Laboratory Data Books

The following information about laboratory data books has been taken from:

> [BSCS] Biological Sciences Curriculum Study. 1963. Student's Manual of Laboratory and Field Investigations: BSCS Green Version High School Biology. Chicago, Illinois. Rand McNally & Co. xii-xiii p.

RECORD-KEEPING

Science deals with verifiable observations. No one can check an observation that is hazy, indefinite, or half-remembered. All scientists must, therefore, keep clear and accurate records of what they have observed, made at the time of observation.

The best method of keeping the primary record-the record of your own observations made at the time of observation-is to jot them down in a data book. This should be a stiff-cover book (not loose-leaf), preferable with unlined pages. It should be kept in diary form, the date being the first item recorded. If observations on two or more exercises are made on the same day, the exercise numbers or abbreviations of the titles can be used as subheadings.

Data to be recorded are usually in one of three forms. First, they may be observations recorded in words. In the laboratory, time will be short, so you should make these notes brief but to the point. It is not necessary to write complete sentences; but single words are seldom satisfactory, either. Phrases are usually most useful.

Second, observations may be recorded in the form of sketches. A drawing often records an observation more easily, completely, and accurately than words. Remember that sketches of this kind are not intended to be works of art. Their success depends upon your ability to observe, not upon your artistic talent. They should be simple, usually without shading, and drawn with a hard pencil.

Third, data may frequently be recorded numerically, as measurements. It is important to give the units in which measurements are made. Often, numerical data are most easily recorded in the form of a table. Your lab directions will suggest forms for recording such data; these should be drawn in your data book before the laboratory period begins.

The data book is your record. Your teacher may wish to look at it occasionally to help you with your work or to check on the source of information you have included in written reports, but it is not to be handed in for grading.

Under no circumstances should data be jotted down on other papers to be copied into the data book later. This practice might increase neatness, but it will decrease accuracy. Both may be virtues in a scientist, but neatness is of value only when it increases accuracy. Your teacher is interested in the accuracy of your data, not in the blots and stains that are a normal hazard of the laboratory.

Remember to:

1) Record accurately.
2) Record completely.
3) Record immediately.

More and more, science is becoming a cooperative enterprise- a team activity. Much of your own laboratory work will be done as a member of a team. Therefore your data book will sometimes contain data contributed by other members of your team. It is important that you know what you have observed yourself and what other members of your team have observed. You can do this if you encircle (or record in a different color) the observations made by others. You should be able to say; "This I know because I saw it; that I believe because I have confidence in my teammates."

The data book should not be used to record information from reading, from class discussion, or from observations of other team or other classes. Such information may be useful, but it is not apart of your laboratory data.

Reports of Laboratory Work

Communication is a most important part of science. Discoveries become a part of science only when they are made known to others- when they are published. In publishing scientific work, the writer must state the results in such a way that another person can repeat the procedures exactly. The reader must know what material was used and be able to comprehend every detail of the work. Scientists must be free to communicate, and they must know how to communicate. Scientific reports are usually written in a rather standard form (see website below.)

Use material from your data book as the basis for your reports. In a report, however, you are not writing for yourself; you are trying to communicate ideas to other. Therefore you need to be especially careful of your style-neatness, spelling, sentence structure, and clearness of expression. Often you will need to construct graphs to make your data easier to understand. In short, the task of writing a report is very different from recording data in the laboratory. But both are a part of the work of the scientist.

Formal Scientific Writing

Types of Formal Reports

Primary research: original observational or experimental research you conduct for the first time. You design and conduct the experiment from scratch. You need to be very detailed in the methods section to include a materials list. Write this section so anyone can duplicate your process.

Laboratory research: is using the methods someone else created. You are duplicating the process and drawing your own conclusions. Quite often you are just citing the source for the methods section, but note any changes made to the procedure or experimental design.

Secondary research: is a formal literature review. This is a library research paper that contains a thesis statement of your main idea. No laboratory investigations are performed in secondary research, so there is no hypothesis or methods section. All facts and conclusions from original sources must be cited.

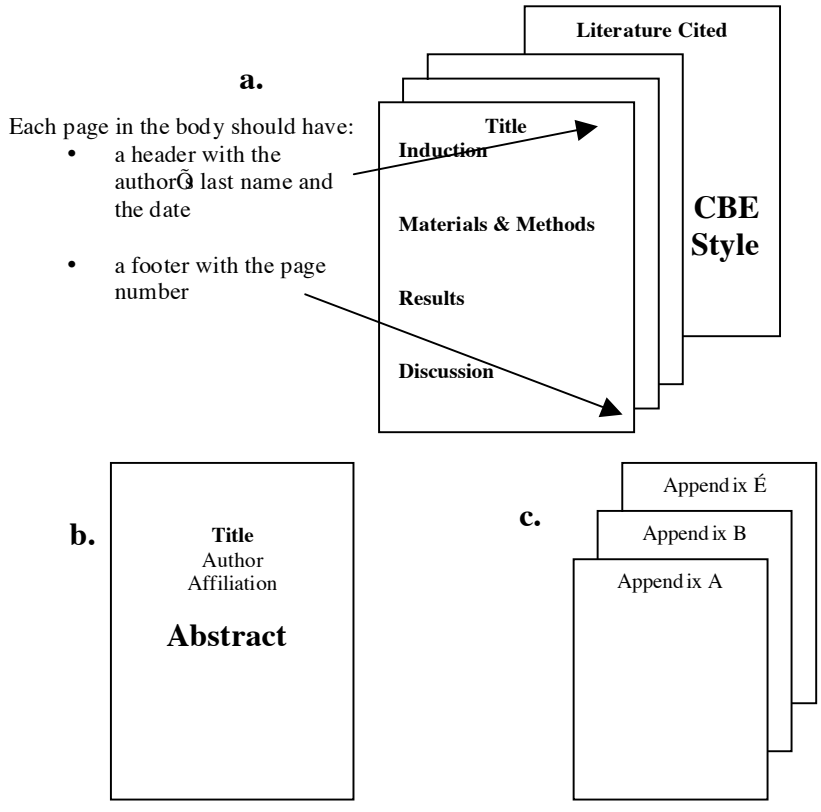
Tips for Formal Writing

- Typed & double spaced, 12-point font, Times New Roman
- Nomenclature: Common names should be followed by the scientific name.
  - This clarifies/references the type of organism or chemical used. After being referenced the use of the common name is appropriate.
  - Biology uses rules of binomial nomenclature.
  - Chemistry uses chemical nomenclature rules approved by the International Union of Pure and Applied Chemistry [IUPAC]
- Do not use contractions ever ("can't" "won't" "didn't" etc…)!
- Do not use pronouns to refer to your antecedents ("it," "thing," "that," "he," "she," etc…).
- Write in the third person (Never use "I," "my," & "me," etc…). ~ NOTE: Do not refer to yourself in the third person.
- Format for dates: Day Month (spelled out) Year: *ex.* 30 August 2006
- Watch out for words that are commonly misused: affect/effect, prey/pray, accept/except, etc.

Paper Layout

- The title, author, & then affiliation should be centered on top of the first page.
- Every section has a heading: Introduction, Methods, Results, Discussion, & Literature Cited.
  - All Headings are bold & left justified
- Header includes: Last Name over the date
- Footer includes: Page number
- For general page lay out see **Figure1.a** below.

Figure 1: The parts of scientific report are: a) body of report, b) cover page layout (*if required*), and c) appendices (*if needed*).



Paper Sections

1. Title – factual not "catchy" (center & bold)
    1. May include:
        i. Scientific Name or Chemical or Natural Phenomenon
        ii. The independent variable and the dependent variable
    b. Author's full name (centered)
    c. Affiliation (centered) *ex.* Eudora High School
2. Introduction (left-justified)
    1. State the objectives
        i. Copy from lab procedures
    2. Background research
        i. Discuss current scientific knowledge
        ii. Define relevant vocabulary
    3. State the Hypothesis (or thesis for secondary research)
3. Methods (left-justified) – NOT INCLUDED IN SECONDARY RESEARCH
    1. Cite source using in-text citation
    2. Note substitution or exceptions
    3. Format is a numbered list of steps if research is original
4. Results (left-justified)
    1. Written Summary – without discussing the implications
        i. Explain and demonstrate calculations used
    2. Data table using standard format (centered)
        i. Referenced as **Table** # in-text
        ii. Titled
        iii. Titled columns
        iv. All rows have headings
        v. Units are specified in either the column or the row
    3. Graph using standard format (centered)
        i. Referenced as **Figure** # in-text
        ii. Titled
        iii. Labels on both axes: including units of measure
        iv. Axes are scaled properly
        v. Key provided for different series of data
5. Discussion (left-justified)
    1. Analysis of hypothesis
        i. Reference the objectives to refocus the reader
        ii. Discuss implications of the data to current scientific knowledge
    2. Sources of error
        i. Reference current scientific knowledge
6. Literature Cited - CSE style.
    1. General guidelines:
        i. Alphabetical order based on author's last name
        ii. Single-spaced
        iii. Left-justified with all following lines indented

CSE Citation Guidelines

[CSE] Council of Scientific Editors. Style Citation Guidelines
*Formally CBE – this is not the same as APA or MLA style.

CSE style is often referred to as the "NAME, YEAR" system because the name(s) of the author(s) and the year of publication are displayed so prominently in the citation. Since scientific research constantly changes as new information is discovered the date of publication is critical to understand the usefulness of the information.

Book

Miller, KR, Levine, J. 2004. Biology. Upper Saddle River, New Jersey. Pearson Prentice Hall. 15-20p.

(Miller and Levine 2004)

Web site

[MVM] Merck Veterinary Manual 2007. *Dermatobia hominis*. <http://www.merckvetmanual.com/mvm/htm/bc/71403.htm>. Accessed 2007 April 17.

([MVM] 2007)

Journal

Siraj DS, Luczkovich J. 2005. Nodular Skin Lesion in a Returning Traveler. Journal of Travel Medicine. Vol 12(4). 229-231p.

(Siraj and Luczkovich 2005)

News Paper

Couch MP. 2000 Aug 8. Razing of contaminated building OK'd - Freight House tenants pleased by EPA action. Kansas City Star; Sect D:4.

(Couch 2000)

Personal Interview

Sample D. 2007. Personal interview. Eudora KS. 2007 November 13.

(Sample 2007)

Lecture

Magette E. 2007. How knowledge of the skeletal system can increase your trick-or-treating success. Human anatomy and physiology class, Eudora High School. Eudora KS. 2007 October 25.

(Magette 2007)

Cases of Multiple Authors ~

If there are more than three authors use "et. al." following the first author's name.

Biggs A. et. al. 2002. Biology: The Dynamics of Life. New York, New York. Glencoe/McGraw-Hill. 6-10p.

(Biggs et. al. 2002)

Cases Without Authors

In cases without authors, reference the following example (Remember that the validity of the source may be in question if no author is given):

[Anonymous] 2000. Close is not enough: SNARE-dependent membrane fusion requires an active mechanism that transduces force to membrane anchors. Journal of Cell Biology 150(1):105-17p.

([Anonymous] 2000)

Cases with Multiple Publication Dates

In cases where multiple publication dates are given, reference only the most current date.

Cases where the author is an organization

Include the organization's abbreviation in brackets, followed by the organization's full name in place of the author. Then cite it as you would any other print or electronic source.

[AP] Associated Press
[BSCS] Biological Sciences Curriculum Study
[EHS] Eudora High School
[EPA] Environmental Protection Agency
[NSF] National Science Foundation

([EPA] 2007)

Abstracts

The abstract is a 100 to 200 word summary of the full formal report. Abstracts are often used to present a preview of research findings. Abstracts allow readers to judge whether or not they need to read the full report. Abstracts are always written last; if you write an abstract first, you run the risk of not summarizing your paper.

Abstracts Include:

1. State the objectives
2. State the hypothesis (or thesis for secondary research)
3. Summary of type of study
4. Summary of data
5. Analysis of hypothesis

*If the abstract is on a cover page it should be left justified and single-spaced. All other formal rules apply. An instructor may require a double-spaced abstract as a stand-alone report, ***but*** be prepared to turn in the full version of the report if requested.

Cover Pages: See **Figure 1.b**.

If a cover page is required you must include the following:

a. Title - centered
b. Author's full name - centered
c. Affiliation - centered
d. Abstract - left justified & single-spaced
e. No headers or footers on the cover page

Appendices

Appendices are not always needed. Additional information that may help clarify ideas in the paper but does not fit well into the format of the paper may be included in an appendix. For example: pictures taken by the researcher, raw data tables and graphs, detailed diagrams of equipment or experimental design

Appendix Format Guidelines:

- Each appendix has its own cover page with a centered descriptive title
- If only one appendix is used no letter is used to differentiate
  - Appendix: Description of Reagents used in Gram Staining Technique
- If multiple appendices are used each appendix will be differentiated by letter
  - Appendix A: Raw Data
  - Appendix B: Graph
- All content is Left-justified

Data Collection and Calculations

In accordance with all current scientific research, the use of The International System of Units (SI) will be required. Along with SI Units, the collection of data will be done using the correct number of significant digits in all measurements. When applicable the last unit of measurement should be estimated. Calculations done with measured data should also reflect the correct usage of significant digits.

Data Tables & Graphs

Guidelines for Using Data Tables and Graphs

- Each data table or graph should be numbered in consecutive order (i.e. "Figure 1", "Table 1", "Figure 2", etc.).
- The term "figure" refers to a graph or illustration. "Table" refers to a data table.
- Each data table or graph should have an appropriate, descriptive title.
- Graphs and data tables should include units of measure. Each axis of a graph should be appropriately labeled.
- Graphs that are hand-drawn should be drawn on graph paper with a ruler.

Always follow your instructor's specific directions as to what type of graph or data table to use and how to treat the data in your tables and graphs (i.e. averages, statistical tests, lines of best fit). *For example*:

- Bar graphs are best used when comparing the averages of groups, or when one variable is qualitative (i.e. comparing average values for two or more experimental groups).
- Line graphs are best used when the independent variable (x-axis) is a continuous numerical scale (i.e. change over time).

When there is a large amount of data, only averages should be given in tables and graphs contained in the body of a formal report. Complete data tables and statistical analyses can be included in the appendices, if necessary.

Remember: The purpose of a data table or graph is to present data trends in an organized, easily understandable fashion. With this in mind:

- Tables and graphs should be able to stand-alone. Someone looking at them should know what they are saying without having to read the entire report.
- Fancy fonts, patterns, color schemes, or formatting should only be used if it does not interfere with the simplicity of the table or graph. The focus is on efficiently presenting data to the reader, not on making a pretty graph.