Writing and Publishing Scientific Papers

A Primer for the Non-English Speaker

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8. Abstract and Keywords

The Abstract (sometimes called the Summary) is always printed near the start of the paper, usually immediately after the title, authors and addresses. This is, one can argue, the most significant part of a paper, because:

- this is the part that is read by most people, even by those who will, ultimately, not read the whole paper.
- most readers, including the first reader of your manuscript submission — the editor — will also start reading here. First impressions are important. Moreover, the editors know from experience that a bad abstract is rarely followed by a brilliant paper. Consequently, after reading the abstract, the editor will be close to forming a first opinion.
- an abstract is often reproduced by itself in various databases. This dictates that the requirement that the summary should be self-explanatory — it must be understood without reference to other parts of the paper. For many readers of the summary, the full paper will not even be available.

Occasionally, an abstract gains additional importance. Conference invitation, participation, and even financial support to attend, can depend on the abstract of a proposed contribution. In these cases, the conference organisers must make their decision based on the abstract only. So, a good abstract can influence organisers to offer conference acceptance and/or funds to support participation.

A good abstract is a mini-review of the paper. It states, briefly, the question/problem, the method(s) used, followed by brief results and the main conclusions. Some journals follow a system of numbered statements, or headings within the summary. A few provide detailed

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instructions (Box 7). However, even if the journal in question does not indicate the main aspects with headings, you have to follow the same structure.

Box 7. Nature's abstract-writing template

nature

How to construct a *Nature* summary paragraph

Annotated example taken from *Nature* **435**, 114-118 (5 May 2005).

*One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.*

*Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.*

*One sentence clearly stating the **general problem** being addressed by this particular study.*

*One sentence summarising the main result (with the words "**here we show**" or their equivalent).*

*Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.*

*One or two sentences to put the results into a more **general context**.*

*Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words.*
(The above example is 190 words without the final section, and 250 words with it).

During cell division, mitotic spindles are assembled by microtubule-based motor proteins[1,2]. The bipolar organization of spindles is essential for proper segregation of chromosomes, and requires plus-end-directed homotetrameric motor proteins of the widely conserved kinesin-5 (BimC) family[3]. Hypotheses for bipolar spindle formation include the 'push–pull mitotic muscle' model, in which kinesin-5 and opposing motor proteins act between overlapping microtubules[2,4,5]. However, the precise roles of kinesin-5 during this process are unknown. Here we show that the vertebrate kinesin-5 Eg5 drives the sliding of microtubules depending on their relative orientation. We found in controlled *in vitro* assays that Eg5 has the remarkable capability of simultaneously moving at ~20 nm s^{-1} towards the plus-ends of each of the two microtubules it crosslinks. For anti-parallel microtubules, this results in relative sliding at ~40 nm s^{-1}, comparable to spindle pole separation rates *in vivo*[6]. Furthermore, we found that Eg5 can tether microtubule plus-ends, suggesting an additional microtubule-binding mode for Eg5. Our results demonstrate how members of the kinesin-5 family are likely to function in mitosis, pushing apart interpolar microtubules as well as recruiting microtubules into bundles that are subsequently polarized by relative sliding. We anticipate our assay to be a starting point for more sophisticated *in vitro* models of mitotic spindles. For example, the individual and combined action of multiple mitotic motors could be tested, including minus-end-directed motors opposing Eg5 motility. Furthermore, Eg5 inhibition is a major target of anti-cancer drug development, and a well-defined and quantitative assay for motor function will be relevant for such developments.

Nature's abstract-writing template, https://www.nature.com/nature/for-authors/formatting-guide.

Because an abstract is often reproduced separately from the full paper, it has to be self-explanatory. Consequently, you should avoid using abbreviations, because they are understandable only by reference to the full article. Similarly, references to figures or tables are not allowed, because readers who only have access to the abstract cannot check or see the figure mentioned. For the same reason, references to published

articles should be avoided. If unavoidable (for example, your paper is a direct reply to a published paper), a short version of the full reference should appear in the abstract. This short version should include the surname of the first author, the year of publication, the abbreviated name of the journal, the volume number, and the number of the first page only.

Style

Abstracts always have a word limit, usually 200-500 words. You cannot go beyond this limit, but it is not mandatory to use all of it. If you can clearly summarise your study in 150 words, you do not have to use 200. The important thing is that you should not list what was done, but concentrate on the results. The abstract centres on your own results, so it should be mostly written in the past tense.

The abstract is a summary of the paper, and there should be no statement or conclusion that is not in the paper. One should be careful not to include information that is not in the text (a surprisingly common error!). A good abstract is not a set of carefully cut-and-pasted sentences from the full paper; you must rephrase the same facts or statements that are present — usually in more detail — in the paper itself. At the end, the conclusions can be mentioned. These, however, should be meaningful. The statement that "The consequences are discussed" is neither very original, nor does it say much. This is the purpose of the discussion, after all. "More research is needed" is another meaningless conclusion. Avoid "throwaway sentences" such as these.

When to Write?

I suggest that the abstract is best written once the manuscript itself is finished. This is only a personal recommendation as I do this myself. If it helps you to structure the paper, you can start with drafting the main points but I find it unlikely that you can write an effective summary of your work before it is completed.

Research Highlights, Graphical Abstract

Several journals now require a tightly structured set of "research highlights". The relationship between these and the full summary is a little like that between the running title and the full title. Concentrate on your main results, and consider, carefully, how to shorten them because this section is limited by the number of spaces, i.e. letters and punctuation.

If required, a graphical abstract accompanies the research highlights. Both will appear on the website of the journal but not, usually, in the final paper. When facing such a task, think about creating a new figure rather than repeating one of your figures from the full paper. However, this is not a rule: in cases when your main results can be effectively presented on a graph, this graphical abstract can be identical to a figure that is also in the paper.

Keywords

Keywords serve to assist those who use various databases and search engines to find your paper. They are usually single words that mention some important concept or aspect of your study. The number of keywords is always limited, usually to 6-10 words (double words and, exceptionally, triple words are also allowed). These key words will be entered into databases and keyword lists.

It is a good idea not to use words that are already contained in the title, because effective title words are always used for the same purpose. Given the limited number of possible "pointers" to your paper, it would be a wasted opportunity to use the same word twice: once in the title, and again among the keywords. Several journals do not allow title words to also be keywords. An effective keyword is a word with a specific meaning or significance; words such as *study, change,* or *experiment* are not effective words in this context.

When considering keywords, imagine yourself as someone searching for your paper. What aspects are relevant? These can be locations, organism names, concepts, or method terms. Avoid fashionable, or too general, keywords — a reader searching for information on a certain topic will probably disregard the results of a search with hundreds

of "hits". Thus, if you include a keyword that is frequently used, your article may be included, but in so large a result list that it does not help the searcher. Still, you can mention broader ideas, or concepts. If your title contains a species name, mention the family or higher taxonomic association. If there is only a scientific name in the title, include the common name. If it contains a location name, add the name of a wider region. Likewise, if you indicated a kind of habitat, add the more precise location as a keyword.

However, use this option in moderation — you do not have to use the maximum number of keywords allowed. You can write fewer keywords if you want, but you cannot include more.

Keywords are usually placed after the abstract — but check the journal instructions for precise placement of the keywords.