

Writing Lab Reports

This guide is designed for Undergraduate Science, Technology and Engineering students.

Introduction

In the Science, Technology and Engineering fields, laboratory reports are used when communicating about 'an investigation' or 'research'. Becoming competent in producing laboratory (or experimental) reports as an undergraduate student will assist you to develop the skills required to write more extended and increasingly original research reports that are usually required from 3rd year onwards.

Purpose

In your report you should aim to provide a factual and accurate account of an investigation - what you did, what you found and what your results mean.



Structure

Most schools provide a structure or 'template' for you to follow and there will be some variation from school to school. Some may even have the introduction and methods already completed. You then read these sections, carry out the investigation and record your results and interpretations. Other schools may require you to plan and write your report from the beginning. You will also need to read further relevant information for your discussion.

This guide gives a basic format for laboratory reports. Each school should have its own publication that details the requirements and this is usually made available to undergraduate students in the early stages of a course. If you are unaware of these publications you need to check if these were part of a set of publications for a prerequisite subject you did not do. This advice also applies to Masters students who may not have completed their undergraduate degree at this university.

A few important points about scientific writing style

- You should write in complete, grammatically correct sentences.
- If most of your sentences are long (4 or more 'clauses' or parts) you will confuse the reader. Consider making two sentences (with 3 or less parts in each) only using long sentences to include a qualification or an example.
- Be concise. If you can use 1 word instead of a phrase with 2 or more words, then choose the 1 word (*get around = avoid*).
- Be objective. Limit your use of personal pronouns (*I, you, we*), emotionally loaded words (*wonderful, useless, lovely*) and casual or ambiguous expressions ('the reaction carried on for 10 minutes').
- Use technical terms correctly. Learn what they mean, how to use them and how to spell them. Your lecturer may be able to recommend a good specialist dictionary.
- Do not use contractions (*isn't, doesn't, it's*). While these are common in speech, in formal writing the full form (*is not, does not, it is*) is expected.

The Simple Report

This is generally only two to five pages long, and usually consists of the following:

- *Aims* • *Method* • *Results* • *Conclusion* • *Discussion* • *References*

Aims (or Objectives)

The purpose of the experiment. There may be one aim or several. For instrumentation-based practicals it is customary to mention the apparatus to be used: for example, the aim for a biochemistry practical which uses a spectrophotometer to determine serum protein levels might be written as "to determine protein levels in normal serum samples by spectrophotometry".

Method (or Materials & Methods)

How you carried out the experiment (and what reagents you used). Normally, the method is given out as part of the practical notes and very rarely would you be required to rewrite it, although you may have to note any alterations. Some lecturers will be happy with a reference to the method, e.g. "see practical notes page xx - alterations noted" and others may require a photocopy of the method attached to the report (with any alterations noted).

PRACTICAL 1 FIXATION 1 22/2/89—1/3/89

OBJECTIVE

To observe the effects of some primary fixatives on a protein solution (egg-albumin).

METHOD

1. Add the following fixatives to separate test tubes:

formalin	.....tube 1	(H. CHO)
chromic acid	.....tube 2	(CrO ₃)
acetic acid	.....tube 3	(CH ₃ COOH)
potassium dichromate	.....tube 4	(K ₂ Cr ₂ O ₇)
mercuric chloride	.....tube 5	(HgCl ₂)
osmium tetroxide	.....tube 6	(OsO ₄)
picric acid	.....tube 7	(C ₆ H ₂ (NO ₂) ₃ OH)

2. For each test tube, fill about 3 cm of dialysis tubing with egg-white and tie securely at each end.
3. Place one of these tubes of protein in each of the fixatives and record observations after 15 minutes, 45 minutes and one week. Comment on the results.

1

RESULTS

FIXATIVE	15 MINUTES	45 MINUTES	1 WEEK
H.CHO	slightly opaque	no change	opaque
CrO ₃	totally opaque	no change	no change
CH ₃ COOH	slightly opaque	more lumpily opaque	no change
K ₂ Cr ₂ O ₇	transparent	no change	opaque
HgCL ₂	totally opaque	no change	no change
OsO ₄	transparent	no change	opaque
ACETIC ACID	totally opaque	no change	no change

CONCLUSION

Chromic acid, mercuric chloride and picric acid coagulate egg-white protein within 15 minutes. Acetic acid causes increased protein precipitation to render the egg-white turbid and 'lumpy'. Potassium dichromate and osmium tetroxide have no apparent effect on the protein for at least 45 minutes, but can render it reasonably opaque within one week. Egg-white treated with formalin becomes slightly opaque within 45 minutes and is reasonably opaque within one week.

2

Results

What you found. This is the raw data and is best presented in the form of tables and graphs. Record your data in tables and use the tabulated data to do the graphs. Record any data you have determined from the graph in a separate table. For example, if you are trying to determine protein levels by spectrophotometry, you would record all the spectrophotometry readings for your standards and samples in the first table, and use the standard readings to construct a graph of protein concentration versus absorbance readings (a standard curve). The concentration of the samples can then be worked out from the graph, and recorded in a separate table. If the amount of raw data is excessive, consider presenting it as an appendix (see page 4 of this handout).

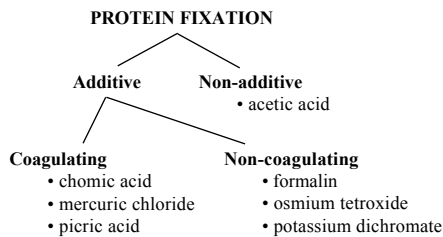
Conclusion

1. An interpretation or summary (not a discussion) of your results. This is normally a brief statement (e.g. "the concentration of protein in serum sample xyz was found to be xx g/L, which is within the normal reference range"), or it may even be a tabulated summary of results. It should always reflect the question(s) posed in the Aim(s).

- Sometimes the conclusion is not separate from the discussion, i.e. you may be asked to give a combined "conclusion/discussion".
- Sometimes the conclusion may be required to go after the discussion, in which case it will not be a summary of the results but will be what you conclude based on your discussion. This type of conclusion will probably be about a paragraph in length.

DISCUSSION

The first requirement of a fixative is that it is not proteolytic, as any substance which breaks the peptide links and sets free soluble amino acids is the opposite of a fixative. Changes should tend in the categories of protein fixation; additive (where certain atoms of the fixative combine chemically with some part of the protein) and non-additive (where this does not appear to occur). Additionally, fixatives may be coagulant or non-coagulant (protein is hardened without separating the water from the protein).



Acetic acid is a non-additive fixative in the sense that none of its constituent atoms join itself to protein, but fixation is achieved by the denaturing of the protein; a thick precipitate is formed, attributed to the action of the acetate ion in splitting off DNA from protein. Acetic acid is used more for its swelling effect, which counteracts the shrinkage caused by other reagents used in fixation and embedding, than for its ability to fix protein.

3

Discussion

What the results mean, whether they were as expected (and if not, why not), any problems with the practical etc. For example, a result outside the normal reference range could indicate one or more disease states, which should be mentioned.

It is usual to run a positive and negative control with any analysis as a way of making sure that the method worked. This would be in the form of a normal and an abnormal control of known value for a practical like the serum protein analysis. If these controls give results within their expected ranges you can generally assume that your sample result is valid. If not, this is a good indication that something went wrong, somewhere!

Sometimes the controls are past their expiry date, which means you have no way of knowing if your results are valid. If your results are not what you expected (as frequently happens in biochemistry practicals), don't panic – you can often score excellent marks by being able to explain what went wrong.

The coagulating additive fixatives turn the protein white and opaque upon coagulation, but the method of combining with the protein differs.

Mercuric chloride can attach itself either through electrostatic attraction between ionised $-NH_3^+$ amino groups and negatively charged mercuric chloride ions, or by reacting with cysteine groups on the proteins to form a bridge to connect these groups. **Picric acid** acts by forming picrates with amino acids, and although **chromic acid** is thought to be an additive fixative, the reactions involved are not well understood.

Formalin reacts with protein end-groups to cross-link molecules giving rise to an insoluble end-product. **Potassium dichromate** gradually renders egg-white more viscous and eventually transforms it into a weak gel; its action is apparently enhanced by bright light, which may account for the opacity we found one week after initial fixation. It is not regarded as a good fixative for proteins, but is used mainly for its action on certain lipids. **Osmium tetroxide** actually renders the protein no longer coagulable by ethanol or heat, and sets strong protein solutions into gels, but although it is an additive fixative the exact site of its attachment to proteins is not well understood.

REFERENCES

- Baker J; in "Cytological Technique", 5th ed., Chapman and Hall 1966, London, pp 14-54.
- Culling CFA, *et al*; in "Cellular Pathology Technique", 4th ed., Butterworths 1985, London, pp 30-35.

4



References

This is usually just a list of the sources you consulted for your discussion.

The Extended Report

This may be ten pages or longer. An extended report consists of the same components of a simple report, plus additional sections, some of which are described on this page:

Possible Sections in an Extended Report

- *Table of Contents*
- *Introduction*
- *Instrumentation*
- *Applied Theory*
- **Aims**
- *Principles*
- *Reagents*
- **Method**
- *Flow Chart*
- *Calculations*
- **Results**
- **Conclusion**
- **Discussion**
- *Appendices*
- *References*

Table of Contents

This is a good idea if the report is very long or complicated, especially if it has many different sections.

Introduction

One or more paragraphs which define the subject of the report. For example, if the subject is "High Performance Liquid Chromatography" (HPLC) you might give a definition of HPLC and outline how HPLC differs from traditional liquid chromatography techniques.

Instrumentation

Several paragraphs that describe how the instruments you will be using to perform the analyses (e.g. spectrophotometer, gas chromatograph etc.) work. It is a good idea to include a block diagram of the basic components of the instrument. If it is a complicated instrument capable of running several types of analyses you should use subheadings.

Applied Theory

In reports that deal with instrumentation, this is usually an explanation of the mathematics involved and consequently will include several equations.

Principles

More equations. Usually only required if one or more chemical reactions are involved.

Reagents

If your method is to be presented as "Materials & Methods" this is unlikely to be required. It is most often asked for when highly toxic reagents are being used.

Flow Chart

This is another way of describing the method, and rewritten as an easy-to-read and logical sequence of events, to allow you to get long incubations etc. underway as soon as possible. Sometimes you may not be allowed into the practical class unless you have a flow chart ready. Preparing a flow chart will allow you to use your lab time as efficiently as possible.

Calculations

These are usually to work out what dilutions of the stock reagents are required in order to prepare working solutions, in the case of biochemistry-related practicals.

Appendices

Sometimes the amount of raw data is excessive (e.g. a computer printout of hundreds of numbers) and it is best to insert this at the end of the report as an appendix and to put a summary of these results in the results section.

References

An extended report may, in addition to the discussion references, include references for the introduction, instrumentation or applied theory sections. Formal referencing, e.g. using the Harvard system, may be required.

Text prepared by Deanna Jones and Pam Mort.

For enquiries and suggestions, contact Pam Mort at The Learning Centre, 9385 1150 p.mort@unsw.edu.au