

Module 6.1: Learn - Biology

6.1: Biology/Statistics

In this section, we will focus on writing up your results and discussion. These are the main elements of a research paper. They describe and detail what work was done, what resources were used and created, and describe what is still needed or should come up next in the field.

Citing papers

Before we begin, one thing we want to emphasize is to write in your own words and always give credit where credit is due! When faced with the task of scientific writing, it is tempting to use sentences from papers you have read as background as an explanation or justification for your own results, but to quote Mando, this is not the way. Instead, before you start writing, set up citation manager software so that you can easily cite results and tools made by others and then you are free to continue on detailing your own results from your own work.

Popular citation managers include: 1) Endnote (there's a basic version available for free), 2) Zotero (free), Mendeley (free), and 4) Paperpile (free trial). All of these allow you to import citations for papers and insert them in the correct format as you write your own paper. You can refer back to the papers that we have read for examples of how this is done.

Here is a video that introduces citation managers if you have never used one before:

[What are Citation Managers?](https://www.youtube.com/watch?v=JCTizduU54o)  <https://www.youtube.com/watch?v=JCTizduU54o>



<https://www.youtube.com/watch?v=JCTizduU54o>)

What are Citation Managers transcript

https://docs.google.com/document/d/1Z4uSHeBYPDJy2b4KjgiCF1_0pNF7Gu3lr0lpv4VTdAE/edit)

If you don't do this, it's plagiarism and trust us when we tell you that people can tell when you are talking about things you didn't do (it's not a good look). No one expects that you came up with everything from scratch. Be clear and confident about the work you did and the ideas you contributed to the project.

Storyboard of figures to writing the Results section

Ok, with that out of the way, let's get to writing. In the previous module, you will have started to plan out the figures you will include and what order you will have them in. Revisit that storyboard to make sure you can easily follow the logic from one figure to the next and that this logical order addresses the concept you are writing about.

This website contains a nice guide on how to write the results:

Organizing Academic Research Papers: 7. The Results  <https://library.sacredheart.edu/c.php?g=29803&p=1>

To summarize, each result paragraph should have:

1. An introduction sentence that tells the reader the main idea of the result you are going to present
2. A description of the results (figures, tables, etc) that points the reader to the parts that are important to note
3. A conclusion sentence that states what you can understand based on the results described in that paragraph

If you have storyboarded your figures well, you can literally go in order with one Results paragraph for each figure. This is how the Results section in publications typically are organized— related figures are put together in figures that appear in the order that they appear.

In the Results section, you are clearly stating your results and directly stating how those figures address the questions. You are not speculating about what they could mean or commenting on your experiences doing the work (save that for the Discussion section next).

More pro tips:

1. Don't try to use flowery language– aim to be clear, accurate, and easy to understand
2. Be detailed in how you describe figures. For example, “Genes are expressed differently in females and males as good as “Differential expression analysis of normalized gene expression values shows that 13 genes are upregulated in female term placentas and 10 genes are significantly upregulated in male term placentas (I
3. Write out all the results in simple words first so you can make sure it all makes sense together before you don't spend all your time obsessing over one thing at the beginning when you end up cutting it by the end
4. Don't hesitate to ask someone else to read something if you are not sure it makes sense the way you wrote it. A feedback channel is a great way to do this.

Figure Legends

Now that you have described your results in the Results section, go through each figure and write a detailed legend.

Go through each figure and come up with:

1. Brief title stating the main conclusion of the figure (ex: Genes are differentially expressed by sex in term placentas)
2. What specific details of the figure mean: what all the colors, axes, abbreviations, symbols, etc refer to (ex: red points for female expression in female samples, blue points for male samples.)
3. Relevant methods and statistics if necessary (ex: Student's t-test p-values show significant pairwise comparisons)

Additional examples can be seen here: [How To Write A Figure Legend + Published Examples](https://www.thesavvyscientist.com/how-to-write-a-figure-legend/) ➡

[\(https://www.thesavvyscientist.com/how-to-write-a-figure-legend/\)](https://www.thesavvyscientist.com/how-to-write-a-figure-legend/)

Speculations and future directions in the Discussion section

The Results section should be all business; the Discussion section is for you to talk about the big picture.

The Discussion can include:

1. Higher level interpretations that involve multiple figures in your work

2. What broader impacts or implications your work has in the field (gaps your research is filling)
3. Other applications for this work
4. What you see as sensible follow-up studies, including data that should be validated in other studies or the answering the research question
5. Any limitations of the current study that need to be considered for any follow up studies, or studies where uses your approaches to answer their own research questions
6. Unexpected results or ways your study is breaking from what is usually done or thought by other research

Here is a guide to help you write the Discussion section: [Organizing Academic Research Papers: 8. The Discussion \(https://library.sacredheart.edu/c.php?g=29803&p=185933\)](https://library.sacredheart.edu/c.php?g=29803&p=185933)

Editing the Abstract


In the last module, you drafted the Abstract to help you list out the main ideas you want to write about. Now that through the results, figures, and discussion, revisit the abstract and make sure that you:

1. Add in any main ideas you have figured out along the way to fill out holes in your logic
2. Make sure that your final order of results is reflected in the abstract
3. Add detail to make your statements more clear and accurate knowing what figures you have in your paper

Introduction and title

By this point you will have clearly described the work that you have done, good job! The last sections written when writing a scientific paper are the introduction and title. Many would argue that this is the most difficult part because you have to decide what you want to include as **relevant** background for your work and make your title catch the eye of as many researchers as possible. The Introduction section typically includes an explanation of the system being studied, results of key published studies, and the groundwork for what you are studying, and describe the gap in field that your study addresses. The title should be as concise as possible while having enough keywords to capture your main results.

Additional Resources

- Famous article that discusses how to write a paper
 - https://intra.ece.ucr.edu/~rlake/Whitesides_writing_res_paper.pdf 
 - [\(https://intra.ece.ucr.edu/~rlake/Whitesides_writing_res_paper.pdf\)](https://intra.ece.ucr.edu/~rlake/Whitesides_writing_res_paper.pdf)