How to Write a Biology Work Term Report (or anything else that is biological science-y)

- When writing a document, try to place yourself in the position of the reader. Write for the sake of the reader, not for you as the writer/author. The writer is the tour guide, and the guide is leading the reader. Write for the reader, and do not write for the sake of producing work that is designed to impress. Aim for clarity and simplicity.

- On the other hand, it is well known that writing greatly benefits the writer via increased understanding of the topic (the idea of "writing to understand"). The effort involved in systematically organizing concepts, ideas and facts about a topic, for the benefit of the reader, also benefits the writer. That is, the act of writing benefits the writer in terms of their own understanding and clarity of thinking.

- Know your audience: When writing a document, it is important to know your audience and to write for your audience. In the case of the Biology Co-op Work Term Report, the audience is an educated-in-biology reader. However, the reader likely does not know all the nuances of the field in which you did your work term. Therefore, please define all terms and abbreviations. As well, do not make assumptions about specialized background knowledge; explain the relevant background information (the Introduction is a good place to do that).

- Information content: Aim for maximum information content of titles, headings and all sentences. Get rid of extraneous words and phrases. Do not use two sentences to describe information that could be described in one sentence.

- Do not be vague. The goals for every sentence are clarity and brevity, with maximum information content.

- Never leave the reader wondering about "why" or "how"; spell it out for the reader. Explain why you are telling the reader about certain observations or facts; do not expect the reader to piece it together (it is not a mystery novel). Outline the reasoning.

- Each paragraph should have a central idea; that central idea should be clear from the first sentence. Each sentence in a paragraph should logically flow from the preceding sentence. Paragraphs are <u>not</u> simply a group of sentences; they have a logical structure.

- Subsequent paragraphs should logically flow from preceding paragraphs. The subject of a new paragraph should never surprise the reader; it should be a logical continuation of a developing theme. Consider using transition words or phrases (e.g. "however", "in addition", "in contrast") to begin paragraphs.

Parts of the Report

Title (on a Title Page)

- Start with a clear and descriptive title. Do not be vague.
- Example of a vague work term report title: "Effects of nutrients on growth of crops."
- This leaves the reader wondering about: Which nutrients, which crops, what aspects of growth?
- A better work term report title: "Interactions between phosphorus and nitrogen application rates on the yield of canola (*Brassica napus*)."

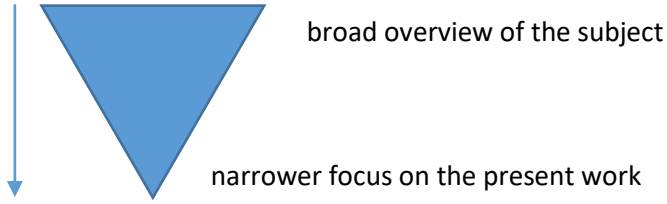
- Your title page should include:
  - Your name.
  - Your student number.
  - The location of the work term.
  - The dates of the work term.

Abstract

- This is a summary of the work, and typically does not contain references.
- The Abstract is a stand-alone single paragraph that provides an overview of the work, without reference to the rest of the document.
- This section briefly states the hypothesis, question or problem being addressed, along with the general approach (methods), major results and major conclusions.

Introduction

- Starts broad, with an overview, and ends more narrowly, focused on the work being described.
- Provides the reader with the relevant background information.
- Describes the hypotheses being tested, or the purpose of the work. What is the question? What is the goal?
- The organization of the Introduction is often described as an inverted triangle, broad at the top and narrowing to a point:



Materials and Methods

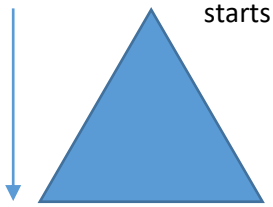
- Provides enough information for the reader to understand how the work was conducted, and potentially to be able to replicate the work.

Results

- This is more than a listing/description of data. Highlight the important results for the reader. However, do not describe every result or piece of data (important ≠ all). Guide the reader to the important stuff. Remember, you are the tour guide.
- Try to avoid the dreaded phraseology that states what "is shown" in a figure or table, e.g., "The results shown in Figure 1 indicate that phosphorus application rates in excess of 25 kg ha^{-1} led to a decrease in canola yield". It is simpler and more efficient to write "Phosphorus application rates in excess of 25 kg ha^{-1} led to a decrease in canola yield (Fig. 1)."
- Another dreaded phraseology: "The data show that phosphorus application rates in excess of 25 kg ha^{-1} led to a decrease in canola yield (Fig. 1)." The first part of that sentence ("the data show") adds no value or meaning to the sentence. Instead, simply state: "Phosphorus application rates in excess of 25 kg ha^{-1} led to a decrease in canola yield (Fig. 1)."
- Do not go into detailed discussions/analyses of the results in the Results section; that is the role of the Discussion.

Discussion

- Places the Results in the context of the hypothesis that was being tested, the question being asked, or the purpose of the work.
- Places the Results within the context of what is already known about the problem or question from previous work.
- Try to avoid the (yet another) dreaded phraseology of "Chen and Jablonski (2023) found that optimal nitrogen application rates to canola are dependent upon the potassium status of the soil". It is simpler to write "Optimal nitrogen application rates to canola are dependent upon the potassium status of the soil (Chen & Jablonski 2020)."
- The Discussion is often described as a triangle sitting on its base:



starts narrow, with a focus on the present work

ends broad, with the "big picture" and perhaps future work

Literature Cited (References)

- In the text (body of the work), cite the authors and the date of publication.
- In the text, for one or two authors, list all of the authors and the date. For three or more authors, list only the first author, use "et al." for the remaining authors, and list the date. E.g.

  "Cucumber plants growing in a hydroponic solution supplemented with silica have a lower rate of fungal infection than in the absence of silica (Agarwal & Igwe, 2022; Yamazaki et al. 2021)."

- "Et al." is an abbreviation for "et alia", which is Latin for "and others".
- Do not use "et al." the Literature Cited section; rather, list all the authors.
- In the Literature Cited section, the citation should include:
  Authors (surname and initials), Year, Title, Journal, Volume Number, Pages, DOI. E.g.

  Rosenvald R, Drenkhan R, Riit T. Lõhmus A (2015). Towards silvicultural mitigation of the European ash (*Fraxinus excelsior*) dieback: the importance of acclimated trees in retention forestry. Canadian Journal of Forest Research 45: 1206–1214. doi:10.1139/cjfr-2014-0512

Conventions about Past and Present Tense in Scientific Writing

- Work that has been published, or is generally accepted to be accurate, is described in the present tense, e.g. "Optimal nitrogen application rates to canola are dependent upon the potassium status of the soil (Chen & Yablonski 2023)."

- Work that you are describing for the first time (e.g. your own results in the present experiment) are described in the past tense, e.g. "Phosphorus application rates in excess of 25 kg ha^{-1} led to a decrease in canola yield (Fig. 1)."

First Person versus Third Person

- Scientific writing has traditionally used a "third person" system; however, "first person" has also become generally accepted. Both formats are acceptable for Biology Co-op Work Term Reports (but please be consistent; switching between formats within a document is not acceptable).

- Example of third person versus first person:
  Third person: "Gibberellic acid (10 µL of a 75 mM solution) was applied to the shoot apical meristem every three days."
  First person: "I applied 10 µL of 75 mM gibberellic acid to the shoot apical meristem every three days."

- More information about third person versus first person is available on the Web, including at:
  https://writingcommons.org/article/a-synthesis-of-professor-perspectives-on-using-first-and-third-person-in-academic-writing/

The Benefits of Getting Started Early

- Written work that is produced in one long session, and then immediately submitted, is typically not nearly as good as work that is written in iterations, put aside for a few days, and then re-examined.

- One possible approach to writing:
  1) Produce a draft that you think is good (you have to think that it is good, otherwise there is no point).
  2) Put the draft away for a few days. Do not think about it.
  3) After a few days, re-read the draft. You will probably find parts that are not as clear as you initially thought. The distance of a few days provides the opportunity to look at the document with "new eyes"; you will be able to see what you actually wrote instead of what you meant to write.

How to Write the Very First, Preliminary Draft

- Some people try to write a perfect first draft. They strive to write a perfect sentence, and then move on to try to write the next perfect sentence, and so on. This does not work, and is so slow and tedious that it is soul-destroying.

- A different approach is to write (quickly) your ideas and key points into the draft, without aiming for perfection or eloquence or perfectly logical sequence. Then start editing. It is far easier to edit existing work than to produce a perfect draft right from the start (and the "perfect" draft would not be perfect anyway).

- So, get the ideas incorporated into the draft, and then start working on clarity of explanations and logical flow.

Aspects of Integrity in Writing

Plagiarism

- In scientific writing, all text is original. Quotes of text generated by other authors are not used.
- You *are* allowed to use the ideas and evidence of other authors (in fact, you are encouraged to do so).
- However, descriptions of the work of other authors must: 1) be in your own words, and 2) be accompanied by an appropriate citation.

Self-Plagiarism

- The prescription that all text must be original also applies to text that you have written; do not recycle or re-use your own written work.
- For example, if you are writing a work term report that continues work from a previous report (perhaps you did consecutive work terms at the same organization), the new work term report cannot incorporate text elements from the first report; that would be self-plagiarism.
- Many practising scientists have fallen victim to self-plagiarism by recycling material (especially from the Introduction or Materials & Methods) from one of their published papers to another. It is quite embarrassing when the self-plagiarism is pointed out.

Using Generative Artificial Intelligence (Generative AI) for Writing

- All writing must be your own writing; that is important.
- Also, please keep in mind that various generative AI writing programs frequently fabricate facts and references. The references seem legitimate; they are good fabrications, but they are nonetheless fabrications.

- *Take home message about integrity in written work:* All text must be original and in your own words, and information and ideas must have appropriate citations. Moreover, recycling is not allowed.

5 December 2024.