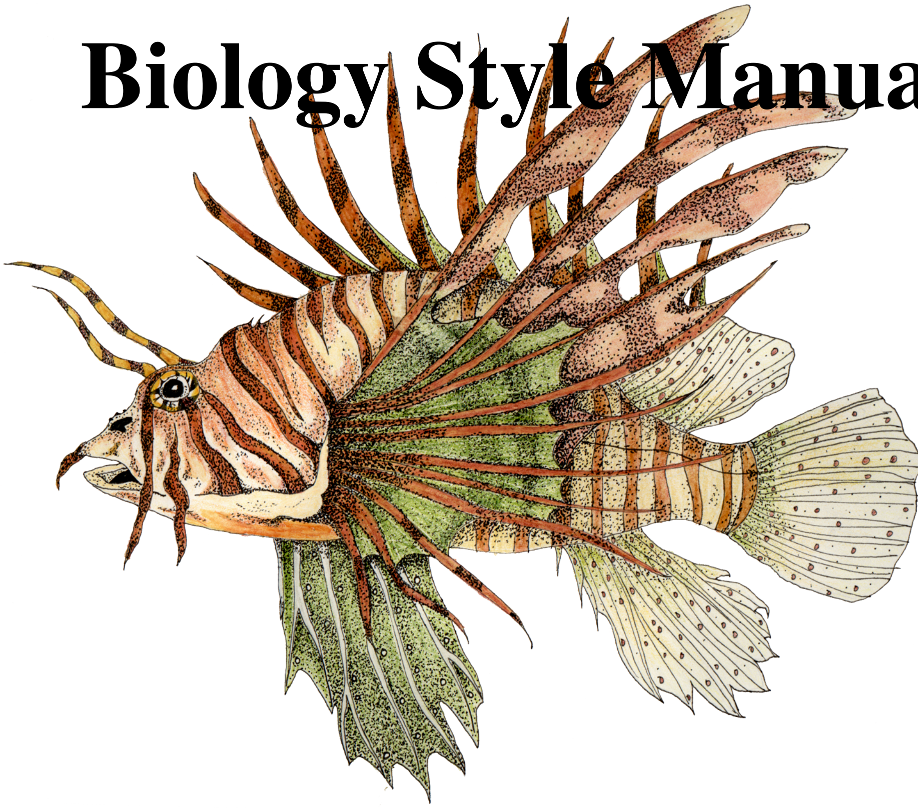
Biology Style Manual



Faculty of the Department of Biology

St. Mary's College of Maryland
St. Mary's City, Maryland

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Purpose

The purpose of the Department of Biology Style Manual is to guide the writing required of biology students throughout their time at St. Mary's College of Maryland. Other objectives of the Style Manual are to provide an agreed standard format for writing and to give the specific requirements and expectations that department instructors will use to evaluate student written work. Because laboratory reports make up much of the writing done in the Department of Biology, the emphasis of this manual is on formal research reports, but the Style Manual also serves as a guide for St. Mary's Projects and other writing done in biology. We start by describing the basic elements of a research report in the first section, the anatomy of a formal research report. Then, we describe the method of citation you should use in making reference to work that has been done by others. A detailed discussion of tables and figures is given in the next section, and in the following sections we offer some suggestions on the elements of good writing, oral presentations, and posters.

The Anatomy of a Formal Research Report

Laboratory or technical reports serve several useful functions: (1) you have a clear record of your laboratory work; (2) you learn to evaluate raw experimental data and to relate them to other information you possess; (3) you learn the elements of scientific writing; and (4) your instructor has a document demonstrating your progress in understanding biology. As biology majors it is absolutely essential that you know how to write technical reports that present the results of your work in a clear and concise way. One of the principle objectives of *all* biology laboratory courses at St. Mary's College is, therefore, to provide you with an opportunity to practice presenting the results of your experiments in a standard format. To this end, you should draft your laboratory reports as scientific communications, that is, as if you were going to send them to an editor for publication in a scientific journal.

A laboratory report, or any report, for that matter, which that communicates the results of an experiment, has a different style than other kinds of writing. The scientific report does, however, include the basic elements of any well-written paper: good grammar, concise sentences, accurate spelling, logical development of ideas, and clear organization.

Below is an outline of the form in which many scientists write their reports. Many of the suggestions offered may not apply to a particular experiment, so don't expect to write all parts all the time. Your report should lead the reader from a clear statement of your subject (or purpose), through the procedures and data, and on to conclusions. Think of your paper as having these main parts: title, abstract, introduction, materials and methods, results, discussion, and literature cited. Be sure to include the appropriate headings for each section of your report.

TITLE
Develop a carefully worded, concise title that describes the experiment.

ABSTRACT
This section is a very brief overview of all of the main sections of the report, highlighting major results and conclusions. Authors often prefer to write this section last since it is a summary of the entire paper. The abstract helps readers decide if the paper is of interest to them. Avoid

references and long discussions in this section. We generally do not require abstracts for laboratory reports.

INTRODUCTION

This section gives background information, setting the stage for your research. Keep the introduction relatively simple and short going from the general to the specific, explaining what is known and why your contribution is valuable and interesting. You will need to cite others' research from journal articles, book chapters, *etc*. Refer to published literature as described in the "Literature Cited" section below. The introduction leads up to the purpose of your experiment, models and hypotheses; these are, which often appear in the last paragraph of the Introduction.

The difference between models and hypotheses is often confusing to students. Try the following approach to understanding them:. You made predictions on the outcomes that you expected from each experiment. These predictions are predictive hypotheses. Now ask yourself *why* you expected these outcomes. The answer to that question is the model for your experiment. Remember that the model must relate to the actual experiments that you conducted. Normally one develops a model first and later develops experiments and predictive hypotheses to test the model.

METHODS

The objective of the Methods section is to allow others to judge the validity of the experiment and even to repeat it for themselves. This section should briefly describe the methods you used for your experiments, including data analyses and any statistical methods used. Be concise and thorough, but avoid unnecessary detail. When possible, save yourself and your reader some work by referring to published methods you have adopted. In journal articles this section is often nearly *all* references, for example, "We prepared the extract using Jones's method (Jones, 1994), analyzed the lysate as described by Smith (1996), and fit the data to Hatch's theory of minimal attendance (Hatch, 1998)." In some cases it is acceptable to simply refer to the lab manual for a general method, and then note any additions or changes you employed (but ask your instructor about specific cases). Always write the Methods section out in text format (, not in a cookbook, outline, or list format). In this section you do not give the results you obtained, nor do you discuss them. Always use the past tense in the Methods section.

Here are some suggestions for writing a good methods section:

1. Arrange the information in a unified and coherent sequence, so that the section develops clearly, but do this in narrative paragraph form, not as a list. This is a report on what you did, not a set of instructions to someone else, so use past tense.
2. Use active voice for brevity and clarity: "We measured coleoptile length…" rather than "Coleoptile length was measured….."
3. Use tables and figures (photographs, drawings, or graphs) sparingly in this section to clarify and document your procedures. You must make reference to these in the Methods narrative, for example (Fig. 1).
4. Include scientific names of organisms, complete names of apparatus (including model number, manufacturer, and place of manufacture), and chemicals, as well as any information that may be significant to your results. For example: We determined photosynthetic rates using a LiCor 6400 portable gas exchange system (LiCor Inc., Lincoln, NE, USA).
5. Remember to underline or italicize scientific names and foreign words. Do not capitalize common names unless they are proper nouns ("brine shrimp" or "blue crab," but "Maine lobster").

6. Do not include results or discussion.
7. Be concise and thorough, but avoid unnecessary detail such as the size of the beakers you used (unless for some reason this information is crucial to repeating the experiment).
8. Remember that the objective of the methods section is to allow others to judge the validity of your experiment or even to repeat it for themselves.

RESULTS

The Results section should include your analyzed data (descriptive statistics, such as means and standard deviations, and tests of significance) and a narrative that presents your observations and data. Do not give unanalyzed, raw data in a lab report unless you are specifically asked to do so. The results section contains an objective description of what happened, without evaluation, (for example): "Respiration rate increased with temperature in all species (Fig.1), but statistical analysis showed that there were significant ($P \leq 0.05$) differences among species (Table 2)." You should state your most general results first then logically move to more specific results. Summarize your results in a narrative and cite significant results in tables and figures where appropriate. For example, the text describing a graph of enzyme activity as a function of temperature might be: "The activity of the enzyme sequence showed a sharp optimum at 87^{o} C (Fig. 1)." Every table and figure must be described in the Results section with text that tells the reader what message to get from the graphic, as in the above example. Tables and figures should be presented in numerical sequence, in the order that they are described in the text of your paper. Do not present the same data twice. Choose the best way to present the data, as a table or as a figure, but not both. For further details about preparing these graphics, see the Tables and Figures section of this Style Manual.

DISCUSSION

The purpose of this section is to discuss and give meaning to the data presented in the results section. The Discussion section should follow the same sequence given in the results section with general first and specifics later. Do your data support the hypothesis that you presented in the introduction? Analyze the meaning of the experiment's results and describe how your data support or refute the hypothesis that you presented in the introduction. If your results do not support your hypothesis, indicate how you might change your understanding of the system to accommodate them, and suggest how your new ideas might be tested. Relate your experiment to previously-published work, as described below in the Literature Cited section, and include logical deductions. Do your data support (or refute) previously published work? Your results have meaning in the context of what other researchers have discovered. Try to provide reasonable suggestions as to why, and account, where you can, for unexpected results (or lack of results). If you think the problem might be approached differently, mention other ways of testing the hypothesis. Usually the last part of the Discussion section is a summary of conclusions, a discussion of significance of the work and/or suggestions for future research.

CONCLUSIONS

This is an optional section and is usually included in longer, more comprehensive research reports. Conclusions may also be inserted (unlabelled) as the last paragraph of the Discussion section. Wherever placed, this section should be very short and it simply summarizes your major conclusions in three or four sentences.

LITERATURE CITED

In the text, literature is referred to by placing the author(s) and the year(s) of the publication in parentheses. For example, a statement in the introduction might read as follows: "The enzyme sequence is found in bacteria from hot springs and is likely to be active at high temperatures (Byrd, 1992)." When you cite multiple papers, list them in chronological order, oldest first. For papers with more than two authors, the first author's name is listed followed by "*et al*." For example, the references listed below can be cited as follows (Swain, 1979; Mann and Lazier, 1991; Arnold *et al*., 1995). Some of the rules that you should pay attention to are: 1) literature should be cited when first referred to, not at the end of the paragraph or section; 2) close paraphrasing or quoting without citing sources are forms of plagiarism; 3) referring to unpublished materials (school papers, lecture notes, etc.) should be avoided; and 4) only sources that you have actually read should be cited.

All literature you cite in your report must be listed in the "Literature Cited" section. Citations should be cited in alphabetical order, followed by chronological order (oldest paper first) when there are several papers by the same author(s). Follow the style shown below. Author's first and middle names are abbreviated, and titles (articles and books) are not capitalized. See the examples given below and refer to the Citing the Work of Others section of this Style Manual.

Arnold, T. M., C. E. Tanner, and W. I. Hatch. 1995. Phenotypic variation in polyphenolic content of the tropical brown alga *Lobophora variegata* as a function of nitrogen availability. Mar. Ecol. Prog. Ser. 123:177-183.

Mann, K. H., and J. R. N. Lazier. 1991. Dynamics of marine ecosystems. Blackwell, Oxford, England.

Swain, T. 1979. Tannins and lignins. Pages 657-682 *in* G. A. Rosenthal and D. H. Janzen, editors. Herbivores, their interaction with secondary plant metabolites. Academic Press, New York, New York, USA.

Citing the Work of Others

Plagiarism and When to Use Citations

When and where do you cite? You do **not** need to cite an idea that is standard biological information, such as material discussed in class or general information your reader knows or can locate easily (*e.g.*, cells are either prokaryotic or eukaryotic, or Charles Darwin (and Alfred Russell Wallace) formulated the theory of evolution by natural selection). Such information is widely available and not disputed. You **do** need to cite a reference for a fact that is not common knowledge.

Whenever you take information (intellectual property) from another person, you must give credit and enable the reader to check your information source as well as learn more about the cited studies. Cite only those sources you actually used in the development of your paper. The placement of citations normally occurs as soon as you end the first sentence containing information from another source. You do not need to cite every sentence. If a paragraph is long (writer's decision) and can be attributed to one source, then you can cite the source either at the end of the paragraph or at the end of the first sentence that introduces the work. Of course if the source of information switches within a paragraph you should cite the different sources. What if information comes from multiple sources within the same sentence? Either scatter citations after their respective part or group them all together at the sentence end. For example, the citation "(Smith, 1996, Thomas and Jones, 2000, Paul et al., 2003)" says that the information in the sentence or paragraph cited is found in all these works. In contrast, a sentence like "Birds (Smith, 1996), bees (Thomas and Jones, 2000) and butterflies (Paul et al., 2003) all see ultraviolet radiation." tells the reader the source of each bit of information. Beware of over-citing, which is usually the result of unnecessary citing of general knowledge or excessive reliance on source material.

The SMCM Student Code and Student Rights and Responsibilities (http://www.smcm.edu/campus/tothepoint0304/studentcodes.pdf) defines plagiarism as the act of appropriating and using the words, ideas, symbols, images, or other works of original expression of others as one's own without giving credit to the person who created the work. Specific instances of plagiarism include, but are not limited to, the following:

a) Word-for-word copying of sentences or paragraphs from one or more sources that are the work or data of other persons (including books, articles, theses, unpublished works, working papers, seminar and conference papers, lecture notes or tapes, graphs, images, charts, data, electronically based materials, etc.), without clearly identifying their origin by appropriate referencing.

b) Closely paraphrasing ideas or information (in whatever form) without appropriate acknowledgement by reference to the original work or works.
c) Presenting material obtained from the Internet as if it were the student's own work.
d) Minor alterations such as adding, subtracting, or rearranging words, or paraphrasing sections of a source without appropriate acknowledgement of the original work or works.
Another useful source of information about plagiarism and how to avoid it is available at:
http://www.web-miner.com/plagiarism

Often students use direct quotes, properly referenced, as a way to guard against plagiarism. However, quotations are rare in scientific writing. Only use direct quotes when the exact words are important, or when they are of historical relevance. Another common problem is to use a close paraphrase of the source material; even with a proper citation, a close paraphrase is plagiarism! At the very least, it represents intellectual laziness. You must read the material, understand it, then write in your own words. Sometimes you may need to put the source material away for a while before you can find another appropriate way of expressing the ideas. Remember, even when you write in your own words, you must include a reference to give credit for the source of the idea or information.

Citation of References in the Text

Below is the format you should use to reference the material that you cite. No reference should appear in the literature cited section of your paper unless it is cited within the text of the paper.

Citation of references in the text should follow the NAME, YEAR system

One author: (Smith, 1998)

Same author(s) of two or more papers in a year: (Smith, 1998a)

Same author(s) multiple years: (Smith, 1998ab, 1999, 2002)

Two authors: (Smith and Jones, 1998)

Three or more authors: (Smith *et al.*, 1998)

Multiple citations, same year: (Smith, 1998; Taylor, 1998)

Multiple citations, different years: (Taylor, 1978; Smith, 1998)

Manuals: (Faculty of the Department of Biology, 2004; American Public Health Association, 1981)

Web Site: (Organization or Author, Date)

Unpublished data: (J.J. Price, Personal Communication, date)
Use personal communication only when necessary. This type of citation is the only case where there is no reference to the citation in the Literature Cited section of the paper.

Citation of References in the Literature Cited Section

The citations in this section should be in alphabetical order by the last name of the first author of the reference. If the same author has been cited more that once, then the order of the publications is by the last name of the second author. Examples of different reference types follow.

Journal Article:

Paul, R.W., W.I. Hatch, W.P. Jordan, and M.J. Stein. 1989. Behavior and respiration of the salt marsh periwinkle, *Littorina irrorata* (Say), during winter. Mar. Behav. Physiol. 15:229-241.

Abbreviations of journal titles should follow the format found in Biosis Serial Sources. A copy of this publication is in the library. You can also access accepted journal title abbreviations online at: http://library.caltech.edu/reference/abbreviations/ just enter the letter of the first name of the journal.

Book (Whole):

Faculty of the Department of Biology. 2004. Biology Style Manual, St. Mary's College of Maryland, St. Mary's City, MD.

Sambrook, J., E.F. Fritsch, and T. Maniatis. 1989. Molecular Cloning: A Laboratory Manual, 2nd ed. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY.

American Public Health Association. 1981. Standard Methods for the Examination of Water and Wastewater, 15th ed. American Public Health Association, Washington, D.C.

Book (Pages):

Sambrook, J., E.F. Fritsch, and T. Maniatis. 1989. Molecular Cloning: A Laboratory Manual, 2nd ed., pp. 23-25. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY.

Book (Chapter):

Byrd, J.J. and R.R. Colwell. 1992. Detection and enumeration of bacteria in the environment by microscopic methods, pp. 93-112. In M.A. Levin, R.J. Seidler, and M. Rogul (ed.), Microbial Ecology: Principles, Methods, and Applications. McGraw-Hill Publish. Co., NY.

Abstract:

Byrd, J.J. and C.W. Kaspar. 1998. Defining substrate-accelerated death: A product of autoclaved glucose kills an rpoS mutant of *Escherichia coli* O157:H7. Abstr. 98th General Meeting of the American Society for Microbiology. Atlanta, GA. May, 1998.

St. Mary's Project/Thesis/Dissertation:

Lyon, D.Y. 1998. The attachment of *Vibrio vulnificus* to chitinous substrates as observed with the scanning electron microscope. Honors Thesis. St. Mary's College of Maryland, St. Mary's City, MD.

Government Publication:

Federal Register. 1979. National interim primary drinking water regulations: control of trihalomethanes in drinking water, final rule. Fed. Regst. 44:68624-68642.

Goehring, H.K. and P.J. Van Soest. 1970. Forage fiber analyses. Apparatus, reagents, procedures, and some applications. U.S. Department of Agriculture Agricultural Handbook no. 379. U.S. Department of Agriculture, Washington, D.C.

Jones, G.L., G.A. Hebert, and W.B. Cherry. 1978. Flourescent antibody techniques and bacterial applications. Center for Disease Control laboratory manual. U.S. Department of Health, Education, and Welfare publication no. (CDC) 78-8264, p. 118. Center for Disease Control and Prevention, Atlanta, GA.

Web sites:

Web site citations should adhere to the following format: Organization or Author of Web Site. Date Created or Updated. Title of Web Site. Official URL. Date accessed.

St. Mary's College of Maryland. November 24, 1998. Welcome to St. Mary's College of Maryland! http://www.smcm.edu. Accessed January 13, 1999.

Centers For Disease Control and Prevention. June 10, 1998. Division of Tuberculosis Elimination - Tuberculosis in the United States 1996. http://www.cdc.gov/nchstp/tb/surv/surv96/surv96.htm. Accessed January 13, 1999.

Video Recording:

Centers for Disease Control and Prevention 1994. E. coli O157:H7: What the clinical microbiologist should know. VHS recording.

CD-ROM or Software Package:

Russell, P.J. 1998. Instructor's Presentation CD for Genetics, 5th ed. Ver. 1.0. Benjamin Cummings Publ., NY.

Maddison, D. R. and W.P. Maddison. 2000. MacClade: Analysis of phylogeny and character evolution. Ver 4.0. Sinauer and Associates, Sunderland. MA.

Tables and Figures

Tables and figures are devices for presenting results more clearly and concisely than can be done in text. It is from your tables and figures that a reader will judge the validity of your work because it is in these presentations that your work is most concisely summarized. A well-designed figure will demonstrate at a glance the functional relationships between variables, and a well-designed table will allow the reader to look up a specific datum in the midst of a complex set of data. Every table and graph must have a number and must be referenced in the text. The tables and graphs should be numbered sequentially with Arabic numerals and referenced as well as displayed in numerical order (*i.e.*, you should not discuss Figure 2 before discussing Figure 1). Tables are numbered separately from figures, but graphs and other illustrations (photographs, drawings, etc.) are numbered together and collectively referred to as "figures."

Tables

Tables usually present specific data that are critical to understanding a scientific paper. A table has two components: 1) the table number with its caption (sometimes called a caption title) and 2) the table itself. Tables are numbered sequentially with Arabic numerals followed by a period, then the table caption with only the first letter capitalized, and finally a period. The table caption is always placed **above** the table and should not extend past the margins of the table itself. The table is bounded by horizontal lines showing where the table begins and ends. The first row in the table contains the column headings and this row is separated from data by another horizontal line. Generally vertical lines are only used to separate columns of data that are grouped. Therefore, do not use lines to identify or separate individual columns.

Since tables have both vertical and horizontal dimensions, data can be arranged with the independent-variable values either across the table or down the table. A table with the data presented vertically provides two advantages: this arrangement allows the reader to grasp the information most easily, and it is in the most compact form. Consider the following examples. Table 1 has the independent variable arranged horizontally:

Table 1. Characteristics of antibiotic-producing *Streptomyces* spp.

Determination	*S. fluoriclor*	*S. griseus*	*S. coelicolor*	*S. nocolor*
Optimal growth temp (° C)	-10	24	28	92
Color of mycelium	Tan	Gray	Red	Purple
Antibiotic produced	Fluoricillinmycin	Streptomycin	Rholmondelaya	Nomycin
Yield of antibiotic (mg/mL)	4	108	78	2

The horizontal arrangement we show in Table 1 is difficult to follow, and the table takes up more space than required. Look at the same data presented vertically in Table 2. Table 2 is far more compact, and it is a simple matter to look up any factor associated with any of the bacteria.

Table 2. Characteristics of antibiotic-producing *Streptomyces* spp.

Organism	Optimal growth temp (°C)	Color of mycelium	Antibiotic produced	Yield of antibiotic (mg/mL)
S. fluoricolor	-10	Tan	Fluoricillinmycin	4
S. griseus	24	Gray	Streptomycin	108
S. coelicolor	28	Red	Rholmondelay	78
S. nocolor	92	Purple	Nomycin	2

Row and Column Headings

The headings in a table must be clear enough to make the meaning of the data clear without reference to the text of the paper. Rows and columns must have heading labels clearly identifying their contents without requiring the reader to refer back to the Methods section. Strictly avoid meaningless labels such as “Treatment 1,” using instead some concise description of the treatment, *e.g.*, "N + P". Numbers must have units. Often units are repetitive and the same for all values in a row or column. If this is the case then incorporate the units into the row or column headings. If the headings need explanation, then the proper place to do that is in the table caption. Use explanatory footnotes sparingly.

A table should contain only data and sufficient information (headings, units, etc.) to make those data clear. It should not contain details of the experiment or conclusions, which should be in the Methods and Discussion sections, respectively. Generally, data in the table should be centered under the heading, which is also centered in the area above the column. Make columns wide enough to contain the headings and the numerical data, but not so wide as to leave large gaps between columns. If necessary, make the headings several lines long in order to minimize the column width (see Table 2 above).

Table Abbreviations

Scientific journals encourage abbreviations in tables to save space. Capitalize an abbreviation only when it is the first word in a heading, and do not use periods except in "no." (for number).

Tables with numerical data (Table 3) need some special considerations. Notice that the heading for needle length has units and that these are common to both pine species, and that the sem (standard error of the mean) as well as mean needle lengths have the same number of significant figures to the right of the decimal place. This indicates that the precision of measurement for all groups was the same. Note as well that all headings are centered over columns and that the columns have appropriate widths for the data. However, the values for "Site" in Table 3 are text and these are generally positioned on the left-hand margin of the column. The data of Table 3 are summary data because they calculate a mean value for each pine species at each location. Therefore, you must tell, in the table title, the sample size (n=100) used to calculate the mean and sem.

Table 3. Mean length ± 1 sem of pine (loblolly – *Pinus taeda* – and Virginia red pine – *Pinus viginiana*) needles (n=100) collected at different locations on the St. Mary's College of Maryland campus (for stand number refer to text).

Stand number	Site	Needle length (mm)	
		Pinus taeda	*Pinus virginiana*
1	Queen Anne Hall - west of parking lot	26.7 ± 7.8	14.6 ± 2.0
2	North Field – behind barns	28.6 ± 6.5	13.6 ± 1.5
3	Northwest of Lewis Quadrangle	26.5 ± 3.9	16.0 ± 2.2
4	Behind Prince George's and Caroline dormitories	27.7 ± 6.8	12.9 ± 1.8

Figures

Figures are graphs, photographs, drawings, and anything else that is not a table. Graphs show relationships between variables. Regardless of the figure type, figure legends are numbered with Arabic numerals and discussed sequentially as are tables. However, figure numbers and legends are placed **underneath** the figure.

Choice of Graph Type

Graphs have become a significant part of scientific communication, and it is difficult to pick up a newspaper or magazine or to look at a scientific web page that does not incorporate them. In general, graphs show the dependence of data (called the dependent variable) on some treatment or condition (called the independent variable). The dependent variable is plotted on the y-axis while the independent or grouping variable is controlled by the researcher and plotted on the x-axis. There are two basic kinds of scientific graphs (bar and line), and you should be careful to select the most appropriate type for your data. Some types of graphs, such as pie charts, are maybe often inappropriate for scientific data even though they are commonly used in business and nonscientific communication.Regardless

Bar Graphs

Some graphs present relationships between variables that cannot be positioned on a number line or assigned a meaningful numerical value. The pine needle data used in Table 3 illustrate how stand location can be used as a grouping variable (even though the x-axis is not numerical). There is clearly a relationship between the site and the length of pine needles, but that relationship cannot be expressed mathematically. A bar graph can be used to illustrate these data (Figure 1). The length of the vertical bar represents a numerical value, and the title of the bar represents an experimental condition that cannot be quantified but can be named. (Remember that you need to decide how to best present your data, as a table or as a figure, not both.) In Figure 1 notice that the figure number and legend are located below and at the left margin of the figure and that the figure legend does not extend beyond the right margin of the figure.

Caution:
When you want to make a bar graph using Microsoft Excel, you will need to select what Excel calls a "column graph".

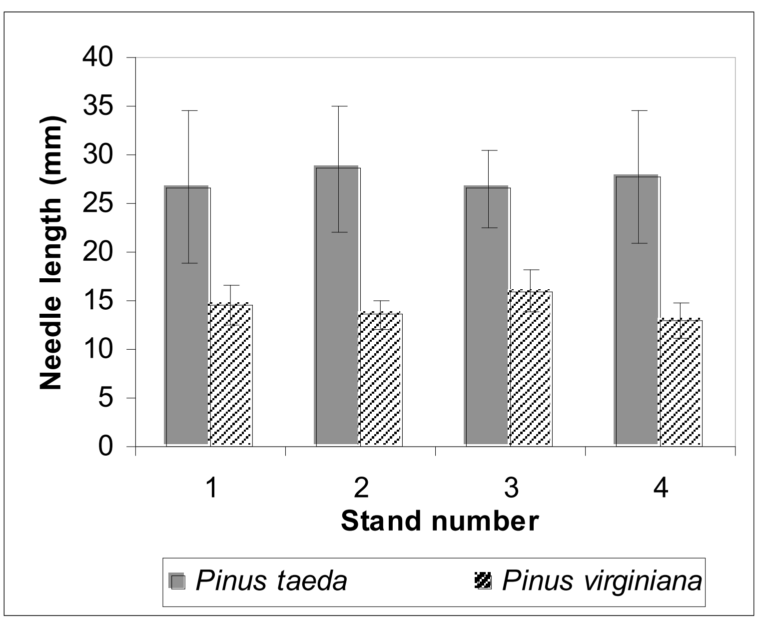

Figure 1. Mean length ± 1 sem of pine needles (n=100) collected at different locations on the St. Mary's College of Maryland campus (for stand number refer to text).

Line Graphs (called scatter plots in Excel)

Some graphs illustrate functional relationships between two numerical variables (numerical data) such as internal osmotic concentration versus external osmotic concentration. This relationship may be linear, logarithmic or something more complex, but in all cases both variables can be assigned a numerical value and positioned on the grid of number lines that constitute the graph. There is a specific symbol for each type of data and these are identified in a legend. Data points must be clearly visible on your graphs. The points are more important than the line for evaluating your graphs. Note also that the line does not necessarily have to connect the data points. The lines on these next two graphs were drawn in to suggest that the relationship is indeed linear or logarithmic. Frequently, however, you will have no idea how the dependent variable depends on the independent variable. In such cases, it is probably best simply to connect the measured points. Notice that the figure does not need to be enclosed in a box as it is in Figure 1, but the figure number and legend do need to be confined to the figure dimensions and located below the figure.

Caution:
In Microsoft Excel, and in some other spreadsheet software packages, the term "line graph" has a very specific meaning. This graph type was produced for certain business applications in which the X axis data are either nominal (Mon., Tues., Wed., *etc.*) or always equally spaced (1 am, 2 am, 3 am, *etc.*). If you select this graph type for numerical data, you will force the data points to be equally spaced even if this is not your intention. Always select "XY" graph types (or "scatter plot") when working in these programs, unless you have a very specific reason to do otherwise.

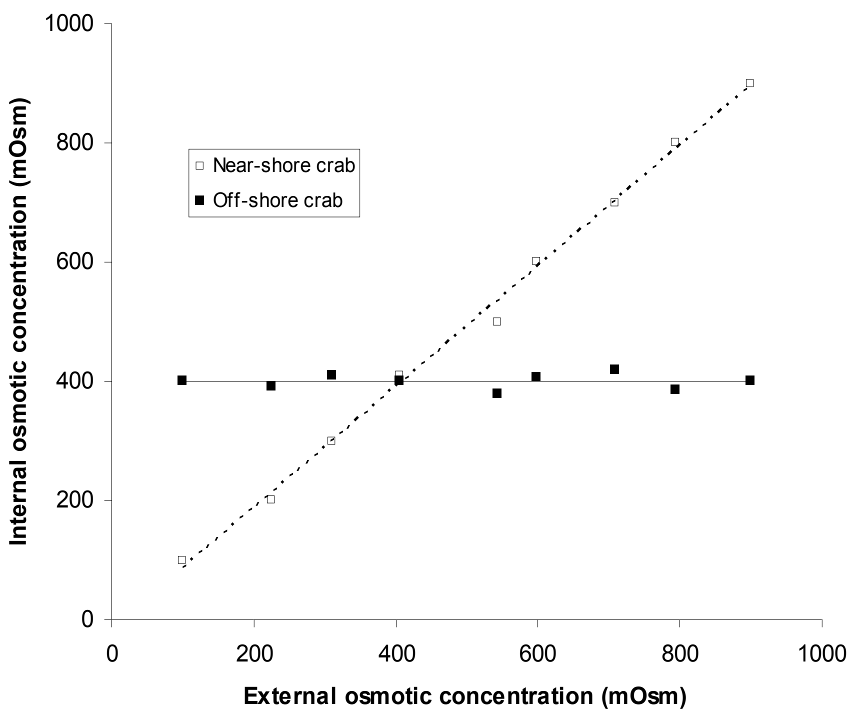

Figure 2. Internal osmotic concentration as a function of external osmotic concentration for near-shore and off-shore crabs.

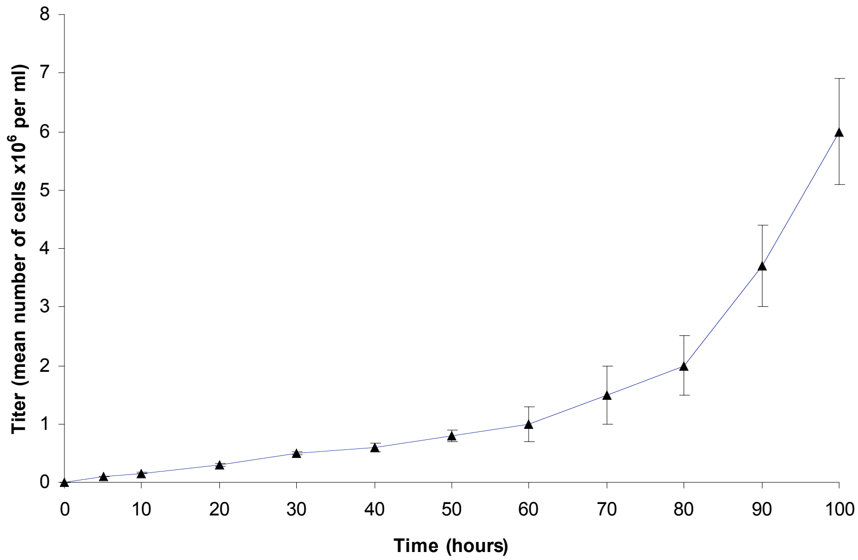

Figure 3. Mean titer $\pm$ 1 standard deviation of bacteria grown in liquid medium for 100 hours at 37°C (n=5).

Figure Conventions

You should observe several important conventions when you make graphs for any biology course.

Figure Captions

Graphs require a figure number and caption, and the caption should clearly and concisely indicate the subject of the graph. As for tables, keep it short and simple, but the caption should make it possible to understand the graph without frequent reference to the text. Place figure captions below the figure for your reports. Captions are often a good place to put details of the method used to obtain the data, the meanings of the symbols in the graph, the sample size, the meaning of the error bars (± one standard deviation, ± two standard errors), *etc.* If data were analyzed statistically, include a *P* value here or in the text of the Results section.

If more than one line appears on a graph, you must identify each (see Figure 2). You may do this verbally in the caption, or include a legend on the graph itself, as in Figure 2. In either case, make sure your labels are clear to someone who did not read the Methods section. For example, suppose you measure absorbance as a function of time at five different pH levels. The curves would be labeled with the corresponding pH, not, for example, a tube number.

Titles

Include captions, as described above, but do not include a "title" (as indicated in the Microsoft Excel program) – it only takes up space and is redundant. (Note: in an oral presentation, you *should* include a title on your slides; there is no caption because you orally explain the figure.)

Axes

By convention the abscissa (X axis) usually shows the independent variable and the ordinate (Y axis), the dependent variable. There are a few specialized exceptions to this convention, for example aquatic biologists often present variables as a function of depth, and to preserve the visual orientation of "down" as deeper they sometimes plot depth on the Y axis even though it is the independent variable.

Axis Labels

The labels for the X and Y axis must be clear enough to make the meaning of the data clear without reference to the text. The axes should have numbers, and the axis labels must include units for these numbers.

Axis Scale

Choose the appropriate scale for your axes so there are not excessive numbers of gradations on the axes, and round the numerical values of axes to values that can actually be seen. For example, the reader really cannot see 30.500%, so it is best to use whole numbers, and a figure with 0 to 100% on the dependent (y) axis will probably have 5 gradations along the axis: 0, 20, 40, 60, 80, and 100. Choose your axis scale to avoid white space on your graph. For example, if you are measuring flower size, and all your values lie between 20 and 30 mm, then use an axis scale from 20 to 30 mm; you do not need to include zero.

Learn from Examples

Review the sample graphs in this Style Manual. Identify the captions, axis labels, and captions on each. Go to the library and find a few journals that interest you (*e.g.*, Ecology, Animal Behavior, Microbiology, *etc.*) and flip through them to observe examples of different formatting styles.

Our Expectations

We expect good writing and will accept nothing less. It is your responsibility to turn in your papers clearly written and on time. It is our responsibility to help you learn by pointing out problems, but we are not proofreaders. It is not our responsibility to try to figure out what you *meant* to say, but rather what you said. Your work must be grammatical (see the section below "How to Judge Writing" from our SMCM Writing Center).

General Suggestions

• Allow enough time to write and revise draft documents.

• Edit and proofread thoroughly. Using a spelling checker is simply not enough.

• The best way to become familiar with the style of scientific papers is to read them. Go to the library and find some journal articles that describe experimental results; use them as a guide in your own writing.

• Refer to a writing handbook if you have questions about grammar. There are many excellent writing guides. You may already have such a handbook, but if not you should consider buying one. We suggest buying the following (it is available in the Campus Store):

McMillan, V.E. 2001. Writing papers in the biological sciences, 3rd ed. Bedford/St. Martins, Boston, MA.

• Get help! Most students admitted to St. Mary's are familiar with most of the rules of grammar and can write well by being more aware and by working seriously. And you will often be working in teams, so you'll have built-in proofreaders—take advantage of this and swap papers for comments! None of your biology faculty members would think of submitting a paper to a journal or a grant proposal for review without first giving it to a colleague for comments. Giving those comments is a service we do for each other. It is part of our professional responsibility, and we take it very seriously. You should too. You can also go to the Writing Center for help.

Specific Suggestions

These are some specific suggestions we have compiled because they address problems we see commonly:

• Use words with precision, clarity, and economy. Every sentence should be as exact as possible. Write correct, straightforward English sentences. Think about what each sentence actually says, not what you think it says. Ask yourself if it is possible to misinterpret it.

• Follow a consistent pattern of tense. Record observations and experiments in the past tense; use the present tense for generalizations and references to stable conditions. Use the past tense for your unpublished results and for the published experimental results to which you refer.

• Avoid direct quotations except when the specific words used by the original author are particularly important, for example, "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material." (Watson J.D. and F.H.C. Crick. 1953. A Structure for Deoxyribose Nucleic Acid. Nature 171:737.). Do not use them just because you cannot easily think of how to say something in your own words.

• The word "data" is plural ("datum" is singular): "My data show…," NOT "My data shows." This a very common error! Other common singular/plural errors are spectrum/spectra and bacterium/bacteria.

• Use the passive voice sparingly; it requires extra words and may not convey the exact meaning. Compare "Fungi produce antibiotics" with "Antibiotics are produced by fungi." The passive here requires two more words and 25% more space. Worse, its idle words are not merely superfluous; they obscure the words that do the work. "It was found to have had" is simply, in the active voice, "It had." Economy of communication and reading time is the major concern. Economy of words also yields clarity. "I found" costs less than half as much as "it was discovered," and identifies the discoverer immediately. When "experiments were conducted," the reader cannot tell whether the author or his predecessors conducted them. If you use "I" or "we" ("we" for two or more writers, never as a substitute for "I"), you easily avoid the passive voice, at least in that one sentence. It may embarrass the writer, but it takes exactly one-tenth the space. Change every "It was discovered that" to "I found." Instead of "It was reported by Smith," just describe what Smith reported and put the name and date in parenthesis at the end (Smith, 1983). Be alert for "by" as the danger sign of the passive voice. You may even enjoy this word game, and the prize is increased professional competence.

• Refer to the subsection, "Editing Symbols and Abbreviations," included at the end of this appendix. It will refresh your mind about some common grammatical errors. Your instructor may use some of these editing marks on your lab reports, but remember that we are not editors. If your lab report contains more than a few such errors, we will return it to you for rewriting.

How to Judge Writing

The SMCM Writing Center prepared the following guidelines several years ago. They do not always apply directly to scientific writing, but they are excellent points to keep in mind. The views that underlie the approach described here are widely shared by writers and thoughtful teachers of writing. With minor changes, this particular formulation appeared in Reichstad and McAndrew's Training Tutors for Writing Conferences, NCTE, 1984. This schema is not only useful for judging the writing of others, but also for understanding how to approach one's own writing tasks.

1. Higher Order Concerns (HOCs)

These concerns are pervasive. They involve the essence and purpose of the piece, and as a rule they cannot be found at particular points on the page. Crucially, they must be improved by revision (*i.e.*, re-seeing), not editing. Fixing problems in grammar, usage, and so on will have no beneficial effect on HOCs. The HOCs are as follows; the questions that accompany them can help a writer determine the extent to which these concerns have been satisfied.

Focus: Is the piece about one main idea? Does it stay with this idea or wander off? Is the idea about the right size for the length of the piece, or is it too general to allow a detailed discussion? Is the focus relevant, useful to the intended readers?

Development: Does the piece present enough information so that the reader feels that the work is complete? Are there specific details that develop or support generalizations? Are uninformative summaries, mere assertions, and other vague subjectivity avoided?

Organization: Is there a plan for the piece? What is the reason for using this plan? Are ideas presented in an order that makes sense, considering the purpose of the paper? Are paragraphs about one main idea? Is the reader introduced to the topic at the beginning and led to an ending that creates a sense of completeness or conclusion? Are sections of the piece linked together by transitions?

Audience: For whom is this piece written? What sort of action or reaction does the writer expect from the audience? How much does the audience know, and what are/might they be interested in? What views or prejudices do they already hold, and has the writer reckoned with these? Do the other HOCs reflect what the writer knows about the audience and his/her purpose?

2. Lower Order Concerns (LOCs)

These are not called lower order because they are unimportant. In fact, getting these concerns wrong will often cause the writer as much trouble as neglecting HOCs. LOCs have their name for three reasons:

a. Writers must worry about them after they have gotten the HOCs into reasonable shape. Making significant editing changes before whole sections of the text are added, moved, or deleted during revision only wastes time, since the HOCs will have to be attended to anyway, and the writer will have to edit again for LOCs.

b. In general, LOCs have to do with the linguistic surface of a piece of writing, not with its content or purpose, which are much more complicated matters.

c. LOCs are fixed by editing, and by referring to rules, a much simpler business for writers than discovering what they are saying and how to say it. Writers should always deal with HOCs first. Examples of LOCs are as follows:

spelling	punctuation	subject-verb agreement
fragments	run-ons	comma splices
parallel structure	misplaced modifiers	dangling modifiers
pronoun agreement	pronoun reference	word choice
verb tense	sentence structure	manuscript form

Posters and Oral Presentations

Posters

At some point in your career at St. Mary's College, you may need to present your work in poster format. This is appropriate when you want to discuss your work with a few people at a time, over the course of a couple of hours. It is often less appropriate for courses because you will want to present your work to your whole class at once, and a large group can't see a poster clearly. We mention it here because many biology students present their work from upper-division classes in public, semester-end poster sessions, and many choose a poster as the format for their public presentation of their St. Mary's Projects. The poster format is extremely important for the dissemination of hot new scientific information. Journal articles are slow to produce and often avoid controversial results. Posters are, however, quick to produce and are presented to any interested persons at poster sessions associated with scientific meetings, symposia and conferences. They serve not as repositories of information, but to stimulate conversation between scientists with similar interests. The poster is far more flexible in its format than a formal research report. Most, however, follow the same basic format described above for reports. The most striking difference between a poster and a report is its length. The abstract, introduction, methods, and literature-cited sections are extremely brief. The results and conclusions dominate the poster. Remember that the objective is to stimulate conversation. The results are therefore prominently displayed in bold graphical formats such as diagrams, photographs, tables, and graphs. The conclusion needs to contain just enough information to tell the observer what you think the results mean.

Oral Presentations

You might also present your results to your class in a formal oral presentation, with visual aids. The following guidelines and suggestions may help you develop a professional presentation:

Mannerisms

- Do not wear a hat or chew gum. Speak in a loud, clear voice, at a moderate speed. Don't say "uhm," "well," or "like." (e.g., "The fish were ***like*** more languid when the water was ***like*** cool."). Avoid pauses in mid-sentence. Don't pace, sway, or use excessive hand gestures. Never begin a presentation by saying "OK..." or "So…".
- Do not read off of the screen (you may, of course, refer to the screen, but you should face your audience). Make eye contact with the audience (not just your instructor)!
- Keep your place with note cards or a single-page outline, but don't read it. Know your material! If giving a group presentation, divide the speaking evenly among group members.

Organization

- Proceed in a logical, step-by-step order following the basic manuscript format of introduction, methods, *etc*., Define any unfamiliar terms to the audience in your introduction.
- Make sure your introduction gives enough background information and sets the stage for your investigation. When you state your hypothesis, be sure you have the audience's attention—they'll be lost forever if they don't know what you're trying to show.
- Describe your procedures in general terms (*e.g.*, don't tell us how you did each individual dilution), but be specific where it matters (*e.g.*, never name a group "treatment 1," but rather "high-temperature treatment" or something else meaningful). Present your results graphically. Describe the graphs and tables. ("The X axis shown here is body weight in

Kg, and the Y axis is nutrient intake in cal/day. Note that the relationship appears to be nonlinear").

- Discuss your results. Say what you think they mean. If your results don't support your hypothesis, give an alternate hypothesis.
- State a conclusion. Just don't stop talking. Say, "In conclusion…."
- Include an "Acknowledgements" slide to thank appropriate people.
- Conclude by taking one step backward and saying "Thank you".

Visual Aids

- Most students use Microsoft PowerPoint to create slides as visual aids. Plan for approximately 1 slide per minute, but practice your presentation to assure your presentation duration is correct.
- Use as few words as possible in your slides without losing clarity (English in visual aids can be less formal than in a lab report).
- Avoid including any information in a slide that you do not specifically refer to in your talk. If including this extra information is unavoidable, steer your audience's attention to the relevant part of your slide.
- Try presenting your methods diagrammatically.
- Use a large, clear font. Put important words in bold. Use bullets or numbers.
- Make things eye-catching, but avoid clutter.
- Figures for a presentation slide look a little different than those for a written report. Axis labels and all text must be large enough to read. A title is better than a lengthy caption because you are there to explain the figure. Be sure your figures are simple; their meaning should be obvious.
- Never display large, dense tables -- two or three columns by two or three rows is plenty.
- The most common mistake in visual aids is trying to put too much information in a single slide.

Answering Questions

- The last step in an oral presentation is to interact with the audience by answering questions. (Hint: try to anticipate what questions you will be asked and how you will answer them.)
- Direct your answer to the person asking the question and keep your response short and to the point.
- If giving a group presentation, group members should take turns fielding questions.
- If you don't know the answer to a question, admit it, and then try an educated guess.

Editing Symbols and Abbreviations

(We do not always use these abbreviations, but you may find the list of common errors useful.)

P Punctuation error. Examples: Henry Ford said, that "History is bunk".

PRO REF Unclear pronoun reference. Example: Lincoln and Jefferson were talking one day, and he said....

PRO AGR Pronoun agreement error. Example: Every person is entitled to the iguana of their choice.

CAP Capitalization error. Examples: The president of the US said that he would visit every State this year.

SP Spelling. Examples: If yu kin reed this, yu are verry persistant.

CS Comma splice. Example: We ate sandwiches after the movie, we thought they were delicious.

ROS Run-on sentence. Example: We ate sandwiches after the movie we thought they were delicious.

FRAG Sentence Fragment. Example: I thought that he would give in. After seeing the annual report.

MS Improper manuscript form. Example: Problems with margins, spacing, typefaces, page numbering, etc.

AGR Subject-verb agreement. Example: A box of oranges were found under the stairs.

¶ Make new paragraph

N¶ Do not make new paragraph

RED Redundancy. Example: Walter moved to an uninhabited island where no one lived.

REP Repetition. Example: Realistically, one can never count realistically on the stock market .

WW Wrong word choice. Example: William decided that he would devour his dinner in the living room.

WDY Wordiness. Example: Sometimes I occasionally wonder whether I would like to begin to consider the possibility that I can write more concisely.

? Confusing thought or wording. Example: The supporters of the U.S. English movement have not only concentrated on trying to pass the Official English movement to the Constitution.

SS Defective sentence structure. Example: Tarantino is the one Stallone wondered whether went to the Cannes Festival.

VT Inconsistent or incorrect verb tense. Example: In the year 1492, Columbus discovers America and reported his findings to the King.

DM Dangling modifier. Example: Exhausted by the long hours in the hot sun, the beach ball was forgotten.

MM Misplaced modifier. Example: Exhausted by the long hours in the hot sun, the beach ball was forgotten by the revelers.

COLL Colloquial expression. Example: In 1066, William the Conqueror got it in his head that he was going to take over England.

|| Faulty parallel structure. Example: In 1066, William the Conqueror ruled his native Normandy, invaded England, and Norman nobles were put in charge of everything.