FOR OFFICIAL USE

Total for Sections B and C

X008/301

NATIONAL QUALIFICATIONS 2010

TUESDAY, 18 MAY
1.00 PM – 3.30 PM

BIOTECHNOLOGY HIGHER

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 (30 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 (100 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 Higher (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 examination, put the **answer sheet for Section A inside the front cover of this answer book**.

Sample Question

What name is given to a culture of micro-organisms which contains more than one species of organisms?

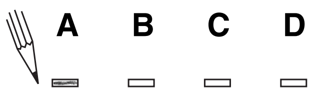
A Mixed

B Pure

C Simple

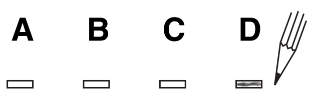
D Complex

The correct answer is **A**—Mixed. 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**.



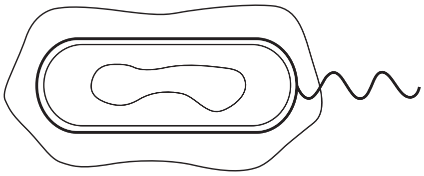
SECTION A

All questions in this Section should be attempted.

Answers should be given on the separate answer sheet provided.

Questions 1 and **2** are based on the diagram shown below.

The diagram shows a bacterial cell.



1. Which line in the table identifies correctly the bacterium?

A	bacillus	motile	has capsule
B	coccus	motile	has no capsule
C	bacillus	non-motile	has capsule
D	coccus	non-motile	has no capsule

2. If the bacterium appeared to be 3·2 mm in length at a magnification of × 800, what is the actual length of the cell?

A 0·4 μm

B 2·56 μm

C 4·0 μm

D 25·6 μm

3. All viruses consist of a protein coat surrounding

A DNA only

B RNA only

C DNA and RNA

D DNA or RNA.

4. A DNA mutation is shown below

TTCGCGTTA
AAGCGCAAT

↓

TTCGGCTTA
AAGCCGAAT

This type of mutation is called

A substitution

B insertion

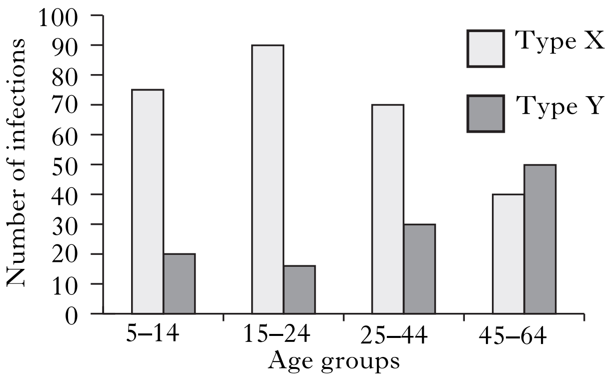
C deletion

D inversion.

[Turn over

Questions 5 and **6** are based on the information given below.

The graph below shows the incidence of two different types of meningitis infection in different age groups in England and Wales in 2005.



5. In which age group did the most meningitis infections occur in 2005?

A 5–14 years

B 15–24 years

C 25–44 years

D 45–64 years

6. Which of the following statements is supported by the data in the graph?

A The number of infections caused by type Y increases with age.

B There were more meningitis infections in people aged under 25 than in people aged 25 and over.

C Type Y meningitis caused more infections than type X in people aged 25 and over.

D Type X meningitis caused more infections than type Y in all age groups.

7. Which line in the table below describes correctly the properties of plasmids and bacterial chromosomes?

	Plasmid	*Bacterial chromosome*
A	Non-essential genes	Essential genes
B	Single-stranded DNA	Double-stranded DNA
C	Circular	Linear
D	In cytoplasm	In nucleus

8. The enzyme that catalyses the addition of nucleotides to the 3' end of a strand of DNA is called

A ligase

B endonuclease

C polymerase

D transcriptase.

9. The following events occur during protein synthesis.

1 bonds form between amino acids

2 mRNA is attached to the ribosome

3 codons and anticodons pair up

4 tRNAs bring amino acids to the ribosome

The correct sequence of events is

A 4 2 3 1

B 2 3 4 1

C 2 4 3 1

D 4 2 1 3.

10. Yeast is used instead of bacteria as a recipient for foreign DNA because of yeast's ability to

A grow rapidly

B produce proteins

C be manipulated easily

D carry out post-translational modification.

11. The cell-mediated response in immunity involves

A B-lymphocytes

B bacteriophages

C T-lymphocytes

D antibodies.

12. Injection of tetanus antitoxin into someone infected with tetanus is an example of

A artificial active immunity

B natural passive immunity

C artificial passive immunity

D natural active immunity.

13. Phagocytes contain many lysosomes so that

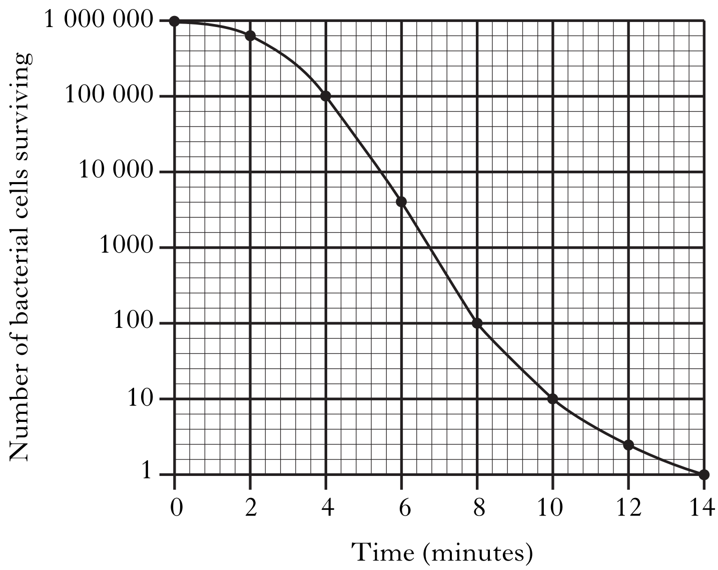
A antibodies can be released in response to bacterial antigens

B viruses can be engulfed by the cytoplasm

C enzymes which destroy bacteria can be stored

D bacteria can be engulfed by the cytoplasm.

14. The number of bacterial cells surviving when heated to 121 °C for different lengths of time is shown in the following graph.



How long does it take for the cell population to be reduced by 90%?

A 2 hours

B 4 hours

C 10 hours

D 12 hours

15. Most species of bacteria can grow on blood agar. Some species will lyse the red blood cells and produce areas of clearing around the colonies.

Blood agar is described as a

A synthetic medium

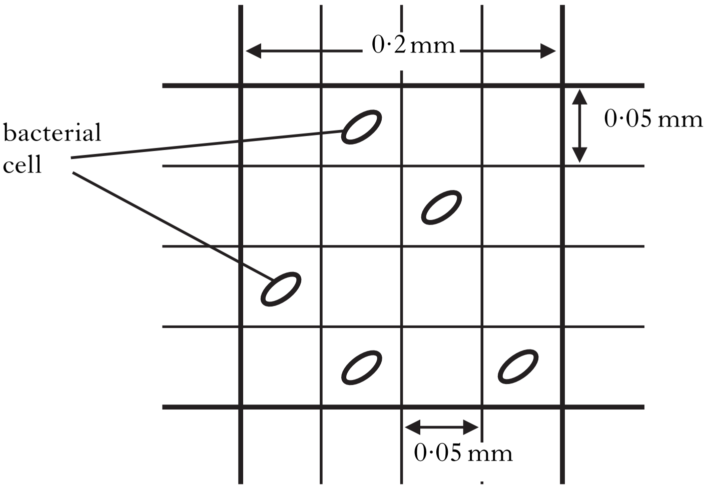
B selective medium

C general purpose medium

D differential medium.

[Turn over

16. A bacterial sample was placed in a haemocytometer chamber with a depth of 0·1 mm. The diagram below shows the results obtained.



The number of bacteria in 1 mm^3 of the sample is

A 5

B 125

C 500

D 1250.

17. Which of the following statements is true?

A Viable count may be less or greater than total count.

B Viable count is always greater than total count.

C Viable count is always equal to total count.

D Viable count is always less than total count.

18. In a biochemical test, cytochrome c activity is an indicator of the presence of

A oxidase

B amylase

C gelatinase

D protease.

19. An experiment to investigate the infection of a bacterial species with a virus was set up following the procedure below.

1 A suspension of virus particles containing 10^7 viruses per cm^3 was used.

2 0·1cm^3 of this viral suspension was added to 9·9 cm^3 of buffer.

3 0·1cm^3 of the diluted viral suspension from stage 2 was added to 0·9 cm^3 of bacterial suspension and mixed.

4 0·1cm^3 of the mixture from stage 3 was added to 1·9 cm^3 of molten agar and poured onto the surface of a nutrient agar plate.

5 After incubation, plaques were observed among the growing bacteria.

How many viral particles were added to the nutrient agar plate at stage 4?

A 50

B 5×10^2

C 1×10^3

D 1×10^4

20. In downstream processing, chalk or lime can be added to precipitate

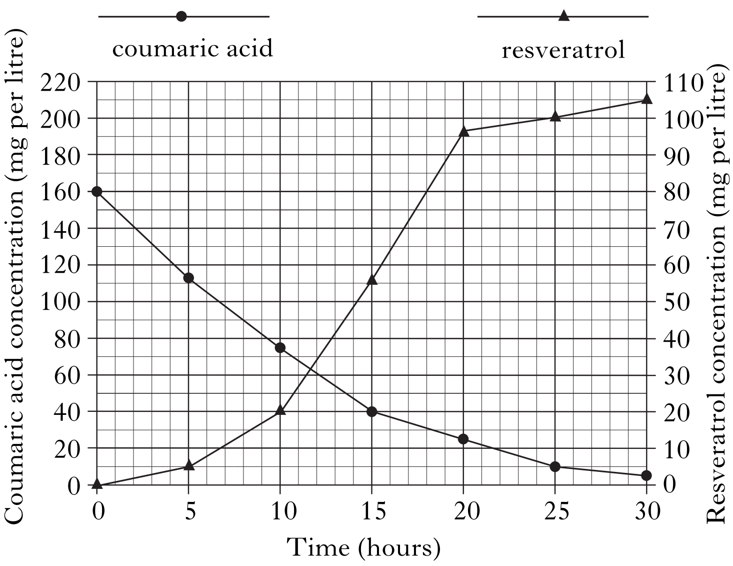
A citric acid

B penicillin

C pectinase

D lysozyme.

21. When genetically modified *E. coli* are grown in a medium containing coumaric acid, the metabolite resveratrol can be produced. The graph below shows coumaric acid and resveratrol concentrations in the culture.



When the coumaric acid concentration is 30 mg per litre, the resveratrol concentration is

A 15 mg per litre

B 44 mg per litre

C 70 mg per litre

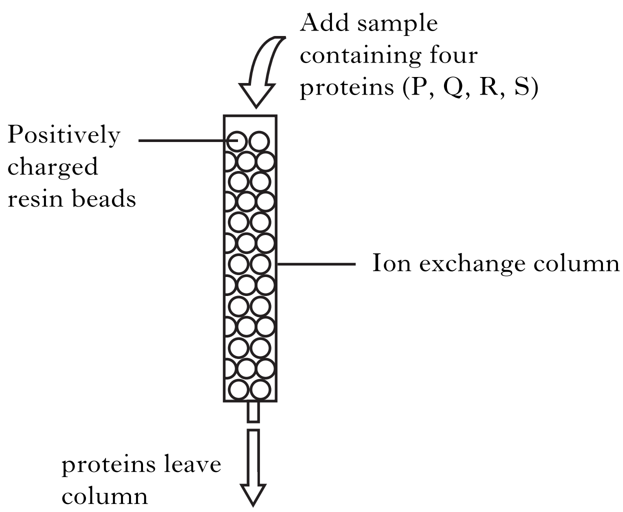
D 80 mg per litre.

22. Following the production of alcohol by yeast, the yeast and alcohol are separated from the medium.

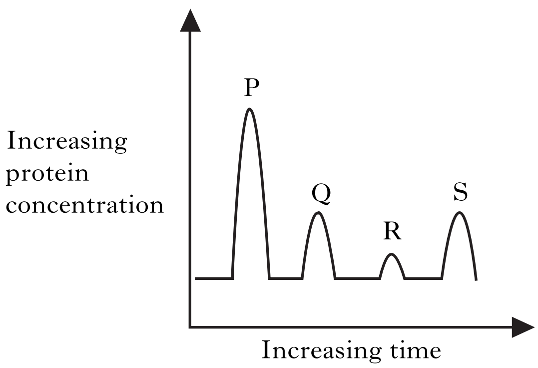
Which line in the table describes correctly the techniques used to separate the yeast and alcohol from the medium?

	Separation of yeast	*Separation of alcohol*
A	flocculation	distillation
B	distillation	flocculation
C	fermentation	distillation
D	flocculation	fermentation

23. Ion exchange chromatography can be used to purify proteins.



The more negatively-charged the protein, the longer it takes to pass through the column. The following diagram shows the time taken for the four proteins to leave the column.



What conclusion can be drawn from this experiment?

A Protein P is more negatively-charged than protein R.

B Protein R is less negatively-charged than protein Q.

C Protein S is more negatively-charged than protein Q.

D Protein S is less negatively-charged than protein R.

[Turn over

24. Which of the following are used for crop protection?

1 Spray plants with *Bacillus thuringiensis*

2 Culture plants from callus tissue

3 Transfer gene for herbicide resistance into plants

4 Transfer gene for Bt toxin into plant

A 1, 2 and 3 only

B 1, 3 and 4 only

C 2, 3 and 4 only

D 1, 2 and 4 only

25. Protoplasts are formed by the removal of the

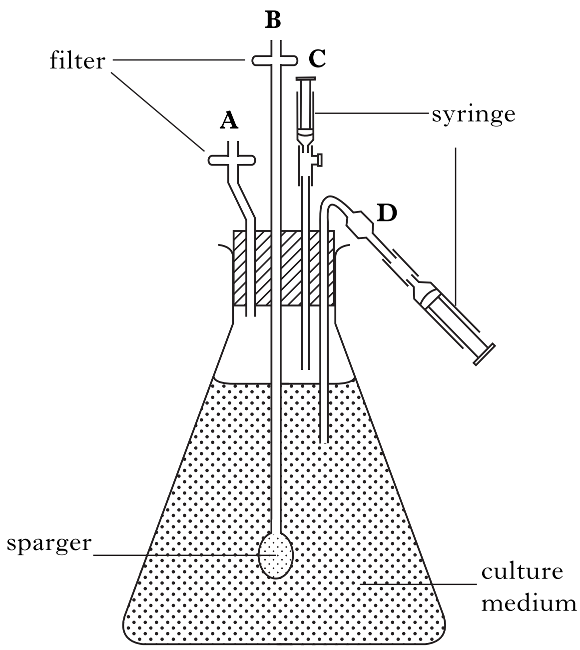
A cell membrane

B cell wall

C cell sap vacuole

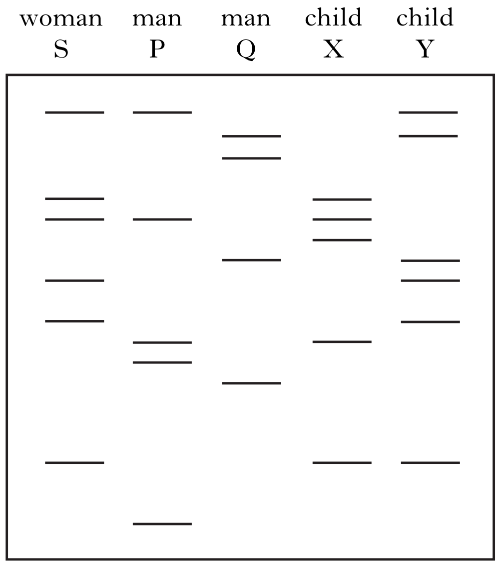
D cell cytoplasm.

26. The diagram below shows a simple laboratory fermenter.



Which port would be used for release of excess air pressure?

27. The diagram below shows the results of a paternity test. Woman S is the mother of child X and Y.



Which of the following conclusions can be drawn from these results?

A Man P is the father of child Y

B Man Q is the father of child Y

C Man P is the father of child X

D Man Q is the father of child X

28. What use is made of the enzyme pectinase?

A Disruption of bacterial cells

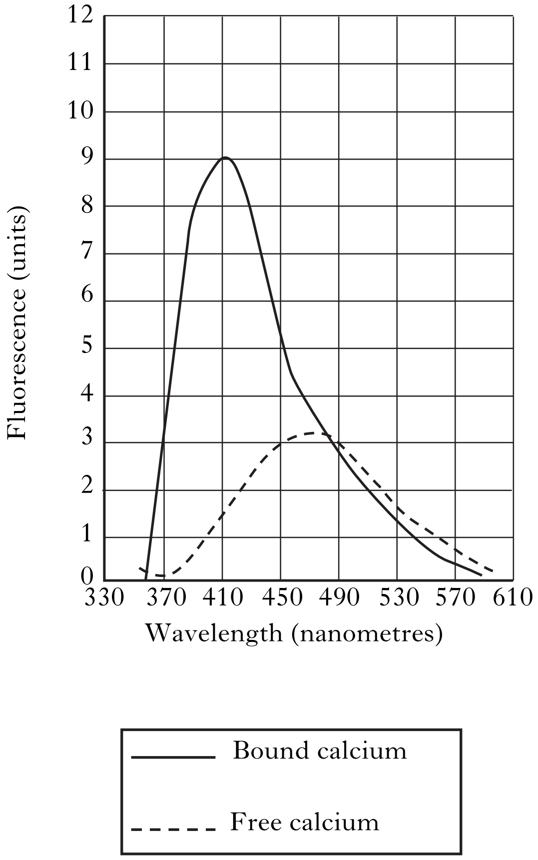
B Conversion of waste to animal feed

C Removal of clots after heart attacks

D Clarification of fruit juice

29. Biosensors have been developed to detect changes in calcium levels within the body.

The graph below shows free and bound calcium levels detected at various wavelengths.



What is the simple whole number ratio of bound to free calcium at a wavelength of 410 nanometres?

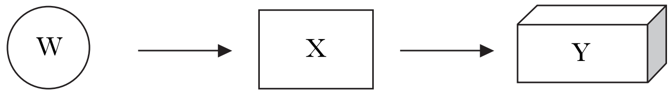
A 1:6

B 6:1

C 18:3

D 3:18

30. The diagram below shows the components of a biosensor.



Which line in the table below identifies correctly the components?

	W	*X*	*Y*
A	enzyme	transducer	detector
B	detector	transducer	enzyme
C	transducer	enzyme	detector
D	enzyme	detector	transducer

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

[Turn over for Section B on *Page ten*

SECTION B

All questions in this section should be attempted.
All answers must be written clearly and legibly in ink.

1. Some characteristics of four bacterial species are shown in Table 1.

Table 1

Bacterial species	*Gram reaction*	*Shape*	*Catalase reaction*	*Spores produced*	*Aerobic/ Anaerobic*
Escherichia coli	Negative	Bacillus	Positive	No	Facultative anaerobe
Micrococcus luteus	Positive	Coccus	Positive	No	Obligate aerobe
Clostridium tetani	Positive	Bacillus	Negative	Yes	Obligate anaerobe
Staphylococcus epidermidis	Positive	Coccus	Positive	No	Facultative anaerobe

Using the information in Table 1, answer the following questions.

(*a*) Name the bacterial species that would appear pink and rod-shaped when viewed under the microscope following Gram staining.

____ **1**

(*b*) *Clostridium tetani* can be differentiated from the other three species using a biochemical test.

Name the chemical used in this test.

____ **1**

(*c*) All four bacteria were heated to 100 °C, inoculated on to agar plates and then incubated.

Name the species that would be likely to grow and give a reason for your answer.

Name ____________________________________

Reason ____ **1**

Marks

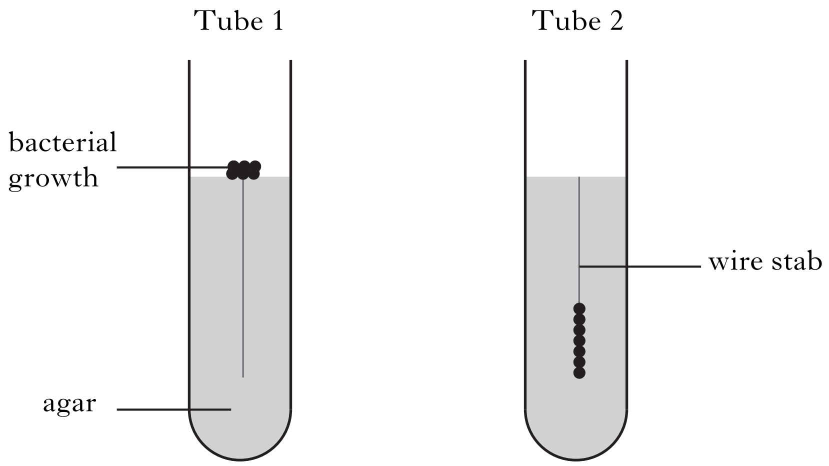
1. (continued)

(*d*) What result would be expected if the four species were inoculated on agar plates containing penicillin and then incubated?

____ **1**

(*e*) Three tubes of agar were inoculated by stabbing with a wire. Each tube was inoculated with a different bacterial species from Table 1.

The diagram below shows the tubes after incubation.



Complete the table below by naming a bacterial species from Table 1 that could have been used to inoculate each tube.

	Name of bacterial species
Tube 1	
Tube 2	
Tube 3	

2

[Turn over

Marks

2. (*a*) Part of the DNA sequence of a gene in a yeast cell is shown in the figure below.

AATCTATCATCAGCATTC

(i) In a double-stranded section of DNA with this sequence, what percentage of the bases would be guanine?

Space for calculation

______________ % **1**

(ii) The table below shows the mRNA codons for five amino acids.

mRNA codon	*Amino acid*
CGU	Arginine (arg)
GAU	Aspartate (asp)
UUA	Leucine (leu)
AAG	Lysine (lys)
AGU	Serine (ser)

Using the information in the table, give the amino acid sequence which would be coded for by the DNA sequence shown in the figure above.

Space for working

Amino acid sequence ____ **1**

Marks

2. (continued)

(*b*) mRNA is transcribed from DNA. The mRNA is then transported from the nucleus to the cytoplasm.

Describe the difference between the mRNA in the nucleus and the mRNA in the cytoplasm.

____

____ **2**

(*c*) The following cell structures are involved in the synthesis and secretion of proteins.

W Golgi apparatus

X Nucleus

Y Ribosome

Z Endoplasmic reticulum

The nucleus is the cell structure which is involved first in these processes.

Use the letters to complete the order in which each of the other cell structures become involved in the process.

First __**X**__

Second _____

Third _____

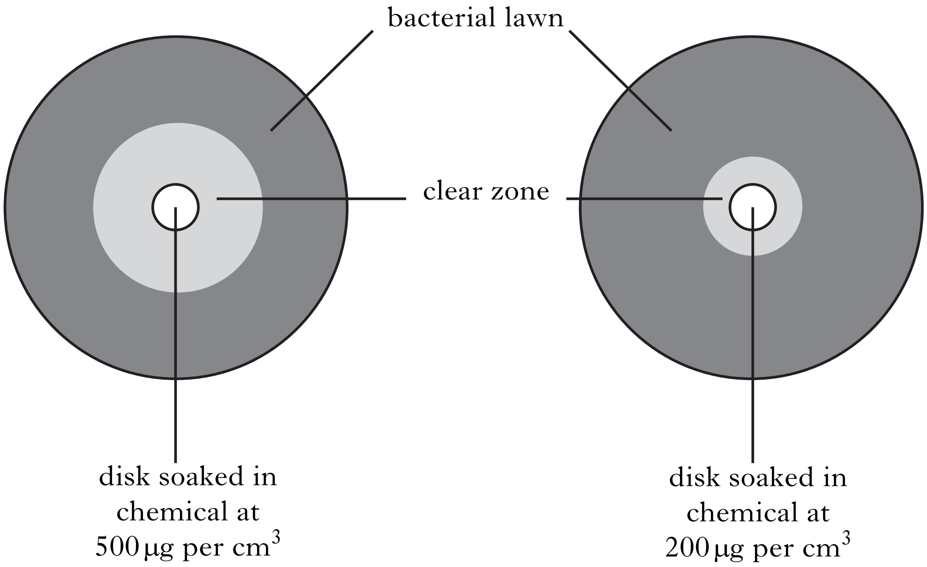
Fourth _____ **1**

[Turn over

3. An investigation was carried out into the effectiveness of two concentrations of a chemical that could be used to disinfect work surfaces.

Filter paper disks were soaked with each concentration of the chemical and placed in the centre of a bacterial lawn.

The results are shown below.



(*a*) Describe the steps involved in preparing a bacterial lawn using a broth culture and an agar plate.

____

____

______________________________ **2**

(*b*) Explain why the same concentration of bacterial cells must be spread on each plate.

______________________________ **1**

(*c*) The two concentrations of the chemical were prepared by diluting a 5 mg per cm^3 stock solution.

What dilution factor would be needed to make the 500 µg per cm^3 concentration of the chemical?

Space for calculation

dilution factor ______________ **1**

Marks

3. (continued)

(*d*) The clear zones on the plates were measured. The result is shown in the table below.

Dilution	500 µg per cm^3	200 µg per cm^3
Diameter of clear zone (mm)	25	15

Calculate the simple whole number ratio of the diameter of the clear zones produced by the 500 µg per cm^3 and 200 µg per cm^3 dilutions.

Space for calculation

__________ 500 µg per cm^3 : __________ 200 µg per cm^3 **1**

(*e*) In a further experiment, the chemical was shown to have a **biostatic** effect on bacteria.

What is meant by a biostatic effect?

____

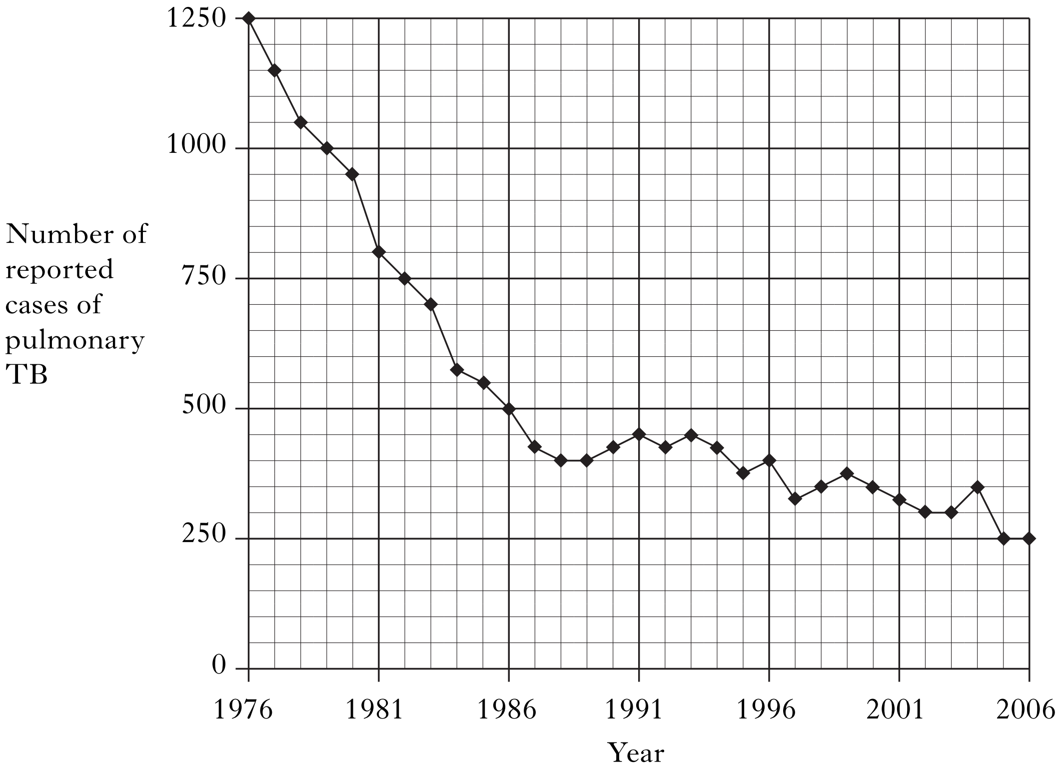
____ **1**

[Turn over

Marks

4. Pulmonary tuberculosis (TB) is a disease of the lungs caused by a bacterium.

The graph below shows the number of cases of pulmonary TB reported in Scotland between 1976 and 2006.



(*a*) Using data from the graph, describe the trend in the number of cases of TB in Scotland between 1976 and 1990.

____

____

____ **2**

(*b*) What was the percentage decrease in the number of cases between 1977 and 1982?

Space for calculation

__________ % **1**

(*c*) During which two consecutive years did the number of cases show the greatest decline?

from ________ to ________ **1**

Marks

4. (continued)

The bacterium that infects the lungs causing pulmonary TB can also damage other organs in the body.

When other organs are damaged, the disease is called **non-pulmonary TB**.

The table below shows the number of reported cases of non-pulmonary TB in Scotland for selected years in the same time period.

Year	*Number of reported cases of non-pulmonary TB*
1976	217
1981	140
1986	178
1991	97
1996	103
2001	115
2006	154

(*d*) Using the graph and the table, what percentage of all TB cases in 1986 were non-pulmonary TB?

Space for calculation

______________ % **1**

(*e*) Some strains of tuberculosis are resistant to treatment with antibiotics. Suggest how antibiotic resistance could be spread between bacterial strains.

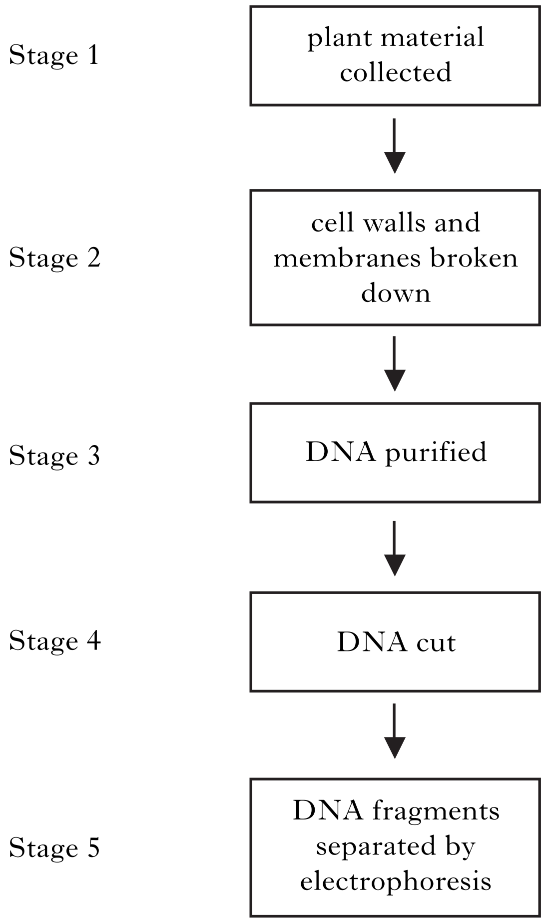
____ **1**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

5. The diagram below shows some of the stages involved in the separation of fragments of DNA from plant material.



(*a*) Describe how the plant cell walls and membranes could be broken down at Stage 2.

____ **1**

(*b*) Name the substance which is removed at Stage 3 when purifying DNA.

____________________________ **1**

(*c*) Restriction endonucleases are enzymes used to cut the DNA at Stage 4. What determines where these enzymes cut the DNA?

____ **1**

Marks

5. (continued)

(*d*) The fragments are separated by gel electrophoresis.

In the following sentences **underline** one of the alternatives in each pair to make the sentences correct.

The DNA travels through the gel towards the $\left\{\begin{matrix}\text{positive}\\\text{negative}\end{matrix}\right\}$ electrode.

The fragments of DNA are separated according to $\left\{\begin{matrix}\text{size}\\\text{charge}\end{matrix}\right\}$. **2**

(*e*) Labelled probes are used to locate desired fragments of DNA.

Describe the features of a labelled probe.

____

____ **2**

[Turn over

Marks

6. A technician prepared media for use in a research laboratory using the following method.

1 Agar powder was weighed and added to a flask.

2 Water was added to the flask which was then heated.

3 The molten agar was transferred into bottles.

4 The bottles were autoclaved.

5 After cooling, plates were poured using the agar from the bottles.

(*a*) The agar is prepared by adding 20 g of agar powder per litre of water.

If each plate receives 25 cm^3 of molten agar, how much agar powder and water should be mixed for pouring 20 plates?

Space for calculation

__________ g agar powder __________ cm^3 water **1**

(*b*) Describe **one** safety precaution that should be taken:

(i) when weighing out agar powder;

______________________________ **1**

(ii) before placing bottles into an autoclave.

______________________________ **1**

(*c*) What would be placed into the autoclave to check that sterilisation was successful?

______________________________ **1**

(*d*) The medium prepared was a selective medium

Describe what is meant by selective medium.

____

______________________________ **1**

(*e*) Give **two** reasons why poured plates might be rejected for use.

1 ______________________________

2 ______________________________ **1**

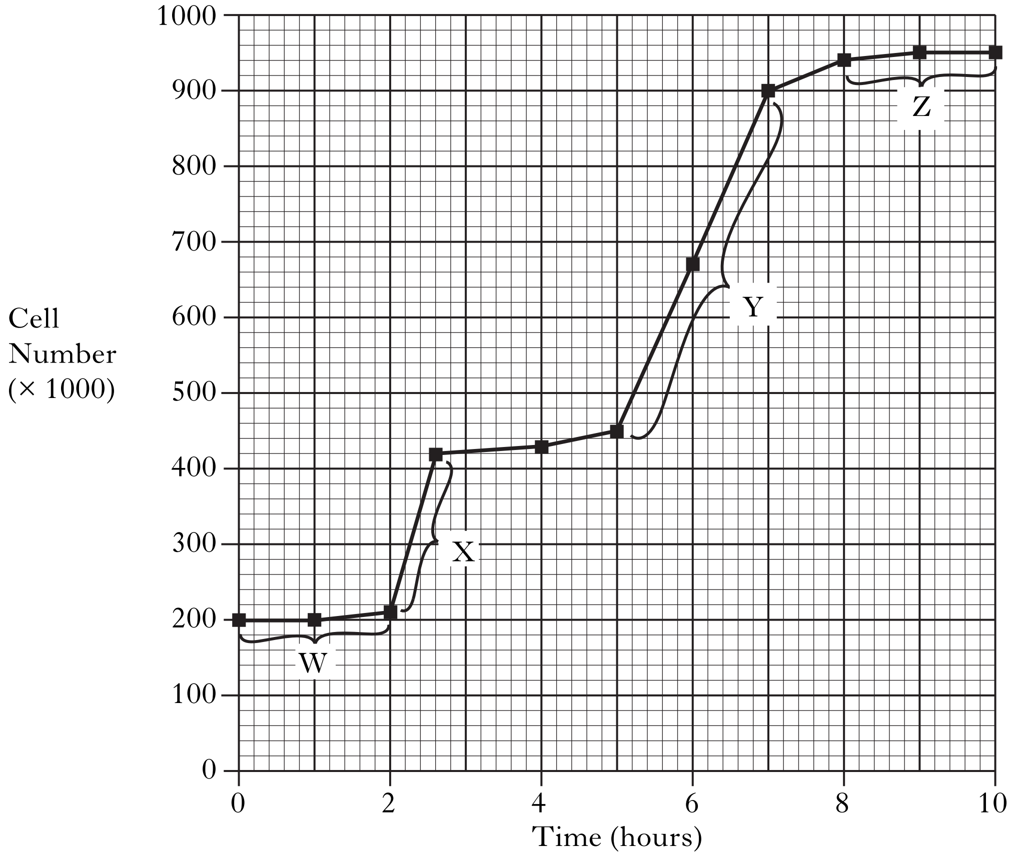
[Turn over for Question 7 on *Page twenty-two*

Marks

7. *E. coli* is grown in a medium containing two sugar sources, glucose and lactose.

The cells will metabolise glucose first and then lactose.

The graph shows a growth curve for *E. coli* grown in this medium.



(*a*) Name the stages of growth indicated by W and X on the graph.

W ______________________________

X ______________________________ **1**

(*b*) (i) At what time do the cells change from glucose to lactose metabolism.

______________________________ **1**

(ii) Calculate the mean generation time during stage Y.

Space for calculation

______________ **1**

7. (*b*) (continued)

(iii) Compare the growth rate when the cells are in phase X with the growth rate during phase Y.

____

______________________________ **1**

(iv) Calculate the percentage increase in cell number from 0 to 10 hours.

Space for calculation

__________ % **1**

(*c*) Explain why the cell population levels off at stage Z.

____

______________________________ **1**

(*d*) Lactose metabolism in *E. coli* is controlled by the *lac* operon.

Describe the action of the *lac* operon in the presence of lactose.

____

____

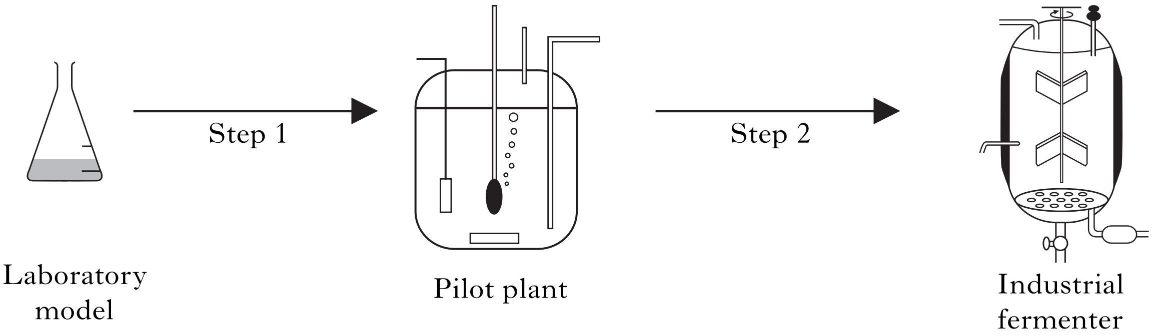
____

______________________________ **3**

[Turn over

Marks

8. The diagram below shows the stages in developing the industrial production of the enzyme amylase by micro-organisms.



(*a*) (i) Name **two** conditions for microbial growth that are optimised at the laboratory model stage.

1 ______________________________

2 ______________________________ **1**

(ii) What term is used to describe Step 1?

______________________________ **1**

(iii) A pilot plant can be used to determine the costs involved in the production process.

State **two** other reasons for the pilot plant stage.

1 ______________________________

____

2 ______________________________

______________________________ **2**

(*b*) (i) Industrial fermenters are usually made from stainless steel. Give **two** reasons why stainless steel is used.

1 ______________________________

2 ______________________________ **1**

(ii) The room in which an industrial fermenter is located must be designed to minimise contamination in the event of a large-scale spillage.

Suggest **two** design features required in such a room.

1 ______________________________

2 ______________________________ **2**

8. (continued)

(*c*) The micro-organism in the fermenter produces an extracellular enzyme. Explain how the method for the isolation of an extracellular enzyme is different to that used for an intracellular enzyme.

____

____

____ **2**

(*d*) Once the enzyme has been isolated it can be immobilised.

(i) Name and describe **one** method of enzyme immobilisation.

Name ______________________

Description ______________________________

____ **1**

(ii) State **two** advantages, apart from cost, of using an immobilised enzyme.

1 ____

2 ____ **1**

[Turn over

9. Arsenic is a contaminant of soil and is known to be harmful to living organisms.

Studies have shown that a species of fern can accumulate arsenic from soil into its rhizomes (roots) and fronds (leaves). Therefore, ferns could be used to remove arsenic from contaminated soil.

In a laboratory experiment, ferns from different countries were grown in soil containing arsenic. The plants were harvested and the concentration of arsenic in the rhizomes and fronds was measured.

The results are shown in the table below.

Country of origin of fern	*Concentration of arsenic in rhizomes and fronds of fern* (mg *arsenic*/kg *plant material*)	
	Rhizomes	*Fronds*
China	150	415
Poland	160	355
UK	165	180
India	155	160

(*a*) Construct a **bar graph** of this data. **2**

(Additional graph paper, if required, can be found on *Page thirty-five*.)

Marks

9. (continued)

(*b*) Apart from temperature, describe **two** variables that should be controlled when setting up this experiment.

1____

2____ **2**

(*c*) Explain why the concentration of arsenic was calculated in mg/kg of plant material.

____

____ **1**

(*d*) Compare the concentration of arsenic in plants from UK and India with that of plants from China and Poland.

____

____

____ **2**

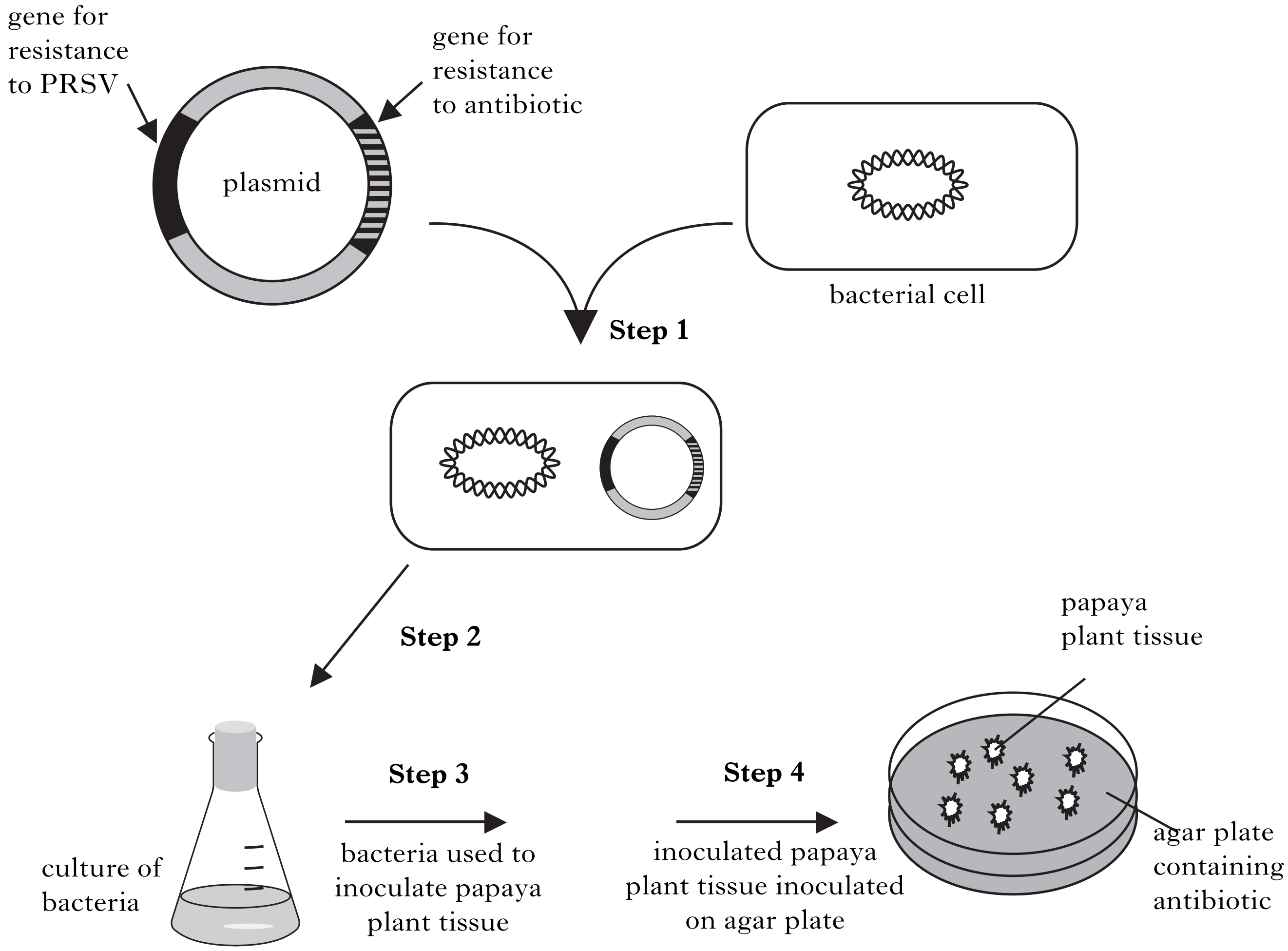
(*e*) What term can be used to describe the process in which plants are used to remove toxic agents from the environment?

____ **1**

[Turn over

10. Papaya is a tropical fruit that is susceptible to Papaya Ringspot Virus (PRSV). A transgenic papaya plant resistant to PRSV has been produced.

An outline of the production of the transgenic papaya is shown below.



(*a*) (i) Name a species of bacteria used in the production of transgenic plants.

______________________________ **1**

(ii) Suggest a reason why this bacterial species is used.

____

______________________________ **1**

(*b*) Name the process shown in Step 1.

______________________________ **1**

Marks

10. (continued)

(*c*) Explain why antibiotic is included in the agar plate.

____

____ **2**

(*d*) (i) Describe a suitable control for this experiment.

____

____ **1**

(ii) Explain why a control is necessary in this experiment.

____

____ **1**

(*e*) Describe the steps that would be taken to produce many identical plants from the papaya plant tissue grown on the agar plate.

____

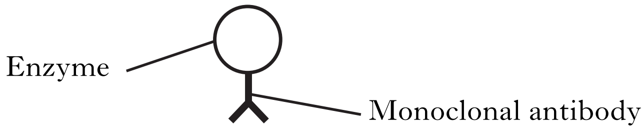
____

____ **2**

[Turn over

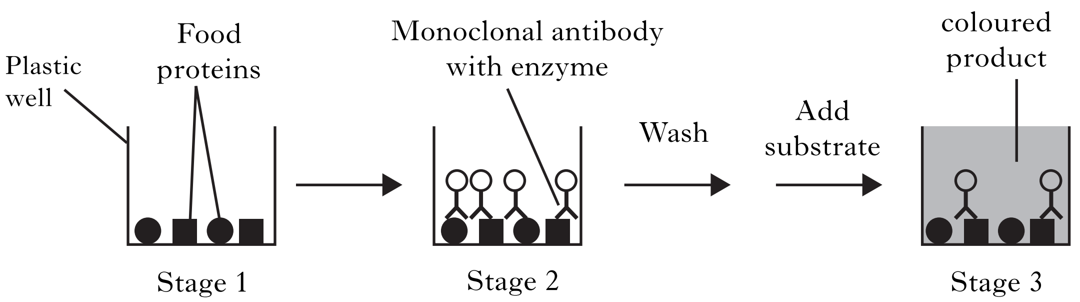
Marks

11. Monoclonal antibodies can be used to detect the presence of specific proteins in food samples. An enzyme is attached to the monoclonal antibody.



The enzyme reacts with a substrate to produce a coloured product.

Some stages involved in detecting food proteins using these monoclonal antibodies are shown below.



Stage 1: Sample of food added to plastic well. Food proteins stick to plastic.

Stage 2: Excess monoclonal antibody with enzyme added to well. It attaches to specific protein, if present.

Stage 3: Attached enzyme turns added substrate into coloured product. Intensity of coloured product is measured.

(*a*) Explain why the intensity of coloured product is related to the concentration of the protein in the food sample.

____

____ **2**

(*b*) Explain why **excess** monoclonal antibody was added to the well at Stage 2.

____

____ **1**

(*c*) Explain why the wells were washed between Stages 2 and 3.

____

____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

11. (continued)

(*d*) (i) Describe how a monoclonal antibody is produced.

____

____

______________________________ **2**

(ii) Give **one** other use of monoclonal antibodies.

______________________________ **1**

[Turn over for Section C on *Page thirty-two*

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.

All answers must be written clearly and legibly in ink.

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

Labelled diagrams may be used where appropriate.

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

A. Give an account of microbial fermentation under the following headings:

(*a*) production of ATP and its role in the cell; **2**

(*b*) aerobic respiration; **6**

(*c*) anaerobic respiration. **2**

(10)

OR

B. Discuss unicellular and multicellular fungi under the following headings:

(*a*) structure; **5**

(*b*) reproduction; **3**

(*c*) uses. **2**

(10)

In Question 2 ONE mark is available for coherence and ONE mark is available for relevance.

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

A. Discuss the use of batch and continuous flow processes in biotechnology. **(10)**

OR

B. Describe the new techniques used for animal breeding. **(10)**

[*END OF QUESTION PAPER*]

SPACE FOR ANSWERS

SPACE FOR ANSWERS

SPACE FOR ANSWERS

ADDITIONAL GRAPH PAPER FOR USE IN QUESTION 9 (*a*)