

## Writing a Research Manuscript

Your Research Manuscript should generally consist of five parts: abstract, introduction, methods, results, and discussion. Your writing should be clear and precise throughout each of these sections.

### Abstract

The abstract is the *final* thing you will write. You should think of the abstract as a miniature version of the whole article. Most often, abstracts are read separately and help readers decide whether or not to read the full article.

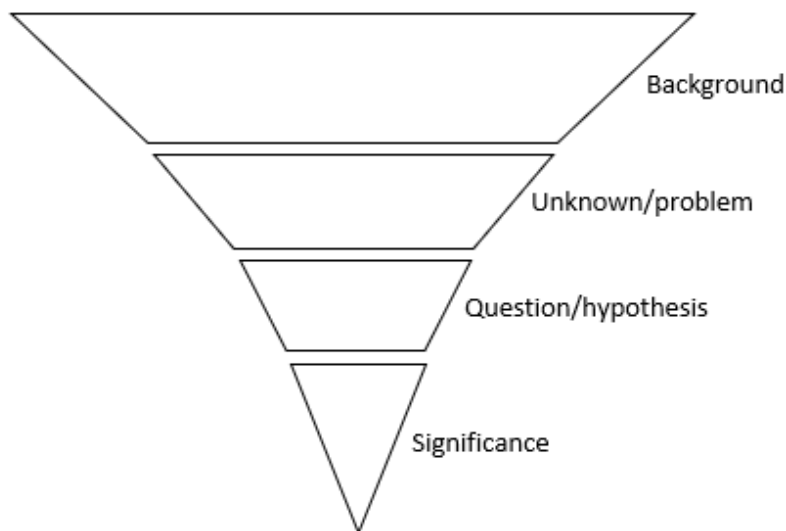
An abstract should include the following elements:

- Question/purpose of the study
- Experimental/study approach
- Results
- Conclusion or answer/implication of the research
- Optional: a short background *and* significance of the study

Using signal phrases in the abstract can help guide the reader and ensure that all the necessary information is present. Below are some examples of signals.

Question/observation	Results	Answer/conclusion	Implication
We asked whether... X was studied by...	We found... Our results show...	We conclude that... Thus...	These results suggest that... Y can be used to...

### Introduction



An introduction should follow a funnel structure that starts broadly and moves to the more specific. Your introduction should not only interest the reader, but also provide enough context that it is evident *why* the study was performed and *what* the specific research question is. The most important part of the introduction is the research question so it should be stated very precisely.

An introduction should include the following elements:

- **Background information:** provide important background information
  - include a brief overview of the current literature in this area and cite relevant studies
  - your results/data/interpretation should not be included here
- **Unknown/problem:** include problems or gaps in previous work as well as unknown factors in this area
- **Question/hypothesis:** what addition to this area does your research provide?
- **Significance:** why is this study important? What gap in the research is this study filling? Stating the significance at the end of the introduction can round out the section and provide an overall perspective of the work to the reader

Just as with the abstract, the introduction should include signal phrases to guide the reader and ensure all necessary is present. Below are some examples of signals.

Background	Unknown	Question/hypothesis	Experimental/ Study approach	Significance
X is... X affects... X is observed when Y happens...	...is unknown. ...is unclear ...does not exist.	To determine... To analyze... In this study we examined...	To test this hypothesis, we... For this purpose, we...	...is important for...  This data is significant because...

### Methods

The methods section describes the experiment/study approach that is used to arrive at your conclusion. This section usually does not include figures or tables unless they are absolutely necessary to describe the study's set-up. The methods section should be detailed enough that a trained scientist could evaluate and repeat the work. Be aware of the appropriate tense in this section. Use the past tense to report completed actions. For example, "Sixty-five patient charts **were reviewed**." Use the present tense for information that is still true and information that references figures, tables, and appendices. For example, "DNA **contains** genetic code," or "Criteria used in selecting subjects **are listed** in Table 2."

The methods section should include the following elements:

- Materials (i.e., drugs, buffer, gases, apparatus used)
- Subjects (i.e., patients, animals, microorganisms, plants)
  - include IRB approval if your study involves human subjects
  - include any inclusion/exclusion criteria
  - include demographic information of study participants (see JAMA <https://jamanetwork.com/journals/jama/fullarticle/2783090> for guidelines on reporting race and ethnicity)
- Design (including independent/dependent variables, experiment/study and control groups)
- Procedures (what, how, and why something was done)
- Statistical analysis
  - Include enough detail for readers to determine if appropriate statistics were used for the study design

### Results

The results section presents the results of the study and directs the reader to the data that supports those results. The chronology of the results section should follow the order in which you present your methodology. The data in the results section is often shown in figures and tables. You should present your main findings in the first paragraph of the results section. You may want to begin with a brief overview of your general observations before you move into the main findings. You should report results in the past tense.

In the subsequent paragraphs, structure each experimental part by stating:

- Experimental approach
- Results

If data is provided *without* an explanation, findings are not very meaningful to the reader. Just as with the abstract and introduction, the results section should include signal phrase for each element. Below are some examples of signals.

Purpose/question	Experimental/study approach	Results
To determine...	...we did...	We found...
To establish if...	X was subject to...	We observed...
Z was tested...	...by/using...	We detected...
For the purpose of XYZ...	ABC was performed.	

### Discussion

Good style and clear, logical presentation of information is especially important in the discussion. The first paragraph of your discussion should include:

- An interpretation or answer based on the key findings
- Supporting evidence for the interpretation or answer

The middle paragraphs of the discussion should include:

- Secondary results
- The limitations of the study
- Any unexpected findings in the study
- Comparisons and contrast to previous studies in the area
- Hypotheses or models for the study

The final and concluding paragraph should include:

- Summary of the study
- The significance of the study and implications for future research

At the end of the discussion, you should provide some closure by writing a one-paragraph summary of the findings.

Just as with the abstract, introduction, and materials and methods sections, using signal phrases can help guide the reader and organize the discussion section. Below are some examples of signals.

Key findings	Interpretation	Significance	Summary
We determined X by...	..., indicating that...	Y indicates that X	In summary...
Our data shows that...	..., consistent with...	might...	In conclusion...
We found that...	..., which indicates	These findings imply	Finally, ...
...has been	that...	that X may...	To summarize our
demonstrated by...	This observation	Here we propose that...	results, ...
	indicates that...		

### Appendices

If your study includes surveys or open-ended questions, those responses should be included in an appendix at the end of your study.

### Writing and Phrasing

For more information and guidelines regarding correct and preferred usage of words and phrases, see the AMA Manual of Style: [https://static.primary.prod.gcms.the-infra.com/static/site/amamanualofstyle/document/CHAPTER\\_11\\_UPDATED.pdf?node=853a7354a4864bda8080](https://static.primary.prod.gcms.the-infra.com/static/site/amamanualofstyle/document/CHAPTER_11_UPDATED.pdf?node=853a7354a4864bda8080)

### References

- Hofman A. *Writing in the Biological Sciences: A Comprehensive Resource for Scientific Communication*. 2<sup>nd</sup> ed. New York: Oxford University Press; 2016.
- Hofman A. *Scientific Writing and Communication: Papers, Proposals, and Presentations*. 2<sup>nd</sup> ed. New York: Oxford University Press; 2014.