FOR OFFICIAL USE

Total for Sections B and C

X008/201

NATIONAL QUALIFICATIONS 2011

TUESDAY, 17 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 final 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.

SQA ©

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 examination, 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?

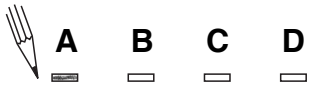
A Butter

B Bread

C Sugar

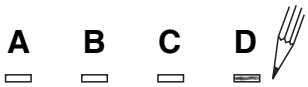
D Apple

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 line in the table below identifies the part of a micro-organism with its correct function?

	Part of micro-organism	*Function*
A	Nucleus	Site of respiration
B	Cell wall	Controls entry and exit of materials
C	Cytoplasm	Site of chemical reactions
D	Vacuole	Site of photosynthesis

2. In the protozoa *Paramecium*, the function of the contractile vacuole is to

A trap light energy

B remove excess water

C help the cell move

D control the entry of materials.

3. Which of the following combinations of microscope lenses provides the **highest** total magnification?

	Eyepiece lens magnification	*Objective lens magnification*
A	×4	×100
B	×8	×80
C	×10	×40
D	×15	×40

4. Asexual reproduction in bacterial cells results in a

A high number of identical cells

B high number of non-identical cells

C low number of identical cells

D low number of non-identical cells.

5. The summary equation for aerobic respiration is

X + oxygen ⟶ energy + carbon dioxide + Y

Which line in the table below correctly identifies X and Y?

	X	Y
A	Glucose	Water
B	Lactic acid	Ethanol
C	Glucose	Lactic acid
D	Water	Glucose

6. The synthesis of enzymes involves the joining together of molecules of

A glucose

B chitin

C amino acids

D cellulose.

7. Which of the following pieces of equipment is **not** suitable for **transferring** a block of agar containing fungal mycelium from one agar plate to another?

A Forceps

B Scalpel

C Wire loop

D Mounted needle

8. Which line in the table below correctly identifies the melting and setting temperatures of nutrient agar?

	Melting temperature (°C)	*Setting temperature* (°C)
A	55	20
B	95	20
C	55	42
D	95	42

9. A malt agar plate was inoculated with a plug of *Mucor* of area $0{\cdot}6\,cm^2$. After 3 days, the *Mucor* had grown to cover an area of $57{\cdot}6\,cm^2$.

The average growth per day of the *Mucor* was

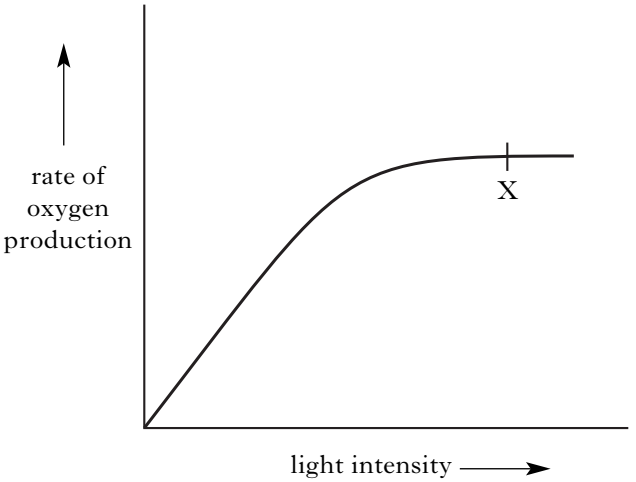
A $17{\cdot}2\,cm^2$ per day

B $19{\cdot}0\,cm^2$ per day

C $19{\cdot}2\,cm^2$ per day

D $57{\cdot}0\,cm^2$ per day.

10. The graph below shows the effect of increasing light intensity on the rate of oxygen production in a culture of photosynthetic algae.



Two factors which could be limiting photosynthesis at point X are

A temperature and carbon dioxide concentration

B light intensity and carbon dioxide concentration

C temperature and oxygen concentration

D light intensity and oxygen concentration.

Questions **11** and **12** refer to the following information.

An experiment was set up to investigate the increase in biomass of the algae *Chlorella* in different conditions.

The table below shows the effect of light intensity and nitrate concentration on the increase in biomass measured after 48 hours.

Flask	*Light intensity* (units)	*Concentration of nitrate* (mg per litre)	*Percentage increase in biomass* (%)
P	2	1	4
Q	4	2	8
R	4	3	10
S	6	3	16

11. Which flasks should be compared to show the effect of light intensity on biomass?

A P and Q

B P and R

C Q and R

D R and S

12. A valid conclusion from comparing flasks Q and R is

A as nitrate concentration increases, biomass decreases

B as nitrate concentration increases, biomass increases

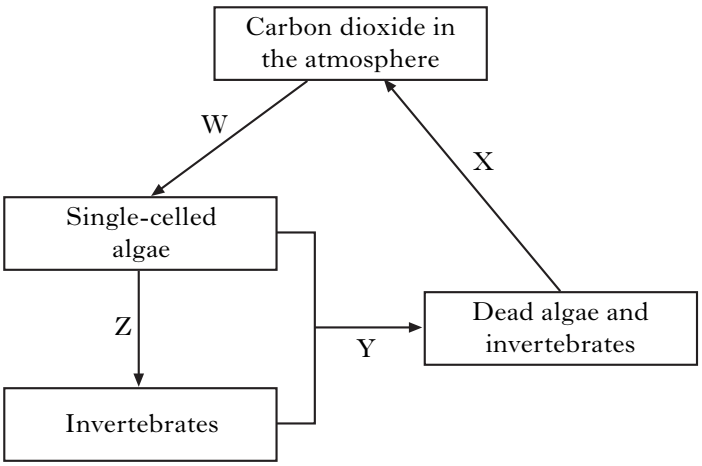
C as light intensity increases, biomass decreases

D as light intensity increases, biomass increases.

13. Which line in the table below matches the micro-organism with its correct commercial product?

	Micro-organism	*Commercial product*
A	*Saccharomyces*	Ethanol
B	*Zygomonas*	Whey
C	*Lactobacillus*	Methane
D	*Mucor*	Penicillin

14. The diagram below shows some of the steps involved in the carbon cycle in the oceans.



Which of these steps represents respiration?

A W

B X

C Y

D Z

15. Fermentation of sugars from energy crops, such as maize, produces ethanol.

Mixing ethanol with petrol produces

A methane

B carbon dioxide

C ammonia

D gasohol.

16. Which line in the table below correctly identifies features of a successful commercial production of single cell protein?

	Cost of raw material	*Effect of raw material on environment*	*Protein content of product*
A	Cheap	Polluting	High
B	Expensive	Polluting	Low
C	Cheap	Non-polluting	High
D	Expensive	Non-polluting	Low

17. Which of the following statements describes correctly the process of using biological filters during the breakdown of sewage?

A Bubbling air into tanks to create anaerobic conditions

B Bubbling air into tanks to create aerobic conditions

C Trickling effluent through stones to create anaerobic conditions

D Trickling effluent through stones to create aerobic conditions

18. Broad spectrum antibiotics are active against a wide range of

A algae

B bacteria

C protozoa

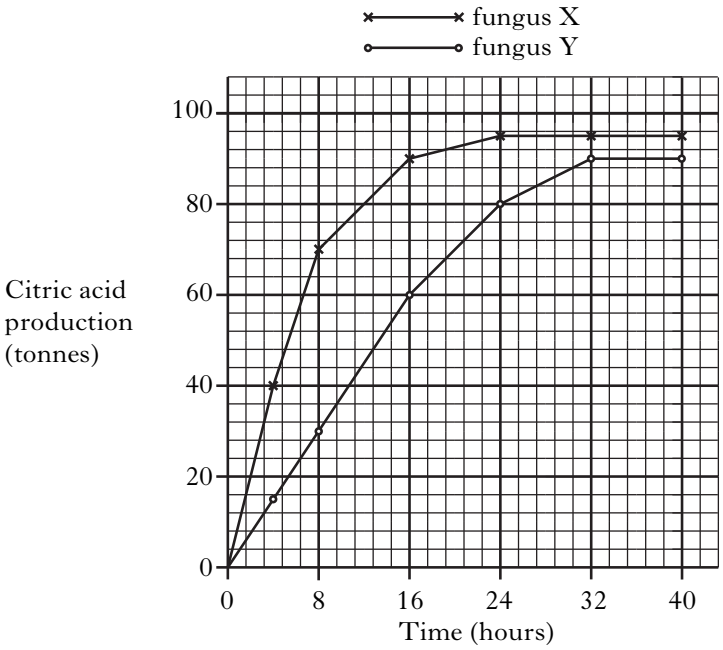
D viruses.

[Turn over

Questions **19**, **20** and **21** refer to the following information about the industrial production of citric acid.

This production depends on a fungus breaking down sugars present in molasses into citric acid in a fermenter.

The graph below shows the results of an investigation into citric acid production in two separate fermenters containing the same quantity of molasses and kept at 25 °C.



19. Which variable was altered in this investigation?

A Citric acid production

B Sugar concentration

C Temperature

D Type of fungus

20. Which of the following statements describes correctly the changes in the contents of both fermenters between 0 and 16 hours?

A Sugar concentration increased and molasses concentration increased

B Citric acid concentration increased and sugar concentration decreased

C Molasses concentration decreased and citric acid concentration decreased

D Citric acid concentration decreased and molasses concentration increased

21. Which of the following conclusions is correct?

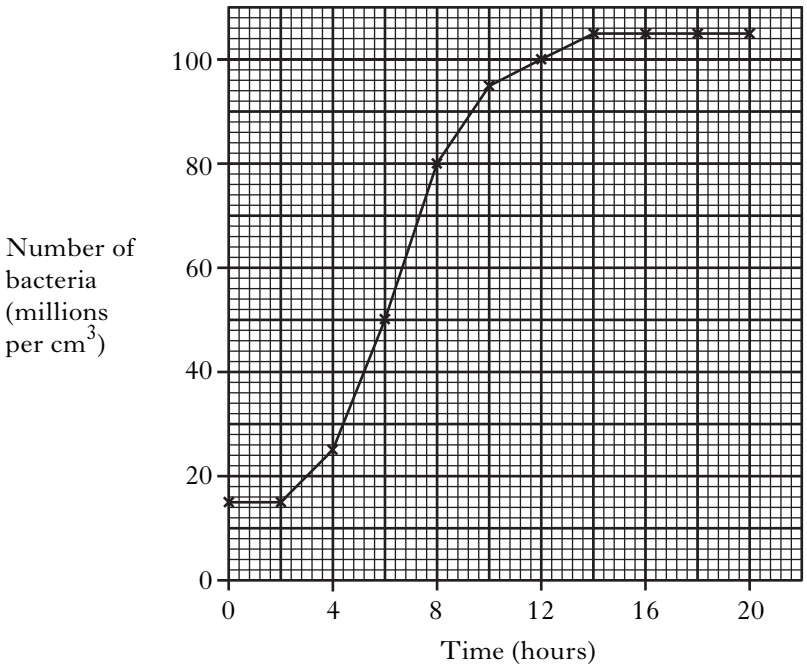
A Fungus X produces citric acid at a slower rate than fungus Y.

B Fungus X produces citric acid at a faster rate than fungus Y.

C Fungus X and fungus Y produce citric acid at the same rate.

D Fungus X and fungus Y eventually produce the same quantity of citric acid.

22. The graph below shows the growth of a population of bacteria over 20 hours.



The population of bacteria doubled during

A 2–4 hours

B 4–6 hours

C 6–8 hours

D 8–10 hours.

23. In the nitrogen cycle, denitrification is the conversion of

A ammonia to nitrate

B nitrogen to nitrate

C nitrate to nitrogen

D protein to nitrogen.

24. The breakdown of organic waste in sewage depends on having

A sediment removed

B aerobic conditions

C anaerobic conditions

D micro-organisms present.

25. One advantage of using tissue culture techniques is to produce a

A large number of identical plants

B small number of identical plants

C large number of non-identical plants

D small number of non-identical plants.

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

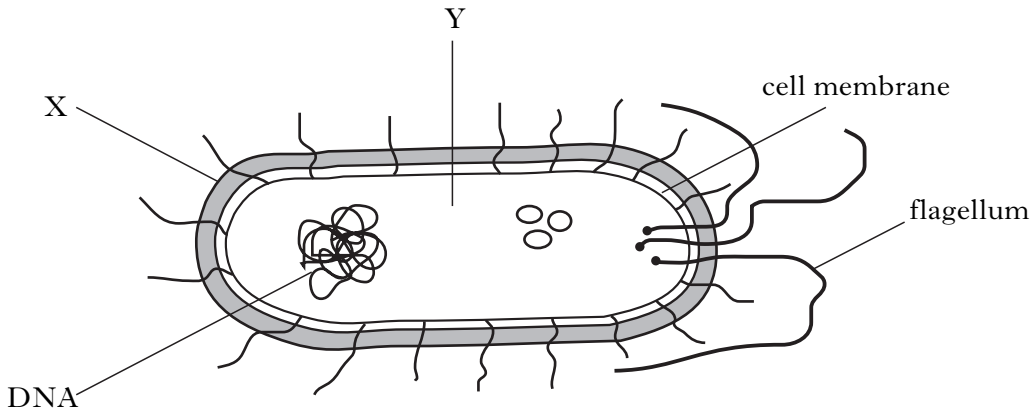
[Turn over for Section B on *Page eight*

Marks

SECTION B

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

1. The diagram below shows the structure of a micro-organism with some of its parts labelled.



(*a*) Name the type of micro-organism shown in the diagram above.

_____ **1**

(*b*) Identify the following parts of the micro-organism.

X _____ **1**

Y _____ **1**

(*c*) State the function of the following parts.

Flagellum _____ **1**

DNA _____ **1**

(*d*) Viruses have a different structure from the micro-organism shown above.
Identify **one** structure found **only** in viruses.
Underline the correct answer.

cell wall protein coat chloroplast plasmid **1**

[Turn over Question 2 on *Page ten*

DO NOT WRITE IN THIS MARGIN

Marks

2. Before starting any microbiological procedure, a student should prepare themself and their work space.

(*a*) Give a reason for each of the following steps in this preparation.

(i) Hand washing

_____

_____ **1**

(ii) Using a smooth work surface

_____

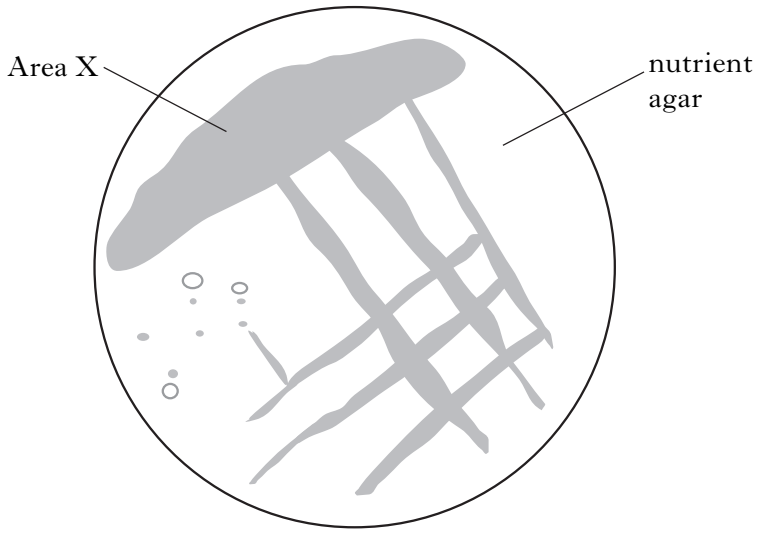
_____ **1**

(iii) Working close to a Bunsen flame

_____

_____ **1**

(*b*) The diagram below shows the result of a procedure which involved inoculating a nutrient agar plate with a sample of bacteria from a mixed broth culture containing *Bacillus subtilis* and *Micrococcus luteus*.



(i) Name the method used in this procedure.

_____ **1**

(ii) Give **one** reason for using this procedure.

_____

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

2. (*b*) (continued)

(iii) Describe how you would use a sterile inoculating loop to create area X.

_____

_____

_____

_____ **2**

(*c*) Bacteria can be identified by cell shape.

Describe the shape of *Bacillus subtilis* and *Micrococcus luteus*.

Bacillus subtilis _____ **1**

Micrococcus luteus _____ **1**

[Turn over

Marks

3. The table below describes some of the stages involved in the fixing of bacteria to a slide.

Stage	*Description*
1	Flame the inoculating loop
2	Transfer sterile water onto slide
3	
4	Transfer micro-organisms to the slide and mix with the sterile water
5	Flame the inoculating loop
6	Lift the slide with sterile forceps
7	

(*a*) Complete the table by describing what happens at stages 3 and 7. **2**

(*b*) After stage 7, the bacteria on the slide are stained with methylene blue.
Explain the reason for staining the bacteria.

_____

_____ **1**

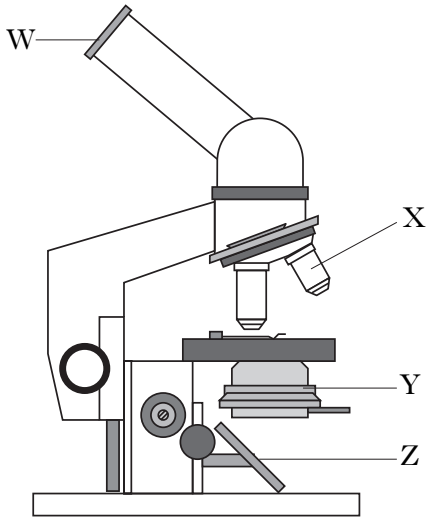
(*c*) Name the type of stain used to observe living micro-organisms.

_____ **1**

Marks

3. (continued)

(*d*) The diagram below shows the light microscope used to view the slide of stained bacteria.



(i) Which letter identifies an objective lens?

Letter _____ **1**

(ii) Complete the table below showing parts of the microscope and their function.

Part of microscope	*Function*
	To hold microscope slide
Eyepiece lens	
Mirror/light source	
	To change distance between stage and objective lens

2

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

4. Scientists are researching the use of photosynthetic algae for the production of fuels.

(*a*) (i) Name the site of photosynthesis in algae.

_____ **1**

(ii) Name a complex carbohydrate made during photosynthesis.

_____ **1**

(*b*) Photosynthesis involves the fixation of energy into biomass for fuel.

State **one** environmental benefit of producing fuel in this way.

_____

_____ **1**

(*c*) Algae and green plants can convert the products of photosynthesis into fuels.

The table below shows the volume of fuel produced by some of these photosynthesising organisms.

Photosynthesising organisms	*Volume of fuel* (litres)
Algae	1920
Sugar cane	680
Palm	440
Corn	280
Soya bean	80

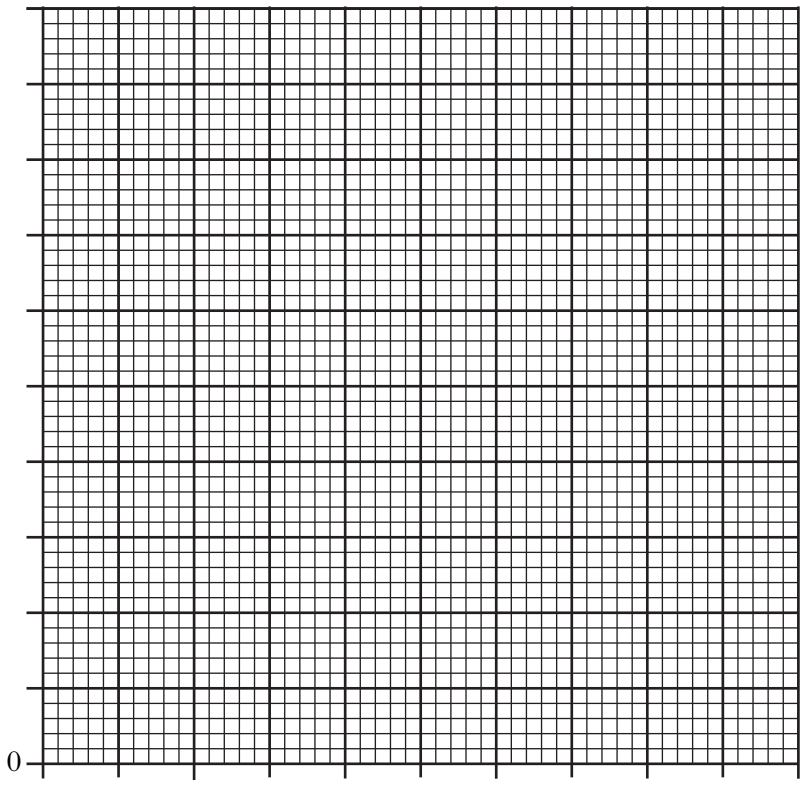
DO NOT WRITE IN THIS MARGIN

Marks

4. (*c*) (continued)

(i) Complete the bar chart below using the information in the table.

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



3

(ii) Calculate the ratio of the volume of fuel produced by algae to soya bean as a simple whole number ratio.

Space for calculation

_____ : _____
algae soya bean

1

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

5. The flow chart below shows some of the steps involved in the production of single cell protein (SCP) by a fungus.

***Stage 1*:**	A sample of the fungus is added to a fermenter containing a culture medium with glucose and nitrogen compounds.
↓	
***Stage 2*:**	Sterile air is pumped into the fermenter at a constant rate.
↓	
***Stage 3*:**	The fermenter is maintained at 30 °C and at pH 6·0 for 3 days.
↓	
***Stage 4*:**	After 3 days, the fungus is collected, heat treated and compressed to form SCP.

(*a*) (i) Explain the reason for adding glucose and nitrogen compounds to the culture medium.

Glucose _____

_____ **1**

Nitrogen compounds _____

_____ **1**

(ii) Suggest a reason why air is pumped into the fermenter in SCP production.

_____

_____ **1**

(iii) Explain why the conditions in the fermenter are kept at a temperature of 30 °C and pH 6·0.

_____

_____

_____

_____ **2**

Marks

5. (continued)

(*b*) The table below shows the protein content of SCP and other foods.

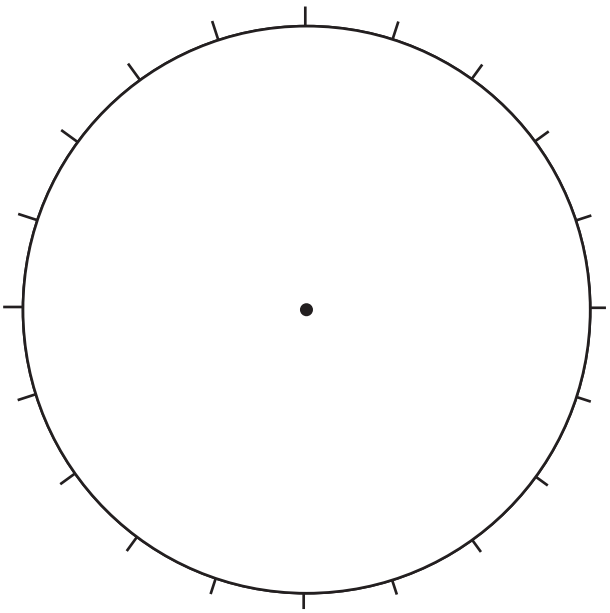
Food	*Protein content* (g per 100 g of food)
Beef	25
Cheese	15
Chicken	30
Egg white	20
SCP	10

(i) What mass of protein would be provided by 225 g of SCP?

Space for calculation

_____ g of protein **1**

(ii) Complete the pie chart using the information shown in the table above.
(An additional pie chart, if required, can be found on *Page thirty-one*.)



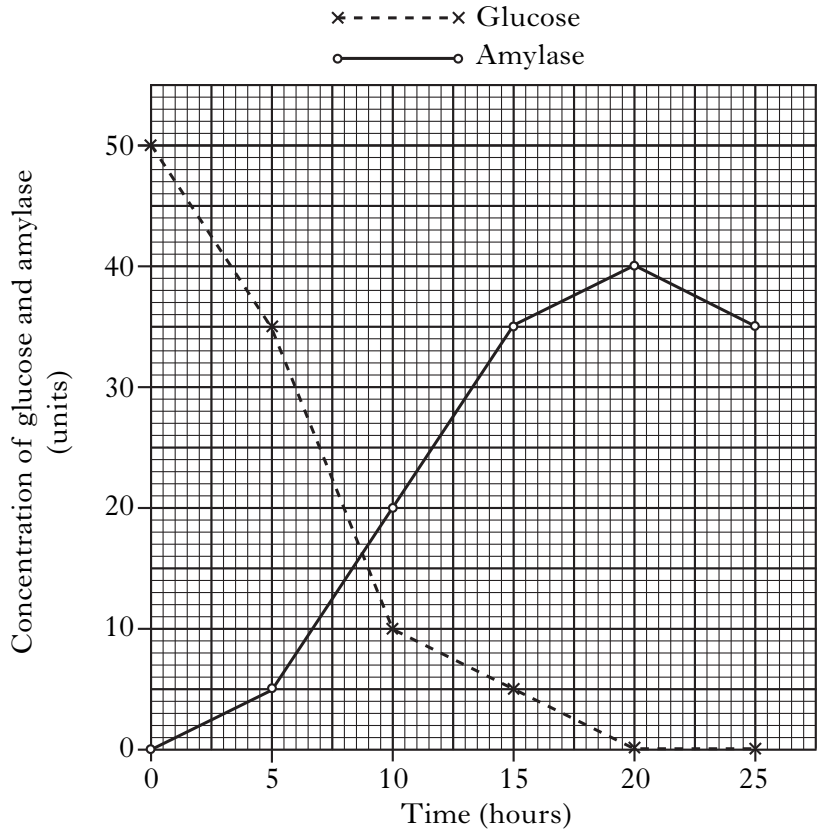
2

[Turn over

Marks

6. A biotechnology company is investigating the production of the enzyme amylase. The amylase is made by bacteria in a fermenter with a culture medium containing glucose. The bacteria release amylase into the medium during their growth.

The graph below shows changes in the glucose and amylase concentration over 25 hours.



(*a*) (i) Describe the relationship between glucose concentration and amylase concentration between 0 and 20 hours.

_____

_____ **1**

(ii) Identify the five hour period which produced the largest decrease in glucose concentration.

Space for calculation

From _____ hours to _____ hours **1**

(iii) Suggest a reason why amylase production decreased between 20 and 25 hours.

_____

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

6. (*a*) (continued)

(iv) Calculate the percentage increase in amylase concentration between 10 and 15 hours.

Space for calculation

_____ %

1

(*b*) Decide if the following statements about enzymes 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*
The enzyme amylase breaks down glucose.			
Enzymes are specific for their substrate.			
Saprophytes are micro-organisms which use intracellular enzymes to digest food sources.			

3

[Turn over

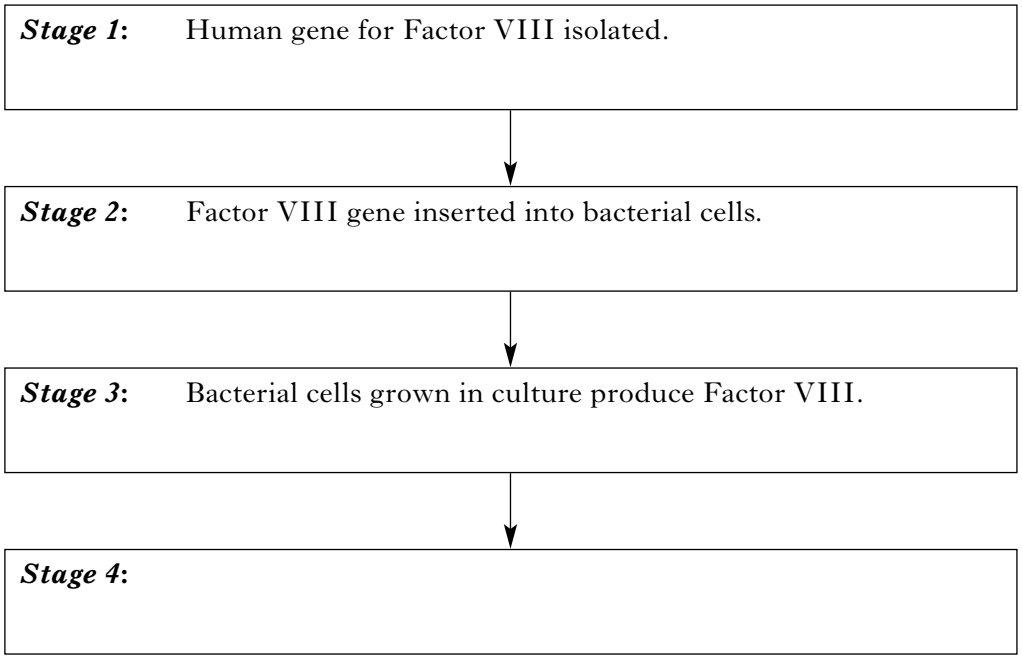
DO NOT WRITE IN THIS MARGIN

Marks

7. Some humans have a blood disorder which means their blood cannot clot. These people have a protein missing from their blood called Factor VIII.

In the past, Factor VIII was obtained from human blood. Nowadays, Factor VIII is produced by genetic engineering.

Some of the stages in genetically engineering Factor VIII are listed below.



(*a*) Complete the box to describe what happens in Stage 4. **1**

(*b*) (i) Name the bacterial structure which can be used to insert a human gene into bacteria.

_____ **1**

(ii) Name a bacterium that can be used in genetic engineering.

_____ **1**

(iii) Give **one** advantage of producing medical products by genetic engineering.

_____

_____ **1**

Marks

7. (continued)

(*c*) The table below shows the number of children under 5 years old diagnosed with diabetes in the European Union between 2006 and 2010.

Year	*Number of diabetic children under 5 years old*
2006	9 950
2007	10 448
2008	10 970
2009	11 518
2010	13 000

(i) Name the genetically engineered medical product that can be used to treat diabetic children.

_____ **1**

(ii) The number of children under 5 years old with diabetes is rising by 5% every year.

Calculate the number of children under 5 years old expected to be diabetic in 2011.

Space for calculation

Number of children _____ **1**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

8. Farmers use anaerobic digesters to produce a gas from organic waste.

(*a*) The anaerobic digesters are disinfected before use.

Explain why it is important to remove all the disinfectant before adding the organic waste.

_____

_____

_____

_____ **2**

(*b*) (i) Name a source of organic waste found on farms that could be used in anaerobic digesters.

_____ **1**

(ii) Name the main gas produced in anaerobic digesters.

_____ **1**

(iii) State a use for this gas.

_____ **1**

(*c*) Anaerobic respiration also occurs in yeast cells.

Complete the following sentences on respiration in **yeast cells** by underlining one of the options in each pair.

Anaerobic respiration takes place when oxygen is {present / absent} releasing {less / more}

energy than aerobic respiration. Anaerobic respiration in yeast cells produces

{ethanol / lactic acid} and carbon dioxide. **2**

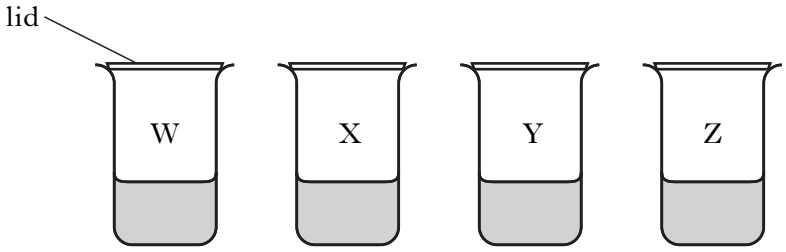
[Turn over Question 9 on *Page twenty-four*

DO NOT WRITE IN THIS MARGIN

Marks

9. An investigation was carried out into yoghurt production. Fresh yoghurt contains living bacteria.

The diagram below shows details of how the experiment was set up.



	W	X	Y	Z
Volume of fresh yoghurt (cm^3)	3	0	3	0
Volume of boiled yoghurt (cm^3)	0	3	0	3
Volume of sterile milk (cm^3)	30	30	30	30
Temperature (°C)	25	25	35	35

(*a*) (i) Identify the **two** beakers which can be used to find out the effect of temperature on yoghurt production.

Beakers: _____ and _____ **1**

(ii) Suggest why a lid was put over each beaker.

_____

_____ **1**

(*b*) The pH of the contents of each beaker was measured at the start of the investigation and after 4 hours.

Complete the table below by matching the beaker letter with the most likely result.

Beaker letter	*pH at start*	*pH after 4 hours*
	6	4·5
	6	4
X	6	6
	6	6

2

DO NOT WRITE IN THIS MARGIN

Marks

9. (continued)

(*c*) (i) Name the chemical product that causes the decrease in pH during the making of yoghurt.

_____ **1**

(ii) What is the benefit of converting milk into yoghurt?

_____

_____ **1**

(*d*) Complete the table below about micro-organisms and their role in the food industry.

Name of micro-organism	*Product*	*Use of product*
	citric acid	anti-oxidant
Acetobacter		

2

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

DO NOT WRITE IN THIS MARGIN

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.

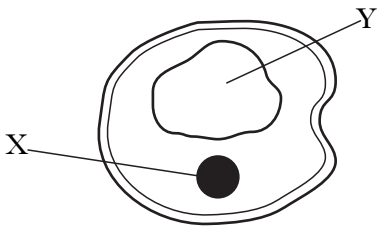
Supplementary sheets, if required, may be obtained from the Invigilator.

Labelled diagrams may be included where appropriate.

Marks

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

A. The diagram below shows a fungal cell.

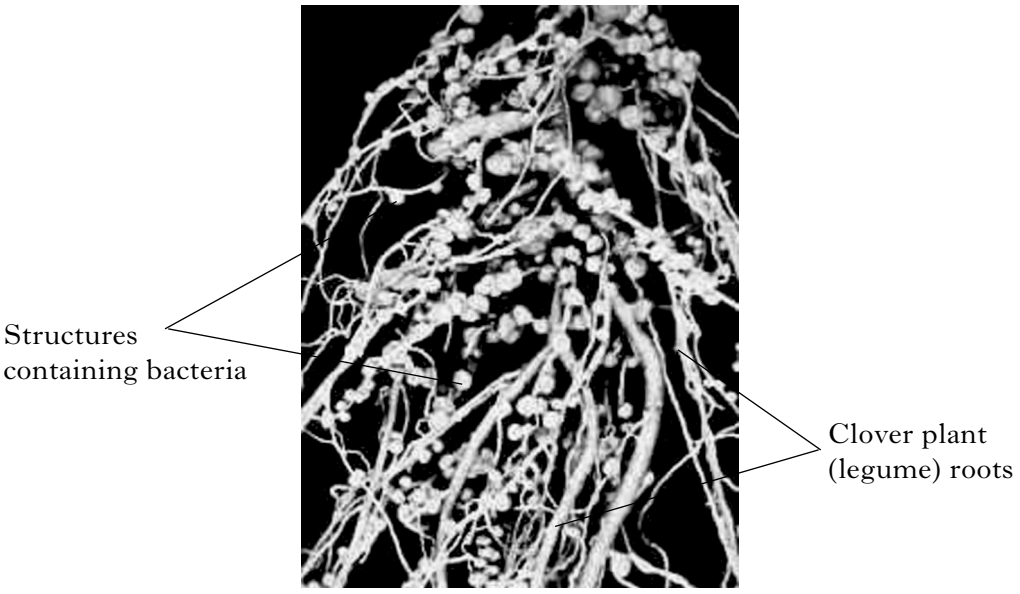


(*a*) Name this fungus and identify structures X and Y.

(*b*) Describe the main features of reproduction in this fungus. **5**

OR

B. The photograph below shows the structures containing micro-organisms on the roots of a clover plant (legume).



(*a*) Name the structures and the micro-organisms they contain.

(*b*) Describe the process carried out by these micro-organisms and state the advantages to the plant. **5**

DO NOT WRITE IN THIS MARGIN

Marks

SPACE FOR ANSWER TO QUESTION 1

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

DO NOT WRITE IN THIS MARGIN

Marks

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

A. Silage is used as winter feed for animals.

Describe how silage is made. State **one** benefit of silage production. **5**

OR

B. Selective breeding and genome mapping can be used to improve plants and animals.

Describe the technique of selective breeding. State the benefits of using genome mapping in selective breeding. **5**

[*END OF QUESTION PAPER*]

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SPACE FOR ANSWER TO QUESTION 2

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

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ADDITIONAL SPACE FOR ANSWERS

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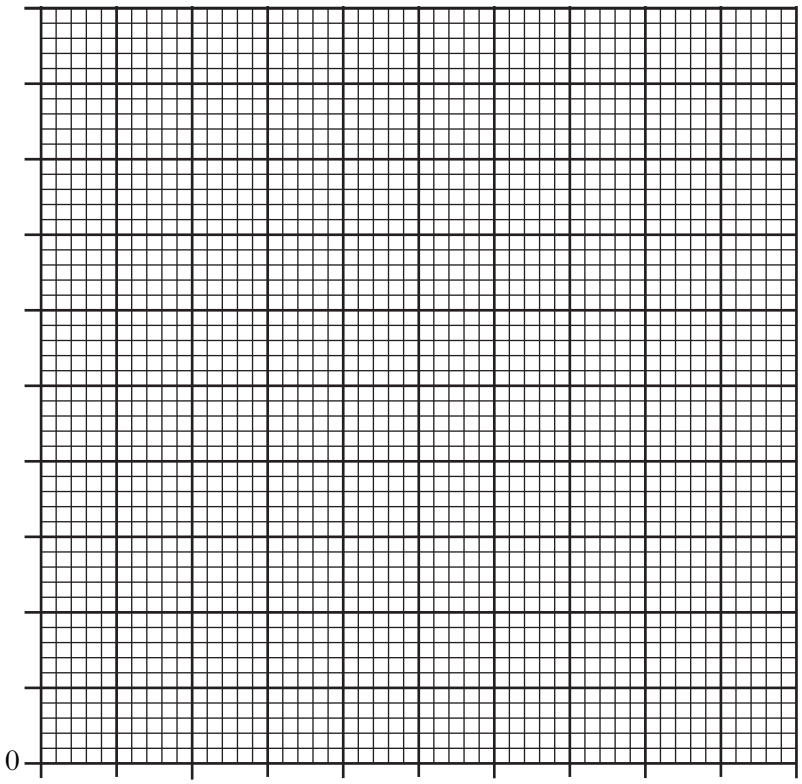
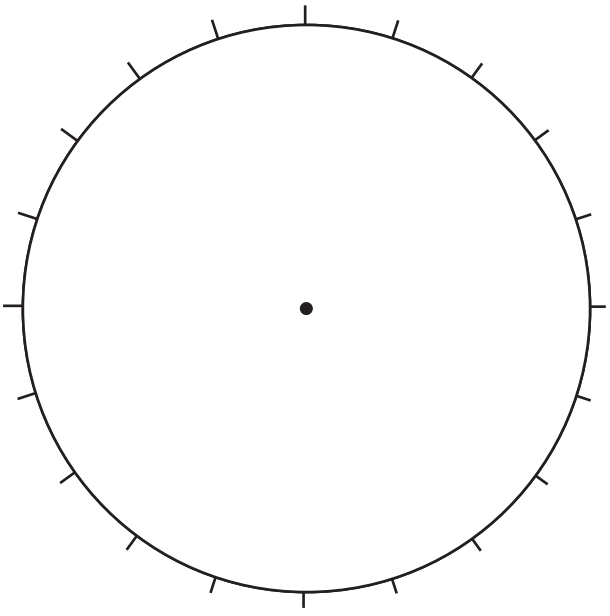
ADDITIONAL SPACE FOR ANSWERS

Additional graph paper for use in Question 4(*c*)(i).



Additional pie chart for use in Question 5(*b*)(ii).



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