

A



Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

A-level

BIOLOGY

Paper 1

7402/1

Thursday 7 June 2018

Morning

Time allowed: 2 hours

For this paper you must have:

- a ruler with millimetre measurements
- a scientific calculator.

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

[Turn over]



J U N 1 8 7 4 0 2 1 0 1

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INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the space provided. Do not write on blank pages.**
- **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.

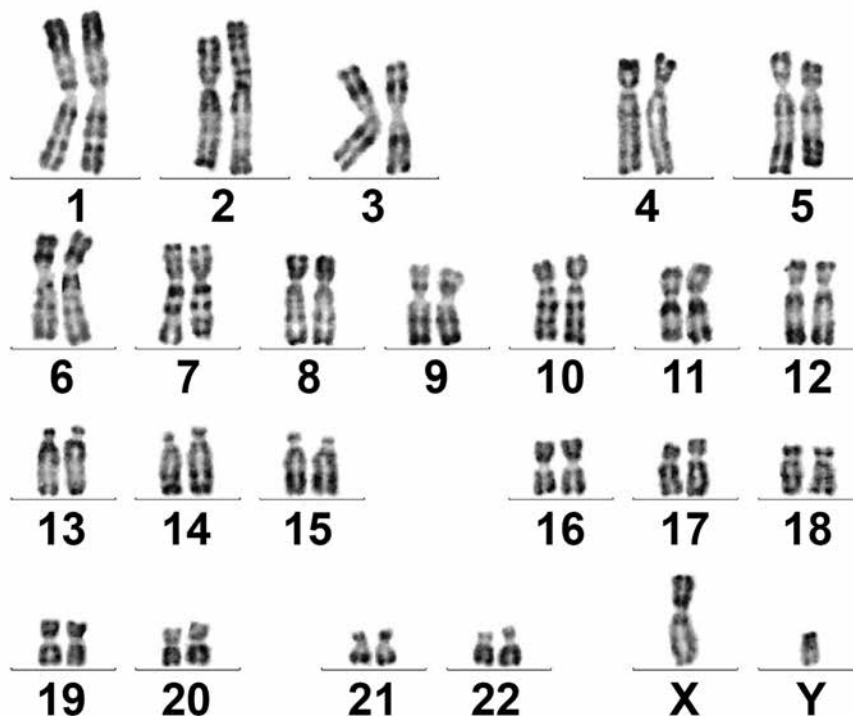
0 1

FIGURE 1 shows all the chromosomes present in one human cell during mitosis. A scientist stained and photographed the chromosomes. In FIGURE 2, the scientist has arranged the images of these chromosomes in homologous pairs.

FIGURE 1



FIGURE 2



0 1 . 1 Give TWO pieces of evidence from FIGURE 1 that this cell was undergoing mitosis. Explain your answers. [2 marks]

1. _____

2. _____

[Turn over]



0 1 . 2 Tick (✓) ONE box that gives the name of the stage of mitosis shown in FIGURE 1. [1 mark]

Anaphase

Interphase

Prophase

Telophase

0 1 . 3 When preparing the cells for observation the scientist placed them in a solution that had a slightly higher (less negative) water potential than the cytoplasm. This did not cause the cells to burst but moved the chromosomes further apart in order to reduce the overlapping of the chromosomes when observed with an optical microscope.

Suggest how this procedure moved the chromosomes apart. [2 marks]



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0 1 . 4 The dark stain used on the chromosomes binds more to some areas of the chromosomes than others, giving the chromosomes a striped appearance.

Suggest ONE way the structure of the chromosome could differ along its length to result in the stain binding more in some areas.

[1 mark]

[Turn over]



01.5

In FIGURE 2 the chromosomes are arranged in homologous pairs.

What is a homologous pair of chromosomes?
[1 mark]

01.6

Give TWO ways in which the arrangement of prokaryotic DNA is different from the arrangement of the human DNA in FIGURE 1. [2 marks]

1. _____

2. _____

[Turn over]

9



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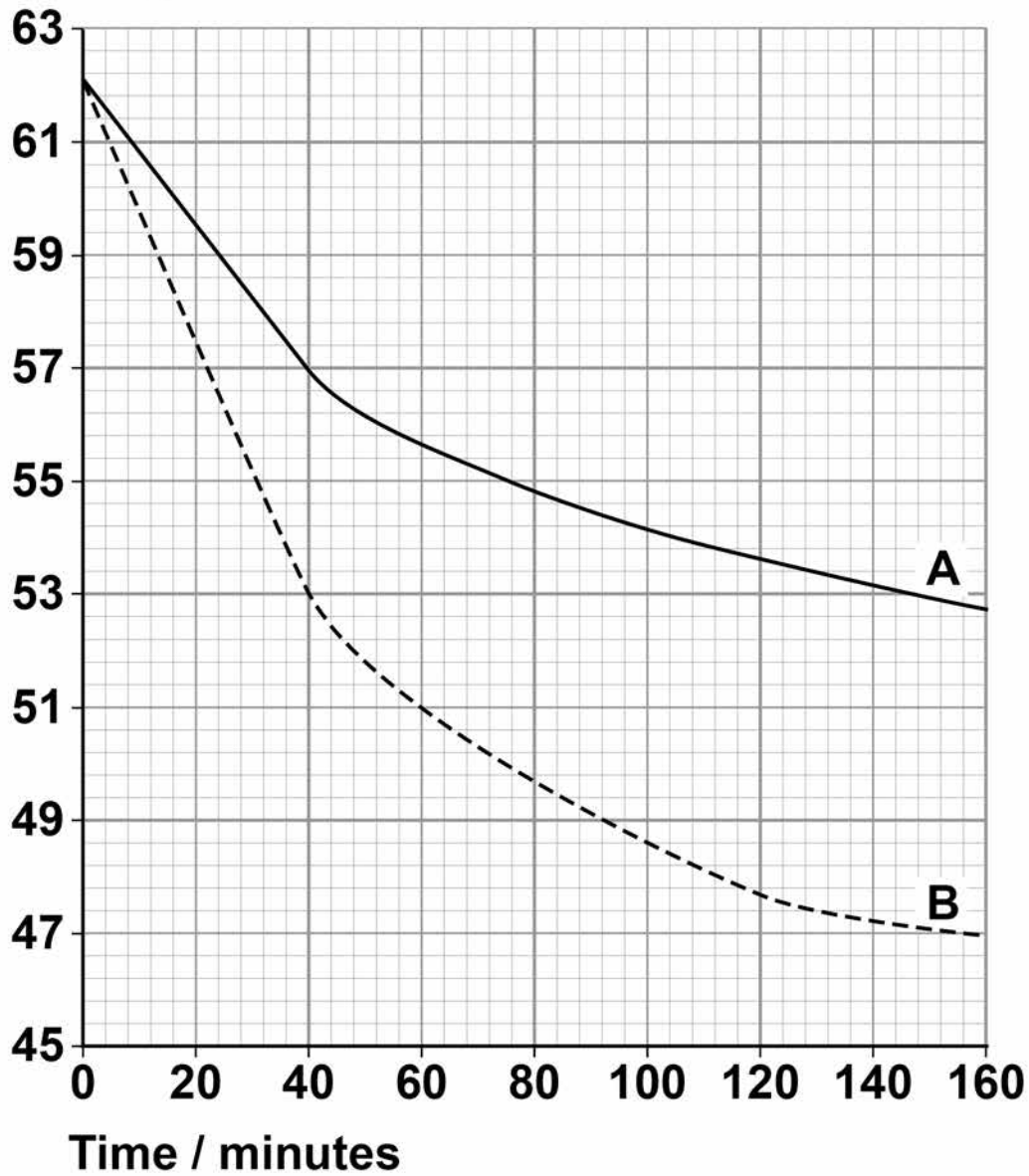
A student investigated the effect of surface area on osmosis in cubes of potato.

- **He cut two cubes of potato tissue, each with sides of 35 mm in length.**
- **He put one cube into a concentrated sucrose solution.**
- **He cut the other cube into eight equal-sized smaller cubes and put them into a sucrose solution of the same concentration as the solution used for the large cube.**
- **He recorded the masses of the cubes at intervals.**

His results are shown in FIGURE 3 on page 13.



FIGURE 3

Total
mass / g

KEY

— 1 large cube ---- 8 small cubes

[Turn over]



03

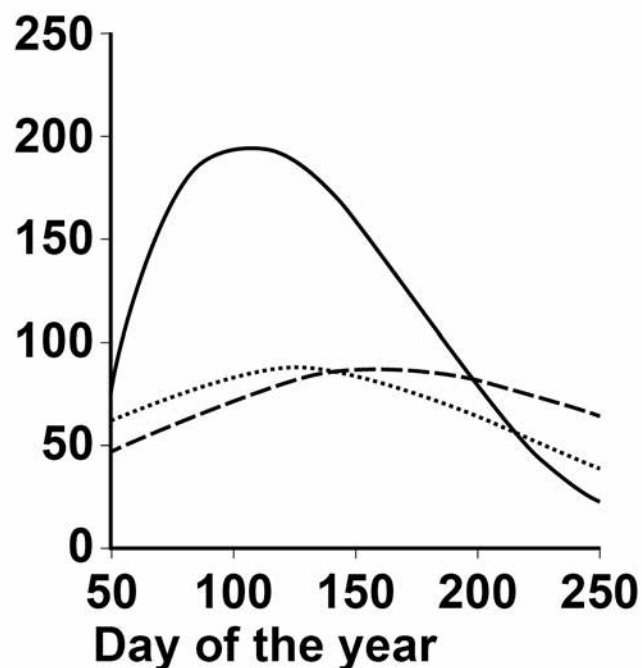
Bees are flying insects that feed on nectar made in flowers. There are many different species of bee.

Scientists investigated how biodiversity of bees varied in three different habitats during a year. They collected bees from eight sites of each habitat four times per year for three years.

The scientists' results are shown in FIGURE 4, below and on page 19, in the form they presented them.

FIGURE 4

Mean number
of bees
collected

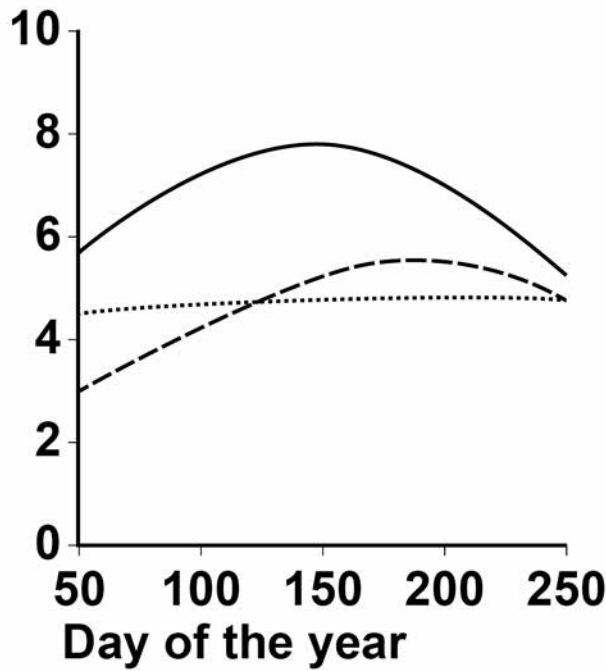


KEY TO HABITATS

— Natural Town ---- Farmland



Mean bee species richness



KEY TO HABITATS

—— Natural Town ---- Farmland

03.1 What is meant by ‘species richness’? [1 mark]

[Turn over]



03.2 From the data in FIGURE 4, a student made the following conclusions.

- 1. The natural habitat is most favourable for bees.**
- 2. The town is the least favourable for bees.**

**Do the data in FIGURE 4 support these conclusions? Explain your answer.
[4 marks]**



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03.4

Suggest and explain TWO ways in which the scientists could have improved the method used for data collection in this investigation. [2 marks]

1. _____

2. _____



[Turn over]



[Turn over]

11



0 4 . 2 A scientist measured the rate of removal of amino acids from a polypeptide with and without an enzyme present. With the enzyme present, 578 amino acids were released per second. Without the enzyme, 3.0×10^{-9} amino acids were released per second.

Calculate by how many times the rate of reaction is greater with the enzyme present. Give your answer in standard form. [2 marks]

Answer = _____ times faster

[Turn over]



Another scientist investigated an enzyme that catalyses the following reaction.



The scientists set up two experiments, C and L.

Experiment C used

- the enzyme
- different concentrations of ATP.

Experiment L used

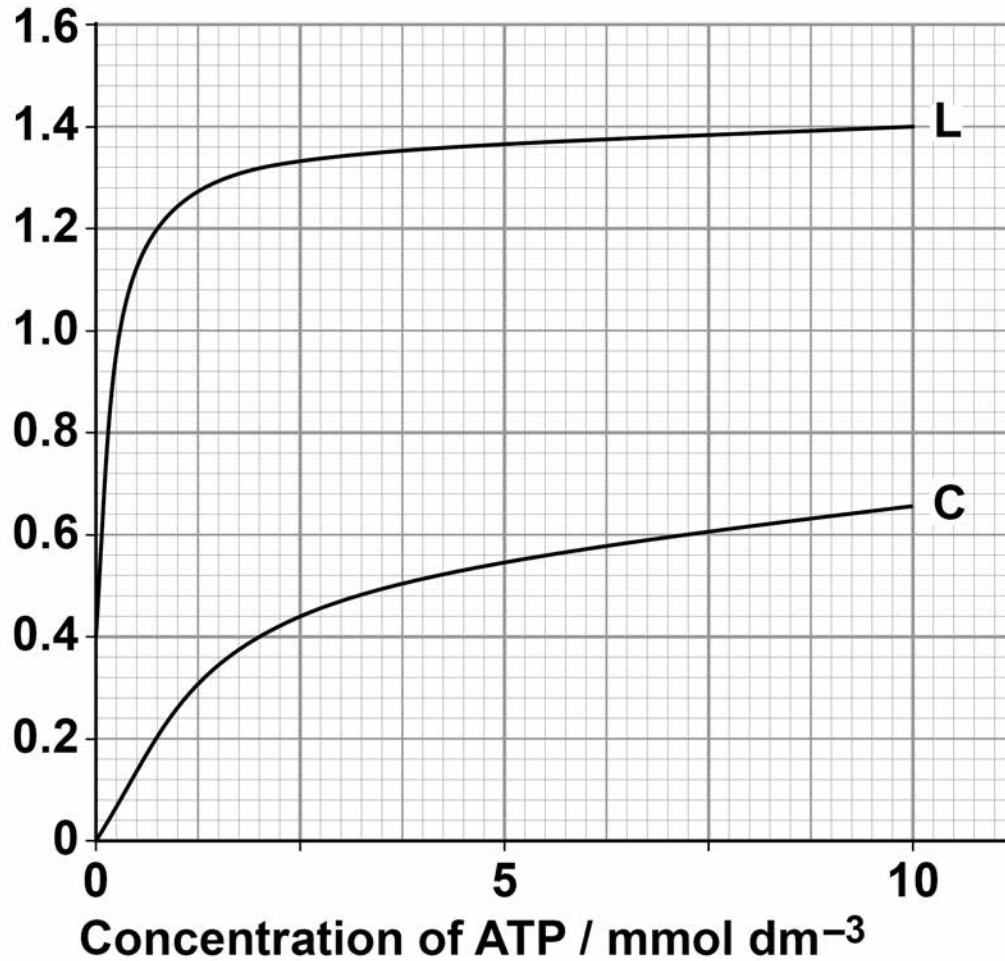
- the enzyme
- different concentrations of ATP
- a sugar called lyxose.

The scientists measured the rate of reaction in each experiment. Their results are shown in FIGURE 5.



FIGURE 5

Rate of reaction /
units of Pi min⁻¹



[Turn over]



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- 04.3** Calculate the rate of reaction of the enzyme activity with no lyxose at 2.5 mmol dm^{-3} of ATP as a percentage of the maximum rate shown with lyxose. [2 marks]

Answer = _____ %

[Turn over]



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05.1 Draw the general structure of an amino acid.
[1 mark]

[Turn over]



TABLE 1 shows mRNA codons and the amino acids coded for by each codon. It also shows some properties of the R group of each amino acid.

TABLE 1

1st base	2nd base				3rd base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Leu		Stop	Stop	C
				Trp	A
					G
C	Leu	Pro	His	Arg	U
			Gln		A
					G
A	Ile	Thr	Asn	Ser	U
	Met		Lys	Arg	C
					A
					G
G	Val	Ala	Asp	Gly	U
			Glu		C
					A
					G

KEY to the properties of the R group of each amino acid

 No overall charge

 Positively charged

 Negatively charged (Asp and Glu only)



A scientist investigated changes in the amino acid sequence of a human enzyme resulting from mutations. All these amino acid changes result from single base substitution mutations.

This enzyme is a polypeptide 465 amino acids long.

TABLE 2 shows the result of three of the base substitutions.

TABLE 2

Amino acid number	Correct amino acid	Amino acid inserted as a result of mutation
203	Val	Ala
279	Glu	Lys
300	Glu	Lys



0 5 . 3 What is the minimum number of bases in the gene coding for this polypeptide? [1 mark]

Answer = _____

0 5 . 4 Use information from TABLE 1, on page 40, to tick (✓) ONE box that shows a single base substitution mutation in DNA that would result in a change from VAL to ALA at amino acid number 203 [1 mark]

CAA → CGA

GUU → GCA

GUU → GUC

CAC → CGG

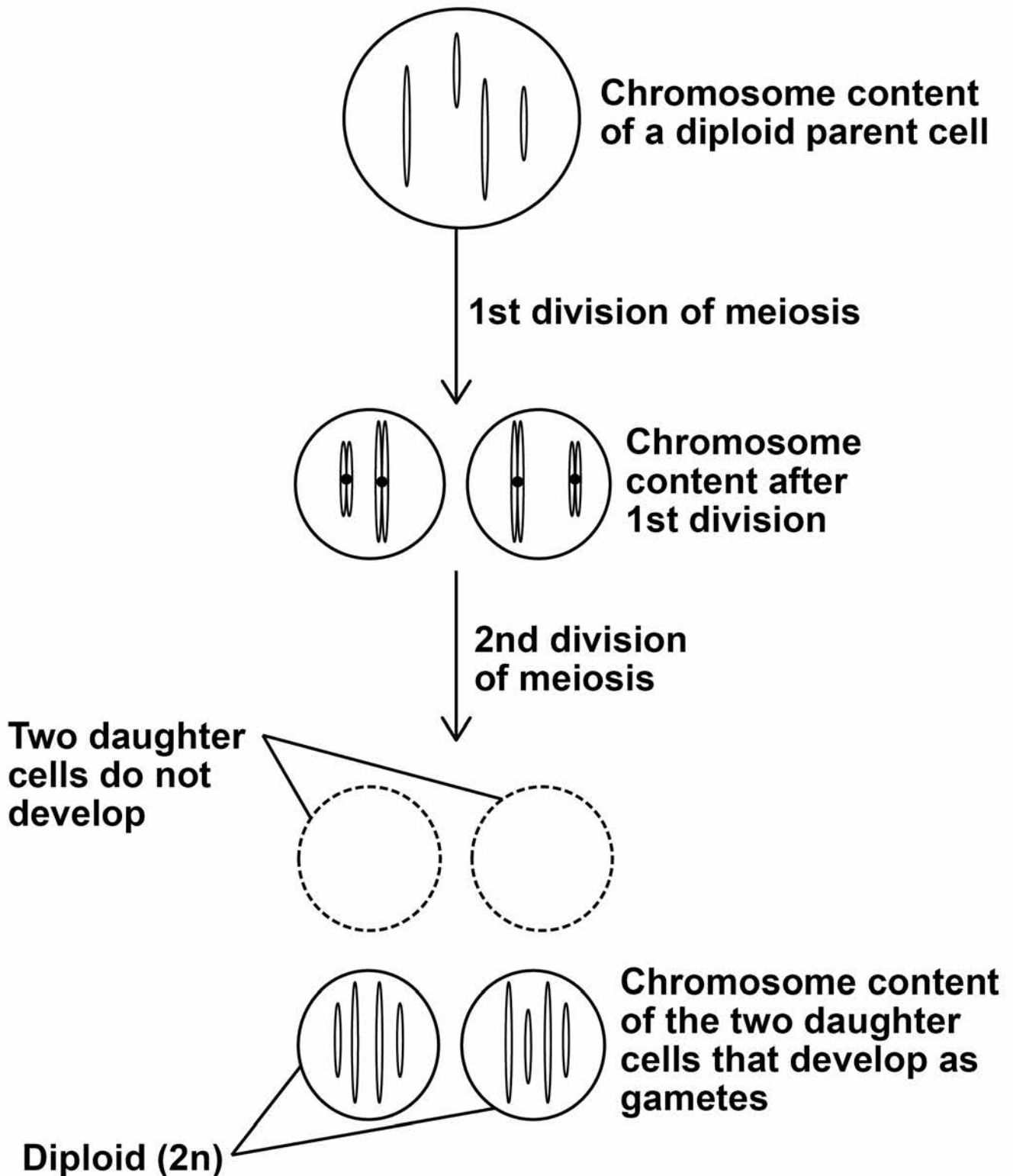
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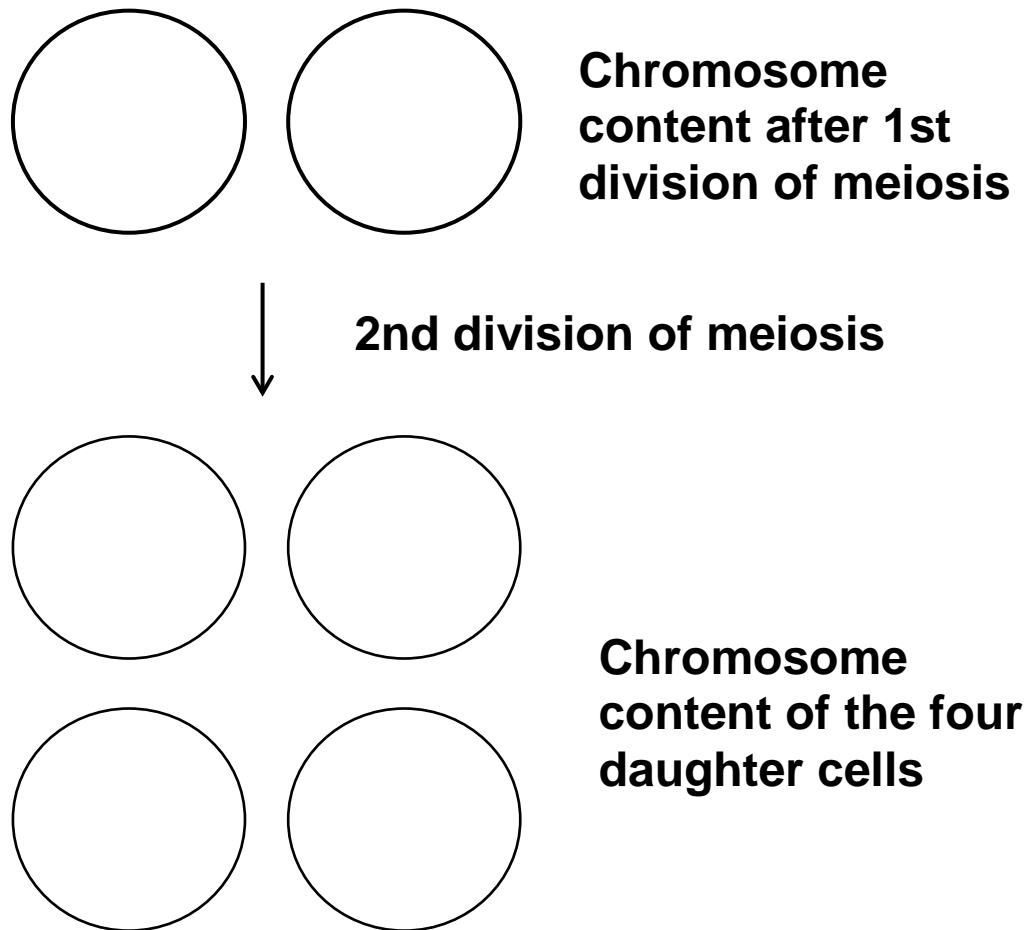
06

FIGURE 6 shows a faulty form of meiosis that can occur in some plants.

FIGURE 6



- 06.1** Complete FIGURE 7 to show the chromosome content of the cells that would result from a normal meiotic division of the diploid parent cell shown in FIGURE 6. [2 marks]

FIGURE 7

[Turn over]



06.2 If two diploid ($2n$) gametes fuse at fertilisation, it can result in the growth of a tetraploid plant which has 4 copies of each chromosome. Red clover is a plant grown to produce cattle feed. Tetraploid red clover plants produce a higher yield than diploid red clover plants. Whether a red clover plant produces $2n$ gametes is genetically controlled.

Scientists investigated the possibility of breeding red clover plants that only produced $2n$ gametes.

- In breeding cycle 0, they grew red clover plants and identified plants that produced $2n$ gametes.
- In breeding cycle 1, they used the plants producing $2n$ gametes to produce offspring.
- In breeding cycles 2 and 3, they identified plants producing $2n$ gametes and used these to produce offspring.

Their results are shown in TABLE 3.



TABLE 3

Breeding cycle	OBSERVED		EXPECTED	
	Number of plants that DID NOT produce $2n$ gametes	Number of plants that DID produce $2n$ gametes	Number of plants that DID NOT produce $2n$ gametes	Number of plants that DID produce $2n$ gametes
0	50	4	50	4
1	14	42	_____	_____
2	2	44		
3	0	56		

The scientists used the following null hypothesis.

‘The proportion of plants that produce $2n$ gametes will not change from one breeding cycle to the next.’

Complete TABLE 3 to show the EXPECTED NUMBER of plants that DID NOT produce $2n$ gametes and the expected number of plants that DID produce $2n$ gametes after 1 cycle.

Give each answer to the nearest whole number.

[2 marks]

[Turn over]



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9

[Turn over]

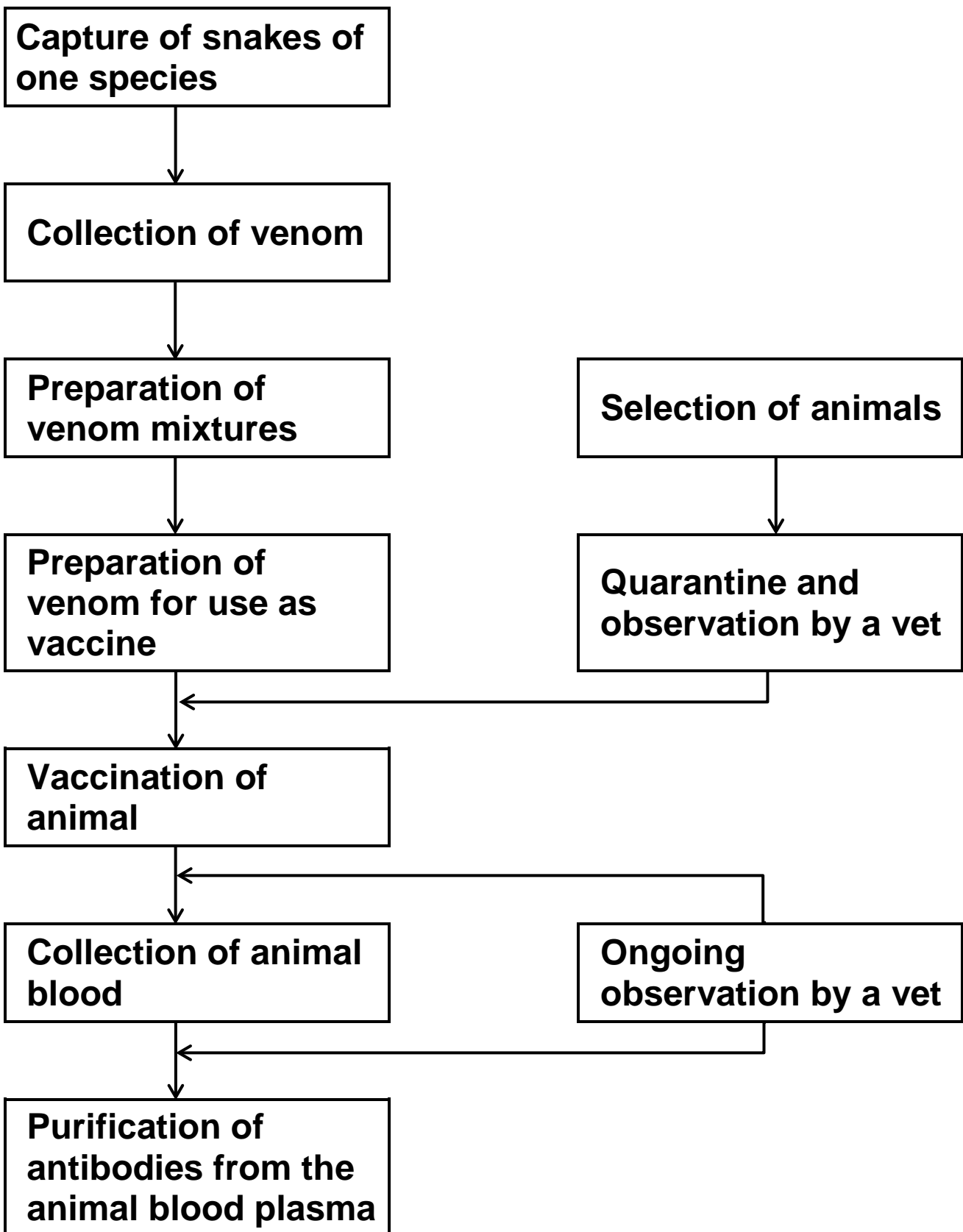


[Turn over]



FIGURE 8 shows a procedure used to produce antivenom.

FIGURE 8



07.4 During the procedure shown in FIGURE 8, on page 56, the animals are under ongoing observation by a vet.

Suggest ONE reason why. [1 mark]

[Turn over]



08

Scientists investigated the effect of a heat treatment on mass transport in barley plants.

- They applied steam to one short section of a leaf of the heat-treated plants. This area is shown by the arrows in FIGURE 9.
- They did not apply steam to the leaves of control plants.
- They then supplied carbon dioxide containing radioactively-labelled carbon to each plant in the area shown by the rectangular boxes in FIGURE 9.
- After 4 hours, they:
 - found the position of the radioactively-labelled carbon in each plant. These results are shown in FIGURE 9 on page 63.
 - recorded the water content of the parts of the leaf that were supplied with radioactively-labelled carbon dioxide. These results are shown in TABLE 4 below.

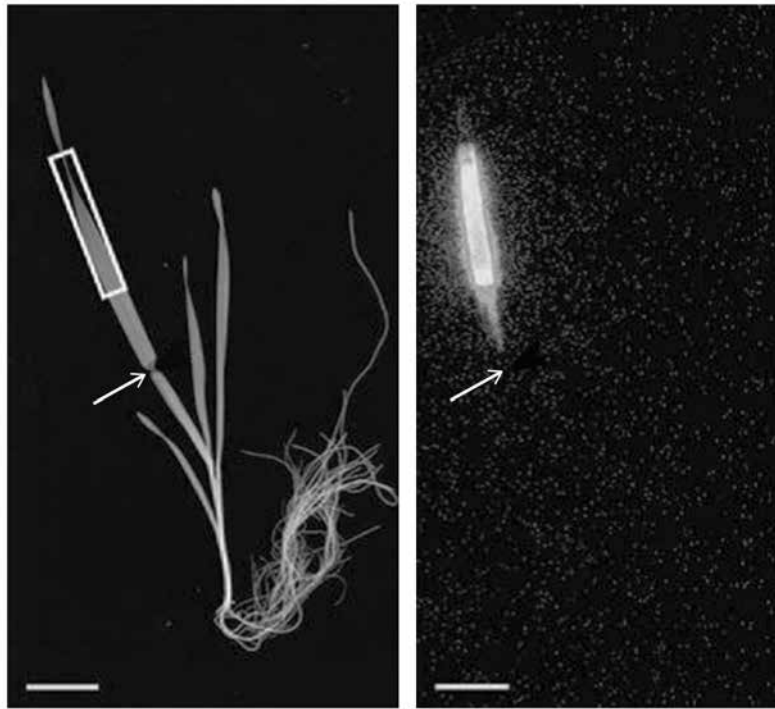
TABLE 4

Plant from which the leaf was taken	Water content of leaf / % of maximum (\pm 2 standard deviations)
Heat-treated Plant A	84.6 (\pm 11.3)
Control Plant, not heat treated B	92.8 (\pm 8.6)



FIGURE 9

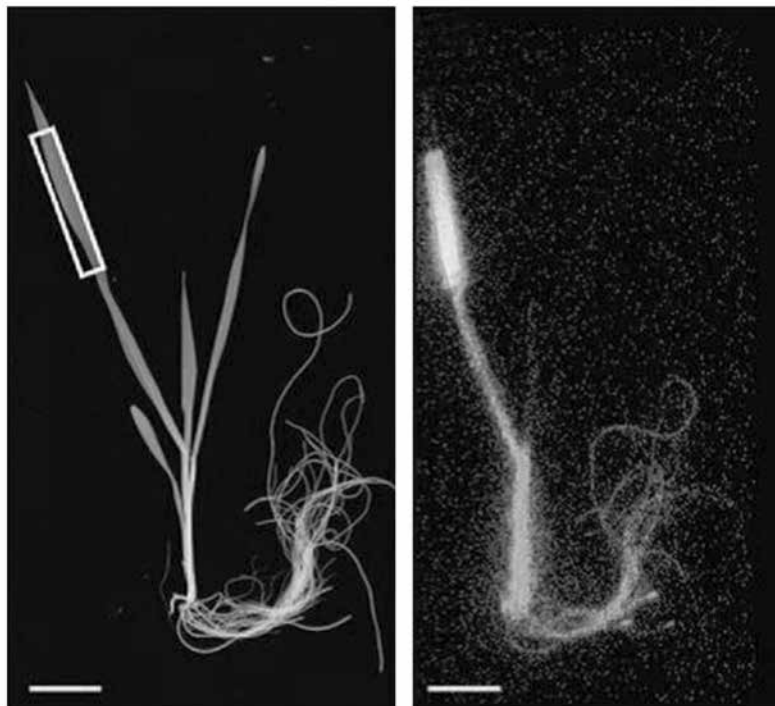
A – Heat-treated Plant



0 hours

4 hours

B – Control Plant, not heat treated



0 hours

4 hours

[Turn over]



6 3

0 8 . 3 The scientists then investigated the movement of iron ions (Fe^{3+}) from the soil to old and young leaves of heat-treated barley plants and to leaves of plants that were not heat treated. Heat treatment was applied half way up the leaves. The scientists determined the concentration of Fe^{3+} in the top and lower halves of the leaves of each plant.

Their results are shown in FIGURE 10.

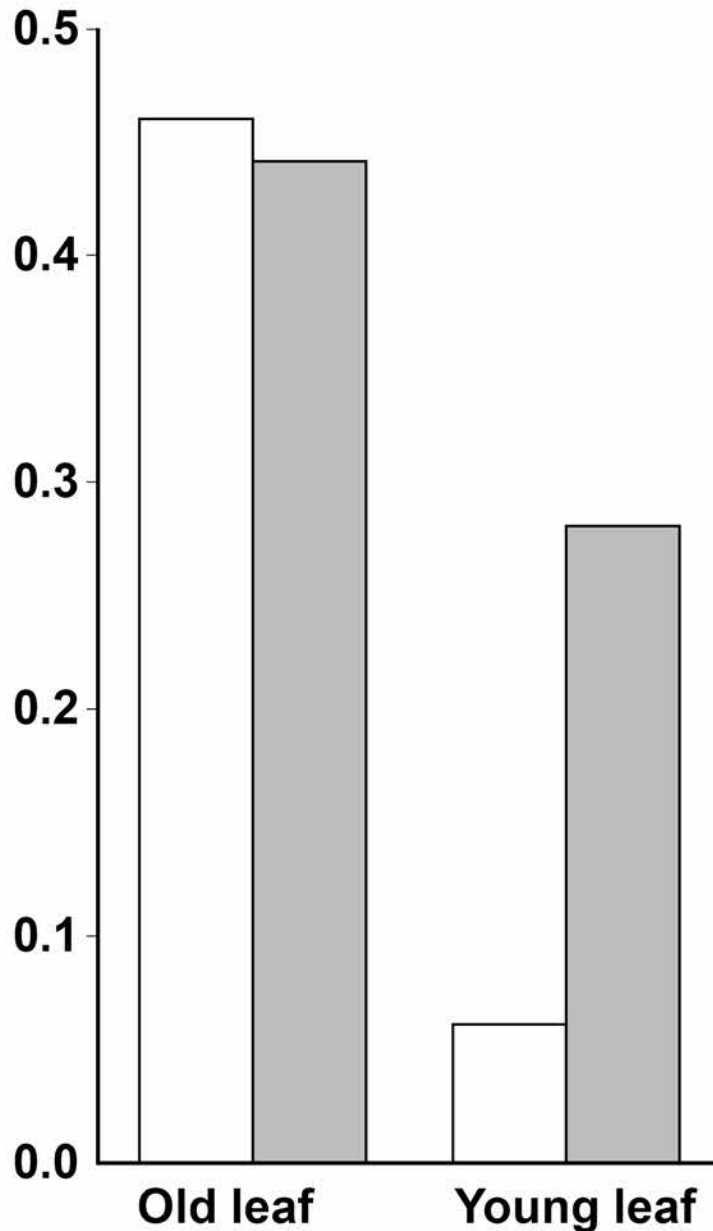
What can you conclude about the movement of Fe^{3+} in barley plants?

Use all the information provided. [4 marks]



FIGURE 10

Ratio of Fe^{3+} concentration
in top half of leaf to
concentration in lower half
of leaf

**KEY**

Heat treatment half way up the leaf



Untreated



[Turn over]

09.2 Scientists investigated the function of a eukaryotic cell protein called cyclin A. This protein is thought to be involved with the binding of one of the enzymes required at the start of DNA replication.

The scientists treated cultures of cells in the following ways.

C – Control cells, untreated

D – Added antibody that binds specifically to cyclin A

E – Added RNA that prevents translation of cyclin A

F – Added RNA that prevents translation of cyclin A AND added cyclin A protein

They then determined the percentage of cells in each culture in which DNA was replicating.

Their results are shown in TABLE 5.



TABLE 5

Cell treatment	Percentage of cells where DNA was replicating
C Control	91
D Antibody that binds specifically to cyclin A	11
E RNA that prevents translation of cyclin A	10
F RNA that prevents translation of cyclin A and added cyclin A protein	92

[Turn over]



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6

[Turn over]





[Turn over]



15

END OF QUESTIONS



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For Examiner's Use	
Question	Mark
1	
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TOTAL	

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