GCE AS/A LEVEL

2400U10-1

TUESDAY, 21 MAY 2019 – AFTERNOON

BIOLOGY – AS unit 1

Basic Biochemistry and Cell Organisation

1 hour 30 minutes plus your additional time allowance

Surname _____

Other Names _____

Centre Number _____

Candidate Number 2 _____

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	10	
2.	15	
3.	14	
4.	18	
5.	14	
6.	9	
Total	**80**	

ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

Answer ALL questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question 6.

The quality of written communication will affect the awarding of marks.

Answer ALL questions.

1(a) **The diagram opposite shows the chromosomes from a single cell of a Chinese daisy, *Aster shennongjiaensis*, during prophase of mitosis.**

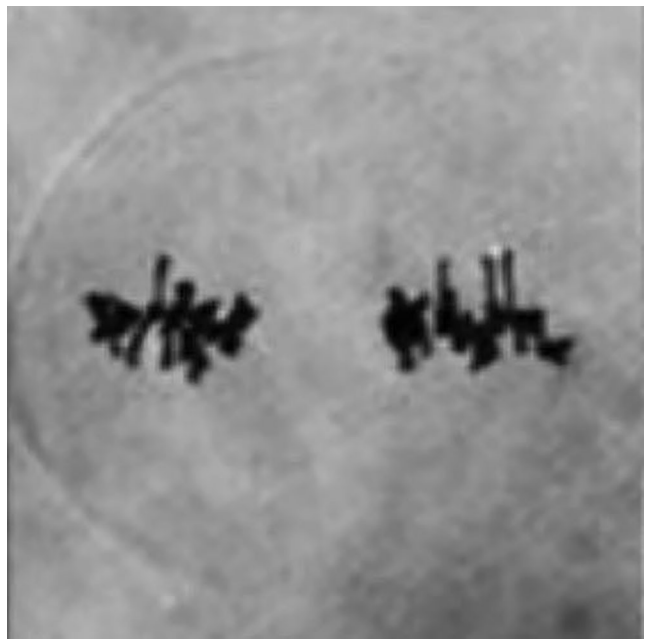
(i) **State the HAPLOID number of chromosomes in this species. [1]**

(ii) **State the evidence from the diagram that the cell is undergoing mitosis and not meiosis. [1]**

1(a) (iii) When the tissues from the plant were removed they were stained before being viewed under the microscope. Explain how this makes the chromosomes visible.

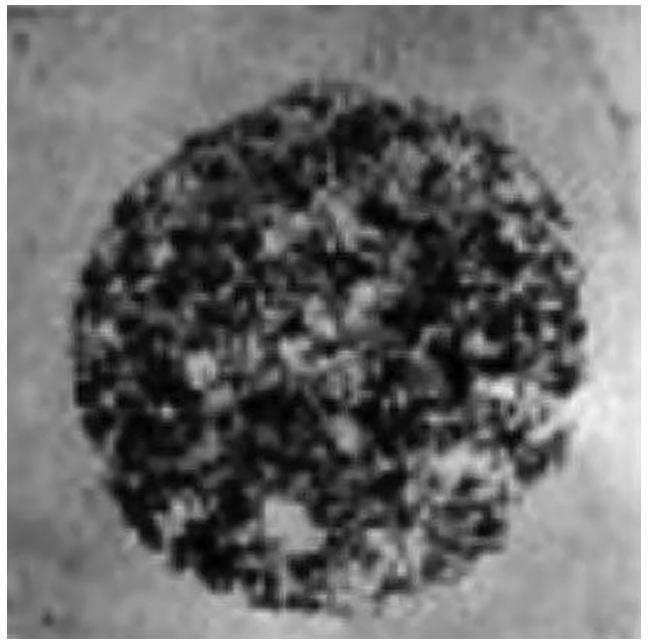
[1]

A

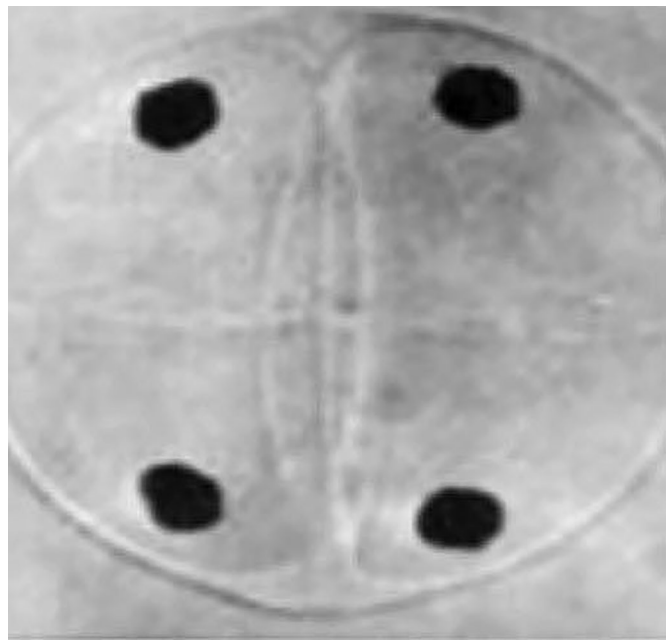


B

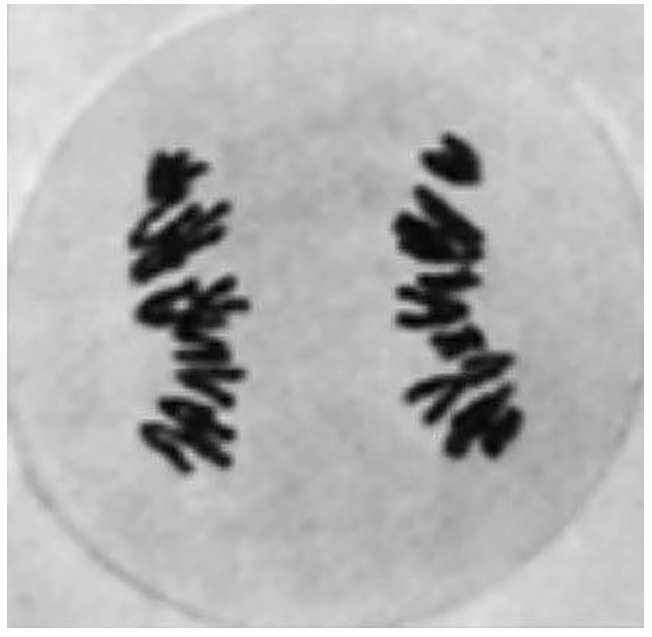
C



D



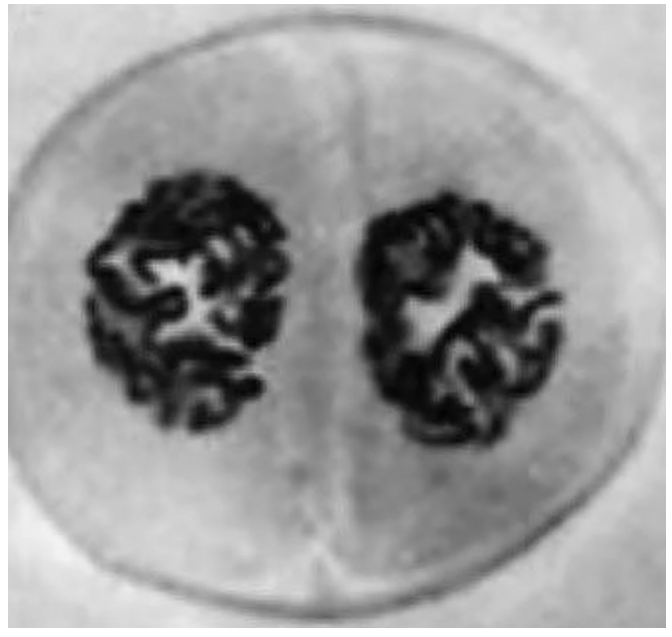
E



F

G

H



1(b) The photomicrographs opposite show different stages of meiosis in a different plant species.

(i) State which organ of the plant could have been used to obtain the photomicrographs above. [1]

(ii) Place the photomicrographs in the correct order. Some letters have been done for you. [1]

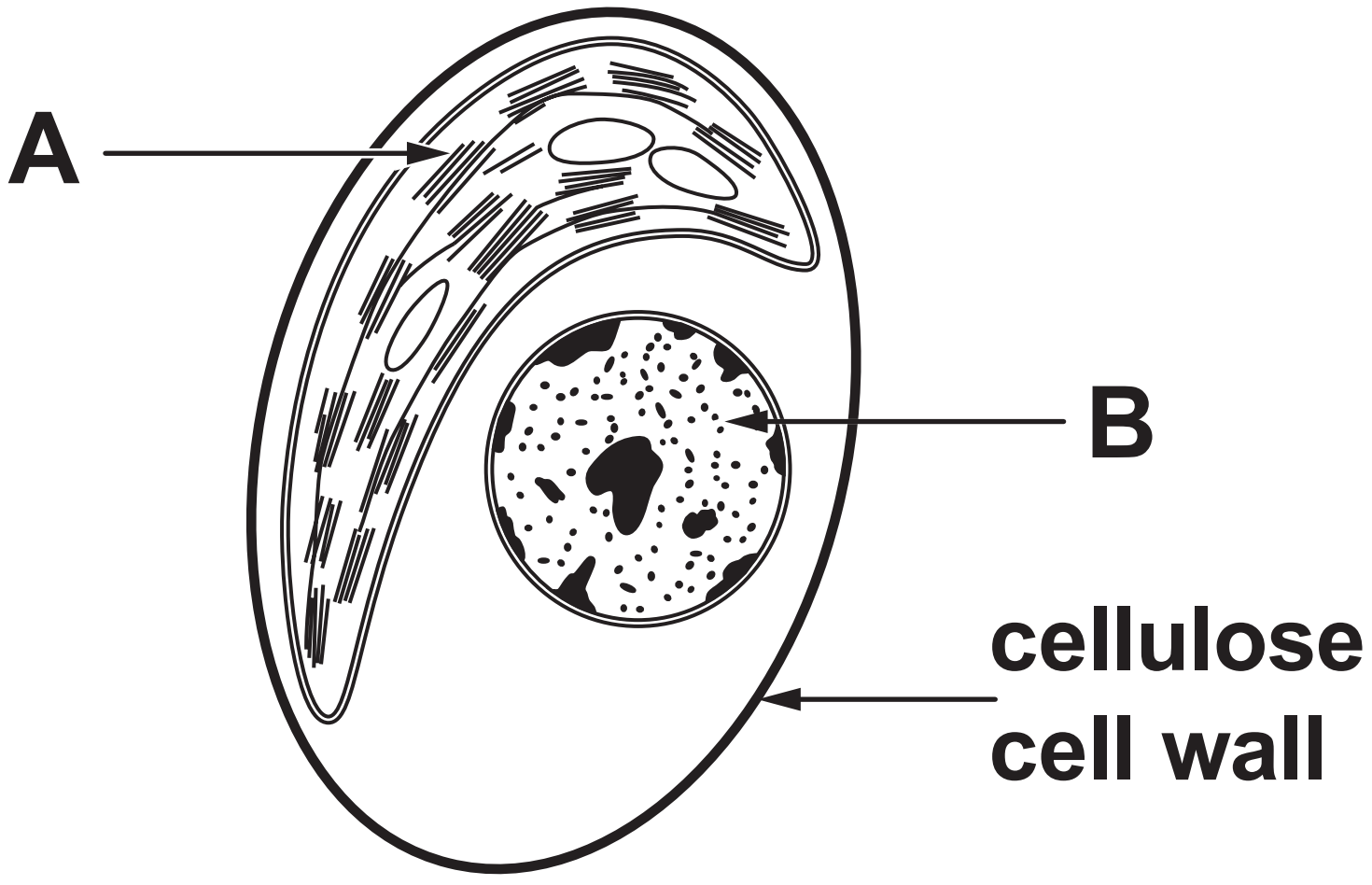
C					A	F	D

1(b) (iii) Use your knowledge of cell division to describe TWO differences between the stages labelled E and F. [2]

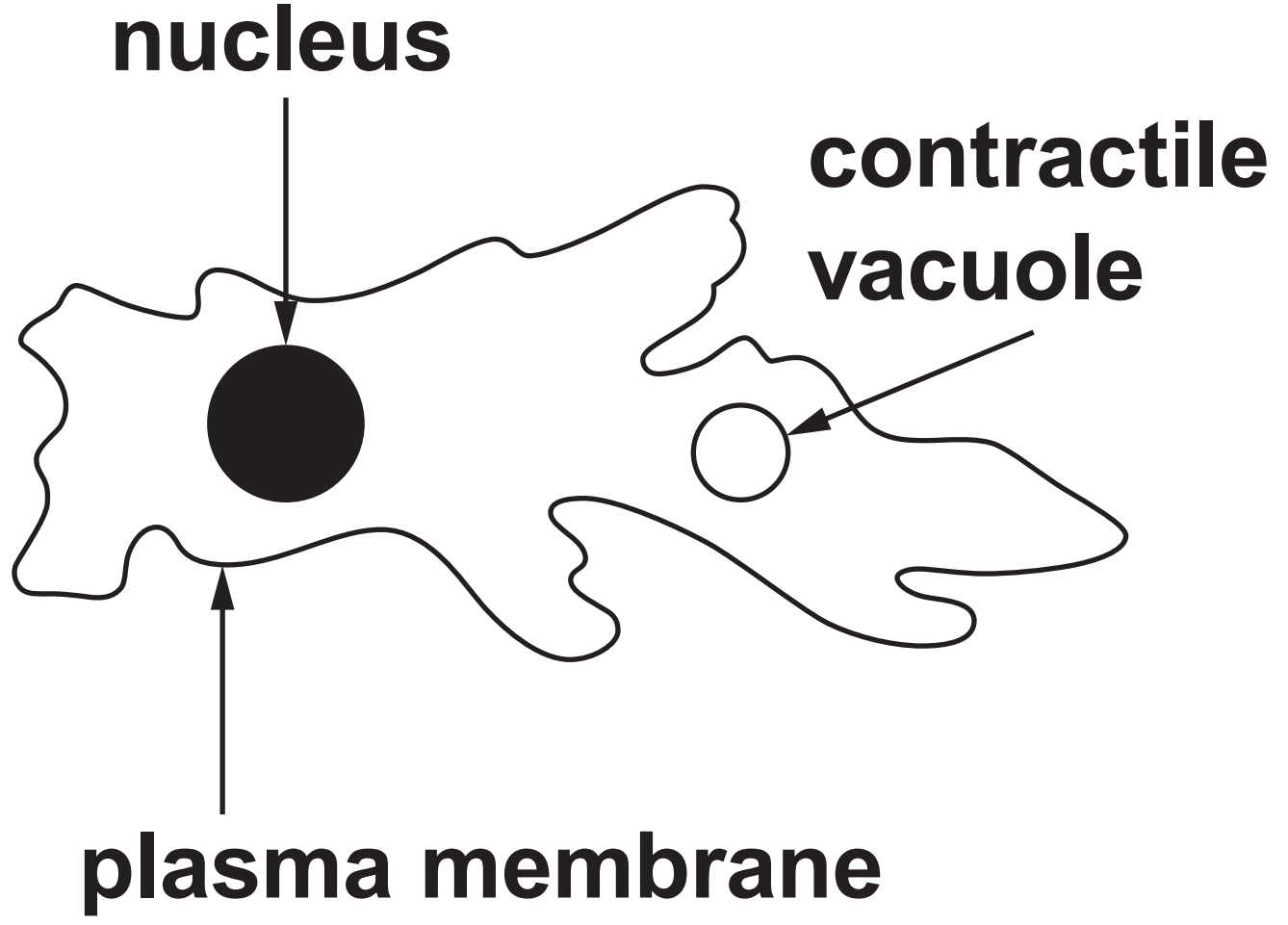
1(b) (iv) **With reference to photomicrographs B and G, state how meiosis contributes to genetic variation in the species and explain why this is important. [3]**

10

CHLORELLA



AMOEBA



2. The diagrams opposite show two unicellular protoctistans (not drawn to scale) that inhabit fresh water ponds. The presence of solutes in the cytoplasm of their cells makes them hypertonic to their environment.

(a) Name organelles **A** and **B**. [1]

organelle **A**:

organelle **B**:

2(b) **Amoeba contains structures called contractile vacuoles which expel excess water from the cell. It can be seen that the contractile vacuole first increases in size, then migrates to and fuses with the plasma membrane. Scientists have recently discovered proteins within the membrane of these vacuoles that can pump ions into it.**

(i) **Use your knowledge of osmosis to explain why contractile vacuoles are necessary for the survival of the Amoeba. [4]**

13

2(b) (ii) **Identify TWO other organelles which must be present in large numbers in the Amoeba in order for this process to occur. Explain your answer for each organelle. [4]**

Organelle 1

Explanation

15

Organelle 2

Explanation

2(c) Although **Chlorella** lives in the same habitat as **Amoeba**, it does not possess a contractile vacuole. Describe and explain how the structure of the cell wall of **Chlorella** allows it to survive in this environment. [4]

17

2(d) Bacteria, such as Cyanophyceae also inhabit fresh water ponds. Describe TWO differences between the structure of Chlorella and Cyanophyceae. [2]

3(a) A student wanted to investigate the concentration of casein in milk powder. Casein is an insoluble protein found in milk. When milk powder is mixed with water it forms an opaque (cloudy) suspension. The enzyme trypsin breaks down the casein into soluble peptides, forming a transparent solution.

To begin with the student needed to construct a calibration curve from known concentrations of milk powder suspensions. He was provided with the following:

- 10 cm^3 suspensions made from milk powder at concentrations of 1 %, 2 %, 3 %, 4 % and 5 % in separate test tubes with a buffer

- 1 % trypsin solution

The milk suspensions and trypsin solution were placed separately in a thermostatically controlled water bath at 30 °C. Once both the milk suspensions and trypsin solution were at the correct temperature, he transferred 2 cm^3 of trypsin to each of the suspensions of milk powder and timed how long it took for the suspensions to become transparent.

3(a)(i) **Using your knowledge of enzymes, explain why:**

I. **it was necessary for a buffer to be added to the solutions; [2]**

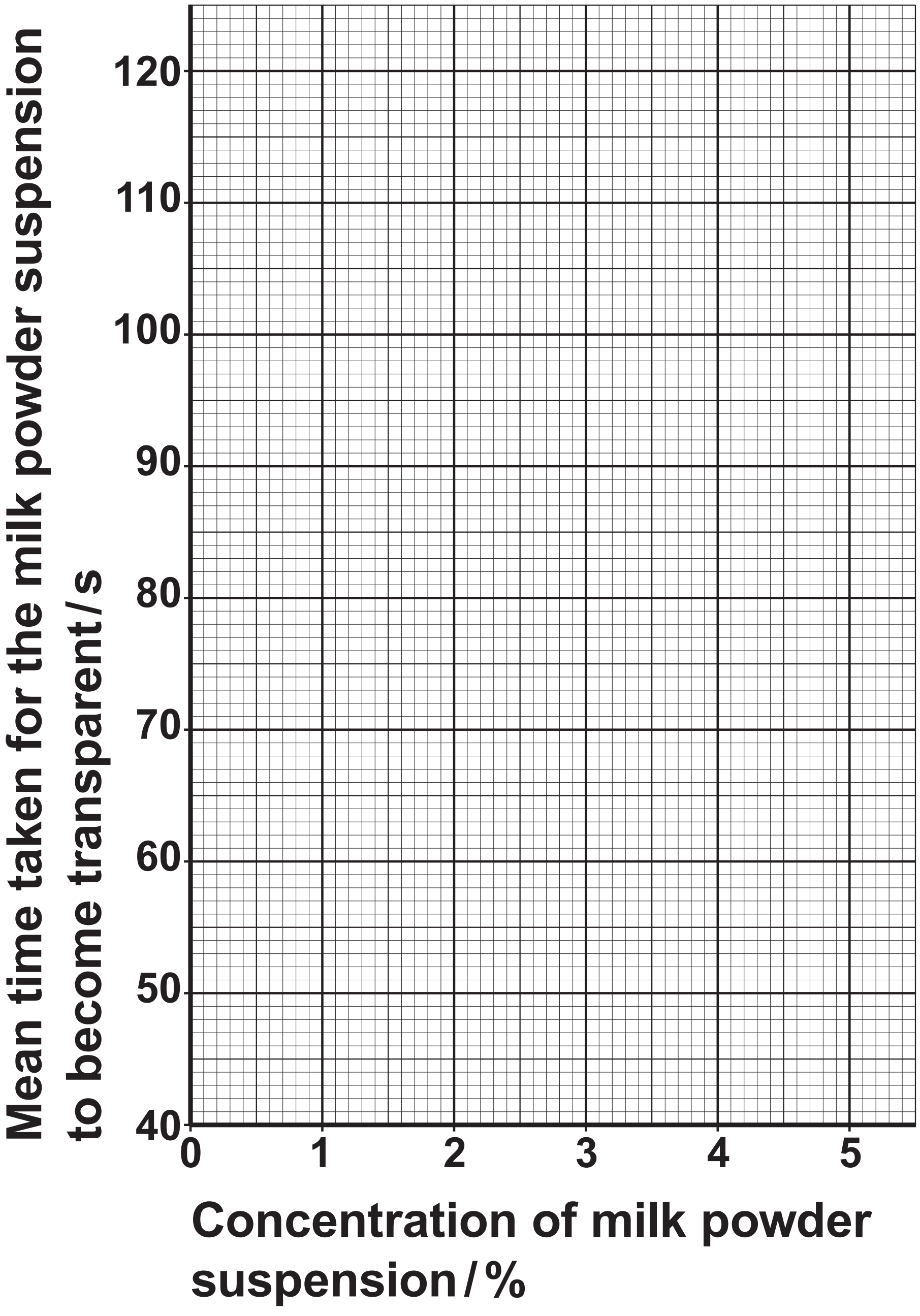
3(a)(i) II. all test tubes were placed in a thermostatically controlled water bath. [2]

Concentration of milk powder suspension/%	Time taken for milk powder suspension to become transparent/s					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	mean
1	49	51	55	52	53	52.0
2	66	64	62	61	63	63.2
3	88	77	73	81	84	80.6
4	91	87	93	86	99	
5	96	109	108	111	105	105.8

The table opposite shows the results.

3(a)(ii) Calculate the mean time taken for the 4% milk powder suspension to become transparent.

WRITE YOUR ANSWER IN THE TABLE. [1]


Mean time taken for the milk powder suspension to become transparent / s
120
110
100
90
80
70
60
50
40
0
1
2
3
4
5
Concentration of milk powder suspension / %

3(a)(iii) Plot the mean data from the table opposite page 23 on the graph paper provided opposite. RANGE BARS SHOULD ALSO BE ADDED TO THE GRAPH. [4]

(b) The student was then provided with two different suspensions of milk powder, X and Y, of unknown casein concentration. He carried out the same procedure and obtained the following mean results: X took 61 seconds to clear and Y took 97 seconds to clear.

(i) Estimate the percentage concentration of casein in these two suspensions. [1]

X: _____

Y: _____

3(b)(ii) The student had more confidence in the estimate for suspension X than the estimate for suspension Y. Use the graph to explain the reason for this statement. [2]

3(b) (iii) **Suggest TWO sources of inaccuracy in this experiment.**

[2]

4. Haemoglobin exhibits quaternary structure and consists of four subunits, two subunits called alpha-globin and two subunits called beta-globin.

(a) Define quaternary structure. [1]

(b)(i) The beta-globin molecule consists of 146 amino acids. State the minimum number of mRNA nucleotides required to code for this molecule. [1]

SECOND LETTER

FIRST LETTER	U	C	A	G	THIRD LETTER
U	UUU, UUC — Phenylalanine UUA, UUG — Leucine	UCU, UCC, UCA, UCG — Serine	UAU, UAC — Tyrosine UAA — Stop codon UAG — Stop codon	UGU, UGC — Cysteine UGA — Stop codon UGG — Tryptophan	U C A G
C	CUU, CUC, CUA, CUG — Leucine	CCU, CCC, CCA, CCG — Proline	CAU, CAC — Histidine CAA, CAG — Glutamine	CGU, CGC, CGA, CGG — Arginine	U C A G
A	AUU, AUC, AUA — Isoleucine AUG — Methionine initiation codon	ACU, ACC, ACA, ACG — Threonine	AAU, AAC — Asparagine AAA, AAG — Lysine	AGU, AGC — Serine AGA, AGG — Arginine	U C A G
G	GUU, GUC, GUA, GUG — Valine	GCU, GCC, GCA, GCG — Alanine	GAU, GAC — Aspartic acid GAA, GAG — Glutamic acid	GGU, GGC, GGA, GGG — Glycine	U C A G

4(b)(ii) The genetic code is a triplet code and is degenerate.

The table opposite show the mRNA codons, that code for specific amino acids.

Use the table to explain why it is necessary that the code is a triplet code and why the code is said to be degenerate. [2]

29

4(b) (iii) The table opposite shows part of the DNA sequence that codes for beta-globin and the corresponding mRNA codons, tRNA anticodons and the amino acid sequence of the molecule.

COMPLETE THE TABLE. [4]

	Codon position number					
	3	4	5	6	7	8
DNA coding strand	GAC	_____	_____	CTC	CTC	_____
mRNA codons	_____	ACU	_____	GAG	GAG	_____
tRNA anticodons	_____	_____	GGA	CUC	CUC	_____
Amino acid sequence	_____	_____	_____	Glutamic acid	Glutamic acid	Lysine

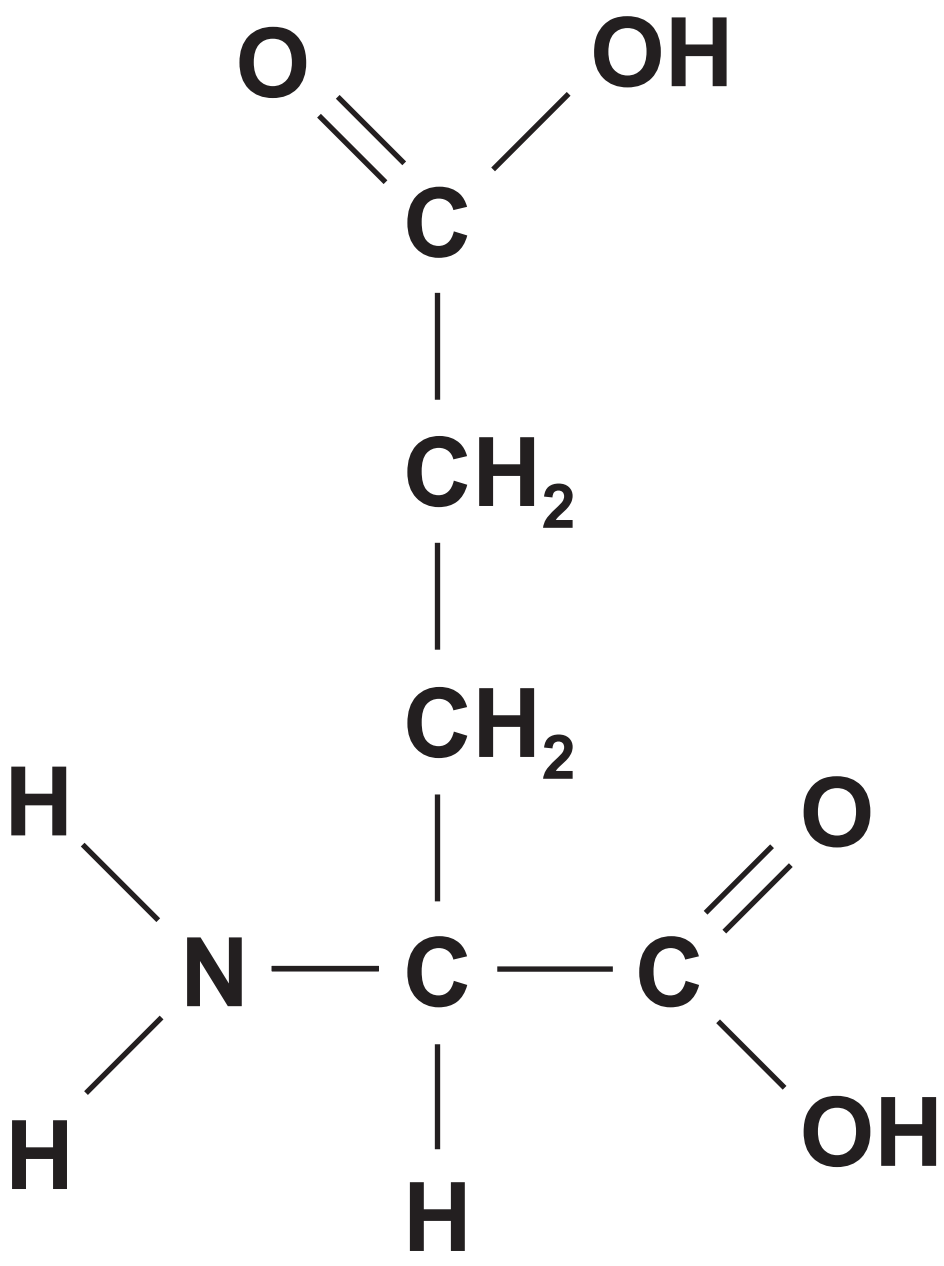
4(c) Describe the events which take place in the production of the beta-globin molecule after the ribosome has attached to the mRNA. [5]

32

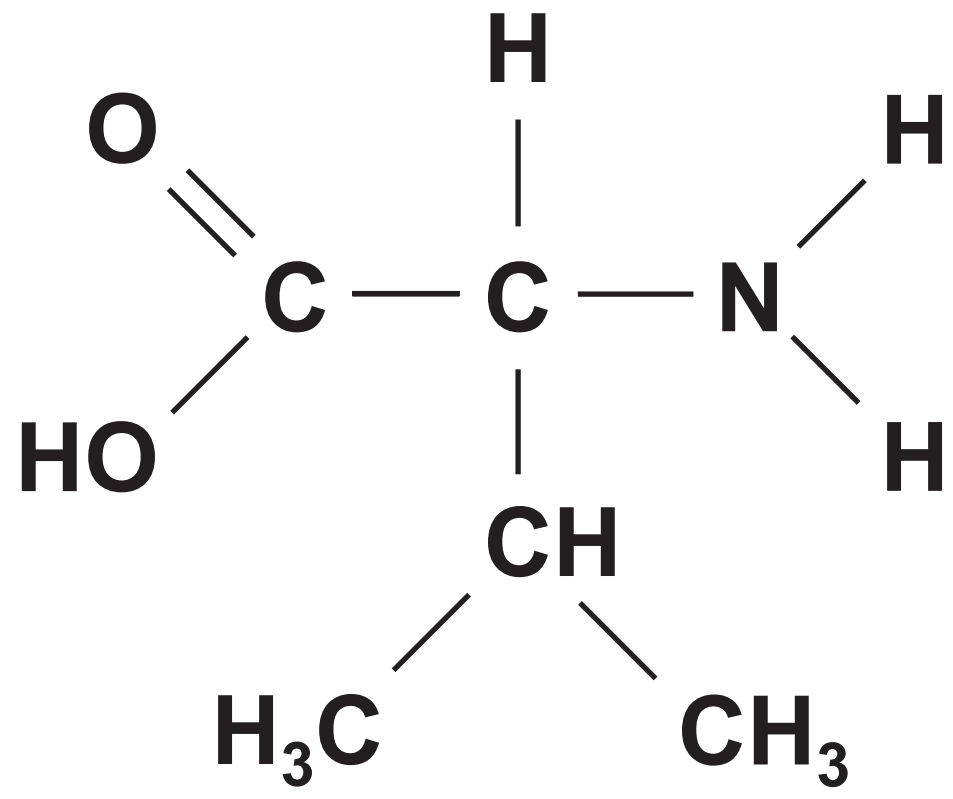
4(d) A mutation, where a single base was substituted by a different base, resulted in glutamic acid being replaced by valine at position 6 in the beta-globin molecule. Use the information provided to determine the mutated DNA base sequence at position 6 on the coding strand of DNA. [1]

_____

_____



glutamic acid



valine

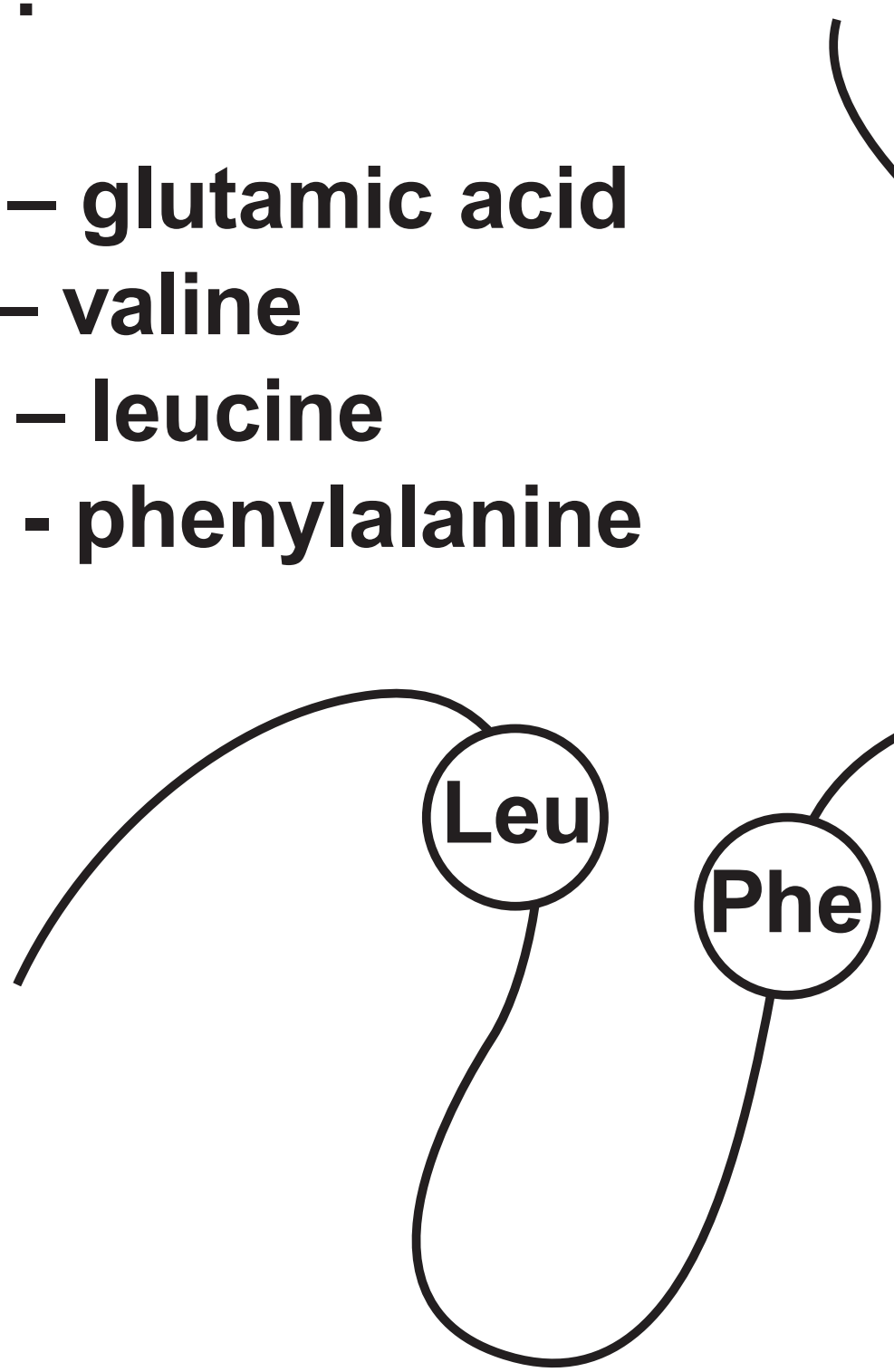
4(e) The diagrams opposite show the structures of glutamic acid and valine.

4(e)(i) DRAW A CIRCLE around the R-groups of the TWO amino acids opposite. [1]

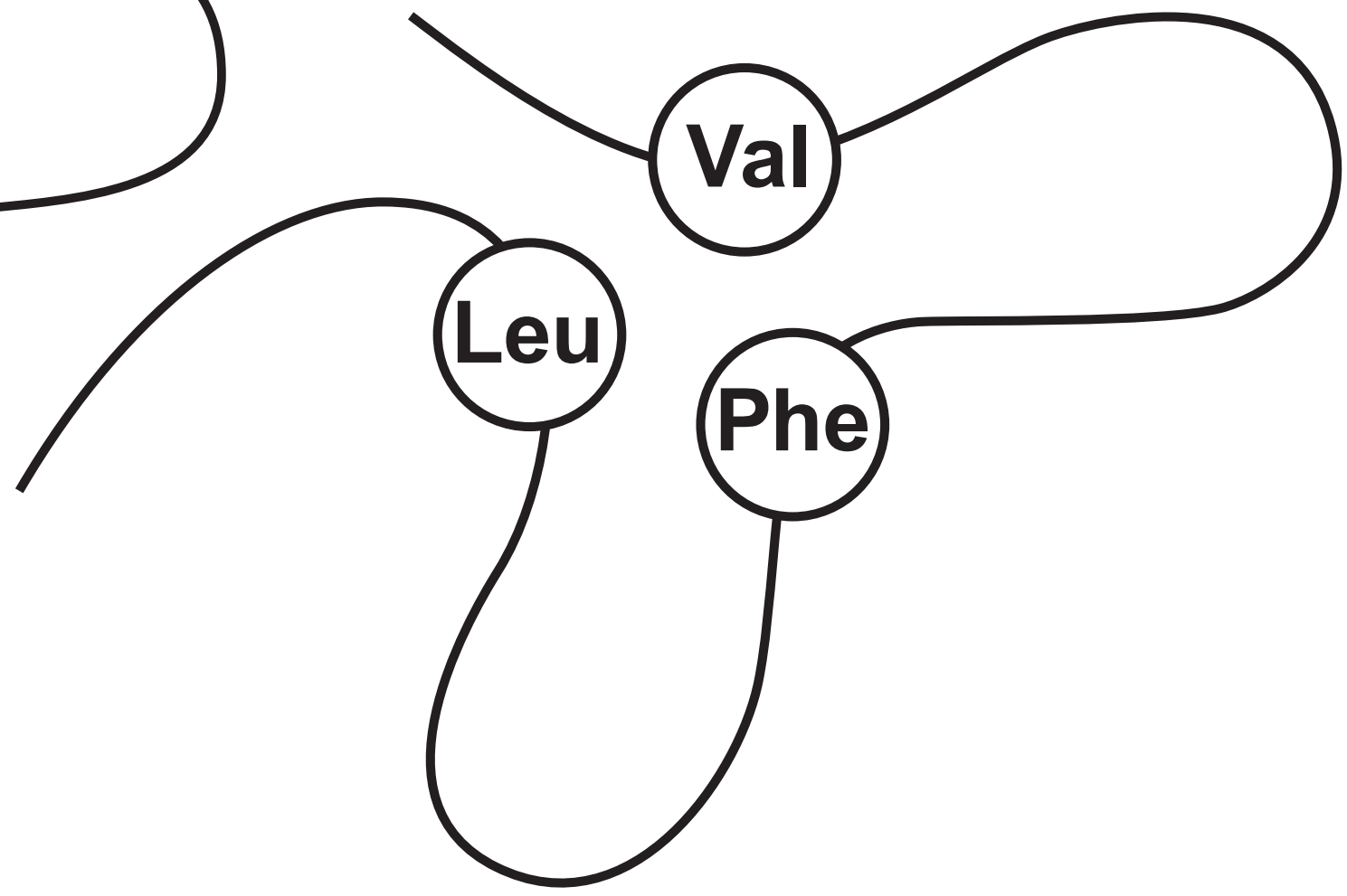
The R-group of glutamic acid is polar whereas the R-group of valine is non-polar. This affects the 3D structure of the resulting beta-globin molecule, as shown in the diagram opposite.

KEY:

Glu – glutamic acid
Val – valine
Leu – leucine
Phe - phenylalanine



Section of beta-globin molecule in a person WITHOUT mutation



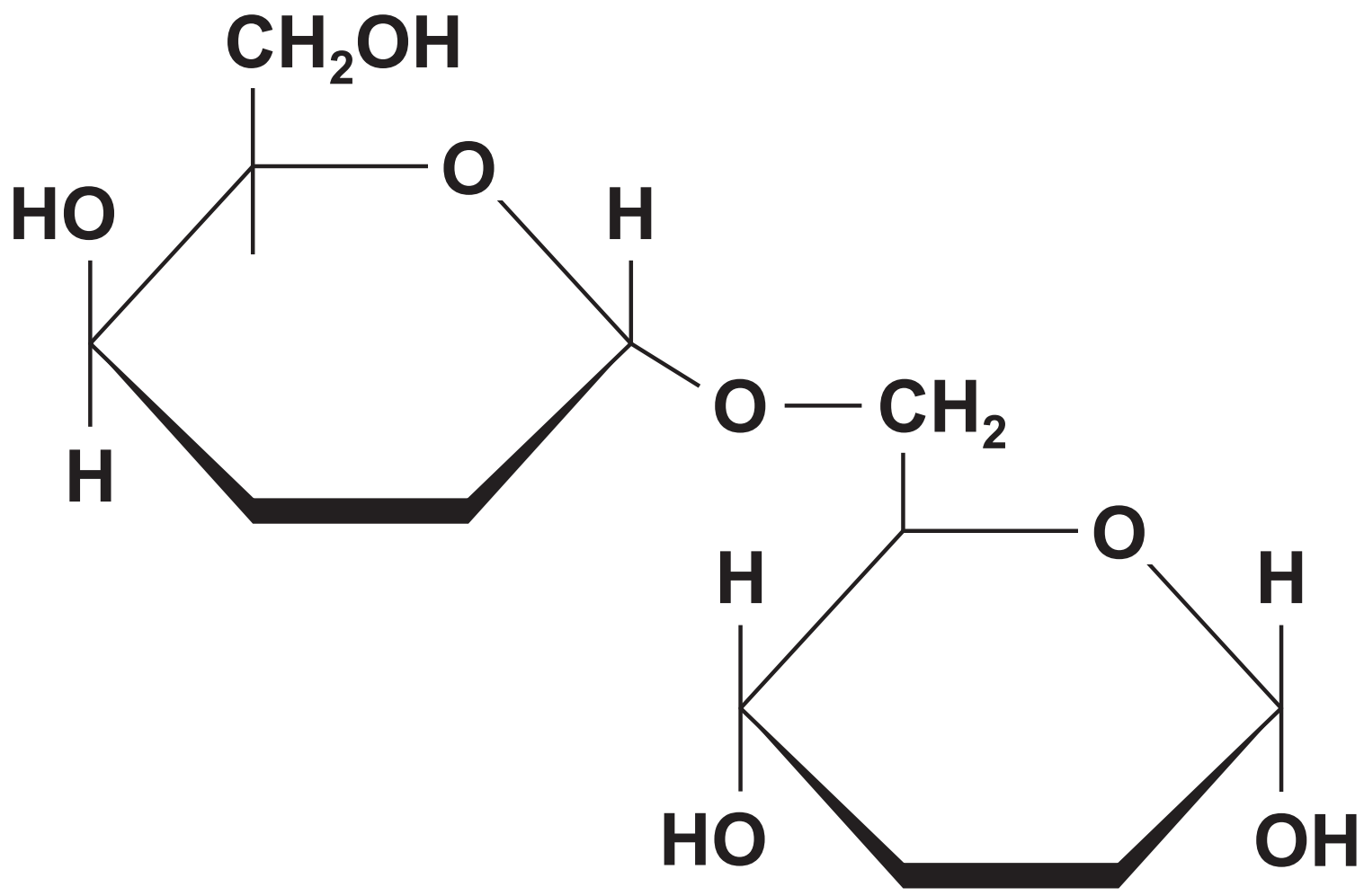
Section of beta-globin molecule in a person WITH mutation

4(e)(ii) Valine interacts with phenylalanine and leucine in the beta-globin molecule. Phenylalanine and leucine both have non-polar R-groups.

Explain how the properties of these amino acids mean that valine interacts with phenylalanine and leucine but glutamic acid does not. [3]

37

18


CH2OH
O
HO
H
H
O
CH2
O
H
H
HO
OH

5. Melibiose is a reducing sugar that is formed from galactose and glucose and is thirty times sweeter than sucrose.

(a) The diagram opposite shows the structure of melibiose.

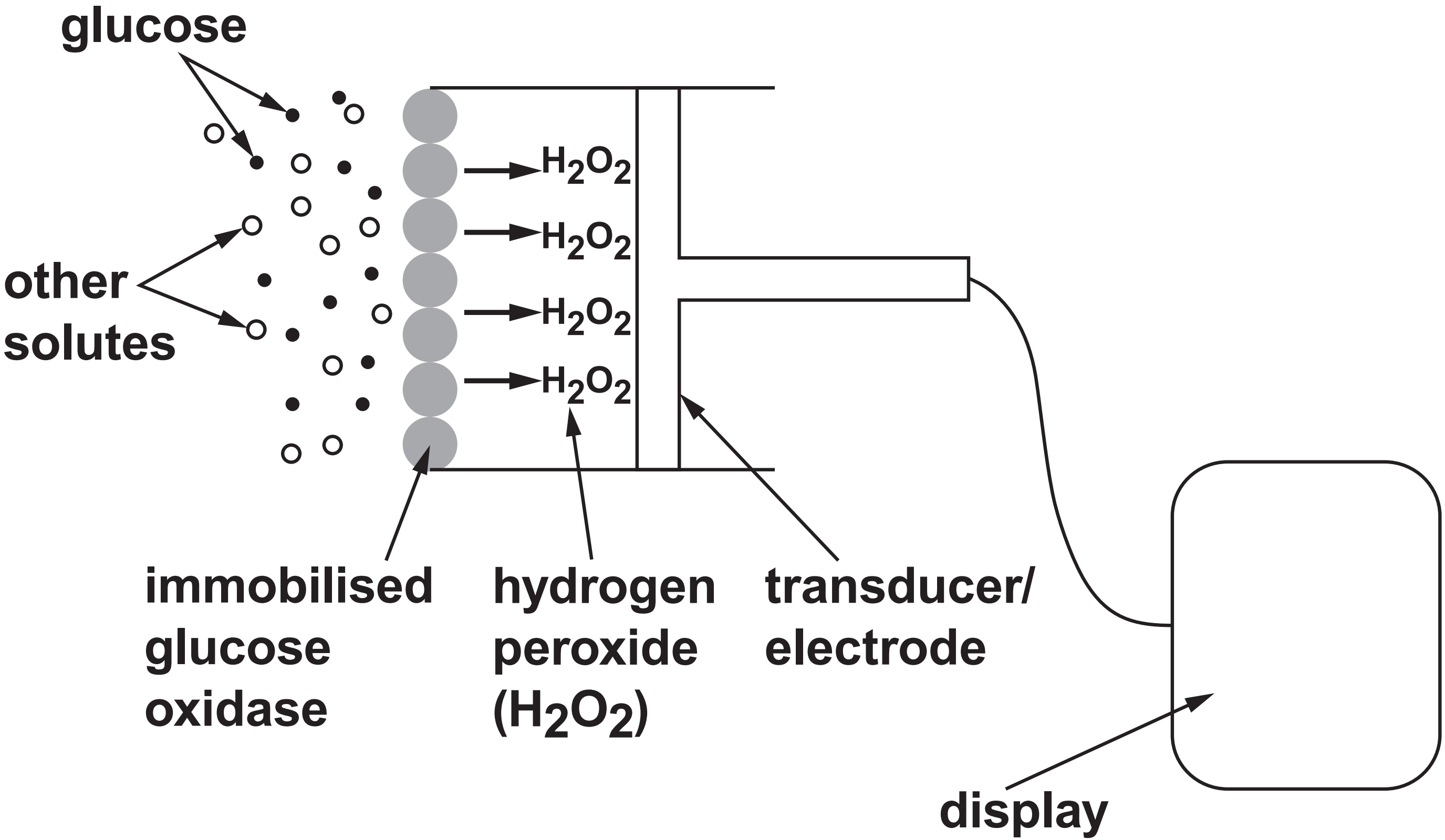
(i) COMPLETE THE DIAGRAM OPPOSITE to show how this molecule would be broken down into two monosaccharides. [2]

(ii) State the type of reaction that occurs when this molecule is broken down into two monosaccharides. [1]

_____

_____

5(a)(iii) Describe a biochemical test that could be used to determine the presence of a reducing sugar such as melibiose. [2]


glucose
other solutes
H_2O_2
H_2O_2
H_2O_2
H_2O_2
immobilised glucose oxidase
hydrogen peroxide (H_2O_2)
transducer/ electrode
display

5(b) **Biosensors make use of immobilised enzymes to detect specific molecules in a mixture. The diagram opposite shows a possible structure of a biosensor that could be used to detect the presence of glucose in a urine sample.**


glucose
oxidase
glucose + oxygen
gluconic acid + hydrogen peroxide

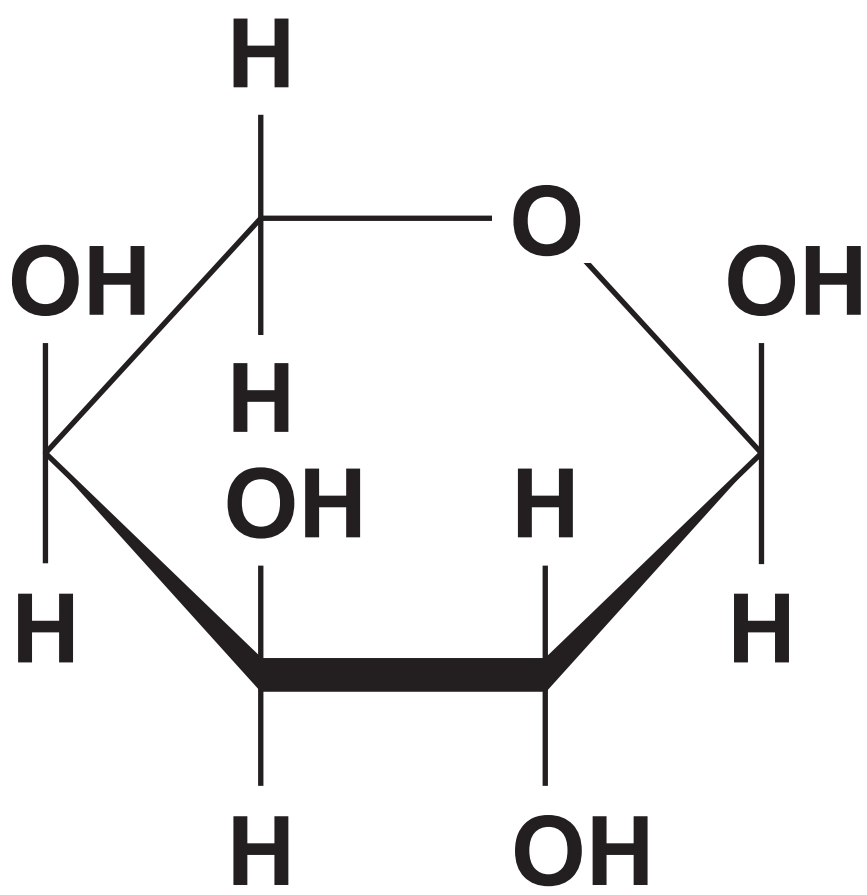
41

Within the biosensor, the glucose oxidase catalyses the reaction opposite:

The concentration of hydrogen peroxide is detected by the transducer and converted into an electrical signal, shown as a measurement on the display.

5(b)(i) Using your knowledge of enzymes explain why this biosensor will only detect the presence of glucose. [3]

5(b)(ii) With reference to the information given, explain how the biosensor could be used to give a measurement of the glucose concentration. [2]



ARABINOSE

5(c) Arabinose is a monosaccharide that can also be used as a sweetener. The diagram opposite shows the structural formula of arabinose.

Experiments have shown that arabinose can inhibit glucose oxidase and therefore affect the accuracy of the biosensor. Using the information provided in part (a) opposite page 38 and the diagram opposite this page, explain why the contamination of a urine sample with arabinose would affect the accuracy of the biosensor. [4]

45

46

14

6. The following extracts are adapted from articles published on the Internet.

Hidden ocean found on Saturn's icy moon, Enceladus, could potentially support life.

Enceladus harbours a big ocean of liquid water beneath its icy crust that may be capable of supporting life as we know it. Researchers said that the water is about 10 kilometres deep and lies beneath a shell of ice 30 to 40 km thick. Furthermore, it is in direct contact with a rocky sea floor, theoretically making possible all kinds of complex chemical reactions – such as the kind that may have led to the rise of life on Earth.

NASA finds more evidence that the ocean on Enceladus could support alien life.

NASA's Cassini spacecraft orbiting the moon has analysed the plumes of gas forced out through fissures in the ice. These plumes have been found to contain four of the six most important elements of life on Earth – carbon, hydrogen, nitrogen and oxygen – only phosphorus and sulfur have not been detected.

6. **Describe the structure of water and explain how the properties of water would be essential to supporting life on Enceladus. Explain how the absence of phosphorus and sulfur would prevent the formation of biochemical molecules essential for life on Earth. [9 QER]**

50

51

52

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54

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56

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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