China Medical Board

Biomedical Writing Course

Lessons on Writing and Publishing Scientific Papers, Part 2

- The Methods Section
- The Author List
- The Results Section
  - Tables
  - Illustrations

Source:

BIOMEDICAL WRITING COURSE

Program Director:
Zhe Dong, PhD
Associate Professor and Dean of Foreign Language Studies
Beijing Medical University

Principal Consultant:
Barbara Gastel, MD
Associate Professor of Journalism and Medical Humanities
Texas A&M University

Principal Course Instructor
Elizabeth Whalen, MA, ELS
Biomedical Writer/Editor
Instructor, University of California at San Diego

Teaching Assistant
Tu Yun-e
Beijing Medical University

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also cover later in this course.

On page 41, Day explains the problem in the first paragraph nicely (the researcher should have stated that the parents or guardians of each patient gave written informed consent). In the final paragraph on page 41, the joke is in the word "theatrical": it is only a few letters different from the correct word ("theoretical"), but those letters make a lot of difference.

As you read Chapter 8, think about how it applies to the Methods section for your article. If you have any questions about this section, now is a good time to ask your local instructor. Next week, you will start writing.

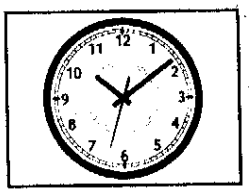
AN ENDING NOTE: Please feel free to contact your local instructor with questions about this lesson.

Lesson Five
Overview of a Research Paper and Writing the Methods Section

OBJECTIVES FOR LESSON FIVE

By the end of this lesson, you will

1. Gain a better perspective on the questions answered by each part of an effective research paper
2. Learn more about the proper format and content of the Methods section of research papers and use that information to write a first draft of the Methods for your own papers.



ASSIGNMENT FOR LESSON FIVE

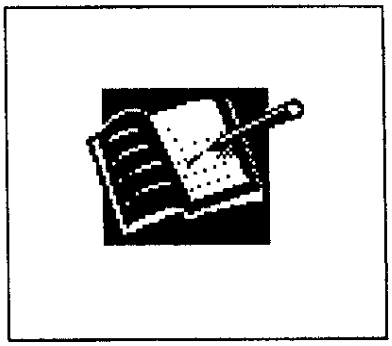
Write a first draft of the Methods section for your paper. This will be explained in more detail at the end of this lesson. Depending on the specific instructions you receive, either give your assignments to your local instructor or send them by e-mail to US contact person.

OVERVIEW OF THE RESEARCH PAPER

Before you start writing the Methods for your paper, let's take a brief look at all the basic components of the research paper. We can see how they fit together by noticing the questions that each section answers.

Title: What is this paper about?

Author List: Who contributed substantively to design and perform this study and to write this paper?



Abstract: What does this paper tell us, in ≤250 words?

Introduction: What is the background and purpose of this study? What is the central question it attempts to answer?

Methods: What was done and how was it done?

Results: What happened? What are the chances that this could have happened by chance?

Discussion: On the basis of the results found, what is the answer to the central question posed in the Introduction? How do those results support this answer?

Acknowledgments: Besides the authors, who else helped perform the study, analyze the results, or write this paper? Who contributed funds, equipment, or supplies to this research?

References: What other studies have been done recently that are relevant to the methods, results, or interpretation of this study? What classic publications contain either the basic methods used or early insights into this topic?

The readers of a well-written research paper know exactly what content each section will cover. And, taken together, all the separate parts come together to form a unified whole.

Appendix B contains samples of 5 good research papers. Throughout the next few weeks, we are going to be looking at these section by section. However, if you wish to be able to understand these sections in context, read the abstracts of the 5 papers in Appendix B. If you wish, you can read the full articles to give you an even clearer picture of how the Methods fit into the research paper. Then come back to this section, and we'll start working on your Methods section.

Appendix C contains two excellent articles written for the Chinese edition of *JAMA* by Dr. Barbara Gastel, who is the U.S. principal consultant for this program. You may find it helpful to read those two articles for a good overview of writing biomedical writing before you start to write your own paper.

WRITING THE METHODS SECTION

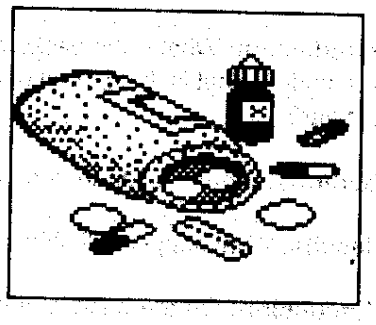
In this lesson, we will be using the term "Methods" section to mean sections that might actually be headed "Materials and Methods" (for studies not involving humans), "Subjects and Methods" (for studies involving healthy volunteers), or "Patients and Methods" (for studies involving patients).

One reason for starting the writing process with the Methods is that you already have most of the information written in your experimental files. In particular, your study protocol or experimental design can be used as the first outline for your Methods section. However, the

Methods section must always reflect what the investigators actually did, which may differ from what they had originally planned to do.

As we saw above, the Methods section answers two basic questions about a scientific study:

1. **What was used for this study? (Materials)**
2. **How was the study done? (Procedures)**



We'll now talk about how to approach each of these questions, discuss 3 standard principles of writing the Methods section, and describe how the Instructions to Authors apply to this task.

What or Whom Was Used for This Study?

To answer this question, you need to describe "materials" first. When you are describing what you used in a study, you must state clearly what products, animals, or humans were being studied or used. In Chapter 8 of Day's book, the requirements are described for specifying your materials that are manufactured products or nonhuman living entities (such as animals and microbes). Note also that most journals require the location of the manufacturer when you use a brand name for equipment, chemical, or drug. That is, you need to provide the manufacturer's name and location (city, U.S. state for U.S. companies; city, country for non-U.S. companies). Below are two examples:

- Ifex (Bristol-Myers Squibb, Princeton, NJ)

- Librium (Roche Products, Manati, Puerto Rico)

If your study involved either volunteers or patients, the requirements for description are important and sometimes vary from journal to journal. For humans studied, indicate all important, relevant demographic characteristics (age, sex, and state of health), as well as other demographic information when it is relevant to the topic of the paper (for example, weight, height, race).

Whenever humans are being studied, you must address the topics of informed consent and institutional committee approval of your study protocol. In some "Instructions to Authors," the editors indicate that an article can be rejected if the human subjects did not give informed consent or the study was not approved. In the U.S., we have strict guidelines about use of experimental therapeutic techniques on humans. The requirements for informed consent and committee approval reflect the importance of these guidelines.

Most journal editors are aware that such guidelines may not exist in other countries. If your institution does not require informed consent or does not have an institutional committee to review study protocol, state those facts in your cover letter and possibly in the Methods section itself. You may also want to add a sentence stating something like this, "However, great care was taken to ensure that the patients were well-informed of the study protocol and any risks; we never allowed the study to compromise the well-being of any patient." State honestly your own methods of ensuring your subjects' well-being, and the journal's editor may find that these methods fulfill the requirements that apply to U.S. research.

How Was the Study Done?

To answer this question, you provide detailed information about the procedures you performed. "Detail" is of primary importance here. For the reporting of most laboratory research and many clinical studies, an acceptable Methods section is written in such detail that another competent researcher could duplicate the study by following the "recipe" given in that section.

At the least, the Methods section should always provide enough detail that other scientists can judge whether the study is valid. The results of a study are not very credible if it is impossible to repeat the study to verify those results. However, if the researcher makes very clear how every step of the study was done, the credibility of the results is strengthened because that researcher is saying, in a way, "Here, you try it. I think you will get the same results."

Principles of Writing the Methods Section

In books about writing biomedical papers, these are the 3 common guidelines given for writing the Methods (these are discussed in greater length in Chapter 8 of your textbook by Day):

1. Use the **past tense** in the Methods section. This is a study you have completed; thus, all the actions were done in the past.

2. Describe the steps of the study **in the order in which they were done** (chronological order) whenever possible. It is easiest for your reader to follow your procedures if you tell them as a story. However, when chronological order does not work well for your specific study, describe the procedures in order from most important to least important.

3. If you use subheads in the Methods section (for example, Group 1, Group 2), you should use those **same subheads** in the Results section. This will help ensure that your paper flows logically and is easy to follow. Sometimes, of course, you will have subheads in the Methods that are needed in that section only. For example, "Statistical Analyses" would be described in the Methods but would not be included in the Results.

Use of the Instructions to Authors

Don't forget to consult the Instructions to Authors and the similar sample articles from the journal you've selected. Notice what the instructions require in the Methods sections, and notice how those requirements are met in the published articles.

SAMPLE METHODS SECTIONS

Let's look at the Methods sections from each of our 5 sample papers (copies of the full papers are in Appendix B).

Lesson Six
Composing The Author List

OBJECTIVES OF LESSON SIX

By the end of this lesson, you will

1. Know more about the criteria for authorship in research papers submitted to American journals.
2. Be able to use those criteria to make a preliminary list of authors for your research paper.

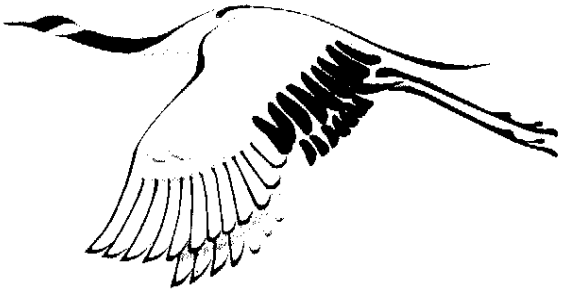
ASSIGNMENTS FOR LESSON SIX

1. Read Chapter 5 ("How to List the Authors and Addresses") in Day's book.
2. Send the preliminary list of authors for your paper, along with their addresses as required by your chosen journal; explain why you think each author deserves authorship on this paper.
3. Read Chapter 9 ("How to Write the Results") in Day's book.

AUTHORSHIP

Authorship Problems in Research Today

In an article published in *European Science Editing,* Qian Shouchu (1995), senior editor of the *Chinese Medical Journal,* explains some of the problems with authorship today. You will find a full copy of his article at the end of this lesson. He notes that those listed as authors for a research paper should have "contributed substantively to the form as well as the content of the report." Mr. Qian goes on to say that authorship is not appropriate for someone who has provided only administrative directorship, financial support, or an edit or review of a manuscript.



The tendency to list as authors those who are not really qualified to be authors is one that has developed over the last 40 years. Felix Chew (1988) showed the progression of this tendency in radiology research as indicated by the increasing number of authors per article in radiology journals. Chew noted, "Diagnostic radiology journals are publishing an increasing number of articles with many authors . . The number of authors per article is also increasing, and this increase in authors has been far more rapid than the increase in articles."

Criteria for Authorship

Hundreds of biomedical journals rely on the authorship criteria stated on pages 7 and 8 of the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" (Appendix A). Huth (1982) explains those criteria clearly (page 44):

1. An author should have generated at least a part of the intellectual content of a paper.
   a. This work could have been conceiving or designing the study reported, if the paper is a research report, or identifying the particular features of a case that justifies a case report. If the paper is a review article or editorial, the equivalent work would have been identifying the question or questions to be answered and developing a plan for the paper.
   b. This work could have been collecting reported data (including clinical observations) and interpreting them for the paper's conclusions. Note that interpreting data is required; collecting of data does not by itself justify authorship.
2. An author should have taken part in writing the paper, reviewing it for possible revision, or revising its intellectual content (not just its technical content).
3. An author should be able to defend publicly in the scientific community all of the intellectual content of the paper.

O'Connor (1991) adds to the explanation with some sound advice about people who should not be cited as authors: "you should not include the head of your department . . . or any other senior colleague as an author unless that person chose the topic of your research, or planned the experimental approach, or made some substantial intellectual contribution to the work - but don't lose your job arguing this point! Don't include as authors people who supplied you with material or simply advised you while you were doing the work, and don't include technical or other staff who helped you as part of their normal duties" (page 11).

If the people listed in the quote above have not earned authorship, how can you acknowledge their contributions? The answer is hidden in the question itself: in the Acknowledgments section of your paper (which we will discuss later in this course).

Remember, however, to always obtain permission to use anyone's name--as an author or in the Acknowledgments section.

The Order of Names in the Author List

The "Uniform Requirements" (Appendix A) say, "The order of authorship should be a joint decision of the coauthors." However, as Day discusses in Chapter 5 of your book, this decision is not always easy. Some authors want their names to be listed first, and others think that the last-named author has more prestige. In the case of a disagreement about order of names, the person most responsible for the study should make the final decision. As Day notes, if all journals took the position that the authors' names should be listed

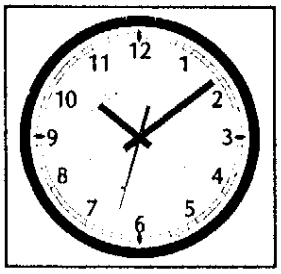
alphabetically (as some journals do), many problems might be avoided.

Why is there such fuss about the order of authors? There are two principal reasons.
1. Many reference citations list only the names of the first 3 authors if there are more than 6 authors listed. That means that author names that are ranked 4th or lower don't appear when the reference is cited. For example, once Elizabeth helped write on a paper that was accepted by a quite prestigious journal. She was listed as 4th of 7 authors. Therefore, she knew that her name would not appear in most citations to the article, simply because the total number of authors was 7, rather than 6. If your paper has more than 6 authors, this is a situation worth considering. Do all the authors meet the criteria for authorship? You can use the Acknowledgments to thank those who do not meet the criteria.

2. Some researchers believe that the place in which their name appears reflects their importance or rank. However, the order of author names should reflect the contribution of each author to that particular paper, not the general prestige of each author's name. For example, if the department head did nothing but review the paper in its final form, she or he certainly deserves an acknowledgment but not authorship.

As you are deciding on who should be authors and what order they should be in, remember that a list of too many names detracts from those who really did the work. Make sure that those who are authors, according to the criteria stated in the "Uniform Requirements," get full credit for their work. The more you dilute the author list with extra names, the less respect there will be for authorship in general.

The Timing of the Creation of the Author List



Authorities vary on the best time to create the author list for a paper. In your booklet by Robert Iles, he says on page 3 that the author list should be the last thing composed: "The reason for writing the authors' names last is you know then who has made contributions. For example, a colleague who revised key paragraphs or made you see the significance of your data would be left out if you tried to write the author list first." At the other extreme is your text by Day, who says: "The sequence of authors on a published paper should be decided, unanimously, *before the research is started*" (page 24, italics added).

Matthews et al. (1996) also advises "Always decide who will author a paper as soon as you can" so that the work can be divided up accordingly and "the best writer" in the group can coordinate the writing of the paper stemming from the research. Of course, no matter how the work is divided up, all authors must approve the manuscript before it is submitted to any journal because all authors bear ethical and legal responsibility for the accuracy of the article's content.

Other writers indicate that a preliminary list should be drawn up early in the process, as you will be doing this week. This list can be changed after the paper is written if there is a good reason to do so, but for the most part you know now who has had a substantial role in the research, and these are the people who qualify for the preliminary list of authors.

DAY'S CHAPTER 5, "HOW TO LIST THE AUTHORS AND ADDRESSES"

For our purposes this week, pages 22-26 of this chapter are the most relevant. We will come back to pages 26-28 when you are ready to create the final title page for submission to the journal. Right now, let's concentrate on the material that will help you put together a preliminary author list.

Day explains clearly the possible problems with the author list, the importance of agreeing on authorship early, and the definition of authorship. We believe that you will find helpful his examples of the levels of conceptual or technical involvement that do or do not earn valid authorship status.

The first sentence of the fifth paragraph on page 24 refers to the "publish or perish syndrome," a commonly accepted practice in U.S. research universities. The instructors at these universities are expected to publish many papers in their field, and the number of published papers is used, among other criteria, to make decisions about promotions. However, some professors in the U.S. suggest that promotions be awarded on the quality rather than the quantity of publications. This change in policy might eliminate the desire that some researchers have to be cited as authors on every possible paper whether or not they have met the authorship criteria.

Later in Chapter 5(on the bottom of page 26), please disregard the text starting with "(You know . . ." and ending with ". . . Much Deeper.)" This is a joke that would be hard to translate and that is not relevant to this course.

THE WRITING ASSIGNMENT

As stated at the start of this lesson, please compose your preliminary list of author names. Give the address for each author according to the requirements of your journal's "Instructions to Authors."

Also, to ensure that the standard criteria for authorship are met, write down a short justification for each author listed. What has she or he contributed that has earned the title of "author" for this paper? Give your list of authors to your local instructor for feedback.

Possible justifications of authorship status include the following: developed the idea for the research, performed the statistical analysis, worked with you on the study design, worked in the clinical or laboratory parts of the study, or helped coordinate the study and write the paper.

INTRODUCTION TO CHAPTER 9 ("HOW TO WRITE THE RESULTS") IN DAY'S BOOK

In the next lesson, you will create the first draft of your Results section, including the

tables and illustrations. This week, the third part of your assignment is to prepare by reading Chapter 9 in Day's book.

You will find that Day gives 3 guidelines for writing the Results section:

1. Give some kind of "overall description" of the experiments or clinical trials.
2. Present representative data. The reader wants to see some proof for your conclusions, but you don't have to list every piece of data. Instead, highlight only some of the data--those data that represent the most relevant results.
3. Use past tense.

On the last line of the first paragraph on page 43, Day quotes John Wesley Powell as saying: "The fool collects facts; the wise man selects them." Don't take this too literally. Of course, all researchers collect facts; that's part of the scientific process. Powell could have added "only" before "collects" to make his meaning clearer. Of course collecting facts is important, but just reciting those facts does not qualify as a research paper. In your paper, you "select" the facts that are the most relevant and interpret those facts for the reader.

Also on page 43, Day tells a funny story. The main point of this "mouse" story is that a result of 33.3% is meaningless when the sample size is only 3.

In the last section of Chapter 9, Day mentions Chapters 13 and 14. This may be a good time for you to read or at least look at those chapters. We will come back to them later in this course, but they will also help you draft your illustrations and tables as you write your first draft of your Results section.

AN ENDING NOTE: Please feel free to contact your local instructor with questions about this lesson or assignment.

Lesson Seven
Writing the Results Section

OBJECTIVES OF LESSON SEVEN

By the end of this lesson, you will

1. Be more familiar with the proper format and content of the Results section of research papers
2. Be able to write a first draft of the Results section for your own paper

ASSIGNMENT FOR WEEK 7

Write a first draft of the Results section of your paper. If your data are not all available yet or have not been analyzed, prepare a draft "skeleton" of the Results into which you can later fit the data. At this point, you should at least be able to determine the subheadings of the Results section, have some preliminary data to configure into tables or illustrations, and have an idea about how significant your results will be for the answers to the research question and subquestions. This assignment will be clarified further later in the lesson.

THE RESULTS SECTION

As you may remember, Day calls the results "the core of the paper" (page 42). Here, we will review Day's chapter on writing the Results, and we will add some information from other sources (Harmon and Gross 1996, Huth 1990, O'Connor 1991, Goodman and Edwards 1991, and Zeiger 1991). Then we will analyze the Results sections from the 5 sample papers, and you will draft or revise your Results section.

Content of the Results Section

At the beginning of Chapter 9, Day talks about the two ingredients of the Results section: (1) the "big picture" of the study and (2) the resulting data. Other authorities emphasize that this section provides the new evidence (the data) needed to answer the question that prompted the research.

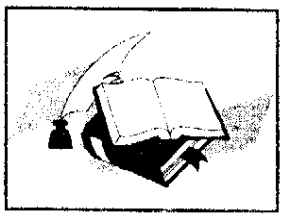
Researchers can't just dump everything from their lab notebooks into their articles and call it "Results." Harmon and Gross (1996) say, "Data go through a transformation in the trip from the laboratory . . . to the printed page." But Day warns that deciding how best to present the data is not always easy. Zeiger (1991) lists three types of data: raw data (the actual numbers found); summarized data (for example, the mean ± the standard deviation); and transformed data (for example, the percentage of control).

The transformation process excludes the irrelevant parts of the research and highlights the most relevant data. Include the data that helps answer your research question. That means including both data that support and data that appear to refute your hypothesis. (The Discussion is a good place to explain the possible reasons for unexpected or

conflicting results.) Use tables and illustrations to present the relevant results in a way that will be meaningful to the reader. We will briefly discuss tables and illustrations later in this lesson and cover them more thoroughly in another lesson.

Interpreting the Data

As mentioned above, the Results section must include the interpretation of the raw data so that the reader understands its meaning clearly. O'Connor (1991) discusses the best use of specific comparison methods. She emphasizes that it is always important to make clear what measurements you are comparing and to distinguish between your primary hypothesis and any exploratory analyses of the data. Her summary of these methods includes the following specific guidelines:



- Standard deviation: shows variability among individuals (use with mean to summarize data)
- Standard error of the mean: shows the precision of the sample mean (be sure to state the number of measurements on which the means are based)
- Median and interquartile range: effectively summarize data from a skewed (asymmetrical) distribution
- Two-sided tests: nearly always necessary for reliable statistical interpretation
- Confidence intervals: establish the degree of uncertainty in the findings

Do not hesitate to consult a standard statistics textbook or a biomedical statistician at your institution for help with your data interpretation. Editors of biomedical journals often ask statisticians to check the appropriateness and accuracy of the data interpretation; be sure that the interpretation of your data can stand up to expert analyses.

Order of the Results Section

The order in which you describe your results depends on the purpose and design of your experiment. As mentioned in Class 5, you may have already divided the research into discrete parts by your headings in the Methods section (Group 1, Group 2, etc.). Here are some other ways in which a well-written Results section may be organized.

- From old to new (for example, beginning from results in control subjects or in patients undergoing the known, traditional treatment and proceeding to results in patients undergoing the new treatment)
- In chronological order based on the timing of the stages of the protocol or procedure
- From most important results to least important results

Some journals combine the Results and Discussion sections. However, we agree with O'Connor (1991), who says, "Results are sometimes combined with the discussion section but this can confuse the reader and it is better to keep these two sections separate" (page 13). O'Connor also says that you can combine the two sections "if you don't intend to discuss the findings in detail." However, in your first draft, we strongly recommend that you create a separate Results section, even if it seems short. After all, Day says that it should be "short and sweet." (If the editor of the journal to which you submit the paper suggests that you combine the Results and Discussion as part of the

revision, this task will be easier than trying to separate them if you have first written them as one section.)

Hints for Writing the Results

Zeiger (1991) notes that in the Results you either present data ("facts, often numbers, obtained from experiments and observations"--page 141) or guide the reader to illustrations and tables that give the supporting evidence. She also provides some good specific tips for writing the Results section:

- State the main results and their significance in the text part of the results, but use tables and illustrations to present most of the data.
- In general, avoid using a table title or a figure legend as the subject of a paragraph's topic sentence. Instead, indicate the conclusion that can be drawn from that table or illustration and place the table or illustration number in parentheses. For example, instead of writing "Figure 1 shows the relationship between A and B," write "A was significantly higher than B at all time points checked (Fig. 1)." There are exceptions to this guideline, as we will see in the sample Results sections below.
- Use the past tense for the Results section.
- Use few, if any references in the Results section.
- Try to avoid sentences that use the words "compared with" instead of stating the comparison clearly. For example, don't write "X was significantly increased compared with Y." Instead, write "X was significantly higher than Y." This second version is shorter, more precise, and easier to understand.

Tables and Illustrations

As you can see in the text of the Results sections below (and in the full articles in Appendix B), tables and illustrations often play a crucial role in the Results section. Now is a good time for you to draft your illustrations and tables; however, be prepared to revise them as your article is revised. Occasionally, a journal editor will ask you to put a very long table into an appendix, so that it does not interrupt the flow of the manuscript, but the data are available for those who want to see them. This is not a criticism, but it is a good opportunity to make your article more readable.

You have already looked at several articles in your target journal. Now look at them again to see how many and what type of tables and illustrations are used in that journal. For example, some journals will not allow huge data tables, but others do print them when they are appropriate for the article. You can also notice in what size the illustrations are printed, which will give you an idea about how much your figures may be reduced. Looking at some samples will help to guide you as you prepare the tables and illustrations for your article.

We will cover tables and illustrations in more detail later in the course. So that you can prepare your first draft now, however, we have summarized below some of the main points of Chapters 13 and 14 in your textbook by Day.

Chapter 13. How to Design Effective Tables

1. Use a table only when repetitive data must be presented.
2. When there are only a few data points, give them in the text rather than in a table.
3. Provide numerical data only for statistically significant results.

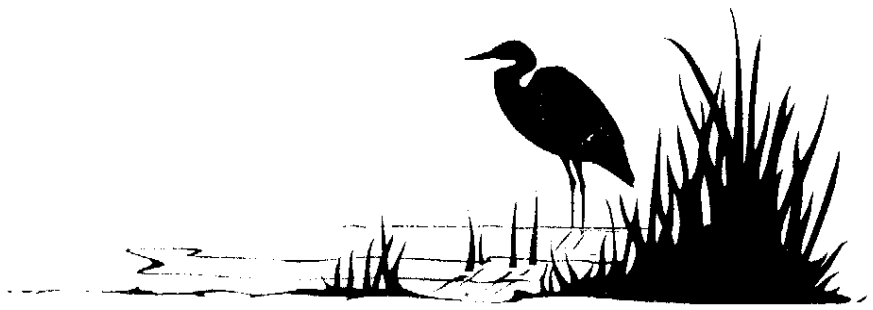
4. Format tables so that data elements of the same type read down, not across.
5. Align words in a column on the left. Align numbers on the right (or on the decimal point).
6. Unless advised otherwise by the journal's editor or "Instructions to Authors," construct all tables with three main horizontal lines (one on top, one under the headings, and one on the bottom of the table). Do not use any vertical lines.
7. Make the table title as concise as possible.
8. Explain all abbreviations in the footnotes to your table.

Chapter 14, How to Prepare Effective Illustrations

1. Use a graph to show pronounced trends.
2. Illustrations will probably be reduced for printing. Use symbols and letters large enough that they will still be clear if they are reduced as much as 50%.
3. Put the key to the symbols within the graph when there is enough space.
4. Type figure legends double-spaced on a separate page; never put them at the bottom or the top of the illustrations.
5. Base the figure size (especially width) of the print on the column and page width of the journal.
6. Put crop marks in the borders of your photographs (or on transparent paper taped over the photograph) to indicate to the editor how the photo can be cropped to highlight the most important details.
7. On the back of each illustration, use a soft pencil to mark "top" and the illustration number in the appropriate place.
8. Place a micrometer marker directly on any micrograph (a photograph taken through a microscope), so that the scale is completely clear to the reader.
9. Consult the "Instructions to Authors or contact the editorial office before submitting color photographs with an article.

SAMPLE RESULTS SECTIONS

Everyone agrees that the best Results sections are clear but brief, and that those sections tell the reader what you found out that is relevant and important to your research question. Look at the Results sections below and the comments about each.



Lesson Eight
Data Tables

OBJECTIVES OF LESSON EIGHT

By the end of this lesson, you will
1. Understand better the objectives of the second semester of this course.
2. Become more familiar with the proper content and format of data tables for research papers.

ASSIGNMENTS FOR LESSON EIGHT

1. Read Chapter 13 ("How to Design Effective Tables") in Day's book, and the supplementary material in this Course Packet. If you have questions, ask the local instructor.
2. Re-read the "Instructions to Authors" in your selected journal and study what it says about tables. If you have questions, ask your local instructor.
3. Evaluate the possible tables (if any) for your own paper. According to the criteria given by Day, are these tables essential and appropriate for your paper?
4. From the material in Chapter 13, this lesson in the Course Packet, and the "Instructions to Authors" in your target journal, create a checklist for making effective tables for your current paper. Give your local instructor a copy of the checklist.
5. Revise those tables that are essential for your paper. Submit them to the local instructor, along with the page of text on which each table is discussed. (This way, your local instructor can check the tables and text for consistency.) If no tables are required for your paper, explain why. See the end of this lesson for further explanation of this assignment.

NOTES ON ASSIGNMENTS

Chapter 13 in Day's Book: "How to Design Effective Tables" This chapter in Day's book covers the important topics of when to use tables and how to arrange the material in them. The chapter also discusses the use of exponents in table headings; marginal indicators; tables, footnotes, and abbreviations; and camera-ready copy for tables. (All the terms used in the previous sentence are explained in Day's Chapter 13.) Not every paper requires tables. Even if your current paper does not contain tables, be sure to read Chapter 13 carefully because it contains some valuable advice.

Below are Day's main points concerning when to use tables.
1. Only include a table when repetitive data must be presented.
2. Whenever you can use a few sentences of text to replace a table or column(s) in a table, do so.
3. Only use significant figures when you present numbers in a table--a long string of numbers after a decimal point may mislead the reader into thinking your calculations are more precise than they really are.
4. Either state the result in the text, illustrate it in a figure (as we will discuss in Lesson

2-2), or put it in a table. Do not repeat the same results in 2 or more of these forms. However, it is acceptable to state the main point of a table or an illustration in the text.

In this first section, Day gives some excellent examples of how material in small tables can be better stated as 1 or 2 sentences in the text. Please note that the footnotes to Tables 1 and 2 on page 60 are meant to be humorous; they show the proper format for footnotes, but not the proper content. For example, footnote "a" in Table 2 is much too long and contains humorous but unnecessary descriptions of thought processes about the wording used.

The second major section is about arranging material in tables. Organize your tables so that the reader understands the point of the material quickly and efficiently. Day recommends that like elements read down, not across -- research on reading has shown that comparisons are easier for readers to understand that way. (Don't be concerned about the term "bass ackward" on page 63; it's an English play on words that is difficult to translate and is not essential for the meaning of the section.) In Tables 5-7 of this chapter, you can see one possible format for table footnotes. However, the content of the footnotes is too humorous to be included in a serious scientific paper.

Alignment of the elements is important so that the reader can quickly grasp the meaning of the data. As Day says on page 63, "Words in a column are lined up on the left. Numbers are lined up on the right (or on the decimal point)." By the way, if plus-or-minus signs(±)are used, they should line up, with the numbers on either side lining up on the decimal point, as shown below:

263.3 ± 25.2
 34.6 ± 3.2

On page 64, Day ends this section by saying "Vertical rules are not used because they are difficult to insert in most typographical systems." (Vertical rules are lines that go from top to bottom, like |, rather than from side to side, like _____, which is a horizonal rule.) This difficulty has been overcome in many systems by the latest software. However, you still should avoid vertical rules in your tables for 2 reasons: (1) they make scanning the horizontal groupings (rows) more difficult for the reader, and (2) they clutter the table unnecessarily, as do too many horizontal rules.

In the 3 short sections that end this chapter, Day first indicates that authors should mark in the margin where they want the tables to appear when the article is published. In our experience, this isn't necessary. It's difficult for authors to tell before the article is typeset where the tables will appear. However, the copyeditors will make sure that they appear in order and as close as possible to their first mention in the text.

Second, he discusses titles, footnotes, and abbreviations. The title of the table must be concise but it must also describe the data comprehensively. For example, for Day's Table 6 on page 63, "Characteristics" is not sufficient; the title shown ("Characteristics of antibiotic-producing *Streptomyces*") is much better because the readers know immediately what they will find in the table. Many journals allow the use of abbreviations in tables. However, most want the abbreviations explained in a footnote. We will explore table footnotes in more detail later in this lesson.

Third, Day discusses providing camera-ready copy of tables (that is, providing perfectly formatted tables on glossy paper so that they can be photographed directly for inclusion in the journal and do not have to be retyped by the publisher). You should spend the extra time and effort to prepare camera-ready tables only if the "Instructions to the Authors" specifically request them. Most scientific journals want double-spaced tables from the author, so that reviewers and editors can easily mark their comments on the table. The journal will prepare the final camera-ready copy of the tables, and thus the format for all tables in the journal will be consistent.

General Advice/Suggestions from Other Sources

As in previous lessons, the advice provided below comes both from from our own experience and from other books on biomedical writing (Huth 1990, Matthews et al. 1996, O'Connor 1991, Zeiger 1991). As we go through this information, we will be referring to the tables in our sample articles (Appendix B). Therefore, you might find it helpful to take out Appendix B now for reference as you read the following sections.

Purposes of Tables

As Day points out, tables are expensive for journals to print, and they are usually time-consuming for authors to prepare. Therefore, ask yourself the following questions before submitting any table to your target journal. If the table is worth publishing in your paper, "yes" should be your answer for number 1 or 2; in either case, "yes" should always be your answer for number 3.

1. Does the table provide essential background material related to the methods (for example, patient characteristics or frequency of symptoms)?
2. Does the table provide data that support the results--either individual data or calculated data (such as means plus-or-minus standard deviations) necessary to make your point?
3. Whichever purpose the table serves, does its presentation provide for the reader the clearest, quickest understanding of the results (or would a text explanation or an illustration be more effective)?

Table Terminology

The illustration below may help you better understand the terms that editors might use in discussing your tables.

Table X. ***Table title***

horizontal rule

Box	*Stub Heading*	*Column Heading*	*Column Heading*	*straddle (or spanner) rule*
Head			*Column Subhead*	*Column Subhead*
Stub item 1 *Stub subitem* *Stub subitem*		*Cell*	*Cell*	*Cell**
		← *FIELD* →		
Stub item 2 *Stub subitem* *Stub subitem*				

Note: *Explanation of methods (if needed) and abbreviations or symbols used.*
**Table footnote(s).*

Look at Table 1 on page B:7 in Appendix B and note the following examples that illustrate these terms. (Table 1 on page B:7 has fewer horizontal rules than does the table shown above; we will discuss this in detail below.)

Table number: Table 1.
Table title: Base-Line Characteristics of the Study Subjects* (The asterisk [*] leads the reader to the footnote below the table.)
Box head: This includes all the words in the 2 lines directly below the double horizontal rule, starting with the row including "PLACEBO GROUP" and ending with the column heading "*P* VALUE."
Stub heading: CHARACTERISTIC
Sample column heading: PLACEBO GROUP
Sample column subhead: (*N* = 425)
Sample stub item: Education (%)
Sample stub subitem: 10-12 yr
Sample cell item: 5.2
Footnote: *Because of rounding, percentages do not always total 100.

The Table Number and Title

Scientific journals use either arabic (1, 2, 3) or roman (I, II, III) numerals for tables. Look again at Appendix B. The tables on page B:7 (Nichol et al.) are numbered Tables 1 and

2, whereas the tables on pages B:11 and B:12 (Chen et al.) are numbered Tables I and II. Check a recent issue of your target journal and follow the journal's numbering format. Be sure to number your tables in the order in which you want them to appear in the text. If there's only 1 table in a paper, the journal may not assign a number to it at all. For example, look at the table on page B:19 (Yao et al.) in Appendix B. This is the only table in the paper, no number is used either in the text citation or before the table title.

Usually, the table title is a phrase rather than a complete sentence. It is as short as possible while still telling the reader what is in the table. For some journals, if your paper has more than 1 table, you can give a full title for Table 1, but shorter titles for subsequent tables. For example, look at the 2 tables in Chen et al. (Appendix B, pages B:11 and B:12). The title of the first table (page B:11) is quite long: "Prevalence of chronic infection with hepatitis B virus and mean lipid concentrations by age in whole study population with ranges in 81 villages in China." Perhaps "by age" could be omitted because that fact is obvious in the table itself; however, the rest is needed to make the table independent of the text. The title of the second table (page B:12) does not need to include "in 81 villages in China" because that fact is included in the title of Table I; thus, Table II's title can be a little briefer.

Notice also that the long title for Table I (page B:11) of Chen et al. is much better than a short, less informative title such as "Prevalence of chronic infection." Table titles should be concise but also should express clearly either the topic or the point of the table.

Horizontal and Vertical Rules (Lines)

Sometimes it seems that vertical or horizontal lines are needed to guide the reader through a complex table. However, when you are preparing a research paper for submission to a biomedical journal, use the same number and type of lines that appear in tables published in that journal.

Look at Appendix B again. The articles by Yao et al., Chen et al., and Nichol et al. contain 1 or more tables. However, the number of horizontal lines used differs among the 3 journals. The table in Yao et al.(page B:19) illustrates the most common format for horizontal rules: 1 rule between the title and the top of the column headings, 1 rule between the column headings and the start of the data cells, and 1 rule between the data cells and the footnote. Also, a spanner (or straddle) rule is used within the column box heads to avoid repeating "platelet aggregation" after the names of each of the 3 species.

The New England Journal of Medicine uses 3 horizontal rules in a slightly different way, as you can see on page B:7 (Nichol et al. in Appendix B). Both Tables 1 and 2 have a double horizontal rule between the table title and the column heads, but no other horizontal rules until the data field is complete. Then a single horizontal rule separates the data field from the footnote.

In contrast, more than 3 horizontal rules are used in Tables I and II of Chen et al. (pages B:11 and B:12). As you can see, the *BMJ*, which published the article, uses extra horizontal rules to separate "overall" data and other types of data from the main data.

None of the 5 sample articles contain tables with vertical rules. As we mentioned above, vertical rules are almost never used in printed tables. Thus, to minimize revision, follow your target journal's format for use of horizontal rules, and do not use vertical rules.

The Column Headings

Column headings need to be brief but clear. Spanner rules help you to avoid repeating headings: you can see this in the 3 spanner headings in Table II in Chen et al.(Appendix B, page B:12): "Cholesterol (mmol/l)," "Apolipoprotein B (g/l)," and "Apolipoprotein A (g/l)."

The 3 headings mentioned above also illustrate nicely how to indicate units of measure in table headings. First, put units of measure in the column heads rather than repeating the unit after every cell entry. Second, use SI (Système International) units of measure so that all your readers will understand the data. (See Appendix 5 in Day's text for a list of SI prefixes and suffixes; if you need to check the correct name of the units, ask your local instructor to check the appropriate sections in their style manuals.) Third, notice that none of these heads use exponents (such as the "3" in 10^3). Exponents can be misleading: Has the number in the column already been multiplied by that power of 10, or does the reader need to do that multiplication to obtain the correct number?--the difference between these 2 choices is 10^6!

The Stub Head and Items

The far left column is very important for understanding any table. The items in that column are often the independent variables (for example, temperature, time, species, patient number). Always put a heading over this column, even though what you are listing may seem obvious. Also, the reason that the independent variables are listed in the stub column is that research on reading has shown that it is easier for the reader to compare results across rows rather than down columns. For example, look at the table on page B:19 in Appendix B (Yao et al.). In this table the stub heading is "Agonist," and the dependent variables (the agonist and dose used) are listed in the 1st column. The independent variables, the species studied, are listed across in the box head. This arrangement makes it easy to compare the platelet aggregation in humans with the platelet aggregation in baboons or dogs for each dose of any agonist studied.

As always, you are wise to look at your target journal and to match the arrangement of material in your tables to the arrangement of material in tables published in that journal.

Table Size

As Day points out, it's usually best to avoid very small tables
because the benefits of table format do not balance the cost and time of creating the table. Instead, the data may be best stated in 1 or 2 sentences in the text. Occasionally, a small table may be justified if it makes a major point very clearly and emphasizes it more strongly than 1 or 2 sentences in the text could. However, before submitting a table that contains only 2 or 3 lines, look at an issue of your target journal to make sure such tables are printed. If you find no small tables, you probably will be asked to convert that small table to text (or to delete it if it repeats text).

Large tables constitute a larger problem. A table is probably too large if it cannot be printed on one journal page in type that is easy for the reader to read. (Count the number of characters in a full-page table printed in your target journal; comparing that count with the number of characters across in your table will tell you if the table will take up too much space when printed. If you really want every reader to see a large data table, do your best to create the table so the journal can publish it on one journal page.

For example, you may try these strategies for managing a large table:

> Make sure that all the columns are necessary. Remember, you need not share every piece of data that you collected--make sure all the columns contain data that are directly relevant to your main point. Sometimes you can omit a column by using a footnote or text material to tell the reader about those results. For example, if the numbers in any column are all or mostly identical (especially if all entries are 0), you may be able to include that information in a table footnote or in the text and then delete the column. Also, some columns may be easily calculated from others, so consider deleting the columns containing the calculations.

If you have trouble constructing the table so that it will fit on a single journal page, try 1 or more of the following suggestions:

> Switch the rows and columns, so that the table is long rather than wide.
> Use abbreviations (explain them all in the table footnotes) to decrease table width.
> Rotate the table (on your word processor, choose "landscape" rather than "portrait" orientation in your "Page Setup" choices). This may work well for submitting the table, but journal editors are often unwilling to print rotated tables because readers may find them annoying and difficult to understand.

A study may involve many important data, and at least some readers may be interested in seeing all the data. However, the journal editor may be unwilling to publish a large table as part of your article. In these cases, you have at least 2 choices:

1. You can suggest to the journal editor that the table(s) be published as an appendix to the article.
2. You may be able, upon the recommendation of the journal editor, to deposit your large data tables with the National Auxiliary Publications Service (NAPS). Then you can mention in your article that the information is available through NAPS. Ask the editor of your target journal for more information if you think this might be a good option.

Accuracy

Most tables contain many numbers, and you may need to change your tables as you revise your paper. Therefore, you must proofread tables very carefully. A reader may not trust the work of a researcher who tries to prove a hypothesis by data in a table that contains arithmetic errors. For example, make sure the numbers in the "TOTAL" row or column are accurate. (Sometimes, however, you may need to justify any difference in a footnote. For example, rounding may make a total slightly different from the actual arithmetic sum of the numbers in a column--see the footnote in Table 1 on page B:7 in Appendix B).

Always double-check the percentages in your tables. If a percentage is wrong, the reader doesn't know if there was an error in division or if 1 of the data points is incorrect. Accurate tables are a reflection of an orderly, logical scientific mind--a mind that can conduct a study whose results are valid.

Footnotes

Many tables in scientific articles need footnotes. Footnotes are used for 3 major purposes:

1. To clarify the experimental methods used to obtain the data

2. To define abbreviations
3. To clarify the statistical significance of the differences shown

In Appendix B, look at the table on page B:19 (Yao et al.). The table has 3 indented footnotes. The first footnote is a general note that applies to the whole table. The other 2 notes indicate the significance of the differences found. There are 2 footnotes about the significance of the data: 1 compares the means in baboons or dogs with those in humans, and 1 compares 1 set of means with another set found by slightly different method.

Tables I and II in Chen et al. (Appendix B, pages B:11 and B:12) also include footnotes. The format differs a little from the table on B:19. In Tables I and II, the footnotes explain the significance of the differences appear first, followed by footnotes dealing with definitions of such terms as "chronic infection" and "past infection" (Table I) or methods of statistical standardization (Table II).

Finally, in the article by Nichol et al. (Appendix B, pages B:7 and B:8), each of the 4 tables has at least 1 footnote. Material included in the footnotes explain why percentages may not add up to exactly 100%, what the data represent, how some of the numbers were derived (from another table in the same paper or an estimation), and how other values were calculated. Note that Nichol et al. say "as described in the Methods section" in the 2nd footnote to Table 4. Such reference to the text is usually discouraged, but sometimes it is unavoidable.

Be sure to check articles in a recent issue of your target journal to see how that journal uses table footnotes.

Submitting Tables for Publication

Tables must be submitted according to the "Instructions to Authors" for your target journal. It is tempting to submit a table that "looks like a published table," but that format is very hard to review or edit.

Unless the "Instructions to the Authors" for your target journal indicate otherwise, follow these 2 guidelines as you prepare your tables:

1. Use a regular-sized type (10- to 12-point) for tables. Such type should be used for all parts, including footnotes.

2. Double space everything in the table, including the title, the column heads, the stub heads, the cell information, and the footnotes. Remember that reviewers and editors need to make notes on tables.

Preparing tables this way makes it easier for editors and reviewers to review your articles. Thus, it can lead to faster publication.

Occasionally, you may see an already published table that you wish to use in your article, perhaps for displaying general background data. You must obtain permission to use it from the copyright holder. Lesson 2-4 of this course will discuss how to obtain such permission.

The Importance of Tables

Creating effective tables is important. For nonnative English speakers, producing the tables may be among the easiest tasks of writing a scientific paper because tables don't require the knowledge of idiomatic English. There are many factors to consider: what to put in the title and in the footnotes, what to use as column heads and stub heads, what units of measure to use, and what information needs to go in the body of the table. Many people who don't read your whole paper will look at the tables, and some will decide whether to read your paper on the basis of the information in the tables.

The Writing Assignment

As you think about the tables (if any) you plan for your current paper, use Day's chapter on tables and the material in this section to make relevant checklists. By "checklist," we mean a list of items that are important to check before you submit a table. For example, you checklist might include such entries as the following:

____ Tables are numbered in the order that they are cited in the text.
____ Data in the table are consistent with the pertinent text.
____ The format of the table(s) follows the "Instructions to Authors." [Here you might add subitems concerning the journal's guidelines.]
____ The format of the table(s) matches the format of the tables published in my target journal. [Here you might add subitems concerning the use of rules and footnotes.]
____ The data in the table are appropriate for a table (rather than a text statement or an illustration.

Even if your current paper does not require tables, create a checklist that will help you make effective tables for future papers. Give the checklist to the local instructor. If your current paper does include table(s), use this week to create the checklists and the close-to-final draft(s) of the table(s) for your paper. Give these tables to your local instructor--double-spaced and in 10- to 12-point type--along with a copy of the text page relevant to each figure.

AN ENDING NOTE: Please feel free to contact your local instructor with questions about this lesson or assignment.

Lesson Nine
Creating Effective Illustrations

OBJECTIVES OF LESSON NINE

By the end of this lesson, you will be more familiar with the most effective ways of using illustrations in research papers.

ASSIGNMENTS FOR LESSON NINE

1. Study the material in this lesson.
2. Read Chapter 14 ("How to Prepare Effective Illustrations") in Day's book. If you have questions, ask your local instructor.
3. Re-read the "Instructions to Authors" for your selected journal, and study the material about illustrations. Also, look at the illustrations in papers published in the journal. If you have questions, ask your local instructor.
4. From the information you obtained in Steps 1-3 above, create a checklist that will help you remember the main principles of effective illustrations and ensure that your illustrations conform to the requirements of your target journal.
5. Revise any illustration(s) needed for your paper and write appropriate legends for them. Submit your illustrations and legends to your local instructor. Also provide the pages of text on which the illustrations are discussed, so your local instructor can check the text and illustrations for consistency. If your paper contains no illustrations, explain why none are needed.

Definitions

In this lesson, we will discuss how to prepare effective illustrations for your papers. Below we define some terms that are often used in the guidelines for illustrations provided in "Instructions to Authors." We will refer to figures in the sample articles in Appendix B of this Course Packet so that you can see examples of many of the items defined below.

If you find other terms that you do not understand in the instructions in your target journal, please ask your local instructor to clarify them. If the term is very specialized, the local instructor can ask us about it, and we will answer the question as soon as we can.

Axis: On a graph, the major vertical line (Y axis) and horizontal line (X axis). These lines show the 2 variables being correlated. The independent variable is usually plotted on the X axis. The dependent variable is usually plotted on the Y axis.

EXAMPLE: For Figure 3A of Yao et al. (page B:18 in Appendix B), the Y-axis label is "PLATELET AGGREGATION," and the X-axis label is "ADP."

Caption: For scientific articles, a synonym for "legend" (see definition below).

Figure: For scientific articles, a synonym for "illustration" (see definition below). ("Illustration" is the preferred term for discussion of these items, because the word "figure" has many different meanings in English.)

"continuous-tone images" (photographs) through a gridded screen to produce dots that compose a "half-tone" image.

EXAMPLE: On pages B:2 and B:3 of Appendix B, the figures used in Gu et al. are all half-tones.

Illustration: An image or graphic portrayal of methods or data in a scientific paper. Types of illustrations include graphs, diagrams, flow charts, photographs, radiographs, and charted recordings such as an electrocardiogram record. Synonym: figure.

EXAMPLE: In Appendix B, any of the graphs or photographs called a "figure" is considered an illustration.

Key: Within a graph, a boxed listing of symbols and what those symbols represent. Some journal editors use keys rather than legends to define the symbols used because keys can be easier and faster for readers to find and understand.

EXAMPLE: On page B:16 in Appendix B, Figure 1 of Yao et al. uses a boxed key to indicate what bars represent control data and what bars represent clopidogrel-treatment data.

Legend: The phrases or sentences that describe and explain an illustration, as well as any symbols or abbreviations used in the illustration. In a printed article, the legend is usually placed below or beside the illustration described. However, when papers are submitted, the legends must be typed in numerical order on pages separate from the illustrations themselves. Legends are necessary so that the illustration can be understood without referring to the text. Synonym: caption.

EXAMPLE: On pages B:16 through B:17 in Appendix B (Yao et al.), there are 3 figures. The legend for Figure 1 is directly underneath it, but the legends for Figures 2 and 3 are beside the illustration.

Line drawing: Any illustration that consists of lines, words, and symbols but no photograph or half-tone. In biomedical writing, the most common kinds of line drawings are graphs and anatomic diagrams (for examples, see the 3 line drawings on pages B:16 through B:17 in Appendix B).

Scale bar: A relatively small bar marked with its relative length. Scale bars are placed on half-tone illustrations, particularly microphotographs, so that the reader can easily tell the magnification. Some journal editors prefer scale bars to a statement in the legend (for example, "magnification, 300X" or "original magnification, X300"). Scale bars remain an accurate representation of size no matter how much the illustration is reduced for printing.

Symbol: A letter or other character that represents a data point of a certain type in a graph or a letter or symbol to easily highlight an area in a half-tone.

EXAMPLE 1: On page B-12 in Appendix B, the figure in Chen et al. used open circles to show data from "non-carriers" and closed circles to show data from "carriers." A key set between the 2 graphs explains the symbols.

between the 2 graphs explains the symbols.
EXAMPLE 2: On page B-3 in Appendix B, the arrows in Figure 2 (Gu et al.) are used to show various features in the radiographs. The legend explains each arrow.

Tick marks: Small lines on axes that correspond to units of measurement. If correctly used, they make the graph easy to understand. If overused, they distract from the message.

EXAMPLE: On page B-12 in Appendix B, the figure in Chen et al. uses tick marks for only the main divisions on the axes. That is, on the top figure, there is a tick mark to connect to the Y axis each of 5 measurements (2.2, 2.4, 2.6, 2.8, and 3.0).

Preview of Chapter 14 in Day's Book ("How to Prepare Effective Illustrations")
As we look at Chapter 14 on illustrations, let us first go through the material page-by-page in this preview. Second, we will review the main points of the chapter.

The quote that starts this chapter indicates powerfully the benefits of good illustrations. Remember, though, that poor or inappropriate illustrations can interfere with getting your message to the readers, including other scientists; reduce the chances of obtaining a grant; confuse students; and mislead the public about the value of your work.

This lesson is devoted to defining an "effective illustration" -- and that task is not simple. However, it is easy to define a poor illustration: A poor illustration is one that is unnecessary, distracting, or misleading. Read carefully Day's section on "When to Illustrate." The guidelines there will tell you how to avoid submitting unnecessary illustrations. The other sections of this chapter discuss the best way to present evidence in graphs, photographs, and micrographs.

We hope the following items will help you understand this chapter more fully so that you can make a good start at revising your own illustrations (if any) this week:

- On page 69, Day indicates that graphs are "called line drawings." On page 81, he says that pen-and-ink illustrations are also line drawings. As long as an illustration does NOT include a photograph or anything that must be printed as a half-tone, it is a line drawing.
- On page 70, the 2 notes to Table 1 at the bottom of the page are meant to be humorous. The format, however, is the same used by some journals.
- On pages 71 and 73, Figures 2 and 3 might be more effective if the symbols explained in the legend were instead incorporated into a boxed key within the graph, as shown in Figure 1 of Yao et al. (page B:16 in Appendix B).
- On page 72, in the second paragraph, Day mentions the possibility of creating graphs with your word processor. To check whether your word processor can be used to create graphs, look under "graph" in the index of its manual or in the index of your online Help. However, it may be a more efficient use of time and resources to have a graphic artist draft your illustrations.
- The fifth paragraph on page 72 notes that a boxed graph "makes it easier to estimate the values on the right-hand side of the graph." Some journal editors like boxed graphs, but some do not. Once again, check your target journal, and format your illustrations to match those in the papers published there.

- On page 76, Day states, "There is no need for glossy prints." we disagree. If the journal instructions say to provide glossy prints, that's what you must submit.
- We have 2 comments about Day's section on cropping figures. First, the bottom image on Figure 5 (p. 77) is much larger than most journals would publish. The sizes shown on the bottom images of Figures 6 and 7 (pages 78 and 79) are more typical publication sizes. Second, if you do not mark crop marks on your half-tones, the journal's editors may do the cropping for you. Check carefully, tell the journal editor if a cropped figure fails to show the most important features of the illustration, and suggest better cropping for the figure.
- On page 80, Day recommends marking "top" to indicate the top of the figure. To be most efficient with labeling your illustrations, follow this advice for all illustrations then, including photographs: write the identifying information (your name, short title of paper, figure number, and an arrow indicating the top of the figure) on a label. THEN place that label on the back of the figure. This avoids any possibility of the writing showing through the image on the front. Be sure that the label is oriented so its "top" marker corresponds to the figure's top.
- Also on page 80, Day discusses putting a micrometer marker (or "scale bar") directly on the micrograph. If you indicate the magnification in the legend instead of using a scale bar, some editors will use your number and call it "original magnification" in the legend. This phrase indicates that the number may not reflect the actual magnification after reduction for printing. As Day indicates, however, a scale bar in the figure is usually the best way to show the size of the features.
- On page 81, Day talks about publication costs of color illustrations. The cost may be reduced if the journal's layout for that issue allows your color illustrations to be in the same "signature" (grouping of pages used in printing) as a color advertisement. However, you cannot predict that this will happen. Also, some journals ask for color prints rather than slides or transparencies--as always, check the "Instructions to Authors."

The following material covers the highlights of Day's chapter on illustrations. You may read the next section as part of the preview. Alternatively, you may read Day's chapter first, and then read the section below as a review.

Review of Chapter 14 in Day's Book

General principles for any illustration:

1. Obtain recent issues of the journal and look at the printed illustrations similar to yours. Use those illustrations as models.
2. Number the illustrations in the order in which they are cited in the text. If you delete or add an illustration, remember to renumber the figure citations, the figure legends, and the labels on the back of the figures.
3. Do not place legends or "titles" at the top or bottom of the illustration. Type the legends on a separate page, as indicated in the journal's "Instructions to Authors."
4. Submit illustrations that will be clear and readable even if reduced up to 50% for publication.
5. If you need a basic anatomic drawing or photo, consider seeking permission to reprint an appropriate drawing from a textbook. In Lesson 2-4, we will discuss the

way to obtain permission to reproduce illustrations that have already been published. Often, this may be less expensive than having the drawing made by a graphic artist.

Principles for preparing effective graphs:

1. Submit neatly drawn, easily understood graphs, either composed by computer program or prepared by a graphic artist.
2. Use letters and symbols large enough to be clear and legible even if the graph is reduced 50% in the final printed version.
3. Make each graph as simple as possible. Don't try to include too much information in 1 graph.
4. When it makes sense to show 2 or more graphs as parts of 1 figure, do so by labeling the graphs clearly A, B, C, etc. The legend must then also describe each part specifically.
5. Extend the x and y axes only as far as needed to show the data.
6. If there is room in the graph, place a boxed key inside the graph to explain the symbols.
7. If you define symbols in the legend, use the most common symbols (that is, open and closed circles, triangles, and squares). These are available on most typesetting systems and are easy for readers to see and distinguish.
8. If you have only 1 curve, use open circles for the data points on that curve.
9. Use EITHER different types of lines (for example, dashed versus solid) OR different symbols to distinguish types of data. However, do not use both in the same graph.
10. Use the same symbols for the same types of data throughout the paper. For example, use open circles for the experimental group and closed circles for the control group in every graph. See Figure 3 on page B:18 in Appendix B (Yao et al.), which shows 1 illustration with 3 parts. In each part, the control group is indicated by a closed circle, and the clopidogrel group is indicated by an open triangle.

Principles for preparing effective photographs/micrographs:

1. Consider the size, especially the width, of your photograph, in relation to the column size used in your target journal.
2. Consider the value of the photographs for your readers. If the photos have little or no value, don't use them in your paper (even if they are pretty). If they contain the primary message of your paper, make sure that your target journal prints such photographs clearly enough for your message to get through to the reader.
3. Put suggested crop marks on the margins of half-tones, on an overlay, or on a photocopy of the half-tone. These will guide the editors so that the most important features on the half-tone will be clear when it is printed. Avoid submitting an illustration that must be reduced by more than 50%.
4. On each half-tone, mark "top" on a label attached to the back of a half-tone.
5. On electron micrographs, use a scale bar to indicate to the reader the original size of important features.
6. If you submit color photographs, be aware that the journal may decide not to use them or may ask you to pay for publishing them.

General Advice/Suggestions from Other Sources

Here are a few ideas from other books on biomedical writing (Huth 1990, Matthews et al. 1996, O'Connor 1991, Zeiger 1991) that might help you as you prepare your illustrations.

Purposes of Illustrations

Illustrations can be helpful in the Methods section. For example, see pages B:2 and B:3 in Appendix B (Gu et al.). The authors used Figure 1 to show the apparatus they used and Figure 2 to show the steps of their method.

Illustrations in the Results section can effectively present evidence that supports the statements in the Results. Remember that you can choose illustrations, tables, or text statements to present evidence. Illustrations are more effective than tables or text for comparing sets of data quickly or showing the relationships among data (rather than the numerical values). For example, look at the 3 figures used in Yao et al. (Appendix B): The authors use a bar diagram (Fig. 1, page B:16); line graphs (Figs. 2 and 3, pages B:17 and B:18); and a table (page B:19) to display their results effectively.

Like Yao et al., you may decide to use different types of graphs to display different types of data. Be aware that certain types of relationships are shown better by certain types of graphs. You can ask your local instructor questions you have about which type of graph is best for a certain type of data. Each local instructor has a copy of Zeiger's book, which contains an excellent section on the different types of graphs.

When you consider the purpose of each illustration, remember this universally accepted rule: Never use an illustration just because you have it. Only use illustrations that aid the reader by telling your story more effectively than either the text or a table could.

Guidelines for Producing the Most Effective Figures

The following guidelines summarize some of the most common suggestions for preparing effective illustrations.

1. Follow the requirements listed in the "Instructions to the Authors." Also, use the figures published in your target journal as models. Sometimes, the instructions in your target journal may disagree with 1 or 2 points below. When this happens, follow the journal's instructions.
2. Many believe that the most pleasing shape for an illustration is a horizontal rectangle (in which the height is about 2/3 of the width). However, some journals prefer square illustrations.
3. As Day emphasized, the lettering on your illustration must be readable even at a 50% reduction. Matthews et al. (1996) suggest that the minimum height for capital letters on an illustration is 2.0 mm after reduction. Consider putting letters on your illustrations that have 4.0-mm-high capital letters.
   Compare the line graphs in the left column of page B:12 of Chen et al. (Appendix B) with the line graphs in Figure 2 of Yao et al. (Appendix B, page B:17). You probably prefer the larger Figure 2 of Yao et al. to the small, unnumbered graphs in Chen et

al., and the larger letters and numbers are easier to read. Readers are more likely to study and understand graphs with reasonably large lettering.

4. Follow these suggestions when constructing graphs, because they may help readers interprete your data correctly:

- Use each graph to make 1 important point.
- Begin scales at 0 (zero) whenever possible.
- Label both the x and the y axes with the variable being measured and the unit of measure.
- Use error bars, and indicate whether they represent the standard error of the mean or the standard deviation.
- If you want readers to compare 2 or more graphs, use the same scales on each.
- Make sure that your symbols indicating different types of data will be easily distinguishable after reduction.
- Beware of drawing the connecting line beyond the final data point--such extrapolation can be misleading and incorrect.

Effective Legends

The illustration's legend is almost as important as the illustration itself. The legend makes the illustration understandable and independent of the text. As you check your page(s) of figure legends, answer these questions for each legend:

> Does the legend match the final version of the figure?
> Are the content and number of the legend consistent with the text?
> Are all abbreviations and symbols in the figure explained in the legend?
> Is the wording of the legend consistent with that of other legends? (For example, be sure that 1 legend doesn't refer to a patient as Patient A when another refers to that same patient as Patient 1.)
> Can the readers understand the illustration if they only read the legend and not the accompanying text? (Avoid "see text" in legends.)

Two Problematic Types of Illustrations: Polygraphs and Chromatographs

Sometimes the primary-evidence illustrations that would present the data best will not reproduce well when printed.

For example, if you use original polygraphs as line drawings, the labels are extremely important. Zeiger (1991) suggests that you remove the grid, add "perfectly accurate" vertical and horizontal scales, and label each axis with the name of the variable and the unit of measure. Such half-tones as chromatographs must be clear and sharp if they are to convey the message to the reader. If you want to present data with these types of illustrations, ask your local instructor for more guidance. (Each local instructor has a copy of Zeiger's book, which contains good suggestions for effectively preparing these types of illustrations.)

Preparing Illustrations for Submission

Illustrations are the most delicate items that you will be submitting. Don't rush when you are creating them or when you are preparing them for submission. They may be

expensive and time-consuming to replace if they get lost or damaged. Below are some tips to help safeguard your illustrations, whether you are handing them to your local instructor for feedback or mailing them overseas:

1. Submit figures that are large enough to be noticed but small enough to go into the envelope without getting bent. The best size for figures is 5" x 7" (127 x 178 mm), although 8.5" x 11" (216 x 279 mm) is also acceptable. Illustrations that are too small or too large may be difficult for the journal office to handle.
2. Put the illustrations in order by number.
3. You have already put labels on the back of each figure or figure part. Make sure that any ink on these labels is dry so that it won't smear the figure beneath it. Also, check that the information on these labels is still consistent with the text and figures.
4. Most journals do not want the figures mounted (that is, pasted or taped to a sheet of paper). Mount your figures only if it is specifically requested in the journal's "Instructions to Authors."
5. Never attach an illustration to something else either with a paper clip or a staple.
6. Before you mail the illustrations or give them to someone for feedback, put them all in an envelope marked with the first author's name and short title of the paper. Put cardboard on each side of the group of illustrations to keep them from being bent. When you do mail them, be sure to write on the envelope "PHOTOS ENCLOSED: PLEASE DO NOT BEND."

As you can see, creating effective illustrations is not simple. There are many factors to consider. But it is very important. Many people who don't read your whole paper will only look at your figures and legends.

The Assignment

As you think about revising the illustrations (if any) for your current paper, use this lesson and Day's chapter to help you make relevant checklists. Even if your current paper does not contain illustrations, create a general checklist for preparing illustrations and give the checklist to the local instructor. If you are revising figures for your paper this week, give the following to the local instructor:

> the checklist based on this week's material
> revised figures
> the figure legends (typed in order on 1 or more pages)
> a copy of the text page relevant to each figure

AN ENDING NOTE: When you finish the figures, congratulation yourself. You have completed the first draft of all sections of your paper. Please feel free to contact your local instructor with questions about this lesson or assignment.