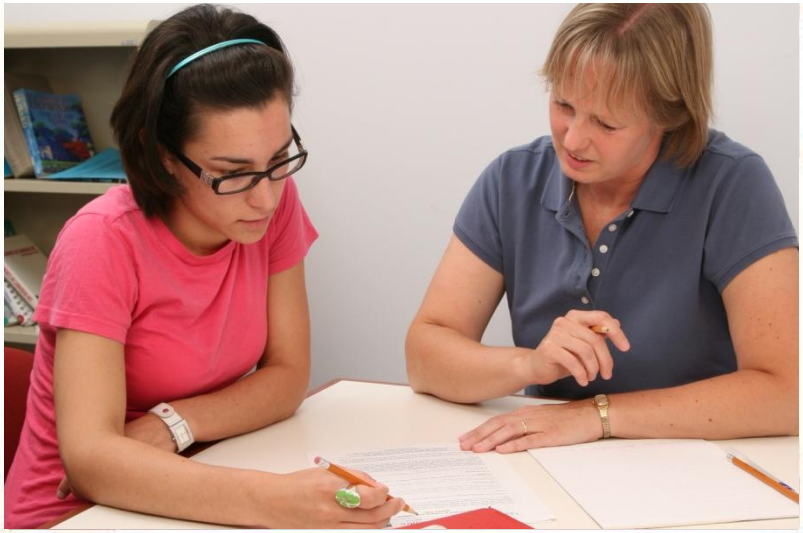
Queen's Writing Centre



- *Workshops*
- *Credit courses*
- *One-on-one writing tutorials*

- *Essay writing*
- *Lab report writing*
- *Thesis writing*
- *Grammar*
- *General writing tips*

www.queensu.ca/writingcentre/ 613-533-6315 Stauffer Library

Science writing should

- Communicate results
- Be accurate and precise
- Allow for repeatable experiments

Principles of Science Writing

- Objective
- Specific, direct, and concise
- Hypothetical
- Well-documented

Science writing is *objective*

- Avoid using first-person ("I," "we")
  - the focus should be on ***what***, ***how***, and ***why***—knowing ***who*** is not important

  *Note: some disciplines in the sciences now allow and even encourage the use of the first-person

- Use ***passive*** voice:
  - the focus should be on the ***results*** of the experiment, rather than on the "doer" of the action

    - ***Active***: The researcher diluted the samples with 100 ml of H_20.
    - ***Passive***: The samples were diluted with 100 ml of H_20.

Science writing is *specific*

- Avoid generalizations
  - focus on the particular study at hand

  For example, rather than explaining at length the processes of photosynthesis, discuss photosynthesis as it relates to your particular experimental questions or focus

  Avoid vague language
  - use precise and concrete words
    - **Not** "Several of the rods got really, really cold" **but** "Twenty of the rods cooled to minus 20 degrees Celcius."

Science writing is *direct and concise*

- Use plain language to support jargon and discipline-specific vocabulary
- Avoid wordiness and elaborate expressions
- Focus on the matter under investigation (procedures, results, implications)

Some methods for eliminating wordiness

- Avoid using a phrase when a word will do
  Not "at this point in time" ***but*** "now"
  Not "due to the fact that" ***but*** "because"

- Eliminate redundant words
  Not "viable alternative" ***but*** "alternative"
  Not "mix together" ***but*** "mix"

- Avoid needless repetition
  Not "In trauma victims, breathing is restored by artificial respiration. Techniques of artificial respiration include mouth-to-mouth respiration and mouth-to-nose respiration" ***but*** "In trauma victims, breathing is restored by either mouth-to-mouth or mouth-to-nose respiration."

- Avoid some “It” sentence openers
  Not “It gives me great pleasure to introduce our speaker”
  but “I am pleased to introduce our speaker.”

- Avoid weak, wordy verbs
  Not “make an assumption” ***but*** “assume”
  Not “come to a conclusion” ***but*** “conclude”
  Not “come to the realization” ***but*** “realize”

- Make negatives positive
  Not “did not succeed” ***but*** “failed”
  Not “does not have” ***but*** “lacks”

- Drop most “There is” and “There are” sentence openers
  Not “There are serious consequences in failing to yield right of way” ***but*** “Failing to yield right of way can have serious consequences.”

Science writing is *hypothetical*

- Allow for a degree of uncertainty/avoid definitive conclusions
  - Results “suggest,” “indicate,” or “are significant”
  - Results do not “prove,” “show,” or “demonstrate” (unless you are referring to trends or tendencies in data)

Science writing is *well-documented*

- Follow documentation style recommended for particular courses
- Always be consistent

Specific referencing styles will be discussed later in this presentation

WRITING EFFECTIVE LAB REPORTS

WHY WRITE LAB REPORTS?

- To accurately report the methods and findings of an experiment (experiment should be repeatable)
- To learn how to communicate effectively in a particular discipline
- To demonstrate understanding of theories, procedures and results related to an experiment
- “To discuss results in an analytical and professional manner” (BIOL 103 lab manual)

The sections

The title

- should not be too vague
- may relate to the main objective, species involved, location (if relevant)
- may be derived from the x/y axis of the main figure in the lab report

Examples:

An analysis of wolverine (Gulo gulo) hunting behaviour in the Claire Lake watershed, Yukon Territory

(includes main objective, species involved, and location)

Heart Mountain and South Fork fault systems: architecture and evolution of the collapse of an Eocene volcanic system, northwest Wyoming

(includes location, geological feature, and age)

The Abstract

- States the purpose of the study
- Summarizes the methods
- Summarizes the results
- Summarizes the discussion

One sentence for each of these is usually sufficient

Sample Abstract

This study was undertaken to determine the wavelengths of light that are most effective in promoting photosynthesis in the aquatic plant *Elodea canadensis* since some wavelengths are generally more effective than others. Rate of photosynthesis was determined at 25C, using wavelengths of 400, 450, 500, 550, 600, 650, and 700 nm and measuring the rate of oxygen production for 1-hr periods at each wavelength. Oxygen production was estimated from the rate of bubble production by the submerged plant. We tested 4 plants at each wavelength. The rate of oxygen production at 450 nm (approximately 2.5 ml O2/mg wet weight of plant/h) was nearly 1.5x greater than that at any other wavelength tested, suggesting that light of this wavelength (blue) is most readily absorbed by the chlorophyll pigments. In contrast, light of 550 nm (green) produced no detectable photosynthesis, suggesting that light of this wavelength is reflected rather than absorbed by the chlorophyll.

From Jan A. Pechenik's *A Short Guide to Writing about Biology,* 2004.

Format – IMRAD

Section	Purpose	Answers these questions
Introduction	Explains central question Gives context for the investigation States primary results	What did you do? Why did you do it? Who else has done related work? How did you do it? What happened?
Materials and Methods	Details the experimental procedure step by step	How could someone else replicate your experiment?
Results	Reports, in detail, the results of the investigation	What actually happened?
Discussion	Comments on the significance of the results Suggests refinements, applications Offers possibilities for further study	Did the experiment do what you expected it to? Why or why not? How might the experiment be improved or adapted? What next?

The introduction

- introduces the topic and conveys why the topic is important or interesting
- provides a short review of relevant, current research (theoretical background)
- states the purpose of the study
- sometimes understood as a mini literature review

A good introduction states the objective of the experiment and provides the reader with background – theory, previous research, or formulas the reader needs to know. It should contain a statement like the following:

> The purpose of this experiment was to identify the specific element in a metal powder sample by determining its crystal structure and atomic radius. These were determined using the Debye-Sherrer (powder camera) method of X-ray diffraction.

This introduction might then describe the Debye-Sherrer method and explain that from the diffraction angles the crystal structure can be found by applying Bragg's law.

Material from the webpage "Writing at the University of Toronto: The Lab Report"

The objective of the experiment can be stated at the beginning or end of an introduction.

Often, an introduction will begin with a rather general statement, then lead to more specific statements and, finally, to the specific research objectives of the study.

Sample: It is well known that plants can use sunlight as an energy source for carbon fixation (Ellmore and Reed, 1993). However, all wavelengths of light need not be equally effective in promoting such photosynthesis. Indeed, the green coloration of most leaves suggests that wavelengths of approximately 550 nm are reflected rather than absorbed so that this wavelength would not be expected to produce much carbon fixation by green plants.

During photosynthesis, oxygen is liberated in proportion to the rate at which carbon dioxide is fixed (Ellmore and Reed, 1993). Thus, relative rates of photosynthesis can be determined either by monitoring rates of oxygen production or by monitoring rates of carbon dioxide uptake. In this experiment, we monitored rates of oxygen production to test the hypothesis that wavelengths of light differ in their ability to promote carbon fixation by the aquatic plant *Elodea candensis*. (From Pechenik).

Results May also be called Observations or Measurements

- includes several sentences that summarize the results of the study (simple description of trends)

- includes figure(s) of graph(s) and/or table(s)

Tips

- do not forget axis labels and units
- use past tense
- avoid redundancy – in the text, do not write exactly what is in each graph; graphs and figures present their own information

Report your observations using specific, concrete language. In the experiment from which the following report sample was taken, the researchers were attempting to convert fullerine into diamond. After subjecting fullerene to extremely high temperatures, they collected what was left.

Each time we subjected sample A to this pressure, we heard a loud explosion inside the anvil. Despite this, we were able to recover the entire samples, which were still surrounded by their pyrophilite rings. They were disk-shaped, with a diameter 1mm and height 0.1 mm. They were brittle, and cracked and broke with handling, giving rise to faces with sharp dendrites. The samples became transparent, with an amber or reddish-brown hue. A small amount of black powder remained on the surface and on the boundary of the pyrophilite sample. (quoted in David Porush's *A Short Guide to Writing about Science*, 1995).

Describe only the relevant, significant data, but all of the relevant data. When possible, present the data in the form of a graph or chart.

Discussion

- analyzes/interprets the results of the study; provides possible explanations
- suggests sources of errors and how experiment could be improved
- provides support from sources
- may suggest how experiment could be applied

In the Discussion section, you analyze and interpret the data. In analysis, you explain what you know with certainty based on your results and draw conclusions.

Sample 1: The discrimination of worker bees against worker-laid eggs could result from three possible factors: the workers somehow "knew" the relatedness of eggs; they preferred queen-laid over worker-laid eggs; or they detected colony odors despite the double screen we used to separate them.

(from Pechenik)

Sample 2: Since none of the samples reacted to the Silver foil test, therefore sulfide, if present at all, does not exceed a concentration of approximately 0.025 g/l. It is therefore unlikely that the water main pipe was the result of sulfide-induced corrosion.

(from U of T website)

When you interpret your results, you discuss their significance, raise questions, and possibly give explanations for problems in the data.

Sample: Although the water samples were received on 14 August 2000, testing could not be started until 10 September 2000. It is normally desirable to test as quickly as possible after sampling in order to avoid potential sample contamination. The effect of the delay is unknown.

The paragraphs in your Discussion section may progress in the following order:

1) Data
2) Generalizations or analyses of data
3) Conclusions with regard to your hypothesis
4) Inferences you can make from your conclusions to larger issues

To support your analysis and interpretation of results, you should use the findings of other related studies

To integrate sources effectively, be sure that the studies you are using are relevant to your experiment

Place information from sources in the context of your discussion of your experiment

Use citations, not quotations, when you are referring to others' research

The following sample is from the Discussion section of a student report

Sample: I find the small number of species represented in our sample surprising, since the pond is fed by several streams that might be expected to introduce a variety of different species into it, assuming that the streams are not polluted. It appears that the conditions in the pond at the time of our sampling were especially suitable for one species in particular out of all those that are most likely to have access to it. Perhaps the physical nature of the pond is such that the number of niches is small, in which case competition would become very keen; only one species can occupy a given niche at any one time (Ricklefs and Miller, 2000). The reproductive pattern of the fishes might also contribute to the observed results. Possibly *Lepomis macrochirus*, the dominant species, lays more eggs than the others, or perhaps the young of this species survive better, or prey on the young of other species.

(from Pechenik)

Conclusion

This section may or may not be included in the report

- provides an answer to the problem raised in the introduction
- concisely restates the result

References

Always acknowledge sources of specific information with citations in the text of your report and references at the end. General knowledge is considered material discussed in class and does not need to be cited.

When using source material, be sure to avoid paraphrasing the source too closely; always use your own words.

Referencing Styles

In most disciplines, lab reports contain in-text references to sources used; for example, after referring to the results of a study, you would write (Semple and Messenger, 2005). This is the name-and-year system.

In some disciplines, you may use the alphabet-number system or the citation-order system (see The Writing Centre's website to access this handout).

The References page provides the full publication information for the source.

Ex. Semple, I and D. Messenger.2004. False positives for the defibrillator: the effects of stress on cardio-pulmonary distress in emergency room patients. Emergent care 201: 147-156.

Tips

Check with your instructor or T.A. to find out the required style

If no particular style is required, check the documentation style used in your source material. Use a source's References page as a guide for your own.

Above all, be consistent