

BIOLOGY
RED LION AREA SENIOR HIGH SCHOOL



LAB REPORT FORMAT
RLASD BIOLOGY COURSES

Laboratory and field-oriented courses in the Department of Biology at Red Lion often entail exercises and experiments that require formal lab reports. Our department has developed a standard lab report format that you will use throughout the curriculum. It is based on the IMRAD format used in virtually all primary research articles in the biological literature. The acronym IMRAD refers to the following sections: Introduction, Methods, Results And Discussion. The complete order of sections should be title page, Abstract, Introduction, Methods, Results, Discussion, Literature Cited, tables, figure legends, and figures. Ask your instructors at the beginning of the semester if they deviate from the guidelines in this document.

Each section of the lab report plays an important and unique role. The following provides guidelines about the information in each section.

TITLE PAGE: Name of experiment or exercise, your name, name of lab partners, name of class, date experiment done, date report submitted. (Separate sheet of paper)

ABSTRACT: This is a single, tightly written paragraph that briefly summarizes the major elements of the lab report. A minimum of one sentence each should be devoted to your objectives, methods, results, and conclusion. Your job will be easier if you write the abstract after the rest of the report is complete. (Separate sheet of paper)

INTRODUCTION: This section supplies background information and may also provide a theoretical basis and historical context for the work done in the lab. To do this, it may be necessary to cite information that has been published in research articles or books. A good Introduction indicates why the work was undertaken and why it is interesting. Toward the end of this section you should explicitly state your hypotheses or objectives.

METHODS (also called MATERIALS AND METHODS): In this section you will describe the procedures that enabled you to collect your data. A simple listing of "materials" is inappropriate. Ideally, you should include the details that would permit someone to repeat your work based on their reading of this section. For most labs, the methods will come from a lab manual handout. The degree to which your manual/handout may be used for citing methodology is up to your instructor. Avoid insignificant details such as the name of the company that made your pipette or the day of the week on which your lab occurred. The predominant verb tense in this section is past tense. The METHODS section is often the most straightforward to write and is therefore a good place to begin your report.

RESULTS: This is the core of the report in which you present your findings, usually in the form of numerical data. Sometimes raw data may be presented, but it is more common and useful to provide data that have been condensed to some degree. If you are presenting calculated means don't forget to include some measure of data variability (e.g. standard deviations). Tables may be needed to organize large groups of numbers. Figures (graphs) can be particularly useful to display trends in data. It is not enough, however, to simply refer readers to tables and figures. Results must be verbally expressed in the Results section. All of your data are not equally important. Draw the reader's attention to particularly noteworthy data or the presence of meaningful trends. If possible, support this with statistical analyses, keeping in mind that statistical significance may conflict with your sense of biological significance. The text of the Results section should summarize the data, but stop short of interpreting their meaning or drawing major conclusions about their importance. Certain biology courses may require a differently structured Results section - see your instructor about appropriate modifications.

DISCUSSION: Interpret your data and evaluate the meaning of your results. Was your hypothesis, as stated in the Introduction, supported by the data? Don't be afraid to report "negative" data (e.g., lack of relationships among variables). In some cases, negative outcomes are more interesting and important than positive and predictable findings. If your data seem anomalous or unreasonable, provide reasons that might help explain this. If possible, connect your findings with the results from published studies by using literature citations. Do your results contradict, reaffirm, or extend previously published findings? How do your results fit into the big picture? Resist the temptation to discuss every aspect of your data and do not provide every conceivable explanation for the obtained results. Speculation should be limited and clearly identified as your own speculation. The last paragraph of this section should be a strong statement of the take-home message.

LITERATURE CITED: All citations that appear in the body of your lab report must be listed in this section. We will use the author-year format to arrange the citations. List the papers in alphabetical order based on the first author's last name. Unfortunately, there are many ways of formatting citations. As a matter of convenience and consistency, we will arbitrarily adopt the following formats:

Research Articles

Booth, D.A. 1995. Cognitive processes in odorant mixture assessment. *Chemical Senses* 20:639-643.

Drews, D., Vaughn, D.B. and Anfiteatro, A. 1992. Beer consumption as a function of music and the presence of others. *Journal of the Pennsylvania Academy of Science* 65:134-136.

Keeling, L.J. and Hernia, J.F. 1996. Social facilitation acts more on the appetitive than the consummatory phase of feeding behaviour in domestic fowl. *Animal Behaviour* 52:1 1-15.

Book

Schmidt-Nielsen, K. 1990. Animal Physiology: adaptation and environment. 4th ed. Cambridge University Press, New York, NY.

Edited Volume

Hocutt, C.H., Baily, R. and Stauffer, J.R. 1992. An environmental primer for less developed countries, with an emphasis on Africa. Pages 39-62 in Cairns, J., Jr., Niederlehner, B.R. and Oivos, D.R. (eds.). Predicting Ecosystem Risk. Princeton Scientific Publishing Co., Inc. Princeton, NJ.

World Wide Web Document

Basic information in the citation:

Author's name(s). Date of publication. Title of work. Available from: Protocol: address and path. Accessed date of visit.

Examples:

Collins, F. and Patrinos, A. 1996 August 16. NCHGR---DOE guidance on human subjects in large-scale DNA sequencing [monograph online]. Available from:
http://www.ornl.gov/TechResources/Human_Genome/archive/mchgrdoe.html. Accessed 1997 January 6.

Fishes of Iowa. Available from: <http://www.state.ia.us/fish/iafish/iafish.htm>. Accessed 1999 August 23.

Electronic Journal Article

Basic information in the citation:

Author's name(s). Date of publication. Title of work. Title of serial [serial online] Volume number: pages. Available from: protocol, address, and path.

Example:

Martin, E.P. 1996. Phylogenies, spatial autoregression, and the comparative method: a computer simulation test. *Evolution* [serial online] 50:1-14. Available from: Infotrac Expanded Academic Index.

Electronic Correspondence

Basic information in the citation:

Author's name(s). Date of message. Title or subject line [type of medium]. Available from: protocol, address, and path.

Examples:

Smith, J. 1997 February 13. Re: Scientific style [email to Keck, A.]. Available from: ajkOO 1 @alpha.momingside.edu

Doe, J. 1997 February 13. Citation formats [discussion online]. Available from: Bibliographic Instruction List B1-L via listserv@bingymb. cc.binghamton. edu

You are encouraged to cite appropriate literature in the Introduction, Methods, and Discussion sections of your lab report. Not surprisingly, there are some rules about how to do it correctly. Citations most commonly appear at the end of a sentence inside parentheses as illustrated in the following three examples:

Growth rates are positively correlated with rainfall (Jones 1993).

Growth rates are positively correlated with rainfall (Jones 1993, Roy and Smith 1988).

Growth rates are positively correlated with rainfall (Jones 1993, Roy and Smith 1988, Williams et al. 1937).

Note that "et al." was used for the last citation. This automatically informs you that Williams had two or more coauthors. All author's names should appear in the complete citation in the Literature Cited section of your report. The above format is preferred although some writers will explicitly insert the cited author's name(s) into a sentence:

Jones (1993) found that growth rates are positively correlated with rainfall.

A positive correlation between growth rates and rainfall was found by Jones (1993).

VISUAL AIDS: TABLES AND FIGURES

The Results section of a lab report often presents data in the form of tables and figures. Your first consideration is deciding if visual aids are truly necessary. If you choose to include them, follow these guidelines.

TABLES

- 1) A table heading is a summary of table contents. It is usually a SINGLE sentence fragment and may, for example, lack a verb.
- 2) Use superscripts and footnotes to provide additional information about the contents of the table.
- 3) Each table should be on its own piece of paper.

Example:

Table 1. Carapace widths (cm) of three spider species in counties of north Georgia.

County	<i>Araneus diadematus</i>			<i>Neoscona hentzii</i>			<i>Neoscona arabesca</i>		
	mean ^a	n ^b	SEM ^c	mean	n	SEM	mean	n	SEM
Clarke	2.3	19	0.5	2.7	22	0.9	2.1	18	0.3
Oconee	2.2	31	0.6	2.9	34	0.7	1.9	29	0.2
Fulton	2.5	29	0.7	3.0	38	0.9	1.9	40	0.1

^acm

^bsample size

^cstandard error of the mean

FIGURES

- 1) Each figure should be centered on its own separate piece of paper.
- 2) The letters and numbers on the X (horizontal) and Y (vertical) axes should be LARGE. Other letters and numbers should be slightly smaller.
- 4) Include a key inside complex figures to identify symbols, lines, or bars.

FIGURE LEGENDS

- 1) Every figure requires a separate figure legend.
- 2) Figure legends should provide just enough information to allow the reader to interpret the figure. Unlike table headings, figure legends may consist of several sentences. The first sentence is often a sentence fragment (a conceptual title).

Example:

Figure 1. Mean wet weight (g), dry weight, and ash weight of pellets from a great-horned owl and a red-tailed hawk. Error bars represent one standard error of the mean and asterisks indicate a significant difference between owl and hawk pellet weights from an unpaired t-test ($p < 0.01$). Means not significantly different are indicated by ns.

