

Checklists for Writing a Scientific Manuscript

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CONSORT Statement

How to Write the Introduction Section

To write the Introduction section, do the following:

- Provide the background information relevant to your paper at a level of detail appropriate for your readers. State what led you to your hypothesis. Give enough background information so that readers will understand why you asked the research question you asked. Discuss the background's concepts from the most general to the most specific (funnel structure). Be sure to make it clear why you performed the study and what you expected to learn from the research.
 - Identify the gap in knowledge your study seeks to fill, and explain why filling the gap is important.
 - State your hypothesis or the purpose of your study. Word it so that the research question is clear and specific and the results can be unambiguously evaluated.
 - Describe how you will test the hypothesis.
 - Briefly state your conclusion about your hypothesis (optional).
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How to Write the Methods Section: Basic Science Studies

One way to write the Methods section of a basic science study is to create paragraphs for each main topic below that applies to your study. The following order works well in many papers.

Materials

- Describe the materials (e.g., animals, drugs, reagents, equipment) used in the study.
- For drugs, use the generic name and specify the concentration and dose. (A trade name may be given in parentheses at first mention.) For reagents, specify the concentration and grade, if appropriate.
- Identify the suppliers of those materials and the locations (city and state) of the suppliers.

Cell Lines and Cultures

- Describe the cell lines and cultures that were used.
- Identify the suppliers of the cell lines and the locations (city and state) of the suppliers.
- Describe how the cultures were prepared.

Human Subjects

- Say whether institutional approval and informed consent were obtained, and if not, explain why not.
- Describe the source of the study population.
- List inclusion and exclusion criteria.
- Tell how samples were collected.
- Tell the number of samples included.

Animals

- Provide the standards of care that were followed in the care of animals.
- Identify the supplier of the animals.
- State how many animals were used.
- Describe what was done to the animals, including how they were killed.

Experiments

- Describe what experiments were performed, why each was performed, and specifically how each was performed. (Each experiment may be described in a separate paragraph, each beginning with an explanation of what the particular experiment was designed to determine.) Chronological order usually works best.
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Statistical Tests

- Identify the statistical tests that were performed.
- State what each test was used to evaluate.
- State the values at which differences were considered statistically significant (for instance, $P < 0.05$).

How to Write the Methods Section: Retrospective Clinical Studies

One way to write the Methods section of a retrospective clinical study is to address each topic below that applies to your study. The following order works well in many papers.

- **Subjects:** Source of the study subjects (for example, chart review, database, patients in a previously reported prospective clinical study).
 - **Selection criteria:** Criteria for selection of the overall study population (inclusion and exclusion criteria, including dates).
 - **Data reviewed:** Types of data reviewed or extracted from patient records.
 - **Subgroups:** How the study subgroups were defined.
 - **Numbers of patients:** Numbers of patients ultimately included in the study and in each subgroup. (Included in most but not all papers. When this information is not reported in the Methods section, it should be reported at the beginning of the Results section.)
 - **Approval of the study by an institutional review board and the use of an informed consent process for subjects (or the board's waiver of this process).**
 - **Evaluations and interventions:** Pretreatment evaluations, treatments and interventions, and follow-up evaluations for patients in the study. Provide general information only. If the evaluations or treatments (for example, chemotherapy regimens, drug doses, radiotherapy techniques) differed from patient to patient and the study was designed to show the effect of those differences on outcome, report the numbers of patients who got each type of evaluation or treatment at the point in the Results section where you report the outcomes.
 - **Outcome measures:** Outcome measures and minimum differences that were considered clinically important.
 - **Statistical methods:** Methods of statistical analysis, described in sufficient detail to permit replication.
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How to Write the Methods Section: Prospective Clinical Studies

One way to write the Methods section of a prospective clinical study is to address each topic below that applies to your study. The following list is from the [CONSORT statement](#), which provides recommendations for reporting the results of prospective randomized clinical trials.

- **Participants:** Eligibility criteria for participants and the settings and locations where the data were collected.
- **Interventions:** Precise details of the interventions intended for each group and how and when they were actually administered.
- **Outcome measures:** Clearly defined primary and secondary outcome measures and, when applicable, any methods used to enhance the quality of measurements (e.g., multiple observations, training of assessors).
- **Sample size:** How sample size was determined and, when applicable, explanation of any interim analyses and stopping rules.
- **Randomization—sequence generation:** Method used to generate the random allocation sequence, including details of any restriction (e.g., blocking, stratification).
- **Randomization—allocation concealment:** Method used to implement the random allocation sequence (e.g., numbered containers or central telephone), clarifying whether the sequence was concealed until interventions were assigned.
- **Randomization—implementation:** Who generated the allocation sequence, who enrolled participants, and who assigned participants to their groups.
- **Blinding (masking):** Whether or not participants, those administering the interventions, and those assessing the outcome were blinded to group assignment. If done, how the success of blinding was evaluated.
- **Statistical methods:** Statistical methods used to compare groups for primary outcome(s); methods for additional analyses, such as subgroup analyses and adjusted analyses.

In addition to the items above, from the [CONSORT statement](#), describe the procedures used to ensure ethical conduct of the study, such as approval of the study by an institutional review board and the use of an informed consent process for participants.

How to Write the Results Section

To write the Results section, try the following:

- Construct your figures and tables. The chapter “Effective Figures and Tables” includes guidelines on how to make them.
 - Outline the Results section using subheadings.
 - Under each subheading, list the figures and tables that you will talk about in that section.
 - Write the text corresponding to each subheading. When appropriate, begin each subsection with a phrase or statement that reminds readers of the experiment or analysis you performed; describe the findings from that experiment or analysis, referring to figures and tables as appropriate; and close with a sentence that indicates what is most important about these data. Minimize repetition between text and figures and tables.
 - Make sure that a result is provided for each method described in the Methods section.
 - When you have finished, make sure that data in text match data in the figures and tables.
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How to Write the Discussion Section

The Discussion is basically an essay on the importance of your findings—how they fit into what is already known in the field, how they affect current scientific thought or medical practice, and what further research they suggest. Your findings can thus be thought of as a brick in the structure of scientific knowledge. They are supported by previous work and in turn will support future research.

To write the Discussion, address all of the following that apply to your study:

- Begin by stating your conclusions based on your findings. Include the major findings that support your conclusions.
 - Interpret your findings—say what the results mean and how they relate to each other.
 - Indicate how your findings fit in with the existing literature:
 - Studies that agree.
 - Studies that disagree, and why.
 - State the novelty or exceptional strengths of your study.
 - Address the limitations and any other potential valid criticisms of your study.
 - State the extent to which your findings can be generalized to other populations.
 - Describe why having filled the knowledge gap is important.
 - Explain the implications of your findings, for example, how they may affect scientific thought or medical practice.
 - Describe avenues for further study that your findings suggest.
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How to Write the Abstract

To construct your abstract, include the information listed below, in the order shown. The suggested number of sentences is shown after each item. (Tip: Sometimes, you can use sentences from the main body of your article instead of writing new sentences.)

- Give the basic background information that led to the development of your study. Be sure to mention the gap in knowledge that this study was designed to fill. *(1 or 2 sentences)*
 - State the hypothesis or purpose of the study. *(1 sentence)*
 - Mention the experimental approach that was used. Describe the patients or materials (e.g., cell lines), the important experiments or interventions, and — for a clinical study — the primary end points of the study. *(Usually 1 to 3 sentences)*
 - Provide the most important results you obtained. State the result for each method that was described in the methods section of the abstract (and be sure that the methods section of the abstract describes a method for each result that is given in the results section of the abstract). The results can be summarized using mean or median values, but specific results necessary to support the conclusion should be described in detail sufficient for that purpose. *(Usually 3 or 4 sentences)*
 - State the conclusion drawn from your most important results and how the conclusion relates to the hypothesis or purpose of the study. *(1 or 2 sentences)*
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Tips for Preparing Figures and Tables

Figures Other than Graphs

- Use arrows or other indicators to point out important items in a figure so that readers do not need to search for them.
- Be sure your figures will be readable after they are reduced for publication. When preparing figures with lettering or symbols on them, think about how big the letters or symbols will be if the figure is printed only 1 column wide.
- Avoid using color in your figures unless it is absolutely necessary for the reader to understand them; most journals will require you to pay for the cost of color printing.
- Whenever possible, put information on the figure itself rather than in the figure legend.
- Be sure to include any relevant information that does not appear on the figure itself in the accompanying legend. General guidelines for legends include the following:
 - Give enough information that the reader can understand the figure without referring to the text of the article.
 - State briefly the message you wish the reader to receive from the figure or the most important finding evident in the figure.
 - State original magnification and stain, if applicable.
 - Define abbreviations and explain symbols used in the figure.
 - Name the method used; describe the method in detail if that is the journal's style.
 - Keep the legend as short as possible.
 - Put the legends for all the figures on a separate page, not on the figures themselves.
- Follow the journal's guidelines regarding acceptable file formats, file naming conventions, and other electronic figure requirements.

Graphs

- Keep your graphs simple. Be selective about which PowerPoint or Excel features you use.
 - Label the axes on your graphs so that readers can tell what variable is shown on each axis and what the units of measure are.
 - Make sure that the increments on the axes are appropriate for the data shown and are uniform.
 - Use 3 dimensions only if you are plotting 3 variables.
 - Make sure the symbols that represent data points are big enough to read and are easily distinguishable from each other.
 - Whenever possible, put the key that identifies lines or bars on the figure itself rather than in the legend.
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- Use black-and-white patterns instead of colors (unless your target journal publishes color figures for free). Gray generally does not reproduce well either; gray bars often look blotchy when printed in a journal, and different shades of gray may all look alike.
- On line graphs, put the dependent variable (the outcome variable of interest) on the vertical axis (y-axis) and the independent variable (the variable that is thought to influence the dependent variable) on the horizontal axis (x-axis).
- On line graphs, avoid having more than 3 or 4 curves (lines).
- On bar graphs, make all the bars the same width, and make the space between the bars less than the bar width.
- On pie graphs, limit the segments to those large enough to be seen and labeled. Group components too small to be shown individually into 1 wedge labeled “other.” Label each segment of the pie, and include the percentage for each segment as part of the label.
- As for all figures, provide legends for your graphs. In general, the legends should
 - Give enough information that the reader can understand the graph without reading the text.
 - Define abbreviations and explain symbols used in the graph.
 - Name the method used; describe the method in detail if that is the journal’s style.
 - Be as short as possible.
- Follow the journal’s guidelines regarding acceptable file formats (PowerPoint [.ppt] and Excel [.xls or .xlsx] are usually not acceptable), file naming conventions, and other electronic figure requirements.

Tables

- Provide a number and title for the table.
 - Provide a heading for each column and a row stub (row heading) for each row.
 - Put material that is to be directly compared in adjacent columns or rows. Readers usually prefer to make comparisons horizontally (across rows) rather than vertically (down columns).
 - Use spanning column headings to avoid repeating the same information in multiple column headings. Indenting row stub subcategories under main categories achieves a similar goal in the row stubs.
 - Leave cells blank only if no value is possible.
 - Be sure that any footnote symbols used in the body of the table match up with the footnotes listed below the table.
 - Do not use vertical lines to separate columns in tables. The careful alignment of columns makes vertical lines unnecessary. By convention, the only horizontal lines used are
 - Lines above and below the column headings,
 - A line below the last row of data, and
 - Lines below spanning column headings.
 - In tables showing comparisons or subsets, give percentages in addition to actual values.
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- If all the values in a column would be the same, present the information in a footnote to the table or in the text instead.
- Be sure that numeric categories do not overlap or leave out possible values.
- In columns, align numbers on the decimal point (real or imaginary). If columns contain text, align the first line in each cell on the left; all lines in a cell after the first line should be indented slightly.
- Be sure to check the numbers in all tables before you submit your manuscript.

How to Write the Title

The purpose of the title is to summarize the essence of the article concisely and definitively in 1 phrase or sentence so that the paper can be easily found in Medline title searches and those who read the title are persuaded to read the entire paper. To write an effective title:

- Name the main factors studied.
 - Name the population (or animal, plant, or cell line) studied, if applicable.
 - For clinical studies, identify the type of study, such as “randomized controlled trial.”
 - Consider stating your study’s major findings.
 - Make your title specific.
 - Start the title with a word or term that represents the most important aspect of the study.
 - Avoid uninformative phrases such as “A Study of,” “A Report of,” “The Treatment of,” “The Role of,” or “The Effects of” in the title and in the subtitle.
 - Use subtitles sparingly.
 - Use approved generic or common nonproprietary names rather than trade names or chemical names for drugs and chemicals.
 - Always check the author instructions of the target journal for specific guidelines on titles.
 - Avoid using abbreviations and acronyms.
 - Keep punctuation to a minimum.
 - Avoid using questions for titles.
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Tips for Writing with Cohesion and Clarity

Tips for Writing Linear Paragraphs

- Begin a new paragraph for each new idea.
- Keep paragraphs short (that is, several to a page).
- Include a topic sentence, usually at the beginning, and include only those sentences that support the topic.
- Connect the ideas within a paragraph in a clearly understandable order.

Tips for Writing Linear Manuscripts

- State your hypothesis early and clearly.
- Include only the information that supports the hypothesis statement or research question, and tie the discussion and conclusion directly to that statement.
- Connect ideas in adjacent paragraphs.

Tips for Clear, Strong, Precise Writing

- Use words that are precise and strong rather than vague or general.
- Use first-person voice rather than third-person voice.
- Use active verbs rather than passive verbs.
- Avoid vague introductory phrases and vague pronouns.
- Use *a*, *an*, and *the* correctly.
- Introduce a term before using its acronym or abbreviation.

Tips for Cohesive Writing

- Use transitional words.
- Repeat key terms as often as needed; do not substitute new words for terms already introduced.
- Use parallel structures in writing sentences and expressing thoughts in paragraphs.

Tips for Streamlined Writing

- Break long sentences into shorter ones.
 - Eliminate wordiness.
 - Use shorter words rather than long ones when possible.
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Checklist for a Good Review

This checklist is adapted from the guidelines presented in the chapters of this notebook on writing sections of a scientific article. The items followed by an asterisk were taken from “Review Criteria for Research Manuscripts,” *Academic Medicine* 76:9, 2001.

Use this checklist when you review a manuscript for a co-author or another colleague (and when you write a manuscript of your own). Make sure your suggestions are specific, thorough, and constructive. Depending on your role in the collaboration and your agreed-upon responsibilities as a co-author, some of the items in the checklist will be beyond the scope of your review.

Overall Manuscript

- Clearly and completely tells “story” of research and findings.
- Is written in clear, grammatically correct language.

Title

- Is clear and informative.*
- Reflects importance of study.*
- States study’s main findings.
- Names main factors studied.
- Uses key terms for indexing.
- States species studied and type of study.

Abstract

- Summarizes entire paper.
 - Is consistent with manuscript and contains no additional information.*
 - Gives basic background information that led to development of study.
 - States gap in knowledge study will fill.
 - States specific purpose of study.
 - Mentions experimental approach used and identifies important tests performed.
 - Mentions most important results and states a result for each method described in abstract.
 - States conclusion that can be drawn from most important results and how it relates to study’s purpose.
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Introduction

- Provides relevant background at level of detail appropriate to readers.
- Includes up-to-date literature review.*
- States what led to hypothesis.
- Gives enough background information so that readers will understand why research question was chosen.
- Discusses background concepts from most general to most specific.
- Makes clear why study was performed and expected lessons from research.
- Identifies gap in knowledge study will fill and explains why filling this gap is important.
- States hypothesis or purpose of study.
- Describes how hypothesis will be tested.

Materials and Methods

- Describes experiments and samples in enough detail that readers can judge validity of data and could repeat study.
- Describes all materials used and identifies their suppliers.
- Describes cell lines and cultures and identifies their suppliers.
- Describes how cultures were prepared.

Human Subjects

- States whether institutional approval and informed consent were obtained and if not, why.
- Describes source of study population.
- Lists inclusion and exclusion criteria.
- Tells how samples were collected.
- Tells number of samples included.

Animals

- Describes standards of care followed.
- Identifies suppliers of animals.
- States how many animals were used.
- Describes what was done to animals, including how they were killed.

Experiments

- Describes what experiments were performed, why each was performed, and how each was performed.
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Statistical Tests

- Identifies statistical tests performed.
- States what each test evaluated.
- States values at which differences were considered statistically significant.

Results

- Presents findings of study.
- Provides result for each experiment discussed in Methods.
- Is consistent with data in figures, tables, and abstract.

Discussion

- Begins by answering research question and stating major findings of study.
- Interprets the findings.
- Indicates how findings fit in with existing literature (studies that agree and disagree).
- States novelty or exceptional strengths of study.
- Addresses limitations and any other potential valid criticisms of study.
- Says whether findings suggest that current scientific thought or medical practice should be changed.
- Describes why having filled knowledge gap is important.
- Describes avenues for further study that findings suggest.

References

- Uses mostly primary sources.*
- Acknowledges sources properly.*
- Cites reference for each previously published fact.
- Cites all relevant previous work (both supporting and refuting).

Tables, Figures, and Legends

- Are clearly understandable.
 - Do not excessively duplicate data presented elsewhere.
 - Are in the most appropriate format (e.g., table vs. graph, line graph vs. bar graph).
 - Are appropriate in number (i.e., not too few or too many).
-