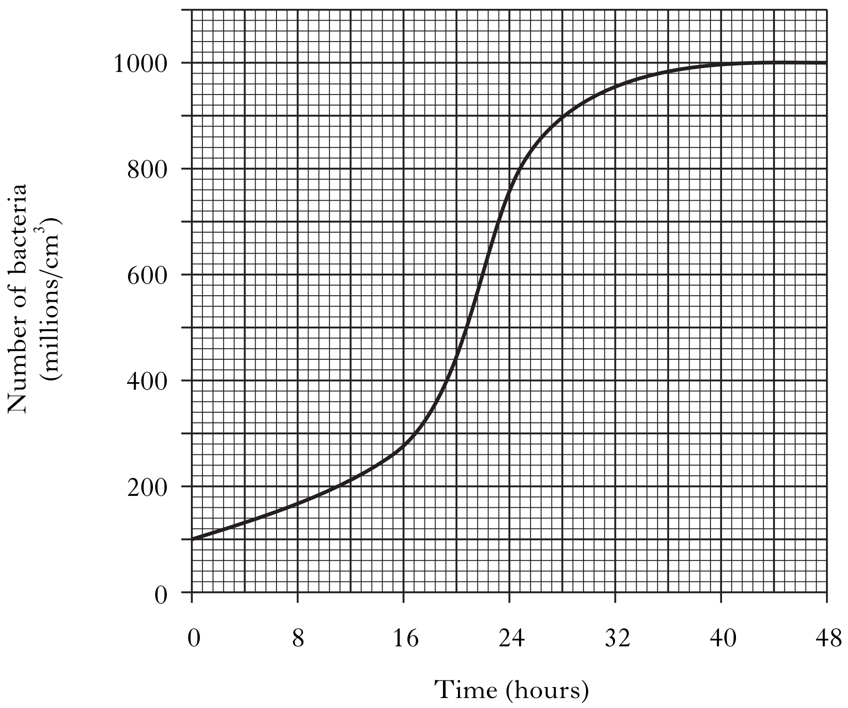
A 0·1% sodium chloride preserves the peas better than 0·1% potassium sorbate

B 10% sodium chloride preserves the peas better than 10% potassium sorbate

C 0·1% potassium sorbate preserves the peas better than 0·1% sodium chloride

D 10% potassium sorbate preserves the peas better than 10% sodium chloride.

24. The change in the number of bacteria growing in nutrient broth culture kept at 30°C for 48 hours is shown in the graph below.



During which 8 hour period was there the greatest increase in the number of bacteria?

A 0 – 8 hours

B 8 – 16 hours

C 16 – 24 hours

D 24 – 32 hours

25. Which line in the table correctly describes activated sludge treatment of sewage?

	Type of micro-organism	*Treatment of sewage*
A	Anaerobic	Mixed by bubbling of air
B	Aerobic	Trickled over stones
C	Anaerobic	Trickled over stones
D	Aerobic	Mixed by bubbling of air

Candidates are reminded that the answer sheet for Section A MUST be returned INSIDE the front cover of this answer book.

[Turn over

DO NOT WRITE IN THIS MARGIN

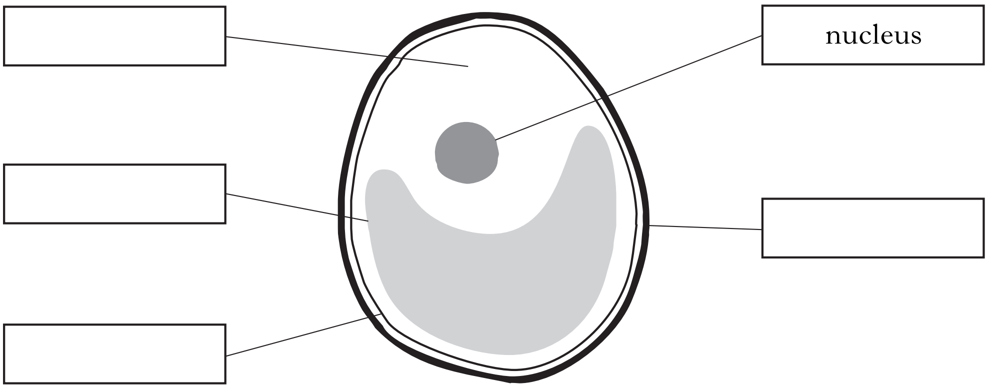
Marks

SECTION B

All questions in this section should be attempted.

All answers must be written clearly and legibly in ink.

1. (*a*) The diagram shows the algal cell *Chlorella*.



(i) Complete the diagram by labelling the structures using the words from the list below. **3**

List
capsule
cytoplasm
food vacuole
cell membrane
chloroplast
cell wall

(ii) State the function of the nucleus.

____ **1**

(iii) Name the method of asexual reproduction used by *Chlorella*.

____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

1. (continued)

(*b*) Japanese seaweed farmers grow algae on nets hung in shallow water. The algae can be harvested for food.

(i) Explain why these algae grow best in **shallow** water.

____

____

______________________________ **2**

(ii) Name the gas released by the algae into the water during daylight.

______________________________ **1**

[Turn over

Marks

2. An experiment was set up to investigate amylase production by different species of bacteria (W, X, Y and Z). The following procedure was carried out.

1 A nutrient broth culture of each species of bacteria (W, X, Y and Z) was prepared.

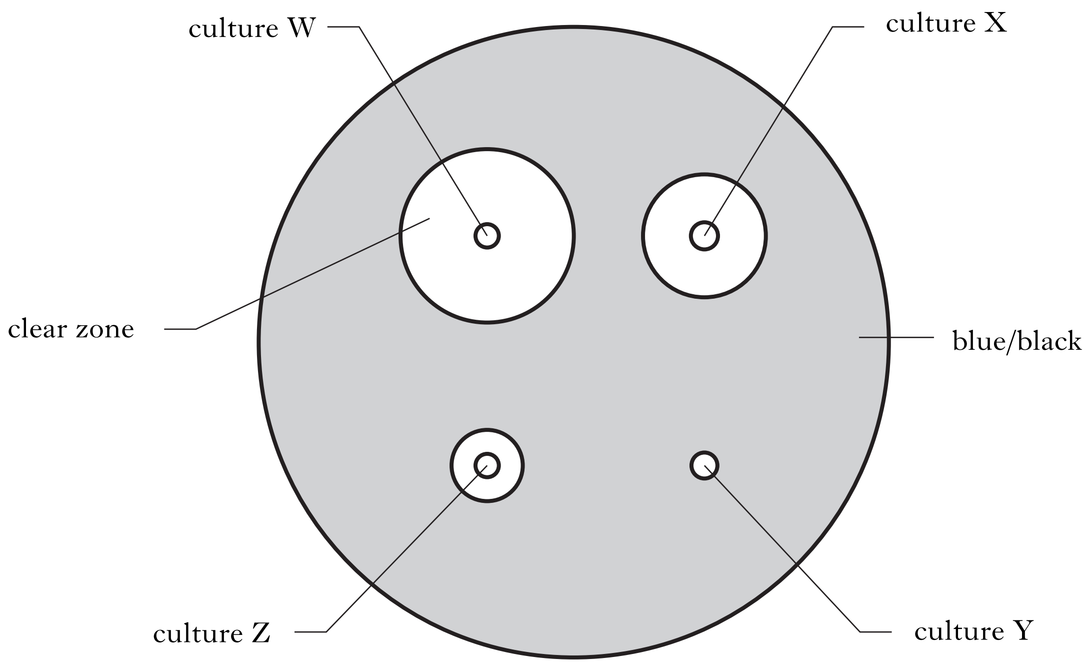
2 The cultures were incubated for 48 hours at 30°C.

3 Liquid from each culture was transferred to separate wells punched in a starch agar plate.

4 The starch agar plate was incubated for 24 hours at 30°C.

5 The plate was flooded with iodine solution.

The diagram shows the results of the experiment after the plate had been flooded with iodine solution. Iodine solution turns blue/black in the presence of starch.



(*a*) (i) Name **one** factor, **not** mentioned above, which should be kept the same to make this experiment valid.

________________________________ **1**

(ii) State **one** way of improving the reliability of this experiment.

________________________________ **1**

Marks

2. (*a*) (continued)

(iii) Give **two** conclusions from the results of this experiment.

Conclusion 1 ____

____ **1**

Conclusion 2 ____

____ **1**

(*b*) The optimum temperature for this enzyme is 30°C.

Describe the effect on the size of the clear zone for culture W of repeating the experiment at 20°C.

____ **1**

(*c*) The wells in the starch agar plate were punched out using a metal cork borer in this experiment.

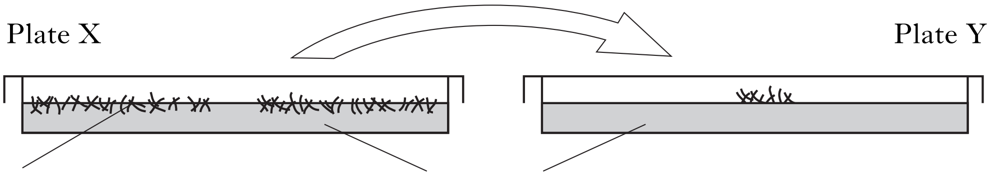
The metal cork borer was dipped in ethanol and then flamed. Give a reason for this procedure.

____ **1**

[Turn over

Marks

3. (*a*) The diagram shows the aseptic transfer of the fungus *Mucor* from one malt agar plate (X) to another malt agar plate (Y).



(i) What is the name given to the mat of fungal threads transferred in the diagram above?

______________________________ **1**

(ii) Name an instrument which could be used in the transfer of *Mucor*.

______________________________ **1**

(iii) The table shows the steps in the aseptic transfer of *Mucor*.

Complete the table by describing what happens in steps 4 and 8. **2**

Step 1: Sterilise instrument that is used to transfer *Mucor*
Step 2: Lift the lid on plate X
Step 3: Cut and remove a block of agar with *Mucor*
Step 4:
Step 5: Lift lid on plate Y
Step 6: Place block of agar with *Mucor* onto plate Y
Step 7: Replace lid on plate Y
Step 8:

Marks

3. (continued)

(*b*) Decide if the following statements about reproduction in *Mucor* are **True** or **False** and tick (✓) the correct box.

If the answer is **False**, write the correct word in the **Correction** box to replace the word underlined in the statement.

Statement	*True*	*False*	*Correction*
Sexual reproduction in *Mucor* occurs by fusion of zygospores.			
Asexual reproduction in *Mucor* produces sporangia.			
The cells in *Mucor* produced by asexual reproduction are identical.			

3

[Turn over

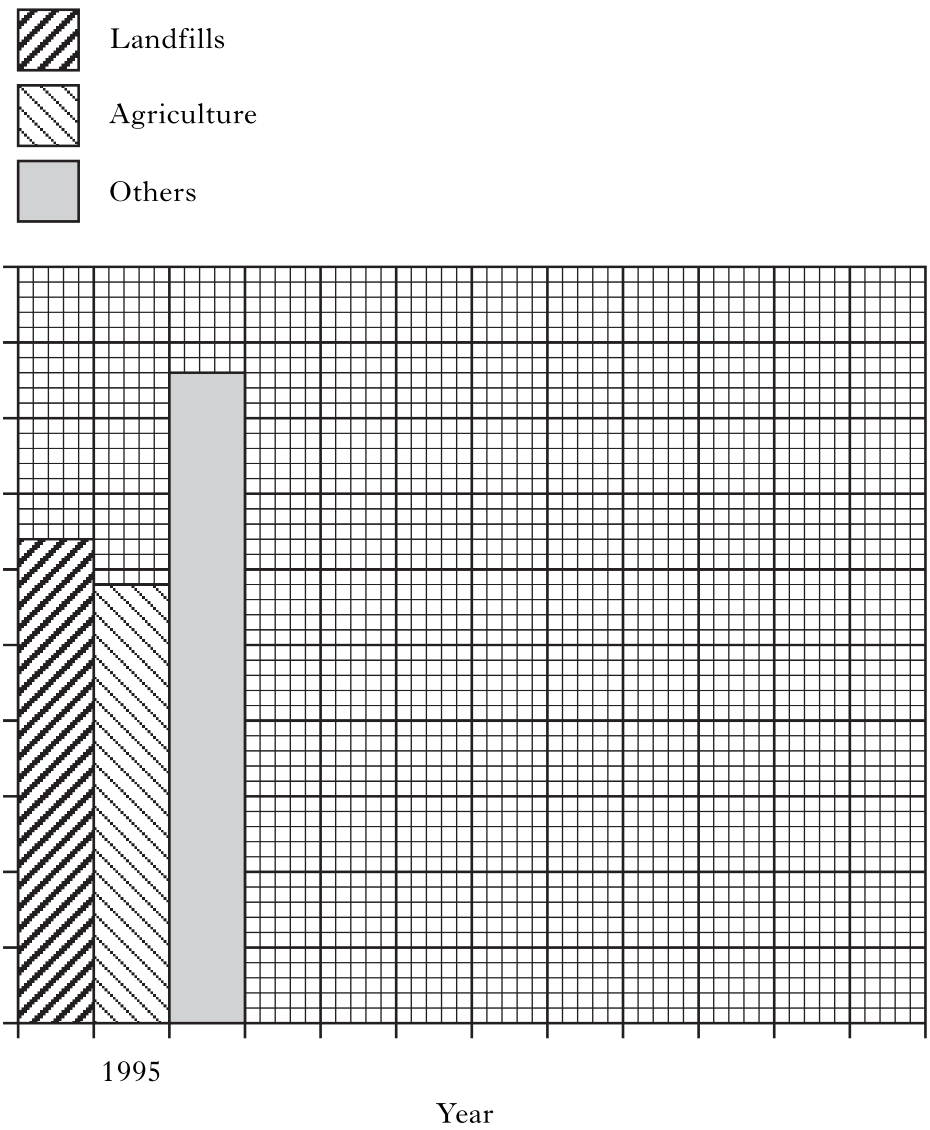
Marks

4. Methane emissions from landfills, agriculture and other sources are shown in the table below.

	Methane emissions (units)		
Source	*1995*	*2000*	*2005*
Landfills	64	56	54
Agriculture	58	58	54
Others	86	28	6

(*a*) Complete the bar chart below to compare methane emissions in 1995 with those in 2000 and 2005.

(Additional graph paper, if required, can be found on page 30.)



3

Marks

4. (continued)

(*b*) Complete the following sentences about landfills by **underlining** one of the options in each pair.

The reduction in methane emissions from landfills has been due to $\left\{\begin{matrix}\text{less}\\\text{more}\end{matrix}\right\}$ organic material being placed into the landfills. The production of methane in landfills is the result of $\left\{\begin{matrix}\text{aerobic}\\\text{anaerobic}\end{matrix}\right\}$ respiration by micro-organisms. **1**

(*c*) Small-scale digesters are used to produce methane in developing countries with an agricultural economy.

(i) What source of materials could be used in these anaerobic digesters?

____ **1**

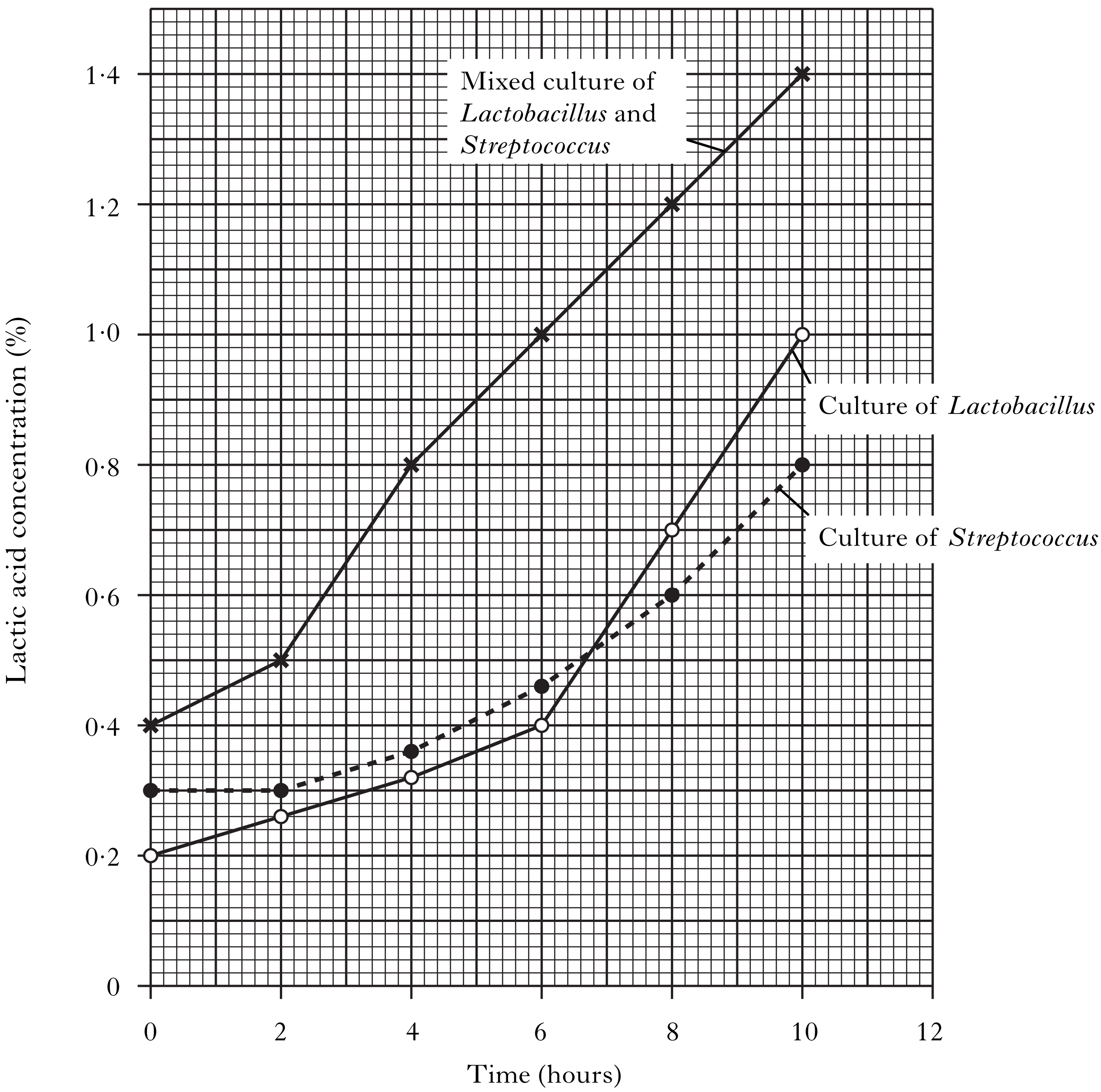
(ii) State one use of the methane produced.

____ **1**

[Turn over

Marks

5. The effect of different bacteria on lactic acid concentration during the production of yoghurt from milk at 30°C is shown in the graph.



(*a*) (i) What is the lactic acid concentration in the culture of *Lactobacillus* after 9 hours?

__________________ % **1**

(ii) How long does it take for the lactic acid concentration to increase by 100% in the culture of *Streptococcus* from the start of the experiment?

__________________ hours **1**

Marks

5. (*a*) (continued)

(iii) Calculate the percentage increase in lactic acid concentration in the mixed culture of *Lactobacillus* and *Streptococcus* after 6 hours.

Space for calculation

________________ % **1**

(*b*) In the milk with the *Lactobacillus* culture, the pH dropped from 6·8 to 4·5 by the end of yoghurt production.

Predict the final pH of the yoghurt if the experiment had been carried out at 15°C, rather than 30°C.

Tick (✓) the correct box

pH

4·0 ☐

4·5 ☐

5·5 ☐

7·5 ☐ **1**

(*c*) Give one benefit of converting milk into yoghurt.

____ **1**

(*d*) Decide if the following statements about yoghurt production are **True** or **False** and tick (✓) the correct box.

If the answer is **False**, write the correct word in the **Correction** box to replace the word underlined in the statement.

Statement	*True*	*False*	*Correction*
Lactic acid can be used as a <u>flavour enhancer</u> in the foods.			
Lactic acid is produced as a result of the breakdown of <u>protein</u> by *Lactobacillus*			

2

Marks

6. Oil seed rape plants can be grown as an energy crop.

Complete the following sentences by <u>underlining</u> one of the options in each pair.

(*a*) Energy can be fixed by crops in the process of $\left\{\begin{array}{l}\text{photosynthesis}\\\text{respiration}\end{array}\right\}$. These energy crops can be used to provide $\left\{\begin{array}{l}\text{medicine}\\\text{fuel}\end{array}\right\}$. One benefit of this form of energy is that it is a $\left\{\begin{array}{l}\text{non-renewable}\\\text{renewable}\end{array}\right\}$ source. **2**

(*b*) The table below shows the area of land set aside to grow energy crops in 2004 in the United Kingdom.

Type of energy crop	*Area of land* (units)
Oil seed rape	10 000
Erucic acid rape	30 000
Linseed	60 000

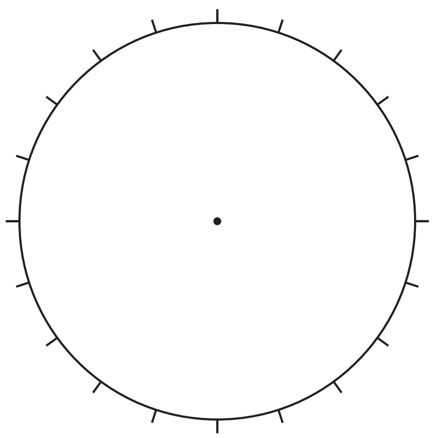
(i) What percentage of the land set aside for energy crops is used to grow linseed?

Space for calculation

______________ % **1**

(ii) Complete the pie chart using all the information in the table. **2**

(An additional pie chart, if required, can be found on page 31.)



Marks

7. Single cell protein (SCP) can be produced by growing micro-organisms on waste materials from industrial sources.

(*a*) Name a suitable waste material used to produce SCP and its industrial source.

Waste material ______________________________ **1**

Source of material ______________________________ **1**

(*b*) Give one benefit to the **industry** of using its waste in SCP production.

____

______________________________ **1**

(*c*) Supermarkets sell meat substitutes made from SCP.

(i) Give one benefit to the **consumer** of this product.

____

______________________________ **1**

(ii) Identify the type of micro-organism involved in the production of SCP.

Underline the correct answer.

Algae Bacteria Fungi Protozoa Viruses **1**

[Turn over

Marks

8. Knowledge of the melting and setting temperatures of agar is necessary before deciding on an appropriate pouring temperature.

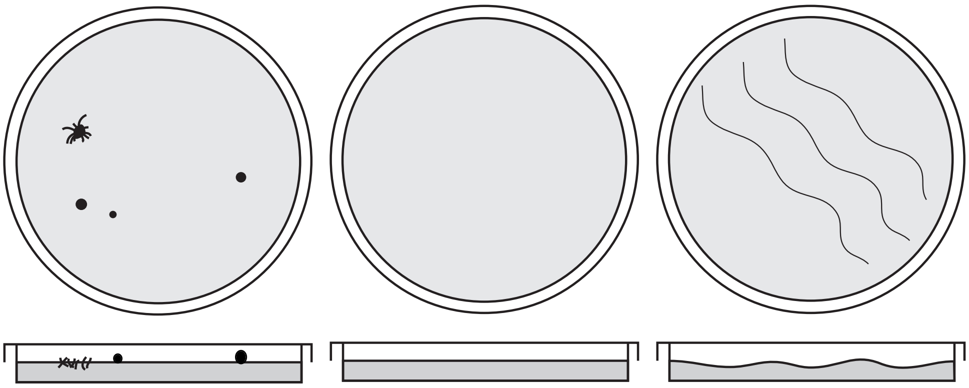
(*a*) Draw lines linking each process to its correct temperature.

Process	*Temperature*
Melting	55°C
Pouring	95°C
Setting	42°C

2

(*b*) The diagrams below show three agar plates (X, Y and Z) poured by a student, viewed from above and the side.

Plate X Plate Y Plate Z



(i) Identify the agar plate suitable for use in culturing micro-organisms.

Plate ______________________ **1**

(ii) The other two plates are unsuitable for use. Identify the unsuitable agar plates and give a reason for each of your choices.

Plate ______________________

Reason ____

____ **1**

Plate ______________________

Reason ____

____ **1**

Marks

8. (*b*) (continued)

(iii) Choose one plate which is unsuitable for use. Describe the error that the student could have made in preparing this plate and how this error could have been prevented.

Plate ____________________

Error ____

____ **1**

Prevention ____

____ **1**

(*c*) After setting, agar plates are stored upside down before use.

Give a reason for storing agar plates in this way.

____

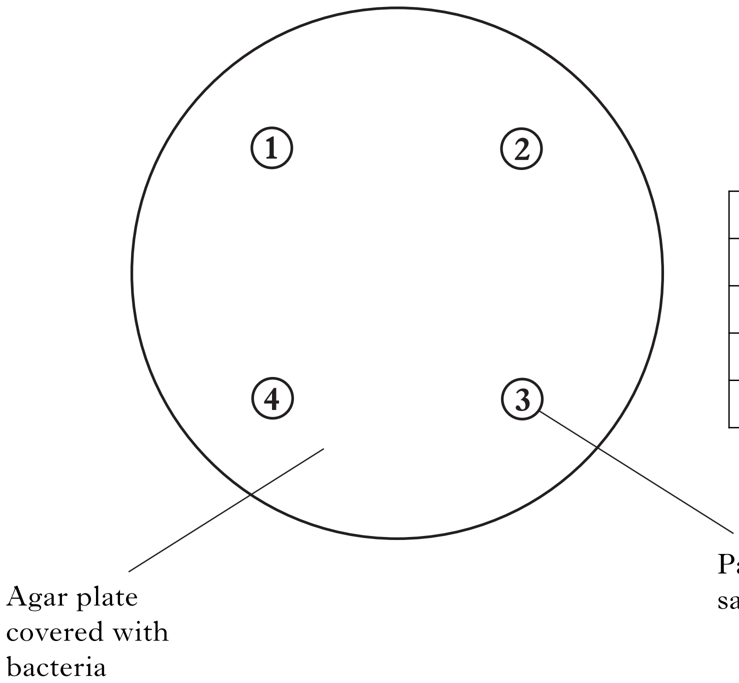
____ **1**

[Turn over

Marks

9. An experiment was set up to investigate whether samples from three different parts of a pine tree (cones, needles and bark) could kill bacteria.

Each sample was crushed and mixed with water and some of the water added to a separate paper disc. The discs were placed on the surface of an agar plate covered with bacteria as shown below.



Paper disc	*Sample*
1	Control
2	Cone
3	Needles
4	Bark

(*a*) (i) Name one factor which should be kept the same when setting up the agar plate in this experiment.

____ **1**

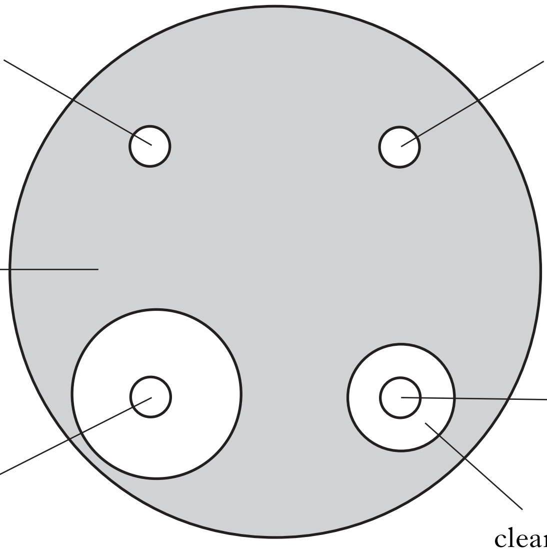
(ii) Describe what should be added to paper disc 1 to make it a valid control.

____ **1**

Marks

9. (continued)

The diagram below shows the results of this experiment after the bacteria have grown.



(*b*) Describe what you would measure to obtain the results in this experiment.

____

____ **1**

(*c*) Which sample(s) from the pine tree stopped the growth of the bacteria?

____ **1**

(*d*) Fungi also produce chemicals which stop the growth of bacteria.

(i) Name this type of chemical.

____ **1**

(ii) Give a reason why some fungi release chemicals into their natural environment which stop the growth of bacteria.

____

____ **1**

[Turn over

Marks

10. Silage is made by the action of micro-organisms on fresh grass. The stages in this process are shown below.

Stage 1: Fresh grass compressed into black, plastic bags

Stage 2: Suitable conditions for growth of micro-organisms

Stage 3: Bacteria break down sugars in grass resulting in a temperature increase

Stage 4: Lactic acid produced

Stage 5: Silage production complete

(*a*) (i) Name the type of micro-organism involved in stage 2.

____ **1**

(ii) Describe the suitable conditions required for stage 2.

____ **1**

(*b*) Name the process that breaks down sugars in stage 3.

____ **1**

(*c*) What effect does the lactic acid produced in stage 4 have on the

(i) number of bacteria causing putrefaction (decay) of the silage?

____ **1**

(ii) quality of silage produced?

____ **1**

(*d*) Give one use of silage.

____ **1**

(*e*) A farmer tried a new technique of adding micro-organisms to the fresh grass.

Identify an advantage of this new technique.

Underline the correct response.

produces more sugars   produces acidic conditions   increases pH **1**

[Turn over for SECTION C on *Page twenty-six*

DO NOT WRITE IN THIS MARGIN

Marks

SECTION C

Both questions in this section should be attempted.

Note that each question contains a choice.

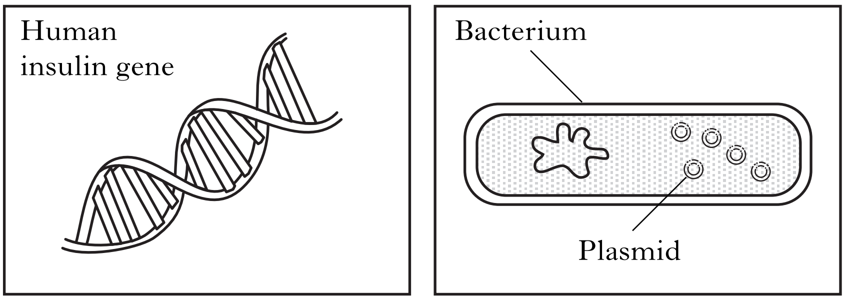
Questions 1 and 2 should be attempted on the blank pages which follow.

Supplementary sheets, if required, may be obtained from the invigilator.

Labelled diagrams may be included where appropriate.

1. Answer **either** A **or** B.

A. The diagrams below show the human insulin gene and a bacterium.

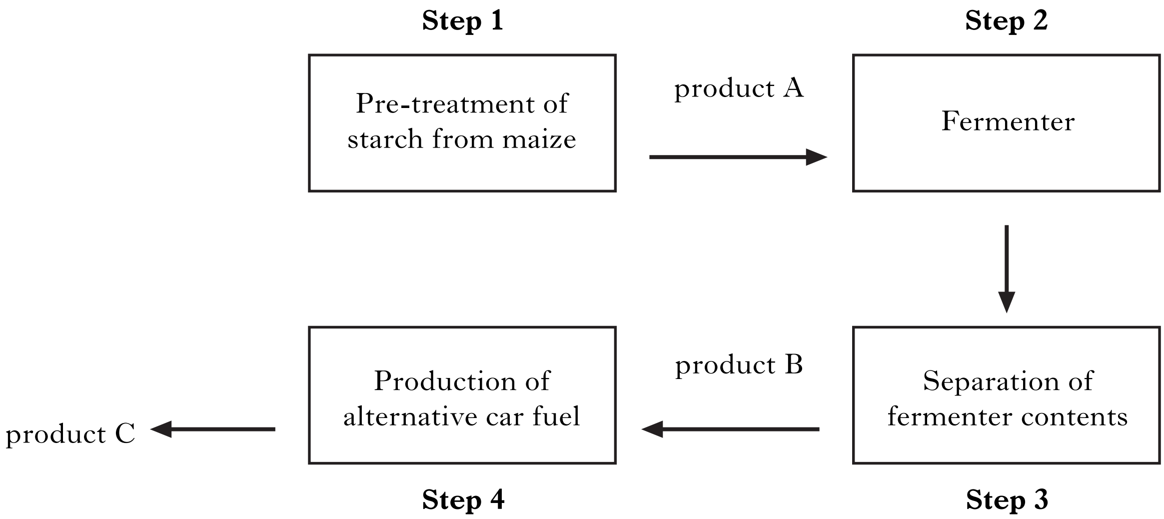


Describe the steps involved in genetically engineering this bacterium to produce human insulin.

Give **one** use and **one** benefit of genetically engineered insulin in medical treatments. **5**

OR

B. The diagram below shows the steps involved in the production of an alternative car fuel using maize.



Name products A, B and C and describe the steps in their production. **5**

Question 2 is on *page twenty-eight*

DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWER TO QUESTION 1

Please complete the box below to indicate which part, A or B, you are answering.

Marks

2. Answer **either** A **or** B.

A. Describe the structure of a virus and the stages in its replication.

(Labelled diagrams may be used in your answer). **5**

OR

B. Compare the processes of aerobic and anaerobic respiration in yeast in terms of raw materials used and products formed.

(A table may be used in your answer). **5**

[*END OF QUESTION PAPER*]

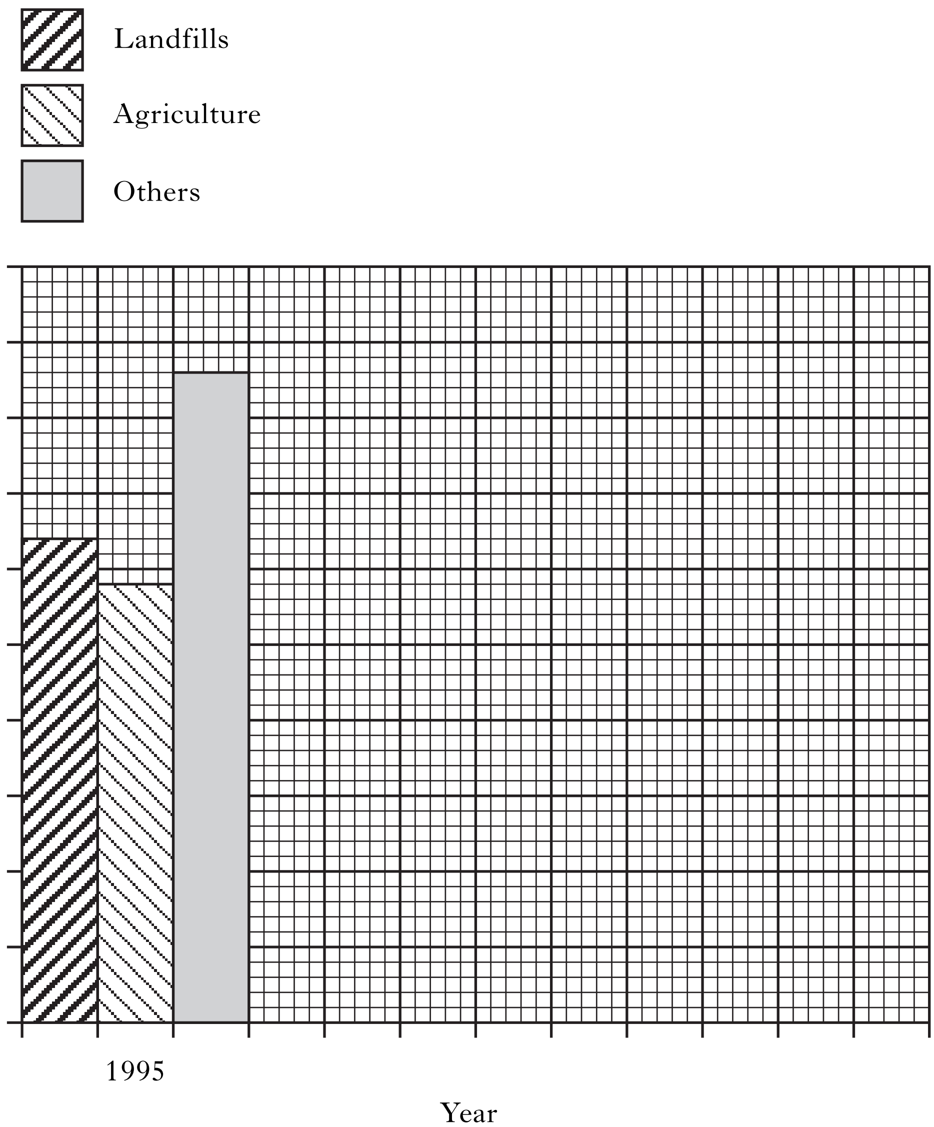
DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWER TO QUESTION 2

Please complete the box below to indicate which part, A or B, you are answering.

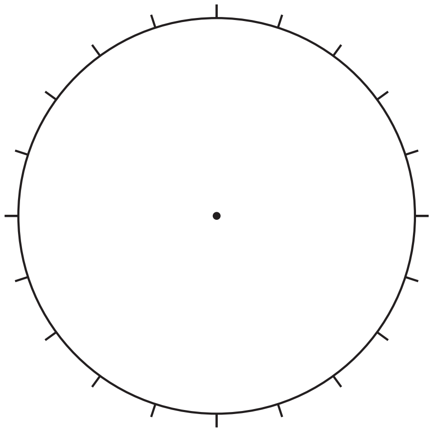
SPACE FOR ANSWERS

ADDITIONAL GRAPH PAPER FOR QUESTION 4(*a*)



ADDITIONAL SPACE FOR ANSWERS

ADDITIONAL PIE CHART FOR QUESTION 6(*b*)(ii)



DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS