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**Pearson Edexcel Level 3 GCE**

**Thursday 4 June 2026**

Afternoon (Time: 1 hour 45 minutes)

Paper reference **9BI0/01**

**Biology B**

**Advanced**

**PAPER 1: Advanced Biochemistry, Microbiology and Genetics**

**You must have:**  
Scientific calculator, HB pencil, ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

## Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (\*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 Gel electrophoresis can be used to determine the parents of a child.

The diagram shows the results of agarose gel electrophoresis analysis for a child and four possible sets of parents.

| Child | Set 1  |      | Set 2  |      | Set 3  |      | Set 4  |      |
|-------|--------|------|--------|------|--------|------|--------|------|
|       | Female | Male | Female | Male | Female | Male | Female | Male |
|       |        |      |        |      |        |      |        |      |

- (a) Which property separates out the DNA fragments in gel electrophoresis?

(1)

- ☐ A charge
- ☐ B colour
- ☐ C size
- ☐ D solubility



(b) Explain how this analysis can be used to determine the parents of this child.

(2)

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(c) Ethidium bromide can be used to stain the DNA.

Ethidium bromide is added to the liquid agarose before the gel plates are poured.

The final concentration of ethidium bromide in the liquid agarose should be  $500 \text{ ng cm}^{-3}$ .

Calculate the mass, **in  $\mu\text{g}$** , of ethidium bromide that has to be added to  $0.8 \text{ dm}^3$  of liquid agarose.

(1)

Answer .....  $\mu\text{g}$

**(Total for Question 1 = 4 marks)**



- 2 In many flowering plants, male gametes and female gametes form in the same flower.

These plants have developed methods to prevent the male gametes from fertilising the female gametes (self-fertilisation).

- (a) Explain the importance to the plants of preventing self-fertilisation.

(2)

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- (b) Some plants produce stigma and pollen proteins. These proteins are produced by genes at the S-locus.

If the stigma and pollen proteins match, the pollen tubes cannot grow.

- (i) Explain why this method prevents self-fertilisation.

(2)

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(ii) Mutations at the S-locus can result in self-fertilisation.

Explain how a mutation at the S-locus could result in self-fertilisation.

(4)

(Total for Question 2 = 8 marks)

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- 3 Bacteria are classified as either Gram positive or Gram negative according to the structure of their cell wall.

The type of cell wall can determine the effect of antibiotics on the bacteria and the types of toxin that they can release.

- (a) Which row of the table describes the structure of a Gram positive cell wall?

(1)

|                            | Thickness of peptidoglycan (murein) layer of Gram positive cell wall compared to that of a Gram negative cell wall | Presence or absence of an outer (lipopolysaccharide) layer in a Gram positive cell wall |
|----------------------------|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| <input type="checkbox"/> A | thicker                                                                                                            | absent                                                                                  |
| <input type="checkbox"/> B | thicker                                                                                                            | present                                                                                 |
| <input type="checkbox"/> C | thinner                                                                                                            | absent                                                                                  |
| <input type="checkbox"/> D | thinner                                                                                                            | present                                                                                 |

- (b) Give **one** reason why the type of cell wall can determine the effect of antibiotics on bacteria.

(1)

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- (c) The effect of antibiotics on the release of an exotoxin, PVL, by *Staphylococcus aureus* (*S.aureus*) was investigated.

- (i) Which of the following statements about PVL and *S.aureus* are correct?

(1)

1. *S.aureus* is Gram positive.
2. Only Gram positive bacteria can release exotoxins.
3. Exotoxins are released only when bacteria die.

- ☐ A 1 only
- ☐ B 2 only
- ☐ C 1 and 3 only
- ☐ D 2 and 3 only



- (ii) The bacteria were cultured in the presence or absence of an antibiotic for 24 hours.

The concentration of PVL released into the culture media was then determined.

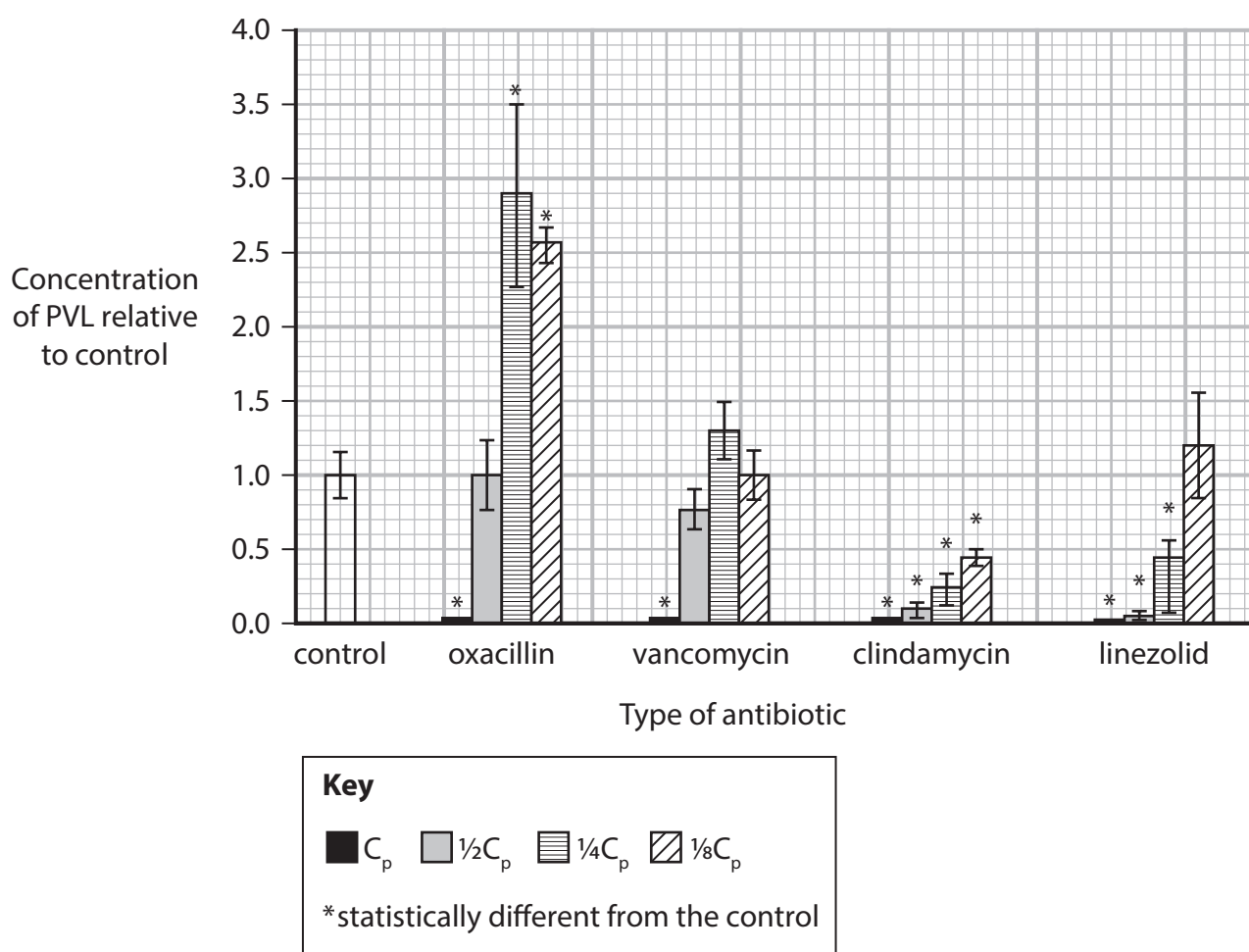
The highest concentration ( $C_p$ ) of each antibiotic used was comparable to those used in patients.

Three other concentrations were also tested:  $\frac{1}{2}C_p$ ,  $\frac{1}{4}C_p$  and  $\frac{1}{8}C_p$ .

Each concentration of each type of antibiotic was tested five times and the means and standard deviations calculated.

The graph shows the results of this investigation.

The concentration of PVL is expressed relative to the concentration released by the bacteria cultured in the absence of any antibiotic (control).



Analyse the data to comment on how the type of antibiotic and the concentration of antibiotic affect the release of PVL by *S.aureus*.

(4)

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(Total for Question 3 = 7 marks)



- 4 The diagram shows the developmental stages of a human embryo during the first 28 days after fertilisation.



- (a) Which row of the table identifies the stem cells present in the embryos at 3 days, 6 days and 28 days?

(1)

| Stem cells present in embryo |             |             |             |
|------------------------------|-------------|-------------|-------------|
|                              | 3 days      | 6 days      | 28 days     |
| <input type="checkbox"/> A   | multipotent | pluripotent | totipotent  |
| <input type="checkbox"/> B   | pluripotent | totipotent  | multipotent |
| <input type="checkbox"/> C   | totipotent  | pluripotent | multipotent |
| <input type="checkbox"/> D   | totipotent  | multipotent | pluripotent |

- (b) Embryos can be grown legally for 14 days in a laboratory.

Analyse the information in the diagram to explain why embryos can only be grown in a laboratory for a maximum of 14 days.

(2)

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- (c) Scientists have created synthetic human embryos for medical research.

These embryos were created using cells cultured from actual human embryos in a laboratory.

Synthetic mouse embryos have also been created. These have shown evidence of a developing brain and a beating heart.

- (i) Analyse the information in the diagram to explain which cells from an actual human embryo should be cultured and used to create a synthetic human embryo.

(3)

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- (ii) Explain whether or not these synthetic human embryos might offer a more ethical alternative to using actual human embryos in the development of new medical advances.

(3)

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- (d) Differentiated fibroblasts can be reprogrammed to form induced pluripotent stem cells (iPS cells).

- (i) Name **one** gene that must be inserted into these fibroblasts to reprogramme them.

(1)

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- (ii) Analyse all the information to explain why these reprogrammed fibroblasts cannot be used to form a synthetic human embryo.

(2)

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(Total for Question 4 = 12 marks)



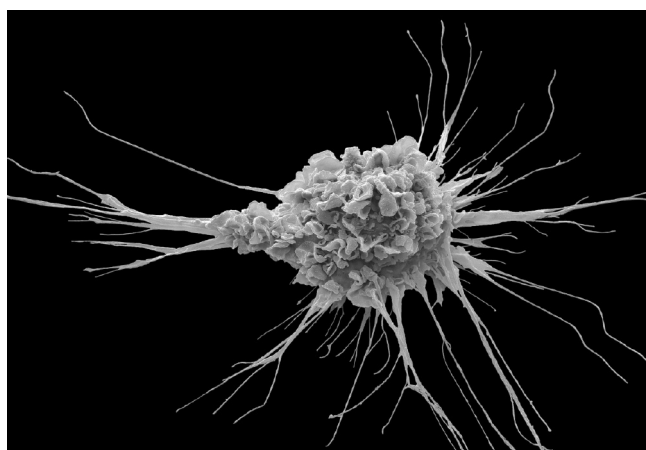
- 5 When a person becomes infected with a pathogen, the immune system needs to be activated to help macrophages destroy the pathogen and immunological memory to be stimulated.

(a) Explain the importance of immunological memory to a person.

(2)

- (b) Dendritic cells are antigen-presenting cells that reside in many tissues of the body.

The photograph shows a dendritic cell.



(Source: © Science Photo Library/Alamy Stock Photo)

Dendritic cells move through the tissue to the site of infection and then migrate to the lymph nodes to present the antigen to lymphocytes.

The dendritic cells are guided to the lymph nodes by chemicals, one of which is chemical 19. The cells are thought to move towards a higher concentration of chemical 19.



- (i) Dendritic cells have receptors on their surface called receptor 7 that are specific to chemical 19.

Describe how chemical 19 is taken into dendritic cells.

(2)

- (ii) Dendritic cells move by changing shape.

Explain how the properties of the cell membrane allow the dendritic cells to change shape.

(2)



- (iii) Scientists have shown that as the dendritic cells migrate, they constantly remove chemical 19 by taking this into their cytoplasm.

Explain how this uptake of chemical 19 helps in the migration of these cells towards the lymph nodes.

(2)

- (iv) Explain why the migration rate of dendritic cells towards the lymph nodes is faster when there are more dendritic cells present.

(2)

**(Total for Question 5 = 10 marks)**



6 Aerobic respiration can be summarised by the word equation:



The respiratory quotient (RQ) is defined as the volume of carbon dioxide produced divided by the volume of oxygen used.

The table shows some RQ values for different respiratory substrates.

| Respiratory substrate | RQ  |
|-----------------------|-----|
| carbohydrate          | 1.0 |
| lipid                 | 0.7 |
| protein               | 0.9 |

(a) (i) State why the aerobic respiration of carbohydrates has an RQ of 1.0.

(1)

(ii) Which of the following is the volume of oxygen used, in  $\text{dm}^3 \text{g}^{-1}$ , when the respiration of protein produced  $0.78 \text{ dm}^3 \text{g}^{-1}$  of carbon dioxide?

(1)

- ☐ A 0.70
- ☐ B 0.87
- ☐ C 1.15
- ☐ D 1.42



(iii) The range of RQ values for humans is from 0.7 to 1.0 in resting conditions.

Explain why humans have this range of RQ values.

(2)

(iv) Explain what an RQ value of  $> 1$  might indicate in some organisms.

(2)

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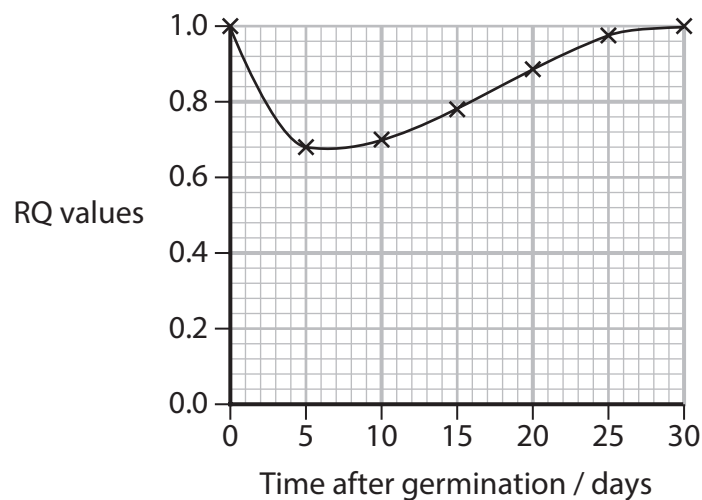
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- (b) A scientist investigated the RQ values of a plant seedling during the first 30 days after germination.

The graph shows the results of this investigation.



Explain the changes in RQ values shown in this graph.

(3)

- (c) The RQ values for plants can appear lower than for humans, even if the respiratory substrate is the same.

State the reason for this difference.

(1)

(Total for Question 6 = 10 marks)



- 7 In 2022, three in ten people around the world went short of food.

Improving plant yields of crops, such as wheat and maize, will help to increase the availability of food but could result in a shortage of water.

- (a) In 2022 there were 8 billion ( $8 \times 10^9$ ) people in the world.

- (i) Calculate the number of people who went short of food in 2022.

Give your answer **in standard form**.

(1)

Answer .....

- (ii) It is estimated that by 2050, there will be 9.7 billion people in the world.

Calculate the percentage increase in the number of people in the world from 2022 to 2050.

Give your answer to **two significant figures**.

(1)

Answer ..... %

- (b) Explain **one** reason why improving plant yields could result in a shortage of water.

(2)

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(c) Grains of wheat and rice are sources of starch and protein.

The table shows some statements about the structures of starch and protein.

Which box in each row of the table is correct?

(3)

| Statement about structure           | Structure found in       |                          |                          |                            |
|-------------------------------------|--------------------------|--------------------------|--------------------------|----------------------------|
|                                     | both starch and protein  | starch only              | protein only             | neither starch nor protein |
| Contain carbon, hydrogen and oxygen | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>   |
| Monomers joined by ester bonds      | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>   |
| Contain hydrogen bonds              | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>   |

\*(d) Scientists are trying to find ways of improving plant yields.

These include:

- 1. Altering the size of the leaves.**
- 2. Changing the angle of branches.**
- 3. Reducing photorespiration.**

In photorespiration, RUBISCO binds with oxygen.

As a result, some of the already-fixed carbon dioxide is lost.

Photorespiration occurs when there is an increase in the ratio of oxygen to carbon dioxide and when the temperature is high.

- 4. Increasing the rate of recovery of plants from photoprotection.**

In photoprotection, plants protect themselves from too much sun by producing proteins that reflect excess light energy.

When light intensity decreases, such as when clouds pass over, this is reversed.

- 5. Modifying plants to carry out C4 photosynthesis.**

In C4 photosynthesis, carbon dioxide accumulates in specialised cells that contain RUBISCO.

This allows photosynthesis to occur even when the stomata are closed.



Explain how these ways could be used to increase the yields of crop plants.

(6)

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(Total for Question 7 = 13 marks)



- 8 Industrial water and household water have to be treated before being returned to rivers.

Treatment plants do not remove all the chemicals and bacteria from the water so that when this water is returned to rivers, it harms the biodiversity of these ecosystems.

- (a) State the meaning of the term **biodiversity**.

(1)

- (b) Give **one** ethical reason for the maintenance of biodiversity.

(1)



(c) Biodiversity can be assessed using an index of diversity.

The index of diversity was determined for River A.

The table shows the number of each species found in a sample of water from this river.

| Species | Number of individuals of that species (n) | n(n-1) |
|---------|-------------------------------------------|--------|
| A       | 67                                        | 4422   |
| B       | 23                                        | 506    |
| C       | 3                                         | 6      |
| D       | 18                                        | 306    |
| E       | 9                                         |        |
| F       | 22                                        |        |
| G       | 13                                        |        |

(i) Calculate the index of diversity (D) for River A.

Use the table and the formula:

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

(3)

Answer .....

(ii) Another river, River B, had an index of diversity of 2.1.

State which river was the least polluted.

Use the values for index of diversity to support your answer.

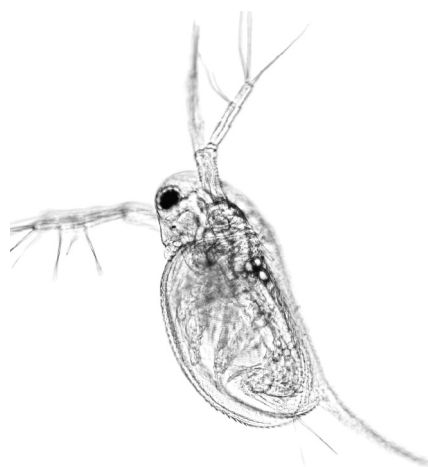
(1)



(d) Scientists are developing water treatments using species of *Daphnia*.

*Daphnia* are filter feeders that can remove bacteria from water.

The photograph shows a *Daphnia*.



(Source: © Viktoriia Ruban/Alamy Stock Photo)

Magnification  $\times 10$

(i) *Daphnia* are animals that belong to the class Crustacea.

The classification system is hierarchical.

Part of this hierarchy is:

- Domain
- Kingdom
- Phylum
- Order
- Genus

Where in this hierarchy should the class Crustacea appear?

(1)

- ☐ **A** between Domain and Kingdom
- ☐ **B** between Kingdom and Phylum
- ☐ **C** between Phylum and Order
- ☐ **D** between Order and Genus



- \* (ii) The scientists tested the water filtered by the *Daphnia* for the presence of *E.coli* bacteria.

Describe how the scientists could use microbial techniques to investigate the effectiveness of *Daphnia* in removing *E.coli* from water.

(6)

(Total for Question 8 = 13 marks)



9 Obesity is a risk factor for atherosclerosis and some types of cancer.

(a) A person is considered obese if they have a body mass index (BMI)  $> 30$ .

Determine whether a person who is 190 cm tall and has a mass of 107 kg is obese.

(1)

Use the formula:

$$\text{BMI} = \frac{\text{mass in kg}}{(\text{height in m})^2}$$

(b) Explain how obesity increases the risk of atherosclerosis.

(4)



- (c) The effect of weight loss in reducing the development of blood cancer in obese people was investigated over a 20-year period.

A group of 4 047 obese people was divided into two groups.

One group of 2 007 people underwent weight-reducing surgery (surgery group).

The other group did not have any surgery (control group).

- (i) In the surgery group, 34 people developed blood cancer.

In the control group, 51 people developed blood cancer.

None of the people in the control group lost weight.

Determine whether or not weight loss reduced the development of blood cancer.

(2)

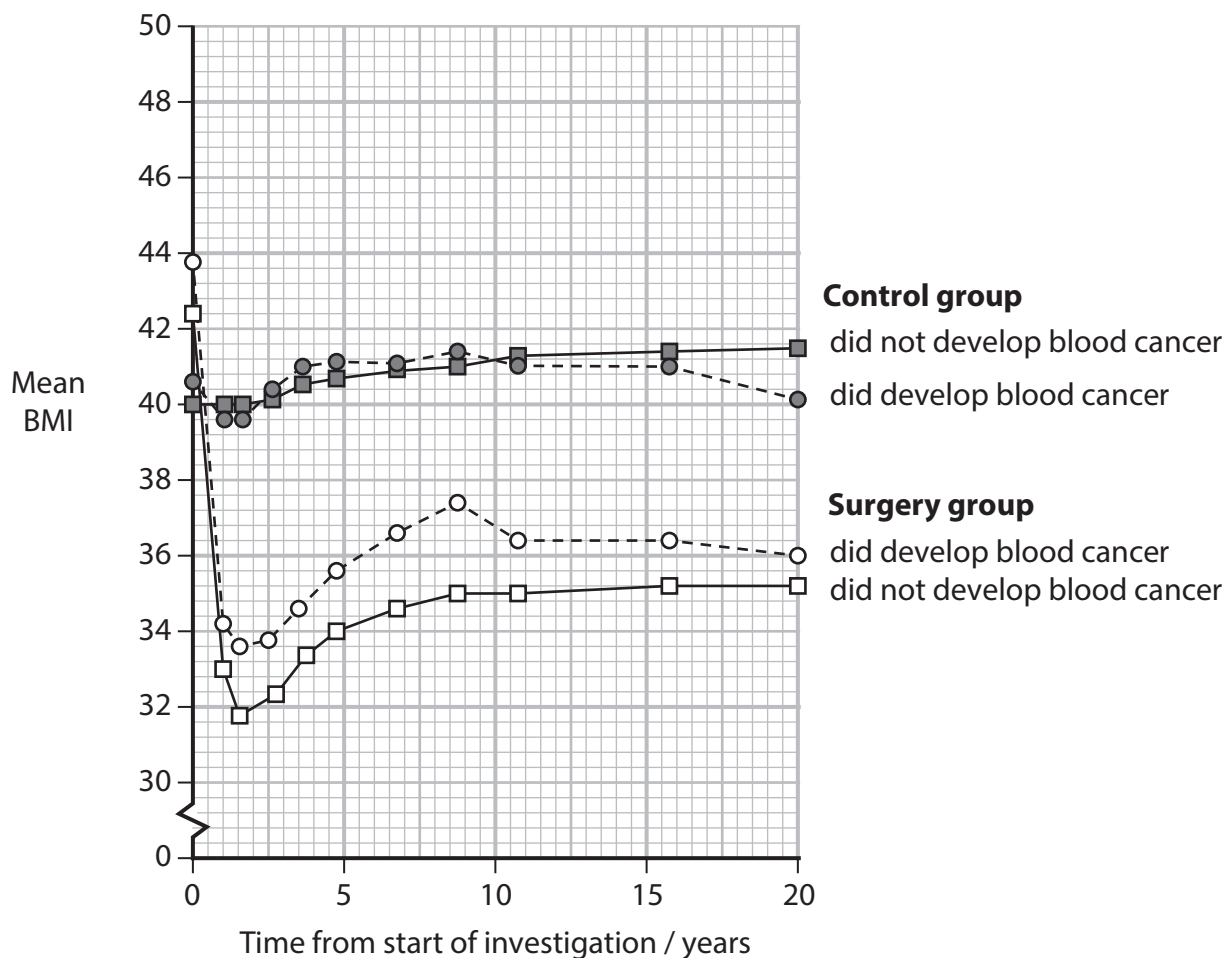
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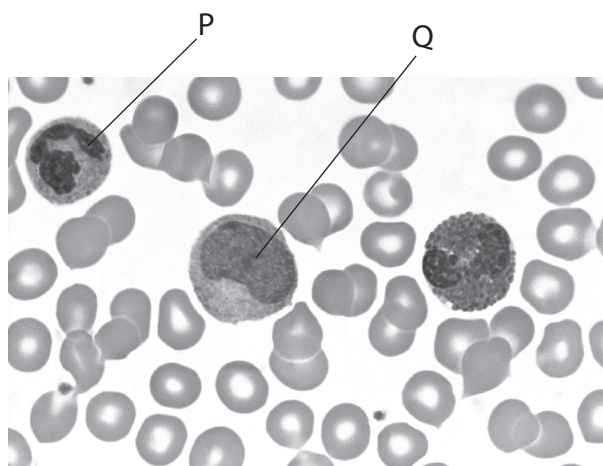
(ii) The graph shows some of the results of this investigation.



Analyse the data to comment on the results shown in this graph.

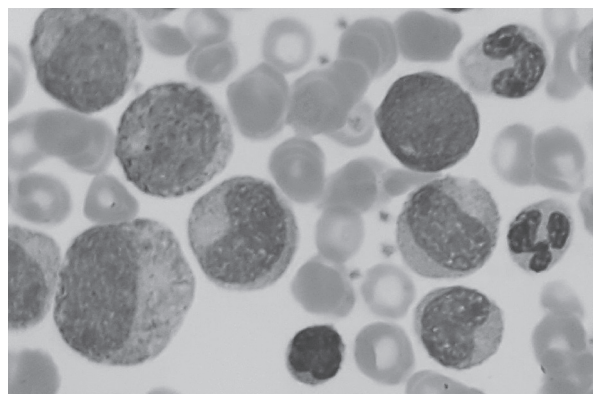
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(d) The photographs show blood smears from a healthy person and from a person with blood cancer.



(Source: © Biophoto Associates/SCIENCE PHOTO LIBRARY)

Healthy person



(Source: © Jangdragon/Shutterstock)

Person with blood cancer

(i) Which row of the table identifies blood cells P and Q?

(1)

|                          |   | Blood cell P | Blood cell Q |
|--------------------------|---|--------------|--------------|
| <input type="checkbox"/> | A | lymphocyte   | eosinophil   |
| <input type="checkbox"/> | B | lymphocyte   | monocyte     |
| <input type="checkbox"/> | C | neutrophil   | eosinophil   |
| <input type="checkbox"/> | D | neutrophil   | monocyte     |

(ii) Explain why blood smears can be used in the diagnosis of blood disorders such as cancer.

(2)

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(Total for Question 9 = 13 marks)

TOTAL FOR PAPER = 90 MARKS



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