Teacher Resources

This brief package is adapted from the Essentials Stage 1 Biology Workbook. It should be used in conjunction with the SACE Subject Outline practical requirements to help develop student skills in Deconstructing, Designing, Conducting and Writing a formal report about a practical experiment.

This 'D&D' package contains (in order)

1. A simple 'Deconstruction and Design' exercise based around factors affecting the rate of osmosis (refer to SIS2.4 on p208-210).
2. A simple theoretical exercise that could be undertaken to develop student skills on the 'Deconstruction' of a Probem for which the outcome is uncertain.
3. Advice about ways to
   - Deconstruct a problem.
   - Design an Investigation.
   - Write a Practical Report.

Deconstruction and Design - Factors affecting the rate of osmosis

Introduction

All living organisms consist of cells and all cells are surrounded by a membrane. One of the major functions of the membrane is to regulate the passage of materials into and out of the cell. The diffusion of water across a partially-permeable membrane is called osmosis.

Possible factors for investigation

There are many factors that affect the rate of osmosis in living organisms.

Several possible problems might arise including:

- What is osmosis and why is it necessary in organisms?
- Does a change in temperature affect the rate of osmosis?
- Does the pH of the solution affect the rate of osmosis?
- Does the concentration gradient affect the rate of osmosis?
- Do different tissues have different rates of osmosis?
- Do saline soils affect the impact on the rate of osmosis with plant tissue?
- Does the SA:V ratio affect the rate of osmosis (i.e. the size and shape of the tissue used)?

With the direction of your teacher you will then you will Deconstruct the problem and then Design and conduct an experiment to determine the effect of one factor on the rate of osmosis.

A Deconstructing the problem

1. Research the process of osmosis and its relevance to organisms, focussing particularly on the factor you are interested in investigating.
2. Explore factors that impact on the rate of osmosis such as those mentioned above.
3. Make informed decisions about determining experimentally how one factor that might affect the rate of osmosis could be measured.
4. Explore and address the health and safety risk factors involved.
5. Select the one factor and develop a method to test the effect of changing this on the rate of osmosis.

B Designing your own investigation

Use the guidelines from the General Appendix of this Workbook and/or the SACE Subject Outline to help you Design your own investigation.

Justify the decisions you have made about such factors as:

- the type of tissue you have chosen
- the independent and dependent variables
- how the independent variable will be changed
- how the dependent variable will be measured (a blank data table should be included)
- what variables will be held constant and why
- the variable factors that may not be able to be held constant or controlled and consider their potential impact.

C Conducting the investigation

Your teacher will set out guidelines, including health and safety considerations, about how this is to be achieved.

D Writing a report

The requirements of the practical report are to be found in the SACE Subject Outline. In particular, the word count for the Introduction, Analysis of results, Evaluation of method/procedure and Conclusion should not exceed 1500 words in Stage 2. The Deconstruction and Design, including the method chosen and the justification of the plan of action must be a maximum of four sides of an A4 page and needs to be attached to the practical report.

? Deconstruction

Introduction

There are three aspects of looking at and investgating a problem as follows:

- **Deconstructing** the Problem
- **Designing** an investigation based on your findings
- **Conducting** the investigation and preparing a report of it.

The activity presented here only involves the theoretical exercise of Deconstructing the problem to develop, in a formative manner, your knowledge and skills. It is important however that this should be able to lead on to the Design and implementation of a Scientific Investigation.

With direction from your teacher, present a one-page Deconstruction of one of the following Problems:

- Does the type of hand wash affect how well the growth of bacteria is prevented?
- Does the species of yeast affect the rate of alcohol fermentation?
- Does the age of the yeast (i.e. use-by-date) affect the rate of alcohol fermentation?
- Does the age of plant tissue affect the rate of osmosis?
- Does the lunar cycle affect bacterial growth?

Use the following steps as a guide to the process of Deconstruction

1. Research the particular Problem you are focussing on and interested in investigating.
2. Explore factors that impact on this particular problem.
3. Make informed decisions about determining experimentally how deliberately changing one factor could impact on the particular problem.
4. Explore and address the health and safety risk factors involved.
5. Select the one factor and develop a method to test the effect on the particular problem.

Planning Notes

Important note to teachers and students: *the following pages are only intended as possible options and resources that may be helpful in teaching and assessing the SACE Stage 2 Biology course.*

The definitive documents are to be found on the SACE website:

<https://www.sace.sa.edu.au/web/biology/stage-2/support-materials>

Science Inquiry Skills (SIS)

Deconstructing a Problem

Introduction

A Problem is a question that is asked for consideration or inquiry. Problems may be raised because of direct observation or may be prompted by discussion or research.

The investigation of a Problem can take various forms. One is to employ scientific methods to collect data to formulate and justify a conclusion. This involves developing a valid procedure that uses scientific equipment, interpreting and analysing the results, and critically evaluating the evidence obtained in order to justify a conclusion.

The process used to determine the best way to investigate a problem is called Deconstruction. This involves breaking the problem down so that a range of aspects that could possibly affect the outcome of the Investigation can be explored, taken into account, and properly discussed. By Deconstructing a problem, the most appropriate procedure to use to investigate it can then be Designed, and conducted.

It is usual to start with a particular 'Problem', or 'Question'.

For example:

'Does the type of honey affect its antibacterial properties'?

One approach could be to consider questions such as those listed below.

- Research the different types of honey and what makes them different. Can they be classified into any groups?
- Research the types of antimicrobial agents or chemicals found in honey e.g. antioxidants or phenolic compounds.
- Explore the availability of different types of honey that you may wish to investigate e.g. what is Manuka honey?
- Explore the types of bacteria that could possibly be used and the safety requirements.
- Decide how you might make informed decisions about measuring the effect of the type of honey on bacterial growth.
- Explore the healing properties of honey e.g. for wounds, ulcers
- Do darker honey varieties have greater antimicrobial power than lighter varieties.
- Investigate the osmotic and pH effects of honey on microbial growth
- Investigate how to properly culture bacteria.

These and other such questions may be considered to be various 'aspects' related to the problem being considered.

- Brainstorm with others, to record questions and points whilst you consider options about formulating your ideas and what you might be able to test.
- Identify any constraints and other considerations with regard to your investigation.
- Also carefully address the healthy safety considerations.

Evidence of Deconstruction may be presented in a number of ways, for example: Notes, a Concept map, a Table, Answers to directed questions or aspects or some other way.

Once you have completed your Deconstruction you may proceed to the next phase which is 'Designing your own Investigation'. A proposed outline of one way of proceeding is included in this Appendix on the following pages.

Designing an Investigation

Introduction

An Investigation is a process that involves inquiry and exploration. Scientific investigation is the way scientists obtain evidence-based solutions to problems, or answers to questions about the world around us.

A scientific Investigation can be undertaken following an existing set of instructions, or one can be planned from the beginning and then carried out. The process used to put together and document an investigation of a problem is called Design. The Design of an investigation is best done following a process of Deconstruction.

To Design an Investigation of a Problem for which the outcome is uncertain, use the following headings and dot-points as a guide:

Justification

It is important to include a rationale or justification of the procedure based on theoretical and safety considerations, pre-trials and other factors that should be included. In other words, students must justify their plan of action. It is recommended that this can be done for each section using, for example, text boxes or a different colour font.

General

- Deconstruct the problem
- Provide justification of choices made in the Design using annotations or another method.

Variables

- Identify the independent variable (IV) to be explored and the dependent variable (DV).
- Make clear how the IV will be changed, and how many times.
- Include how the IV and DV will measured, and the units of measurement.
- List factors to be held constant, and describe how and why they need to be held constant.
- List factors that may not be able to be held constant or controlled, state why not, and consider the potential impact of this on the data/investigation.

Hypothesis

- Provide a hypothesis expressed with a single IV and DV as a … If … then … statement. This needs to relate to the purpose of the Investigation.

Equipment/materials

- List as dot points all of the equipment/materials required to carry out the investigation, including the quantities and volumes/concentrations as appropriate.

Procedure

- List as numbered steps how the investigation will be carried out.
- Make clear the type and amount of data to be collected e.g. qualitative data (descriptive), quantitative data (numerical), sample sizes, and averages.
- Detail how data will be collected that is reliable, and accurate.

Other considerations

- Include a blank table to show the data to be collected and recorded.
- Provide a description of the expected results.
- Identify safety and/or ethical risks, and describe how they will be managed.
- Include at the end of the Design an overall safety rating /10.

Evidence of Design may be presented in a number of ways. One example of a suggested layout that uses a combination of sub-headings and tables for different parts of the Design is shown below.

Your teacher will provide further direction about what is required.

Problem: ....

Variables

Independent variable ....

Dependent variable ....

Factors to be held constant

5 factors to be held constant	How the factors will be held constant	Why the factors need to be held constant

Factors that may not be able to be controlled

2 factors that cannot be controlled	Why the factors cannot be controlled	Potential effect on the data/ investigation

Hypothesis

....

....

Equipment/materials

....

....

Procedure

....

....

....

....

Safety and/or ethical risks

Safety risks	**Management**
Ethical risks	**Management**

Overall safety rating – circle

1 2 3 4 5 6 7 8 9 10

Science Inquiry Skills (SIS)

Part A: Writing a Practical Investigation Report

Introduction

An important way to study biology is through practical investigation. This may involve using science inquiry skills either to complete an experiment about a problem or Deconsructing a problem to Design a valid procedure to use to investigate the problem, then carrying it out.

There are a number of ways students can present a report of a practical investigation that includes an experiment and a Deconsruction with Design.

General

- One Design practical investigation report has a maximum word count of 1500 words. Only the Introduction, Analysis, Evaluation, and Conclusion are included in this word count.
- Appropriately acknowledge all sources of information in and at the end of the report.

Deconstruction and Design proposal

- Deconstruct a problem for which the outcome is uncertain and attach to the report evidence of the Deconstruction.
- Design of an investigation for which the outcome is uncertain and attach to the report a document that includes the variables, hypothesis, equipment/materials, procedure and ethical/safety risks.
- Provide evidence of Deconsruction and your method chosen
- Justify your plan of action

(Note: This section must be a maximum of 4 sides of an A4 page)

Introduction

- Present biological information/theory relevant to the investigation.

Purpose

- State the aim of the investigation.

Hypothesis

- State the hypothesis used in the experiment.

Results

- Display the results using tables and graphs.
- Support processed data using sample calculations.
- Ensure the format of the tables and graph is consistent with conventions regarding titles, headings, symbols and SI units, and use of significant figures.

Analysis

- Analyse the data to identify a trend or pattern (if any) and discuss the relationship between the independent and dependent variable using biological information/theory.

Evaluation

- Evaluate the procedure and data to identify sources of uncertainty, including sources of random and systematic errors, and factors that cannot be controlled.
- Assess the reliability, accuracy and validity of the results, by discussing sample size, precision, random error, systematic error, and factors that cannot be controlled.

Conclusion

- Form and justify a conclusion that relates to the hypothesis.
- Discuss the limitations of the conclusion based on the procedure and the results.

Part B: A sample Task Sheet for a Deconstruction and Design

Your teacher will provide you with a task sheet to use to prepare a report of a 'Design practical investigation' for summative assessment. Part of one (which has been adapted from SACE) is shown below for illustration.

A guide to approximately how many words for each section is given in brackets. The Purpose, Hypothesis, Results, Deconstruction, Design, and References sections are not in the word count. For the relevant Assessment Design Criteria see the Criteria column.

Note: the word count for Introduction, Discussion and Conclusion in Stage 2 is a maximum 1500 words.

Section	Evidence	Criteria
Deconstruct and Design proposal	An investigable question or hypothesis is formulated that relates to the purpose of the investigation. A method is designed that includes: • a list of all equipment required (with details of sizes and quantities), • describes how the independent variable is varied, • describes how the dependent variable is measured • states the number of trials to be conducted. • procedures to identify how to keep other factors constant • identification of factors that cannot be controlled • procedures to manage ethical and safety considerations. A rationale or justification for the details in the procedure, based on theoretical considerations, safety considerations, student pre-trials or other considerations, should be included. *Note: Evidence of Deconsruction outlining the Deconsruction process, the method chosen as most appropriate, and a justification of the plan of action, must be a maximum of 4 sides of an A4 page. This evidence must be attached to the practical report.*	IAE1
Introduction (~300 words)	• Explanation of relevant science concepts that relate specifically to the hypothesis. • The purpose of the experiment, the hypothesis or investigable question, the independent, dependent and controlled variables are identified.	KA1
Results	• Data is represented in appropriate formats. • Tables with relevant column headings and including units. • The number of significant figures used is appropriate. • Graphs with labelled axes (with units), appropriate scales, an appropriate size, and in a format to suit the type of data.	IAE2
Discussion (i.e. analysis and evaluation) (~900 words)	• Trends in the data are identified and an explanation of these trends in terms of relevant concepts is provided. • An evaluation of the experimental method and its effect on the data is included. • Sources of uncertainty, including random and systematic error, which could have affected the data, are identified and their significance on the validity and reliability of the data is discussed. • The effects of factors that cannot be kept constant on the data obtained are considered.	IAE3 IAE4
Conclusion (~300 words)	• Indicates whether the hypothesis is supported or rejected and states the overall trend indicated by the data. Reasoning based on the data for supporting or rejecting the hypothesis is provided. • Limitations of the conclusion may be discussed and recommendations based upon the conclusion can be made.	IAE3
Communication	• The correct format for the structure of a report is used. • Information is communicated clearly. • Appropriate science terms, equations and conventions are used. • External references (if used) are acknowledged appropriately.	KA4