FOR OFFICIAL USE

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Total for Sections B and C

# X008/11/02

NATIONAL QUALIFICATIONS 2012

THURSDAY, 24 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.

## 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**

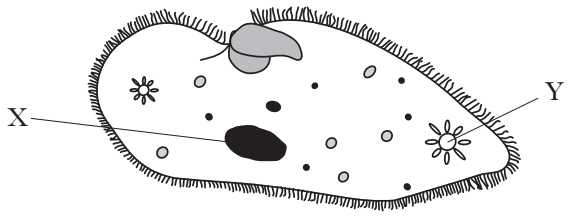
If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.

## SECTION A

**All questions in this Section should be attempted.**

**Answers should be given on the separate answer sheet provided.**

Questions **1** and **2** relate to the following diagram of a protozoan.




**1.** Part X is the

A cytoplasm

B nucleus

C plasma membrane

D food vacuole.

**2.** Identify the function of the contractile vacuole Y.

A maintains water balance

B controls activities of protozoa

C allows cells to move

D stores food

**3.** When bacteria reproduce using conjugation, there will be

A an increase in number and a decrease in variation

B a decrease in number and an increase in variation

C a decrease in number and a decrease in variation

D an increase in number and an increase in variation.

**4.** In *Mucor*, a zygospore is produced through the

A sexual reproduction of gametes that separate

B sexual reproduction of gametes that fuse

C asexual reproduction of gametes that fuse

D asexual reproduction of gametes that separate.

**5.** Which line in the table below correctly identifies mycorrhizal associations?

| | *Benefit for fungus* | *Benefit for plant* |
|---|---|---|
| A | Gains nitrate | Gains carbohydrate |
| B | Gains carbohydrate | Gains nitrate |
| C | Gains amino acids | Gains carbohydrate |
| D | Gains carbohydrate | Gains amino acids |

**6.** A parasite

A obtains food from a dead organism

B supplies food to a dead organism

C obtains food from a living organism

D supplies food to a living organism.

**7.** Which piece of equipment should **not** be used to transfer a block of agar with fungal mycelium?

A Forceps

B Cork borer

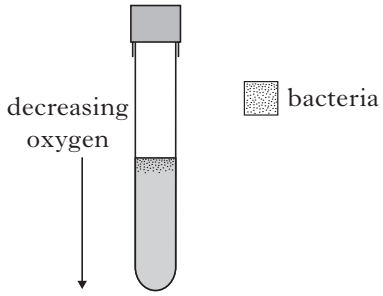
C Inoculating loop

D Scalpel

**[Turn over**

**8.** In an experiment, bacteria were allowed to grow in a tube of nutrient broth for 24 hours.

The distribution of the bacteria after 24 hours is shown in the diagram below.




One conclusion from this experiment is that these bacteria are

A facultative parasites

B obligate anaerobes

C facultative anaerobes

D obligate aerobes.

**9.** Streak plating is a technique used to

A fix micro-organisms

B separate species of micro-organisms

C stain micro-organisms

D kill micro-organisms.

**10.** One reason for using a vital stain when preparing micro-organisms for microscopy is to

A keep the micro-organisms alive on the slide

B kill the micro-organisms on the slide

C attach the micro-organisms to the slide

D magnify the micro-organisms on the slide.

**11.** A technician was planning to make some agar plates and slopes for students.

He prepared 600 $cm^3$ of agar in total. Each plate required 25 $cm^3$ of agar and each slope 15 $cm^3$. Each student needs 1 plate and 1 slope.

How many students could he prepare a plate and slope for?

A 40

B 24

C 15

D 12

**12.** Which of the following is the correct order of steps when preparing to work aseptically in a biotechnology lab?

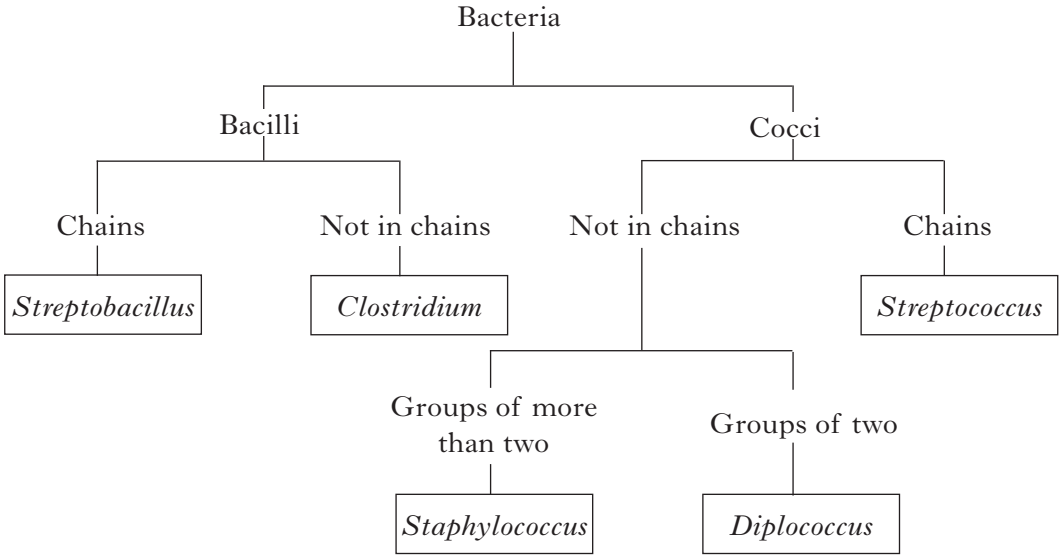
A Wash and dry hands ⟶ put on lab coat ⟶ wipe work area with disinfectant

B Wipe work area with disinfectant ⟶ wash and dry hands ⟶ put on lab coat

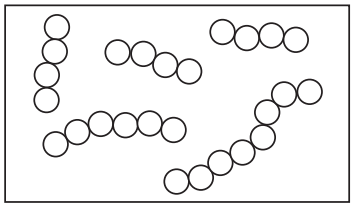
C Put on lab coat ⟶ wipe work area with disinfectant ⟶ wash and dry hands

D Wash and dry hands ⟶ wipe work area with disinfectant ⟶ put on lab coat

**13.** The branched key below shows the shapes and arrangement of some bacteria.




Use the key to identify the name of the micro-organism shown below.



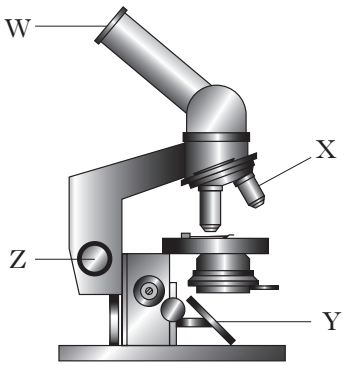
A *Clostridium*

B *Streptococcus*

C *Staphylococcus*

D *Streptobacillus*

**14.** The diagram below shows a microscope with some parts labelled.




Which line in the table below identifies the correct parts of the microscope?

| | *Part of microscope* | | | |
|---|---|---|---|---|
| | W | X | Y | Z |
| A | Objective lens | Focus control | Stage | Mirror |
| B | Eyepiece lens | Mirror | Objective lens | Focus control |
| C | Objective lens | Eyepiece lens | Focus control | Mirror |
| D | Eyepiece lens | Objective lens | Mirror | Focus control |

**15.** The table below shows the number of bacterial colonies counted on four separate agar plates of *E.coli*.

| *Plate* | *Number of E.coli colonies* |
|---|---|
| W | 254 |
| X | 212 |
| Y | 198 |
| Z | 212 |

The average number of *E.coli* colonies was

A 212

B 219

C 292

D 876.

**16.** Small-scale digesters in farms produce a gas which can be used as a fuel.

The micro-organisms which produce this gas are

A aerobic and producers of oxygen gas

B aerobic and producers of methane gas

C anaerobic and producers of methane gas

D anaerobic and producers of oxygen gas.

**17.** Landfills produce a gas which can cause pollution. The production of this gas is being **reduced** by

A cutting down the organic waste in landfill contents

B compacting landfill contents to create anaerobic conditions

C lowering landfill temperature

D removing toxic pollutants from landfill contents.

**18.** Identify the line in the table below that correctly describes the process of selective breeding.

| | *Aim of technique* | *Feature of technique* |
|---|---|---|
| A | Identify gene function | Slows down selective breeding programmes |
| B | Identify gene function | Speeds up selective breeding programmes |
| C | Maximise desired characteristic | Guaranteed result |
| D | Maximise desired characteristic | Desired results take long time |

**19.** The micro-organism which is used to produce citric acid is a

A fungus called *Acetobacter*

B bacterium called *Acetobacter*

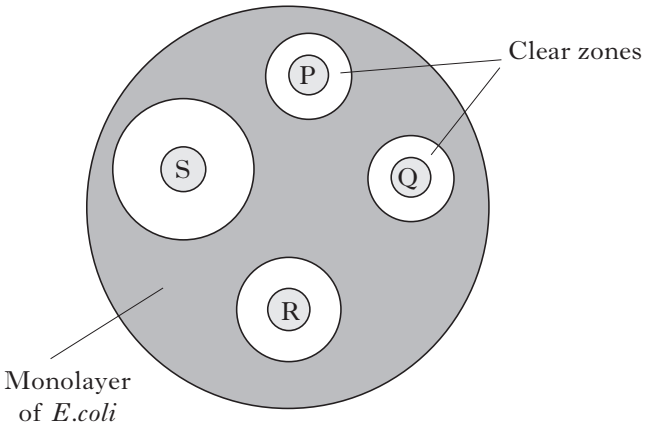
C bacterium called *Aspergillus*

D fungus called *Aspergillus*.

**20.** Which line in the table below correctly describes features of single cell proteins and their production?

| | *Raw materials used in production* | *Effect of production process* | *Feature of single cell protein* |
|---|---|---|---|
| A | Energy crops | Reduces pollution | High protein food |
| B | Energy crops | Increases pollution | High fat food |
| C | Waste whey | Reduces pollution | High protein food |
| D | Waste whey | Increases pollution | High fat food |

**21.** The diagram below shows the effects of four different antibiotics (P, Q, R and S) on the growth of the bacterium *E.coli*.




A valid conclusion which can be drawn from the results of **this experiment** is that

A antibiotic P stops the growth of all species of bacteria

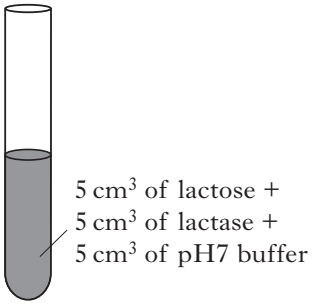
B antibiotic S is the least efficient at stopping the growth of *E.coli*

C antibiotic Q is the most efficient at stopping the growth of *E.coli*

D antibiotic R stops the growth of *E.coli*.

**22.** The enzyme lactase breaks down the sugar lactose.

A student set up the experiment shown in the diagram below. Both the lactose and the lactase were dissolved in pH7 buffer.




He also set up four other tubes as described in the table below.

| *Tube* | *Volume of lactose* ($cm^3$) | *Volume of lactase* ($cm^3$) | *Volume of pH buffer* ($cm^3$) |
|---|---|---|---|
| A | 0 | 10 | 5 |
| B | 5 | 10 | 0 |
| C | 5 | 0 | 10 |
| D | 10 | 5 | 0 |

Which tube could be used as a control in this experiment to show that lactase breaks down lactose?

**23.** The table below shows the conditions in four separate small-scale fermenters set up to produce citric acid.

| *Fermenter* | *Initial inoculum of micro-organism* ($cm^3$) | *pH* | *Mass of molasses* (g) |
|---|---|---|---|
| W | 5 | 6·2 | 15 |
| X | 10 | 6·5 | 20 |
| Y | 5 | 6·5 | 15 |
| Z | 10 | 6·2 | 25 |

To find the effect of pH on the production of citric acid, the results should be compared from fermenters

A W and Y

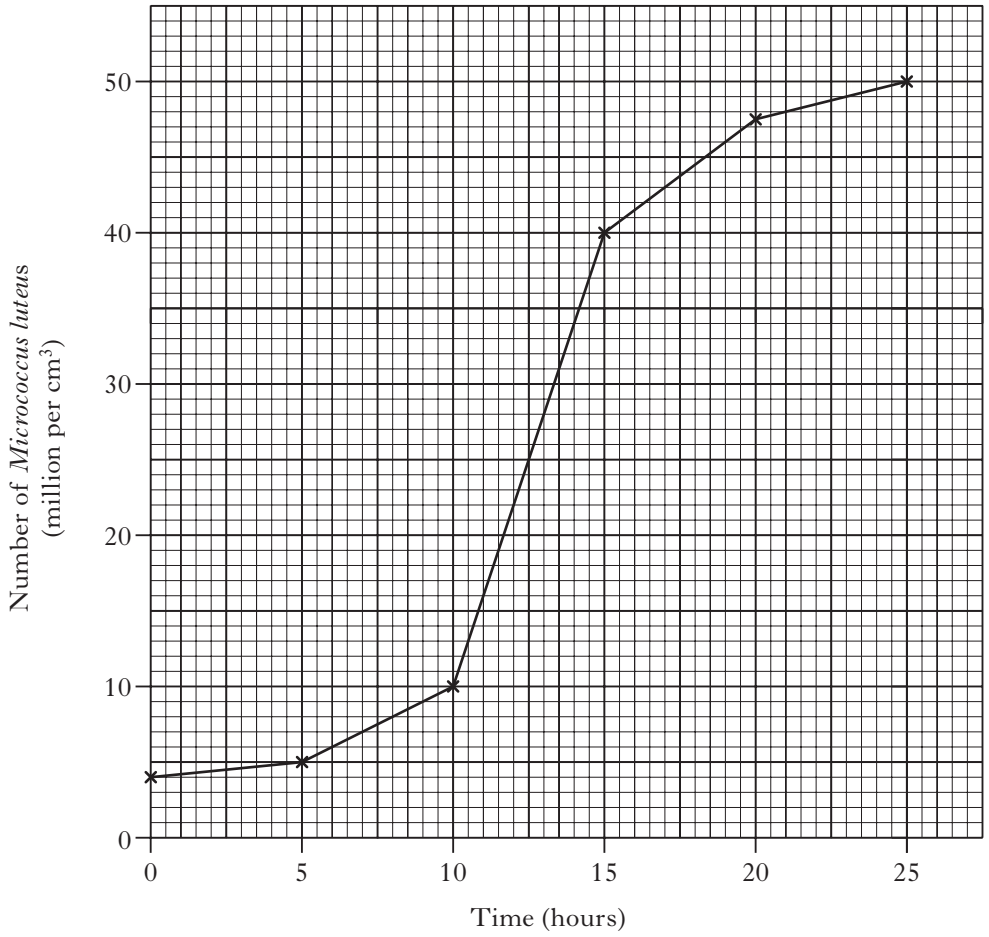
B X and Z

C W and Z

D Y and Z.

Questions **24** and **25** are based on the information shown in the graph below.

The change in the number of *Micrococcus luteus* growing in a broth culture at 30 °C for 25 hours is shown in the graph below.




**24.** During which 5 hour period did the number of *Micrococcus luteus* increase by 300% in the broth culture?

A 0–5 hours

B 5–10 hours

C 10–15 hours

D 15–20 hours

**25.** If the same experiment was carried out at 20 °C, the number of *Micrococcus luteus* in the broth culture at 25 hours is most likely to be

A 2 million per $cm^3$

B 10 million per $cm^3$

C 50 million per $cm^3$

D 60 million per $cm^3$.

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

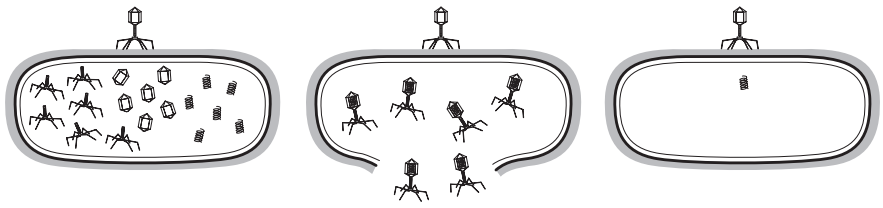
**[Turn over for SECTION B on *Page ten***

*Marks*

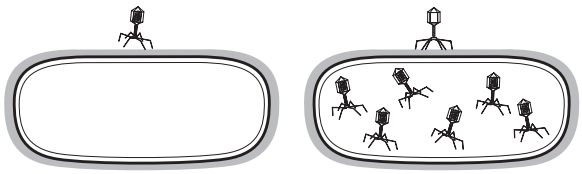
## SECTION B

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

**1.** The diagrams below show some of the stages in the replication of a virus.

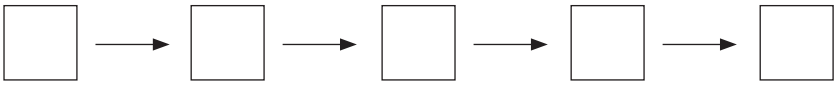


A B C



D E

(*a*) Place the stages in the correct order by inserting the correct letter in each box.



**2**

(*b*) The table below compares the structure of bacteria and viruses.

Complete the table by inserting **Yes** or **No** in each box to show the differences in structure between bacteria and viruses.

| *Structure* | *Bacteria* | *Viruses* |
|---|---|---|
| Cytoplasm | **Yes** | **No** |
| Cell wall | | |
| DNA | | |
| Protein coat | | |
| Cell membrane | | |

**2**

*Marks*

**1. (continued)**

(*c*) A bacterium was measured and found to be 2 micrometres in length.

A virus was 0·01 micrometre in length.

Calculate the simple whole number ratio of length of the bacterium to the virus.

*Space for calculation*

_____ : _____
bacterium virus

**1**

(*d*) Decide if the following statements about reproduction in bacteria 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 <u>underlined</u> in the statement.

| *Statement* | *True* | *False* | *Correction* |
|---|---|---|---|
| Asexual reproduction in bacteria results in <u>non-identical</u> cells. | | | |
| Bacteria reproduce by <u>binary fission</u>. | | | |
| Asexual reproduction leads to a <u>slow</u> increase in number of bacteria. | | | |

**3**

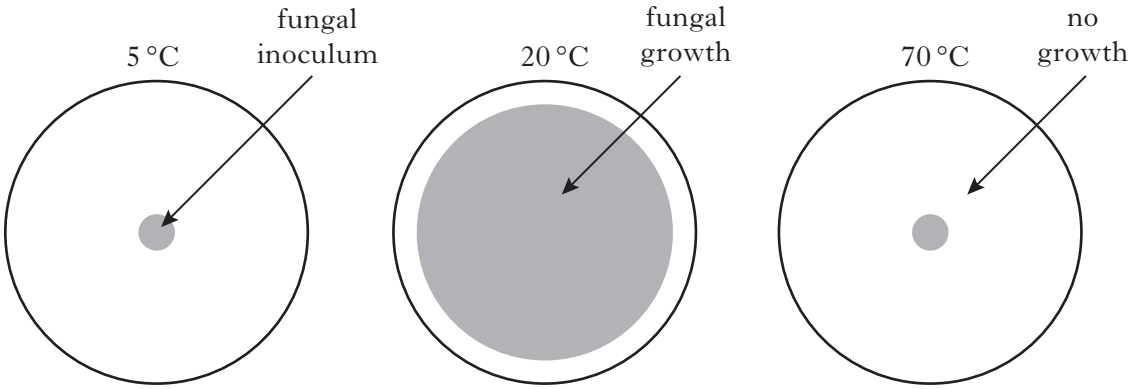
**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**2.** An experiment was set up to investigate the growth of a fungus on agar at different temperatures. Aseptic technique was used to transfer an inoculum from the same culture onto three agar plates.

The diagram below shows fungal growth at 20 °C and 70 °C after 5 days.




(*a*) (i) Show the expected appearance of fungal growth at 5 °C by **completing** the diagram. **1**

(ii) At 70 °C the enzymes in this fungus have become inactive.

What term describes these inactive enzymes?

_____ **1**

(*b*) State **two** variables which should be kept the same to make this experiment valid.

Variable 1 _____ **1**

Variable 2 _____ **1**

(*c*) Describe why it is difficult to measure fungal growth in the above experiment.

_____

_____ **1**

(*d*) Describe how the reliability of the results could be improved.

_____

_____ **1**

*Marks*

**3.** To produce agar plates, liquid agar is poured into sterile Petri dishes and stored before use.

(*a*) Complete the table below showing the states of agar and their correct temperatures.

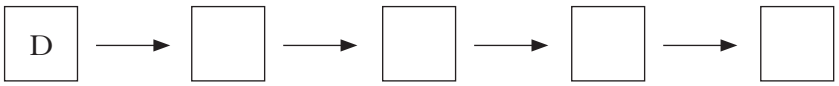
| *State of agar* | *Temperature* (°C) |
|---|---|
| | 95 |
| Pouring | |
| | 42 |

**2**

(*b*) The statements below describe some of the steps in pouring an agar plate.

Step A Open Petri dish
Step B Heat agar to correct temperature
Step C Pour in agar to cover base
Step D Label base of Petri dish
Step E Replace lid of Petri dish

(i) Place the steps in the correct order by inserting the correct letter into each box.




**1**

(ii) State **one** essential feature that makes an agar plate suitable for use.

Feature _____ **1**

Describe how you would ensure an agar plate had this feature.

_____

_____ **1**

(*c*) State **two** reasons for the presence of a Bunsen burner during plate pouring.

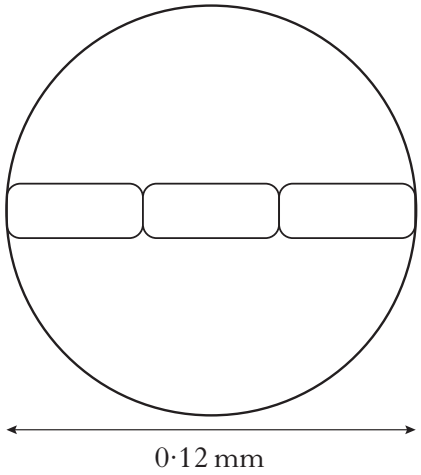
1 _____ **1**

2 _____ **1**

**[Turn over**

*Marks*

**4.** The diagram below shows the filamentous alga *Oedogonium* viewed under a microscope at high power.




(*a*) Calculate the length of one *Oedogonium* algal cell in micrometres.
(1 millimetre = 1000 micrometres)

*Space for calculation*

_____ micrometres **1**

(*b*) How would reducing the magnification to a lower power affect the number of cells seen in the field of view?

_____ **1**

*Marks*

**4. (continued)**

(*c*) The lenses used in the microscope have the following magnifications:

Eyepiece lens × 10 magnification
Objective lenses × 4, × 10 and × 40 magnification

Use the information above to calculate total magnifications and then complete the table below.

*Space for calculations*

| | | *Total magnification* |
|---|---|---|
| | × 4 | |
| | | |
| | | |

**3**

(*d*) Some micro-organisms are fixed and stained before viewing under a microscope.

Give **one** advantage and **one** disadvantage of fixing micro-organisms.

Advantage _____

_____ **1**

Disadvantage _____

_____ **1**

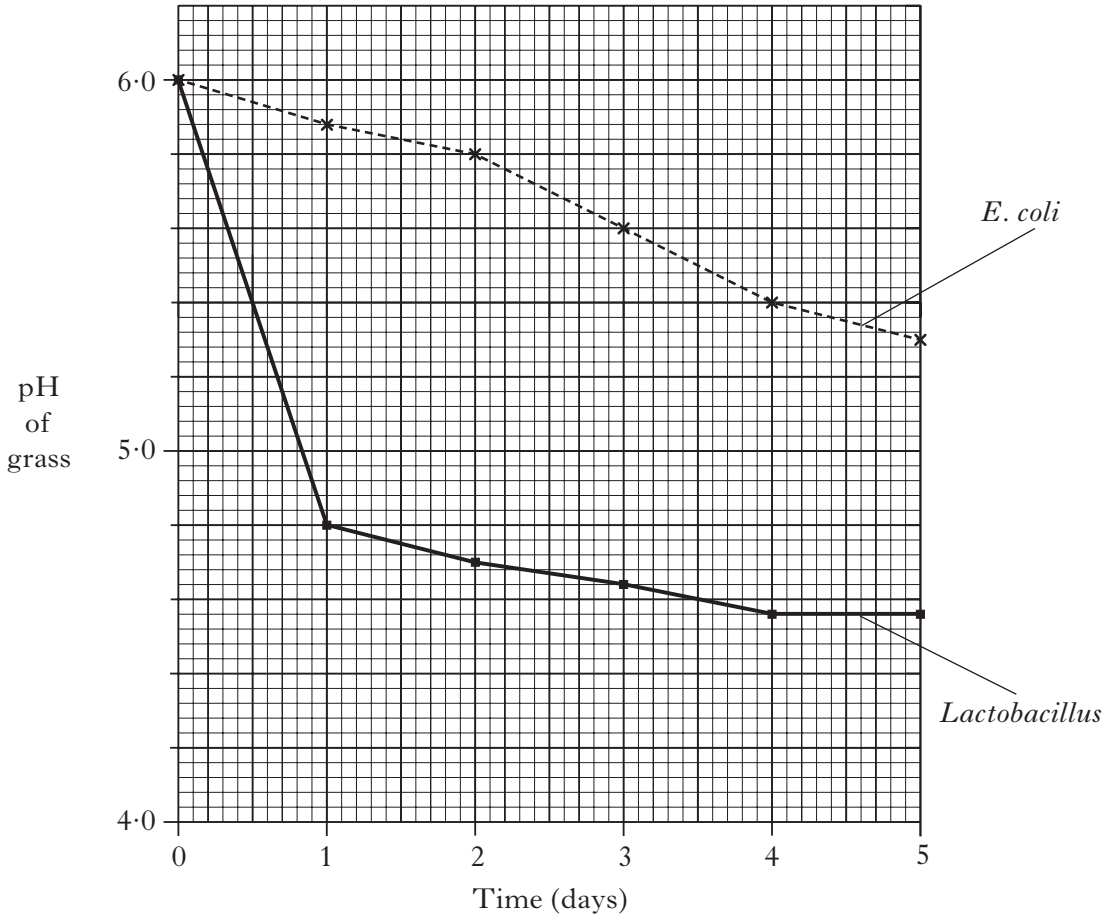
**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**5.** An investigation was set up to compare the efficiency of two species of micro-organisms, *E. coli* and *Lactobacillus*, in silage production.

Silage production was monitored by measuring the pH of fresh grass in a silage bag over 5 days, as shown in the graph below.




(*a*) (i) Calculate the percentage decrease in pH in the grass with *Lactobacillus* between day 0 and day 1.

*Space for calculation*

_____ % **1**

(ii) Which micro-organism would be better for the production of silage?

Micro-organism _____

Explain your choice.

_____

_____ **1**

DO NOT WRITE IN THIS MARGIN

*Marks*

**5. (*a*) (continued)**

(iii) State **two** factors which must be kept the same to make this investigation fair.

1 _____ **1**

2 _____ **1**

(*b*) The fresh grass is compressed into silage bags before the addition of the micro-organisms.

Suggest a reason for compressing the grass.

_____

_____ **1**

(*c*) Name the chemical produced by the micro-organisms which preserves the nutritional value of the silage.

_____ **1**

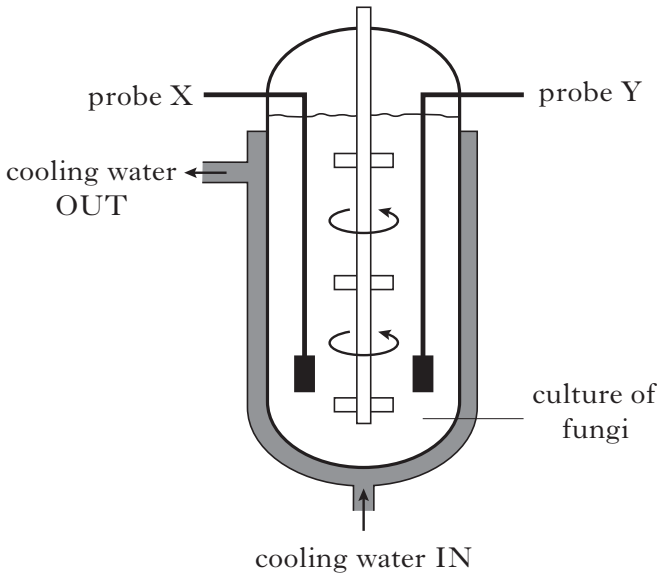
(*d*) What is silage used for?

_____ **1**

**[Turn over**

*Marks*

**6.** The diagram below shows an industrial batch fermenter set up for the production of antibiotics from a culture of fungi.




(*a*) Name a fungus which could be used in the industrial production of antibiotics.

_____ **1**

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

Fermenters can also be set up for continuous flow processing, which involves

{ a closed / an open } system. Continuous flow can use { immobilised / denatured } cells which will make the separation of { cells / products } easier. **2**

(*c*) The diagram shows two probes (X and Y) that are used to monitor the conditions in the batch fermenter.

Name **two** conditions that require to be monitored to maximise the production of antibiotics.

Condition 1 _____ **1**

Condition 2 _____ **1**

DO NOT WRITE IN THIS MARGIN

*Marks*

**6. (continued)**

(*d*) Antibiotics are used to treat infectious diseases caused by bacteria in humans.

(i) Explain why it is important that these antibiotics should be stable in acid.

_____

_____ **1**

(ii) Some antibiotics are described as narrow spectrum or broad spectrum in their action.

Compare the action of a narrow spectrum antibiotic with a broad spectrum antibiotic.

_____

_____

_____

_____ **2**

(*e*) Suggest a reason why some soil fungi produce antibiotics in their natural environment.

_____

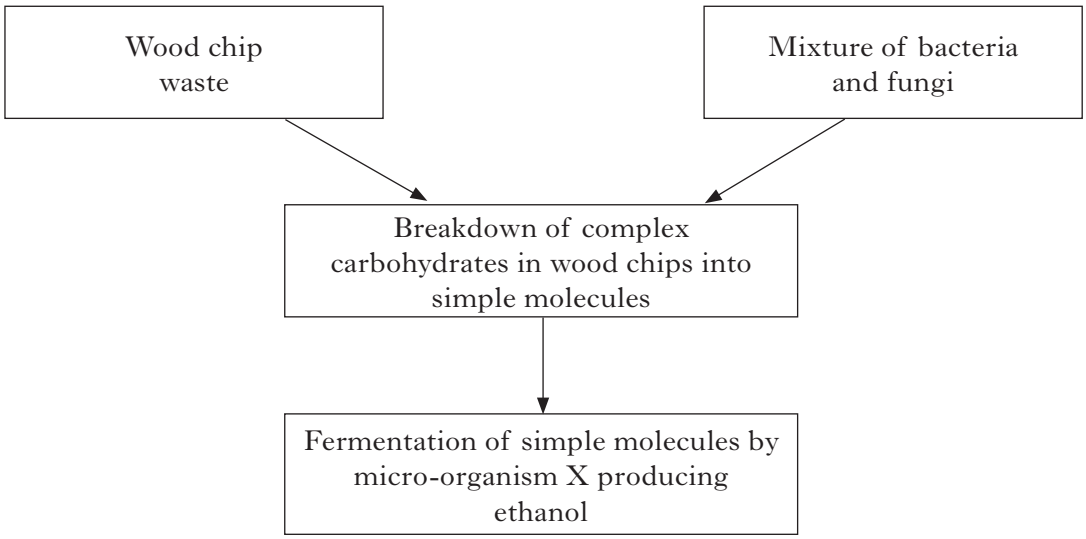
_____ **1**

**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**7.** The flowchart below shows some of the steps in the production of ethanol using wood chip waste from timber yards.




(*a*) (i) Name the type of substance made by the mixture of bacteria and fungi to breakdown the complex carbohydrates.

_____ **1**

(ii) Name the simple molecules produced by the breakdown of the complex carbohydrates.

_____ **1**

(iii) Name micro-organism X which is used to produce ethanol.

_____ **1**

(*b*) Name a method which could be used to separate ethanol from the fermentation.

_____ **1**

DO NOT WRITE IN THIS MARGIN

*Marks*

**7. (continued)**

(*c*) This production of ethanol depends on the fixation of energy into biomass.

(i) Name the process that fixes energy into biomass.

_____ **1**

(ii) Identify the biomass used in this production of ethanol.

_____ **1**

(iii) Describe **one** advantage of using the ethanol produced as a source of fuel.

_____

_____ **1**

(*d*) Micro-organisms can be genetically modified to increase their ability to produce fuel.

Complete the following sentence by underlining one of the options in each pair.

Genetic modification involves transferring a desirable { protein / gene } from one organism into the { chromosome / capsule } of another organism. **1**

**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**8.** The making of sourdough bread involves two micro-organisms, *Saccharomyces* and *Lactobacillus*.

Water and flour are mixed with a starter culture of the two micro-organisms to form a dough. The dough is left at 27 °C for several hours before baking in an oven at 220 °C. *Saccharomyces* makes an enzyme which breaks down starch in flour into sugars.

(*a*) (i) Complete the table below to predict the changes in the dough during incubation at 27 °C before baking.

| *Variable* | *Change (increase/decrease)* |
|---|---|
| Number of *Saccharomyces* | |
| Starch concentration | |
| Carbon dioxide concentration | |
| Lactic acid concentration | |

**2**

(ii) Name the enzyme produced by *Saccharomyces* which breaks down the starch in flour into sugars.

_____ **1**

(iii) Suggest a reason why the dough is left at 27 °C for several hours before baking in the oven at 220 °C.

_____

_____ **1**

(iv) Name the process which releases energy in micro-organisms.

_____ **1**

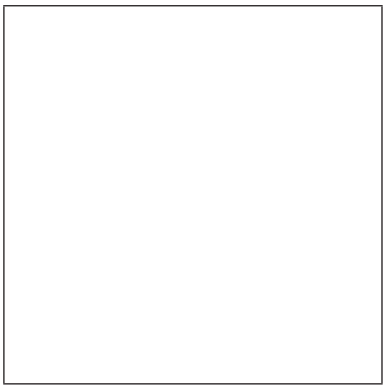
*Marks*

**8. (continued)**

(*b*) (i) What type of micro-organism is *Lactobacillus*?

_____ **1**

(ii) Draw a picture in the box below to show the shape of a single *Lactobacillus*.



**1**

(iii) *Lactobacilli* make a chemical which extends the shelf life of the bread.

What name is given to chemicals which extend the shelf life of foods?

_____ **1**

**[Turn over**

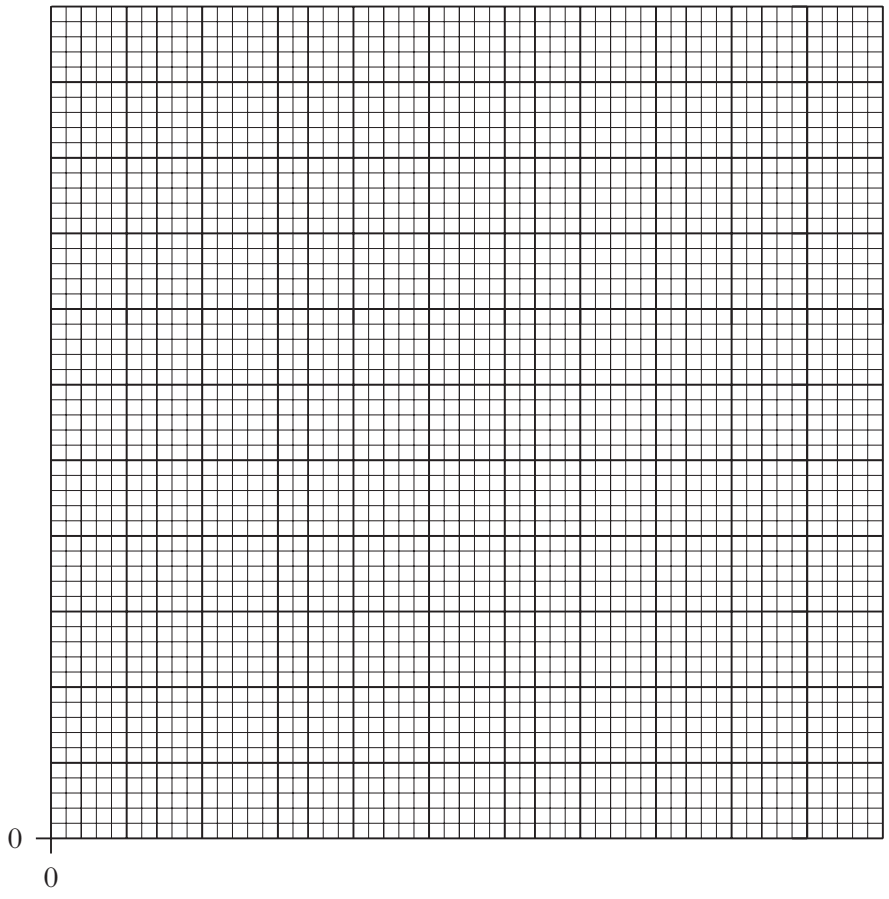
**9.** An algal culture was grown in media containing nitrate. *Marks*

After one week, the effect of light intensity on the change in the oxygen concentration in the algal culture was measured. The table below shows the results from this experiment.

| *Light intensity* (units) | *Oxygen concentration* (%) |
|---|---|
| 0 | 0 |
| 20 | 10 |
| 40 | 16 |
| 60 | 18 |
| 80 | 18 |
| 100 | 18 |

(*a*) Draw a line graph below by plotting light intensity (units) against oxygen concentration (%).

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




**2**

DO NOT WRITE IN THIS MARGIN

*Marks*

**9. (continued)**

(*b*) Using the information in the table on *Page twenty-four*, identify the factor limiting photosynthesis at 80 light intensity units.

_____ **1**

(*c*) (i) Name an organic molecule that requires nitrates for its synthesis.

_____ **1**

(ii) Explain the importance of nitrates for the growth of algae.

_____

_____ **1**

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

## SECTION C

*Marks*

**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.**

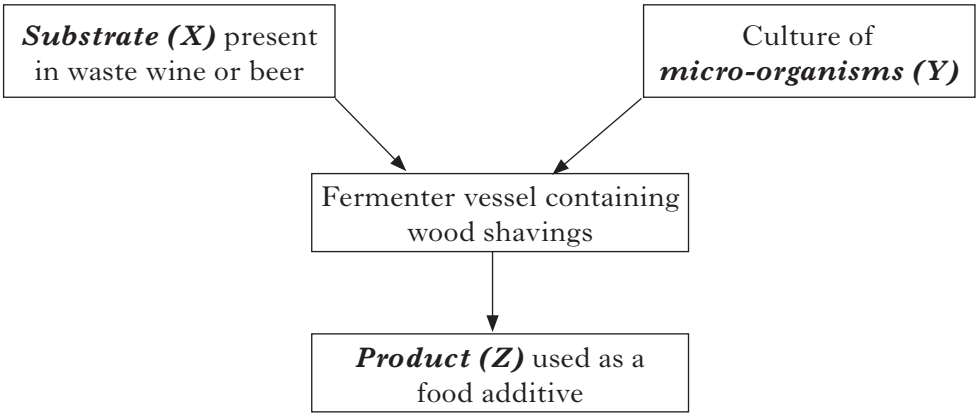
**Supplementary sheets, if required, may be obtained from the Invigilator.**

**Labelled diagrams may be included where appropriate.**

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

**A.** The food industry can use waste wine or beer to produce a food additive.

The diagram below shows some of the steps in the manufacture of this food additive.

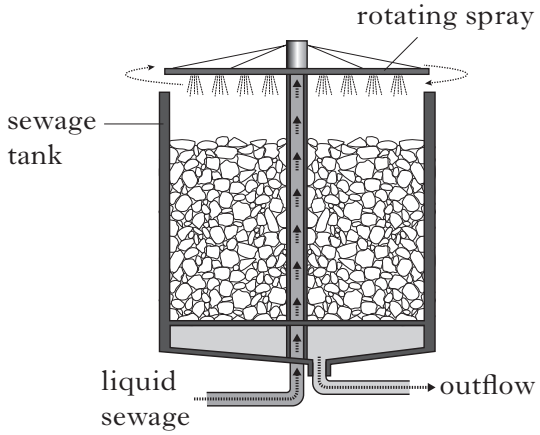



(*a*) Identify the substrate (X), micro-organism (Y) and product (Z) involved in these steps.

(*b*) Give the uses and the benefits of this food additive. **5**

**OR**

**B.** The diagram below shows one way of treating liquid sewage.




(*a*) Name this method of sewage treatment.

(*b*) Describe the roles of the micro-organisms, the stones and the rotating arm in the treatment of sewage. **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.

*Marks*

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

**A.** Describe the structure and reproduction of yeast. **5**

**OR**

**B.** Describe how a saprophyte obtains its food.

Give the advantages of this process to the saprophyte and the environment. **5**

[*END OF QUESTION PAPER*]

DO NOT WRITE IN THIS MARGIN

*Marks*

**SPACE FOR ANSWER TO QUESTION 2**

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

DO NOT WRITE IN THIS MARGIN

*Marks*

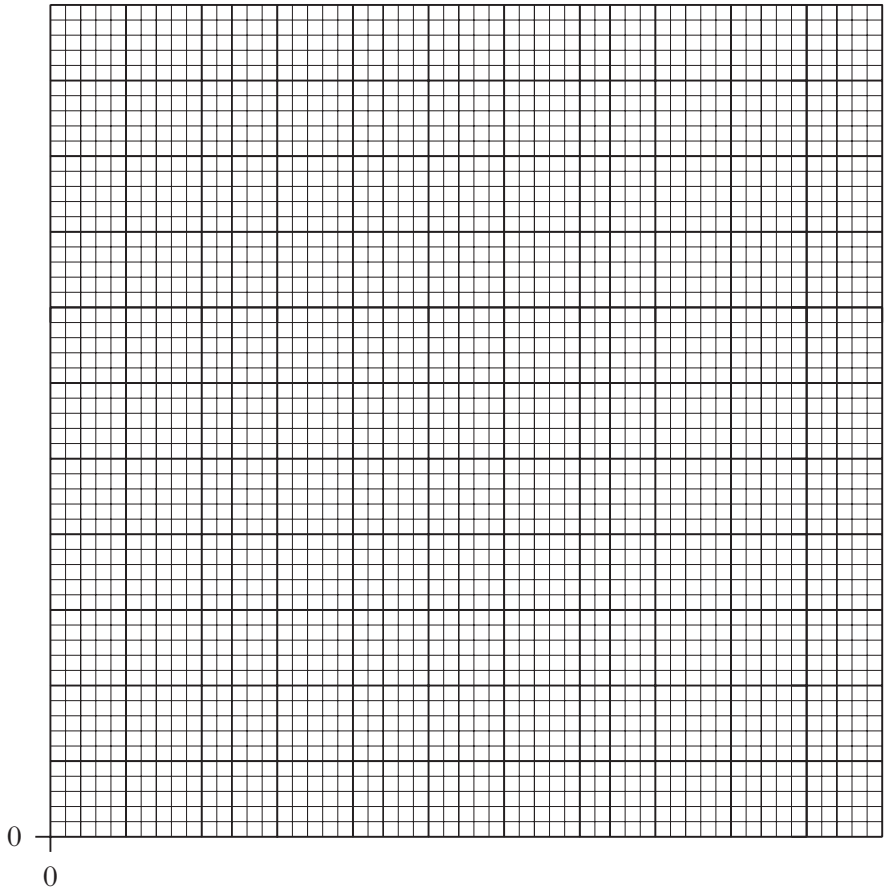
**ADDITIONAL SPACE FOR ANSWERS**

DO NOT WRITE IN THIS MARGIN

*Marks*

## ADDITIONAL SPACE FOR ANSWERS

Additional graph paper for use in Question 9(*a*).



**[BLANK PAGE]**