

# GETTING PUBLISHED *in the* LIFE SCIENCES

RICHARD J. GLADON · WILLIAM R. GRAVES · J. MICHAEL KELLY



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*GETTING PUBLISHED IN  
THE LIFE SCIENCES*

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# *GETTING PUBLISHED IN THE LIFE SCIENCES*

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# PREFACE

This book evolved from a course we taught to students in the life sciences at Iowa State University. Most institutions of higher learning do not have a formal course that teaches the processes associated with preparation of a manuscript for a refereed journal. At Iowa State University, students usually take this course when they begin to write their undergraduate research project report or, more commonly, their thesis or dissertation. This book will also be useful for professional scientists who would like to increase their ability to communicate their work to an audience. Ultimately, the main goal of this book is to make it easier for a scientist to write journal articles, and it was developed to guide inexperienced writers through the process of manuscript development and submission to a refereed journal in the life sciences. However, the book should not be limited to writers in the life sciences, and scientists in other disciplines will also find it useful for developing their writing skills.

Part I of this book addresses issues the author(s) must consider before they enter the writing stage, and maybe before they enter the thinking and organizing stage. This section also contains a chapter devoted to ethics in publishing. Part II presents our method for developing and writing the manuscript. Part III recreates the scenario of submission, external peer review, revision, and other miscellaneous events that occur after the manuscript has been written, submitted, and accepted.

Books and manuals are available to assist inexperienced students and professionals with their writing for a refereed journal. These publications are valuable. However, the manner in which the writer typically learns to construct the manuscript often leads to expansion of the scope of the article rather than development of a focus on specific points. In the end, much more has been written than can be accommodated in a typical manuscript, and the writer must reduce the length and content of the manuscript to bring it into compliance with the current standards of the journal of choice. This can be very difficult for an inexperienced writer, especially students who recently finished their thesis or dissertation research, and feel all their data must be presented. Thus, frustrations set in, and productivity wanes. Our approach to organizing, developing, and writing the manuscript is quite different, and it helps to streamline the entire writing process.

Our book differs from others because the focus throughout is on how the writer can unequivocally convey the most salient information to the reader. We call these packages of salient information “take-home messages,” and the manuscript is built around them. After the take-home messages have been developed, the writer adds to the manuscript only the information that provides the evidence needed to support, and prove, those take-home messages.

Another unique feature of this book is our liberal inclusion of exercises we have developed while teaching the course. These exercises help novice writers build a solid foundation, and they allow experienced writers to improve their skills in manuscript development. Our core philosophy is to advance science by conveying take-home messages clearly and concisely. Our success rate has been very good. About two-thirds of the manuscripts developed in our course are published, and this is especially significant

when one takes into account that our students are usually first-time writers of manuscripts for refereed journals.

We must add a word of caution to this preface. Use of this book, the principles within it, and the exercises within it, cannot cure bad science. Make sure you use good scientific processes and you execute the scientific method to the letter. Bad scientific procedures and practices cannot be repaired; they only can be renovated. A writer cannot compensate for that bad science with an extremely well written manuscript.

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# ACKNOWLEDGMENTS

We are grateful to our mentors, peers, and students, who have inspired much of the content of this book. For example, Dr George L. Staby introduced the idea of developing take-home messages to his graduate student Richard J. Gladon at The Ohio State University. William R. Graves and Richard J. Gladon both benefitted from a research-writing class at Purdue University taught by Dr Charles Bracker. All three authors appreciate the students in their course at Iowa State University, *Publishing in Biological Sciences Journals*; successful publishing outcomes achieved by these students reinforce to us the value of the methods presented in this book. Thanks are also given to Dr James A. Schrader for his assistance with creating the images found in several chapters and proofreading the entire manuscript. Dr Philip Dixon provided critical review and comments on Chapter 10, and Dr J. Clark Wolf critically reviewed our discussion of ethical issues in publishing in Chapter 3. The American Society for Horticultural Science, and its Director, Michael Neff, generously allowed us to use various publication and reviewers' forms and a society style manual.

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PART

**I**

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*PRELIMINARY  
CONSIDERATIONS*

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# THE IMPORTANCE OF AND NEED FOR PUBLISHING

We are all apprentices of a craft where no one ever becomes a master.

—Ernest Hemingway

Press on. Nothing in the world can take the place of persistence. Talent will not; nothing is more common than unsuccessful men (women) with talent. Genius will not; unrewarded genius is almost a proverb. Education alone will not; the world is full of educated derelicts. Persistence and determination alone are omnipotent.

—Ray A. Kroc, Founder of McDonalds

## DEFINITION AND NEED

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The activities of scientists in the search for new knowledge are focused into a sequence of events we call the scientific method. Dissemination of the information discovered by the scientist is the last step in the scientific method, and publication of the information in written form is one of several vehicles for dissemination. This dissemination of these new discoveries in the form of writing may take place in one of several venues, including books, refereed periodicals, or nonrefereed publications (e.g., trade magazines or popular publications). The process of publication, especially publication of the information in a refereed journal, consists of many activities that must be completed sequentially in a clear and concise manner.

This book focuses on the steps in the process of preparing a manuscript for subsequent submission to a refereed journal in the life sciences. The dissemination of newly discovered information is critical to the advancement of science, and practicing scientists have a duty to complete the scientific method by publishing their information. However, for a variety of reasons, practicing scientists often do not complete this final step in the process efficiently. Science suffers because scientists “reinvent the wheel” when the information they need is locked in the mind or a filing cabinet of someone who has not published important information.

As a practicing scientist, you might start the task of publishing by asking yourself some simple questions. What is it that you enjoy most about being a scientist? How well do you like to communicate your results to other scientists? How well do you like to write? If you are like most of the scientists we have encountered, writing is not what you enjoy most about being a scientist, and the chances are good that you are not particularly eager to write.

Often, writing is not on the top-ten list of things that need to be done today, because it is human nature to avoid what we do not enjoy.

For many scientists, the thrilling aspects of science involve developing a hypothesis, conducting experiments, and collaborating with others who can offer new perspectives on and skills for solving the problem at hand. Writing about the research results is well down the list of motivators for many scientists. Yet, writing about our work is essential. And it can be rewarding, perhaps even fun. If you are a practicing scientist not already drawn to the act of writing, then we advise you to learn about writing and to learn to like it. Although you may find this difficult to imagine, your professional career and advancement will depend almost entirely upon your ability to communicate with other scientists. The better you communicate orally and by written word, the more rewarding will be your career as a scientist. Few activities bring more rewards to the career of a scientist than the act of publishing scholarly work.

The essential unit of publishing for a scientist is the refereed journal article, and all work done by a scientist, even the most preliminary experiments, should be conducted with a mindset that a refereed journal article ultimately will be the result of that work. Our overarching goal in this book is to help you develop the techniques and skills that make publishing in refereed journals as pleasant as possible. Let us begin with some basics regarding the contemporary meaning of publishing in refereed journals.

## THE EVOLVING DEFINITION OF PUBLISHING

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Decades ago, most scientists did not face the pressure to publish as frequently as they do today. A scientist may have worked for several years to examine an intellectual issue from numerous angles and, eventually, a publication might result, but sometimes there was none. The articles that were published, however, tended to be long and very thorough. The term “monograph” was sometimes used to describe such an article, with the implication that just one (mono) article contained all the known information about the topic.

Today, most scientists in the academic arena are under quite substantial pressure to publish at a greater rate. Consequently, contemporary journal articles are often shorter and more restricted in their focus, and, in most cases, the article is focused on just one or a few objectives. The quality of the content of the article remains critical, but the ability of a scientist to produce several shorter articles of high quality rather than one longer diatribe is a critical skill that can make or break a research career. Central to the development of this skill is an awareness of the so-called least publishable unit (LPU). The LPU has been described as the minimum amount of information (data) sufficient for a manuscript to be accepted for publication in a reputable, refereed journal (Broad, 1981).

An LPU must support at least one conclusion that your community of scientists (peers) will consider, and this conclusion should have the following features.

1. It should be *original* (the conclusion has never been drawn before).
2. It should be *important* (the conclusion is likely to have some kind of impact).
3. It should be based on research conducted by *using accepted norms of the discipline* (Broad, 1981).

Another evolving aspect of publishing is the ever-increasing array of venues in which you may choose to submit your manuscript. New journals are being developed and brought to publication at a greater rate than historical journals are being discontinued, and this leads

to a net gain in the number of journals that might be an avenue for you to publish your manuscript. This represents a wonderful opportunity for you as an author, because you can select the venue that will be most appropriate for your manuscript. It also means that if your manuscript is not accepted by the first choice of journals, there are several other options. Indeed, perseverance is a key trait of successful scientists.

Another related change in the publication process is the mode of review. Nowadays, very few journals conduct reviews by sending each reviewer a hard copy of the manuscript. Most manuscripts are now submitted electronically, and the editorial office of the journal sends the manuscript for review via electronic mail. In turn, the judgment of the reviewers is reported electronically as well. Questions remain as to whether the electronic movement of manuscripts is affecting the quality of reviews, but there is no doubt that reviews can be done more efficiently and rapidly than ever before. Thus, although your manuscript might be released or rejected, the relatively rapid decision leaves you with more time to improve it and pursue revision and resubmission to the same journal or publication in another journal.

## WHY PUBLISH?

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Before we address this question of why publish, it is important that each of us critically analyzes ourselves to determine our motivation for publishing. There are several very good reasons why you should publish your work, and Peat et al. (2002) have a good discourse on this subject. We summarize their information here.

1. First and foremost, if you have new information, you have an irrevocable duty as a scientist to disseminate that information to other scientists.
2. Publication of research results permits scientists to study those results and use them to advance science, scientific thought processes, and, ultimately, benefit society via practical utilization of these new discoveries.
3. As an extension of no. 2, with help from our current information retrieval systems, it helps your information get out to a broader audience. This is extremely important, as all disciplines learn from high quality science conducted by people in different disciplines. For instance, many things we know today in plant science have their foundation in animal or medical sciences, and vice versa.
4. Most research today is made possible by funding from many possible entities. These may be large government programs, such as the National Science Foundation, the National Institutes of Health, and so on, state and local sources, and private foundations. It is imperative that you publish the results evolving from the funds the granting agency has invested in your research program.
5. As an extension of no. 4, publications in refereed scientific journals will increase your probability of obtaining continued funding for the same project, or funding to conduct other, related research projects. Success breeds success.
6. Publishing your results can lead to rewards such as promotions and recognitions by professional groups. Publications will strengthen your track record for these promotions and recognitions, and they will add credibility to your dossier. Conversely, not publishing your results can damage an otherwise promising career. Most academic units require a minimum of eight to fifteen publications in refereed scientific journals for promotion (and possible tenure) from one rank to the next highest rank.

Likewise, publications add a strong measure of credibility to the entire research team. A publication, or publications, in a refereed scientific journal is the benchmark by which almost all people measure success in research.

7. In virtually every research organization, except perhaps some industries, publication of research results in refereed scientific journals is the accountability factor used most for decisions affecting the life of that unit.

## **IN THE END, IT IS REALLY FOR THE SAKE OF SCIENCE**

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Why is publication so valued? At the simplest level, publications in refereed journals are the vehicles by which science advances, that is, the engine that carries science from one level to the next higher level. Refereed journals represent a repository where, ideally, only new, important, and verifiable data are reported and placed in context. As we will consider later, the referees, your peers, are critical, in fact so critical that the peer review process may frustrate you mightily from time to time. These peers determine the originality, importance, and soundness of your manuscript, and they attempt to “weed out” unoriginal, unimportant, or inadequate work by releasing the manuscript. This release may come in one of two forms. Peer reviewers may release the manuscript but recommend revision and resubmission. On the other hand, one or more of the reviewers may release the manuscript without a recommendation for revision and resubmission. Conversely, the acceptance of your manuscript by peer referees, either as is, or more commonly, with revisions, signifies that your work merits entering the permanent collection of scholarly information on the topic. That collection is available to all other scientists who can use it to shape future research questions and the conduct of future research investigations. Your accepted manuscript thus makes a permanent mark on science and advances our collective state of knowledge. It is a necessary part of science, and also a significant achievement for you, professionally.

We hope it is obvious that you have a responsibility to publish all your work that, at minimum, meets the requirements of the LPU. Publication is essential to science because it is the engine that moves science forward; however, scientists still, sometimes, do not write (Boice and Jones, 1984). It is also essential to you, because it moves you forward professionally. In most instances, only those academic scientists and noncommercial research scientists who demonstrate the ability to publish their data regularly will have stable careers marked by achieving tenure, being promoted, and enjoying a favorable reputation. Publishing skills are critical lessons to learn as early as possible, because those lessons will carry you as far as you can go professionally.

## **WHY YOU SHOULD BE A GOOD WRITER**

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High-school students who write well are competitive when seeking entrance to colleges that are highly ranked. Undergraduate students with strong communication skills are recruited actively to become graduate students. A graduate student who has articles accepted during her or his Master of Science degree program will be actively recruited to continue their education and pursue a PhD. PhD graduates with multiple refereed publications are also particularly successful when they search for a postdoctoral, nonacademic professional, or tenure-track faculty position. In addition, a faculty member at a junior academic rank must

document their scholarship by publishing in refereed journals, or they will not move to higher ranks (Long et al., 1993).

We can also talk about this concept on a more practical level. Here are some important reasons why you should be a good writer.

1. Manuscripts that are written well are easy to read, and the reader finds them interesting to read and visually pleasing (Peat et al., 2002).
2. Manuscripts that are well written will move through the review process much more quickly. This will lead to it being more likely that the manuscript, which contains a record of all your hard work, will result in a publication (Peat et al., 2002). Reviewers and associate editors are busy people. They do not have time to correct your English and grammar. If your manuscript is written poorly, there is a chance it will not even be sent out for review until you revise it and resubmit it. This process of returning your manuscript, revision, and then resubmission will take several weeks, and that process does not even start until you have recovered from the painful exposure that your writing habits and use of English and grammar are not what they should be. The sooner you can correct these bad habits, the better.
3. If your manuscripts are written well, your peers will take you more seriously (Peat et al., 2002). The last thing a reviewer wants is to receive a poorly written manuscript (maybe from a friend) that is so poorly written they have to reject it on the basis of poor English and grammar before they get to the level of judging the science contained in the article.
4. Continued publication on a topic can also lead to continued funding via successful grant applications (Peat et al., 2002). As you publish more, it becomes apparent that you are becoming an expert (maybe *the* expert) in a given field or discipline. The more you are known for conducting good science and getting it published, the greater is the probability that you will receive continued funding. In addition, good writing skills developed while writing refereed publications will carry over to greater skills in writing grant applications.
5. As you become an expert in a field or discipline, your professional peers will call on you more often to be a reviewer of manuscripts in your area of study. Continued good work by you may lead to you becoming an associate editor, consulting editor, or editorial board member in your discipline. This is the icing on the cake, which will allow you to sharpen your skills even further, and this will advance your career rapidly.
6. The more you review journal manuscripts, the better a writer you will become. During the process of review of submitted manuscripts, you will learn things that you can do to make your writing better on several fronts. However, and maybe even more importantly, you will learn things *not* to do when writing.
7. As you learn to write better, the time required to write and complete a manuscript and submit it for publication will reduce (Peat et al., 2002). This will allow you to become more efficient in your writing. This also will lead to fewer frustrating encounters with the keyboard of your computer as you try to get a manuscript completed and submitted.
8. It is not necessary for you to be verbose to get your point(s) across to the reader. The journal article by Watson and Crick (1953) that explained (i) that DNA existed as a double helix and (ii) how genetic replication could occur was slightly more than one printed page. And we all know they were awarded a Nobel Prize for their efforts.

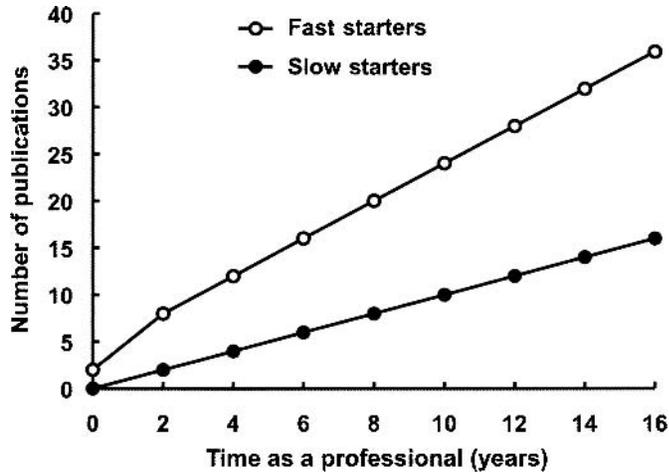


Figure 1.1 Idealized representation of the publication record of a fast starter and a slow starter.

## QUICK STARTERS AND CAREER DEVELOPMENT

The quicker a person starts writing and publishing, the faster their professional career develops, and the faster her or his number of publications accumulates (Boice, 1991). In essence, the number of publications the quick starter has over their professional career becomes a “snowball rolling down a hill.” In this case, the gap between a slow starter and a quick starter continuously becomes greater throughout each scientist’s professional career. This is shown in our idealized representation in Figure 1.1, and it leads to a greater number of doors being opened professionally. The figure depicts the publication record over time of a theoretical fast starter and a slow starter. The slow starter begins a career after graduate school with no publications, whereas the fast starter has published two papers as a graduate student. Note how the difference between the two scientists becomes more pronounced over time.

Evidence supporting the importance of publication(s) in academic careers abounds (Blackburn et al., 1978; Boice, 1991, 1992), and quick starters develop accomplished careers that bring professional rewards that slower starters never attain. Books are available to help young professionals having trouble preparing manuscripts evolving from their scholarly work, and all levels of writers can benefit from this information (Boice, 1990, 1996).

## SOME WORDS OF WISDOM

We close this chapter with some advice regarding the entire publication process.

1. Conceptualize every research activity you do in terms of the refereed journal article that could result from it.
2. Design every experiment you conduct, even preliminary or peripheral work, in a statistically appropriate manner so that publishing the work might be possible.
3. Never consider an experiment complete until it is published, whether it was or was not a preliminary or peripheral experiment.
4. If the work you are describing is good, and in your mind it should be published, then never accept release or rejection of a manuscript as the final outcome.

5. Do not take negative reviews personally and do not allow them to destroy your confidence and ability to function as a scientist, and for that matter, a writer. Remain positive about your writing ability, persevere to the end, learn from your mistakes, seek the help of good writers, and continuously hone your skills.
6. Learn how to write manuscripts for refereed journals, and then follow through until they are published. The quick starter attains a career level that slower starters do not achieve, and the rewards you will receive will be well worth the time and energy you will need to spend to become a quick starter.

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# STEPS IN MANUSCRIPT PREPARATION AND GETTING STARTED

In short, the preparation of a scientific paper has less to do with literary skill than with **organization**. A scientific paper is not literature. The preparer of a scientific paper is not an author in the literary sense.

—Robert A. Day and Barbara Gastel

## PRINCIPLES

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Advanced undergraduate students and graduate students in the middle of their degree programs probably have not been exposed to the steps that constitute the publishing process, simply because they have not yet had the opportunity to publish the results of completed research. In addition, some postgraduate professionals may not have had the opportunity to publish, even though they may have one or more postbaccalaureate degrees. This chapter provides an overview of the publishing process up to the time the manuscript is submitted to a journal. We will present several of the most likely postsubmission events later in this book. We encourage all users of this book to complete the important exercises at the end of this chapter. They set the novice author on a course to learn how to prepare a manuscript for publication.

It is difficult to delineate one universal flow of events that covers all possibilities for the publication process. We present in this chapter an overview of each of the parts of the method we have developed for preparing manuscripts for submission to refereed journals. In Part II of this book, we expand this introduction and teach how to complete each of these parts in a logical, straightforward manner. Use of this process, and especially completion of the associated exercises, lightens the burden of writing a publication on first-time writers because our approach teaches the writer to move on a very focused path from start to finish. It is a unique method for the preparation of manuscripts that is effective because it permits scientists to focus on a few take-home messages and write about them.

As undergraduate students in science classes we were taught to use the scientific method as our basis for constructing our laboratory reports. As such, Knisely (2005) and McMillan (2006) have written excellent student handbooks for writing laboratory reports in biology courses, and again, the basis for preparing the report is the flow of the scientific method. For graduate students, several books or manuals exist for helping the novice writer learn how to synthesize the necessary information into a manuscript for submission

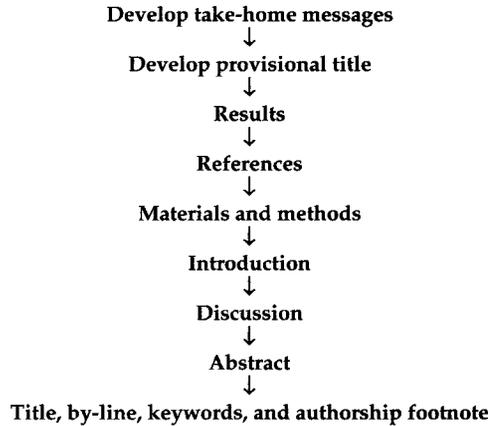
to a refereed journal (Davis, 2005; Day and Gastel, 2006; Gustavii, 2003; Katz, 1985; Matthews et al., 2000; Woodford, 1968). In addition, there are texts that can aid in writing better scientific reports (Booth, 1993; O'Connor and Woodford, 1975; Tichy [with Fourdrinier], 1988; Woolston et al., 1988).

These books, manuals, and other methods for manuscript preparation focus on a continuous paring of information until the writer arrives at a point where they can start to write the manuscript. Even at this point, there will be continued paring of the information until one reaches the endpoint of the manuscript. This is a difficult approach to master, because it requires a continuously new set of realizations by the author that some of the research she or he has completed is not of enough value for it to be placed in a manuscript. For many researchers, but especially young researchers, this is a difficult pill to swallow, and they fight removal of these data. In the method that is the thesis of this book, we have the writer focus on the major points he or she wants to convey before they start to write any prose. Basically, this allows the writer to focus on the most important points of her or his research, and then write about those points only, expanding the base of information presented as is necessary only for a prospective reader to understand what was done, why it was done, how it was done, and what it means.

Another unique approach we have developed in this book is the sequence with which the manuscript is developed. Most guides to help novice writers through their first several manuscripts have the writer prepare the manuscript in the same sequence in which they read a published journal article (e.g., Day and Gastel, 2006; Gustavii, 2003). In this sequence, the writer first prepares the title and by-line, followed, in order, by the abstract, introduction, materials and methods, results (including tables, figures, and photographs), discussion, and then finishing with the references section. We believe this sequence for producing the manuscript immediately multiplies the troubles encountered by the author producing the manuscript. Getting past the preparation of a good solid title and abstract, as well as appropriate introduction and materials and methods sections, often frustrates first-time writers to the point where they cannot move forward on preparation of the manuscript. First-time writers often get part of the way through these early sections of the manuscript, and in a massive display of frustration, crumple up the manuscript and throw it away so that they can start again with a clean slate. Others begin the sequence of units written with a section from the middle part of the manuscript (e.g., Katz, 1985; Mathews et al., 2000).

We advocate an inside-out approach. By starting the production of the manuscript with the development of the two to four take-home messages that will be the focus of the manuscript, and then a provisional title that encompasses those take-home messages, the writer is now focused on a limited number of items, and this reduces the interferences and blocking of the writing that frustrates so many writers, both first-time and experienced. This first step results in a logical flow to the presentation of the research data in the form of tables, figures, and/or photographs and then the results section text. This allows the writer to start by creating the heart of the paper, which sets the tone for the entire manuscript. This approach has the positive psychological impact of breaking the entire, often daunting, process into a series of smaller, manageable steps, rather than the more laborious process of writing the manuscript from start to finish. In addition, this approach allows the author to begin writing with the end product clearly in mind.

Figure 2.1 presents an overview flow diagram of the method we use in this book. Our hope is that you adopt this sequence and produce high-quality manuscripts with relative ease. Certainly, after the writer has completed several repetitions of this process (i.e., published several journal articles), she or he then can adjust their approach to fit their individual flair.



**Figure 2.1** Overview of manuscript development.

## OVERVIEW OF MANUSCRIPT PREPARATION PROCEDURE

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The following paragraphs outline the steps and give key items to which attention must be given during the preparation of the manuscript. This sequence is one that reflects a useful and orderly chronology of activities that will guide authors through the entire process of manuscript preparation. We find this sequence extremely helpful for writers who are experiencing manuscript preparation for the first or second time. We have also found it to be helpful for more experienced writers who have encountered difficulties getting to the point of a finished product ready for submission.

### Overview

The production of a manuscript for publication in a refereed journal occurs after the laboratory, field, or clinical research work has been completed. Young scientists new to practicing the scientific method and conducting research often learn of the project from their major professor. A student new to scientific research often assumes the major professor is completely up to date on all relevant literature. The assumption made by the student is that the pile of journal articles they received from their major professor represents a thorough and complete search of the literature. Often, this is completely untrue. The major professor may have missed portions of the relevant literature, and the student new to this research area starts work without a complete review of the pertinent literature. Ultimately, the student is responsible for a complete review of the pertinent literature for their thesis or dissertation research project. In practice, all authors need to be responsible for the review of the relevant literature, and the best start to a research project is not in the laboratory, but rather in the library. The student should take it upon himself or herself to conduct a complete search of the literature and to synthesize it before starting laboratory, field, or clinical work. As the research is conducted and completed, almost without fail, the student will find additional literature that must be cited, and then they realize they should have known about this published research long before now. As this reading and search of the literature is completed, the student should be aggregating these references into a bibliography, part of which will later become the first draft of the references section of the manuscript. At this point, the writer must know, or at least have some notion, about the journal to which the manuscript will be submitted

so that the manuscript may be produced in a format that meets the requirements of that journal. To help the writer, especially a novice, in determining the journal to which the manuscript should be submitted, we have included in Chapter 5 information on knowing and choosing your journal. That chapter contains a discourse on factors that influence the decision on which journal to choose and an exercise on knowing and choosing your journal.

### **Take-Home Messages and Provisional Title**

The writer must decide when to start writing and where to publish the manuscript. Immediately after the decision is made to proceed, the writer should begin to identify and articulate the take-home messages that have evolved from the research. The take-home messages are the essence of the publication, and they are the pieces of information you want every reader to remember and understand unequivocally when they have finished reading the article. The writer should now be in position to look at the words used to construct the take-home messages, and from these words, he or she should try and formulate a provisional title that will clarify the author's thought process and establish the focal point(s) and scope of the manuscript.

Authors may also prepare a provisional synopsis or abstract of what will become the contents of the manuscript. This provisional abstract may have been formulated previously as an abstract for a presentation at a scientific meeting. Provisional is an important word to remember at this stage, because it is not the appropriate time to settle on a final title and a final abstract. If the author(s) have not chosen a journal to which they will submit the manuscript, they should begin to do so at this time. Also, the author(s) should have decided on the basic form of the manuscript: will it be a note, a short communication, or a complete research report? Finally, the author(s) should already have collected most of the information needed to complete what will become the major sections of the manuscript.

### **Results**

The purpose of the results section of the manuscript is to relay to the reader the new facts (data) obtained by the conduct of this research. However, these data should be presented only if they support and provide evidence for one or more of the take-home messages of the manuscript. In constructing this section of the manuscript, the author needs to determine what data are critical to building a case for the take-home messages and the conclusions coming from the research. Now is the time to produce rough drafts of the tables, figures, photographs, and any other forms of data that will appear in the manuscript. The author(s) must choose and use their data wisely and objectively, and they should use only enough data (representative and/or informative) to make an unequivocal case for their take-home messages. The writer must use the *Système Internationale* for all aspects of manuscript preparation. The writer should remember at this point that the tables, figures, and photographs should be chosen and used only for their value as supporting evidence that helps to make the take-home messages easily understood and credible, that provides answers to your objective statement(s) in the introduction section, and that the writer can interpret and place into context easily. Many writers find that tables, figures, and photographs produced at this stage are rough drafts that must be modified later so that the take-home messages can become even clearer to the reader.

If the writer(s) have not done so already, a complete outline of the text of the manuscript should be developed. Writers should never attempt to put text onto the pages of a manuscript without first constructing either a word, sentence, or topic outline for each

section of the manuscript. Do not use the IMRAD (introduction, materials and methods, results, and discussion) sequence of sections for developing the manuscript because it will create difficulties developing a linkage between the sections and the take-home messages.

Use take-home messages, an outline of the results section, and the rough drafts of the tables, figures, and photographs to prepare the text of the results section. This will probably be the shortest section of the manuscript, and it will contain only simple, declarative sentences. Usually just one to two typed, double-spaced pages is sufficient for the text of the results, and only information that is supported by the data and provides evidence for the take-home messages should be included. The writer should now reexamine the suitability of the table(s), figure(s), and photograph(s) for the text just written and revise as needed to enhance consistency throughout the results section.

After both the text and supplemental forms of data presentation have been revised and polished, it is a good time for the writer to get the entire results section to the coauthors and maybe even an outside reviewer or two to make sure the writer is setting the correct direction for the manuscript before the writing goes too far. This allows the writer to confirm that the take-home messages truly are the focal point of the manuscript up to this time and that the results presented support and provide evidence for the take-home messages. While the results section is being reviewed, the writer should start on the materials and methods section. Sometimes, if the writer has trouble getting his or her ideas into the results section of the manuscript properly, he or she may want to make some limited progress on the materials and methods section. The results section should be finished before much of the materials and methods section is completed because too much revision of the materials and methods section may need to be done when the results section has not yet been solidified.

## References

The overall purpose of the references section is to present the reader with the sources of information used in the present work (appropriate credit to the previous work of the authors and others). It also shows the location of related, extended information on the subject matter covered in the manuscript. This section builds confidence among readers that the author(s) are current in their knowledge of the subject and that the review of literature is complete. There should have been no references to anything presented in the results section, because only the results of the author(s) work were presented. However, at this point, and throughout the remainder of the manuscript, the writer will need to refer to the literature in terms of what has been done previously (the introduction), how the previous research was conducted and used in this research (the materials and methods), and how the research reported in this manuscript compares with previous research (the discussion).

The writer should cite in the text only literature that is of significance to the work in the manuscript, and the references section should not be cluttered with references to theses, dissertations, abstracts, and so on. In addition, information from the World Wide Web may change quickly, so try and not use this source unless absolutely necessary. In the listing of the references, the exact descriptor of the location within the source (volume, page numbers, etc.) must be presented, in the order and style required by the particular journal. The writer or another author should double-check the descriptors of all references for accuracy in their entirety by matching the citation with the resource. Authors must be sure all citations in the text are presented in the references section, and vice versa. If one or more of the authors has accumulated literature and formed a compendium of those sources, then the writer should transfer that compendium into the references section of the manuscript now being

produced. When literature searches are conducted, deposit all citation information needed to locate the resource in an accessible file that can be changed readily. As the writer now needs to refer to something they knew from the earlier literature, they may refer to the references in this newly created references file. When the manuscript has been completed, the writer should then be sure to eliminate the citations that were not used. Use the citation system of the journal where you will submit, if it is known during preparation of the manuscript. The Harvard System (name[s] and year) should be used unless it is not allowed by the journal. As any editor of a journal will tell you, no other section of the manuscript will have as many errors as the references section and its associated in-text citations.

## Materials and Methods

The overall purposes of the materials and methods section are to describe how the work was conducted, including the experimental design and statistical analysis, and to supply a competent, informed reader with enough detail that he or she will have confidence in the work and be able to repeat it as needed. In some cases, a new procedure or new apparatus will have been developed and used, and describing this is an important part of reporting the research work. In general, the following subsections should be included, usually in this order: source and handling of experimental material; any treatments, and how they were applied; preparation of the experimental material for analysis; chemical analyses; enzymatic analyses; miscellaneous analyses and procedures; and the experimental design and data analysis procedures. The materials and methods section must be able to stand alone, without reference to other parts of the manuscript. Often, this section is the easiest to write because it is simply a descriptive compilation of the operations the researcher(s) completed to accomplish the research. Normally, it will be very factual and straightforward, and nothing should be analyzed and interpreted. Writing should be for readers who are informed about the general subject, so background information should be minimal. The presentation of information should be limited to only what is necessary for the reader to understand how the presented results were generated, and it must be logical, almost to a fault. This section is often two to five typed, double-spaced pages, and it may contain references, tables, figures, or photographs, as necessary, for helping the reader understand what was done and how it was done. Again, the writer must use the *Système Internationale* for all aspects of manuscript preparation.

## Introduction

The overall purpose of the introduction is to set the complete rationale for conducting the research reported in the manuscript. It should begin strongly and end strongly. The introduction supplies sufficient background information to allow the reader to understand why the research was done, and at the same time, allow a reviewer to begin to evaluate whether or not the research merits publication. Normally, the introduction contains three major parts. They are the specific rationale for conducting the research, a review of the pertinent literature, and the statement(s) of objectives that embody the hypotheses the research will test.

The specific rationale is necessary because it sets the stage for the justification of the methods that were used and the data that were gathered by using those methods. The review of literature should not be exhaustive, in a way expected of review articles. The number of citations and the discussion of the pertinent literature should be limited to only that required to demonstrate the need for the research (i.e., the rationale) and to set the tone for what will

be presented within the manuscript. References acknowledge previous work of other researchers or one of the authors, and the writer must show how that previous work relates to the research reported in this manuscript. Many times, if the review of literature is written appropriately, the author can create a direct linkage to the discussion section so that they may analyze, interpret, and criticize the existing literature. This allows the writer to show why the previous research needed to be extended. The introduction section should end with a paragraph that contains clear and concise statements of the purpose(s) of the research reported. Depending upon the scope of the research project reported, this could be focused on one very specific objective of the research. Alternately, it could be focused on an overall objective of the research with clarifying specific objectives that, when taken together, make the overall objective more understandable to the reader. This overall objective often relates to the overall conclusion of the results of the work, and the specific objectives will almost certainly correspond to the take-home messages of the manuscript, after both of them have been rearranged, revised, and polished. Some authors and/or some journals will report in the introduction section an overview of the findings of the research. The writer should determine whether this is typical of articles in the journal being targeted and include or avoid an overview of the findings accordingly. Be sure you avoid an unnecessarily long historical review of the published literature, and make sure you avoid loose, scattered, or illogical writing or organizational style. And whatever you do, do not promise more than you can deliver!

## **Discussion**

The overall purposes of the discussion section are to analyze and interpret the data derived from the research and to relate those data to the work of others. There are also several secondary purposes of this section of the manuscript. The discussion drives home the take-home messages, and it shows how this new information is either consistent or inconsistent with our base of previous knowledge. Along with that, the discussion presents the implications of the research, both practical and esoteric, and who should care about that new information. Finally, in many cases, it answers the question that many readers will formulate when they understand the content of the manuscript: what is next?

A good discussion includes, but is not limited to, the following: statements of the take-home messages and conclusion(s); references to acknowledge previously published research and the value of this previous research to the work in this manuscript; comparisons and contrasts between the research in this report and work already published; and a clear indication of how these research results advance the state of knowledge in this specific area of research (i.e., we think you should publish this manuscript because . . .).

First-time authors and others with little experience often find the discussion section difficult to write, because the data and conclusions derived from the research must now be analyzed, interpreted, and compared with the work of others. This is usually challenging, but a strong discussion will enhance your paper and its value to others.

## **Abstract**

The purpose of the abstract is to present a synopsis of the entire body of information in the manuscript. The abstract should answer several questions about the research reported. For instance, the abstract should clearly delineate the rationale, or justification, for conducting the research, as well as the objectives of the research. It should describe what new information and conclusion(s) (i.e., take-home messages) can be drawn from this research.

And the abstract should indicate what the new information means to people other than the author(s). An effective abstract normally presents a brief summary of each section of the paper, and the take-home messages and conclusion(s) must be presented unequivocally. The abstract should be a single paragraph, and rarely more than 200 to 250 words; indeed, 100 to 200 words might be a better target. A good abstract must stand alone, because it will be republished by abstracting services, and in this form, it will be read without the supporting evidence contained in the manuscript.

### **Title, By-line, Keywords, and Authorship Footnote**

The title, in its final form, should be an adjustment from the provisional title developed at the earliest stages of the writing process. The title is the most succinct summary of the contents of the manuscript. The title should be brief yet contain high-impact words that tell or indicate to the reader the ultimate take-home message(s) of the article.

The by-line is the name(s) and complete address(es) (for mailing purposes) of all authors (individuals who will take credit and responsibility for the contents of the manuscript). The by-line also designates credit to the institution(s) where the research was conceived and conducted, something that is extremely important in the determination of the status of the institution(s). *Whose name will appear in the by-line, the order of appearance, and who will be the corresponding author are items that must be decided before work on the manuscript commences.* The manner in which the names of the authors are presented (i.e., initials only, complete first name, and initial of middle name, etc.) must conform to the format of the journal. Normally, all coauthors are not involved in correspondence with the editorial staff of the publisher. The person who takes charge of all communications between the authors and the editorial office is called the corresponding author. This individual must “ride herd” on the manuscript to avoid publication delays and to serve the interests of the coauthors.

The keywords are an extremely important part of the manuscript, because they are a major mechanism with which other people can find the published paper. Researchers cannot review tables of content of all journals in their field as each issue is published. Most research scientists will use an abstracting and indexing service that will filter the peripheral articles so that the researcher can quickly find the key articles they need to read and understand to remain up to date in their field. All words of impact in the title become keywords, and the authors can expand this list by selecting words not in the title that have a direct and important relationship with the content of the manuscript. The choice of these keywords should not be taken lightly. They play a critical role in the dissemination of your results and interpretations.

The authorship footnote usually appears at the base of the first page of the published paper. It is a footnote linked to the title, but most journals no longer use a superscripted numeral at the end of the title to designate it. In most instances, the first part of the authorship footnote is the “received for publication” date and the “accepted for publication” date. This footnote may contain an approval for publication by the institution(s) that sponsored the research, which may be in the form of a journal manuscript number assigned to this article. The footnote also may contain reference to funding sources that enabled the work. It may also acknowledge persons who helped with the research in some way, but not to the extent where their involvement warranted authorship. This latter segment of the authorship footnote is sometimes placed in a specific section of the manuscript that is located elsewhere. Be sure to reference the footnoting style of your chosen journal before you submit the manuscript.