

## Research Report structure and guidelines

The structure of an effective scientific paper contains a scope that changes from broad to narrow and back to broad again, analogous to an hourglass (Figure 1; Turbek et al. 2016). The Introduction section starts broadly and narrows to the specific project question. The Methods and Results sections maintain the narrow scope defined by the question. The Discussion section begins with a narrow answer to the question and widens by relating the answer to the broader topic and its importance.

The Introduction section should lead by stating the general topic addressed by the project, followed by a statement of the importance or relevance of the topic. Then the Introduction reviews scientific literature relevant to the topic. The literature review should summarize existing knowledge about the topic and narrow the scope to a knowledge gap. The last paragraph in the Introduction should translate the knowledge gap into a research question, followed by hypotheses that answer the question. The Methods section describes in detail the project’s approach to test the hypotheses, including a summary of the study system. The Results section states evidence obtained using the methods, described in objective terms. Results should be supported by data analysis, illustrated by tables and/or figures. The Discussion section should interpret the results, potentially including subjective language. It should lead with an answer to the project question, then relate to results in other scientific articles. The Discussion should conclude with assessment of project limitations, directions for future research, and broader implications or recommendations.

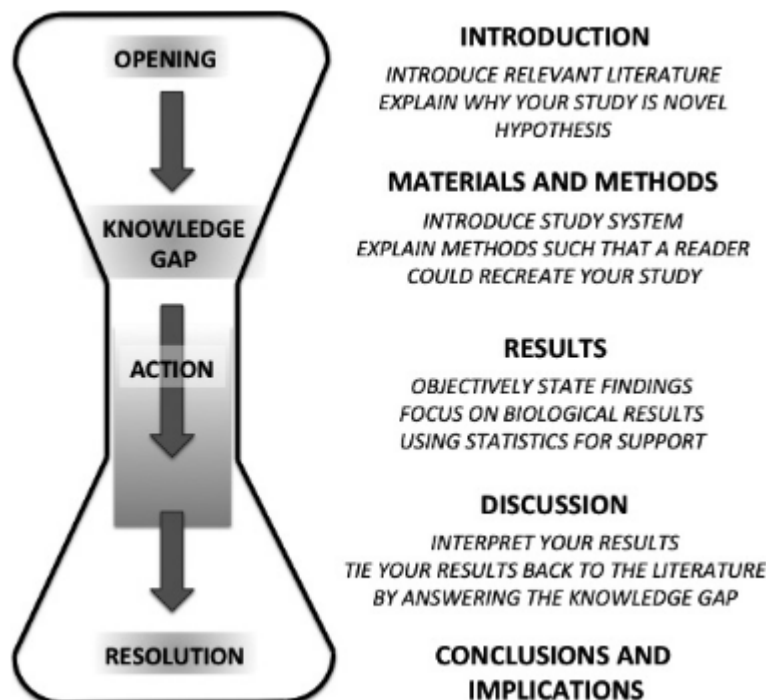


Figure 1. Hourglass structure for a scientific paper. Paper begins broadly and narrows to the specific question addressed by the project. The Methods and Results sections maintain the narrow scope. The Discussion begins with a narrow answer to the research question and widens by relating project results to the literature. Figure from Turbek et al. (2016).

Outlined below are components or subsections recommended for the Introduction, Methods, Results, and Discussion sections – to develop the structure described above.

## Introduction

First sentence(s): state general topic (wide opening of the hourglass).

Second sentence(s): state importance of the topic.

Following paragraphs review scientific literature on the topic, narrowing to a knowledge gap.

The last paragraph should translate the knowledge gap into a research question, then state hypotheses that provide answers to the question. Multiple hypotheses pose alternative answers. The paragraph should conclude with a brief statement of the project approach to testing the hypotheses.

## Methods

The first sub-section describes the study area, including geographic location, climate, landforms, vegetation, and other site features relevant to the project. As appropriate, also summarize history of disturbances or human uses in the study area. If the project focuses on particular species, their natural histories should be summarize here.

The second subsection or paragraph should describe the study design, including distribution of sampling locations in space and/or time.

The next paragraph(s) should describe the variables you measured and the procedures used to measure them. You should describe your procedures in sufficient detail that the reader could replicate your project. If you used equipment, include manufacturers and model numbers.

The last paragraph of subsection should describe data analyses you conducted, in detail sufficient for others to replicate your analysis. Identify any statistical software you used, including citation(s).

## Results

The first Results paragraph should summarize data you collected, including sample sizes, means or medians for each variable, and measures of variability for each variable (e.g., standard deviation or standard error). If the project involved surveying multiple species, this first paragraph should state number of individuals and number of species observed.

Subsequent paragraphs should describe your results using objective language. Put any subjective interpretation in the Discussion section. Text in the Results section should describe and cite relevant tables and figures, without repeating their content. Results should be supported by statistical analysis to provide confidence, but they should emphasize magnitude or importance of the effects revealed by the data. For example, if you conduct linear regression to evaluate a causal relationship between variables  $x$  and  $y$ , the regression  $p$ -value may lend confidence, but the most important result of the analysis is the magnitude of the regression slope. You should consider whether that slope is steep enough to be matter in your study system, and whether the relationship accounts for enough of the variation (in  $y$ ) to be meaningful.

## Discussion

The Discussion section interprets your results. The scope should begin narrowly, with an answer to your project question, and widen by relating your results to the broader topic.

The first Discussion paragraph should provide a clear and concise answer to the project question: it should provide a direct response to the last paragraph in the Introduction. Then it should evaluate each hypothesis using your results.

Subsequent paragraph(s) should relate your results to other scientific articles, and broaden the scope back to that of the general topic. Here you should compare your results to those reported by others, and account for consistencies or inconsistencies. If your results differ from other studies, you should suggest likely or potential explanations for differences. The comparison should clarify how project results help fill the knowledge gap identified in the Introduction.

Next, include a paragraph on disclaimers, limitations, and sources of error or uncertainty. Describe what you would do differently if you could repeat the project, or if you had more time and other resources. Some writers end their papers with this paragraph, but your report will be more compelling if it concludes positively as described below rather than by listing your project's shortcomings.

The penultimate Discussion paragraph usually describes opportunities, directions, or needs for further research. This paragraph could help readers identify knowledge gaps remaining after your project, just as you may have identified knowledge gaps by reading other scientific papers.

The Discussion should conclude by translating project results into applications, implications, or recommendations for science, management, restoration or other relevant policies and actions. You should leave your readers with a clear understanding of insights derived from your project and broader applications of those insights.

## Reference

Turbek SP, TM Chock, K Donahue, CA Havrilla, AM Oliverio, AK Polutchko, LG Shoemaker, L Vimercati. 2016. Scientific writing made easy: A step-by-step guide to undergraduate writing in the biological sciences. *Bull.Ecol.Soc.Am.* 97(4):417-426. [online]  
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