

Guide for Writing in Biology

About Writing in Biology

By Dr. Romi Burks
& Dr. Maria Todd

Why Good Writing Really Matters in Biology

Strong writing skills in biology facilitate professional success in multiple arenas, from securing job employment to professional school admission to obtaining grants for future research. Quality writing exemplifies the basic skills expected of a trained biologist: organization, attention to detail, evidence-based decision making and critical analysis. We estimate that professional biologists spend at least one third of their time writing in some form. The study and practice of scientific writing plays an equally critical role in a scientist's education as the acquisition of scientific knowledge.

Writing in biology does not need to be boring. In fact, successful writing strives for just the opposite. The most convincing science comes together as a compelling story and quality writing helps deliver the intended message to the appropriate audience. It is critical that the author makes specific effort to engage the readership and justify the time, investment, and implication of the work presented, whether that work involves basic or applied research. The written work of biologists reflects the perceived quality of their science. In other words, if you produce shoddy writing, then people think you do shoddy science.

Biologists primarily write for other biologists or a broader scientific audience. Types of "scientific writing" vary from abstracts to lab reports to full-length manuscripts about research outcomes. However, with the growing recognition of the need to communicate science to the general public, biologists also now find themselves writing about biology research for primarily non-technical audiences. We refer to this as "writing about science" rather than "scientific writing."

About this guide

This guide contains the following sections:

- About Writing in Biology
- Types of Writing in Biology
- Evidence in Biology
- Conventions of Writing in Biology
- Citations & Formatting
- Common Errors in Writing in Biology
- Further Resources for Writing in Biology

The Disciplinary Writing Guides are designed to provide an introduction to the conventions, or rules, of writing in different subjects. These guides have been designed by Southwestern professors to help you understand what will be expected of you in your classes.

Why No Set “Rules” Exist for Writing in Biology

Biology as a discipline involves multiple areas of study that often intersect or develop their own specialized conventions. The face of biology writing continues to change with the increase in the interdisciplinary nature of science. Unlike other disciplines (e.g., psychology or chemistry), no one society or organization dictates the standards of writing in biology. Citations and reference materials routinely appear in journal-specific formats. In other words, a molecular biology paper may differ somewhat in its construction from that of a molecular ecology paper. In terms of content, biologists strive for accurate and concise statements supported by peer-reviewed evidence whenever available. Across core areas of biology, however, the basic structure of peer-reviewed publications remains consistent.

Publishing in Biology: Follow the Directions

In terms of writing style, papers in biology must meet agreed upon standards for organization, clarity, coherency and consistency in form (i.e., voice, tense, notation, citation, figures, etc.). In traditional outlets for sharing results (peer-reviewed journals), biologists do not get paid for writing papers. In fact, journals often charge authors a certain amount per page to publish. **This practice literally makes every word count.** A biologist must learn how to convey the key results in the fewest words possible. Authors of journal articles must carefully read and adhere to the “Guide to Authors” for each specific journal before submitting a manuscript. If the manuscript gets rejected, the authors may submit it to another journal but only after they have reformatted it according to the specific journal guidelines. Your own writing in different biology courses is designed to mimic this professional process of scientific publication.

The Interdisciplinary Nature of Writing in Biology

Biology involves the study of life at many levels from the macro (e.g., ecological habitat) to the micro (e.g., cell behavior) to the molecular (e.g., DNA sequence). Often, the most groundbreaking research occurs at the intersection of these different sub-disciplines, most notably in the emerging fields of molecular ecology, molecular neuroscience, and translational medicine—all of which now have their own journals. Regardless of the subject, authors must follow the directions for any journal.

Types of Writing in Biology

Research Proposals or Grants

Proposals typically undergo peer review and usually include a short justification for the work, proposed methods, hypotheses, and expected results along with the broader implications of the work. Depending on the approach, some proposals may include broader impacts as defined by the National Science Foundation. Broader impacts might include making the results of the science available to the public, training students or contributing to solve a problem in society. Several small grant opportunities exist for undergraduate biologists, and practicing the art of writing grants can help you learn to justify your science.

Laboratory Notebooks

Laboratory notebooks serve two purposes. First, they act as a technical resource and reference for other scientists in the lab. Secondly, lab notebooks provide an authentic, verifiable record of the research performed by a particular individual. Lab notebooks constitute an accurate record of a scientist's research activities, and the content within varies from scientist to scientist. However, when a scientist leaves a lab, their notebook (which is the property of the lab) remains behind. Consequently, you need to include legible, accurate and detailed information in your lab notebook. Information should never be deleted from the notebook. All entries should be dated.

Laboratory Reports

Laboratory reports communicate the findings of a single experiment or short set of experiments. The report usually includes a brief experimental objective (usually one sentence), a short introduction (to provide the context for the research), description of the methods used, a detailed report of the data obtained (including relevant tables and figures), and an interpretation of the results.

Research Manuscripts

Research manuscripts are **primary literature** that communicate results of scientific experiments. They vary in length from "short notes" that highlight a notable result to "full length reports" that describe a more lengthy series of experiments that tell a more complete story. In addition to the standard sections of a paper (see above), these research manuscripts (referred to as publications once they have completed the process) also include acknowledgments of financial and technical aid and a list of references/resources.

Review Papers

Review papers are **secondary literature** that provide a comprehensive summary of the published findings relating to a broad or highly specialized topic in biology and are useful resources for scientists entering a new field. Following the gathering of the relevant primary literature, the authors of a review deftly synthesize the material into a structured, coherent, and accurately referenced narrative.

Primary Literature Critiques

Primary literature critiques examine the content and quality of a publication. To conduct a comprehensive review, the person conducting the critique needs first to put the critiqued paper in context, then to identify the take home message, and finally to examine the details associated with the methods and results. Overall, critique authors need to consider the readability of the manuscript and identify whether it conforms to the expected guidelines. Primary literature critiques generally include strengths and weaknesses of both the experiments described as well as the writing style.

Abstracts

Abstracts serve as a summary of either a research paper or a poster. As such, an abstract contains the most relevant information from each section of the document including a 1-2 sentence introduction, the major objective(s), methodological approaches used, major findings and a short interpretation of the data. In most fields, it is acceptable to provide 1-2 sentences highlighting the implications of the research. You will write abstracts when you apply to present results at a scientific meeting.

Posters

Posters act as a visual aid for an interactive oral presentation by the scientist. The visual design of a poster therefore requires a certain amount of creativity in addition to technical flair. Having said that, the written content and data presentation should conform to the same high standards as that of a research paper.

Writing About Science

These assignments employ the same general skill sets as scientific writing but use more common language and style to increase engagement with the reader. Blog posts, persuasive essays, tweets, discussion forums, or informative pieces that translate scientific journal articles represent examples of writing about science. In general, we find that approaches to improve writing reach across both enterprises (i.e., scientific writing and writing about science) but certain conventions appear more often in scientific writing (e.g., use of SI units, citation of primary literature, use of scientific versus common names, etc.)

Evidence in Biology

Once you understand the writing of professional biologists, it's easy to see how these practices are reflected in the writing you'll do for your courses. Scientific writing in biology incorporates peer-reviewed literature to justify the need for the study (Introduction), refers to methodology (Methods), or places the work in a comparative or broader context (Discussion). In their introductions, biologists may include other mainstream sources, but these sources do not replace peer-reviewed ones. Peer-reviewed literature comes in two forms: primary or secondary. For the results sections, information about the data provides the evidence for any speculation included in the discussion. You might think about the evidence used in biology writing as consisting of four categories: primary sources, secondary sources, mainstream sources, and data.

Primary sources

Usually taking the form of journal articles, primary sources contain analysis of original data and ideas that represent the first published record of that study. Quality primary literature **has undergone peer-review** (the quality of which varies) by the scientific community prior to publication. Most primary literature papers follow a traditional format: abstract, introduction, methods, results, and discussion. The abstract should be a stand-alone paragraph summarizing the entire study. Please note that you must read an entire primary source; relying only on the abstract as a source is unacceptable.

Secondary sources

Often referred to as “review papers,” secondary sources include publications that compile and synthesize information from primary literature. Secondary sources may rearrange or modify data, looking for connections between several publications, or they may conduct “metadata” analyses on information compiled from other sources. These analyses look for patterns in data conducted by other researchers. Some secondary sources, particularly those found in book chapters, may be peer-reviewed. However, secondary sources do not represent original data or ideas to the extent that primary literature does.

Mainstream sources

Other, non peer-reviewed sources (newspapers, encyclopedias, textbooks, etc.) may discuss science more generally or provide background information instead of new discoveries. Writing about science efforts usually rely more heavily on review summaries, websites, and other forms of science translation to support a story. Certain websites (especially institutional websites or government sites) provide valuable information for biologists, but you should exercise caution in how much you depend on websites for information. Wikipedia does not count as a reliable source.

Mainstream sources (continued):

When evaluating websites, you should consider the accuracy of the content, the authority (i.e., credentials) of the author(s), the currency (up-to-date nature) of the information, the objectiveness of the website, and the coverage provided. It is often best to check with your professor before you rely on a website as a source. Laboratory reports may contain references to textbooks or lab manuals.

Data

Data in papers is presented in many forms, including graphs, tables, pictures (e.g., gel photos), or schematics. Presentation of data may be tweaked to improve clarity but should **never ever** alter the authenticity of the data

or skew the interpretation of the results. Regardless of form, presentations of data need proper labeling and descriptions that give the work context. All presentations of data should contain sufficient labeling and description so that they can stand alone outside the paper. In terms of numerical analysis, authors should present averages accompanied by a measure of variation (mostly commonly one SD [standard deviation] or one SE [standard error]) instead of including individual raw data. When tests for statistical significance have been performed, p values should be always be reported, along with the appropriate test statistic (e. g., F for ANOVA, R for correlation analyses, R^2 for regression). Regarding agarose or polyacrylamide gel images, bands need to be visible with an indication of their molecular weight where appropriate and the contents of the lanes need to be labeled.

Conventions of Writing in Biology

Although there are no set “rules” for writing in biology, scientific writing generally adheres to a set of conventions you should follow in your papers. Below are a few frequently asked questions about the conventions of writing in biology.

Who is the audience for scientific papers?

The majority of scientific articles are written in English, but it important to remember that English is not the native language of many of the world’s scientists. Therefore, **it is imperative that writers use correct English, free of colloquialisms, jargon, country-specific slang, and cultural references.**

In general, biologists **write to an audience in third person** to maintain a professional tone.

What subtle differences occur between writing in subdisciplines of biology?

The degree of creativity used in the construction of manuscript and poster titles varies between subdisciplines. Whereas ecologists often convey the science in the context of a witty metaphor, cell and molecular biologists almost always conform to conventional use of purely technical titles.

Scientists trained in ecology write with an emphasis on active voice. Cell biologists instead emphasize the exclusive use of passive voice when training students to write. Molecular biologists, on the other hand, favor the passive voice but do use the active voice sparingly for emphasis.

You can remember these conventions by understanding that ecologists study organisms that “act” (e.g., the snail moved) versus the more inanimate objects generally being acted upon (e.g., the pipette was moved; the solution was mixed) in cell and molecular biology.

When, if ever, should one quote instead of paraphrase?

Rarely quote. In scientific writing, you need to avoid quotes 99.9% of the time. In review papers or perhaps in introductions of manuscripts, special exceptions to the “rarely quote rule” may occur when paying homage to historical scientific figures or a well-accepted adage (e.g., “nothing makes sense except in the light of evolution” by T. Dobzhansky). Instead of quoting, biologists paraphrase the content of sources in their own words and then provide the proper citation. **No excuse ever exists for direct copying of text from any resource.**

Formatting & Citation for Writing in Biology

No single citation style applies to all subdisciplines of biology. You must therefore read and follow the guidelines for a particular publication or class assignment. If none is specified, the CSE style is typical (links to examples of this style are available in the “Student Resources” section of the Debby Ellis Writing Center website). **Generally, citations for peer-reviewed primary literature include authors, year, title, journal, volume (issue) and pages.** Within text, biologists commonly use parenthetical notation to refer to sources, figures or statistical support. Sources typically occur in a “Name and Year” format (i.e., Burks & Todd 2015) with or without a comma depending on the journal. Statistical tests, programs, and instrumental parameters can also appear in parentheses. We recommended consulting examples from the specific target journal. Footnotes rarely appear in scientific papers, although a few select publications use a numbered reference superscript to refer to the list of references (e.g., *Nature* and *Science*).

A Few Last Tips for Avoiding Common Errors

Latin Names: It is important that you pay special attention to formatting when using Latin.

- Ecology-side: Genus and species of any organism is always in italics or underlined. Genus is capitalized. Species is not. Examples: *Pomacea maculata*
- Molecular-side: The formatting conventions for genes and their products vary from species to species. It is important to use the correct convention for the species of interest and to apply the format consistently throughout the text.
- You might also consult websites devoted to specific species contain formatting information, e.g., The National Center for Biotechnology Information (bacteria), flybase.org (flies), or genenames.org (humans).

Chemical formulae must be written correctly. “CO₂” is the molecule carbon dioxide. “CO2” (no subscript) is meaningless.

Voice & Tense: In most cases, use active voice, past tense. Active voice means that the subject of the sentence performed the verb. Past tense means that the action has already occurred. In addition, consider person (1st [I] vs. 3rd [The organisms], almost never 2nd [you]) and subject/verb agreement (in both number and tense)

- We hypothesized. (1st person, plural, active, present)
- We tested. (1st person, plural, active, past)
- The subject was tested. (3rd person, singular, passive, past)

Units: All units of measure must be metric or SI (International system). If you need to convert, online tools are available at goconvert.com and at the website of the Bates College guide listed in the “Sources & Further Resources” section of this guide.

Contractions: Do not use contractions in formal writing.

Because vs. Since: “Since” implies time. “Because” gives a reason. Although in other disciplines these words may be interchangeable, successful biology writers avoid using “since” when “because” represents the better choice.

Affect vs. Effect: “Affect” is a verb. “Effect” is a noun.

While vs. Although: “While” means “simultaneously.” If you mean to contrast two things, try “although,” or “whereas.”

i.e. vs. e.g.: The first means “that is” (Latin *id est*) and is followed by an explanation. The second means “for example” (Latin *exempli gratia*) is followed by an example.

Data: “Data are.” Use the plural.

Species: The word is both singular and plural.

Sources & Further Resources

General Websites for Writing in Biology:

“[Writing in Biology](#)” O’Donnell, B. University of Connecticut Writing Center.

“[How to Write a Paper in Scientific Journal Style and Format](#)” Bates College Department of Biology.

Scientific Writing:

Bourne, P. E. 2005. [Ten simple rules for getting published](#). *PLoS Comput Biol* 1(5): e57.

Gillen, C. M. 2007. [Reading primary literature: A practical guide to evaluating research articles in biology](#). Benjamin Cummins Publishing.

Gopen, George D., & J. A. Swan. 1990. [The science of scientific writing](#). *American Scientist* 78: 550-558.

Nicholas, K. A. & W. S. Gordon. 2011. [A quick guide to writing a solid peer review](#). *EOS* 92(28): 233-240.

Wells, W. 2004. [Me write pretty one day: how to write a good scientific paper](#). *The Journal of Cell Biology* 165(6): 757–758.

Style Guides for Scientific Writing:

Day, R. A. & B. Gastel. 2011. *How to Write and Publish a Scientific Paper*, 7th edition. Greenwood Press, 300 pages.

Graff, G. & C. Birkenstein. 2010. *They Say I Say: The Moves That Matter in Academic Writing*, 2nd edition. W. W. Norton and Company, 245 pages.

Strunk, W. Jr. & E. B. White. 1999. *The Elements of Style*, 4th edition. Longman Publishing, 105 pages.

Bedford/St. Martin’s Writer’s Help.

Books for Writing About Science:

Blum, D., M. Knudson & R. Marantz Henig. 2006. *A Field Guide for Science Writers: The Official Guide of the National Association of Science Writers*. Oxford University Press, 321 pages.

Hancock, E. 2003. *Ideas Into Words: Mastering the Craft of Science Writing*. The John Hopkins University Press, 151 pages.

Hayden, T. & M. Nijhuis (eds). 2013. *The Science Writers’ Handbook: Everything You Need to Know to Pitch, Publish, and Prosper in the Digital Age*. DaCapo Press, 308 pages.

Zinsser, W. 2006. *On Writing Well: The Classic Guide to Writing Nonfiction*, 7th edition. Harper Collins Publishing, 321 pages.

McMillan, Victoria E. (2012). *Writing Papers in the Biological Sciences*, 5th edition.