How to Write a Scientific Report[1]

Approximately 5000 journals in the life sciences are regularly published; of this number, about 3500 are "important." In addition, there are large numbers of journals in allied fields such as clinical medicine, agriculture, and physical sciences. From these brief comments, you should reach several conclusions, among them: you must present your work carefully if you expect anyone to read it. Your work must be distilled to the essentials if you expect an editor to publish it. (In other words, a scientific report is **not** a diary.) If you understand the importance and costs of communicating science, you are well on your way to creating a good report. In the brief space available, I can not provide a manual. Instead, I will briefly describe the major elements of a typical report. *This description should give some structure to your browsing through the literature*. The best way to learn to write is to read, and then write for the purpose at hand. E.g., nonnative speakers will have difficulty with complex grammar, long sentences, uncommon vocabulary. Get your point across in the simplest straightforward manner. There is no room for personal style, rambling, or inaccuracies in scientific writing.

Title

Thousands and thousands of people will read your title. How many will be stimulated to read your paper? Make every word count. Here's a bad title: "Effect of temperature on plants." Here is a good title: "The temperature threshold for dormancy induction in *Malus* seedlings." Remember that most articles are not even retrieved by people; computers do it on the basis of key words. "Effects of..." or "Studies on..." are dead, meaningless words. On the other hand, "dormancy" will alert the searcher right away. No one will go after the first title because there is little chance that the study will be relevant to the researcher. Only truly interested people will go after the second title, which may be an advantage to you. (It is common practice to send the author a reprint-request card. Reprints are expensive to buy and expensive to mail. Once you go to the trouble to send a reprint, you **do** hope that it will be read.)

Abstract

If you did a good job with the title, you may attract readers to the abstract, which is a summary of the essential pieces of information and conclusions reached. Brevity is of the

[1] François Jacob wrote in his autobiography, "writing a paper is to substitute order for the disorder and agitation that animate life in the laboratory . . . to replace the real order of events and discoveries by what appears as the logical order, the one that should have been followed if the conclusions were known from the start."

essence. E.g., methodological *details*, unless important to the conclusion, should be omitted. References to previous work usually should be omitted. A reader will use the abstract to determine quickly whether the full document has relevancy to his or her interest. The task is to put into 200 words the major elements of a scientific paper, viz., (a) the question investigated and why, (b) the general methods employed, (c) the essence of the results, and (d) the principal conclusions.

The shortest abstract ever written, according to R.A. Day, was "$e = mc^2$."

Introduction

The purpose of the introduction is to **introduce** the paper. You should state the nature and the scope of the problem. Why *was* it interesting and worthwhile to do? You should provide scientific background; the reader in your target audience should not have to consult other work for a general understanding of your paper. What will the data permit the reader to conclude? Chart the course that will follow; the introduction is a kind of map—scientists are busy, make it easy for them.

Materials and Methods

You must include full details that permit a competent colleague to reproduce the paper. The Materials and Methods and the Results are the cornerstones of a scientific paper. Sometimes, I read only these two sections because I will put the work into the context of the literature and make the conclusions myself. It is fine to reference other work that is readily available or common knowledge. Everyone will know "according to the method of Lowry[2] *et al.* (1951)," but for most methods, even if you reference, you will want to give the reader a notion of the approach, e.g., "Potassium was determined by flame photometry (Doe and Doe, 1994)."

Results

This is the new knowledge. It is what you are contributing. It is not a place to rehash methods. It is not a place to express opinions. Predigest your data. The reader is not interested in the results on the day that you forgot to complete the cocktail. It is your responsibility to edit your work--no one has the interest or time to go through the hundreds of readings that you may have taken. Use representative experiments or, if appropriate, statistical representations, such as the mean and associated errors. Remember that the other parts of the report are included as support for the results.

Discussion

[2] Dr. Lowry died in 1996, before reaching his 86th birthday on July 18. All of us, and I in particular, must always remember that it is much easier for us to stand tall today because we stand on the shoulders of giants like Dr. Lowry.

The discussion is perhaps the hardest part to write, as it requires "the grand vision." What do the data mean? How do your results *and all other results* provide a more complete interpretation of how the world works? Your task here is to discuss, not simply to restate, the results. Do your data fit with those of Jones *et al.*(1998)? Are your results internally inconsistent? Point to the strengths and weaknesses of your work. Are there alternative interpretations? When you finish writing the discussion, which you should do last, you should decide whether to throw the paper away or try to get it published.

Literature

Your research started with the literature, and it is fitting that the report should end with it. Restrict the number of references to the minimum. No one cares how many papers you have read. For generally accepted ideas (e.g., mass action), use no reference. For accepted ideas more or less peripheral to the central issue of your work, provide a reference to the secondary literature (reviews). Then the choice is harder. Do NOT simply cite a paper because it conveniently supports your work. Do what is right, fair, and accurate. Cite the first paper that provided unambiguous proof for the idea *or* cite several typical papers (if you wish to establish the generality of the phenomenon).

Credit

The report cannot be used to satisy the Gordon Rule.