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# The Science of Scientific Writing or

The Technique of Technical Writing...

# Sections of a Scientific Report

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Process	Section of Paper
What did I do in a nutshell?	<u>Abstract</u>
What is the problem?	<u>Introduction</u>
How did I solve the problem?	<u>Methods</u>
What did I find out?	<u>Results</u>
What does it mean?	<u>Discussion</u>
Whose work did I refer to?	<u>Literature Cited</u>

# Abstract

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- ▶ A stand alone, mini-version of the paper (250 words or less).
- ▶ Summarizes the main sections of the paper.
- ▶ States the purpose, findings, and impact of the work.
- ▶ The Goal is an Economy of Words
  - ▶ Provide an abstracted version of the paper in as few words as possible.
  - ▶ Choose each word carefully. Make them clear and significant.
  - ▶ Provide only the key points.

# Some Pitfalls of Abstracts

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- ▶ Contains extraneous detail or information or conclusions not stated in the paper.
- ▶ Contains abbreviations, chemical formulas, jargon or references to the literature, tables, or figures.
- ▶ Failure to state the purpose of the work at the outset.
- ▶ Failure to state the importance of the work and where it leads at the end.

# 1. Introduction

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- ▶ An introduction is a method to familiarize and orient your readers.
- ▶ Provide the context of the work (research space, define gap in knowledge)
- ▶ State your focus (hypothesis, question).
- ▶ Provide justification for the work (how it can answer the question).

# Common Pitfalls of an Introduction Section

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- ▶ Including unnecessary background or being repetitive.
- ▶ Exaggerating (or understating) the importance of the work.
- ▶ Not grounding the work in a context that will be important to your reader.
- ▶ Not focusing on a clear research question or hypothesis.

# Guidelines for Introductions from Two Scientific Organizations

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From the International Committee of Medical Journal Editors:

- ▶ “State the purpose of the article and summarize the rationale for the study or observation.
- ▶ Give only strictly pertinent references and do not include data or conclusions from the work being reported.”

From the American Society for Microbiology:

- ▶ The introduction should supply sufficient background information to allow the reader to understand and evaluate the results of the present study without referring to previous publications on the topic.
- ▶ The introduction should also provide the hypothesis that was addressed or the rationale for the present study.
- ▶ Use only those references required to provide the most salient background rather than an exhaustive review of the topic.”

## 2. Methods

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- ▶ Present the experimental design.
- ▶ Provide enough detail to allow readers to interpret the results.
- ▶ Give enough detail for readers to replicate the work.
- ▶ “The key to a successful Methods section is to include the right amount of detail—too much, and it begins to sound like a laboratory manual; too little, and no one can repeat what was done.”



# Some Pitfalls in Methods section

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- ▶ Providing too little or too much information.
- ▶ Reiterating published methods rather than citing them.
- ▶ Writing strictly in chronological order (alternatives: most important first, most fundamental first, etc.).
- ▶ Methods and results don't correspond (you have to provide methods for all the experiments reported).
- ▶ Forgetting to use visual organizers that direct readers to specific aspects of the methods section, e.g., subheads.
- ▶ Failing to provide a context for the methods themselves:  
“In order to . . . , the experiment . . . ”  $\Leftarrow$  context for the particular method is provided.

# Methods pitfalls (cont.)

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- ▶ Writing a Protocol instead of a Methods section.
- ▶ A Protocol is ...
  - ▶ A series of steps to be carried out.
  - ▶ Written in sequential or temporal order.
  - ▶ Intended for the reader to achieve a final result.
- ▶ A Methods Section is ..
  - ▶ A series of steps already completed and is written in past tense.
  - ▶ Written in logical order.
  - ▶ Intended for the reader to replicate the experiment.

### 3. Results Section

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- ▶ Objectivity: Make the data, just the data, easy to find.
- ▶ Some readers want to interpret the data themselves rather than accepting the interpretation presented in the discussion.
- ▶ Description: Describe the data presented in figures and tables.

# Good “Results” section

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- ▶ A brief description of the experiment or rationale at the beginning of each subsection
  - ▶ “In order to . . . .As a result, they found that . . . .).
- ▶ The data (in past tense).
- ▶ Descriptive text for FEW determinations.
- ▶ Tables or graphs for REPETITIVE determinations.
- ▶ All data that “Methods” indicated would be produced
- ▶ Data answering the questions established in “Introduction.
- ▶ Results are presented in a logical order.
  - ▶ e.g., most important first, most fundamental first, etc

# Some pitfalls in “Results” section

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- ▶ Overstating the results
  - ▶ e.g., “Figure X clearly shows...”
- ▶ Reporting irrelevant results
  - ▶ but it is sometimes useful to report experiments that didn’t work.
- ▶ Omitting visual organizers, such as subheaders.
- ▶ Including inappropriate illustrations.
- ▶ Including methods and/or discussion: Overlap is acceptable in some circumstances.

# What Differentiates “Results” from its neighboring sections?

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Difference from the “Methods”:

- ▶ Methods = How the data were accumulated.
- ▶ Results = What data were accumulated.

Difference from the “Discussion”:

- ▶ Results = Data presentation
  - ▶ “Experiments showed that . . . .”
- ▶ Discussion = Data interpretation
  - ▶ “Experiments suggest that..”

# Illustrations (Figures and Tables)

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- ▶ Condense large amounts of information
- ▶ Convince readers of the findings (by showing data quality).
- ▶ Focus attention on certain findings
  - ▶ e.g., relationship between values)
- ▶ Simplify complex findings.
- ▶ Promote thinking and discussion.
- ▶ “The most beautiful illustration cannot hide lousy content--content is key”.

# Some Pitfalls of Figures and Titles/Captions

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## Figures

- ▶ Not mentioned in text.
- ▶ Textual data inconsistent with figures.
- ▶ Mislabeling.
- ▶ Symbols, data points, unreadable or cluttered.
- ▶ Ugliness (failure to get help from graphic designer).

## Captions

- ▶ Reiterate results section
- ▶ Written in shorthand, abbreviated form rather than whole sentences.



## 5. Discussion/Conclusion

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- ▶ Summarize findings presented in the results section
- ▶ Cite supporting literature.
- ▶ Explain discrepancies between the findings and previous reports.
- ▶ Point out shortcomings of the work and define unsettled points.
- ▶ Discuss theoretical and practical implications of the work.
- ▶ End with a short summary or conclusion about the work's importance.

# Questions to Address in a Discussion Section

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- ▶ What was expected to find, and why?
- ▶ How did the results compare with those expected?
- ▶ How can unexpected results be explained?
- ▶ How might these potential explanations be tested?
- ▶ “This is the place to interpret your results against a background of existing knowledge. Explain what is new in your work, and why it matters. Discuss both the limitations and the implications of your results, and relate observations to other relevant studies. State new hypotheses when warranted, clearly labeled as such. Include recommendations, when appropriate.”

# Remember to include in Discussion section:

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- ▶ Background information
- ▶ Statement of results
- ▶ (Un)expected outcome
- ▶ Reference to previous research
- ▶ Explanation
- ▶ Exemplification
- ▶ Deduction and Hypothesis
- ▶ Recommendation

# Some Pitfalls of a Discussion/Conclusion Section

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- ▶ Including too much information (wordy arguments, not focused, meandering, etc.).
- ▶ Failure to follow arguments set up in the introduction.
- ▶ Failure to focus on the current results.
- ▶ Speculating too much or not enough.
- ▶ Improper tense (Discussion largely in present tense).
- ▶ Hedging excessively
  - ▶ “The cause of the degenerative changes is unknown but **possibly** one cause **may be** infection by a **presumed** parasite.”