Welcome to the PLOS Writing Center

Your source for scientific writing & publishing essentials

A collection of free, practical guides and hands-on resources for authors looking to improve their scientific publishing skillset.

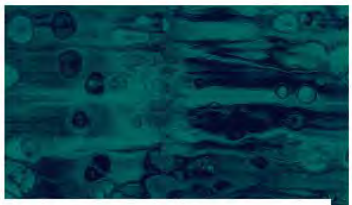
ARTICLE-WRITING ESSENTIALS

Learn how to prepare each of the key components of a research article from start to finish.

How to Write a Great Title

Your title is the first thing anyone who reads your article is going to see, and for many it will be where they stop reading. Learn how to write a title that helps readers find your article, draws your audience in and sets the stage for your research!

Read more...



How to Write an Abstract

The abstract is your chance to let your readers know what they can expect from your article. Learn how to write a clear, and concise abstract that will keep your audience reading.

Read more...

How to Write Your Methods

A clear methods section impacts editorial evaluation and readers' understanding, and is also the backbone of transparency and replicability. Learn what to include in your methods section, and how much detail is appropriate.

Read more...

How to Report Statistics

In many fields, a statistical analysis forms the heart of both the methods and results sections of a manuscript. Learn how to report statistical analyses, and what other context is important for publication success and future reproducibility.

Read more...

How to Write Discussions and Conclusions

The discussion section contains the results and outcomes of a study. An effective discussion informs readers what can be learned from your experiment and provides context for the results.

How to Edit Your Work

Ensuring your manuscript is well-written makes it easier for editors, reviewers and readers to understand your work. Avoiding language errors can help accelerate review and minimize delays in the publication of your research.

Read more...

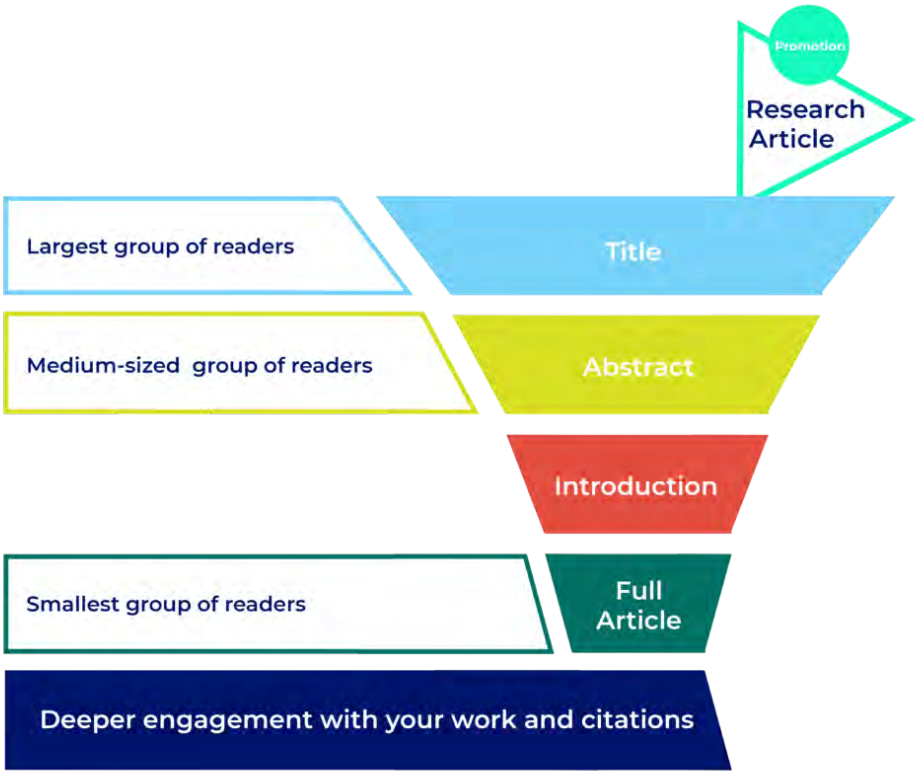
https://plos.org/resources/writing-center/

How to write a great title

Maximize search-ability and engage your readers from the very beginning.
Your title is the first thing anyone who reads your article is going to see, and for many it will be where they stop reading. Learn how to write a title that helps readers find your article, draws your audience in and sets the stage for your research!

How your title impacts the success of your article

Researchers are busy and there will always be more articles to read than time to read them. Good titles help readers find your research, and decide whether to keep reading. Search engines use titles to retrieve relevant articles based on users' keyword searches. Once readers find your article, they'll use the title as the first filter to decide whether your research is what they're looking for. A strong and specific title is the first step toward citations, inclusion in meta-analyses, and influencing your field.



What to include in a title

Include the most important information that will signal to your target audience that they should keep reading.

- Key information about the study design
- Important keywords
- What you discovered

Writing tips

Getting the title right can be more difficult than it seems, and researchers refine their writing skills throughout their career. Some journals even help editors to re-write their titles during the publication process!

Do

Keep it concise and informative
What's appropriate for titles varies greatly across disciplines. Take a look at some articles published in your field, and check the journal guidelines for character limits. Aim for fewer than 12 words, and check for journal specific word limits.

Write for your audience
Consider who your primary audience is: are they specialists in your specific field, are they cross-disciplinary, are they non-specialists?

Entice the reader
Find a way to pique your readers' interest, give them enough information to keep them reading.

Incorporate important keywords
Consider what about your article will be most interesting to your audience: Most readers come to an article from a search engine, so take some time and include the important ones in your title!

Write in sentence case
In scientific writing, titles are given in sentence case. Capitalize only the first word of the text, proper nouns, and genus names. See our examples below.

Don't

Write your title as a question
In most cases, you shouldn't need to frame your title as a question. You have the answers, you know what you found. Writing your title as a question might draw your readers in, but it's more likely to put them off.

Sensationalize your research
Be honest with yourself about what you truly discovered. A sensationalized or dramatic title might make a few extra people read a bit further into your article, but you don't want them disappointed when they get to the results.

Tip: How to edit your work

Editing is challenging, especially if you are acting as both a writer and an editor. Read our guidelines for advice on how to refine your work, including useful tips for setting your intentions, re-review, and consultation with colleagues.

Format: Prevalence of [disease] in [population] in [location]
Example: Prevalence of tuberculosis in homeless women in San Francisco

Format: Risk factors for [condition] among [population] in [location]
Example: Risk factors for preterm births among low-income women in Mexico City

Format (systematic review/meta-analysis): Effectiveness of [treatment] for [disease] in [population] for [outcome]: A systematic review and meta-analysis
Example: Effectiveness of Hepatitis B treatment in HIV-infected adolescents in the prevention of liver disease: A systematic review and meta-analysis

Format (clinical trial): [Intervention] improved [symptoms] of [disease] in [population]: A randomized controlled clinical trial
Example: Using a sleep app lessened insomnia in post-menopausal women in southwest United States: A randomized controlled clinical trial

Format (general molecular studies): Characterization/identification/evaluation of [molecule name] in/from [organism/tissue] (by [specific biological methods])
Example: Identification of putative Type-I sex pheromone biosynthesis-related genes expressed in the female pheromone gland of Streltzoviella insularis

Format (general molecular studies): [specific methods/analysis] of organism/tissue reveal insights into [function/role] of [molecule name] in [biological process]
Example: Transcriptome landscape of Rafflesia cantleyi floral buds reveals insights into the roles of transcription factors and phytohormones in flower development

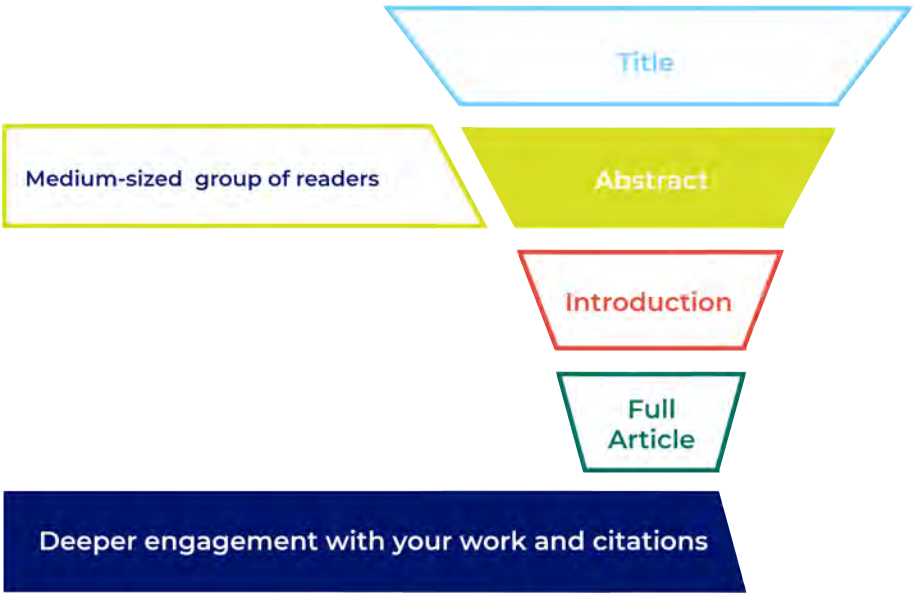
Format (software/method papers): [tool/method/software] for [what purpose] in [what research area]
Example: CRISPR-based tools for targeted transcriptional and epigenetic regulation in plants

How to write an abstract

Expedite peer review, increase search-ability, and set the tone for your study.
The abstract is your chance to let your readers know what they can expect from your article. Learn how to write a clear, and concise abstract that will keep your audience reading.

How your abstract impacts editorial evaluation and future readership

After the title, the abstract is the second-most-read part of your article. A good abstract can help to expedite peer review and, if your article is accepted for publication, it's an important tool for readers to find and evaluate your work. Editors use your abstract when they first assess your article. Prospective reviewers see it when they decide whether to accept an invitation to review. Once published, the abstract gets indexed in PubMed and Google Scholar, as well as library systems and other popular databases. Like the title, your abstract influences keyword search results. Readers will use it to decide whether to read the rest of your article. Other researchers will use it to evaluate your work for inclusion in systematic reviews and meta-analysis. It should be a concise standalone piece that accurately represents your research.



What to include in an abstract

The main challenge you'll face when writing your abstract is keeping it concise AND fitting in all the information you need. Depending on your subject area the journal may require a structured abstract following specific headings. A structured abstract helps your readers understand your study more easily. If your journal doesn't require a structured abstract it's still a good idea to follow a similar format, just present the abstract as one paragraph without headings.

Background or Introduction – What is currently known?
Start with a brief, 2 or 3 sentence, introduction to the research area.

Objectives or Aims – What is the study and why did you do it?
Clearly state the research question you're trying to answer.

Methods – What did you do?
Explain what you did and how you did it. Include important information about your methods, but avoid the low-level specifics. Some disciplines have specific requirements for abstract methods.

CONSORT for randomized trials.
STROBE for observational studies
PRISMA for systematic reviews and meta-analyses
Results – What did you find?
Briefly give the key findings of your study. Include key numeric data (including confidence intervals or p values), where possible.

Conclusions – What did you conclude?
Tell the reader why your findings matter, and what this could mean for the 'bigger picture' of this area of research.

Writing tips

The main challenge you may find when writing your abstract is keeping it concise AND convering all the information you need to.

Do

- Keep it concise and to the point. Most journals have a maximum word count, so check guidelines before you write the abstract to save time editing it later.
- Write for your audience. Are they specialists in your specific field? Are they cross-disciplinary? Are they non-specialists? If you're writing for a general audience, or your research could be of interest to the public keep your language as straightforward as possible. If you're writing in English, do remember that not all of your readers will necessarily be native English speakers.
- Focus on key results, conclusions and take home messages.
- Write your paper first, then create the abstract as a summary.
- Check the journal requirements before you write your abstract, eg. required subheadings.
- Include keywords or phrases to help readers search for your work in indexing databases like PubMed or Google Scholar.
- Double and triple check your abstract for spelling and grammar errors. These kind of errors can give potential reviewers the impression that your research isn't sound, and can make it easier to find reviewers who accept the invitation to review your manuscript.
- Your abstract should be a taste of what is to come in the rest of your article.

Don't

- Sensationalize your research.
- Speculate about where this research might lead in the future.
- Use abbreviations or acronyms (unless absolutely necessary or unless they're widely known, eg. DNA).
- Repeat yourself unnecessarily, eg. "Methods: We used X technique.Results: Using X technique, we found…"
- Contradict anything in the rest of your manuscript.
- Include content that isn't also covered in the main manuscript.
- Include citations or references.

Tip: How to edit your work

Editing is challenging, especially if you are acting as both a writer and an editor. Read our guidelines for advice on how to refine your work, including useful tips for setting your intentions, re-review, and consultation with colleagues.

How to write your methods

Ensure understanding, reproducibility and replicability.
What should you include in your methods section, and how much detail is appropriate?

Why methods matter

The methods section was once the most likely part of a paper to be unfairly abbreviated, overly summarized, or even relegated to hard-to-find sections of a publisher's website. While some journals may responsibly include more detailed elements of methods in supplementary sections, the movement for increased reproducibility and rigor in science has reinstated the importance of the methods section. Methods are now viewed as a key element in establishing the credibility of the research being reported, alongside the open availability of data and results.

A clear methods section impacts editorial evaluation and readers' understanding, and is also the backbone of transparency and replicability.
For example, the Reproducibility Project: Cancer Biology project set out in 2013 to replicate experiments from 50 high profile cancer papers, but revised their target to 18 papers once they understood how much methodological detail was not contained in the original papers.

What to include in your methods section

What you include in your methods sections depends on what field you are in and what experiments you are performing. However, the general principle in place at the majority of journals is summarized well by the guidelines at *PLOS ONE*: "The Materials and Methods section should provide enough detail to allow suitably skilled investigators to fully replicate your study." The emphases here are deliberate: the methods should enable readers to understand your paper, and replicate your study. However, there is no need to go into the level of detail that a lay-person would require—the focus is on the reader who is also trained in your field, with the suitable skills and knowledge to attempt a replication.

A constant principle of rigorous science
A methods section that enables other researchers to understand and replicate your results is a constant principle of rigorous, transparent, and Open Science. Aim to be thorough, even if a particular journal doesn't require the same level of detail . Reproducibility is all of our responsibility. You cannot create any problems by exceeding a minimum standard of information. If a journal still has word-limits—either for the overall article or specific sections—and requires some methodological details to be in a supplemental section, that is OK as long as the extra details are searchable and findable.

Imagine replicating your own work, years in the future
As part of PLOS' presentation on Reproducibility and Open Publishing (part of UCSF's Reproducibility Series) we recommend planning the level of detail in your methods section by imagining you are writing for your future self, replicating your own work. When you consider that you might be at a different institution, with different account logins, applications, resources, and access levels—you can help yourself imagine the level of specificity that you yourself would require to redo the exact experiment. Consider:

- Which details would you need to be reminded of?
- Which cell line, or antibody, or software, or reagent did you use, and does it have a Research Resource ID (RRID) that you can cite?
- Which version of a questionnaire did you use in your survey?
- Exactly which visual stimulus did you show participants, and is it publicly available?
- What participants did you decide to exclude?
- What process did you adjust, during your work?

Visual aids for methods help when reading the whole paper
Consider whether a visual representation of your methods could be appropriate or aid understanding your process. A visual reference readers can easily return to, like a flow-diagram, decision-tree, or checklist, can help readers to better understand the complete article, not just the methods section.

Tip: Be sure to capture any changes to your protocols

You yourself would want to know about any adjustments, if you ever replicate the work, so you can surmise that anyone else would want to as well. Even if a necessary adjustment you made was not ideal, transparency is the key to ensuring this is not regarded as an issue in the future. It is far better to transparently convey any non-optimal methods, or methodological constraints, than to conceal them, which could result in reproducibility or ethical issues downstream.

Ethical considerations

In addition to describing what you did, it is just as important to assure readers that you also followed all relevant ethical guidelines when conducting your research. While ethical standards and reporting guidelines are often presented in a separate section of a paper, ensure that your methods and protocols actually follow these guidelines. Read more about ethics.

Existing standards, checklists, guidelines, partners
While the level of detail contained in a methods section should be guided by the universal principles of rigorous science outlined above, various disciplines, fields, and projects have worked hard to design and develop consistent standards, guidelines, and tools to help with reporting all types of experiment. Below, you'll find some of the key initiatives. Ensure you read the submission guidelines for the specific journal you are submitting to, in order to discover any further journal- or field-specific policies to follow, or initiatives/tools to utilize.

Randomized controlled trials – CONSORT
The Consolidated Standards of Reporting Trials (CONSORT) project covers various initiatives intended to prevent the problems of inadequate reporting of randomized controlled trials. The primary initiative is an evidence-based minimum set of recommendations for reporting randomized trials known as the CONSORT Statement.

Systematic reviews and meta-analyses – PRISMA
The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) is an evidence-based minimum set of items focusing on the reporting of reviews evaluating randomized trials and other types of research.

Research using animals – ARRIVE
The Animal Research: Reporting of In Vivo Experiments (ARRIVE) guidelines encourage maximizing the information reported in research using animals thereby minimizing unnecessary studies. (Original study and proposal, and updated guidelines, in *PLOS Biology*.)

Laboratory protocols
Protocols.io has developed a platform specifically for the sharing and updating of laboratory protocols, which are assigned their own DOI and can be linked from methods sections of papers to enhance reproducibility. Contextualize your protocol and improve discovery with an accompanying Lab Protocol article in *PLOS ONE*.

Consistent reporting of materials, design and analysis – the MDAR checklist
A cross-publisher group of editors and experts have developed, tested, and rolled out a checklist to help establish and harmonize reporting standards in the Life Sciences. The checklist, which is available for use by authors to compile their methods, and editors/reviewers to check methods, establishes a minimum set of requirements in transparent reporting and is adaptable to any discipline within the Life Sciences, by covering a breadth of potentially relevant methodological items and considerations. If you are in the Life Sciences and writing up your methods section, try working through the MDAR checklist and see whether it helps you include all relevant details into your methods, and whether it reminded you of anything you might have missed otherwise.
The main challenge you may find when writing your abstract is keeping it concise AND convering all the information you need to.

Tip: Keep your paper moving forward by providing the proper paperwork up front

Be sure to check the journal guidelines and provide the necessary documents with your manuscript submission. Collecting the necessary documentation can greatly slow the first round of peer review, or cause delays when you submit your revision.

Summary Writing tips

The main challenge you may find when writing your methods is keeping it readable AND covering all the details needed for reproducibility and replicability. While this is difficult, do not compromise on rigorous standards for credibility!

Do

- Keep it concise and to the point. Most journals have a maximum word count, so check guidelines before you write the abstract to save time editing it later.
- Write for your audience. Are they specialists in your specific field? Are they cross-disciplinary? Are they non-specialists? If you're writing for a general audience, or your research could be of interest to the public keep your language as straightforward as possible. If you're writing in English, do remember that not all of your readers will necessarily be native English speakers.
- Focus on key results, conclusions and take home messages.
- Write your paper first, then create the abstract as a summary.
- Check the journal requirements before you write your abstract, eg. required subheadings.
- Include keywords or phrases to help readers search for your work in indexing databases like PubMed or Google Scholar.
- Double and triple check your abstract for spelling and grammar errors. These kind of errors can give potential reviewers the impression that your research isn't sound, and can make it easier to find reviewers who accept the invitation to review your manuscript.
- Your abstract should be a taste of what is to come in the rest of your article.

Don't

- Sensationalize your research.
- Speculate about where this research might lead in the future.
- Use abbreviations or acronyms (unless absolutely necessary or unless they're widely known, eg. DNA).
- Repeat yourself unnecessarily, eg. "Methods: We used X technique.Results: Using X technique, we found…"
- Contradict anything in the rest of your manuscript.
- Include content that isn't also covered in the main manuscript.
- Include citations or references.

How to report statistics

Ensure appropriateness and rigor, avoid flexibility and above all never manipulate results
In many fields, a statistical analysis forms the heart of both the methods and results sections of a manuscript. Learn how to report statistical analyses, and what other context is important for publication success and future reproducibility.

A matter of principle

First and foremost, the statistical methods employed in research must always be:

- Appropriate for study design
- Rigorously reported in sufficient detail for others to reproduce the analysis
- Free of manipulation, selective reporting, or other forms of "spin"

Supporting public trust in science through transparency and consistency

Along with clear methods and transparent study design, the appropriate use of statistical methods and analyses impacts editorial evaluation and readers' understanding and trust in science.

Just as importantly, statistical practices must never be manipulated or misused. Misrepresenting data, selectively reporting results or searching for patterns that can be presented as statistically significant, in an attempt to yield a conclusion that is believed to be more worthy of attention or publication is a serious ethical violation. Although it may seem harmless, using statistics to "spin" results can prevent publication, undermine a published study, or lead to investigation and retraction.

In 2011 False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant exposed that "flexibility in data collection, analysis, and reporting dramatically increases actual false-positive rates" and demonstrated "how unacceptably easy it is to accumulate (and report) statistically significant evidence for a false hypothesis".

Arguably, such problems with flexible analysis lead to the "reproducibility crisis" that we read about today.

A constant principle of rigorous science
The appropriate, rigorous, and transparent use of statistics is a constant principle of rigorous, transparent, and Open Science. Aim to be thorough, even if a particular journal doesn't require the same level of detail. Trust in science is all of our responsibility. You cannot create any problems by exceeding a minimum standard of information and reporting.

Sound statistical practices

While it is hard to provide statistical guidelines that are relevant for all disciplines, types of research, and all analytical techniques, adherence to rigorous and appropriate principles remains key. Here are some ways to ensure your statistics are sound.

Define your analytical methodology before you begin
Take the time to consider and develop a thorough study design that defines your line of inquiry, what you plan to do, what data you will collect, and how you will analyze it. (If you applied for research grants or ethical approval, you probably already have a plan in hand!) Refer back to your study design at key moments in the research process, and above all, stick to it.

To avoid flexibility and improve the odds of acceptance, preregister your study design with a journal
Many journals offer the option to submit a study design for peer review before research begins through a practice known as preregistration. If the editors approve your study design, you'll receive a provisional acceptance for a future research article reporting the results. Preregistering is a great way to head off any intentional or unintentional flexibility in analysis. By declaring your analytical approach in advance you'll increase the credibility and reproducibility of your results and help address publication bias, too. Getting peer review feedback on your study design and analysis plan before it has begun (when you can still make changes!) makes your research even stronger AND increases your chances of publication—even if the results are negative or null. Never underestimate how much you can help increase the public's trust in science by planning your research in this way.

Imagine replicating or extending your own work, years in the future
Imagine that you are describing your approach to statistical analysis for your future self, in exactly the same way as we have described for writing your methods section. What would you need to know to replicate or extend your own work? When you consider that you might be at a different institution, working with different colleagues, using different programs, applications, resources — or maybe even adopting new statistical techniques that have emerged — you can help yourself imagine the level of reporting specificity that you yourself would require to redo or extend your work. Consider:

- Which details would you need to be reminded of?
- What did you do to the raw data before analysis?
- Did the purpose of the analysis change before or during the experiments?
- What participants did you decide to exclude?
- What process did you adjust, during your work?

- Even if a necessary adjustment you made was not ideal, **transparency** is the key to ensuring this is not regarded as an issue in the future. It is far better to transparently convey any non-optimal techniques or constraints than to conceal them, which could result in reproducibility or ethical issues downstream.

Existing standards, checklists, guidelines for specific disciplines

You can apply the Open Science practices outlined above no matter what your area of expertise—but in many cases, you may still need more detailed guidance specific to your own field. Many disciplines, fields, and projects have worked hard to develop guidelines and resources to help with statistics, and to identify and avoid bad statistical practices. Below, you'll find some of the key materials.

Biomedical Research	**SAMPL guidelines** **The "Statistical Analyses and Methods in the Published Literature" (SAMPL) guidelines covers basic statistical reporting for research in biomedical journals.**
General	***PLOS ONE* guidelines for statistical reporting** **While specific to PLOS ONE, these guidelines should be applicable to most research contexts since the journal serves many research disciplines.**
Systematic reviews & Meta-analyses	**PRISMA** **The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) is an evidence-based minimum set of items focusing on the reporting of reviews evaluating randomized trials and other types of research.**
Life sciences	**MDAR checklist** **The "Consistent reporting of Materials, Design, and Analysis" (MDAR) checklist was developed and tested by a cross-publisher group of editors and experts in order to establish and harmonize reporting standards in the Life Sciences. The checklist, which is available for use by authors to compile their methods, and editors/reviewers to check methods, establishes a minimum set of requirements in transparent reporting and is adaptable to any discipline within the Life Sciences, by covering a breadth of potentially relevant methodological items and considerations.**

TIP: Do you have a specific journal in mind?

Be sure to read the submission guidelines for the specific journal you are submitting to, in order to discover any journal- or field-specific policies, initiatives or tools to utilize.

Articles on statistical methods and reporting

Makin, T.R., Orban de Xivry, J. **Science Forum: Ten common statistical mistakes to watch out for when writing or reviewing a manuscript.** eLife 2019;8:e48175 (2019). https://-doi.org/10.7554/eLife.48175

Munafò, M., Nosek, B., Bishop, D. et al. **A manifesto for reproducible science.** Nat Hum Behav 1, 0021 (2017). https://-doi.org/10.1038/s41562-016-0021

Writing tips

Your use of statistics should be rigorous, appropriate, and uncompromising in avoidance of analytical flexibility. While this is difficult, do not compromise on rigorous standards for credibility!

Do

- Remember that trust in science is everyone's responsibility.
- Keep in mind future replicability.
- Consider preregistering your analysis plan to have it (i) reviewed before results are collected to check problems before they occur and (ii) to avoid any analytical flexibility.
- Follow principles, but also checklists and field- and journal-specific guidelines.
- Consider a commitment to rigorous and transparent science a personal responsibility, and not simple adhering to journal guidelines.
- Be specific about all decisions made during the experiments that someone reproducing your work would need to know.
- Consider a course in advanced and new statistics, if you feel you have not focused on it enough during your research training.

Don't

- Misuse statistics to influence significance or other interpretations of results
- Conduct your statistical analyses if you are unsure of what you are doing—seek feedback (e.g. via preregistration) from a statistical specialist first.

How to write discussions and conclusions

The discussion section contains the results and outcomes of a study. An effective discussion informs readers what can be learned from your experiment and provides context for the results.

What makes an effective discussion?

When you're ready to write your discussion, you've already introduced the purpose of your study and provided an in-depth description of the methodology. The discussion informs readers about the larger implications of your study based on the results. Highlighting these implications while not overstating the findings can be challenging, especially when you're submitting to a journal that selects articles based on novelty or potential impact. Regardless of what journal you are submitting to, the discussion section always serves the same purpose: concluding what your study results actually mean.

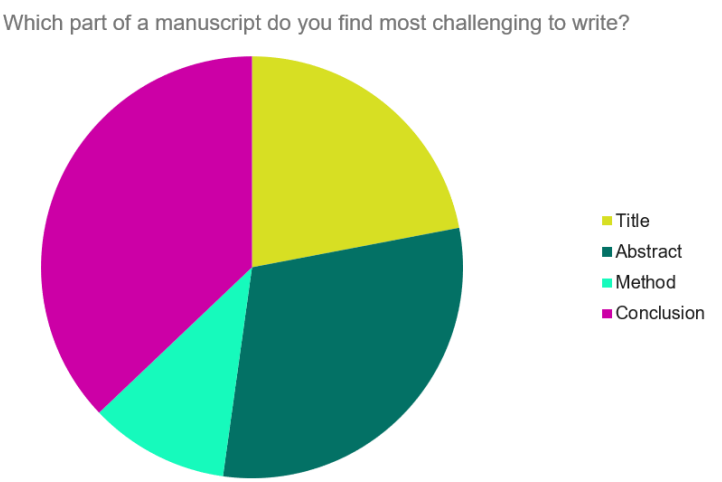
Tip: Not all journals share the same naming conventions.

You can apply the advice in this article to the conclusion, results or discussion sections of your manuscript.

A successful discussion section puts your findings in context. It should include:

- the results of your research,
- a discussion of related research, and
- a comparison between your results and initial hypothesis.

Our Early Career Researcher community tells us that the conclusion is often considered the most difficult aspect of a manuscript to write. To help, this guide provides questions to ask yourself, a basic structure to model your discussion off of and examples from published manuscripts.



Questions to ask yourself:

- Was my hypothesis correct?
- If my hypothesis is partially correct or entirely different, what can be learned from the results?
- How do the conclusions reshape or add onto the existing knowledge in the field? What does previous research say about the topic?
- Why are the results important or relevant to your audience? Do they add further evidence to a scientific consensus or disprove prior studies?
- How can future research build on these observations? What are the key experiments that must be done?
- What is the "take-home" message you want your reader to leave with?

How to structure a discussion

Trying to fit a complete discussion into a single paragraph can add unnecessary stress to the writing process. If possible, you'll want to give yourself two or three paragraphs to give the reader a comprehensive understanding of your study as a whole. Here's one way to structure an effective discussion:

1. First paragraph
   - Provide the essential interpretation based on key findings
   - Include a main piece of supporting evidence
2. Second paragraph
   - Compare and contrast to previous studies
   - Highlight the strengths and limitations of the study
   - Discuss any unexpected findings
3. Last paragraph
   - Summarice the hypothesis and purpose of the study
   - Highlight the significance of the study
   - Discuss unanswered questions and potential future research

Writing tips

While the above sections can help you brainstorm and structure your discussion, there are many common mistakes that writers revert to when having difficulties with their paper. Writing a discussion can be a delicate balance between summarizing your results, providing proper context for your research and avoiding introducing new information. Remember that your paper should be both confident and honest about the results!

Do

- Read the journal's guidelines on the discussion and conclusion sections. If possible, learn about the guidelines before writing the discussion to ensure you're writing to meet their expectations.
- Begin with a clear statement of the principal findings. This will reinforce the main take-away for the reader and set up the rest of the discussion.
- Explain why the outcomes of your study are important to the reader. Discuss the implications of your findings realistically based on previous literature, highlighting both the strengths and limitations of the research.
- State whether the results prove or disprove your hypothesis. If your hypothesis was disproved, what might be the reasons?
- Introduce new or expanded ways to think about the research question. Indicate what next steps can be taken to further pursue any unresolved questions.
- If dealing with a contemporary or ongoing problem, such as climate change, discuss possible consequences if the problem is avoided.
- Be concise. Adding unnecessary detail can distract from the main findings.

Don't

- Rewrite your abstract. Statements with "we investigated" or "we studied" generally do not belong in the discussion.
- Include new arguments or evidence not previously discussed. Necessary information and evidence should be introduced in the main body of the paper.
- Apologize. Even if your research contains significant limitations, don't undermine your authority by including statements that doubt your methodology or execution.
- Shy away from speaking on limitations or negative results. Including limitations and negative results will give readers a complete understanding of the presented research. Potential limitations include sources of potential bias, threats to internal or external validity, barriers to implementing an intervention and other issues inherent to the study design.
- Overstate the importance of your findings. Making grand statements about how a study will fully resolve large questions can lead readers to doubt the success of the research.

Snippets of Effective Discussions:

Summarize the key findings in clear and concise language
"The general recommendations for actions to reduce plastic pollution that emerged from the present study were: (1) refuse non-necessary plastic items, such as straws; (2) reduce dependence on traditionally single-use plastic items (e.g. shampoo bottles), for example by refilling or buying larger bottles; (3) replace plastic items with reusable and/or alternative products with a lower environment impact; (4) correctly dispose of items, such as wet wipes, that may be essential and this impossible to refuse or reuse."
Consumer-based actions to reduce plastic pollution in rivers: A multi-criteria decision analysis approach

Acknowledge when a hypothesis may be incorrect
"All reported neck postures attained by live giraffes in the wild can be replicated with the virtual skeleton range of motion without disarticulating the cervical vertebrae. Therefore, the cervical range of motion of extinct vertebrates should follow the same criteria until evidence suggests otherwise. Hypothesis (ii) "some neck postures attained in life require disarticulating vertebrae", can be refuted."
Ontogenetic similarities between giraffe and sauropod neck osteological mobility

Place your study within the context of previous studies
"Our results, consistent with a number of studies of other species suggest that body mass, rather than CIs (condition indices), may be one of the most useful measures for linking nutritional changes to population dynamics."
Identifying reliable indicators of fitness in polar bears

Discuss potential future research
"Our results open an exciting new avenue of study focused on laryngeal variation among further mammalian clades, which will provide the context required to determine how particular the differences we observe here are to the evolution of the primate larynx. If the relative flexibility of the primate larynx is robust to future analyses with more clades, it would indicate an increased capacity to explore trait space in our lineage, which may in turn explain why primates have developed such diverse and complex uses of the vocal organ."
Rapid evolution of the primate larynx?

Provide the reader with a "take-away" statement to end the manuscript
"This further reinforces the notion that beyond being the apex predator of the latest Cretaceous Laurasian ecosystems, the tyrannosaurids were amongst the most accomplished hunters amongst large bodied theropods. We find that their anatomy, at once efficient and elegant, yet also capable of bursts of incredible violence and brute force, lives up to their monikers as the tyrant kings and queens, of the dinosaurs."
The fast and the frugal: Divergent locomotory strategies drive limb lengthening in theropod dinosaurs

How to edit your work

Craft clear, understandable prose that gives readers the information they need to understand your study
Ensuring your manuscript is well-written makes it easier for editors, reviewers and readers to understand your work. Avoiding language errors can help accelerate review and minimize delays in the publication of your research.

Why editing matters

Clear and accurate writing increases accessibility
Typographical errors, grammar mistakes, and translation inconsistencies can make your manuscript difficult to understand. A clear, well-written manuscript that is free from errors will help convey your research in a concise way that is easier for your fellow researchers to read and understand.

Proofreading and copyediting your work can accelerate review
Journal staff, editors, and reviewers must be able to understand your article in order to move it through the editorial screening and peer review processes. Proofreading and copyediting your work early—before you submit—can help accelerate review and minimize delays in the publication of your research.

Having trouble spotting errors?

After dozens of read-throughs, catching errors can become more difficult. Reading your manuscript aloud helps to ensure each sentence makes sense and avoid skimming over mistakes. For a radically new perspective, try reading your manuscript in reverse order, one sentence at a time. This trick forces you to focus on the sense and structure of each passage.

Start out strong by setting goals

Establishing clear goals makes both writing and editing your early drafts much easier. When you're deeply engaged with your research it's hard to intuit the appropriate level of information to share; as an expert, aspects of the work that seem obvious to you may be new to your readers.

Take a moment to plan out what you need to cover in your article.
Before you start drafting your journal article, write a short list articulating what you hope to communicate in your article.

Check your work against your intentions.
When your first draft is complete, revisit the original list. Have you hit all the points you identified? Are they presented clearly, with enough supporting information?

Easy ways to ensure your writing is clear and engaging

Writing your manuscript in a way that is clear and concise will save you time in proofreading later and make it easier to understand your work. As you work, aim to:

- Introduce only one new idea per sentence
- Don't use double negatives. For example: "not uncommon"
- Avoid over-repetition of information
- Be careful not to over-complicate by using a variety of terminology to refer to the same phenomenon
- Draw clear and explicit links between ideas (don't rely on readers to connect the dots themselves)
- Be specific and direct. Try to avoid filler words and general terms like "very often" or "different sources." Instead, say how often, exactly. Describe which sources in particular and how you identified them.

Put your best manuscript forward

Most journal editors are more interested in the science behind your study than your typos and grammar, but making your manuscript easy to understand will enable editors and reviewers to easily make sense of your research, and help to ensure a fast and fair assessment.

- Write for your audience. If you're submitting to a highly technical, discipline-specific journal your language should reflect that. If readership is more broad, make sure the concepts described in your paper are easy to understand.
- Get a second opinion. Before you submit, ask a colleague to read through your manuscript to make sure it's easy to read and free of errors. See our tips for asking a colleague for help below.
- Decide whether you will need professional copyediting service. If you are struggling with grammar and syntax, consider a copyediting service. Does the journal employ a professional copyeditor? If so, find out what this service will cost and when to request it. If not, plan for extra time to engage a copyeditor of your own.
- Make edits while you can. Different journals will have different cut offs for edits, and some won't allow general edits after acceptance,so the earlier you proofread your manuscript, the better.
- Check your proof thoroughly. Before publication, some journals supply an author proof of the typeset article. It's important to check this thoroughly for any last minute issues or errors.

Writing (and editing) in another language

If the language you're writing in isn't your first language and you're concerned your science might get lost in translation, use these tips to make your writing as clear as possible.

1. **Don't rely on text translators alone**
   Basic text translators are a good start but they aren't equipped to deal with technical language and can introduce new errors. Always proofread your translated work, or ask a colleague with knowledge of your discipline to proofread for you.

2. **Engage a professional translation service**
   If you have some budget available, consider engaging a professional translation service that can match your paper to an editor with experience in your discipline. Here are a few to start with:

   - AJE Translation Services
   - Editage translation services
   - AuthorAid resources and mentoring

3. **Check it yourself using the EASE Guidelines**
   If you don't have a budget for a professional, don't worry! Use the EASE guidelines for translation to help you proofread the article yourself. You could also ask a colleague to use the guidelines and check your work.

Tips on asking a colleague for help

If you have someone you can ask it's a great idea to get feedback on your writing. Be specific about what you're hoping for help with.

1. **Start with the context**
   Let your colleague know what you hope to accomplish with your article, why you're reaching out to them for feedback, and if you've asked for feedback from anyone else.

2. **Give a timeline**
   It's more than likely that anyone you ask for help is pretty busy themselves. Give them a date that you're hoping for some feedback by, so that they have a target and can let you know if they aren't available.

3. **Tell them your opinion**
   Get them caught up fast by sharing what you think: If you're happy with one part, tell them; if you know another isn't as good but you're struggling to make it clearer, shorter etc. tell them.

4. **Ask for the kind of feedback you want**
   Feedback on your writing could be anything from 'Please perform a quick proofread to check for errors', to 'Please help me re-write this whole section so that it makes more sense'. Let your colleague know what you're really worried about so that they can provide the kind of feedback you're looking for.

This should help your friend/colleague to focus on what you really want help with, and worry less about hurting your feelings or providing too much or too little feedback.

Understanding the publishing process

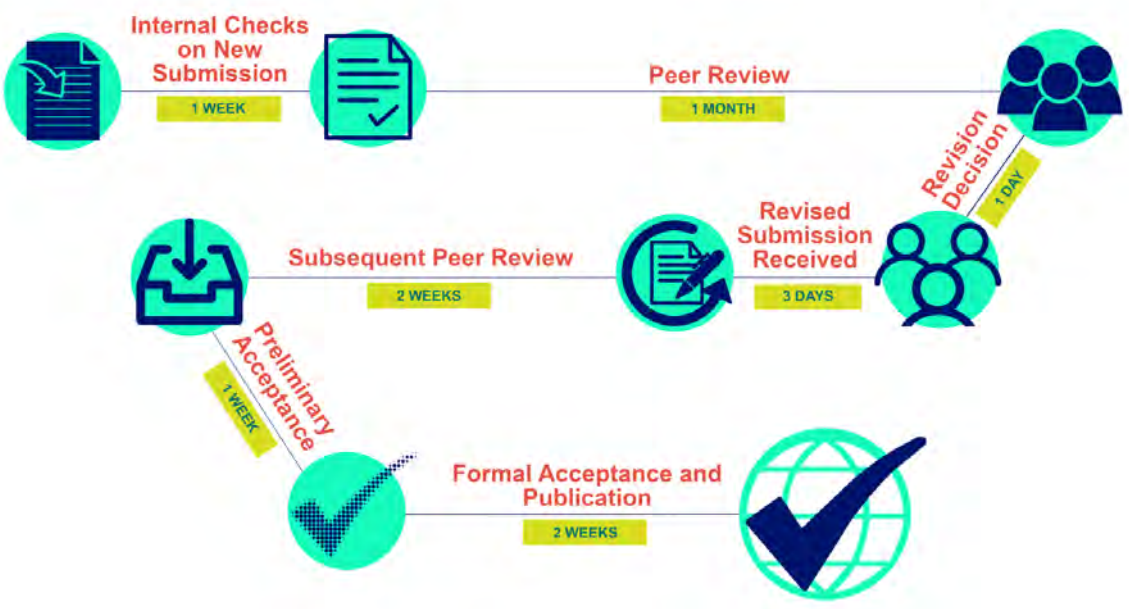
What's happening with my paper? The publication process explained
The path to publication can be unsettling when you're unsure what's happening with your paper. Learn about staple journal workflows to see the detailed steps required for ensuring a rigorous and ethical publication.

Your team has prepared the paper, written a cover letter and completed the submission form. From here, it can sometimes feel like a waiting game while the journal has your paper. It can be unclear exactly who is currently handling your paper as most individuals are only involved in a few steps of the overall process. Journals are responsible for overseeing the peer review, publication and archival process: editors, reviewers, technical editors, production staff and other internal staff all have their roles in ensuring submissions meet rigorous scientific and ethical reporting standards.

Read on for an inside look at how a conventional peer-reviewed journal helps authors transform their initial submission to a certified publication.

Tip: Not all journals share the same naming conventions.

You can apply the advice in this article to the conclusion, results or discussion sections of your manuscript.



Internal checks on new submissions

Estimated time: 10 days
When a journal first receives your submission, there are typically two separate checks to confirm that the paper is appropriate and ready for peer review:

1. Technical check. Performed by a technical editor to ensure that the submission has been properly completed and is ready for further assessment. Blurry figures, missing ethical statements, and incomplete author affiliations are common issues that are addressed at this initial stage. Typically, there are three technical checks: upon initial submission, alongside the first decision letter, and upon acceptance.

2. Editorial screening. Once a paper passes the first check, an editor with subject expertise assesses the paper and determines whether it is within the journal's scope and if it could potentially meet the required publication criteria. While there may be requests for further information and minor edits from the author as needed, the paper will either be desk rejected by the editor or allowed to proceed to peer review.

Both editors at this point will additionally make notes for items to be followed-up on at later stages. The publication process involves finding a careful balance for when each check occurs. Early checks need to be thorough so that editors with relevant expertise can focus on the scientific content and more advanced reporting standards, but no one wants to be asked to reformat references only to have their paper desk rejected a few days later.

Peer review

Estimated time: 1 month
Depending on the journal's editorial structure, the editor who performed the initial assessment may also oversee peer review or another editor with more specific expertise may be assigned. Regardless of the journal's specific process, the various roles and responsibilities during peer review include:

Editor	Initial evaluation to ensure the paper is ready for review, securing reviewers with relevant expertise and processing a decision on the paper.
Reviewer	Submitting reviewer comments within a reasonable timeframe, typically around 2 weeks unless an extension is requested.
Journal Staff	Ensuring that the process follows journal guidelines and proceeds on an acceptable schedule; answering questions to provide assistance for editors, reviewers and authors.

When you have questions or are unsure who your manuscripts is currently with, reach out to the journal staff for help (eg. plosone@plos.org). They will be your lifeline, connecting you to all the other contributors working to assess the manuscript.

Whether an editor needs a reminder that all reviews are complete or a reviewer has asked for an extension, the journal acts as a central hub of communication for those involved with the publication process. As editors and reviewers are used to hearing from journal staff about their duties, any messages you send to the journal can be forwarded to them with proper context and instructions on how to proceed appropriately. Additionally, journal staff will be able to inform you of any delays, such as reviewer availability during summer and holiday periods.

Revision decision

Estimated time: 1 day
Editors evaluate peer reviewer feedback and their own expert assessment of the manuscript to reach a decision. After your editor submits a decision on your manuscript, the journal may review it before formally processing the decision and sending it on to you.

A technical editor may scan the manuscript and the review comments to ensure that journal standards have been followed. At this stage, the technical editor will also add requests to ensure the paper, if published, will adhere to journal requirements for data sharing, copyright, ethical reporting and the like.

Performing the second technical check at this stage and adding the journal requirements to the decision letter ultimately saves time by allowing authors to resolve the journal's queries while making revisions based on comments from the reviewers.

Revised submission received

Estimated time: 3 days
Upon receiving your revised submission, a technical editor will assess the revisions to confirm that the requests from the journal have been properly addressed. Before the paper is returned to the editor for their consideration, the journal needs to be confident that the paper won't have any issues related to the metadata and reporting standards that could prevent publication. The editor may contact you to resolve any serious issues, though minor items can wait until the paper is accepted.

Subsequent peer review

Estimated time: 2 weeks, highly variable
When your resubmitted paper has passed the required checks, it'll be assigned back to the same editor who handled it during the first round of peer review. At this point, your paper has gone through two sets of journal checks and one round of peer review. If all has gone well so far, the paper should feel quite solid both in terms of scientific content and proper reporting standards.

When the editor receives your revised paper, they are asked to check if all reviewer comments have been adequately addressed and if the paper now adheres to the journal's publication criteria. Depending on the situation, some editors may feel confident making this decision based on their own expertise while others may re-invite the previous reviewers for their opinions.

Individual responsibilities are the same as the initial round of peer review, but it is generally expected that later stages of peer review proceed quicker unless new concerns have been introduced as part of the revision.

Preliminary acceptance

Estimated time: 1 week
Your editor is satisfied with the scientific quality of your work and has chosen to accept it in principle. Before it can proceed to production and typesetting, the journal office will perform it's third and final technical check, requesting any formatting changes or additional details that may be required.

When fulfilling these final journal requests, double check the final files to confirm all information is correct. If you need to make changes beyond those specifically required in the decision letter, inform the journal and explain why you made the unrequested changes. Any change that could affect the scientific meaning of the work will need to be approved by the handling editor. While including your rationale for the changes will help avoid delays, if there are extensive changes made at this point the paper may need to go through another round of formal review.

Formal acceptance and publication

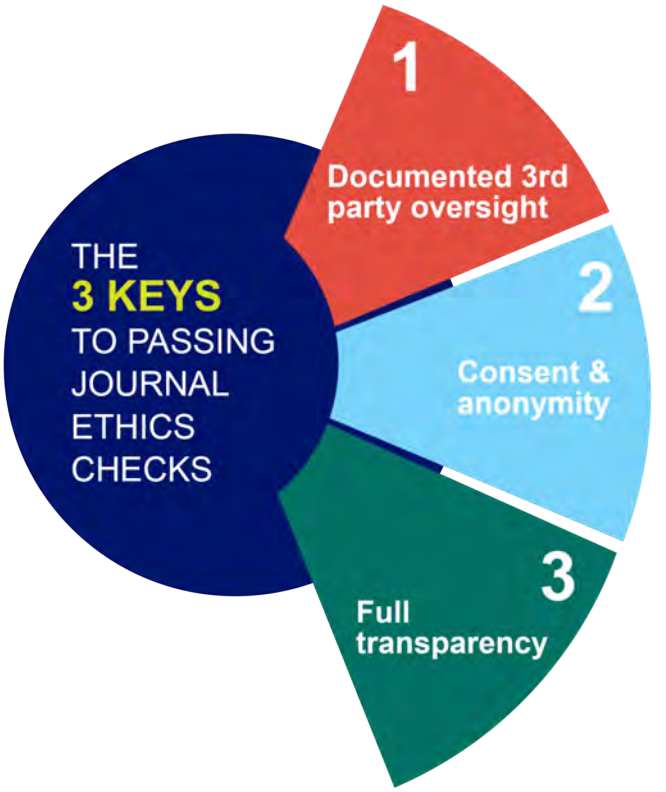
Estimated time: 2 weeks
After a technical editor has confirmed that all requests from the provisional acceptance letter have been addressed, you will receive your formal acceptance letter. This letter indicates that your paper is being passed from the Editorial department to the production department—that all information has been editorially approved. The scientific content has been approved through peer review, and the journal's publication requirements have been met.

Congratulations to you and your co-authors! Your article will be available as soon as the journal transforms the submission into a typeset, consistently structured scientific manuscript, ready to be read and cited by your peers.

Understanding scientific and research ethics

How to pass journal ethics checks to ensure a smooth submission and publication process

Reputable journals screen for ethics at submission—and inability to pass ethics checks is one of the most common reasons for rejection. Unfortunately, once a study has begun, it's often too late to secure the requisite ethical reviews and clearances. Learn how to prepare for publication success by ensuring your study meets all ethical requirements before work begins.



Documented 3rd party oversight

If your research is 100% theoretical, you might be able to skip this one. But if you work with living organisms in any capacity—whether you're administering a survey, collecting data from medical records, culturing cells, working with zebrafish, or counting plant species in a ring—oversight and approval by an ethics committee is a prerequisite for publication. This oversight can take many different forms:

For **human studies** and studies using human tissue or cells, obtain approval from your institutional review board (IRB). Register clinical trials with the World Health Organization (WHO) or International Committee of Medical Journal Editors (ICMJE).

For **animal research** consult with your institutional animal care and use committee (IACUC). Note that there may be special requirements for non-human primates, cephalopods, and other specific species, as well as for wild animals.

For **field studies**, **anthropology** and **paleontology**, the type of permission required will depend on many factors, like the location of the study, whether the site is publicly or privately owned, possible impacts on endangered or protected species, and local permit requirements.

TIP: You're not exempt until your committee tells you so

Even if you think your study probably doesn't require approval, submit it to the review board anyway. Many journals won't consider retrospective approvals. Obtaining formal approval or an exemption up front is worth it to ensure your research is eligible for publication in the future.

TIP: Keep your committee records close

Clearly label your IRB/IACUC paperwork, permit numbers, and any participant permission forms (including blank copies), and keep them in a safe place. You will need them when you submit to a journal. Providing these details proactively as part of your initial submission can minimize delays and get your manuscript through journal checks and into the hands of reviewers sooner.

Consent & anonymity

Obtaining consent from human subjects
You may not conduct research on human beings unless the subjects understand what you are doing and agree to be a part of your study. If you work with human subjects, you must obtain informed written consent from the participants or their legal guardians.

There are many circumstances where extra care may be required in order to obtain consent. The more vulnerable the population you are working with the stricter these guidelines will be. For example, your IRB may have special requirements for working with minors, the elderly, or developmentally delayed participants. Remember that these rules may vary from country to country. Providing a link to the relevant legal reference in your area can help speed the screening and approval process.

Consent and reporting for human tissue and cell lines
Consent from the participant or their next-of-kin is also required for the use of human tissue and cell lines. This includes discarded tissue, for example the by-products of surgery.

When working with cell lines transparency and good record keeping are essential. Here are some basic guidelines to bear in mind:

- When working with established cell lines, cite the published article where the cell line was first described.
- If you're using repository or commercial cell lines, explain exactly which ones, and provide the catalog or repository number.
- If you received a cell line from a colleague, rather than directly from a repository or company, be sure to mention it. Explain who gifted the cells and when.
- For a new cell line obtained from a colleague there may not be a published article to cite yet, but the work to generate the cell line must meet the usual requirements of consent—even if it was carried out by another research group. You'll need to provide a copy of your colleagues' IRB approval and details about the consent procedures in order to publish the work.

Anonymity
Finally, you're obliged to keep your human subjects anonymous and to protect any identifying information in photos and raw data. Remove all names, birth dates, detailed addresses, or job information from files you plan to share. Blur faces and tattoos in any images. Details such as geography (city/country), gender, age, or profession may be shared at a generalized level and in aggregate. Read more about standards for de-identifying datasets in *The BMJ*.

TIP: What if you are working with a population where reading and writing aren't common?

Alternatives to written consent (such as verbal consent or a thumbprint) are acceptable in some cases, but consent still has to be clearly documented. To ensure eligibility for publication, be sure to:

- Get IRB approval for obtaining verbal rather than written consent
- Be prepared to explain why written consent could not be obtained
- Keep a copy of the script you used to obtain this consent, and record when consent was obtained for your own records

TIP: Anonymity can be important in field work too

Be careful about revealing geographic data in fieldwork. You don't want to tip poachers off to the location of the endangered elephant population you studied, or expose petroglyphs to vandalism.

Full transparency

No matter the discipline, transparent reporting of methods, results, data, software and code is essential to ethical research practice. Transparency is also key to the future reproducibility of your work.

When you submit your study to a journal, you'll be asked to provide a variety of statements certifying that you've obtained the appropriate permissions and clearances, and explaining how you conducted the work. You may also be asked to provide supporting documentation, including field records and raw data. Provide as much detail as you can at this stage. Clear and complete disclosure statements will minimize back-and-forth with the journal, helping your submission to clear ethics checks and move on to the assessment stage sooner.

Save that data
As you work, be sure to clearly label and organize your data files in a way that will make sense to you later. As close as you are to the work as you conduct your study, remember that two years could easily pass between capturing your data and publishing an article reporting the results. You don't want to be stuck piecing together confusing records in order to create figures and data files for repositories.

Keep in mind that scientific and research ethics are always evolving. As laws change and as we learn more about influence, implicit bias and animal sentience, the scientific community continues to strive to elevate our research practice.

A checklist to ensure you're ethics-check ready

Before you begin your research

- Obtain approval from your IRB, IACUC or other approving body
- Obtain written informed consent from human participants, guardians or next-of-kin
- Obtain permits or permission from property owners, or confirm that permits are not required
- Label and save all of records

As you work

- Adhere strictly to the protocols approved by your committee
- Clearly label your data, and store it in a way that will make sense to your future self

As you write, submit and deposit your results

- Be ready to cite specific approval organizations, permit numbers, cell lines, and other details in your ethics statement and in the methods section of your manuscript
- Anonymize all participant data (including human and in some cases animal or geographic data)
- If a figure does include identifying information (e.g. a participant's face) obtain special consent

How to share your research

From preregistration, to preprints, to publication—learn how and when to share your study

When should you start to share results, and what are the best formats? Are there advantages or risks associated with sharing early or late?

Publishing your study

A published, peer-reviewed research article is the primary way that scientists communicate the results of their investigations. Once formally published in a journal, your article is indexed and archived, becoming a permanent part of the scientific record.

TIP: Choosing where to submit

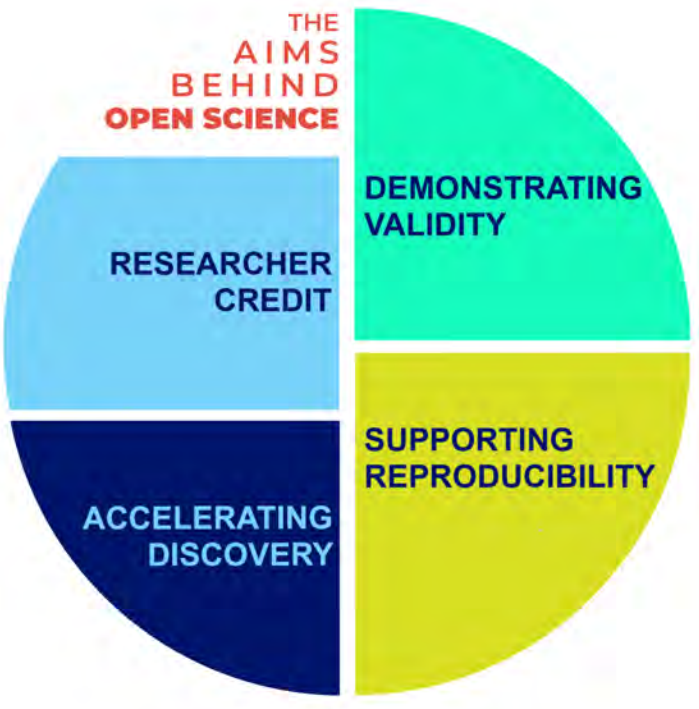
There are many considerations to weigh when choosing where to submit your research. Consult our guide to choosing the journal that's right for you at plos.org.

The benefits to sharing more, sooner

There is much more to conducting research than can be conveyed in a traditional research article. Through Open Science practices like sharing detailed protocols and methods, data and code, sharing work early with preprints, and publishing peer reviews, researchers can communicate their science more fully.

There are four main arguments in favor of sharing research prior to publication, and making more of the background and supporting materials available alongside published articles.

1. **Accelerating discovery** – when new information is available to the research community earlier, other scientists can begin iterating on and incorporating it into their work sooner. That helps knowledge progress more quickly.
2. **Reproducibility** – making supporting materials and background information available alongside a published article ensures that the work can be reproduced and reanalyzed.
3. **Demonstrated validity** – sharing the data and documentation behind the research article is also a statement of confidence on the part of the researchers, a way of standing behind the work and asserting its quality.
4. **Credit** – publishing research articles is seen as the capstone of a scientific study…but there's so much more that goes into each discovery, from research design and collecting and analyzing data to writing a peer review or serving as an editor. When more of the scientific process becomes public, researchers get academic credit for the work they do behind the scenes.



The many other ways to share your science

A published, peer-reviewed research article is the gold standard in scientific communications—but there are many different ways to communicate your research. Here are some of the methods researchers are choosing to communicate their work beyond publication.

Preregistered study design protocols can be deposited with a registration service or submitted to a journal prior to conducting the investigation.

Preprints can be posted in databases like bioRxiv prior to peer review and formal publication in a journal.

Data & code can be entered into repositories, where other researchers can reference your results, conduct re-analyses or meta-analyses, or replicate and validate your work.

Peer reviews and your responses can be published alongside journal articles, demonstrating the validity of your research and giving readers access to more expert opinions and a deeper understanding of the work.

When not to share early

There are cases when sharing results prior to peer review can be dangerous. Some examples include:

- Medical research that might include identifying personal information about a patient
- Research with implications for public health
- Dual use research of concern

Common concerns answered

I am concerned that other publishers won't consider a paper that's already been posted as a preprint.

Preprints have taken hold in some research areas more than others. Today, most top-tier biomedical journals happily consider submissions with preprints. In fact, more than 40 major publishers have policies welcoming preprints in all subject areas, including all journals under the umbrellas of: BMJ, Sage, Elsevier (including Cell and The Lancet), Springer (including the Nature and BMC journals), Taylor & Francis, Wiley, and of course, PLOS. Lots of major society publishers also consider preprinted submissions.

There are some notable exceptions though: certain medical journals, such as the New England Journal of Medicine and JAMA network journals will not consider preprints.

Our advice: *if you have your eye on a particular journal, check their website for guidelines—especially if you're in a medical field. Wikipedia also offers a nice list of preprint-compatible publishers.*

I'm concerned that another research group might scoop my study if I make protocols or preprints public too soon.

Depositing your protocol in a database doesn't necessarily mean it has to be made public immediately. Using the Center for Open Science, you have the option to keep the protocol private until your final article is published.

With that said, both preprints and protocols can be used to establish priority, staking your claim earlier in the research process. And if you're publishing with PLOS, all of our selective journals offer six months of scooping protection under our complementary research policy.

Our advice: *protocols and preprints can both be used to time-stamp your discoveries and showcase your most current work for review boards and tenure committees—but they're just options. Do what makes you most comfortable.*

How to store and manage your data

Ensure that you're publication-ready and ensure future reproducibility through good data management

How you store your data matters. Even after you publish your article, your data needs to be accessible and useable for the long term so that other researchers can continue building on your work. Good data management practices make your data discoverable and easy to use, promote a strong foundation for reproducibility and increase your likelihood of citations.

Have a data management plan

Before you begin your study, be sure to have a thorough and robust data management plan. Knowing what you'll need to do to optimize the storage and sharing of your data before you begin collecting it will set you up for better reproducibility and demonstrate the rigor of your study.

To start, check to see if your funder or institution offers a template that you can adapt. The Digital Curation Center provides a thorough overview of data management plans if you're starting from scratch. The Gurdon Institute also offers a great resource if you don't have one, or just want a second opinion. The article suggests asking yourself:

- What types of data will be created?
- How will these data be processed?
- How will they be stored and backed up?
- How will they be documented (inc. naming conventions, directory structures etc)?
- How will these data be of benefit to the broader scientific community?
- How will they be archived and will they comply with any data/metadata standards?
- How will they be made available and discoverable to the broader community?
- What are the policies for sharing, re-use etc?

Download Free Data Management Templates and Resources

If your institution or funder doesn't already offer a Data Management Plan template or requirements, consider starting with one of these open resources:

DMPonline helps you to create, review, and share data management plans that meet institutional and funder requirements. It is provided by the Digital Curation Centre (DCC)

Choosing a repository

There are a number of repositories to choose from, each with unique pros and cons. Centralized, Open Access repositories make it easier for a broad audience to discover, analyze, and reuse your data, though a specialized repository may be the best solution for you if you require unique formatting.

Having more options available enables you to choose a repository that fits your specific needs, but more sources can also make it difficult for other researchers to find your data if they aren't looking in the right place.

Before you decide on a repository, consider the following:

Your audience
Your data should be accessible and easy to find by the people (or machines) most likely to use it. This might include:

- Other **researchers in your field** and the data analysis, search, and retrieval software they rely on to find and reuse your datasets. If this is your primary audience, you might consider a centralized, field-specific repository.
- Other **researchers outside of your field** or professional groups. This is especially important for highly interdisciplinary work. You might consider a public repository that is widely known and serves many disciplines
- **Funding agencies** that you may wish to apply to for future grants to continue the work. Choosing an Open Access data repository will ensure there are never future issues in accessing and sharing your data. Some funders may even require you to do so.
- **Editors and reviewers** at the journal. Even if your data is confidential or proprietary, you will need a way to make this accessible to key stakeholders in the evaluation of your manuscript.

Long-term accessibility

- **Can those who need access to your data find it easily?** For example, if you've used a field-specific repository for interdisciplinary work, other researchers may not know where to look.
- **Is your data optimized for machine readability?** Your data should be structured in a simple, consistent format that makes it easier for researchers to access and reuse without manual intervention.
- **Will you be able to access your own data when you leave your institution**? If your institution provides a repository but restricts access to the public, you may lose access if you move on to a different organization.
- **Should access to your data be restricted?** If your data contains sensitive information about a vulnerable population or other sensitive topic that cannot be made widely available, have you provided a clear path for those who do need verified access to be able to obtain it?

Compliance

- **Can those who need access to your data find it easily?** For example, if you've used a field-specific repository for interdisciplinary work, other researchers may not know where to look.
- **Is your data optimized for machine readability?** Your data should be structured in a simple, consistent format that makes it easier for researchers to access and reuse without manual intervention.
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- **Should access to your data be restricted?** If your data contains sensitive information about a vulnerable population or other sensitive topic that cannot be made widely available, have you provided a clear path for those who do need verified access to be able to obtain it?

Proprietary data

You may find yourself in a situation where your ideal sharing method or repository is at odds with one of these requirements. For example, your institution or funder may insist the data you've collected is proprietary which could limit you from publishing in journals where Open Data is required. In either case, you should make sure your data is available to editors and reviewers at your selected journal so they can properly evaluate the work

Reproducibility checklist

Making your data easy to follow ensures that other researchers will be able to confirm your results. This is the first step in building a reliable foundation for future research.

- Data follows the FAIR Principles (see below)
- Data is Open and accessible for broad use
- There is a plan for the long-term accessibility
- Data and metadata are clearly labeled and interpretable
- Data and metadata are formatted to allow maximum use by both humans and machines
- Datasets are complete–including negative and null results

Commit to open data

Your impact goes further when it reaches a broader audience. You can help advance progress in your field more swiftly by removing barriers to access and reuse your published work. By making all of your data available in open repositories, you help increase our collective knowledge and make it easier for other researchers to build upon your study.

70% of surveyed researchers say they're likely to use open datasets for their future research.	**79% of surveyed researchers support mandatesfor making primary research openly available.**	**Papers linking to open data can have up to 25.36% higher citation impact.**

FAIR principles

The FAIR data principles (standing for Findable, Accessible, Interoperable, and Reusable) are a set of community-designed guidelines to provide measurable, consistent data standards for data sharing and increase data reusability.

Findable: Metadata and data should be easy to find for both humans and computers.

Accessible: There is a clear path for a user to retrieve your data and obtain any necessary authentication and authorization.

Interoperable: The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing.

Reusable: To achieve this, metadata and data should be well-described so that they can be replicated and/or combined in different settings.

Read more: https://www.go-fair.org/fair-principles/

Sample repositories

FAIRsharing provides a comprehensive list of repositories filterable by discipline, journal recommendation, and region.

For quick access to some of the most common repositories, browse the list below.

OA Repositories (by discipline)

PLOS Recommended Repositories

Open Access Directory

OA Cross-Disciplinary Repositories

Dryad Digital Repository

figshare

Harvard Dataverse Network

Kaggle

Network Data Exchange (NDEx)

Open Science Framework

Zenodo

How to receive and respond to peer review feedback

A thoughtful, thorough approach to your revision response now can save you time in further rounds of review.

You've just spent months completing your study, writing up the results and submitting to your top-choice journal. Now the feedback is in and it's time to revise. Set out a clear plan for your response to keep yourself on-track and ensure edits don't fall through the cracks..

Keep calm and take stock

From time to time, you're going to get frustrating comments. Even though it may sometimes feel like the reviewers haven't spent enough time with your work, are overly-critical, or lack the right expertise, remember that a lot can get lost in translation. Always start by assuming reviewers have the best intentions.

Bear in mind that the goal of peer review feedback is to verify and strengthen your work so that it is ultimately a more effective communication. Reviewers are a good representation of the journal's general readership and their reactions can help you craft a better, clearer publication for your audience.

After reviewing your manuscript comments, it might be helpful to take a step back and clear your head. When you come back to it, ask yourself: *what are the fundamental issues the reviewer wants me to address?*

Set a plan for revisions and response

Don't lose track of important changes you intend to make. Making a plan for revising and crafting your response to the reviewers can help you organize your steps, get a better idea of what work needs to be done, and make the process run more smoothly.

1. **Start a list of essential vs. unessential requests to prioritize your work.**
   The editor's note may help you see which edits are required to meet the journal's standards. Don't disregard the unessential list, however. While these edits may be "nice to have" rather than "required," they can strengthen your work for that journal's typical audience. If you have time and resources to tackle these, do so.

2. **Decide whether you'll need time to conduct additional experiments.**
   Don't shy away from providing additional data. If you already have the data requested by the reviewers, but don't feel it fits the scope of your work, you can include these in your response as a show of good faith, and indicate in your letter why you think they should be left off the published article. If you need extra time for your revision to complete the additional research, make sure you let your editor know.

3. **Make sure you have a system for responding to each comment, and demonstrating your changes.**
   This might sound tedious, but a clear, point-by-point response can save you time in subsequent rounds of review. Use track changes to show your edits and/or indicate line numbers in your response where the requested change can be found in the manuscript.

4. **Don't ignore any comments.**
   Even if you've decided not to make a change, your response to the reviewers should explain why you've done so. You may need to provide additional evidence as to why this isn't relevant. That's OK. Your goal here is to make sure reviewers have enough clarity of your work to understand your thinking. Without an adequate reason, reviewers may request the same change in subsequent rounds of review.

Tip: Build in a little extra time for a final review

Once you've updated and revised your manuscript, give yourself a little lee way—let the paper rest for a day or two and give it another read, checking to make sure that your edits make sense with the rest of the paper. For more tips, visit our guide to editing your work.

Conflicting feedback

It's almost inevitable that you will encounter reviewers who disagree on a course of action, or even an editor who disagrees with the reviewers. Here are some tips for navigating each case:

Reviewer vs editor
In general, the editor should be able to provide commentary more closely aligned with the journal's scope and editorial policies. If the editor disagrees on a suggested edit, you should cite the editor's comments in your response to the reviewers.

Reviewer vs reviewer
When two reviewers offer conflicting advice, your editor may be able to provide guidance as to the journal's standards, and which course of action they feel is more appropriate. As before, be sure to cite the editor's advice in your response.
If the editor hasn't provided clarity in their response, ask a colleague familiar with your work and check in with your coauthors for a second opinion.
Rely on yourself. Ultimately, the decision to make any change is up to you. Provide a clear and defensible response to reviewers, citing your reasons for complying or not complying with a suggested edit, so that the reviewers and the editor understand your decision.

Writing your response

- **Include a cover letter.** Keep this short, but do call out important information about your changes and any points you wish to clarify further. If you found reviewer advice particularly helpful, thank them for their thoughtful commentary! Here's a quick template you can follow:

  Thank you for taking the time to review and comment upon our manuscript, %%Manuscript Number%%, %%Title%%. We found the advice constructive and have incorporated many of the suggestions into our revision…

  We've responded to each comment individually below and would like to draw your attention to….

  Thank you again for your thoughtful comments…

  Sincerely,
  %%Name%%

  You can also find a number of full cover letter examples online for inspiration.

- **Assume both the editor and reviewers will see everything that you write.** If you've submitted to a journal with an open peer review process, your readers could see your comments as well

- **Keep your responses clear, unemotional, and easy to follow**. Respond in-line to every comment, indicating line numbers where a change can be found

  Reviewer Comment 1: Suggestion for additional charts.

  Response: We have not added an additional chart as the requested data can already be found in Figure 1. Instead, we've adjusted the colors and weighting to make this line clearer.

  Reviewer Comment 2: Suggested clarification or correction.

  Response: We have made this change in line 44.

- **Write your response, take a break, and come back to it**. Re-read your comments and make sure they come across calm and professional. If you're struggling to come up with the right way to say something, try these reviewer response examples for inspiration.