



How to write a scientific research paper

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The very first decision you need to make is to which journal you intend to submit. This in itself is often a difficult task. Many factors are involved in the decision (e.g. impact of the journal vs probability of acceptance; publication lag; desired audience, etc)

Once you decide, read the journal's "Instructions for authors", usually found inside the front or back cover. Ensure that you follow all of these to the letter.

Also, journals differ in style - some use "Introduction" as a heading for that section, others don't. Peruse some published papers to acquaint yourself with the journal's style. This is much easier than reading the formatting instructions.

The Sections of a Research Paper

Different journals may use different section headings and subheadings. But most or all of the following usually occur:

- Title
- Abstract
- Introduction
- Methods
- Results
- Discussion
- Acknowledgements
- References
- Tables
- Figure Legends
- Figures

Note that the Methods section usually contains subsections, most frequently (although there is variation depending on the nature of the research):

- Subjects
- Apparatus
- Stimuli
- Procedures

It is extremely important that everything goes in the correct place. Thus, Apparatus (equipment, tests, lab or room etc) should not refer to Procedures (instructions, flash duration, experimental design, time of day, etc) and *vice-versa*.

Similarly, the Results section should contain just factual result reporting (in the past tense) including statistical tests but no discussion.

Let's now consider each of the sections in turn.

Title: This should be as short as possible but should also give a clear indication of the paper's content

Abstract: No longer than 100-200 words. Should factually describe the purpose, techniques, results and implications. No details of methods. It should grab attention and create a desire to read on. Write it last, when you know what's in the paper. Absolutely no jargon.

Introduction: Places the study in the context of previous research but tells only what the reader needs to know to understand the present work. Either avoid jargon or explain it very clearly.

Methods: The first paragraph of the Introduction is the hardest part of a paper to write. Methods is the easiest and can be started even when the research is unfinished. So start there. Must be specific enough to permit replication. Where necessary, justify choices made (of variables, techniques etc).

Results: The results - writing, statistics and graphs - should be presented as simply as possible. Try to make figure legends self contained (see Discussion below) so that reference to the text is unnecessary. Do not present irrelevant data to which the Discussion will not refer. Past tense: “Regression analysis indicated ...”

Discussion: When most people read a paper, they read the Abstract first, then the Introduction, some graphs or tables and then the Discussion. Therefore, the Discussion should begin by summarising the main findings. Then interpret the findings in relation to the Introduction and finally draw conclusions. Keep the discussion to the results, i.e. do not go beyond the data. Present tense: “One possible explanation is

Acknowledgments: Acknowledge the significant assistance of those who helped you plus any financial support (e.g. grant agency) or in-kind support.

References: Make sure that you use the style of referencing that the journal requires. Software such as EndNote, Reference Manager or ProCite makes this easy and ends typing References for ever. Ensure all cited items are listed and no listed references are uncited in the text. Editors use References to choose referees - you can make use of this!

Tables: Use the style of table specified in the Instructions to authors or used in papers in the journal

Figure Legends: Make these as clear as possible, ensuring that there are no aspects of the figure which are not explained either in the legend or the figure itself.

Figures: Make these as uncluttered and as easy to read as possible. Always present error bars. It is really worth investing in software which gives you complete and quality control of graph design (e.g. Kaleidagraph)

Writing a Research Paper: Hints and Tips

This is a list of hints and common flaws, in no particular order:

- Always write a draft and leave a day or two before rereading to polish
- Avoid clumsy phrasing and try to eliminate all unnecessary words
- Give the draft to an experienced author and take heed of comments
- Avoid unnecessary meaningless words - “basically”, “as such”
- Don’t use plural (criteria, phenomena) when you mean singular (criterion, phenomenon)
- Don’t use “less” (quantity) when you mean “fewer” (number).
- Always do a spell check. Reviewers hate multiple spelling errors
- When ready to send the paper, don’t. Wait a day and read it once more. You will almost certainly find errors you had missed. *This is personal experience talking*

Writing a Research Paper: Hints and Tips

- Use active voice (“I/We estimated the midpoint”) rather than passive (“The midpoint was estimated”)
- Avoid split infinitives (“..to manually invert”) by placing the adverb after the verb (“..to invert manually”)
- Aim for economy - replace “based upon the fact that” and “for the purpose of” with “because” and “to”.
- When you write a paper - just as when you give a talk - there are lots of ways to turn your audience off. Being boring is one
- ... another is using endless footnotes, which breaks continuity. Avoid!
- Whether a paper or talk, know, and be considerate of, your audience.
- Don’t get hamstrung by statistics: the aim of statistics is to describe your results succinctly and clearly - in my view, nothing more

Writing a Research Paper: Hints and Tips

- Rarely is a paper accepted without revision. When a paper is returned for revision, the referee reports always sound worse than they are on first reading. Make a list of exactly what you need to do, then do it.
- When returning a revision, attach a letter specifying exactly what you've done to meet each referee's criticisms. Where you haven't done something requested justify not doing it. That is, address every point.
- If one of three referees says more experiments are needed you might try to argue against that. But if all three say it, it is probably true.
- In the end, if a paper is rejected outright, don't react negatively. Use the referee reports to improve the paper for submission to another journal.