

# How to Write Your Scientific Paper

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Scientists frequently communicate the results of their work in research reports. They tell others **what** study they performed, **why** they did it, **what** they discovered, and **what** it means. Regardless of the specific discipline involved, **all research reports follow a general format**: *Title Page, Abstract, Acknowledgments, Introduction, Methods and Materials, Results, Discussion, Conclusion, and Literature Cited* (and *Appendices*, if necessary). The separate sections are described below. Additional helpful information about writing a scientific paper can be found at the JSHS website [www.jshs.org](http://www.jshs.org) under Guidelines.

Your paper should follow this format, be neatly typed (double-spaced using 12 point font, and printed with a letter quality printer), and carefully edited. Your paper should not exceed 20 pages, not including appendices, tables, and figures. **Each section of the paper should be clearly labeled with a section title.** Refer to the *Scientific Paper*

*Evaluation Form* for details about how your paper will be evaluated in determining whether or not you will be invited to present your research at the ASHSSS meeting.

## Title Page

Title page should include Research Paper Title, Author, School, City, State, and Date. Make the title of your study **concise, descriptive, and informative**. Your title should indicate the nature of your research. "Studies on slug slime" is not as descriptive as "Chemical constituents of slug slime."

## Abstract

It is best to write your abstract **AFTER** completing a draft of your scientific paper.

(See [How to Write An Abstract](#) for more details.)

## Acknowledgments

You should acknowledge the assistance of those who helped with your study: mentors, financial supporters, teachers, scientists, proofreaders, typists, etc. You should keep this section brief, but be sure to identify major contributions. Some examples of acknowledgments include: "I thank Backwoods Paper Company for needed supplies, research space, and advice..." "I thank the following for advice and guidance: Mr. James Sprague (my teacher), Ms. Joy Adams, Mr. Todd Reed, and Ms. Rita I retowsha (fellow students)..."

## Introduction

What problem did you investigate? Why did you choose this subject, and why is it important? What hypotheses did you test? Based upon your reading, what results did you anticipate, and why? The

introduction should address these and similar questions. To tackle the last question, some literature (library) research will be necessary. If you include information from other sources to explain what is currently known about the topic and why you are anticipating certain results, **be sure to cite those references in the body of your paper.** (See the [Literature Cited](#) section of these instructions for details.) Assume that the reader is scientifically literate, but may not be familiar with the specifics of your study.

Be careful not to fall into the trap of believing that all research must have world-shaking consequences to the human race. That certainly is not true. You may be simply investigating a small facet of the life history of some creature. If so, don't bother fabricating a story simply to "justify" your work.

## Methods and Materials

**How** did you conduct your study? **What equipment** did you use? **What procedures** did you follow?

Relate your procedures in **sufficient detail** so that someone else (or you!) could repeat the experiment. Species of organisms studied **may** be important (depending upon the type of study); the level of precision of your instruments is certainly important to mention here. Since your procedures have been completed, **report them using past tense.** You may use first person, active voice ("We added 2 ml of water...") or passive voice ("Two ml of water were added..."). This section should be written in narrative, paragraph format, not as a list of numbered steps, and should not include any results. Materials should not be listed separately, but should be included in the description of the methods. Use figures, if appropriate, to help the reader picture the equipment. Include criteria for selection and an "informed consent" statement if human subjects were used. If using a standard method, you may cite the literature reference and give only the details specific to your experiment. If your work is based on a questionnaire or survey, include

the blank questionnaire/survey as part of the Methods section (or place it in an appendix and refer to it in the Methods section).

## Results

**What did you find?** Present the results of your research in a logical order. Use tables and figures (such as graphs) to visually aid your reader to see and understand your results readily. Tables and figures need to be numbered and titled separately. This will enable you to refer to them in text quite easily ("Data in Table 3 suggest that plants are..."). Each table or figure also needs a descriptive caption to aid the reader in deciphering what is supposed to be seen in that particular table or figure. Even though you may present your results in a table or figure, be certain to **explain in the body of your paper** the important features of each. If a trend is indicated in a figure, point out that trend to your reader. **DO NOT INTERPRET your results in this section.** That comes next!

## Discussion

In this section, you should interpret your results. What do your results mean? Are data consistent with your initial hypothesis? Do data support or reject your hypothesis? Do you need to revise the hypothesis? How do your results compare with the results of other scientists performing similar experiments? What conclusions can be drawn from the results of your experiment? If there are ambiguities in your results, what further experiments need to be performed? What are possible directions for future research? What are the theoretical implications or practical applications of your work?

## Conclusion

What do you conclude, based upon your work and reading on this topic? Wrap up your paper with a brief summary of your conclusions.

## Literature Cited

When you refer to the work of another scientist in your paper, **you must indicate the source** of that information. That way, someone reading your paper will realize that the information comes from another project. Also, the reader may wish to examine other experiments, such as the one you cited. Failure to cite the work of another scientist (that you used in writing your paper) results in a serious offense (plagiarism) that is akin to stealing and is severely frowned upon. Therefore, all information that is not from your experiment and is not "common knowledge" must be acknowledged by a citation.

The preferred method of **citing a reference in text** in most scientific papers is the author-date system. The citation (author last name and year of publication) should be placed naturally into the flow of the sentence. If the name of the author appears as part of the text, cite only the year of the publication. For example, "Campbell (1975) saw gulls driving incubating females from their nests." Otherwise, place both the name and year in parentheses, as in "Gulls have been observed to drive incubating females from their nests (Campbell 1975)." If there are two authors, cite them both, as in "(Dwernychuk and Boag 1972)." When there are more than two authors, cite only the name of the first author and indicate the rest by using "et al." (meaning "and all others"), as in "(Divoky et al. 1974)." When a reference has no individual author or the author is unknown, use the name of the agency or group which published the document, or the name of the lead editor. If there is no author, agency, or editor, use all or part of the title (enough of the title that the reference can be easily identified).

The most common method of listing articles cited in your paper is to place them in a "Literature Cited" section at the end of the paper. **All literature cited in the body of your paper must be listed in your Literature Cited section, and all references in the list must be cited in the text.** Sources not actually cited should not be included in

the Literature Cited section. (This is different from a bibliography, in which you list everything you read, whether or not you actually cited it in your paper.)

**References should be listed in alphabetical order, according to the first author's last name.** All types of references should be lumped together before you alphabetize--do **not** make separate lists for books, articles, etc. References should be single spaced and left justified, with additional lines indented five spaces (1/2 inch). Double-space **between** references. Works by the same person should be arranged chronologically by the date of publication. Be sure to include enough information that each source can be identified and located. The following examples should be helpful.

(The comments on the left are there to explain each entry, but should not be included in the Literature Cited section of your paper. The information inside the box is what your Literature Cited section should look like.)

|   | <u>Literature Cited</u>   |
|---|---|
| pamphlet,<br>organization as<br>author      | American Society for Microbiology. 1994. Slide and poster requirements. Pamphlet. Washington, DC: ASM.        |
| interview                                   | Barber, J.D. 8 May 1995. Interview by author. Carbondale, IL.   |
| telephone<br>conversation                   | Barber, J.D. 15 May 1995. Personal communication.   |
| book, one author                            | Day, R.A. 1994. <i>How to write and publish a scientific paper</i> . 4 <sup>th</sup> ed. Phoenix: Oryx Press. |
| journal article,<br>more than one<br>author | Kohara, Y., K. Akiyama, and K. Isono. 1987. The physical map of the whole E.                                  |

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|-----------------------------------|---|
|                                   | <u>coli</u> chromosome: application of a new strategy for rapid analysis and sorting of a large genomic library. <i>Cell</i> 50:495-508.  |
| encyclopedia,<br>editor/no author | Lorimer, L.T., ed. 1993. Magnet and magnetism. In <i>Encyclopedia Americana</i> . Vol. 15. New York: Americana Corp.  |
| internet                          | Martin, Linda. 08 Nov. 1997. General Information.<br>< <a href="http://www.science.siu.edu/ijshs/info.html">http://www.science.siu.edu/ijshs/info.html</a> > Accessed 20 Nov. 1997. |
| newspaper,<br>discontinuous pages | McDonald, K.A. 15 Dec 1995. Researchers ponder a stormy forecast. <i>The Chronicle of Higher Education</i> . A12, A16.  |
| newspaper, no<br>author           | Study finds free care used more. May 1989. <i>APA Monitor</i> . 14.   |

## Appendix

Appendices contain supplemental information such as lists of terms, definitions, or questionnaires that are useful but not essential to the body of the research paper. If you have a large table of raw data, but most of it is not essential to the discussion in your paper, you could include the complete table as an appendix. A smaller table with a subset of data (or a summary of the data) could then be included in the body of your paper. If you have more than one set of materials to include, give each a number: Appendix 1, Appendix 2, etc.

