OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

BIOLOGY

2806/01

Unifying Concepts in Biology

Tuesday **28 JANUARY 2003** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers, in blue or black ink, in the spaces on the question paper.
- Read each question carefully before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	15	
2	12	
3	11	
4	11	
5	11	
TOTAL	60	

This question paper consists of 17 printed pages and 3 blank pages.

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For Examiner Use

Answer **all** the questions.

1 Human blood from different individuals may have different types of haemoglobin. The common type is called haemoglobin A. A second type, haemoglobin S, causes sickle cell anaemia and a third type, haemoglobin C, produces a less serious form of anaemia.

Haemoglobin types are identified by a technique called electrophoresis.

- Red cells in blood samples are broken open to release the haemoglobin.
- Wells are cut in a block of polysaccharide gel.
- The samples are placed in the wells.
- An electrical potential is applied across the gel.
- Haemoglobin molecules move through the gel towards the anode.
- Each type of haemoglobin moves at a slightly different rate to form distinct bands in the gel.

Fig. 1.1 shows the result of electrophoresis of haemoglobin from several people.

- Samples 1 and 8 were from individuals who were known to have only common haemoglobin.
- Sample 3 was from an individual known to have haemoglobin C anaemia.
- Sample 5 was from an individual known to have sickle cell anaemia.
- Samples 2, 4, 6 and 7 were from blood samples being tested.

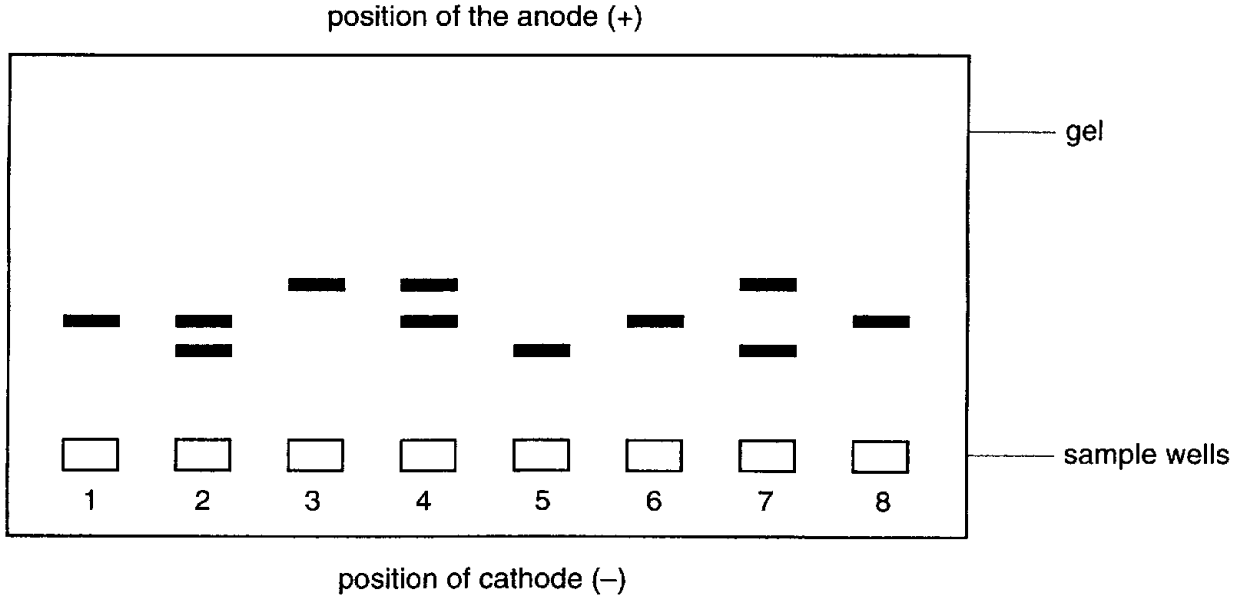

Fig. 1.1

(a) Using the information provided, and Fig. 1.1,

(i) suggest why samples from people with common haemoglobin were placed in wells at positions 1 and 8;

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..... [2]

(ii) name the haemoglobin types present in samples 2, 4, 6 and 7.

2. ..... 4. .....

6. ..... 7. ..... [2]

(b) Haemoglobin types are genetically controlled. They are the result of single nucleotide polymorphisms.

Single nucleotide polymorphisms (SNPs) are DNA variants that involve a difference in only one base pair, as shown in Fig. 1.2.

... A A A G C T T T T T G A C T T C G G G T T A C ...
... T T T C G A A A A A C T G A A G C C C A A T G ...

and

... A A A G C T T T T T G A C A T C G G G T T A C ...
... T T T C G A A A A A C T G T A G C C C A A T G ...

Fig. 1.2

Each polymorphism is believed to have originated as a random mutation. This became more common, either as a result of selection or by chance.

(i) Explain what is meant by *selection*.

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(ii) Suggest how a new DNA nucleotide sequence may become common by chance.

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(c) Several SNPs exist in the DNA that codes for the haemoglobin polypeptides. Molecules of human haemoglobin have two alpha polypeptides and two beta polypeptides.

The sixth amino acid in the beta polypeptide is

- glutamic acid **(glu)** in haemoglobin A
- valine **(val)** in haemoglobin S
- lysine **(lys)** in haemoglobin C.

Fig. 1.3 shows the genetic code. The first, second and third base in each codon are shown on the sides of the figure.

SECOND BASE

FIRST BASE	U		C		A		G		THIRD BASE
U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys	U
	UUC		UCC		UAC		UGC		C
	UUA	leu	UCA		UAA	**stop**	UGA	**stop**	A
	UUG		UCG		UAG		UGG	try	G
C	CUU		CCU	pro	CAU	his	CGU	arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	ile	ACU	thr	AAU	asn	AGU	ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	lys	AGA	arg	A
	AUG	met/**start**	ACG		AAG		AGG		G
G	GUU	val	GCU	ala	GAU	asp	GGU	gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	glu	GGA		A
	GUG		GCG		GAG		GGG		G

Fig. 1.3

(i) The codon for methionine (met) is AUG. Define the term *codon*.

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(ii) Explain why the code shown is mRNA rather than DNA.

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..... [1]

(iii) Give the mRNA base change that results in each of the following types of haemoglobin.

haemoglobin S from base ..... to base .....

haemoglobin C from base ..... to base ..... [2]

(d) Explain how a single amino acid substitution can change the properties of the haemoglobin significantly.

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..... [2]

[Total: 15]

2 Several groups of discs cut from spinach leaves were placed in test tubes of water. The discs all sank to the bottoms of the tubes. The tubes were each placed at a measured distance from a lamp, as shown in Fig. 2.1.

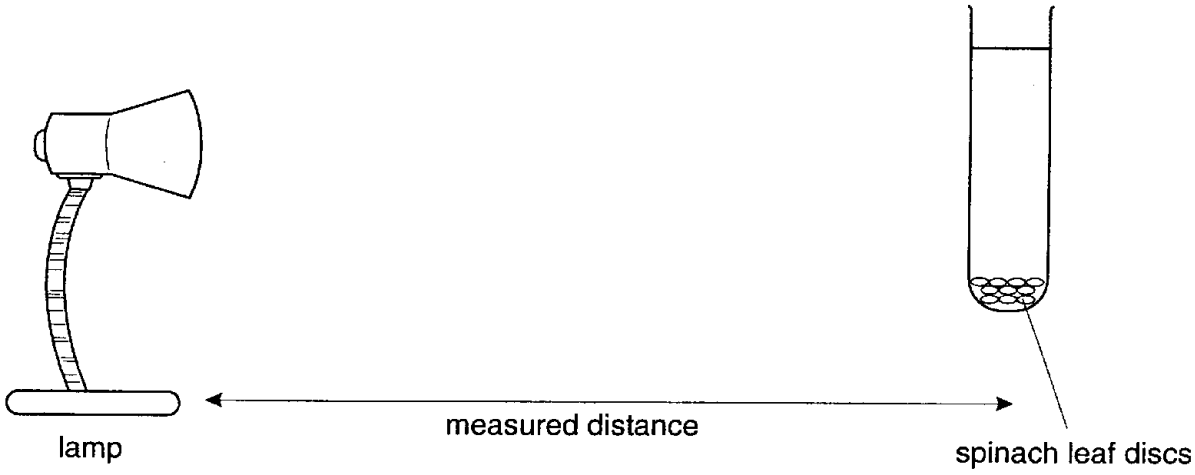

Fig. 2.1

(a) The experiment was carried out at a constant temperature. Explain why.

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The lamp was switched on and the time taken for five of the ten discs in each tube to float was recorded. The results are shown in Table 2.1.

Table 2.1

tube number	distance from lamp / mm	time taken for 5 discs to float / seconds
1	50	125
2	100	210
3	150	360
4	200	600
5	250	none floated in the time available

(b) **(i)** Describe and explain the trend shown by the results in Table 2.1.

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(ii) Suggest why the experimenter recorded the time taken for five discs to float rather than the time taken for all of them to float.

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(c) The experiment was repeated by putting spinach leaf discs into water that had been boiled for several minutes and cooled in the absence of air. None of the discs floated. Explain why.

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(d) The experiment was repeated at a lower temperature. The results are shown in Table 2.2.

Table 2.2

tube number	distance from lamp / mm	time taken for 5 discs to float / seconds
1	50	275
2	100	390
3	150	410
4	200	620
5	250	none floated in the time available

Using the data in Tables 2.1 and 2.2, explain why the effect of temperature change is greater when the lamp is closer to the tube.

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..... [2]

[Total: 12]

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3 **(a)** Fig. 3.1 shows two ways in which water uptake and loss by a shoot could be investigated.

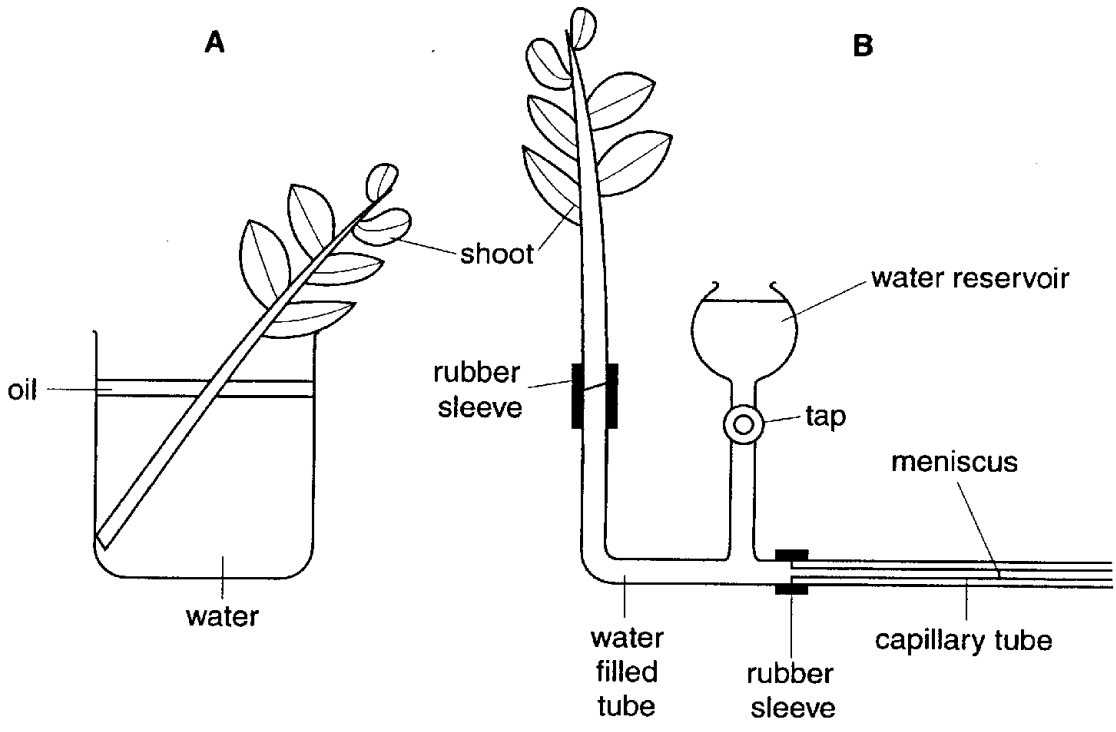

Fig. 3.1

In method **A**, the whole apparatus is weighed, either at intervals or on a balance that allows a continuous record to be maintained, and the mass lost is recorded. Oil prevents evaporation.

In method **B**, the time taken for the water meniscus to move a measured distance towards the shoot is recorded.

Discuss the advantages and disadvantages of these methods.

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For Examiner's Use

(b) In this question, one mark is available for the quality of written communication.

Discuss the importance of water in the life of plants.

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Quality of Written Communication [1]

[Total: 11]

[Turn over

4 More than one mechanism helps to regulate human blood pressure, maintaining it within limits and returning it to resting values after changes brought about by exercise. One of these mechanisms involves the afferent arterioles that supply blood to the glomeruli of the kidneys.

(a) Explain why blood pressure is important for kidney function.

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The kidneys help to regulate blood pressure by means of a hormone called angiotensin II. Fig. 4.1 shows the way in which this hormone is produced and how it acts to change blood pressure.

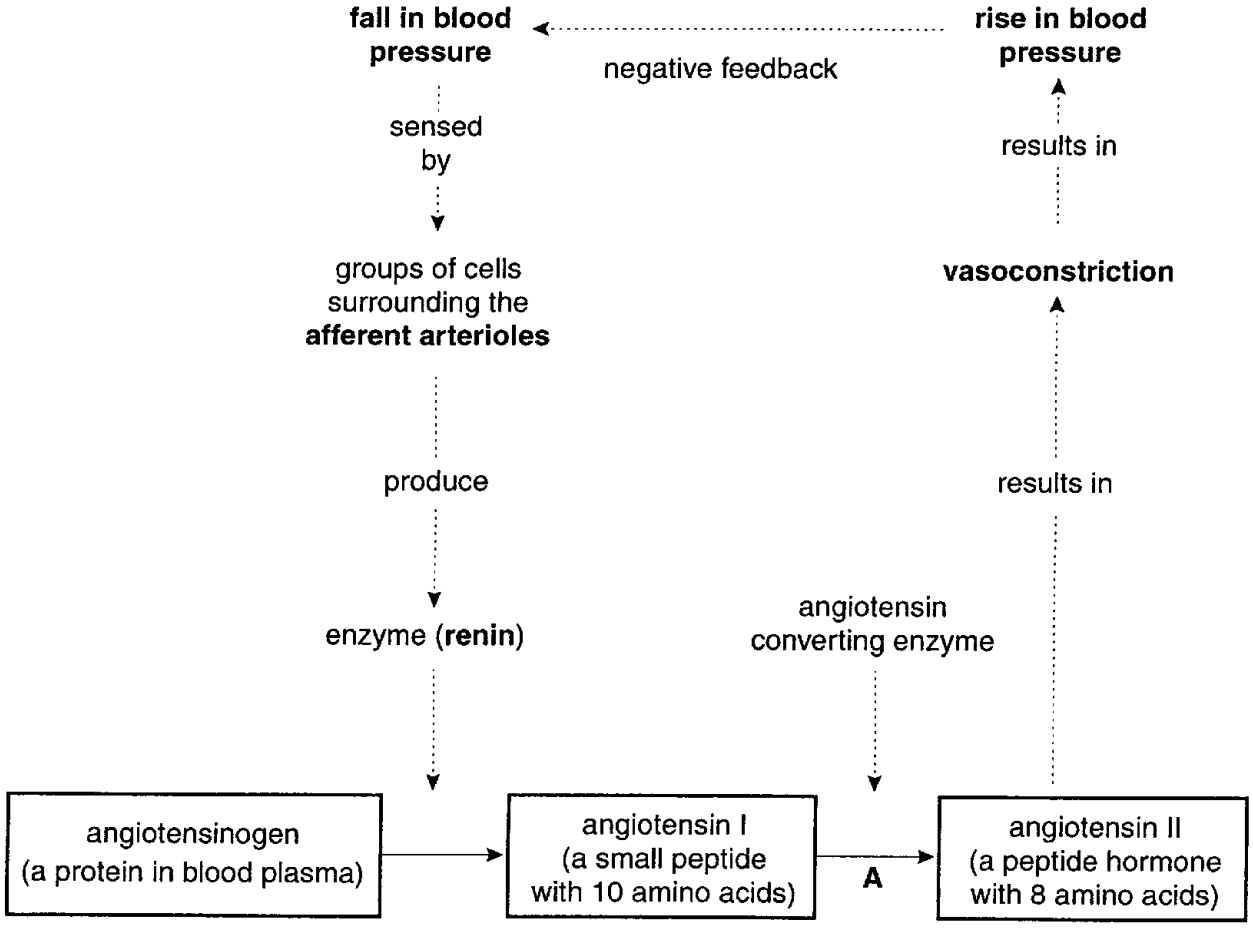

Fig. 4.1

(b) Using Fig. 4.1,

(i) state the type of reaction occurring at **A**.

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(ii) Explain why this system is an example of negative feedback.

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(c) Vasoconstriction is the narrowing of arterioles and small arteries.

(i) Explain how vasoconstriction is brought about.

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(ii) Suggest how angiotensin II may act to increase the extent of vasoconstriction.

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..... [1]

(d) A person with a resting blood pressure that is significantly above normal has hypertension. This is a risk factor in several life threatening diseases and may be controlled by the use of drugs.

Using Fig. 4.1, suggest and explain one way in which a drug might act to lower blood pressure.

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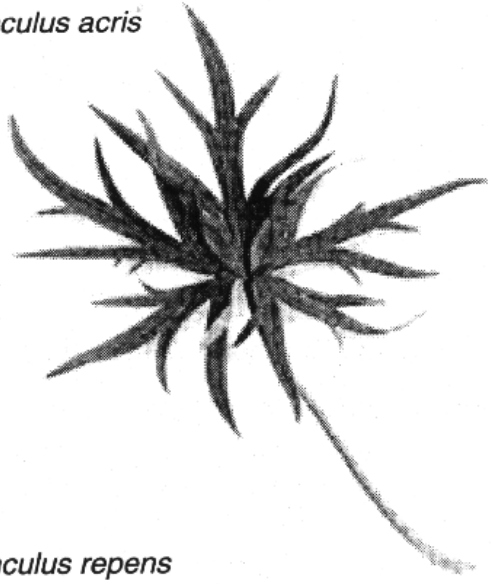
[Total: 11]

[Turn over

5 *Ranunculus acris* and *Ranunculus repens* are common plants in fields, road verges and other habitats. Both are known by the popular name 'buttercup'. Each has characteristic structural features that allow the two species to be identified reliably. Preserved fruits and pollen from both have been found in deposits dating from before the last ice age, so they have coexisted in the British Isles for many thousands of years.

Fig. 5.1 shows leaves of both species, taken from plants growing less than a metre apart on the same lawn.

Ranunculus acris



Ranunculus repens

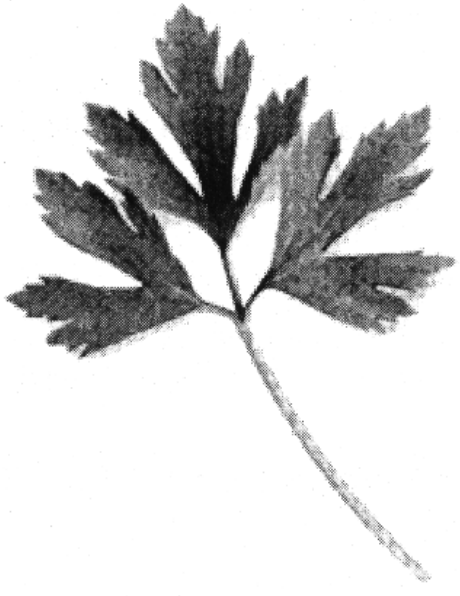


Fig. 5.1

(a) Describe **two** ways, **other than size**, in which the leaves of the species differ.

1. .....

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2. .....

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(b) Ecologists are always interested in examples of similar species that are members of the same community. Theory suggests that this should not occur.

Explain why two very similar species are not expected to occur together in the same community.

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(c) In an investigation of the influence of soil water content on the establishment of buttercups, containers were set up as shown in Fig. 5.2.

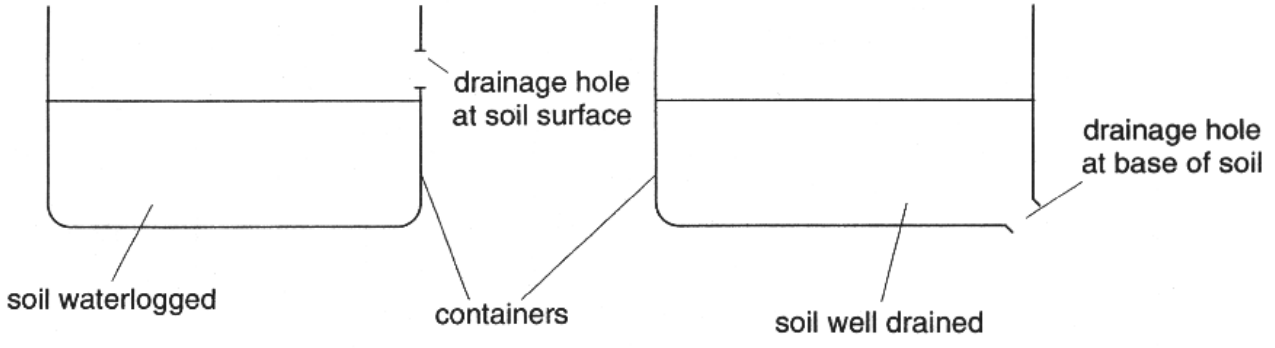

Fig. 5.2

Seeds of *Ranunculus acris* and *Ranunculus repens* were sown on the surface of the soil in the containers. The number of plants of each species that became established in each container was recorded.

List **three** variables that need to be controlled to make this investigation valid.

1. .....

2. .....

3. ..... [3]

[Turn over for the rest of Question 5

(d) Several replicate containers were prepared and 100 buttercup seeds were sown in each. The sowings, in both waterlogged and in well-drained soils, were as follows:

- only *Ranunculus acris* (pure *acris*)
- only *Ranunculus repens* (pure *repens*)
- 50 seeds of each species (mixed sowing)

The number of plants of each species that became established in each container was recorded and the results of the investigation are shown in Table 5.1.

Table 5.1

		waterlogged soil			well-drained soil		
		pure *acris* sown	pure *repens* sown	mixed sowing	pure *acris* sown	pure *repens* sown	mixed sowing
number of plants established in each container	*acris*	2	–	0	60	–	13
	repens	–	31	11	–	3	1
	acris	0	–	1	56	–	17
	repens	–	23	17	–	2	1
	acris	0	–	0	61	–	18
	repens	–	26	15	–	0	0
	acris	1	–	0	47	–	32
	repens	–	17	9	–	0	0
	acris	0	–	1	52	–	29
	repens	–	22	12	–	0	0
mean	*acris*	1	–	0	55	–	
	repens	–	24	13	–	1	

(i) Calculate and insert in the shaded boxes in Table 5.1, the mean values that have been omitted. **Give your answers to the nearest whole number.** [2]

(ii) Does the data in Table 5.1 support the hypothesis that there is competition between *R. acris* and *R. repens*? Explain your answer.

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..... [2]

[Total: 11]