HOW TO WRITE A RESEARCH PAPER

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Before starting to write

- Put together structure of the paper:

  - Title, authors, addresses, possibly key words, etc.
  - Abstract
  - 1. Introduction
  - 2. Survey of the literature
  - Methods , Materials, Data
  - 3. Results
  - 4. Conclusions
  - References
  - Appendix

Before starting to write

- Select which results to show
  - Often a good idea to choose the figures to be published
  - Criteria: **Does the figure show something new? Is it important to understand technique or results?**
  - Remember: your interest in the details of your work is larger than that of the reader ➔ choose!
- Find the order of writing the various parts of the paper that is most natural for you
  - E.g. I like to start at introduction and write through to the end, then add figure captions, references and abstract
  - **Or figure captions ->abstract -> main -> abstract**

The Title

- The title often decides if the paper is looked at by colleagues: So many papers, so little time!
  - I first check the title (and/or authors). If interesting I look at the abstract. If I'm still interested I look at the figures and only then do I read through the text.

- The title should be attractive
- The title should not be too long
- It should reflect the general field of the paper
- It should be as precise as possible
- It should not be too grandiose or promise too much.

Authors & Affiliations

- Choosing the authors and their order can sometimes be a delicate matter.
  - Researchers do research because they enjoy it. However, they usually don't mind some recognition for their work, or their ideas ➔ Co-authorship as a reward.
  - Authorship of good papers is also important for a Researcher's career
  - Deciding who should be a co-author, who should be in the acknowledgements & the order in which authors stand on the paper can be tricky.

Authors & Affiliations

- Write out first names or only use initials?
  - Check the guidelines of the journal you propose to publish in.
  - Full name is of advantage if
    - There is another reasearcher with your Surname and first initial
    - You are a woman in a male-dominated field. Specially important if you are the only author, so that your work isn't cited as, "German idiosyncrasies have been charmingly discussed by M. Curie (2004). As he has shown...."

Abstract

- Structure of abstracts: condensate of paper in one paragraph
  - Start with typically 1-2 sentences on background & aims
  - Followed by a very short description of what has been done
  - Finally bring the main results & major consequences
- I suggest using the **active voice** (first person)
- No figures, no tables, no references (usually), no footnotes, avoid abbreviations, equations and symbols, make sentences short.

The Introduction and the survey of literature

- In the introduction you describe the background and context of your work and the structure of the paper,
- A short overview of the relevant literature. Say **why the present work needs to be done. Some criticism of earlier work may be necessary.** Try to be mild**.** You don't want others to be harsh about your work either.
- Definitely needed: Goals of your paper. If similar papers exist: **what is new** in the method or results.

Methods and Data

- Scientific results **must be reproducible**. The Methods and data section is the key to guaranteeing reproducibility of your results, since it describes what you have done, how you have done it and with what.

- The “when” can also be important: give the time & date(s) of your observations, specially when studying variable phenomena.

- This section is often studied carefully by the referee. It can decide whether he/she feels that the results can be trusted or not. If he/she feels that **the technique isn’t strong enough, the paper will be rejected.**

Methods and Data

- Rule of thumb:
  - New method, new instrument, new type of data ➔ Describe in detail, since required for reproducibility.
  - Known method or instrument, previously used and described in other paper(s) ➔ Often a reference is sufficient.
- Do not repeat descriptions
- Often a figure can illustrate & clarify the method

Results

- The core of the paper, where the results obtained during the long labour of research are presented.

- Be concise. Pre-select the results (i.e. identify the important and new results) before writing about them in the results section.

➔Keep in mind:

The fool collects facts, the wise man selects them

(John W. Powell)

(don't be too wise: first collect the facts, then select them)

Results: Figures

- Use figures to show the main results if possible.
- Each figure must be referred to in the text.
- Each figure must have a caption.
  - Captions should be short, but **self-explaining**, since often figures are looked at before the text is read. I.e. if symbols or abbreviations are used, then they must have been defined in an earlier figure caption.
  - Captions should only clarify what is plotted and not try to interpret the figure. **Interpret the figures in the main text.**

Tables

- Make a table if you have multiple numbers to show
  - and you cannot put them into a figure,
  - or if the exact numbers are important
- Remember, figures are generally easier to read than tables.
- A table may also be useful in the Methods section – e.g. a table of observations.
- Each table must have a title. Keep it short.
- Each table must be referred to in the text.
- Describe the different columns of the table

Discussion

- In this section the already presented results are discussed and conclusions are drawn from them.

- Alternative title: Discussion and conclusions. Sometime broken up into two separate sections.

- This is often a difficult section to write, since drawing conclusions from the given data or theoretical results is not always straightforward. **Drawing conclusions is an exercise in logic**, requires some knowledge of the literature and some experience of the object being studied.

References

- References are a place where a lot of errors are propagated.
  - Make sure that the references are correct! Check with the paper directly Check if all papers cited in the text are also present in the references and vice versa
  - Check if dates, authors etc. agree between text & reference list; e.g. a paper that appeared in 1995a is also listed as such in the references.

Appendices

- Material that may be of interest for some readers, but not for most (e.g. lengthy tables, derivations of equations) can be put into an appendix or into multiple appendices.
- Most papers do not have an appendix.
- An appendix must be referred to in the main paper

Don’t forget the reader

- Remember the reader. Aim at a junior PhD student working in the same general field. The 4 principles of writing for the reader:
  - The clarity principle: Make everything clear to the reader, but do not give more information than is necessary.
  - The reality principle: Assume that your readers know how the world works and do not need to be told everything, but be sure to tell them anything that you believe that they may not know & need to know.
  - The relevance principle: Stick to your topic and don’t lose the aim of your paper from sight.
  - The honesty principle: State only what you can provide evidence for.

Style: The Dos

- Spell out your assumptions (Intro. or Methods Sect.)
- Be as precise as possible. If you have numbers, use them.
- Avoid using too many abbreviations. Define the abbreviations the first time they are used. E.g.: “Another name for Father Christmas (FC) is Santa Clause (SC). FC does most of his work in the run up to Christmas and so does SC, of course.”
- Define all symbols the first time you use them
- Give the units! SI units are now generally agreed upon.

Style: The Don'ts

- Don't copy whole sections or paragraphs from other papers, including your own, even if this seems inviting since they are already well formulated.
- There are also problems of ethics with this practice, specially if you are copying from papers that aren't your own
- If you do that, your scientific career is very likely to be dead.