Tips for Reporting your Work in Publications and Lab Write-ups[1,2]

Data is a crucial part of research. It needs to be presented effectively in a publication to allow readers to understand the key arguments/points you make. The goal of this guide is to provide you with a brief summary of how to best compile and format the copious amounts of experimental data you collect in the laboratory so that they can be easily read through tables, graphs and figures. This will ultimately help you to present data to readers in a visually appealing and concise manner that can support your scientific claims or arguments in publications.

Common ways to present data are to use graphs, figures and tables. **Tables** are best used for data that are qualitative, data sets that include only a few points, or when you want to show the actual, specific values of your measurements. Tables are most effective when seeing the details of the values/results will help to convince the reader of your claim. Alternately, tables are the appropriate choice when it is necessary to present each value for future reference. **Graphs** can be used to show trends or the relationship between different sets of data rather than the detailed information in a table. Scatter plots, line, bar, pie graphs, and histograms are some examples of graphs. **Figures** can be in the form of drawings, photos, graphics or maps. Figures often communicate concepts far more effectively than a table or text. Common software that can be used to create high-quality graphs, figures and tables include, but are not limited to, Adobe Illustrator, Microsoft Excel, Microsoft Powerpoint, Tableau, MatLab and OriginPro. For optimal results, they should be done in vector format.

Example of a well-executed graph:

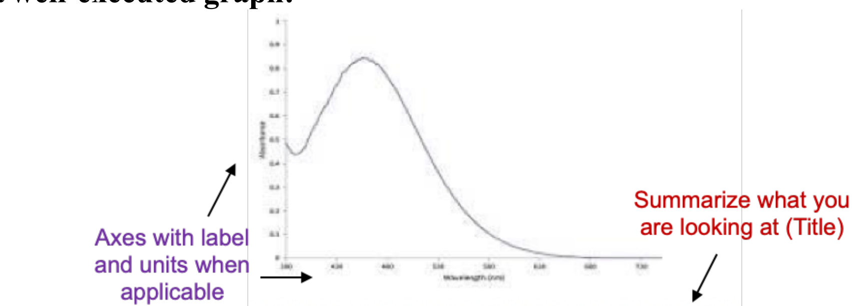


Figure 1: UV-Vis spectrum of carboxyfluorescein in methanol (5×10^{-3} M). Data was collected using a 1.00 cm cuvette on a Cary 60 spectrophotometer, in the range of 380-730 nm with a1 nm step size and 5 s averaging time. The maximum absorbance wavelength, λ_{max}, is located at 455.0 nm.

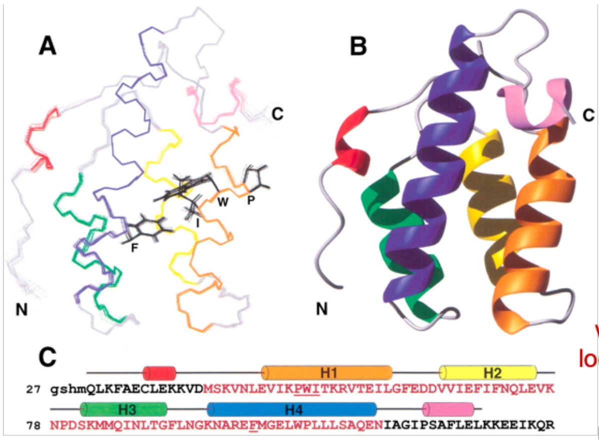
What makes a good graph?

- **Choosing the right graph type** – Bar graphs are useful for presenting data to be contrasted, but that is not related. For data that shows a correlation (whether linear or non-linear), it is appropriate to use an x-y scatter plot.
- **Captions** - *<u>Graphs do not have titles above them</u>* but are captioned on the bottom. The caption begins with the graph title. The title needs to be descriptive and provide a brief overview of the entire figure to reader. The caption should include information about what is presented, how the information was obtained and what conclusions can be drawn. In the case of a graph with two lines and no legend, the caption should also serve as a legend (i.e., `The trend before reaction (solid line) and after the reaction (dashed line)...').
- **Axes** - All axes need a label and units, unless the graphed quantity is unitless (such as pH or absorbance). Units should be included in parentheses. Variables should be clearly written out - e.g., Wavelength (nm), Temperature (K). Seconds should be

abbreviated as "s", not "sec"; minutes should be abbreviated as "min."; and hours should not be abbreviated. Scales or axes should not extend way beyond the range of the data plotted. The independent (manipulated) variable is plotted on the horizontal axis and the dependent (responding) variable is plotted on the vertical axis (y-axis).

- **Legend** - Useful if you are plotting more than one set of data on the same graph. Legends are necessary for graphs that present more than 2 data sets. If you have only two datasets, clearly describe them in the figure caption.
- **Color and shapes** – Use different colors or markers to differentiate multiple datasets on the same graph.
- **Trendlines** - Where appropriate, for showing trends in the data, add a trendline and display its equation on the graph and display the R^2 value. A calibration curve (whether linear or non-linear) should never be forced to through the origin (point 0,0).
- **Error bars** – Error bars can be used in graphs to show errors and uncertainty in a measurement, giving information about confidence intervals, standard errors, standard deviations, or other quantities. These should be clearly labeled on the graph itself. Captions should contain information whether a number that follows the ± sign is a standard error (SEM) or a standard deviation (SD).

Example of a well-executed figure:



Summarize what you are looking at (Title)

What is being presented

Figure 3: Solution structure of the PWI motif from SRm160. (*A*) Best-fit superimposition of the backbone atoms from the 20 lowest-energy structures of SRm160 residues 27–126. Residues 127–134, which are disordered, are excluded from the figure for clarity. Helical regions are colored, and nonhelical regions are in gray. Locations of the signature Pro (50), Trp (51), and Ile (52) residues, as well as the highly conserved Phe (101) residue, are indicated in black. (*B*) Ribbon representation of the lowest-energy calculated structure. The orientation and color scheme are the same as in *A*. (*C*) Sequence of the polypeptide used in structure determination. Residues labeled in brown correspond to those that constitute the PWI domain, and the black letters indicate those found in the flanking sequences. Colored cylinders above the sequence indicate α-helices, and follow the same color scheme used in *A* and *B*.[3]

Use colors to emphasize key aspects and explain in caption

What makes a good figure?

- **Captions** – _Figures, like graphs, do not have titles above them_, and are captioned on the bottom similar to graphs. The caption should include a title, details about the image shown, how the details were obtained and what conclusions can be drawn. If there are multiple panels in a figure, each panel must be explicitly referenced and described. All labels, abbreviations, and symbols used should be explained in the caption.
- **Color and shapes** – Colors or shapes can be used to highlight key differences or aspects in a figure, when relevant. For example, protein structures are often presented using cartoons and often color-coded to emphasize certain aspects of the protein to readers. Colors can be used to depict various secondary structures e.g. red (alpha-helices), blue (beta-strands), and green (random coil).
- **Blot and gel results** – Images should not be manipulated in any way that could affect the scientific information displayed. Any adjustments to improve visibility of the data must be consistently applied to the entire image. The image should contain clear annotation of the loading order, identity of experimental samples and the method used to capture the image. Molecular weight markers should also be included. If required to compare amongst bands, the samples, including relevant controls, should be run on the same blot/gel.

Example of a well-executed table:

Information about what is being shown (Title)

Table 6.1 - Cereal and Fe standard addition solutions

Solution #	Volume Cereal Solution (mL)	Volume Standard Fe Solution (mL)	Total Volume (mL)	Average Absorbance
1	10	0	100	0.0012
2	10	1	100	0.0025
3	10	2	100	0.0065
4	10	5	100	0.0125
5	10	10	100	0.0250
6	10	15	100	0.0375
7	10	20	100	0.0500
8	10	25	100	0.0630

Header row, include units

What makes a good table?

- **Title** - Located above the table. Title gives enough information about the table/figure for a reader to understand what the table is showing. An example of a Table title might be: `Table 1: Titration of 0.1 M Histidine with 0.5 M NaOH.' Tables rarely have captions, unless there is a special note. In that case, a special character is placed in the table (e.g., an asterisk (*)) and the note is placed below the table as a caption.
- **Header row(s)** - All tables have a header row at the top. These headers explain the type of data that will be found in a given column. <u>Units are always included in the header rows</u>, sometimes in the second row. Choose units that will enable the reader to easily understand data in the body of the table. For example, if milligram mass measurements are being displayed, report the values in milligrams, and report the units (in the header row) as mg or 10^{-3} g. Often, header rows are bolded or shaded so that they are easily distinguished from the other rows.
- **Breaking up the rows** - Data should be divided into categories for clarity. Horizontal lines are used to create separation between the header row(s) and the data below. All rows should be the same height, with the exception of header rows that can be taller than the others.
- **Units and precision** - Units are ***not*** included in the cells with the data but in the header.

Writing conclusion for publications and lab-write ups:
Another important component of a publication is the conclusion. It provides closure for the reader by giving them a concise summary of what was accomplished in the experiment/study, in the context of the objectives. This involves stepping back from the specifics in order to view the bigger picture of what has been done. It is not for merely summarizing what you did in the laboratory and regurgitating data to readers. Additionally, authors will evaluate and makes claims about the relative successes/failures of the work, suggests possible future work, and relate the broader significance the results will have on the field and society. Conclusion should be written in a succinct yet impactful manner. A longer conclusion only gives a false belief that it is more impressive and even distract readers from the main findings..

Example of a conclusion:
[Overview of the main argument] Chemical pollution in the air and water by factories is increasing globally every year, disrupting the biological rhythms of many insects. A decline in the populations of xyz bee species have been observed twice as frequently in the cities of abc with more factories moving into the area. **[Key takeaways]** The study indicates changes in the egg-laying behavior of xyz bee species. Detection of chemical X in the guts of xyz bees also spiked compared to five years ago, indicating possible transfer of pollutants released by factories into the diets of xyz bees. **[Limitations, further work]** Further work is needed to clarify the role of chemical pollution in disrupting other behaviors in bees, as well as in other insects in the area. Considering the government plan to further develop abc for economic purposes, proper pollution management should be carried out to minimize the detrimental effects on insect populations.

What makes a good conclusion?
- **Key takeaways from experiment/study** – Include a brief summary of the main points of the study, but do not simply repeat and restate data.
- **Limitations/issues faced in experiment/study** – Highlight the shortcomings encountered during the study, what remains unanswered and propose a course of action or a solution that can improve the study.
- **Point to broader implications** – Consider broader issues, make new connections, and elaborate on the significance of your findings to the field/society in general.

References:

1. Adapted from "Undergraduate's Guide to Writing Chemistry Papers" 2017-2018 Edition by Binyomin Abrams
2. Adapted from "Guide to Preparing Professional Exhibits" by Didem Vardar-Ulu
3. Figure taken from Szymczyna, B.R. et al. *Genes & Dev.* 2003. 17: 461-475