Practical M3 ENZYME ACTIVITY

INTRODUCTION

An enzyme is a molecule found in living cells that is capable of speeding up a chemical reaction without being permanently changed itself. Catalse is an enzyme found in most living cells, including yeast, and it causes hydrogen peroxide to break down into water and oxygen according to the following equation:

Hydrogen peroxide $\xrightarrow{\text{catalase}}$ Water + Oxygen

$2H_2O_2 \longrightarrow 2H_2O + O_2$

If small discs are cut from filter paper, immersed in yeast suspension and then dropped into a solution of hydrogen peroxide, a reaction will occur producing bubbles which will adhere to the paper and carry the discs to the surface of the liquid The faster the rate of reaction occurs, the quicker the discs will rise.
To measure the rate of catalase activity in this practical, you are going to measure the time it takes for the paper discs to rise to the surface of liquid in a beaker.

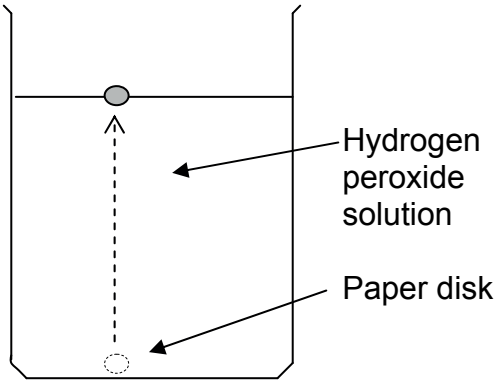
Part A Validating the technique

MATERIALS REQUIRED

Cork borer or hole punch (~5mm)	filter paper
Yeast suspension	Forceps
50 mL measuring cylinder	Distilled water
Stop watch	0.1% hydrogen peroxide solution

Solutions of hydrogen peroxide with varying pH as provided (see Teaching Notes)

METHOD



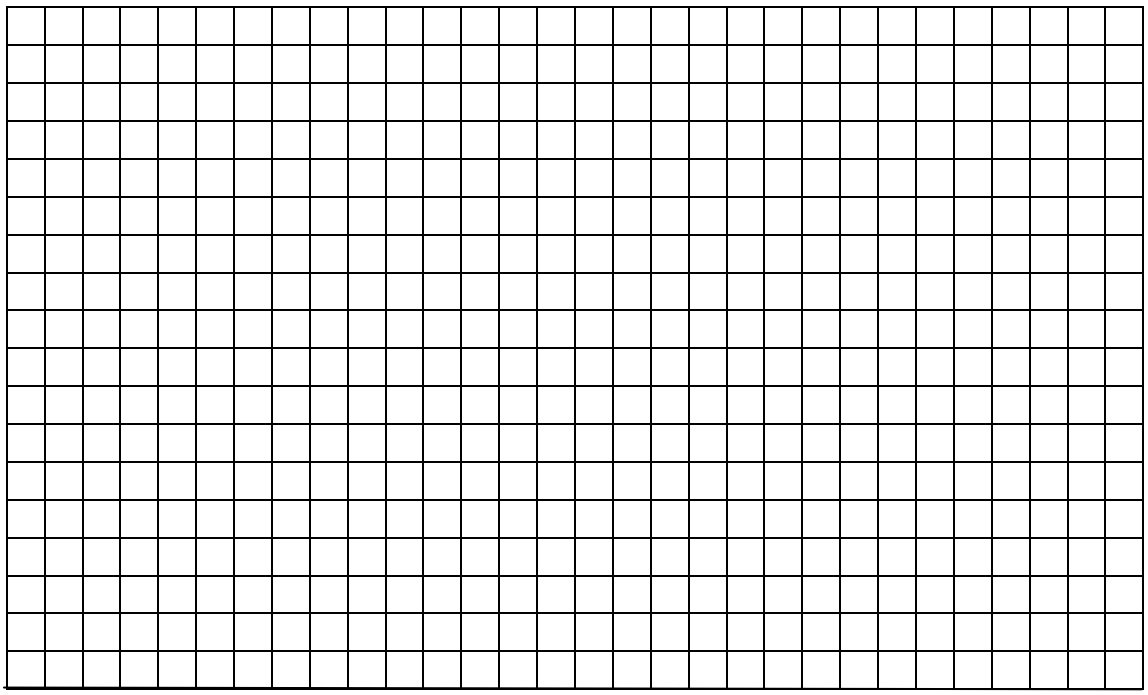
1. Make up a suspension of yeast by adding about 10g of dry yeast to 100mL warm (~30^0C) water and allowing to stand for 10 minutes.
2. Measure 40 mL of 0.1% hydrogen peroxide solution into a small beaker. (*More information about how to do this is provided in the Teaching Notes*)
3. Use a hole punch or cork borer (approx 5 mm in diameter) to cut about 30 disks from good quality filter paper. Try to avoid touching these disks with your fingers or contaminating them in any other way.
4. Dip a single disk in the yeast suspension, shake of excess yeast suspension and then drop it into the hydrogen peroxide solution and start the stopwatch. Measure the time taken for the disk to rise to the surface and record this is a suitable data table (see step 9). *(Although it is simpler to do the disks one at a time, you may be able to do several at a time provided that this does not increase errors in your technique and observations.)*
6. Repeat this technique at least 5 times or until you obtain consistent data.
7. From the data it is possible to work out the average time taken (in seconds) for the discs to rise

in each beaker. To estimate the rate of the reaction, calculate the reciprocal of the average time and then convert to scientific notation. This will represent the rate of activity of catalase in breaking down the substrate hydrogen peroxide.

Example:

Average time taken for the discs to rise	= 43 seconds
Estimate of the rate of reaction	= $1/43$ sec^{-1}
	= 0.023 sec^{-1}
In scientific notation	= 2.3×10^{-2} sec^{-1}

8. Now repeat this technique with solutions of different pH as provided in your laboratory.
9. Design and prepare a table that you can use to record the data in the space provided below. The table should include individual disc times and average rates of reaction for each beaker. This data can be used to construct a graph using the grid provided.



10. **Discuss** your results using the guidelines given and state any **conclusions** that you can reach.

Part B 'Design your own' Practical

At the discretion of your teacher you may now be required to use the technique and knowledge from Part A to Design, Conduct and Report on your own practical investigation of another factor may affect catalase activity.

You will need to:

- prepare an **Abstract** after you have finished your experiment
- write an **Introduction**
- List the **Materials** you will need and explain the **Method** you will use
- Record your **Results** in whatever form(s) you think appropriate
- Write a **Discussion** of your method and results
- State a **Conclusion** about the validity or otherwise of your hypothesis

You may refer to the Assessment Table for more detail about the relevant Intended Student Learnings and suggested marks for each of these headings. Feel free to paste in sheets of paper if you prefer to use a Word Processor and/or label and securely attach additional sheets if you wish.

ABSTRACT

INTRODUCTION

METHOD

RESULTS

Pattern of results

DISCUSSION and CONCLUSION

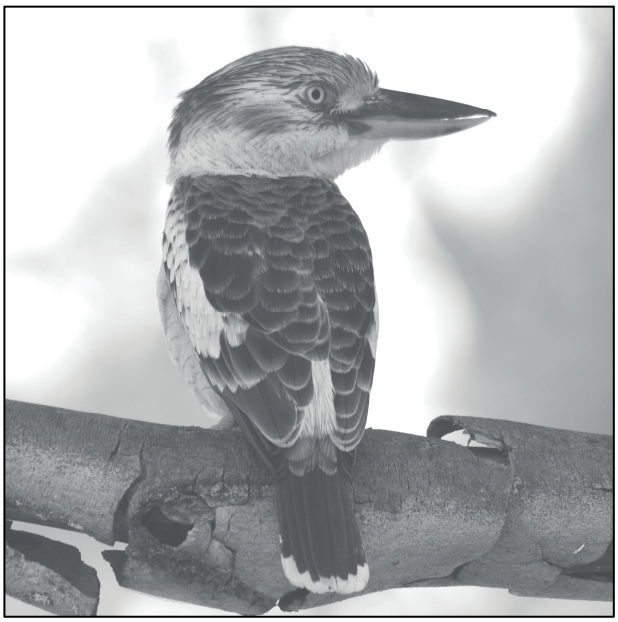
Practical M3 Specific Skills Checklist

Skills	TEACHER USE	
	Comments	Check
Techniques and choice of apparatus • Correct measurement of yeast and water • Accurately cutting disks • Using trial and error to obtain consistent amount of yeast on the disks •		
Team Work • Work collaboratively to design and conduct experiment • Equitable distribution of tasks after negotiation with other group members • Complete tasks within the time allocated •		
Safety considerations • Follows instructions as they relate to laboratory safety procedures • Safe handling of relevant apparatus and chemicals • Use of skin/clothing/eye protection as appropriate • Safe behaviour handling laboratory apparatus • Mindful of activity of others in the lab • Appropriate handling of pH solutions •		
Observations and measurements recorded • Accurate timing of disks rising to appropriate number of significant figures • Appropriately discarding outliers • Other relevant qualitative observations recorded •		
Ethical practices • Correct disposal of hazardous materials with regard of environmental impact • Maintain confidentiality and authenticity of data • Acknowledge the work of other people •		

SACE STAGE 2 BIOLOGY

Practical Manual

Version 15



Cover photo: Blue wing Kookaburra (Dacelo leachii) (male)
Photo courtesy of Colin Theakstone

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TABLE OF CONTENTS

SECTION		Page
Preface		4
Syllabus extracts		5
Practical Skills		
Assessment tables		13
'Scientific Method' Exercise		13
Guidelines for practical reports		16
THE PUZZLE OF THE PALE PUMPKINS		15
Guidelines for writing a report of your own Investigations		18
Practical M1	TESTING FOR MACROMOLECULES	19
Practical M2	NUCLEIC ACIDS	22
Practical M3	ENZYME ACTIVITY	26
Practical C1	OBSERVING CELLS	36
Practical C2	MITOSIS	41
Practical C3	RATE OF DIFFUSION	45
Practical O1	KIDNEY STRUCTURE AND FUNCTION	54
Practical O2	RATE OF PHOTOSYNTHESIS	59
Practical O3	RATE OF FERMENTATION	67
Practical E1	NATURAL SELECTION MODELLING	75
Practical E2	SUCCESSION (A second-hand data exercise)	81
Practical E3	FACTORS AFFECTING GERMINATION	88

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PREFACE

The Biology Practical Manual was first published in 1995 and in every year since then has been modified to meet the changing needs of teachers and students doing the successive Year 12 (Stage 2) SACE Biology course. In 2014 we celebrate the 20th annual edition of this Manual. The advent of the 'new SACE' provides another opportunity to extensively revise the content and format of the practical activities in a way that meets the needs of teachers and students and in a form that will assist with the **moderation procedures** that were introduced in Stage 2 Biology in 2011.

In order to do this we have worked closely with other experienced Senior Biology teachers and

- Devised an '**Assessment Design Overview'** table in which we have shown how each activity can be used to teach and assess the **6 Learning Requirements** and meet the special features of the **4 Assessment Design Criteria (ADC).** Teachers can then use this information to prepare their particular Assessment Plan as required by the SACE Board.

- Revised some familiar practicals providing some **choice** for schools and teachers to accommodate the various learning needs of students. Schools will also have a choice concerning which practicals they use for assessment purposes.

- Devised Assessments Tables for each practical which include the traditional headings used in a Science report (Method, Results, Discussion, Conclusion etc.) but also including the special features of the **Assessment Design Criteria** with reference also to the **Intended Student Learnings**.

- Devised an '**Assessment Record'** table which can be used by teachers and students to record and collate the marks obtained for each of the special features of the Assessment Design Criteria and provide evidence of **Performance Standards** as required in the moderation process. Space is also provided for comments.

- Following clarification of SACE requirements and feedback from colleagues during 2011, we have added a '**Specific Skills Checklist**' for the final Practical in each major Topic for this version (2012) of the Manual. These may assist in the allocation of performance standards for student's practical skills. We would appreciate any comments about the usefulness or otherwise of this addition and any other suggestions teachers or students may have for improvement.

- Revised the information in the free copy of the 'Teaching Notes' booklet which should have come with your school order of the Manuals but is otherwise available from the SASTA website (www.sasta.asn.au). IF THIS HAS NOT BEEN RECEIVED, OR IF YOU CANNOT ACCESS THE SASTA WEBSITE, SCHOOLS SHOULD CONTACT SASTA DIRECTLY (Ph. 8346 6922).

- We have done our best on the basis of the information available to schools but no doubt some SACE requirements will change over time so we will appreciate any feedback and plan to make further changes as necessary in the future.


Alan Crierie and David Greig October 2013

Practical Activity		Learning Requirements						Assessment Design Criteria			
Topic	Practical	identify and formulate questions, hypotheses, concepts, and purposes that guide biological investigations (© *SACE Board 2011*)	design and conduct individual and collaborative biological investigations	manipulate apparatus and use technological tools and numeracy skills to obtain, represent, analyse, interpret, and evaluate data and observations from biological investigations	select and critically evaluate biological evidence from different sources and present informed conclusions and personal views on social, ethical, and environmental issues	communicate their knowledge and understanding of biological concepts using appropriate biological terms and conventions	demonstrate and apply biological knowledge and understanding of concepts and interrelationships to a range of contexts and problems, including by presenting alternative explanations	**Investigation (I)**	**Analysis and Evaluation (AE)**	**Application (A)**	**Knowledge and Understanding (KU)**
Macromolecules	1					✓	✓			2, 3	1, 3
	2			✓		✓	✓			2, 3	1, 3
	3	✓	✓	✓		✓	✓	1, 3, 4	1, 2	2, 3	1, 3
Cells	1			✓		✓	✓			2, 3	1, 3
	2			✓		✓	✓			2, 3	1, 3
	3	✓	✓	✓		✓	✓	1, 3, 4	1, 2	2, 3	1, 3
Organisms	1			✓		✓	✓			2, 3	1, 3
	2			✓		✓	✓	1, 3, 4	1, 2	2, 3	1, 3
	3	✓		✓		✓	✓		1, 2	2, 3	1, 3
Ecosystems	1			✓		✓	✓			2, 3	1, 3
	2				✓	✓	✓			2, 3	1, 3
© S.T.A.R. 2010. Unauthorized copying prohibited.	3	✓	✓	✓		✓	✓	1, 3, 4	1, 2	2, 3	1, 3

Practical C3 RATE OF DIFFUSION

BACKGROUND

Diffusion is the nett movement of particles from regions of high concentration to regions of low concentration. It is one of the major processes used by cells to supply them with the essential requirements – for example water, oxygen and nutrients and to excrete wastes such as urea and carbon dioxide.

The rate of diffusion is influenced by a number of factors including the concentration gradient, temperature and the size and chemical composition of the diffusing molecules. Another factor that directly affects the rate of diffusion is the surface area to volume ratio of the cell.

Part A Validating the technique

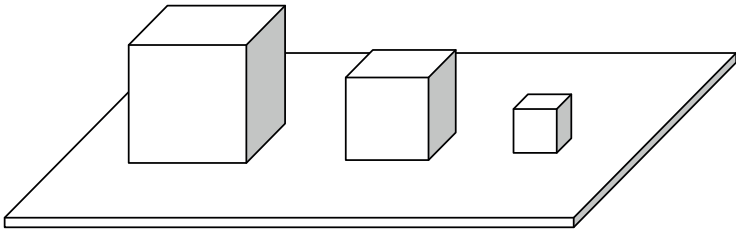
AIM

The Aim in this experiment is to use agar blocks to investigate the effect of surface area to volume ratio on the rate of diffusion.

MATERIALS REQUIRED (per group)

phenolphthalein agar (see teaching notes for instructions)
knife (for cutting agar)
white tiles
ruler
100 mL measuring cylinder
paper towelling
spoon (for removing agar from the acid)
3 x 250 mL beakers
dilute (0.1M) sulfuric acid

METHOD



1. Obtain an agar block that is sufficient for you to cut 3 cubes with the following dimensions: 1cm, 2cm and 3cm.
2. Measure 150mL of the dilute sulfuric acid in to each of the 250 mL beakers.
3. Place 1 cube into each beaker and begin timing. The acid in solution will diffuse into the agar and the rate of diffusion can be measured by the amount of decolouration occurring in the cube. (Phenolphthalein is an indicator that turns colourless in the presence of acid). Leave the cubes in the acid for 10 minutes.
4. Use the spoon to carefully remove each cube from the beaker and blot it dry by placing the cube on paper towelling.
5. Cut each cube in half and measure the dimensions of the coloured section remaining.
6. Complete the following measurements and calculations and enter the data in the tables provided in the Results section for each cube.
    - Surface area, volume, and the surface area to volume ratio.
    - The dimensions of the coloured section remaining
    - The volume of the coloured section remaining
    - The Volume diffused
    - The % volume diffused
7. Repeat the above procedures to validate your results.

RESULTS

Record your results in the tables below.

Table A

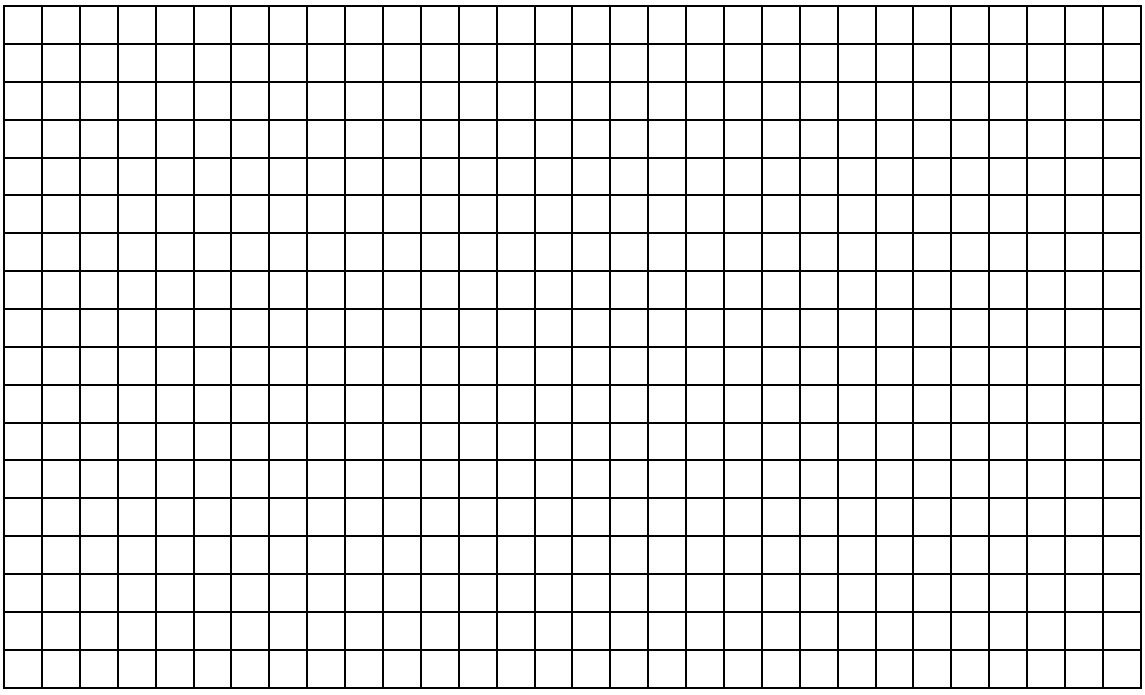
Calculations of the surface area to volume ratio of each of the cubes

Size of the cube	Surface area (cm^2)	Volume (cm^3)	Surface area/volume ratio
1 cm			
2 cm			
3 cm			

Table B

Results of the diffusion of acid into the agar after 10 minutes.

Size of the cube	Dimensions of the coloured section remaining (cm)	Volume of the coloured section remaining (B) (cm^3)	Initial volume of the cube (A) (cm^3)	Volume diffused (A – B) (cm^3)	% volume diffused (A – B)/A x 100/1
1 cm					
2 cm					
3 cm					



Part B 'Design your own' Practical

At the discretion of your teacher you may now be required to use the technique and knowledge from Part A to Design, Conduct and Report on your own practical investigation of this or another factor that may affect diffusion in agar.

You will need to:

- prepare an **Abstract** after you have finished your experiment
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You may refer to the Assessment Table on the last page for more detail about the relevant Intended Student Learnings and suggested marks for each of these headings. Feel free to paste in sheets of paper if you prefer to use a Word Processor and/or label and securely attach additional sheets if you wish.

ABSTRACT

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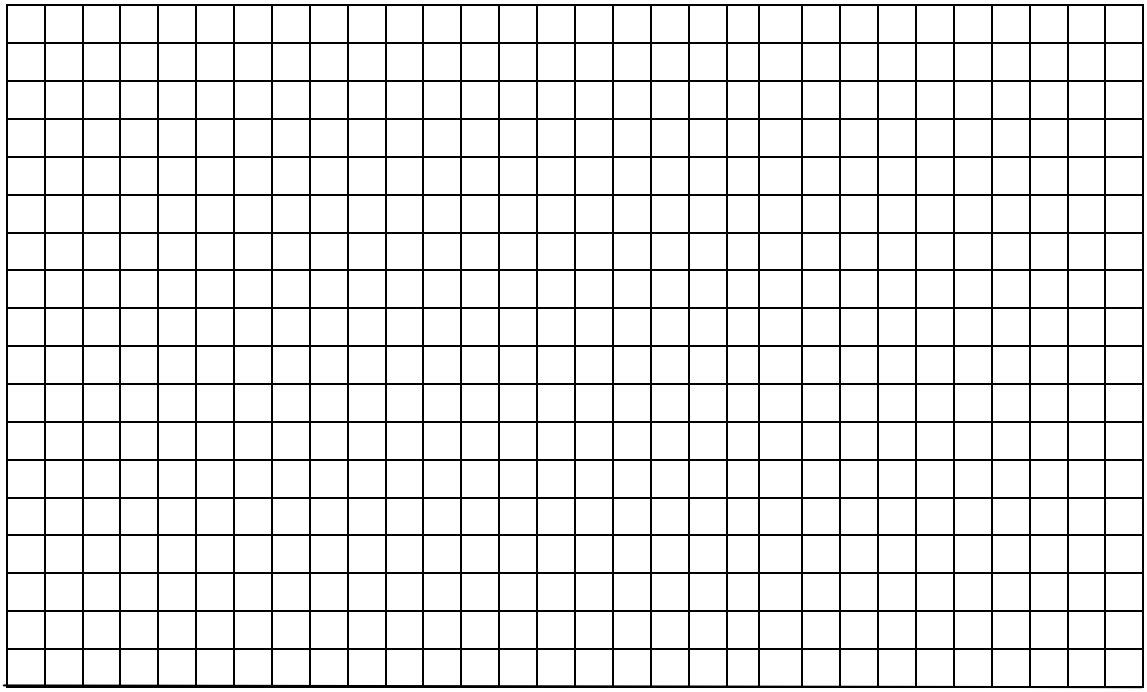
RESULTS



Pattern of results

DISCUSSION and CONCLUSION

Practical C3 Specific Skills Checklist

Skills	TEACHER USE	
	Comments	Check

Techniques and choice of apparatus
• Accurately cutting agar blocks
• Correct measurement of
  o dimensions and calculation of SA/V ratios
  o acid volume
  o the time of immersion of blocks in acid
•		

Team Work • Work collaboratively to design and conduct experiment • Equitable distribution of tasks after negotiation with other group members • Complete tasks within the time allocated •		
Safety considerations • Follows instructions as they relate to laboratory safety procedures • Safe handling of relevant apparatus and chemicals • Use of skin/clothing/eye protection as appropriate • Appropriate care taken with the use of acid •		
Observations and measurements recorded • Accurate measurement of coloured/uncoloured portions to appropriate resolution • Correct calculation of % volume diffused • Recording qualitative observations •		
Ethical practices • Correct disposal of hazardous materials with regard of environmental impact • Maintain confidentiality and authenticity of data • Acknowledge the work of other people		

Practical C3 ASSESSMENT TABLE

A. D. C.	Report headings and Intended Student Learnings *In their laboratory work and their written report, students should provide evidence of how well they have achieved the following student learnings:*	Teacher check and comments (related to Performance standards)	Suggested max. mk	Actual max. mk	Mark obtained
KU3	**Abstract** • Write a (concise) report of an investigation that includes a description of its purpose and procedure, results, analysis, interpretation, and conclusions.		5		
I1	**Introduction** • State the purpose of the investigation or experiment. • State the key ideas or background biology • State a testable hypothesis • Formulate a question for an investigation • Suggest possible investigations to test the question		6		
I1 I3,4	**Materials and Methods** • Identify and classify variables (independent and dependent) • Identify any factors that are deliberately held constant • Design and carry out investigations or experiments • Describe the steps of an investigation or procedure • Draw or interpret diagrams of the apparatus • Collect data using measurements that can be reproduced consistently. • Select an instrument of appropriate resolution		10		
I4	**Results** • Record and analyse observations • Use measurements to an appropriate number of significant figures • Distinguish between quantitative and qualitative evidence. • record careful and honest observations • use a table to present data • Plot a graph of dependent variable versus independent variable • Draw a line of best fit through a series of points on a graph		7		
AE1 AE2	**Discussion** • Identify sources of errors and uncertainty • Distinguish between random and systematic errors • Explain the importance of increasing the number of samples • Explain the importance of repeating a practical investigation • Determine which of two or more sets of measurements is most reliable • Use averages or graphing as a means of detecting or minimising random errors. • State which result of two or more experiments is most accurate • Describe a pattern observed in the results • Using the scatter in the graphs to compare the random errors. • Analyse and evaluate information, interpret results and suggest improvements		10		
AE1	**Conclusion** • Write a conclusion that is based on the results of an investigation		2		
A2 A3	**Application skills** • Use biological terminology, conventions, and symbols • Use concise language and graphics to present information. • Work ethically with animals • Report accurately and honestly • Recognise hazards and work safely • Demonstrate initiative and focused work skills • Negotiate procedures with the other members of the team • Perform the role of a team member.		5		
KU1 KU3	**Communication** • Demonstrate knowledge and understanding of biological concepts • Communication of knowledge and understanding of biology		5		
	© S.T.A.R. 2010. Unauthorized copying prohibited.	***TOTALS***	50		