

# Tips for Writing a Paper

By Prof. Bruce Budowle

**Writing a scientific paper is an achievement** and is essential to progressing science and developing one's career. But quality scientific writing, a goal all scientists should strive to achieve, is demanding and requires commitment. However, most scientists, even though they have read many papers, have little or no training in writing scientific papers. Thus, the endeavor can be quite challenging, especially to those scientists who are at the beginning of their careers. A well-written manuscript conveys the purpose or goal of the work, the subject matter, methods, results, conclusions to be reached, the contribution made, and future directions in a clear and concise manner. Although, it is not possible to cover in detail all aspects and nuances to writing high-quality scientific papers, the following are recommendations that may provide some guidance towards crafting a scientific paper that can be well-structured and engages the intended readership audience.

- First and foremost, scientists should select a topic that is interesting to them, of which they have passion, and then make it interesting to the reader.

- Convey the goal, why the issue and work are important, and what value it adds.

- Focus on one topic; multiple topics or foci become diluted, and the important message can be lost.

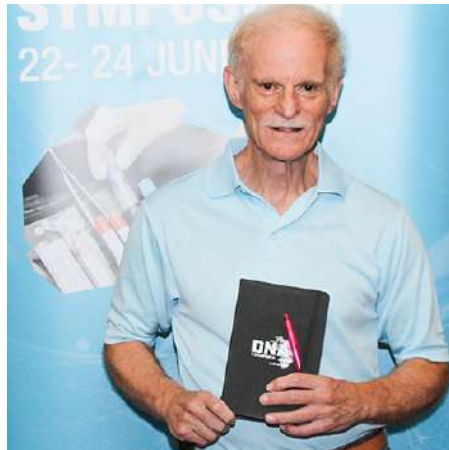
- Communicate clearly and concisely. Try to minimize redundancy. Only the main idea should be stressed multiple times. Each component should be covered in its proper place and order. Maintain continuity.

- Interconnect across disciplines and strengthen concepts across specialized sub-disciplines; engage the readership by conveying in a sound and memorable manner.

- Although the readership is highly specialized and educated, do not assume the readership is as familiar with the subject and material. Communicate simply and explain the topics and technical terms/jargon as if the reader is new to the field.

- Collaboration is an important part of research and is the norm in the complex world of science. When preparing a manuscript identify authors and their roles. Doing so can reduce conflict. Authorship is important to scientists and proper credit should be given to those who make contributions to the paper. Authorship should not be a token.

- Select a title that attracts readership and entices them to read beyond the title. In other words, capture the interest of the reader. Although the title is the first thing that will be read, it should be the last thing done in writing a paper as the content of a paper can change and be revised until it is completed.



**Prof. Bruce Budowle holds a rare academic distinction as Regents Professor for the impact of his extensive body of work.**

- Most scientific papers contain an abstract, introduction, results, discussion, and a conclusion or some variation of this theme. Look to the journal that the paper will be submitted for the specific structure.

- Beyond the title, the abstract likely is the first part, and for many readers the only part, of the paper that will be read. Thus, the abstract serves to motivate the reader to dive deeper into the paper (often jumping immediately to the conclusions and if still interested the rest of the body of the paper). The abstract is a summary of the work that very briefly captures the purpose and conclusion. Write the abstract after completing the paper because the focus and messaging may change and be revised several times before completion.

- The introduction highlights the issue/hypothesis/goal, describes the scope, current knowledge or methods, and the importance of the work. Prepare the introduction starting off generally and become progressively more precise about the reason the work needs to be done. In many ways, the introduction is telling a scientific story. Be convincing and get to the point quickly.

- The methods section describes how the work was performed and data were analyzed. Be sufficiently detailed so that a reader may be able to replicate the work if so desired and importantly can understand and interpret the results.

- The results section should provide the data and logic that support the hypothesis or goal of the research. Ensure that the results address the aim(s) of the research. Also, ensure that the methods and results align and that the aspects of each result are sufficiently explained.

- The discussion section ties together the findings and the goal(s) and explains how the results support or refute the hypothesis or aim(s). Additionally, the limitations of the interpretation provided and how the paper advances the science by identifying new prospects for future research are explained. While the introduction section was structured from general to detail, the discussion section should take the opposite format and start with results and end with general impact. Sometimes the results and discussion sections are combined; if allowable by the journal combining these sections reduces redundancy and jumping back and forth between various topics which can impact negatively the messaging and continuity.

- The conclusion section is an opportunity to highlight the big picture and the significance that impacts the greater discipline or field.

- Figures and tables (and their titles and legends) are particularly helpful because they display the data in (hopefully) a cogent manner and support the claims in the paper. Most readers who are interested in the data gravitate to the figures and tables; thus, the use of figures and tables is a great opportunity to effectively and again quickly communicate the main findings of the work.

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- Any statements of other work or supporting data outside of the novel work presented by the authors should be cited. The references should properly support the statement(s) in the text. Give proper citation; not everything that has been developed occurred in the last two years or is at the top of a google search. It may take some effort but try to reference primary sources whenever possible. Avoid citing secondary or tertiary sources. Textbooks are not primary sources and should not be referenced unless absolutely necessary to do so. Cross referencing from other papers should be avoided. Sometimes the usage of a reference in another paper does not support that paper's statement(s); the scientist always should verify what the reference actually supports.
- Embrace and eagerly seek feedback. Writing is hard and ensuring that the work is well thought out, well-structured, well-supported and effectively communicated is a challenge. Critical review from multiple people can help achieve these goals. Do not become defensive; sincerely listen to the constructive comments. Feedback more often than not will improve the paper. Having said that do not be compliant and acquiesce to all suggestions; weigh them out and make sound decisions on what feedback to accept and what feedback to not use. Do not become frustrated if multiple revisions need to be undertaken. After all, the authors have the responsibility for the final product, and all authors should want their paper to be the best presentation possible.
- Many scientific journals communicate in English. For some English is not a native language. So, during the internal review and feedback phase seek out people that can check and edit the grammar. Good writing sends a message of quality to the reviewers.
- Finally, select the best journal(s) for the work and for communicating with the intended audience. Format the manuscript and references according to the journal's policies. Proper formatting sends a message of quality to the reviewers.



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