

LABORATORY NOTEBOOKS IN THE NATURAL AND PHYSICAL SCIENCES

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This document represents one approach to maintaining a lab notebook. There are others. (A Google search on “lab notebook” generated more than 1.5 million entries!) What is critical is that you have an approach that will allow you to provide a record for yourself and others of the experiments you did and the results you obtained, and that you reach an agreement regarding that approach with the director of your lab. Indeed, we strongly suggest that once you think you have reached an agreement, follow it *for a few days* (only) and then ask your lab director to go over your notebook and provide feedback. This is *critical*. Learning after the fact that you are not doing an acceptable job of maintaining your lab notebook can lead to disaster!

1. Purpose and Disposition of Lab Notebooks

Your *individual lab notebooks*, when taken together with any lab *group notebooks*, should provide a complete and permanent record of all aspects of all experiments. With the information contained within these notebooks it should be possible at any time in the future to reconstruct exactly what was done in any given experiment. This, in turn, is a key to being able to (a) communicate the results, (b) replicate the results, (c) establish ownership of the intellectual property represented by the results, and (d) document the veracity of all reports. Thus, whereas the information will be of particular importance to you, your collaborators, and the director of the lab in which you work, it also will be of importance to others who wish in the future to explore an issue related in some way to experiments you perform.

It is common for someone to refer to a lab notebook as “my notebook” – common, but misleading. All lab notebooks ultimately belong to the agency that funded the research, the institution within which the research was done, the recipient of the grant, and/or the lab director. They should be available to other members of the lab and must remain with the lab if and when you leave for another position.

Despite the fact that lab notebooks do not belong to you, most institutions permit you to prepare a copy of your notebook for your own use and to take that copy with you when you leave. You should establish this at the outset of your work in the lab. Assuming that this is the case, you are encouraged to do so. Having a copy will not allow you to have access to your notes should this be of value to you in the preparation of any manuscripts still outstanding when you have left (hopefully a rare occurrence!), and may also prove useful in your future research. In addition, it will facilitate your ability to answer questions about your work should any arise.

To prepare such a copy of your work you should regularly make photocopies of any pages of interest. (An alternative is to use a type of lab notebook that has carbon paper and second, perforated sheets, though that is somewhat cumbersome. Moreover, it does not allow you to deal with material that must be pasted into the notebook, such as print out from a machine.)

2. Style of Notebook

The precise type of notebook you use is a matter of choice – yours or that of the director. But the basic lab notebook should have three characteristics: (1) it should be bound and reasonably sturdy, (2) the paper should be of high quality (durable and long-lasting), and (3) pages should be numbered. There are a wide range of notebooks that meet these criteria.

3. Individual Lab Notebooks

In general, each member of a lab should maintain at least one *individual lab notebook* at all times. In this notebook they should record most of the information of relevance to their research, making use of other specialized *group notebooks* as appropriate (see below). Lab members may wish to maintain separate lab notebooks for different types of experiments or to combine all their research in a single notebook, using an index to help locate different experiments. Here are some general guidelines:

1. Lab notebooks are not designed to be works of art but accurate *and legible* records of *all* you did (and *most* of what you thought while doing it!). Thus, use it as a moment-to-moment log rather than a report written after the fact. ***Never write bits of information on scraps of paper for later inclusion into your notebook!*** This leads to errors and to missing information. It may even raise questions regarding the accuracy of your records.
2. Notebooks should be numbered and have a clear indication on the cover and binding of your name and the inclusive dates (start and end of entries). For example: #2009-3, Abigail Adams, June15 – August 15, 2009.
3. Provide your current contact information as well as the name of the lab director and their contact information. This can be placed on the outside and/or inside cover of the notebook.
4. One or two pages should be set aside at the beginning of each lab notebook to permit the creation of a table of contents. If different types of experiments are contained in the same notebook, an index grouping experiments by type also is useful. A glossary of special abbreviations that you use may also be useful to others who make use of the notebook in your absence.
5. ***Notebooks must remain on site at all times***, either in the lab or in your office or cubical, and they should be stored in a safe location (preferably fireproof or at least away from chemicals) when not in use. ***They should never be taken home for any purpose***. If information is needed off site (e.g., for performing calculation or preparing reports), then copies must be used.

6. ***All writing must be easily legible***, to both yourself and others and be in permanent blue or black ink. (Never use pencil or ink colors other than **black** or a reasonably dark blue and always test for water resistance).
7. If corrections must be made, the incorrect information should be crossed out with a single, indelible line (~~such as this~~), permitting the original entry to be read but making it clear that you wish to delete it. ***Never ever erase or “white-out” data.***
8. All information should be entered in chronological order. There should be no blank spaces except in so far as this is necessary to permit you to start a new experiment on a fresh page. In this case, a line should be drawn through the blank space. Even if you are working simultaneously on two experiments and entering them into the same notebook, it is best to enter information chronologically. ***No pages should ever be removed from a lab notebook!***

In entering information into your lab notebook, keep in mind that it may prove to be an important record for you or another person many years from now. Also remember that short-term memory is just that, *short-term*. (Just ask yourself how many of the details of what you did last year you can still remember!)

4. Entries for Individual Experiments

For each experiment, you are advised to include the following even if it seems unnecessary at the time:

1. ***A unique numerical designation and a descriptive title.*** This will permit you and others to find the right book and page for this experiment.
2. ***Date of entry.*** Each entry for a given experiment should be dated. If an experiment lasts several days, a new date should be added. If additional experiments are done in the interim, and you are keeping all experiments in a single notebook, pages should not be skipped but an indication of where a given experiment is continued should be provided at the end of a day's entry (e.g., “continued on page 23”).
3. ***Purpose.*** A few sentences summarizing what you hope to accomplish with this experiment written *before* you do the work. (Seems unnecessary? Just wait until you go back to your notebook next year and wonder why on earth you ever did a given experiment!)
4. ***Methods.*** Rule of thumb: ***include all details needed to allow you, a lab member, or anyone else to replicate your procedure precisely.*** This is just as critical as is the entry of the data themselves! Critical information might include which of several reagent bottles, constructs, or antibodies (company, catalogue number, and lot number; bottle number), solutions (date made, person making it), and pieces of equipment. The latter is especially important if there is more than one option – e.g., as in the case of micropipettes, stereotaxic instruments, and the like). This may require numbering duplicate pieces of

equipment (e.g., HPLC-1, 2, 3... or micropipette 1, 2, 3...). In some cases you may wish to include sketches of your set up.

If you were assisted in any way by others, their names and contributions should be entered.

Note: In some instances you will be able to indicate that additional details can be found in previous experimental write-ups. In such a case it is not necessary to repeat the details. However, be specific about where that information can be found, and be sure that the information is still accurate. ***Be aware of the fact that methods “drift,” and thus that the procedure used last year may not be quite the same as that being used now.***

5. **Results.** Same rule of thumb should be used for entering your results as for your methods: *all* data, *all* calculations, and *all* incidental observations go directly into your lab notebook. “Data” refers to *primary* data as well as any subsequent transformations or analyses. (Transformations alone are insufficient. They obscure the raw data and may also introduce errors.) Since these are results that you observed (past tense), any words used to describe them are usually provided in the past tense. (“The animal *failed* to press the lever.”)

All data should be entered even if you feel that some data should not be included in your subsequent statistical analysis. If the latter proves to be the case, you should have a clear reason for excluding the data from your analysis, one that is stated explicitly and would be generally accepted, such as being >2 standard deviations from the mean or resulting from an obvious technical error.

There are several special cases in which it is not practical to place the actual raw data in your bound notebook (see "Special Cases" below). However, even in those circumstances it is essential to provide an indication of where the data can be found and to enter the transformed data (either by hand or by permanently attaching a computer print-out)

6. **Conclusions.** A short paragraph indicating your *conclusions* and, where appropriate, a discussion of possible *future experiments* can be very helpful months or years from now when you or someone else is trying to reconstruct your thoughts. (Again this may seem unnecessary. It isn't. A year from now you will have neither the time nor the inclination to go through your entire write up to figure out what the bottom line was.)
7. **Signatures:** If you think that there is any reason that an observation or thought you have had might result in a patent application, make sure that all relevant pages are signed and dated by a witness who indicates in the notebook that they have read and understood your entry.

5. Special Cases:

It is no longer practical to place some types of data into your notebook, either directly or by being pasted it. This might include data from HPLC, spectrophotometers, scintillation counters, microscopes, electrophysiology rigs, gels, slides, and so forth. Thus, it is acceptable to store certain forms of data in a loose leaf notebook and/or a disk with a clear indication of your name and the date. Histology slides should be stored in slide boxes coded. Be sure to that all information needed to retrieve these data is indicated in your bound notebook. When in doubt, consult people who are experienced at collecting and storing such data to determine common practice – ***then evaluate that practice yourself to be sure that it is adequate.***

When another person or lab is involved in a ***collaborative experiment*** it may be necessary to work out a compromise that suits all participants. This can be doubly complex when the collaboration involves different geographical locations. The compromise should be devised on a case by case basis. However, the basic standards described above still apply – data collected by any given person for a given experiment should be collected into a single notebook that remains in their lab and meets specifications. To this might be added that each collaborator should be provided with a copy of each set of data that they maintain, together with copies of their own data, in a single folder or loose leaf notebook.

7. Other Types of Lab Notebooks

There are several common lab notebooks. When entering information in any of these notebooks remember to indicate your name and the date.

a. *Equipment Notebooks*: Each major piece of equipment should have its own notebook. This is the place to indicate information of general interest such as (a) standard curves (along with chromatograms), (b) inspections, changes, and repairs, and (c) problems in equipment functioning.

b. *Solution Notebook*: Each time you make a solution that will be used by anyone other than yourself (e.g., a buffer or a stock solution of acid or base), *all* the information needed to make that solution must be available in the lab's *Solution Notebook*. This includes all the information needed to find the particular reagent bottle you used, the amounts you measured out, and the calculations you did to determine those amounts. If you are making a solution that has already been entered into the *Solution Notebook* you can refer back to the page on which the information exists. However, be sure to record any deviations from the previous information (e.g., a different bottle of a reagent).

c. *Methods Notebook*: The *Methods Notebook* should contain all methods that have been used the lab and all subsequent modifications. It is important to retain all of these notebooks while also continually updating the notebook by adding new versions. In this way it is possible to determine how a given procedure was carried out at any time in the past and at the present time.

The *Methods Notebook* should contain a complete description of **all** methods used in the lab, including surgical procedures, the construction of probes and electrodes, and the preparation of reagents. These descriptions should be prepared with sufficient care to permit someone in another lab to reproduce out method without any additional information. Thus, all the little tricks should be including - heating, stirring, adding in a particular order, using a particular brand, and so forth. Specific things to avoid can also be helpful, as can danger signs (color change, precipitate, etc.)

d. *Drug/Solution Notebook*: This Notebook should contain all the vital information needed to use any specialized compound, including (a) source, (b) structure, (c) molecular weight, (d) solubility, and (e) people within the group with experience in its usage.

SELECTED BIBLIOGRAPHY

Here is a short list of valuable sources. Most deal with a range of issues in addition to those directly connected to lab notebooks.

Barker, K. *At the Helm* (2002)

Bebeau MJ & members of the Poynter Center. *Moral Reasoning in Scientific Research* (1995)

Meisenholder, G. The paperless lab, Database systems for the life sciences, *The Scientist*, **13**: 19, 1999.

Boorstin, DJ. *The Discoverers* (1983)

Gawrylewski, A. Fixing fraud, *The Scientist*, **23**: 67, 2009 (online at: <http://www.the-scientist.com/article/display/55476/>)

Kanare, HM. *Writing the Laboratory Notebook* (1985)

Macrina, FL. *Scientific Integrity*, 3rd edition (2005)

See also entries generated by a computer based search on “lab notebook” and even “lab notebook misconduct” – there are a great many!

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