



General Certificate of Education
Advanced Subsidiary Examination
June 2011

Human Biology

HBI3X/TN

Unit 3X AS Externally Marked Practical Assignment

Teachers' Notes

Confidential

**A copy should be given immediately to the teacher(s) responsible for
GCE Human Biology**

Open on receipt

Teachers' Notes**CONFIDENTIAL**

These notes must be read in conjunction with *Instructions for the Administration of the Externally Marked Practical Assignment* for GCE Human Biology published on the AQA website.

The digestion of lactose by lactase

In Task 1, the breakdown of lactose can be shown by the appearance of glucose, one of the products of hydrolysis. A glucose test strip is used to measure the concentration of glucose by using a colour chart. This method will be used in Task 2 to determine differences between fresh samples of normal semi-skimmed milk and 'lactose free' semi-skimmed milk. This is milk that has been treated with lactase by the manufacturers.

Task 1: Showing the effect of the enzyme lactase**Materials**

In addition to access to general laboratory equipment, each candidate needs

- 10 cm³ 1 % lactose solution
- 5 cm³ pH7 buffer
- 10 cm³ 10 % lactase solution
- 6 glucose test strips
- colour chart
- 2 test tubes
- test tube rack
- 3 graduated pipettes or syringes capable of measuring up to 2 cm³
- timer
- marker pen

Managing the investigation

Task 1 is carried out at room temperature; in this investigation there is no need for a candidate to use a water bath.

Glucose test strips are available as reagent strips for urine analysis. They can also be used to determine the concentration of glucose in other liquids. This experiment was successfully trialled using two similar brands of test strips. These were *Diastix*, Reagent Strips for Urinalysis, from Philip Harris and *Reagent Strips for Urinalysis* from Scientific & Chemical. The colour chart and stated concentrations of glucose are marginally different in these two versions but this does not matter.

- **Do not use keto-diastix because the results may be different.**
- **Do not use Clinistix because these do not give quantitative information about the concentration of glucose.**

Please note the storage requirements for the test strips and the shelf life of the product. If you have existing supplies, establish that the reagents on the test strip are still active before using them in the investigation. Test them with a positive control (5 % glucose solution) and a negative control (distilled water). If the test strips register that the glucose solution has **no** glucose in it, these should be discarded and a new supply obtained. You can increase your supply of test strips by cutting them in half lengthways.

Lactose powder and lactase (as a liquid) can also be obtained from either Philip Harris or Scientific & Chemical. Lactase should be kept refrigerated before use and brought up to temperature only when required.

A colour chart is on the side of the container in which the test strips are supplied. Candidates will need access to a chart. It might be possible to copy the chart using a colour photocopier, or to photograph the chart and make prints of the image.

The task will need to be trialled before use.

Candidates **must not** be given information about an EMPA assessment until one week before Task 1. One week before Task 1, candidates should be given the following information.

You will investigate the digestion of the disaccharide lactose by the enzyme lactase, the problem of lactose intolerance and the evolution of lactose tolerance.

There **must** be no further discussion and candidates **must not** be given any further resources to prepare for the assessment.

In this investigation, teachers must not give candidates the following information

- how to interpret colour changes.

Task 2: Comparing normal semi-skimmed milk and 'lactose free' semi-skimmed milk

Materials

In addition to access to general laboratory equipment, each candidate needs

- 25 cm³ **Milk A**
- 25 cm³ **Milk B**
- 50 cm³ 10 % lactase solution
- 25 cm³ pH7 buffer
- 20 glucose test strips
- colour chart
- 12 test tubes
- test tube rack
- 4 graduated pipettes or syringes capable of measuring up to 3 cm³
- timer
- marker pen

Managing the investigation

As for Task 1, it should be established that the glucose test strips are active before use. Task 2 is also carried out at room temperature; there is no need for a candidate to use a water bath.

Lactose free milk is available as a branded product from supermarkets such as ASDA or Sainsbury's and referred to as *lactofree*. Fresh lactofree semi-skimmed milk should be purchased close to the day of the investigation. Candidates should be provided with their sample in a bottle or covered tube labelled as **Milk A**.

Fresh normal semi-skimmed milk should be purchased close to the day of the investigation. Candidates should be provided with their sample in a bottle or covered tube labelled as **Milk B**. Reliable results were obtained from milks used one or two days after purchase but having been kept refrigerated.

To repeat, it is essential that

- the sample labelled **Milk A** contains fresh lactofree semi-skimmed milk
- the sample labelled **Milk B** contains fresh normal semi-skimmed milk.

Candidates **must not be told** which type of milk corresponds to which sample.

In this investigation, teachers must not give candidates the following information

- the type of milk in either of the two samples
- how to interpret colour changes
- the number of repeats required.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 1



General Certificate of Education
Advanced Subsidiary Examination
June 2011

Human Biology

HBI3X/PM1

Unit 3X AS Externally Marked Practical Assignment

Task Sheet 1

To be completed before Task Sheet 2.

For submission by 15 May 2011

For this paper you must have:

- a ruler with millimetre measurements
- a calculator.

Showing the effect of the enzyme lactase

Introduction

Lactose is a disaccharide found in milk and milk products. Some humans produce the enzyme lactase that digests lactose. During digestion, lactose is broken down into two monosaccharides, glucose and galactose. How much lactose has been broken down can be determined from how much glucose is produced.

Glucose test strips can be used to show the concentration of glucose in a solution. The presence of glucose will change the colour of a test strip as shown.

Test strip blue (No glucose present)	—————→	Test strip green (Low concentration of glucose recorded)	—————→	Test strip brown (Highest concentration of glucose recorded)
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By comparing the colour of the test strip to the range of colours on a standard colour chart, the concentration of glucose present can be determined.

Task 1

In Task 1, you will investigate the effect of lactase, at room temperature, by measuring the concentration of glucose produced in a given length of time.

Materials

You are provided with

- lactose solution
- pH7 buffer
- lactase (enzyme) solution
- glucose test strips
- colour chart
- test tubes
- test tube rack
- graduated pipettes or syringes
- timer
- marker pen

You may ask your teacher for any other apparatus you require.

Outline method

Read these instructions carefully before you start your investigation.

The procedure for using glucose test strips is as follows:

- dip the coloured end of a test strip into the solution being tested for five seconds
- wipe the strip against the top of the tube to remove excess solution
- wait two minutes for any colour change to develop. Ignore colour changes that occur after the two minutes
- compare the test strip colour with the colour chart and record the concentration of glucose.

1. Label two test tubes as **X** and **Y**.
2. In tube **X**, mix together 2 cm³ lactose solution and 1 cm³ buffer.
3. Into tube **Y** put 2 cm³ lactase solution.
4. Add the contents of tube **Y** to tube **X**, mix and immediately start the timer.
5. Measure the concentration of glucose immediately (time 0) and every 2 minutes for 10 minutes following the procedure for using glucose test strips.

You will need to decide for yourself

- if the test strip colour is intermediate between two consecutive colours on the chart and whether an estimate of the concentration of glucose is required.

Recording your results

Record your results in the table.

Time / minutes	Colour of glucose test strip	Concentration of glucose / mmol dm ⁻³
0		
2		
4		
6		
8		
10		

Questions on Task 1

Answer **all** questions in the spaces provided.

-
- 1** Lactase catalyses the hydrolysis of lactose. What is hydrolysis?
 - 2** Buffer solution was added to tube **X**.
 - 2 (a)** Explain why buffer solution was added.
 - 2 (b)** Suggest why a buffer of pH7 was used.
 - 3** You were told to wipe the end of the test strip against the top of the tube to remove excess solution. If you had not done this it could have affected the accuracy of the measure of concentration of glucose. Explain why.
 - 4** A student who carried out this investigation included another tube, **Z**, as a control experiment. Describe what tube **Z** should contain.
 - 5** Describe how you could use a graph of concentration of glucose against time to determine the rate of lactase activity.
 - 6** Another student did the same experiment as you but only recorded the colour shown on each of his test strips. He was not able to present his results as a line graph. Explain why.

END OF TASK 1

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use Total Task 2



General Certificate of Education
Advanced Subsidiary Examination
June 2011

Human Biology

HBI3X/PM2

Unit 3X AS Externally Marked Practical Assignment

Task Sheet 2

To be completed before the EMPA Written Test.

For submission by 15 May 2011

For this paper you must have:

- a ruler with millimetre measurements
- a calculator.

Comparing normal semi-skimmed milk and 'lactose free' semi-skimmed milk

Introduction

Lactose is a disaccharide found in milk and milk products. Lactase is an enzyme that digests lactose. During digestion, lactose is broken down into two monosaccharides, glucose and galactose. How much lactose has been broken down can be determined from how much glucose is produced.



Some people do not produce lactase and are lactose intolerant. Milk can be bought that is described as 'lactose free'. This milk has had lactase added to it during the production process. People with lactose intolerance can drink this type of milk.

Task 2

In Task 2, you will investigate the action of lactase on two samples of milk, labelled **Milk A** and **Milk B**. One milk is normal semi-skimmed milk and the other is 'lactose free' semi-skimmed milk. You will not be told which milk is in **A** and which milk is in **B**. You will measure the concentration of glucose in each milk before and after you add lactase to it. In some cases there may be no glucose present. All your experiments will be carried out at room temperature.

Materials

You are provided with

- **Milk A**
- **Milk B**
- lactase solution
- pH7 buffer
- glucose test strips
- colour chart
- test tubes
- test tube rack
- graduated pipettes or syringes
- timer
- marker pen

You may ask your teacher for any other apparatus you require.

Method

Read these instructions carefully before you start your investigation.

The procedure for using glucose test strips is as follows:

- dip the coloured end of a test strip into the solution being tested for five seconds
- wipe the strip against the top of the tube to remove excess solution
- wait two minutes for any colour change to develop. Ignore colour changes that occur after two minutes
- compare the test strip colour with the standard colour chart and record the concentration of glucose.

1. Label two test tubes, **1** and **2**.
2. Put 2 cm³ of **Milk A** and 1 cm³ buffer into tube **1**.
3. Measure the concentration of glucose by using a glucose test strip.
4. Put 2 cm³ of lactase solution into tube **2**.
5. Add the contents of tube **1** to tube **2**, mix and start the timer.
6. After 2 minutes use a glucose test strip to measure the concentration of glucose.
7. Repeat steps 1 to 6 for **Milk B**.

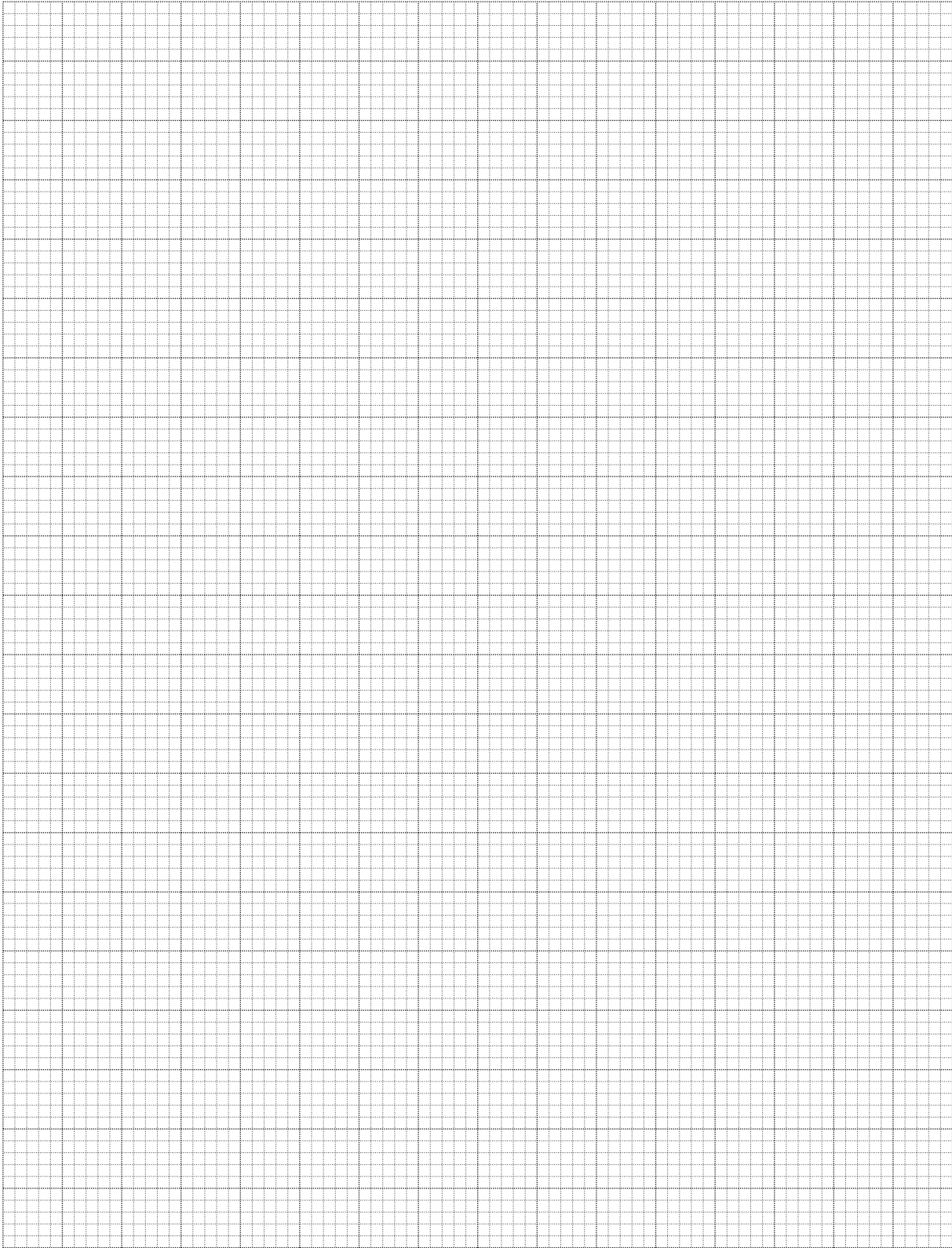
You will need to decide for yourself

- how many repeats to use for each sample of milk
- if the test strip colour is intermediate between two consecutive colours on the chart and whether an estimate of the concentration of glucose is required
- how to interpret the test strip results.

Presenting data

- 7** Record the results of your investigation in an appropriate table in the space below.
Use the space below to do any calculations.

- 8 Use the graph paper to plot an appropriate graph of your processed data.



END OF TASK 2

Centre Number						Candidate Number					
Surname						Other Names					
Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.											
Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.											
Candidate Signature						Date					

For Examiner's Use	
Total EMPA mark	
Examiner's Initials	
Section	Mark
Task 1	
Task 2	
Section A	
Section B	
TOTAL EMPA MARK	



General Certificate of Education
Advanced Subsidiary Examination
June 2011

Human Biology

HBI3X

Unit 3X AS Externally Marked Practical Assignment

For submission by 15 May 2011

For this paper you must have: • your Task Sheet 2, your results and your calculations • a ruler with millimetre measurements • a calculator.	Time allowed • 1 hour 15 minutes
Instructions: • Use black ink or black ball-point pen. • Fill in the boxes at the top of this page. • Answer all questions. • You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages. • Do all rough work in this book. Cross through any work you do not want to be marked.	Information • The marks for questions are shown in brackets. • The maximum mark for this paper is 30. • You will be marked on your ability to: – use good English – organise information clearly – use scientific terminology accurately.
Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes, give the details below or on a separate page. Yes ☐ No ☐	

Teacher Declaration:

I confirm that the candidate has met the requirements of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.

Practical Skills Verification	Yes ☐
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Signature of teacher Date

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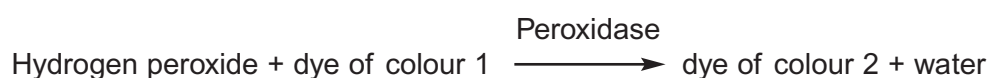
Section A

These questions relate to your investigation into the effect of lactase on lactose digestion.

Use your Task Sheet 2, your results, processed data and your graph to answer the questions.

Answer **all** questions in the spaces provided.

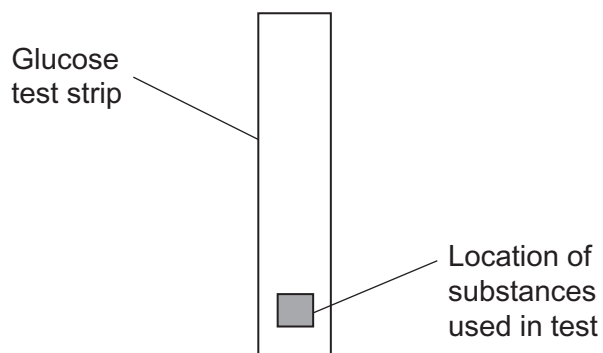
- 9** You used glucose test strips to measure the concentration of glucose in your samples. The following equations show how a glucose test strip works.



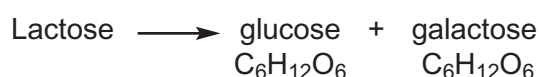
The colour change shown on the glucose test strip depends on the concentration of dye of colour 2 that is produced.

Figure 1 shows where the substances used in the test are located on the glucose test strip.

Figure 1



- 9 (a)** Identify **all** the substances located on the end of the glucose test strip.
- 9 (b)** Glucose test strips can be used to determine the concentration of glucose in the milk samples. The Benedict's test cannot be used for this purpose. Explain why.
- 10** Lactase only catalyses the hydrolysis of lactose. Explain why.
- 11** A student carried out the same investigation as you but at 30 °C. She placed tube **1** and tube **2** into a water bath at 30 °C for 5 minutes. Explain why it was important to wait 5 minutes before mixing the contents.
- 12** The diagram shows the hydrolysis of lactose. The chemical formulae for glucose and galactose are shown.



What is the chemical formula of lactose?

- 13** Another student carried out the same investigation as you. He also tested the two samples of milk for glucose before and after he added lactase to them. His results are shown in the table below.

Milk sample	Presence or absence of glucose	
	Before adding lactase during investigation	After adding lactase during investigation
A	Present	Present
B	Absent	Present

Which sample of milk was 'lactose free' milk? Explain your answer.

- 14** Sterilised milk is milk that has been heated to 120 °C for 30 minutes and then cooled. A student investigated the effect of adding lactase to this milk. Assuming that temperature does not affect the structure of lactose, complete the table below to show the results you would expect for this investigation.

Milk sample	Presence or absence of glucose	
	Before adding lactase	After adding lactase
Sterilised milk		

- 15** Explain **one** way in which you could change your method to improve the reliability of the results.

Resource Sheet

Introduction

Human infants produce the enzyme lactase which hydrolyses lactose in the milk they feed on. In most adults, the gene which codes for the production of lactase is switched off. As a result, worldwide, most adults are lactose intolerant.

Resource A

In people with lactose intolerance, the undigested lactose in their large intestine affects osmosis and results in watery faeces (diarrhoea). Bacteria in the large intestine digest lactose, producing carbon dioxide and hydrogen. These gases cause bloating and discomfort.

To help diagnose lactose intolerance, the hydrogen breath test is used. A person swallows a lactose-containing drink and then samples of breath are taken to measure the amount of hydrogen present. Hydrogen is not normally found in high concentrations in the breath.

Resource B

Some human populations have a lot of milk and dairy products in their diet. A researcher investigated the relationship between annual milk production by dairy farming and lactose intolerance in human populations. **Figure 2** and **Figure 3** show his results.

Figure 2

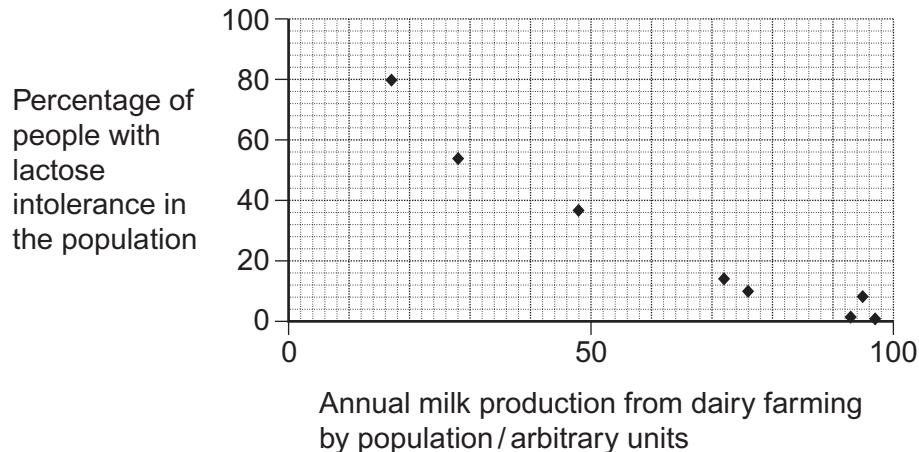


Figure 3

Population	Percentage of people with lactose intolerance
African Americans	96
African cattle herders	8
African hunter-gatherers	87
Greeks	48
Northern Europeans	4

Resource C

Milk and milk products are a major source of calcium. A shortage of calcium can produce bones that fracture easily. **Figure 4** shows suggested daily calcium intake by age group.

Figure 4

Age group / years	Suggested daily calcium intake / mg
0 to 0.4	210
0.5 to 0.9	270
1 to 3	500
4 to 8	800
9 to 18	1300
19 to 50	1000

Section B

Use the information in the **Resource Sheet** to answer the questions.

Answer **all** the questions in the spaces provided.

Use the information in **Resource A** to answer Questions **16** to **18**.

- 16** One consequence of lactose intolerance is watery faeces. Use your knowledge of osmosis to explain why.
- 17** The diet of an infant changes from milk to solid foods during weaning. Some doctors believe that lactose intolerant infants are likely to be more easily weaned. Suggest why their lactose intolerance may lead to their being easier to wean.
- 18** A doctor suspected that a patient with symptoms of bloating and discomfort had lactose intolerance. Because the hydrogen breath test is expensive and time-consuming, the doctor suggested a simple course of action to the patient. Suggest and explain what this course of action would be.

Use the information provided in **Resource B** to answer Question **19**.

- 19 (a)** What relationship is shown by the results in **Figure 2**?
- 19 (b)** Use **Figure 3** to identify the populations of people that are most likely to use milk and milk products as a major part of their diet. Explain why you think these people are most likely to use milk and milk products as a major part of their diet.

Use the information provided in **Resource C** to answer Question **20**.

- 20 (a)** Describe and explain the trend shown by the data for suggested daily calcium intake.
- 20 (b)** Between which two consecutive age groups in **Figure 4** is there the greatest percentage change in suggested daily calcium intake?
- 21** Use the information provided in **Resources A, B and C** to suggest how lactose tolerance in adults may have evolved in human populations.

END OF QUESTIONS

There are no questions printed on this page

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**