

Dr. Clark's Scientific Paper Overview

Lab reports across Biology courses all follow the same general style and format, which is structured to mimic the format used to write the manuscripts that become primary research articles. Refer to the BIOL 190 Guidelines book and *A Short Guide to Writing About Biology* (Jan Pechenik) for more comprehensive information about how to write reports for this course. Below is a brief description of the major sections of reports, writing strategy, and the rubric I will use to grade your reports.

Reports should be divided into subsections of: Title, Abstract (approx 1/2 page), Introduction (2-3 pages), Methods (1-2 pages), Results (1-2 pages), Discussion (1-3 pages), References, Figures and Tables.

Title: A summary statement of the key outcomes from the experiment. *Not* just a label.

Abstract: Write this section last. Briefly describe observation/background, question, hypotheses, results, and conclusion (usually 1 sentence for each component).

Introduction, Paragraph-by-Paragraph:

Write this section after writing your Methods and Results sections. Should include references/citations to the scientific literature.

I. General introduction to a biological phenomenon/topic of broad interest, and why we should care. Statement of your broad question of interest (“How does ____ work?” “Why does ____ happen?”).

II. More specific information to address the broad question – background information plus general hypothesis/hypotheses, with several sentences explaining your hypotheses – i.e. providing specific justifications/rationale for why those hypotheses are reasonable.

III-IV. Introduction to a specific study system or organism that can be used to test those hypotheses. Justification of why it's a useful study system, plus any critical background information that is useful for understanding the specific experiments to be conducted.

V. Final paragraph: Specific goals for experiments or studies that were carried out, often along with specific predictions that are based on the hypotheses and the particular experiments that were conducted. May also include a significance statement about how findings advance our knowledge in this subject area.

Materials and Methods Sections – Numbers of paragraphs vary

Write this section first. Break into subsections as appropriate.

I. Details about the study organism – rearing and/or collection methods, general overview of procedures.

II. Specific procedures for specific experiments, written in narrative form in past tense. Needs to include enough detail that another person could re-create and replicate your experiment.

III. Measurements, calculations, and data analysis, including statistical tests used and which software was used.

Results - Paragraph Structure

Write this section second. Organized to follow the same order as the Materials and Methods, and can include subsections for different experiments if appropriate. This section needs to summarize major results and include both written text and summary figures that can each independently accomplish this goal.

In general, aim for one paragraph per figure/major result. Create your figures and then create your written Results. Be sure to include detailed quantitative comparisons (means \pm variation), not just lists of numbers. Also include references to figures, and appropriate statistics.

General structure for each paragraph of the Results:

a. Introductory sentence that summarizes the overall finding highlighted in the paragraph, with a reference to figures and tables that show this finding (e.g. "Altogether, participants who drank more caffeine showed a heightened microcirculatory response compared to those who did not, when immersing their hands in room-temperature water (Figure 1).")

b. Specific quantitative details. Make it clear whether a comparison is statistically significant or not. ("Specifically, the caffeine drinkers had a mean pulse amplitude that was 1.2 times higher than the pulse amplitude of the non-caffeine drinkers (Figure 1a; $x = 4.1 \pm 0.42$ for caffeine vs. 3.4 ± 0.31 for non-caffeine; t-test, $t=3.56$, $df=12$, $P = 0.003$). Meanwhile, although caffeine drinkers had higher mean pulse frequencies than non-caffeine drinkers (68 ± 12 bpm vs. 62 ± 8 bpm), this difference was not statistically significant (Figure 1b; t-test; $t = 1.04$, $df=12$, $P=0.12$).")

An alternative way to phrase the second sentence: "In contrast, caffeine drinkers and non-caffeine drinkers had similar pulse frequencies (overall mean = 64 ± 10 bpm; t-test, $t=1.04$, $df=12$, $P=0.012$)."

c. May include relevant qualitative/anecdotal observations that will be talked about further in the Discussion ("In addition, we noticed that the caffeine drinkers had a difficult time holding still during the pulse amplitude measurements, and tended to squirm for approximately half of the 5-minute trial (R.C., personal observation).")

Discussion, Paragraph-by-Paragraph Outline

Write this section second to last, after the Introduction.

I. Initial paragraph should first answer the question as to whether, overall, the results (a) support the hypothesis/hypotheses, (b) do not support the hypothesis/hypotheses, or (c) provide partial support for the hypothesis/hypotheses. Also include general statements about the implications/intellectual significance of these findings for our general understanding of the broad question introduced at the start of the introduction ("These findings indicate that further

experiments are needed to determine the physiological mechanisms that specifically lead to heightened microcirculatory responses in caffeine drinkers.").

II. Allocate roughly one paragraph per figure to more detailed Discussion of the implications of your specific findings. Some pointers: Do talk about unexpected outcomes and relate your results to other published studies (being as specific and quantitative as possible). Talk about what can be done in the future to resolve any conflicting or ambiguous evidence – think "better or different experimental design" rather than "mindlessly increase the sample size." If all the existing evidence clearly and unambiguously points to the same conclusion, talk about future research directions that could build off of these conclusive outcomes. How *general* do you think the observed phenomenon might be? Should it next be explored in a different species or population? Is it unique to the specific study system?

III. Add a short concluding paragraph that summarizes the major points in your Discussion in just a couple of sentences.

References and in-text citations: Include citations for all outside sources used in the Introduction and Discussion. For citations within the text, avoid direct quotations; re-phrase the ideas that support your arguments in your own words. In the text, use parenthetical citations of the author's last name and the publication year, for example:

Isopods like to disco dance, but only if they like the music (Smith 2000).

For two authors, use (Smith and Johnson 1985). For more than two authors, use (Smith et al. 1862). ("*Et al*" is Latin for "and others."). At the end of your paper, include a complete citation of the article in a References section, such as:

Smith, J, and Q Johnson. (1985) Dancing behavior in isopods. **Animal Behavior** 187: 4-12.

Acknowledgements: Include a specific section thanking the appropriate individuals for their contributions to your report. Be sure to describe your team members' specific contributions (i.e. "Thank you to Dr. Clark with providing ideas to refine our hypothesis, and to Bart Simpson for help with data collection and analysis.")

Figures: Create before written Results. See separate document on figure creation.

Procrastinators, beware! While you will generally have **one week** to complete a lab report, within two days, the majority of the experience will have evaporated from your brain. Therefore, I strongly encourage you to either take extremely thorough notes (heck, they'll practically be an outline) or to write your lab report very soon.