How to Write and Publish a Scientific Paper

NINTH EDITION

Thoroughly updated throughout, the authors of this classic guide put their advice into practice by keeping the book as clear and simple as possible. They provide early-career scientists and experienced researchers with practical support on writing for different audiences and getting published. This ninth edition retains the key material – including preparing text and graphics, publishing research papers, writing grant proposals, rights and permissions, and a wealth of advice on writing style – while new material includes new guidance on navigating copyright, presenting online, identifying co-authors, creating visual abstracts, and writing in English as a non-native language. Valuable appendices provide a ready reference on words and expressions to avoid, SI prefixes, useful websites, and a handy glossary. Postgraduate students and working scientists will want to keep *How to Write and Publish a Scientific Paper* at their desks and refer to it at every stage of writing and publication.

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Preparation of the current edition of this book began as the COVID-19 pandemic was arriving. The pandemic has highlighted the importance of communicating science and has spurred changes in this regard. It is to the scientists who have helped us understand and control COVID-19, the editors who have helped ensure that the findings are shared expeditiously and soundly, and the many whose lives have been lost in the pandemic that we dedicate this edition.

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Preface

Criticism and testing are of the essence of our work. This means that science is a fundamentally social activity, which implies that it depends on good communication. In the practice of science, we are aware of this, and that is why it is right for our journals to insist on clarity and intelligibility.

—Hermann Bondi

The goal of scientific research is publication. Scientists, starting as graduate students or earlier, are measured primarily not by their adeptness in the laboratory, not by their knowledge of scientific subjects, and certainly not by their wit or charm; they are measured and become known (or remain unknown) on the basis of their publications. On a practical level, a scientist typically needs publications to get a job, obtain funding to keep doing research in that job, and get promoted. At some institutions, publications are needed to obtain a doctorate.

A scientific experiment, no matter how spectacular the results, is not completed until the results are published. In fact, the cornerstone of the philosophy of science is based on the fundamental assumption that original research *must* be published; only thus can new knowledge be authenticated and then added to the existing database that we call scientific knowledge.

Unlike those in many other fields, scientists must provide a document showing what they did, why it was done, how it was done (so others can try to repeat it), and what was learned from it. The key word is *reproducibility*. That is what makes science and scientific writing unique.

Thus, the scientist must not only "do" science but also "write" science. Bad writing can (and often does) prevent or delay the publication of good science.

Unfortunately, the education of scientists is often so overwhelmingly committed to the technical aspects of science that the communication arts are neglected or ignored. In short, many good scientists are poor writers. Certainly, many scientists do not like to write. As Charles Darwin said, "A naturalist's life would be a happy one if he had only to observe and never to write" (quoted by Trelease 1958).

Most of today's scientists did not have a chance to take a formal course in scientific writing. As graduate students, they learned to imitate the style and approach of their professors and previous authors. Some scientists became good writers anyway. Many, however, learned only to imitate the writing of the authors before them—with all its defects—thus establishing a system of error in perpetuity.

The main purpose of this book is to help scientists and students of the sciences in all disciplines to prepare manuscripts likely to be accepted for publication and to be completely understood when they are published. Because the requirements of journals vary widely from discipline to discipline, and even within the same discipline, it is not possible to offer recommendations that are universally acceptable. In this book, we present certain basic principles that are accepted in most disciplines.

Let us tell you a bit about the history of this book. The development of *How to Write and Publish a Scientific Paper* began many years ago, when one of us (Robert A. Day) taught a graduate seminar in scientific writing at the Institute of Microbiology at Rutgers University. It quickly became clear that graduate students in the sciences both wanted and needed *practical* information about writing. If a lecture was about the pros and cons of split infinitives, the students became somnolent; if it addressed how to organize data into a table, they were wide awake. Therefore, a straightforward "how to" approach was used for an article (Day 1975) based on the lecture notes. The article turned out to be surprisingly popular, which led to the first edition of this book.

The first edition led naturally to the second edition, and then to succeeding editions. Because this book is now being used in teaching programs in many colleges and universities, it seems especially desirable to keep it up to date. We thank those readers who kindly commented on previous editions, and we invite suggestions that may improve future editions. Please send suggestions and comments to Barbara Gastel at b-gastel@tamu.edu.

This edition, the ninth, is the fourth for which Barbara Gastel joins Robert A. Day. Regrettably, Day did not live to see its publication. He died peacefully at age 97, having lived a vibrant and productive life and having retained his sharp mind despite declining health. Gastel remains grateful to Day for asking her to collaborate, and she feels honored to maintain his legacy. We were delighted that our previous editions together have been translated into at least

five languages, and the hope persists that the current edition will be widely translated too.

In keeping with its title, this book has always focused primarily on writing and publishing scientific papers. It also has long provided broader advice on scientific communication. Beginning with the first edition, it has contained chapters to help readers write review papers, conference reports, and theses. Over time, chapters have been added on other topics, such as how to approach a writing project, how to present a paper orally, how to prepare a poster presentation, how to prepare a grant proposal, how to write about science in English as a foreign language, how to communicate science to the public, how to provide peer review, and how to edit one's own work.

The current edition maintains this overall scope but has been substantially updated and otherwise revised. Newly addressed topics include posting preprints, providing visual abstracts, writing personal essays for journal publication, and presenting online. We have expanded the guidance on the writing process, and we have revamped the chapter on the use (and misuse) of English. The list of electronic resources also has been updated. Cartoons have long been a popular feature of the book; we have retained favorites from previous editions and added several new cartoons.

This book remains a "how-to book" or "cookbook," focusing mainly on points of practical importance. As in past editions, the book also contains some other items, such as examples of humorous errors, intended to lighten the reading. Readers wishing to explore topics further are encouraged to consult works noted in the text or cited as references and to look at websites mentioned in this book.

We hope that, as well as increasing your skill, this book will increase your confidence in communicating science. Yes, writing a scientific paper is a substantial task. But it relies largely on the same attributes—such as intelligence, organization, and perseverance—as doing science does. If you can do research, you can communicate it. After a course using this book, a student said that whereas previously she had likened writing a scientific paper to climbing Mount Everest, she now viewed it more like climbing a high but surmountable peak at a state park. We hope this book will be a faithful guide and good companion during your climb.

Good scientific writing is crucial to scientists' careers, science, and society. We hope this book will demystify writing and publishing a scientific paper and help you communicate about your work effectively, efficiently, and even enjoyably. Your success will be our greatest reward.

A Word to International Readers

For researchers throughout the world, communicating in English in standard Western formats has become largely the norm for sharing information widely. Thus, over the years, *How to Write and Publish a Scientific Paper* has had many readers for whom English is not their native language. We hope that the current edition will serve an even wider readership.

Aware of the diversity of our readers, we have tried especially hard in the current edition to present the main content in language that nonnative users of English can easily understand. Likewise, in choosing cartoons and other humor, we have increasingly favored items that readers from varied backgrounds can appreciate. We realize, though, that sometimes humor does not translate well. If, as an international reader, you are puzzled by a cartoon or silly-seeming comment, do not worry that something is wrong or that you have missed an important point. Rather, realize that you are seeing some examples of American humor.

We welcome readers from throughout the world and hope that they will find our book helpful in communicating science internationally.

Acknowledgments

Over the years and over the editions, many colleagues and others have contributed directly or indirectly to this book. Those we have worked with in scientific publishing and academia have shared information and ideas. So have fellow members of the Council of Science Editors, the Society for Scholarly Publishing, and other organizations. Students and other users of the book have made suggestions. Many colleagues read and commented on manuscripts for early editions. Sarah Allen, Wura Aribisala, Melissa Espinoza, Tara Gray, George Hale, Duanduan Han, Daniel Limonta Velázquez, Arkady Mak, Corley-Ann Parker, Nancy Day Sakaduski, and Roberto Tuda Rivas read recent editions or parts thereof and offered thoughtful suggestions. Editors and production staff brought the work to publication. We thank all these people. We also thank our families for their support, encouragement, and counsel.