Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
January 2009
Advanced Subsidiary Examination

BIOLOGY (SPECIFICATION A) **BYA2**
Unit 2 Making Use of Biology

Thursday 8 January 2009 9.00 am to 10.30 am

For this paper you must have:
- a ruler with millimetre measurements.

You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. **Answers written in margins or on blank pages will not be marked.**
- If you need extra space use page 22 for your answers.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You will be marked on your ability to use good English, to organise information clearly and to use accurate scientific terminology where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

1 (a) mRNA may be described as a polymer. Explain why.

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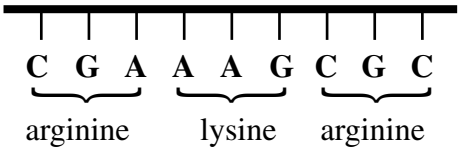
(1 mark)

1 (b) The diagram shows part of an mRNA molecule. It also shows the amino acids for which it codes.



The genetic code is non-overlapping and degenerate. Use the diagram to explain what is meant by the code being

1 (b) (i) non-overlapping

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(1 mark)

1 (b) (ii) degenerate.

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(2 marks)

1 (c) The table shows the percentages of different bases in two molecules of mRNA obtained from the same cell. Molecule **X** was transcribed from the DNA in one chromosome. Molecule **Y** was transcribed from the DNA in a different chromosome.

mRNA	Adenine	Cytosine	Guanine	Base **Z**
Molecule **X**	21	36	29	
Molecule **Y**	16	26	32	

1 (c) (i) Name base **Z**.

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(1 mark)

1 (c) (ii) Complete the table by writing in the percentages of base **Z** in molecules **X** and **Y**.

(1 mark)

1 (c) (iii) The percentages of bases in molecule **X** are different from the percentages of bases in molecule **Y**. Explain how transcription from DNA causes this difference.

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(2 marks)

8

Turn over for the next question

2 (a) Some women are infertile. Explain how each of the following may cause infertility.

2 (a) (i) FSH is only secreted in a low concentration.

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(2 marks)

2 (a) (ii) There is no surge in LH concentration.

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(1 mark)

2 (b) A woman has ovulated but did not become pregnant. The concentration of progesterone in her blood rose immediately after she ovulated then fell before her next period. Explain these changes in the concentration of progesterone.

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(3 marks)

(Extra space) .....

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2 (c) Some oral contraceptives contain oestrogen. How does oestrogen prevent ovulation?

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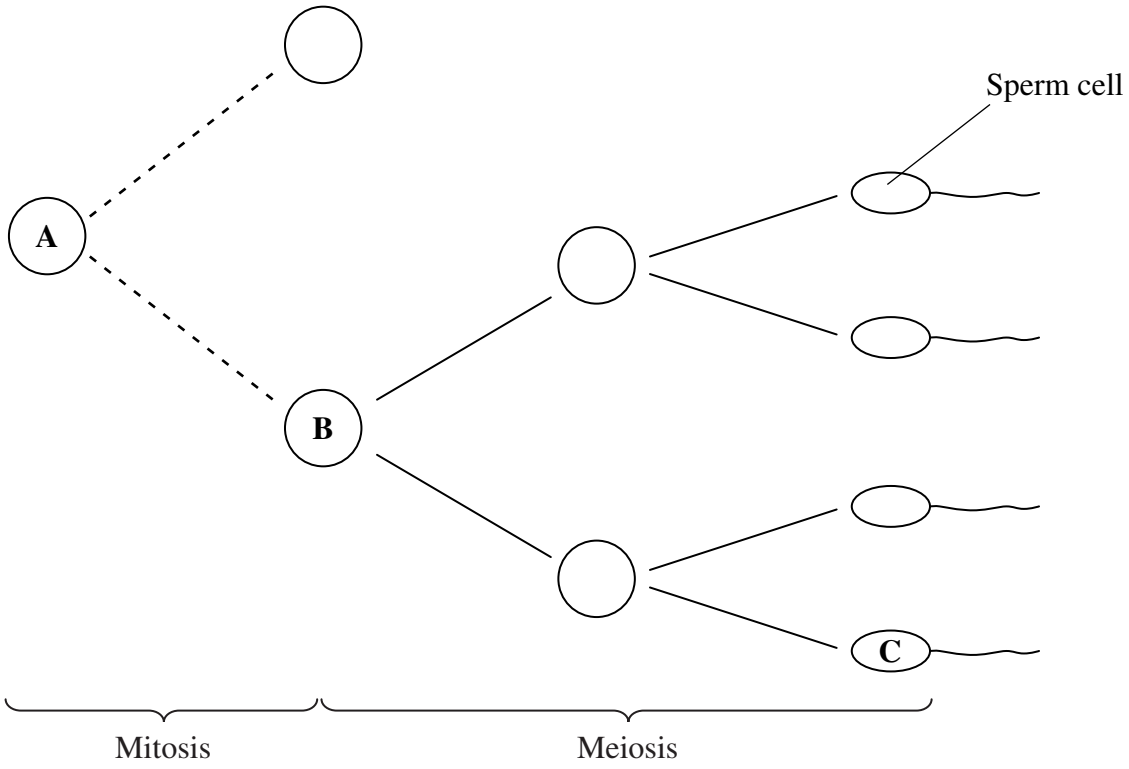
(1 mark)

7

Turn over for the next question

3 (a) The diagram shows how mitosis and meiosis are involved in the formation of sperm cells in a human.



Cell **A** contains two copies of a gene for brown eyes. How many copies of this gene are there in

3 (a) (i) cell **B** at the start of interphase

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(1 mark)

3 (a) (ii) cell **C**

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(1 mark)

3 (a) (iii) a white blood cell from this person?

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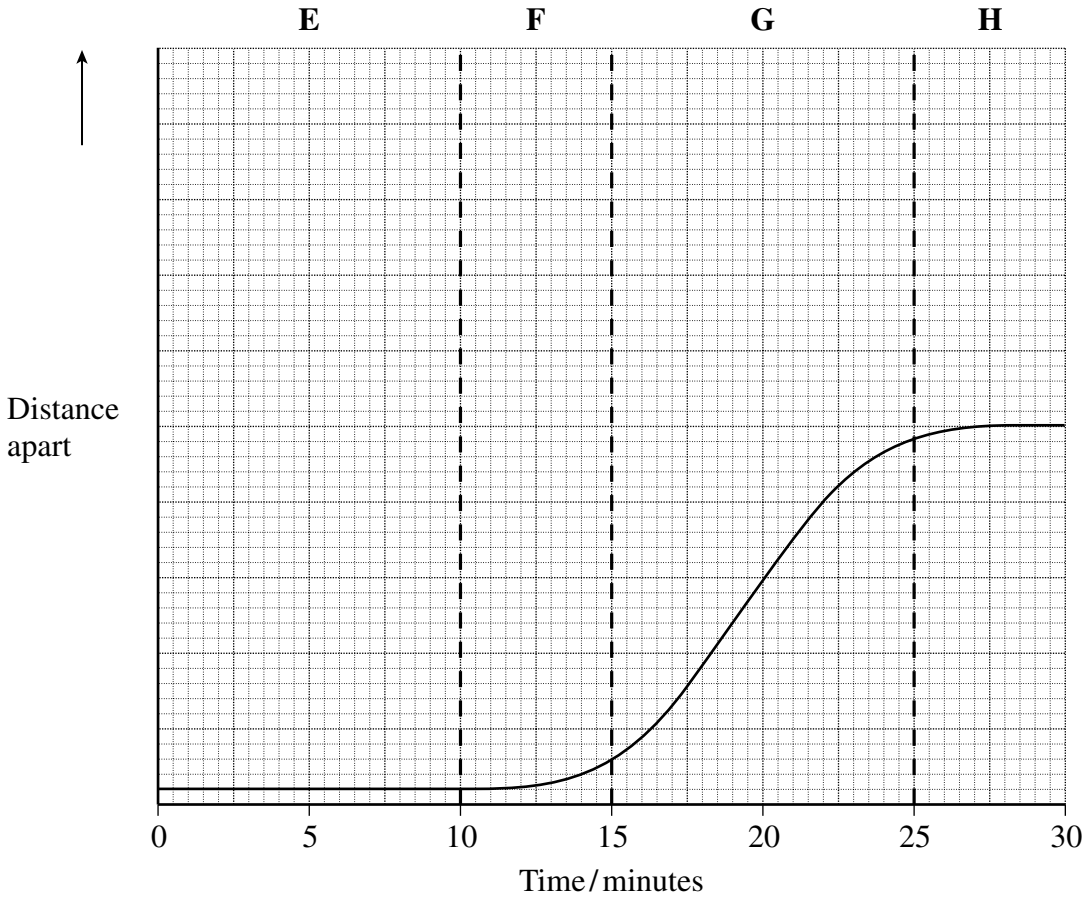
(1 mark)

3 (b) During mitosis chromosomes line up on the equator of the cell. Each chromosome consists of a pair of chromatids. Each chromatid then moves towards a pole of the cell.

The graph shows how the distance between a centromere and the equator of the cell changes during mitosis.



3 (b) (i) Sketch a curve on the graph to show the change in the distance apart of the centromeres on a pair of chromatids during this mitotic division. *(2 marks)*

3 (b) (ii) What phase of mitosis is represented by stage **H** on the graph?

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(1 mark)

3 (b) (iii) What causes the distance between the centromere and the equator to change during stage **G**?

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(1 mark)

7

Turn over ▶

4 Scientists know that plasmids are passed from one species of bacterium to another. They used gene technology to investigate this.

4 (a) The scientists produced plasmids containing the gene for resistance to antibiotic **X**. They used a restriction endonuclease and ligase to insert the gene into the plasmid. Describe the part played by

4 (a) (i) the restriction endonuclease

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(1 mark)

4 (a) (ii) the ligase.

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(1 mark)

4 (b) The scientists mixed two species of bacteria, **A** and **B**, in a single culture.

- All the bacteria of species **A** carried the plasmid giving resistance to antibiotic **X**. These bacteria were not resistant to antibiotic **Y**.
- None of the bacteria of species **B** were resistant to antibiotic **X**. They were resistant to antibiotic **Y**.

4 (b) (i) Complete the table to show the antibiotics to which each of the bacteria was resistant.

Use a tick if the bacteria were resistant and a cross if they were **not** resistant.

Antibiotic	**Bacteria**		
	Species **A**	Species **B** that had taken up plasmids from species **A**	Species **B** that had **not** taken up plasmids from species **A**
X			
Y			

(2 marks)

4 (b) (ii) A bacterium that can live on an agar plate will multiply and form a colony. Use this information to explain how scientists could use agar plates and antibiotics **X** and **Y** to find out whether bacteria of species **B** had taken up plasmids from species **A**.

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(2 marks)

4 (c) Scientists genetically modify bacteria to produce useful substances. They often add a marker gene to the modified plasmid.

4 (c) (i) What is a marker gene?

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(2 marks)

4 (c) (ii) It may not be wise to use antibiotic resistance genes as marker genes when genetically modifying bacteria. Use information from Question 4 to explain why.

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(2 marks)

10

5 Forensic scientists can identify the sex of a person from a small piece of bone, even if it is very old. They analyse the DNA in the bone.

5 (a) The scientists use the polymerase chain reaction (PCR) to copy part of the gene for amelogenin. Primers are used in this process.

5 (a) (i) What is a primer?

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5 (a) (ii) What are primers used for in this example?

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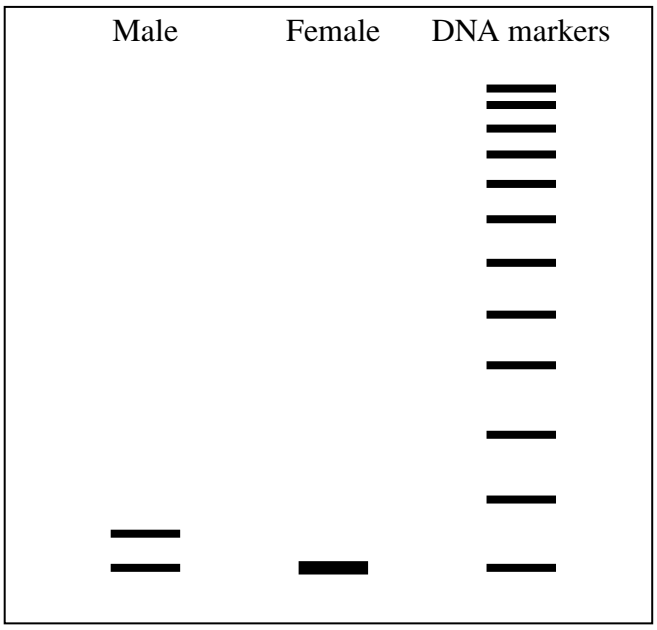
(3 marks)

The gene for amelogenin is on the sex chromosomes.

- The part of the gene for amelogenin copied from the X chromosome is 106 base pairs long.
- The part of the gene for amelogenin copied from the Y chromosome is 112 base pairs long.

The products of the PCR are now separated by electrophoresis. The diagram shows the results of carrying out this test on a bone sample from a male and a bone sample from a female.



5 (b) The DNA markers enable the size of the DNA fragments to be determined. What does a DNA marker consist of?

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(1 mark)

5 (c) (i) On the diagram, draw an arrow to show the direction in which the fragments of DNA moved.

(1 mark)

5 (c) (ii) Explain how you arrived at your answer to part (c) (i).

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(2 marks)

7

6 (a) Give **two** ways in which the leaves of sorghum are adapted to hot, dry conditions.

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(2 marks)

6 (b) Sorghum can tolerate high temperatures. Scientists think that one reason for this is that sorghum plants contain a substance called GB.

The scientists obtained two varieties of sorghum plants. One variety produces a lot of GB. The other variety produces very little GB. Samples of each variety were grown in distilled water. Other samples were grown in sodium chloride solution. All the samples were grown at a temperature of 38 °C. The scientists measured the rate of photosynthesis of the plants. The results are shown in the table.

Variety of sorghum	**Rate of photosynthesis / arbitrary units when grown in**	
	distilled water	sodium chloride solution
High GB	30	17
Low GB	32	9

6 (b) (i) Other than temperature, give **two** factors that may limit the rate of photosynthesis and so must be kept constant in this investigation.

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(1 mark)

6 (b) (ii) Sorghum plants are often irrigated. The water supplied to them may contain sodium chloride.

GB might be important to the growth of sorghum when the crop is irrigated in hot conditions. Use information in the table to suggest how.

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(3 marks)

(Extra space) .....

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6

Turn over for the next question

7 Read the following passage.

Annuals are plants that live for one year or less. The seed of an annual germinates and the seedling develops into a mature plant. The plant develops flowers, produces seeds and then dies. Cereals such as maize, rice and wheat are annuals.

In natural ecosystems, many plants are perennials. A perennial lives for many years, producing a fresh crop of seeds every year.

Scientists think that there are advantages in growing crops of perennial cereal plants such as wheat grass. They compared the root systems of annual wheat with those of perennial wheat grass. They found that most of the roots of wheat were in the top 30 cm of the soil. The roots of wheat grass penetrated the soil to ten times this depth. In addition, the length of life of the two types of plant had an important effect on the presence of living roots in the soil.

Use information from the passage and your own knowledge to answer the questions.

7 (a) Complete the table to give **two** differences between the root system of wheat and the root system of wheat grass.

Feature of root system	Wheat	Wheat grass

(2 marks)

7 (b) (i) Scientists predict that a wheat grass crop would need less weed killer than a wheat crop. Use information from lines 6 to 10 to explain why.

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(3 marks)

(Extra space) .....

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7 (b) (ii) Other than the cost of the weed killer, suggest **one** financial advantage of applying less weed killer to a crop.

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(1 mark)

7 (c) Farmers apply nitrate-containing fertilisers to wheat crops.

7 (c) (i) Explain why farmers need to apply fertilisers to annual crops that are grown in the same soil, year after year.

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(1 mark)

7 (c) (ii) The nitrate may be lost from the soil in which wheat is growing. Explain how this loss of nitrate may be related to the root system of wheat.

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(2 marks)

Question 7 continues on the next page

7 (c) (iii) Nitrate from fertiliser applied to crops such as wheat may enter ponds and streams. Explain how nitrate may affect organisms found in fresh water.

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(6 marks)

(Extra space) .....

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15

Turn over for the next question

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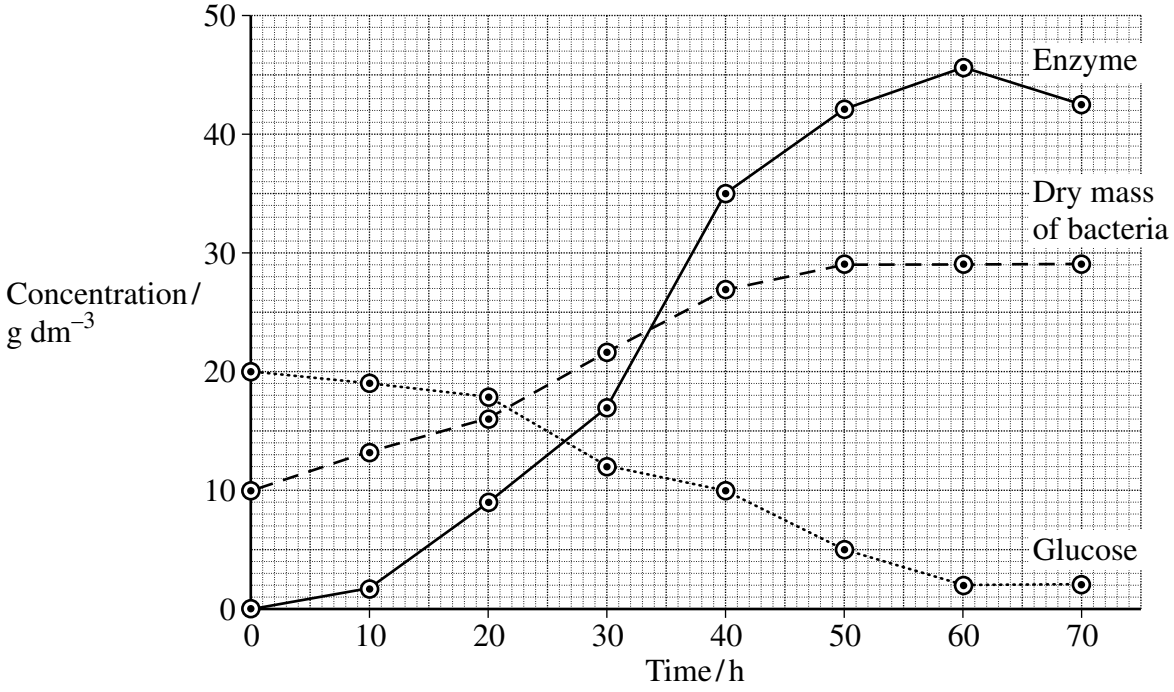
8 (a) The graph shows some of the changes that take place in a fermenter during the commercial production of an enzyme.



8 (a) (i) Between what times is the rate of production of the enzyme at its maximum?

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(1 mark)

8 (a) (ii) Calculate the rate of increase of the dry mass of the bacteria between 0 and 20 hours. Show your working and give your answer in g dm^{-3} h^{-1}.

Answer ..... g dm^{-3} h^{-1}

(2 marks)

8 (a) (iii) Explain the shape of the curve for concentration of glucose in the culture medium between 20 and 60 hours.

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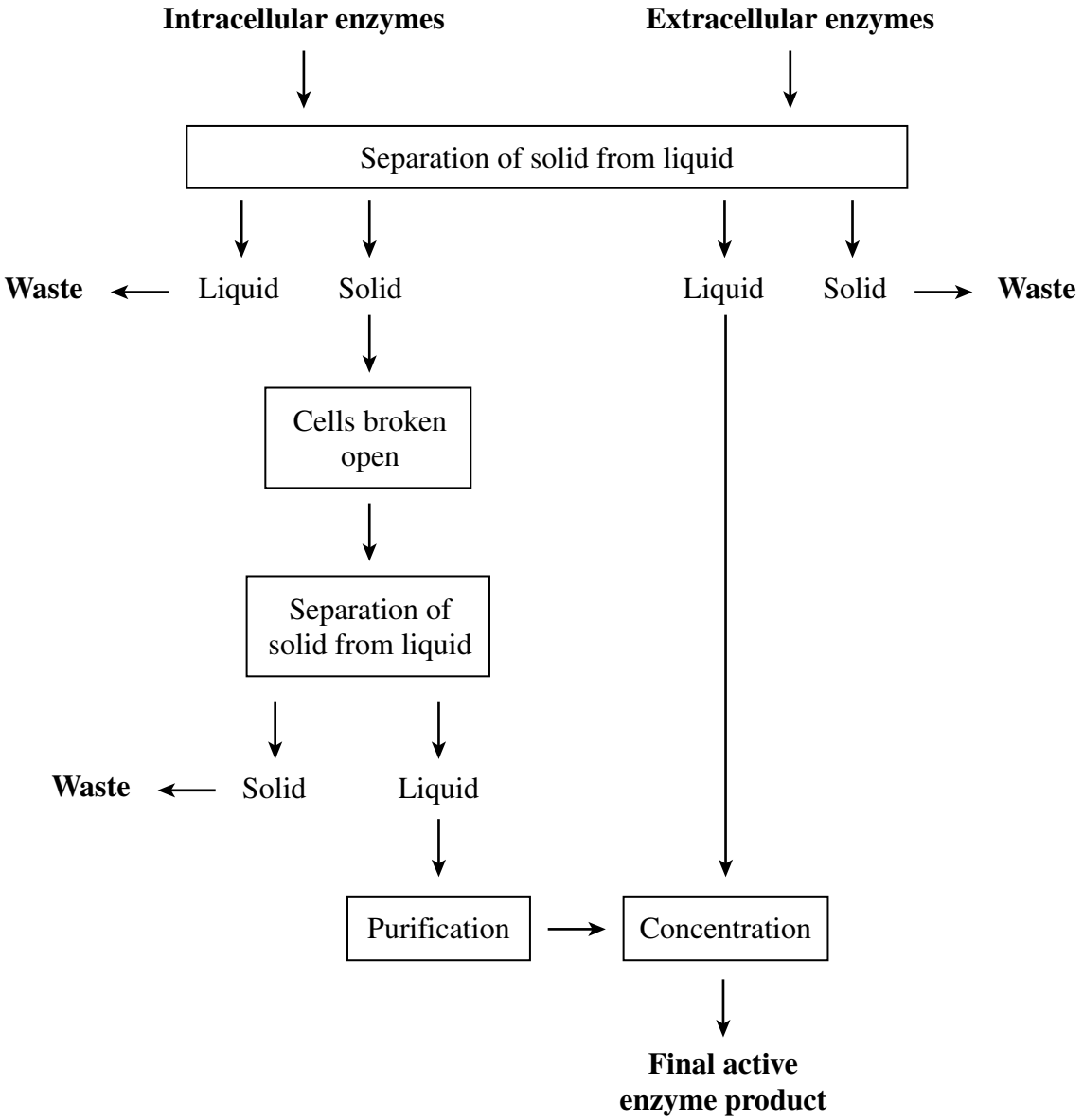
(2 marks)

When enzymes have been produced, they are purified and concentrated before they are sold. This is downstream processing. The flowchart shows how intracellular and extracellular enzymes are purified and concentrated.



8 (b) Purification is always necessary for intracellular enzymes but is not always necessary for extracellular enzymes. Explain why purification is always necessary for intracellular enzymes.

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(1 mark)

Question 8 continues on the next page

Turn over ▶

8 (c) Why would you expect the yield of the active enzyme product to be lower with intracellular enzymes than with extracellular enzymes?

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(1 mark)

8 (d) All the stages of downstream processing produce heat. Explain how heat lowers the yield of the final active enzyme product.

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(2 marks)

8 (e) Enzymes are used in biotechnological processes. Use your knowledge of enzymes and how they work to explain the advantages of using enzymes in biotechnological processes.

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15

END OF QUESTIONS

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