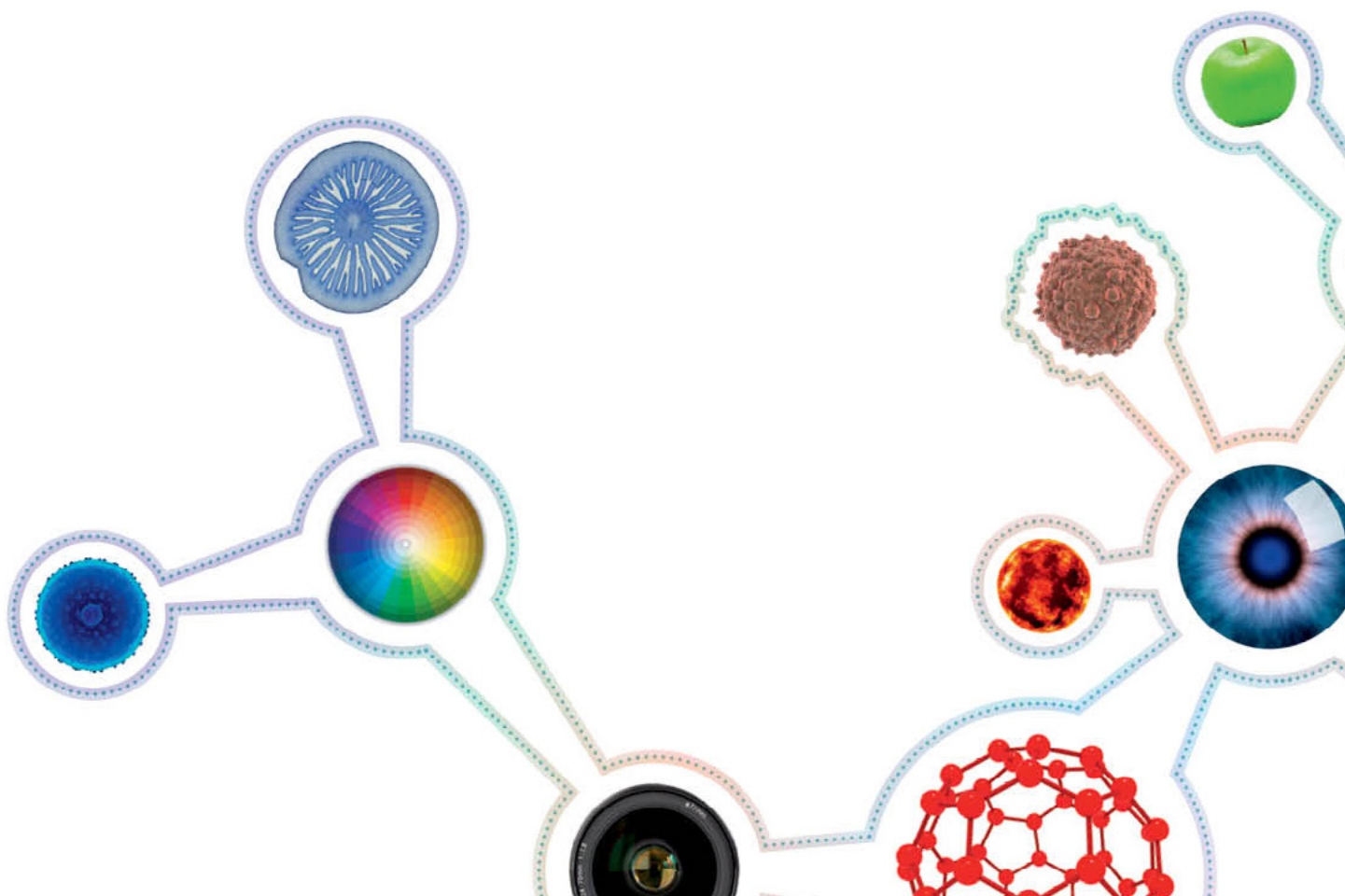


TWENTY FIRST CENTURY  
SCIENCE SUITE  
**UNIT A164 :**  
**SAMPLE CANDIDATE**  
**WORK AND MARKING**  
**COMMENTARIES**

VERSION 1 MAY 2012

# INDEX

<b>Introduction</b>	<b>3</b>
<b>Information for Teachers</b>	<b>4</b>
<b>Information for Candidates</b>	<b>9</b>
<b>Candidate Script and Commentary</b>	<b>15</b>



# INTRODUCTION

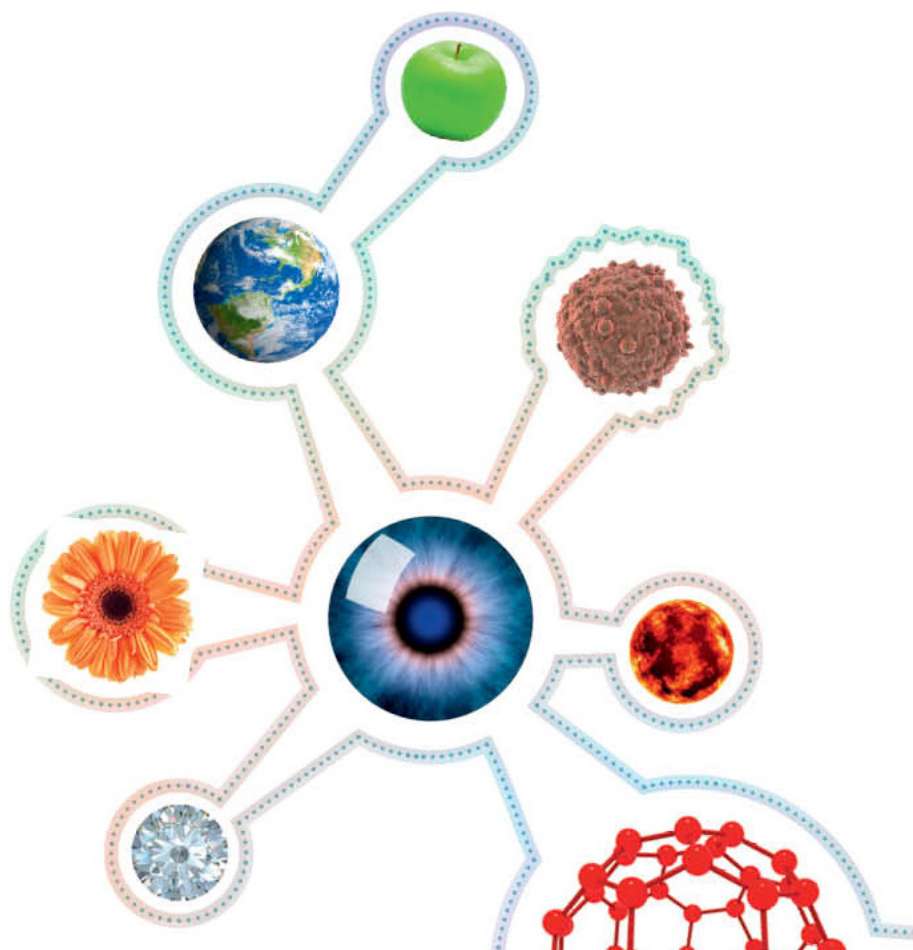
These support materials are intended to support teachers in their marking. There is a candidate style response with accompanying commentary. These exemplars are based on the published Specimen Assessment Materials (SAMs), which can be downloaded from the relevant OCR webpage for the specification.

The exemplars and commentaries should be read alongside the Specifications and the Guide to Controlled Assessment for GCSE Twenty First Century Science, all of which are available from the website.

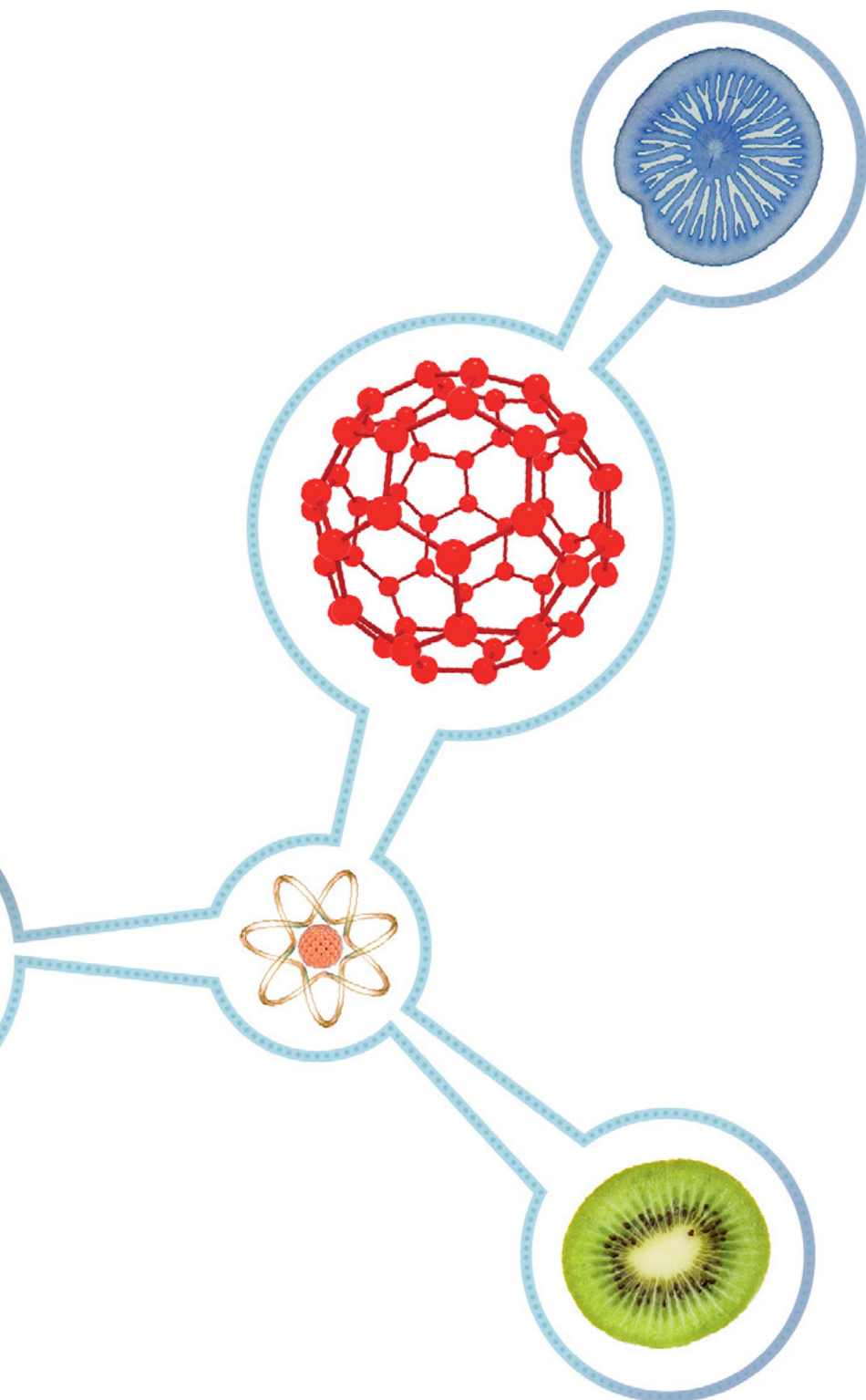
OCR will update these materials as appropriate.

Centres may wish to use these support materials in a number of ways:

- teacher training in interpretation of the marking criteria
- departmental standardisation meetings
- exemplars for candidates to review.



# INFORMATION FOR TEACHERS



**GCSE TWENTY FIRST CENTURY SCIENCE  
ADDITIONAL SCIENCE A A154/INST  
BIOLOGY A A164/INST**

**Practical Investigation**

Factors that affect the rate of fermentation.

**CONTROLLED ASSESSMENT  
INFORMATION FOR TEACHERS**

This assessment will be changed every year. Please check on OCR Interchange that you have the Controlled Assessment material valid for the appropriate assessment session.

- This document is confidential to teachers and must not be released to candidates.
- For details of the level of control required for this assessment refer to Section 5 of the specifications.
- There are two documents provided for candidates for this Controlled Assessment task:
  - Information for candidates (1)** defines the topic of the investigation and places it into a relevant context. This should be issued to candidates at the start of the task.
  - Information for candidates (2)** provides some secondary data to supplement that which candidates collect for themselves. It should be issued to candidates only on completion of the data collection part of their investigation.
- The total number of marks for this Controlled Assessment task is **64**.
- Internally assessed marks **must** be submitted by 15 May.
- This Controlled Assessment task is valid for submission in the June examination series only.
- This document consists of **4** pages. Any blank pages are indicated.

**Teachers are responsible for ensuring that assessment is carried out against the Controlled Assessment set for the relevant examination series (detailed above).**

**Assessment evidence produced that does not reflect the relevant examination series will not be accepted.**

## Introduction

This 'Information for teachers' is confidential and must not be released to candidates.

This document gives information about the Practical Investigation task for Additional Science A Unit A154 / Biology A Unit A164:

**Task title:** Factors that affect the rate of fermentation.

Each candidate for Controlled Assessment in the June examination series must present marks for one of the Practical Investigation tasks that is appropriate to the applicable specification. All internally assessed marks must be submitted by 15 May.

The marked work of all candidates must be retained by the centre. Some of the work will be required for moderation.

## General guidance for teachers

These notes provide background information for the preparation of candidates for these tasks and advice on the assessment of the Practical Investigation report.

Reference should also be made to Section 5 of the specification for Additional Science A or Biology A and to the *Guide for Controlled Assessment for GCSE Twenty First Century Science*.

Task setting is under high control. Tasks are therefore set by OCR. Where appropriate, tasks may be contextualised by individual centres to take account of local circumstances, including availability of resources and the needs of candidates. However, assessments must be based on the published marking criteria (within Section 5 of the specifications). If there is any doubt about whether a contextualised task still sufficiently matches the task and criteria, centres should seek confirmation from OCR that the task is still valid.

## Preparation of candidates

It is expected that before candidates attempt a Controlled Assessment task they will have received general preparation in their lessons. Learning activities to develop the relevant skills should have been provided and the broad requirements of the assessment made clear to candidates.

More specific details of practical techniques, the development of skills associated with these techniques, and possible methods and choice of equipment for the task should be covered when teaching the relevant part(s) of the specifications, and must be completed prior to setting the task.

From their work for Module B4: The Process of Life, candidates should be familiar with the principles of enzyme activity.

## Assessment of the quality of written communication (QWC)

The quality of written communication is assessed in Strands S and R of this Controlled Assessment task. Candidates should be advised that the quality of their written communication will be assessed. Further information about the assessment of QWC may be found in the specifications.

## Risk assessment

It is the centre's responsibility to ensure the safety of all candidates. Teachers are responsible for making their own risk assessment for the task prior to candidates attempting the practical work, and

for ensuring that appropriate health and safety procedures are carried out. However, teachers must not provide candidates with a risk assessment since this is included in the marking criteria for Aspect S(b). If candidates require additional guidance on managing safety once the task has started then this will need to be reflected in the marks awarded.

## Guidance on assessment

All assessment of the Practical Investigation Controlled Assessment is based on the final report submitted by the candidates.

The marking procedure and marking criteria are described in detail within Section 5 of the specifications. Marking decisions should be recorded on the respective cover sheets (available to download from [www.ocr.org.uk](http://www.ocr.org.uk) and included in the *Guide for Controlled Assessment for GCSE Twenty First Century Science*). Candidates' reports should be annotated to show how marks have been awarded in relation to the marking criteria.

## Additional guidance on marking criteria

Detailed guidance on applying the marking criteria will be found in the *Guide for Controlled Assessment for GCSE Twenty First Century Science*.

The following additional brief notes provide some clarification of what may be expected from candidates in some strands. However, all marking decisions must be consistent with the marking criteria.

### Strand S

Reference should be made to the appropriate science in Module B4: The Process of Life.

Quality of written communication is assessed in this strand.

### Strand R

Reference should be made to the appropriate science in Module B4: The Process of Life.

Quality of written communication is assessed in this strand.

## Guidance for technicians and teachers

<b>Task title:</b> Factors that affect the rate of fermentation.
--

Candidates plan their own investigations and may therefore require access to other apparatus at the discretion of the centre.

Teachers are advised to check that the range of apparatus provided will enable candidates to plan and carry out appropriate experiments to collect valid data.

The factors under investigation could include temperature, the carbohydrate available as a respiratory substrate, the concentration of the respiratory substrate, pH and the effect of concentration.

### Apparatus suggested

#### For all investigations:

- Yeast suspension, 5% in water
- Solid sugars, or 5% solutions (e.g. glucose, fructose, lactose, maltose and sucrose)
- Starch solution (1%)

## 4

- Fermentation vessel or equivalent (e.g. conical flasks)
- Water baths at appropriate temperatures
- Buffer solutions across range of pH values

**For syringe method:**

- Graduated pipettes (1 cm<sup>3</sup>)
- Syringes (5 cm<sup>3</sup>)
- Rubber tubing

**For cell counts:**

- Haemocytometers
- Microscopes
- Pasteur pipettes

**For dilutions:**

- Volumetric flasks (10 cm<sup>3</sup> or 100 cm<sup>3</sup>)
- Pipettes (1 cm<sup>3</sup> or 10 cm<sup>3</sup>)

**Bubble counts or volume of carbon dioxide:**

- Conical flasks or boiling tubes with side arm
- Delivery tubes
- Boiling tubes
- Gas syringes

**Datalogging:**

- Pressure sensors and datalogging equipment
- Fermentation vessel with airtight lid

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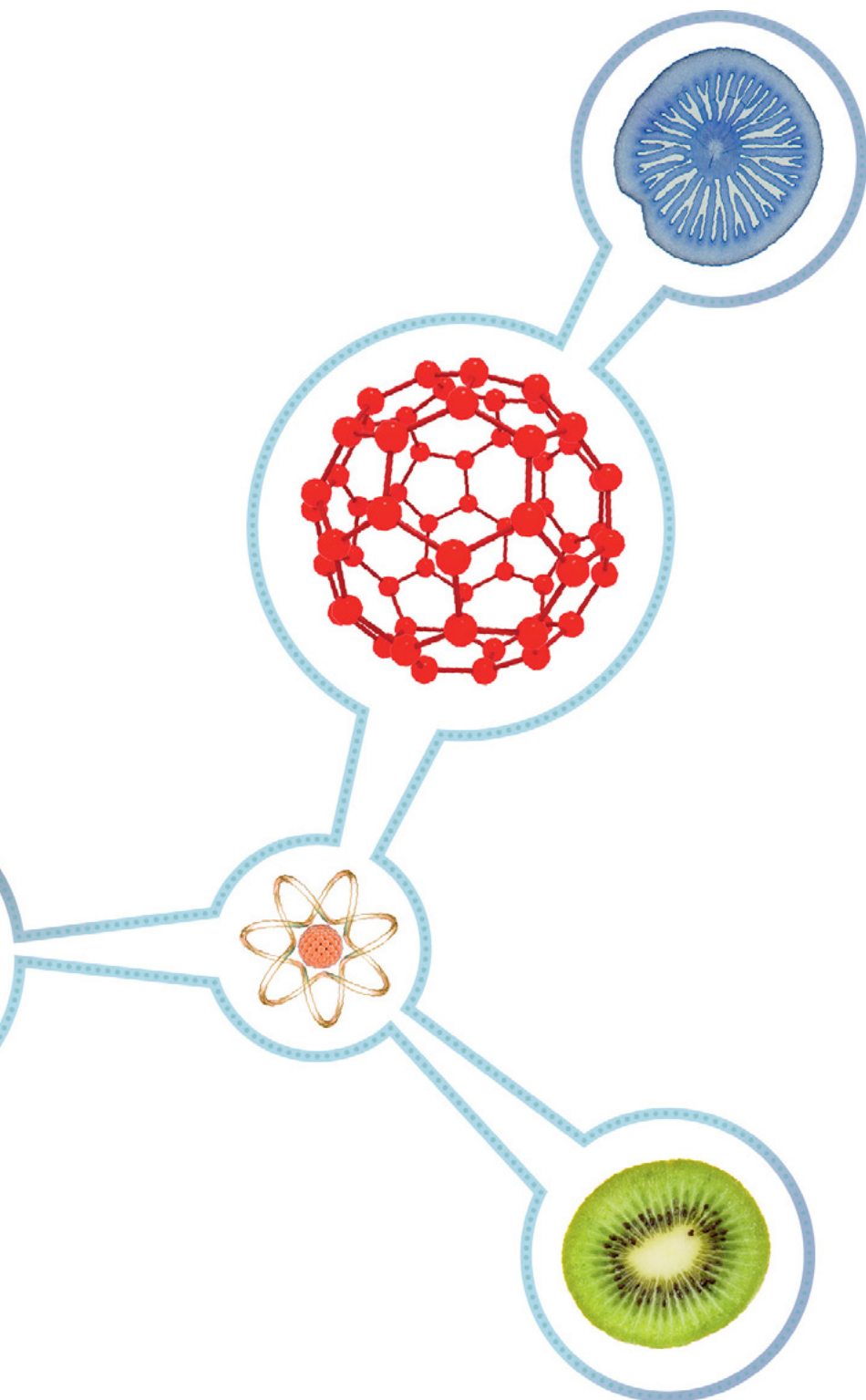
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# INFORMATION FOR CANDIDATES



**GCSE TWENTY FIRST CENTURY SCIENCE  
ADDITIONAL SCIENCE A A154  
BIOLOGY A A164**

**Practical Investigation**

Factors that affect the rate of fermentation.

**CONTROLLED ASSESSMENT  
INFORMATION FOR CANDIDATES (1)**

This assessment will be changed every year. Please check on OCR Interchange that you have the Controlled Assessment material valid for the appropriate assessment session.

- To be issued to candidates at the start of the task.
- Your quality of written communication will be assessed.
- The total number of marks for this Controlled Assessment task is **64**.
- This Controlled Assessment task is valid for submission in the June examination series only.
- This document consists of **2** pages. Any blank pages are indicated.

**Teachers are responsible for ensuring that assessment is carried out against the Controlled Assessment set for the relevant examination series (detailed above).**

**Assessment evidence produced that does not reflect the relevant examination series will not be accepted.**

## Information for candidates

**You are going to carry out an investigation into a factor that affects the rate of fermentation.**

### Background

The world production of ethanol is around 70 billion litres per year. Alcohol is important as a fuel, in alcohol beverages and as a feedstock for the chemical industry. By far the biggest use of alcohol is as a fuel.

Only around 5% of the ethanol produced is produced synthetically. The rest is produced by a biological process – fermentation. The main organism used to produce ethanol is a species of yeast called *Saccharomyces cerevisiae*. In the absence of oxygen, yeast respire anaerobically. It ferments various sugars to produce ethanol and carbon dioxide.

It is important that alcohol producers worldwide obtain maximum yields of alcohol in fermentation.

You will choose one factor and investigate this factor's effect on the rate of fermentation.

**GCSE TWENTY FIRST CENTURY SCIENCE  
ADDITIONAL SCIENCE A A154  
BIOLOGY A A164****Practical Investigation**

Factors that affect the rate of fermentation.

**CONTROLLED ASSESSMENT  
INFORMATION FOR CANDIDATES (2)**

This assessment will be changed every year. Please check on OCR Interchange that you have the Controlled Assessment material valid for the appropriate assessment session.

- To be issued to candidates **only** on completion of the data collection part of their Practical Investigation.
- Your quality of written communication will be assessed.
- The total number of marks for this Controlled Assessment task is **64**.
- This Controlled Assessment task is valid for submission in the June examination series only.
- This document consists of **3** pages. Any blank pages are indicated.

**Teachers are responsible for ensuring that assessment is carried out against the Controlled Assessment set for the relevant examination series (detailed above).**

**Assessment evidence produced that does not reflect the relevant examination series will not be accepted.**

These secondary data can be used as part of your Practical Investigation.

You can select the data that is useful for you.

Many breweries around the world are experimenting with the production of high alcohol beers.

Researchers in a Canadian brewery have been investigating fermentation in a strain of yeast, *Saccharomyces cerevisiae*, Strain 3001. When grown in a 10% glucose solution at 30°C, the researchers obtained the following results.

Time in hours	ethanol concentration in g/dm <sup>3</sup>
0	0
6	5
12	22
24	44
48	42
72	41
96	41
120	40

In a follow-up study, they investigated the ethanol production using the same type of yeast, grown in different concentrations of glucose solution at 30°C.

Some of their results are shown below.

Time in hours	ethanol concentration in g/dm <sup>3</sup>			
	10% glucose solution	20% glucose solution	30% glucose solution	40% glucose solution
0	0	0	0	0
6	5	4	2	0
12	22	17	7	5
24	44	48	34	22
48	42	52	67	37
72	41	54	83	42
96	41	53	84	42
120	40	51	85	41

## 3

Other researchers have been investigating the rate of yeast fermentation using different types of carbohydrate. Their results are shown below.

type of carbohydrate	mean rate of carbon dioxide production in $\text{cm}^3/\text{min}$
fructose	0.091
glucose	0.100
lactose	0.000
maltose	0.085
starch	0.000
sucrose	0.080

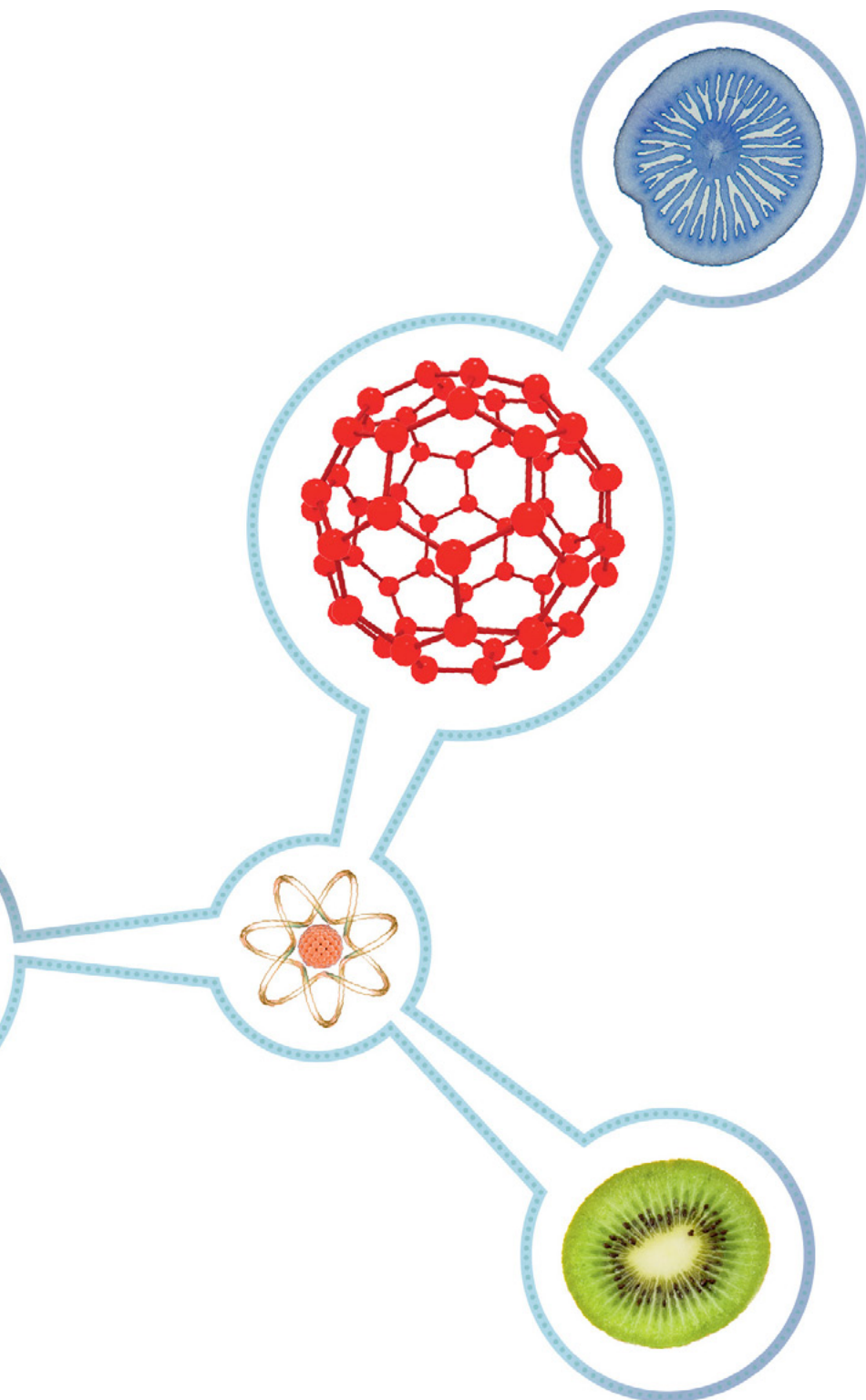
In a follow-up investigation on the fermentation of glucose, the following results were obtained.

% glucose concentration	mean rate of carbon dioxide production in $\text{cm}^3/\text{min}$
0	0.002
1	0.005
2	0.069
3	0.120
4	0.122
5	0.122

In a further investigation on the effect of temperature on the fermentation of glucose, the following results were obtained.

temperature in $^{\circ}\text{C}$	mean rate of carbon dioxide production in $\text{cm}^3/\text{min}$
0	0.002
10	0.062
20	0.120
30	0.235
40	0.237
50	0.202

# CANDIDATE SCRIPT AND COMMENTARY



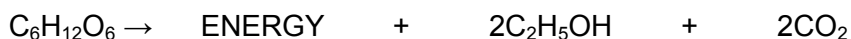
## CA Investigation Exemplar 1 - Biology - Fermentation - Script

### Investigation: Factors that affect the rate of fermentation

#### Introduction

In this activity I am going to monitor the growth of brewer's yeast, *Saccharomyces cerevisiae*. Yeast is a microorganism which under the correct conditions produces alcohol and carbon dioxide by the fermentation of sugars. Fermentation is a type of anaerobic respiration.

Yeast is a Fungus that lives on the surface of fruit. It feeds on sugars to obtain its energy, producing carbon dioxide and water. In a brewery fermenter, however, the oxygen runs out, and its respiration switches from aerobic to anaerobic respiration. Alcohol and carbon dioxide are produced:



Alcoholic fermentations are extremely important economically to many people, ranging from the manufacturer of alcoholic drinks, the baker, to the industrial chemist. In 2009, 73 billion litres of alcohol were produced worldwide [1]. All but 5% of which was from fermentation [2].

It is important that the producer of alcohol provides the optimum conditions for yeast to grow in order to obtain maximum alcohol production. This investigation sets out to investigate how one factor affects the rate of fermentation of yeast.

#### Factors that might affect yeast growth

Factors that might affect yeast growth are:

- Temperature
- Concentration of yeast
- Concentration of sugar
- Concentration of oxygen
- Concentration of ethanol
- Time for fermentation
- pH
- Light

#### Factor chosen: temperature

In this investigation, the effect of temperature on yeast growth will be monitored.

Temperature is one of the most important factors affecting the activity of all organisms. The production of alcohol and carbon dioxide and alcohol by yeast is a series of chemical reactions called anaerobic respiration or fermentation. So I would expect that as the temperature increases, the rate of reaction will also increase.

My hypothesis is therefore:

Changing the temperature will affect the rate of fermentation of yeast

I predict that as the temperature increases, the rate of fermentation will also increase. For many biological reactions, I have found out that there is a doubling of the rate or reaction for every 10°C [3], so I would expect the rate of fermentation at 20°C to be double that at 10°C, and the rate at 30°C to be double that at 20°C, etc. I predict that the fermentation rate will increase up to a certain temperature, however. Above 40-50°C, I would expect the enzymes in the yeast (which



control the rate of fermentation) to be denatured by the high temperatures, so the rate of fermentation will decrease.

### Strategy

I found several methods of measuring the rate of fermentation:

- Measuring carbon dioxide production [4]
- Measuring ethanol production [4]
- Counting the yeast cells [5]. The energy produced by anaerobic respiration (fermentation) is used for growth of yeast cells and cell division so the number of yeast cells is an indirect way of measuring the rate of fermentation.
- Another way is to filter off the yeast cells, wash them, then weigh the yeast cells.

I have decided to measure the rate of fermentation by the yeast cell counting method. The methods I have seen for measuring carbon dioxide production do not look reliable. It would also be difficult to set these pieces of equipment up at different temperatures and keep them at these temperatures for several days.

Measuring the rate of alcohol production may be the best method, but it is too difficult to do in the school lab.

Measuring the mass of the yeast cells would be difficult. This would yield inaccurate results because of the small masses involved (one yeast cell weighs only approximately  $0.02 \mu\text{g}$ ), so yeast cells from a sample of only  $5\text{-}10 \text{ cm}^3$  would be difficult to weigh.

I will set up yeast fermentations at a range of different temperatures, keeping other factors, i.e. light, concentration of yeast, concentration of sugar and pH constant. The range of temperatures we have chosen is  $0 - 50^\circ\text{C}$ . This is a range of temperatures over which most organisms live. Investigating a higher range would not be appropriate as commercial organisations that produce alcohol would not use high temperatures because of the energy inputs required to maintain the fermentations.

A suitable time over which to do the investigation is 10 days – most fermentations are complete inside this time.

The counting technique we will use uses a device called a haemocytometer, used in hospitals to count red blood cells.

### Risk assessment

Hazard	Risk	Reducing risk	Comments
Bunsen Burner	Of burning you.	Make sure that its used carefully, and close the air hole so that the flame can be seen when you're not heating things. Wear eye protection when using.	
Glassware (beakers, boiling tubes, pipettes, haemocytometer)	When it gets hot you could burn your hand or you could drop it break it and cut yourself.	Wait for glassware to cool, or use tongs to remove hot glassware from the incubator. Be careful when using the haemocytometer not to	Make sure the broken glass kit is available. Record accidents and seek medical help.

		break it or the coverslip (focus away from the slide).	
Yeast	A microorganism (fungus) but low risk.	Wipe up any spills. Wash hands after use.	
Glucose	Low risk.	Wipe up any spills. Wash hands after use. Wear goggles and a lab coat. Wash hands after use. Always check with HAZCARD and CLEAPSS before carrying out an investigation.	Make sure Hazcards are available.
Microscope	Chance of being blinded or getting eye damage from light.	Check that the microscope is on low illumination before looking down it.	
Incubator	Chance of electrocution.	Check for label on incubator to show that its been tested this year.	

### Materials and Methods

We set a number of boiling tubes. In each, we added a solution of glucose containing 200 g/ glucose per  $\text{dm}^3$  of water. The mixture was heated for 30 minutes to kill any microorganisms present. When the liquid was cool, I added 1 g of yeast to the mixture, and mixed it thoroughly. I then pipetted  $20 \text{ cm}^3$  of the mixture into each boiling tube (a pipette will measure the volume more accurately than a measuring cylinder). I think that this is a better method than adding yeast to individual boiling tubes. I am more likely to put an identical amount of yeast in each tube doing it this way.

The boiling tubes were placed at six different temperatures – 4, 13, 25, 30, 40 and  $50^\circ\text{C}$ . The samples at  $4^\circ\text{C}$  were placed in the fridge. The samples at  $13^\circ\text{C}$  were placed in store room. The others were placed in incubators at set temperatures. We set up repeats at each temperature to make sure that we got reliable results.

After ten days, we did the cell counts. First we gently shook the boiling tubes to mix up the contents. We then pipetted a little of each liquid onto a haemocytometer, and counted the yeast cells in ten  $1 \times 1 \text{ mm}$  squares, then took an average.

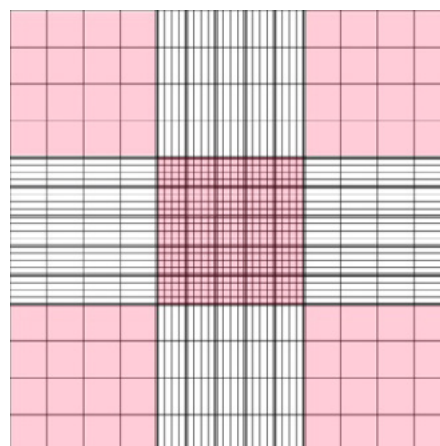
### My results

This table shows the cell counts in the 10 large cells counted over the two grids on the haemocytometer. From my results, I calculated the mean number of yeast cells per haemocytometer square. One or two of the results were very different – I think they were outliers, so I didn't include them in my calculations when working out the averages.

I counted cells in these squares on each of the two haemocytometer grids.

Image [6] from:

[http://en.wikipedia.org/wiki/File:Haemocytometer\\_Grid.png](http://en.wikipedia.org/wiki/File:Haemocytometer_Grid.png)



Temperature, °C	Yeast cell counts, per 1.0 x 1.0 x 0.1 mm <sup>3</sup> 'cell' of haemocytometer										Mean count per cell
	1	2	3	4	5	6	7	8	9	10	
4	37	28	38	43	45	43	38	39	47	44	40
13	123	122	100	130	120	124	105	127	103	111	117
25	634	627	612	640	638	606	523	590	537	520	593
30	701	683	743	707	900	850	770	695	587	756	721
40	810	747	927	673	776	712	827	696	721	698	740
50	8	9	12	8	12	2	12	12	8	10	10

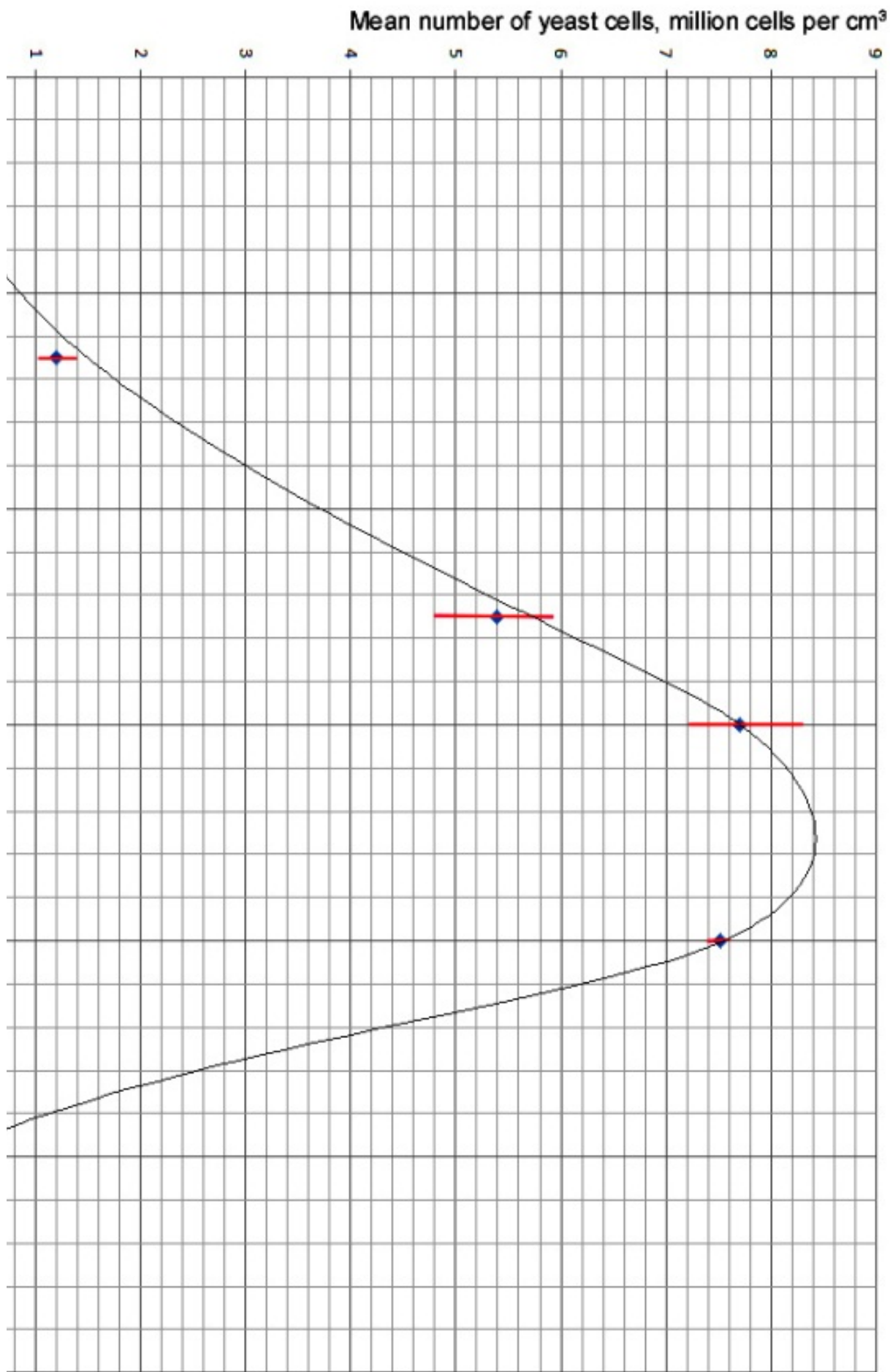
The volume of the small haemocytometer cells is  $1.0 \times 1.0 \times 0.1 \text{ mm}^3 = 0.1 \text{ mm}^3$

So I then calculated cell counts per  $\text{cm}^3$  by multiplying each figure by 10 000.

Temperature, °C	Mean yeast cell count per 0.1 mm <sup>3</sup>	Mean yeast cell count per cm <sup>3</sup>
4	40	400 000
13	117	1 170 000
25	593	5 930 000
30	721	7 210 000
40	740	7 400 000
50	10	100 000

We repeated the investigation at each temperature. The results are below (I have not written out all the results – just the mean number of yeast cells per  $\text{cm}^3$ ).

Temperature, °C	Results 1 Yeast cell count, millions of cells per cm <sup>3</sup>	Results 2 Yeast cell count, millions of cells per cm <sup>3</sup>	Results 3 Yeast cell count, millions of cells per cm <sup>3</sup>	Mean yeast cell count, millions of cells per cm <sup>3</sup>
4	0.40	0.25	0.22	0.29
13	1.17	1.40	1.02	1.20
25	5.93	4.81	5.46	5.40
30	7.21	8.33	7.54	7.70
40	7.40	7.60	7.55	7.52
50	0.10	0.15	0.18	0.14



5

## Evaluation

The results we obtained were repeatable. The readings for 4, 13, 40 and 50°C were very close together, as shown by the error bars on my graph. The results for 25 and 30°C were not quite as consistent, and the error bars were longer. Also, we left some readings out at these temperatures. When doing cell counts with a haemocytometer, the World Health Organisation [7] says that for a valid test, the results of the two counts should be within 20% of the mean value.

In any scientific investigation in the laboratory, the results will always vary slightly from one group of researchers to another. This is called random error. Other kinds of error are down to the scientist and can be eliminated. These are often due to the equipment or technique used.

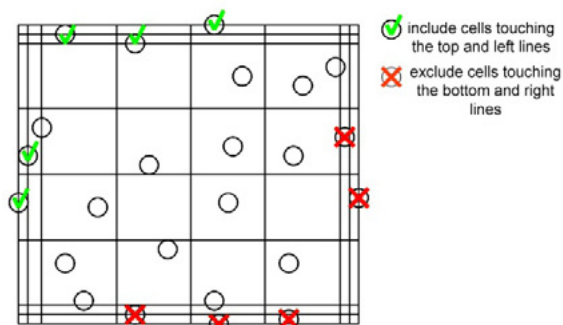
When we placed the boiling tubes in the incubators at different temperatures, the contents of the boiling tubes would not reach the temperature immediately. This problem should have been eliminated, though, as we left the yeast to grow for 10 days. But it could have meant that at 50°C, when I expected no growth, the yeast could have fermented before the contents of the tube got up to the temperature.

I think a major problem though was the thorough mixing of the contents of the boiling tubes before pipetting some of the liquid onto the haemocytometer. We were careful that we did this, but other groups, who got different results, might not have been as careful.

The counting of the cells was also difficult. It is important to be consistent when counting cells on the boundary of a square. The way to do this is to include cells touching the top and left of the grid, but don't include the cells touching the bottom and right side.

Diagram from [8]

<http://www.hpacultures.org.uk/technical/ccp/cellcounting.jsp>



When samples were placed on the haemocytometer, air bubbles would have made the volume of liquid trapped under the coverslip less than  $1 \times 1 \times 0.1 \text{ mm}^3$  and the multiplication factor (10 000) would have magnified the error.

Some groups of students may also have made errors when counting the cells, or for cells on the edge of squares, been inconsistent as to whether to include these or not.

When looking at other groups' results, it was the 50°C results that varied most. When we made our count, there appeared to be a lot of what looked like dead cells or bits of cells. We did not include these, but I think that other groups might have included these in their counts. We could have added methylene blue to our haemocytometer. This will show up yeast cells that are dead (blue) and those that are living (colourless) to improve the validity of our results.

Also, the temperatures in the incubators and storeroom could have fluctuated. We could have set up a datalogger to see if these varied.

## Review

My results, along with the results of other groups in the class and some of the OCR secondary data, increase my confidence in my hypothesis and prediction.

**My hypothesis:****Changing the temperature will affect the rate of fermentation of yeast**

**I predict that as the temperature increases, the rate of fermentation will also increase.**

As the temperature increases up to around 35°C, the numbers of yeast cells produced over a 10 day period increases, indicating that the rate of fermentation increases. The rate of fermentation was greatest between 30°C and 40°C. This agrees with the results from the other groups, showing that ours are reproducible, and also with the OCR secondary data [9]:

Here, the rate of fermentation is greatest at 40°C, as shown by the rate of carbon dioxide production. The secondary data also suggest that there is a doubling of fermentation rate every ten degrees between 10 and 30°C. I did not find this in my results, but when I did my research, I discovered that "a 10° temperature rise doubles reaction rates" is just a rule of thumb, not a law of nature [10]."

temperature in °C	mean rate of carbon dioxide production in cm <sup>3</sup> /min
0	0.002
10	0.062
20	0.120
30	0.235
40	0.237
50	0.202

The secondary data also suggest that some fermentation takes place at 50°C. We found evidence of very little. Yeasts, as do most living things, grow more quickly as cell or body temperature increases, and have an optimum temperature of around 37°C, because this is the temperature at which their enzymes work best. I would expect that at temperatures higher than 50°C in yeast, the enzymes in yeast cells are denatured and the yeast dies. I think that all we could see was cell debris – this is dead yeast cells, but I think other groups counted these as living cells. The methylene blue test would help us to find out if they were dead or alive. At low temperature, molecular collisions are slower, so the enzymes used for respiration will not be working as quickly and the yeast will not grow and reproduce as quickly.

Theoretically, 37°C should be the best temperature for producing alcohol. Brewers do not use such a high temperature. Economically, it would also be too expensive, and at high temperatures, some of the alcohol would be converted into fruity chemicals called esters [10].

I could improve my investigation by monitoring yeast cell numbers over several days, and not just taking a count at the end. It is possible that the rate of fermentation is not constant over the ten day period. This is supported by some of the OCR secondary data [8].

time in hours	ethanol concentration in g/dm <sup>3</sup>
0	0
6	5
12	22
24	44
48	42
72	41
96	41
120	40

Also, I used glucose in my investigation, and the OCR secondary data show that the rate of fermentation in yeast is different when the yeast is using different sugars. The data show that glucose produces the fastest rate of fermentation (0.100 cm<sup>3</sup> carbon dioxide per minute in the study), followed by fructose (0.091 cm<sup>3</sup> carbon dioxide per minute in the study), maltose (0.085 cm<sup>3</sup> carbon dioxide per minute in the study), then sucrose (0.080 cm<sup>3</sup> carbon dioxide per minute in the study). No fermentation is obtained with the sugar lactose or with starch. I could extend my investigation to see if my hypothesis is also true when yeast is using these other sugars for respiration.

## References

- [1] Geiver L. and Jessen Holly. International Ethanol Report: 2010. <http://www.ethanolproducer.com/articles/6696/international-ethanol-report-2010>. 2010.
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## Commentary - Investigation Title: Fermentation

Strand/Aspect	Mark	Comments
<b>S(a)</b> - formulate a hypothesis or prediction	7	The candidate has used scientific knowledge to list relevant factors and to propose a testable hypothesis and quantitative prediction. However the factors are not fully considered and some are irrelevant. This section of the report is comprehensive and clear, with no significant errors in spelling, punctuation or grammar. Scientific terminology is used correctly; Criteria for 6 are fully met, but criteria for 8 only partially. 7 marks awarded.
<b>S(b)</b> - design of techniques and choice of equipment	8	The equipment, procedure and range of data selected are all appropriate and choices justified. The data recorded is valid and precise. The risk assessment is complete with ways of reducing risk identified. 8 marks awarded.
<b>C</b> - range and quality of primary data	7	The range of data collected is suitable to the task of testing the hypothesis. Repeats are carried out. The data is of high quality. Some checking is apparent in the repeats, but the outliers do not appear to have been checked and they are not dealt with appropriately (In this case they should be included in the averages). Not all raw data is recorded in the report. Criteria for 6 are fully met, but criteria for 8 only partially. 7 marks awarded.
<b>A</b> - revealing patterns in data	8	The graph is correctly drawn with sensible axes and scales. The line of best fit is appropriate and the spread of data is clearly shown. 8 marks awarded.
<b>E(a)</b> - evaluation of apparatus and procedures	6	Limitations to the procedure used are clearly identified and some suggestions are made. However there is little detail in the suggested improvements. No criteria for 7-8 met. 6 marks awarded.
<b>E(b)</b> - evaluation of primary data	8	Outliers are identified (although it is questionable whether these are truly outliers, acceptable at GCSE level). A correct attempt is made to explain the outliers in terms of random variation. The degree of scatter and general pattern are used to critically consider the evidence. 8 marks awarded.
<b>R(a)</b> - collection and use of secondary data	7	The extent to which secondary data supports the hypothesis is explained well. A possible problem with the secondary data from other groups is identified but there is no other consideration of the reliability of secondary sources. A full range of secondary sources is used; data from other groups, data provided by OCR and Internet/textbook sources. Most of these are fully referenced. The criteria for 6 marks are fully met; however the criteria for 8 marks are not fully met. 7 marks awarded.
<b>R(b)</b> - reviewing confidence in the hypothesis	7	The candidate has used relevant science to explain how the patterns shown in the data support the hypothesis. The suggestion concerning collecting extra data is limited and lacks detail. The report is comprehensive and logically sequenced, with effective use of scientific terminology. The spelling, punctuation and grammar are good. The criteria for 6 marks are fully met; however the criteria for 8 marks are not fully met. 7 marks awarded.
<b>Total:</b>	<b>58/64</b>	



