



Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

BIOLOGY

Paper 2

7402/2

Time allowed: 2 hours

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]



For this paper you must have:

- **a ruler with millimetre measurements**
- **a scientific calculator.**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Show all your working.**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**



INFORMATION

- **The marks for the questions are shown in brackets.**
- **The maximum mark for this paper is 91.**

DO NOT TURN OVER UNTIL TOLD TO DO SO



Answer ALL questions in the spaces provided.

01.1

**Describe the process of glycolysis.
[4 marks]**



[Turn over]

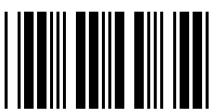


0	1	.	2
---	---	---	---

Malonate inhibits a reaction in the Krebs cycle.

Explain why malonate would decrease the uptake of oxygen in a respiring cell.
[2 marks]

6



0	2	.	1
---	---	---	---

Explain how a resting potential is maintained across the axon membrane in a neurone. [3 marks]

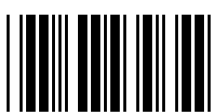
This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



0	2	.	2
---	---	---	---

Explain why the speed of transmission of impulses is faster along a myelinated axon than along a non-myelinated axon.
[3 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

0	2	.	3
---	---	---	---

A scientist investigated the effect of inhibitors on neurones. She added a respiratory inhibitor to a neurone. The resting potential of the neurone changed from -70 mV to 0 mV.

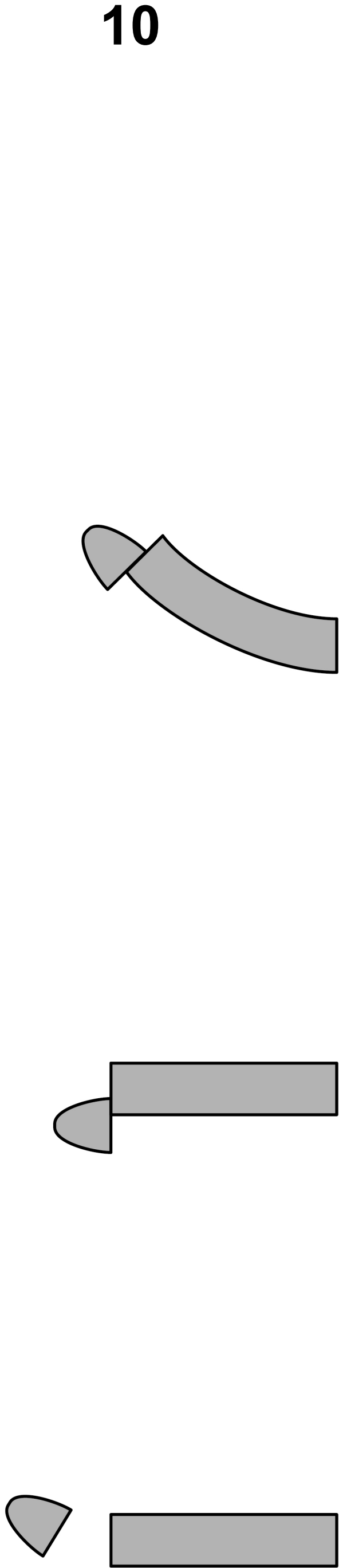
Explain why. [3 marks]

[Turn over]



FIGURE 1 shows an investigation into growth factors in plants.

FIGURE 1



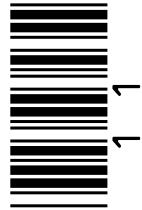
Tip removed
from shoot
of plant

Then, tip
replaced on
one side of
cut shoot

Then, growth curvature
occurred **WITHOUT** a
directional light source

03.1

Use your knowledge of indoleacetic acid (IAA) to explain the growth curvature shown in FIGURE 1. [3 marks]



A bioassay is a method to determine the concentration of a substance by its effect on living tissues.

FIGURE 2, on the opposite page, shows the practical procedure used in a growth curvature bioassay to determine the concentration of IAA in shoot tips.

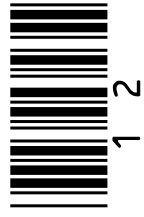


FIGURE 2

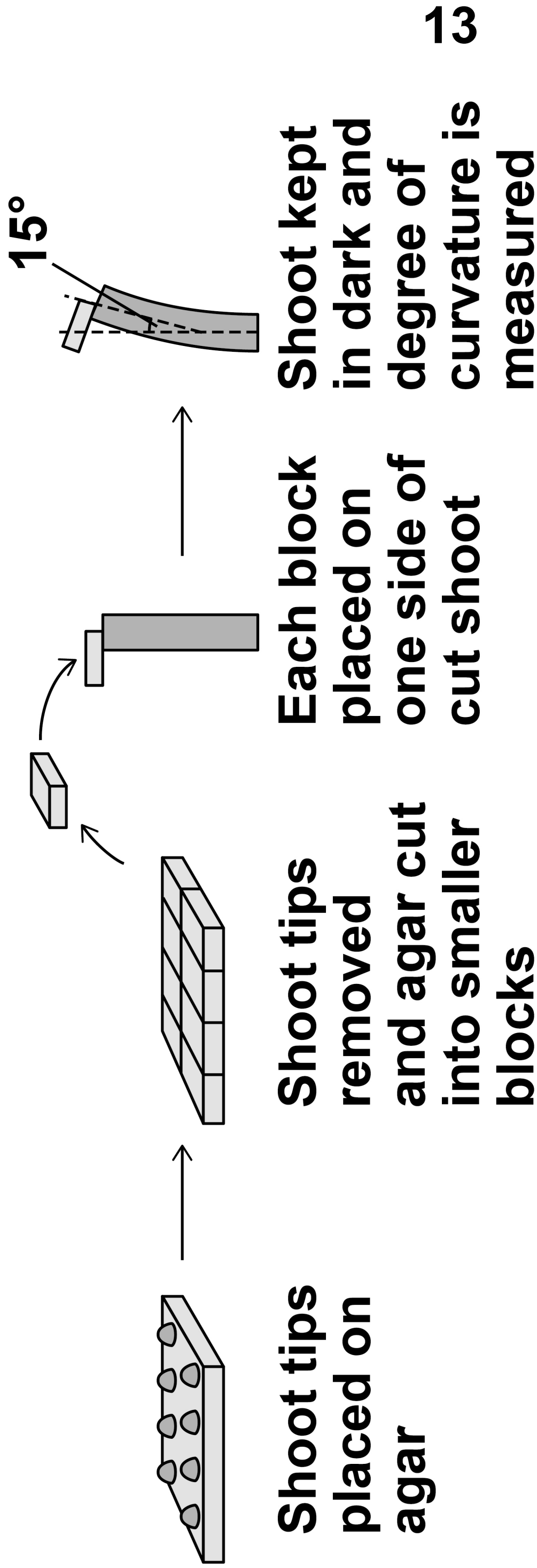


FIGURE 3, on page 14, shows the calibration curve for this growth curvature bioassay.

[Turn over]

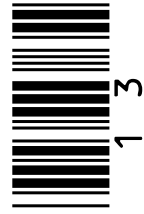
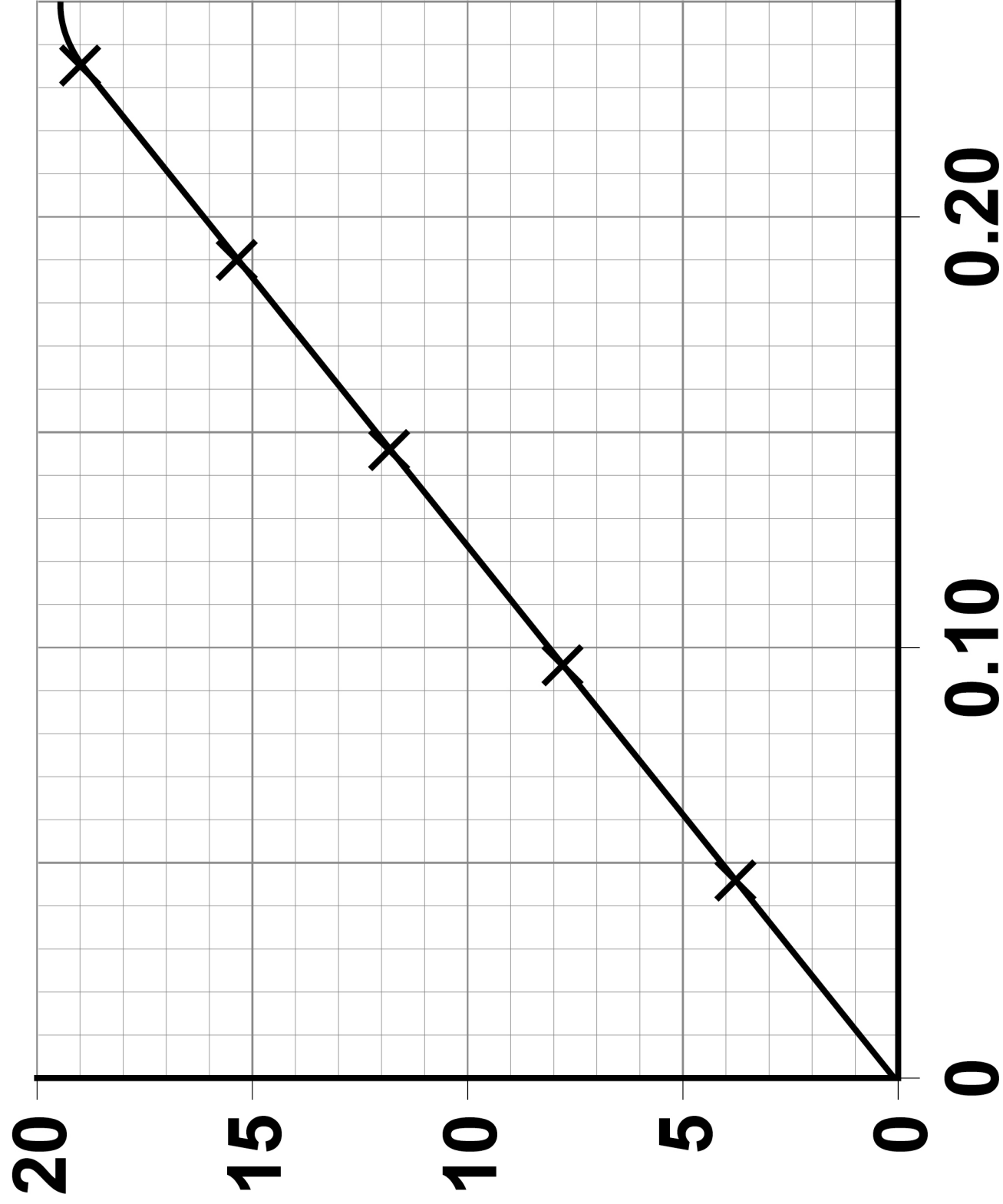
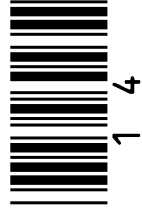


FIGURE 3

Degree of curvature



**IAA concentration in
agar block / mg dm⁻³**



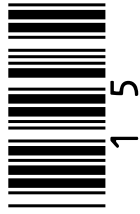
Using the procedure in FIGURE 2, on page 13, and the calibration curve in FIGURE 3, on page 14, describe how you could compare the IAA concentration in shoot tips from two different plant species.

In your answer you should refer to all the variables that should be controlled to produce a valid comparison.

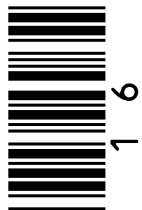
[5 marks]

15

[Turn over]

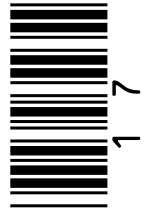


--	--	--	--	--	--	--	--	--	--	--



BLANK PAGE

[Turn over]



A scientist investigated the effect of a directional light stimulus on the distribution of IAA in shoot tips. The scientist set up three experiments as shown in FIGURE 4.

All variables were controlled apart from exposure to light.

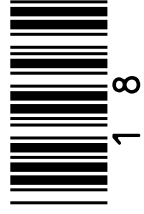
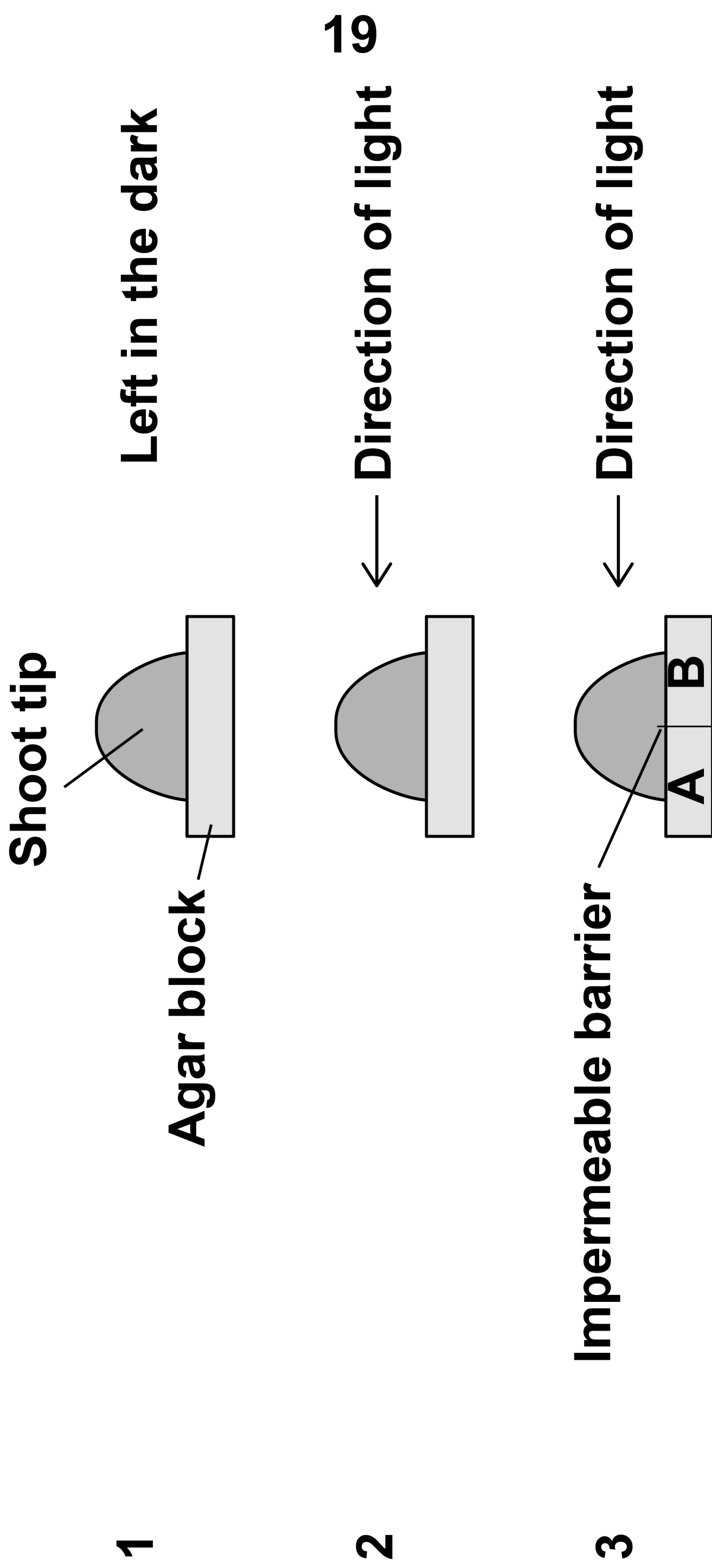
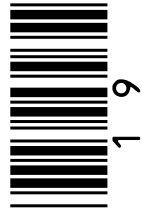


FIGURE 4
EXPERIMENT

TREATMENT



[Turn over]



She then used the growth curvature bioassay to compare the IAA concentrations in the agar blocks from:

- experiment 1
- experiment 2
- experiment 3 section A
- experiment 3 section B.

TABLE 1 shows the scientist’s results.

TABLE 1

Experiment	Degree of curvature in Bioassay / degrees
1	17.69
2	17.61
3A	11.22
3B	6.50



$$\frac{3}{30}$$

State TWO conclusions about IAA that you can make from the results shown in TABLE 1. [2 marks]

2

21

[Turn over]



0	4
---	---

In fruit flies, males have the sex chromosomes XY and the females have XX.

In fruit flies, a gene for eye colour is carried on the X chromosome. The allele for red eyes, R, is dominant to the allele for white eyes, r.

0	4	.	1
---	---	---	---

Male fruit flies are more likely than female fruit flies to have white eyes.

Explain why. [2 marks]



[Turn over]



0	4	.	2
---	---	---	---

A female fruit fly with white eyes was crossed with a male fruit fly with red eyes to produce a large number of offspring.

**Tick (✓) ONE box next to the statement which correctly describes the phenotypes produced from this cross.
[1 mark]**

☐

All offspring red-eyed

☐

All females red-eyed, all males white-eyed

☐

All males red-eyed, all females white-eyed

☐

All males white-eyed, females red-eyed and females white-eyed



BLANK PAGE

[Turn over]



In fruit flies, the genes for body colour and for wing development are not on the sex chromosomes. The allele for grey body colour, G, is dominant to the allele for black body colour, g. The allele for long wings, L, is dominant to the allele for short wings, l.

A geneticist carried out a cross between fruit flies with grey bodies and long wings (heterozygous for both genes) and fruit flies with black bodies and short wings.

TABLE 2 shows the results of this cross.

TABLE 2

Phenotype of offspring	Number of offspring
Grey body AND long wings	223
Black body AND short wings	218



0	4	.	3
---	---	---	---

**Explain the results in TABLE 2.
[3 marks]**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



04.4

The FIRST generation of a population of fruit flies had 50 females.

Calculate how many female fruit flies would be produced from this population in the FIFTH generation.

You can assume:

- **each female produces 400 offspring each generation**
- **half the offspring produced each generation are female**
- **there is no immigration or emigration**
- **no flies die before reproducing.**

On the opposite page, show your working.



**Give your answer in standard form.
[3 marks]**

Answer _____

[Turn over]

9



0	5	.	1
---	---	---	---

Neonatal diabetes is a disease that affects newly born children. The disease is caused by a change in the amino acid sequence of insulin.

**This change prevents insulin binding to its receptor. Explain why this change prevents insulin binding to its receptor.
[2 marks]**



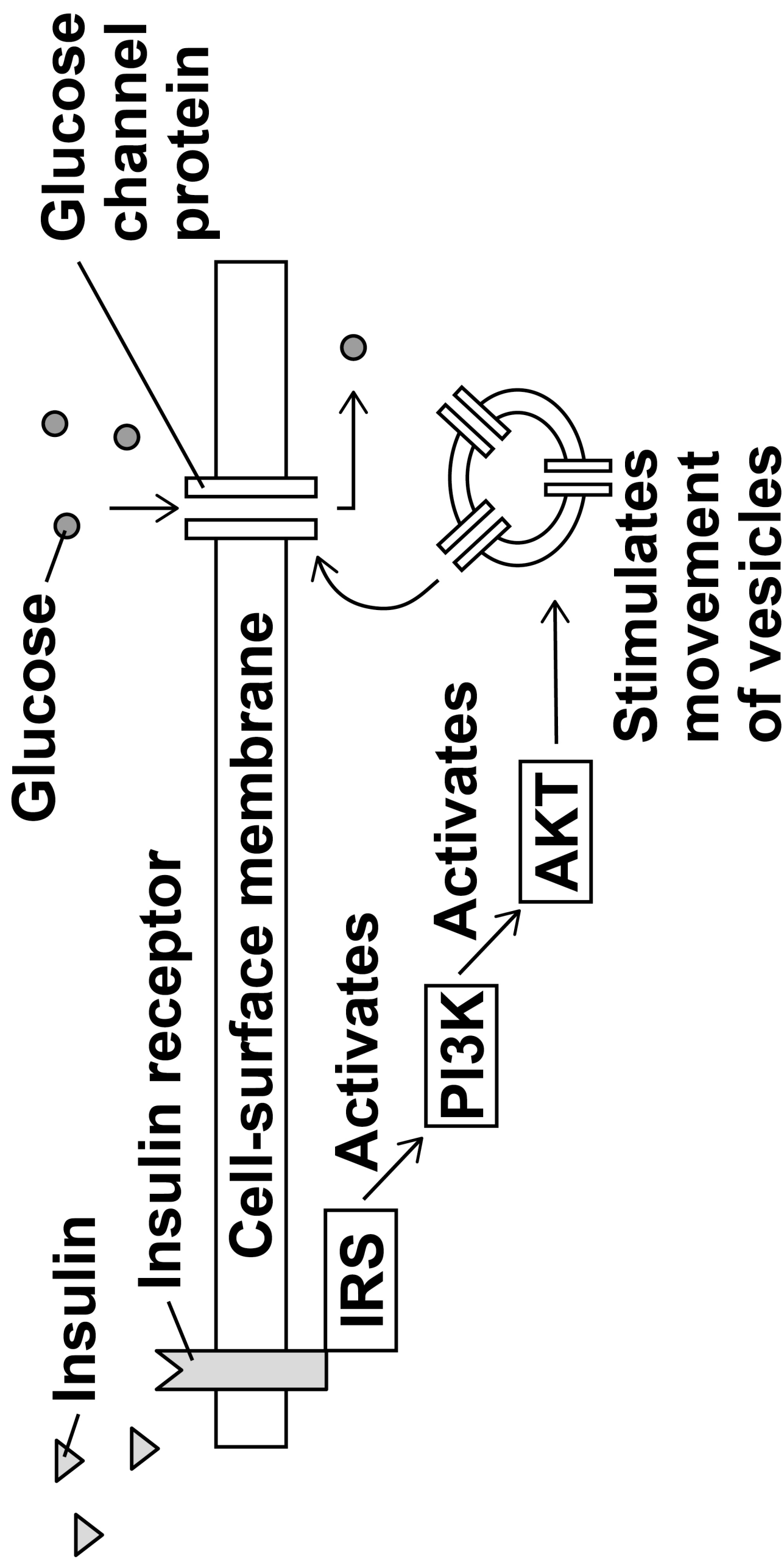
Phosphoinositide 3-kinase (PI3K) is an enzyme in several metabolic processes.

FIGURE 5, on page 32, shows the role of PI3K in the control of blood glucose concentration.

[Turn over]



FIGURE 5



05.2

A decrease in the activity of PI3K can cause type II diabetes.
Use FIGURE 5 to explain why. [3 marks]

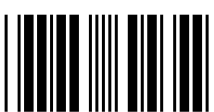
[Turn over]



05.3

Using your knowledge of the kidney, explain why glucose is found in the urine of a person with untreated diabetes.

[3 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

BLANK PAGE

[Turn over]



0	6
---	---

Myelodysplastic syndromes (MDS) are a group of malignant cancers. In MDS, the bone marrow does not produce healthy blood cells.

Haematopoietic stem cell transplantation (HSCT) is one treatment for MDS. In HSCT, the patient receives stem cells from the bone marrow of a person who does not have MDS. Before the treatment starts, the patient's faulty bone marrow is destroyed.



0	6	.	1
---	---	---	---

For some patients, HSCT is an effective treatment for MDS.

Explain how. [3 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



06.2

MDS can develop from epigenetic changes to tumour suppressor genes. In some patients, the drug AZA has reduced the effects of MDS. AZA is an inhibitor of DNA methyltransferases. These enzymes add methyl groups to cytosine bases.

Suggest and explain how AZA can reduce the effects of MDS in some patients. [3 marks]



Scientists investigated the effectiveness of AZA in patients with MDS.

A total of 360 patients were randomised in the ratio of 1:1 to receive AZA or conventional drugs (control).

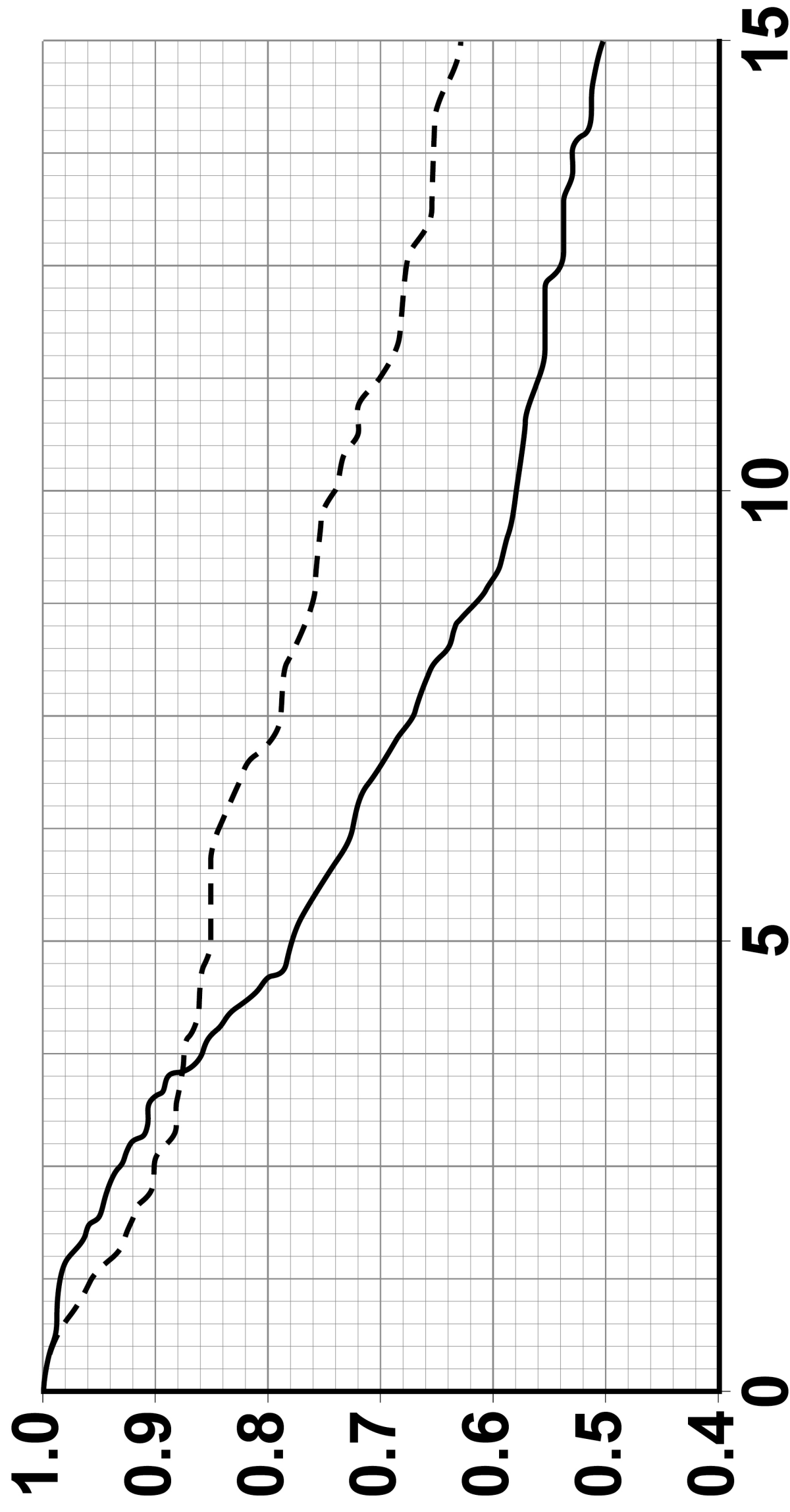
FIGURE 6, on page 40, shows the scientists' results.

[Turn over]



FIGURE 6

Proportion surviving



KEY

--- AZA — Conventional drugs

06.3

The control patients were treated with conventional drugs.

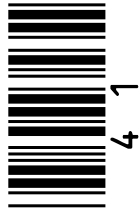
Give TWO reasons why. [2 marks]

- 1

- 2

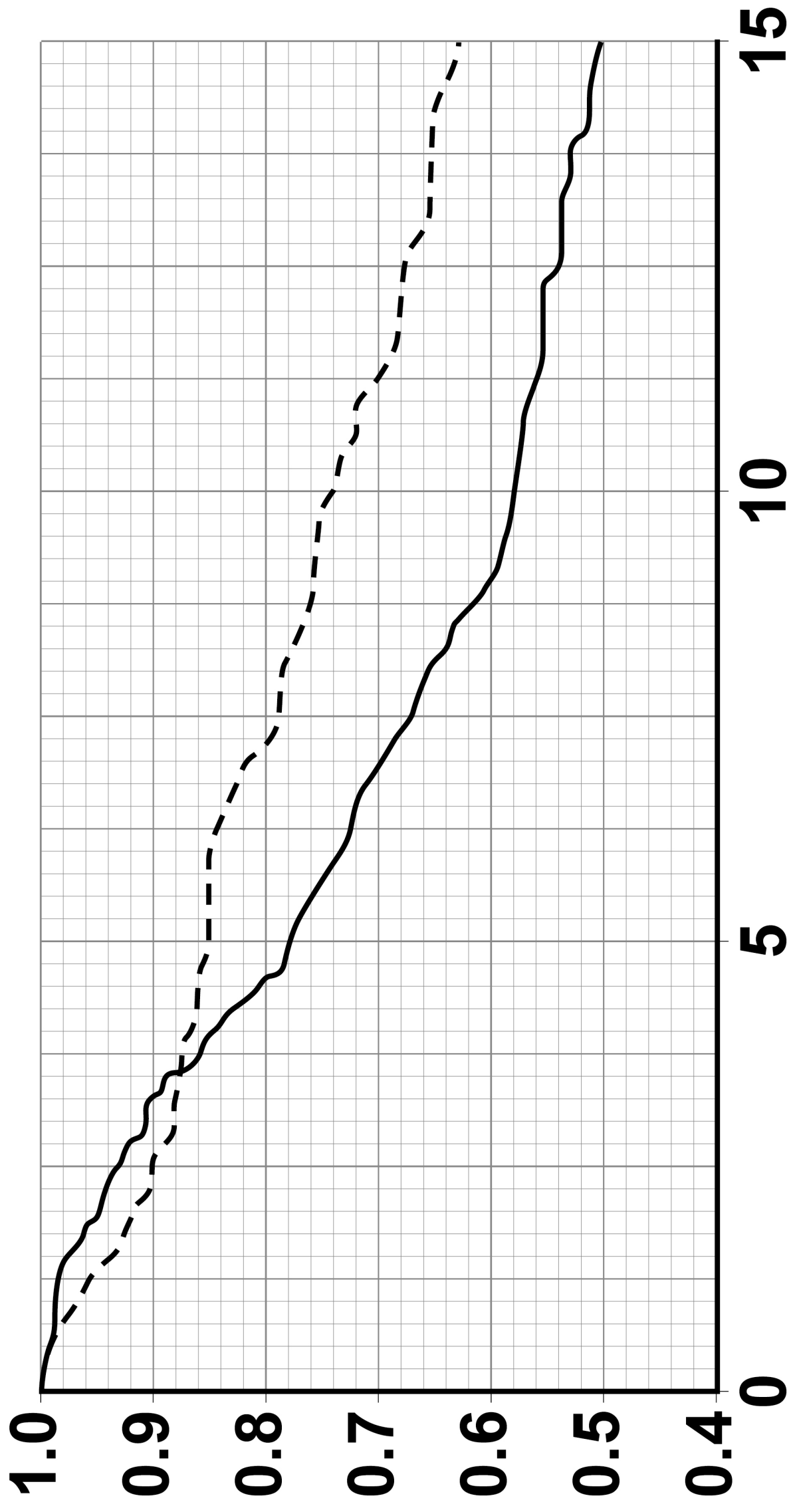
- 41

[Turn over]



REPEAT OF FIGURE 6

Proportion surviving



Time after treatment / months

KEY

--- AZA — Conventional drugs



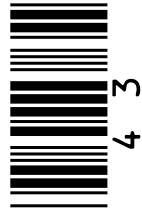
06.4

Use FIGURE 6, and the information provided on page 39, to calculate the difference in the number of patients surviving at 10 months after treatment with AZA compared with conventional drugs. [2 marks]

43

Answer

[Turn over]



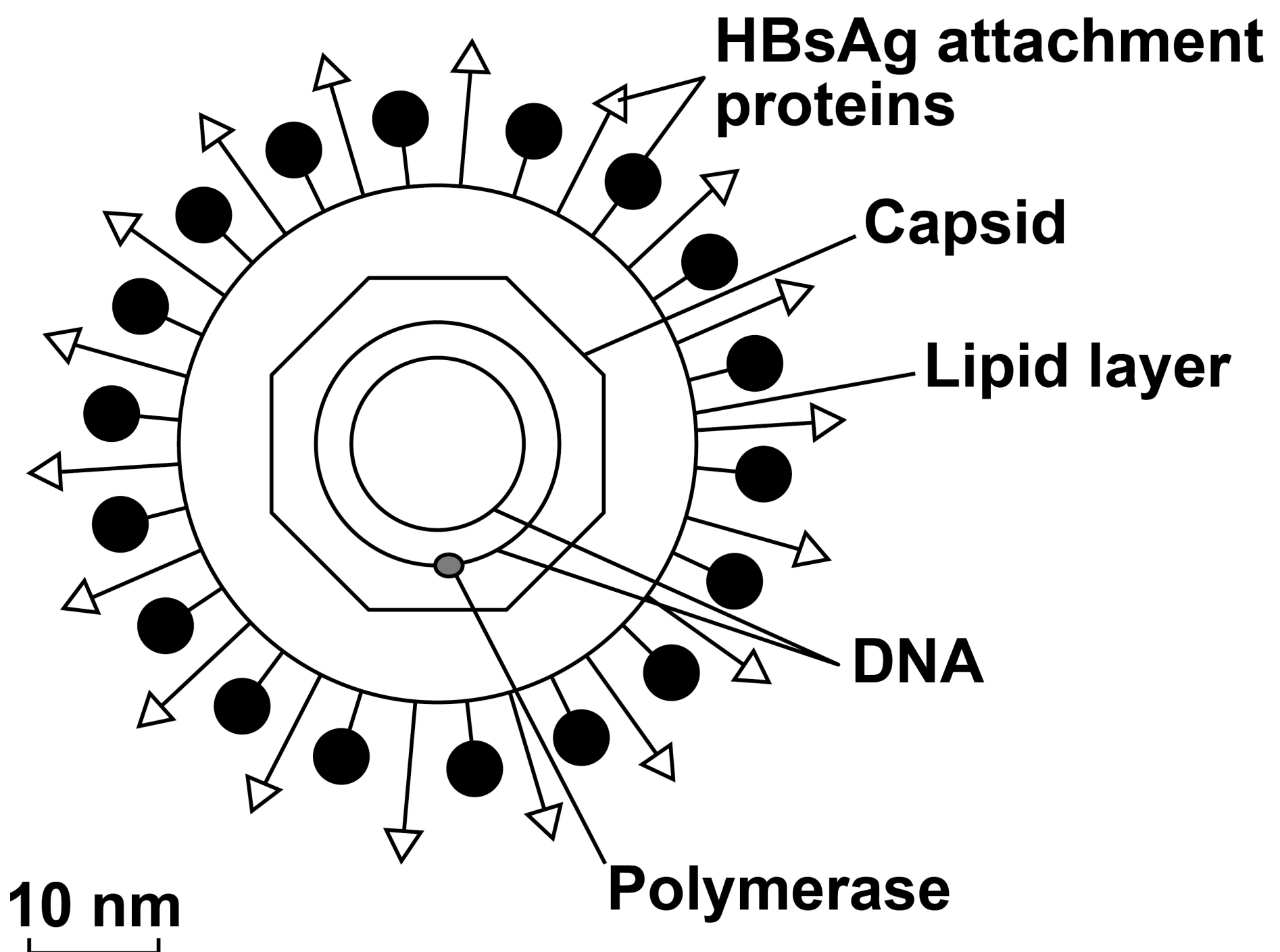
10

07

Hepatitis B is a life-threatening liver infection caused by the hepatitis B virus (HBV).

FIGURE 7 shows the structure of HBV.

FIGURE 7



0	7	.	1
---	---	---	---

HBV infects a liver cell. The liver cell is $25\mu\text{m}$ in diameter.

Use FIGURE 7 to calculate how many times larger in diameter this cell is than HBV. You should use the lipid layer to measure the diameter of HBV. [2 marks]

Answer _____ times larger

[Turn over]



Scientists investigated the effectiveness of two types of RNA interference (RNAi) molecules on reducing HBV replication. These molecules were:

- short hairpin RNA (shRNA)**
- long hairpin RNA (lhRNA).**

The scientists infected mouse liver cells with HBV and transferred either shRNA or lhRNA into these cells. Then they determined the concentration of the attachment proteins, HBsAg, in these cells.

The concentration of HBsAg is a measure of HBV replication.

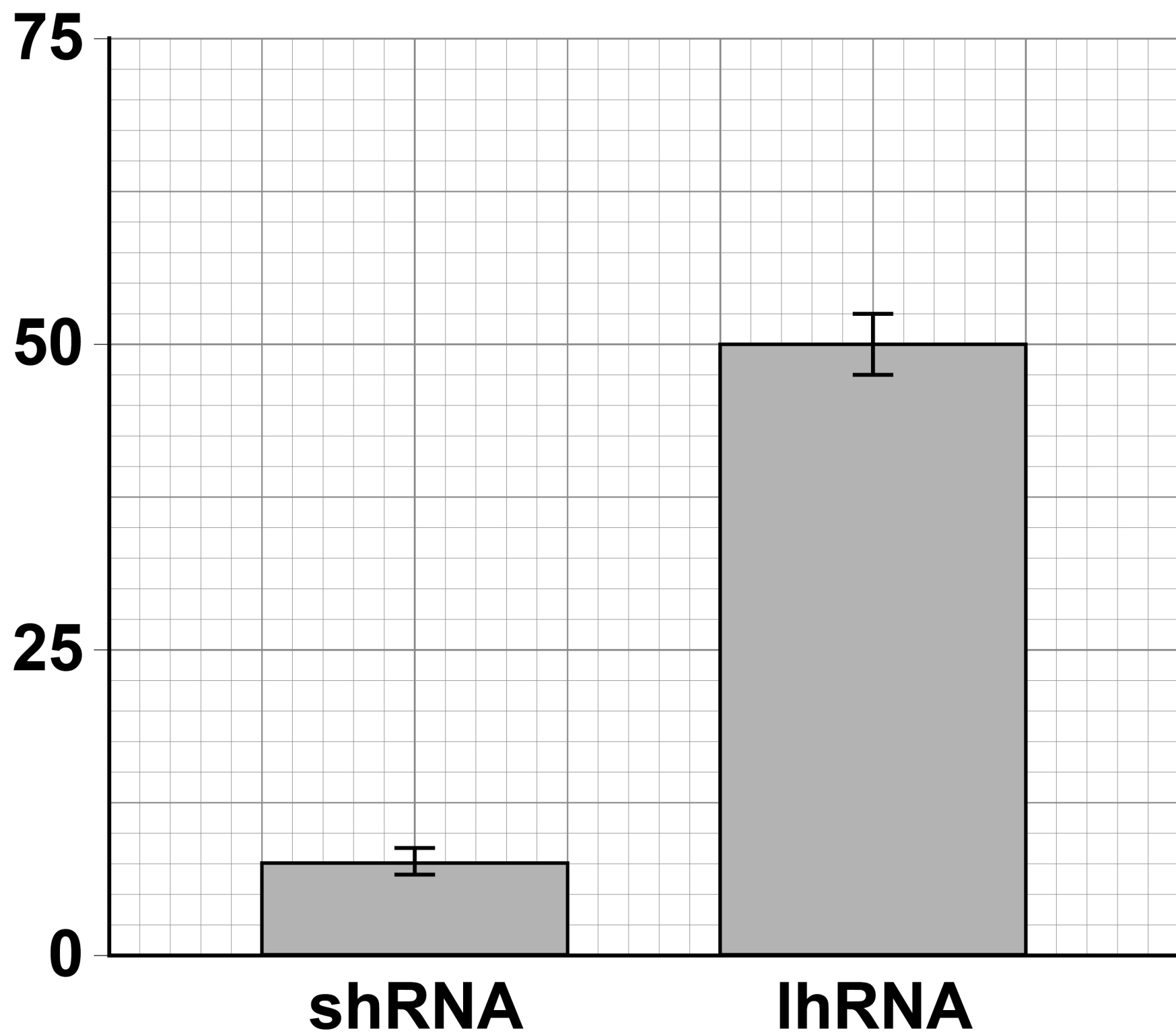
FIGURE 8, on the opposite page, shows the scientists' results.

The error bars represent ± 2 standard deviations from the mean, which includes over 95% of the data.



FIGURE 8

**Mean HBsAg
concentration
/ percentage
of control**



[Turn over]



07.2

One method of transferring RNAi molecules into cells involves combining these molecules with a lipid. Suggest why this increases uptake of RNAi molecules into cells. [1 mark]

07.3

Using all the information provided on pages 46 and 47, evaluate the use of the two types of RNAi in treating hepatitis B in humans.



Do NOT refer in your answer to how RNAi reduces HBV replication. [5 marks]

[illegible]

[Turn over]





08.1

Describe and explain how the polymerase chain reaction (PCR) is used to amplify a DNA fragment. [4 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

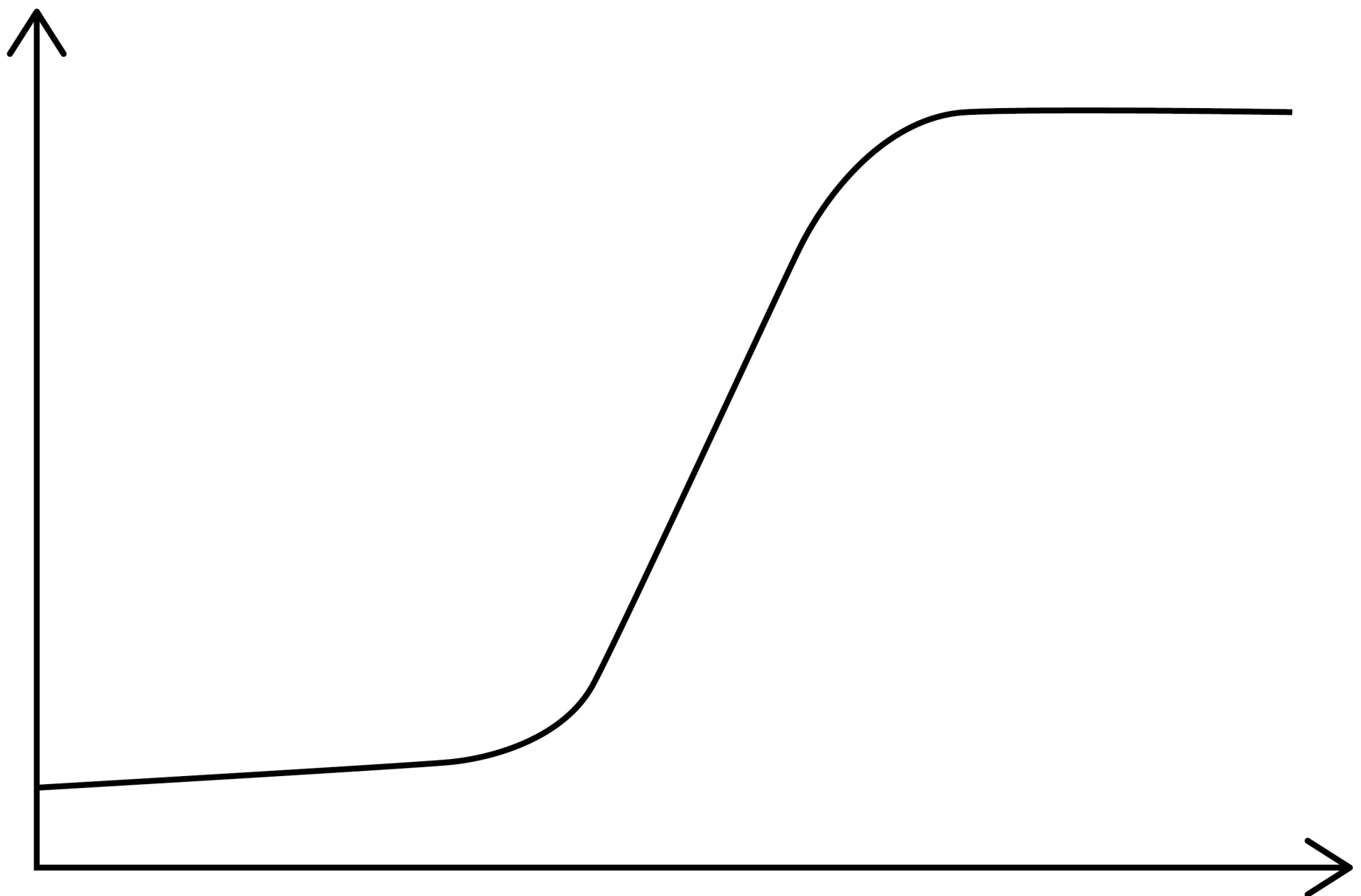
[Turn over]



FIGURE 9 shows the number of DNA molecules produced using a PCR.

FIGURE 9

**Number
of DNA
molecules**



Number of PCR cycles



08.2

Explain the shape of the curve in
FIGURE 9. [2 marks]

[Turn over]

6



0	9
---	---

A coral reef is an underwater ecosystem formed as a ridge of mainly calcium carbonate deposits. Algae are photosynthesising organisms. Some algae grow on coral reefs. Succession results in a wide variety of fish living on coral reefs.

0	9	.	1
---	---	---	---

Describe a method that could be used to determine the mean percentage cover of algae on a coral reef.

Do NOT include information on the difficulties of using your method underwater. [3 marks]



[Turn over]



0	9	.	2
---	---	---	---

Explain how succession results in a wide variety of fish living on coral reefs.

Do NOT describe the process of succession in your answer. [2 marks]



BLANK PAGE

[Turn over]



Ecologists investigated the effect of two fish species, the redband parrotfish and the ocean surgeonfish, on algal growth on an artificial reef. They made this artificial reef by submerging many large concrete blocks at a depth of 16–18 metres off the coast of Florida. They attached four large wire cages, A, B, C and D, to each block and populated the cages as shown.

A – No fish

B – Two redband parrotfish

C – Two ocean surgeonfish

D – One redband parrotfish and one ocean surgeonfish

After 34 weeks, the ecologists measured the mean percentage cover of all algae within each set of wire cages. The ecologists used a statistical test to find out whether the mean for each set of



cages was significantly lower than the mean for set A.

TABLE 3 shows the probability (P) values that the ecologists obtained using this statistical test.

TABLE 3

Set of cages	P value
B	=0.841
C	<0.001
D	=0.634

[Turn over]



BLANK PAGE



0	9	.	3
---	---	---	---

Using all the information, on pages 58 and 59, evaluate the effect of the two fish species on algal growth on coral reefs.

[5 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



1	0
---	---

Read the following passage.

Lake Malawi in East Africa has more species of fish than any other lake in the world. Many of these species have evolved from a common ancestor.

Lake Malawi is one of the largest lakes in the world and was formed several million years ago. Since then, the water level has fluctuated greatly. As a result, what is now a large lake was at one time many smaller, separate lakes.

The country of Malawi has a total area of 118 000 km². The actual land area is only 94 080 km², because approximately one-fifth of the country is Lake Malawi.

In December 1990, forests covered 41.4% of the actual land area of Malawi. In December 2016, forests



**covered 26.4% of the actual land area
of Malawi. 20**

**Deforestation and farming along the
shores of Lake Malawi have caused
increased soil erosion and loss of
nutrients into the lake. This has
resulted in a decrease in some fish 25
populations. The
mark-release-recapture method can be
used to estimate the size of a fish
population. However, this method can
produce unreliable results in very 30
large lakes.**

**Use the information in the passage and
your own knowledge to answer the
following questions.**

[Turn over]



1 0 . 1

Lake Malawi in East Africa has more species of fish than any other lake in the world (lines 1–3).

Suggest and explain how this speciation may have occurred. [4 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



1	0	.	2
---	---	---	---

The percentage of forest cover in Malawi decreased between December 1990 and December 2016 (lines 16–20).

**Calculate the mean loss of forest cover in km² per week during this time period.
[2 marks]**

Answer _____ **km² per week**



1 0 . 3

Loss of nutrients INTO Lake Malawi has resulted in a decrease in some fish populations (lines 23–26).

Explain why. [4 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]





1	0	.	4
---	---	---	---

The mark-release-recapture method can be used to estimate the size of a fish population (lines 26–29).

Explain how. [4 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



70

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

1	0	.	5
---	---	---	---

Suggest why the mark-release-recapture method can produce unreliable results in very large lakes (lines 29–31). [1 mark]

END OF QUESTIONS

15



**Additional page, if required.
Write the question numbers in the
left-hand margin.**

This image shows a blank sheet of white paper with horizontal ruling lines. A single vertical line runs down the left side, creating a narrow margin. There are 20 horizontal lines in total, evenly spaced across the page. The lines are thin and black.

**Additional page, if required.
Write the question numbers in the
left-hand margin.**

This image shows a blank sheet of white paper with horizontal ruling lines. A single vertical line runs down the left side, creating a margin. There are 20 horizontal lines in total, evenly spaced across the page. The lines are thin and black.

BLANK PAGE

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Copyright information

For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from www.aqa.org.uk.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.

Copyright © 2021 AQA and its licensors. All rights reserved.

IB/M/CD/Jun21/7402/2/E2

