The Laboratory Notebook

Few documents in science are more important than the laboratory notebook. The notebook is for the immediate recording of what a researcher does in the laboratory.

Normally, the ultimate objective of a research project is the publication of a paper or patent that describes the work to the rest of the scientific community. Notebooks are important because they are the primary source of information used when writing a manuscript for publication or for a patent. The notebook is the key document in this process for a number of reasons.

i) *Memories fade*. While some projects can be taken from inception to publication in a few months, longer than a year is far more common. Trying to remember all of the details of an experiment done last summer is always a problem. Even waiting until the following day can cause mistakes and omissions.

ii) *Memories become confused*. Few experiments are done only once and published. Experiments are almost always done multiple times and are modified to maximize the desired result (e.g. yield, signal-to-noise ration, etc.). Months later, people will forget the exact experimental parameters of the runs that worked best.

iii) *Experimenters depart*. Students either graduate or complete their research course. Particularly if a student has left campus, the notebook may be the only way to recreate an experiment.

iv) *It is required*. Although uncommon, journals and courts of law (for patents) sometimes request documentation made at the time of the work to demonstrate its validity. Records made at the time the work was done are considered more likely to be accurate than those made at a later date or simply pulled from memory. Failure to have a notebook that is consistent with reported results generally results in the work being considered invalid.

As a result, most faculty are particular about having their students keep a high quality notebook. Before you start your research lab work, you should discuss how your research advisor wants your notebook constructed. Many faculty are quite particular about how your notebook will be organized and written. Still, there are general rules that apply to most labs, many of which you have seen before. A few of them follow below.

1. Write in the past tense. There is no need to use the personal pronoun "I." It is presumed the person writing the notebook is the person who did the experiment. If someone is assisting you in a significant way, the person should be identified. Thus, if you have to leave the lab early and ask someone turn a switch on or off, there is no need to name (or mention) him/her, but if you are doing an experiment with someone else she/he should be named.

2. Describe what you actually did, not what you should have done or intended to do. While one should always have a plan for an experiment, the notebook isn't the place to record that. Many times when doing an experiment, the experimenter will make small, seemingly trivial changes that alter the course of a procedure. An inaccurate record makes discovering the problem much more difficult.

3. When writing be concise, but don't sacrifice detail for brevity. Also, try to write neatly because your notebook is as much for your advisor as it is for you.

4. Be precise in your descriptions. Give observations along the way, particularly if you see something change. Did you add the reagent quickly or drip it in? Did a color change? Was it permanent and at what point did you observe it? (e.g. as you drip base solution into an acid with phenolphthalein, your initial drops of base result in flashes of deep pink, which last longer and ultimately persist when you reach the endpoint).

5. Record time intervals. e.g. How long did the test tube sit in the boiling water? Did you take the measurement on a freshly made sample or one that is hours or days old?

6. Earlier it was said the notebook is for "immediate recording" of an experiment. What this means is that notebooks should be filled out as you do an experiment, within reason. In general, you should fill out your notebook during time gaps while doing the experiment. If you are making measurements, you might set up a table in the notebook and record readings as you go. On the other hand, if you are setting up a reaction, you might wait until you've started the reaction before describing the apparatus since it will be sitting in front of you. You can record weights and volumes on the facing page. What you **should not** do is wait for hours to record what you've done. Unless told otherwise, you **should not** take your notebook home with you. It should stay in the lab where your advisor can find it.

7. Using abbreviations is permissible for common words (e.g. g for grams). In addition, less common abbreviations are acceptable if you put a glossary of terms in the front or back of your notebook. They should be kept to a minimum and used only for frequently used, long words.

8. All experiments should have descriptive titles, but they don't have to be unique. Thus, if you are making a compound the title might be "Preparation of Compound X." If you make it 5 times, you can reuse the title as often as needed.

9. An index is a good idea, and better than a table of contents. After a while, you can make a list of all of the experiments you have done and then create an index at the back of your notebook. Later, when it comes time to write your senior thesis (or your advisor writes a manuscript), finding relevant experiments becomes much easier. Without an index, one has to frequently flip through a notebook and it's very possible that some work will be missed. A table of contents is helpful, but less useful because similar experiments are not grouped together and it is still possible to skip over something useful.

10. It is usually best to write your experimental descriptions on the right hand page of the open notebook. Use the left side for calculations or descriptions that exceed one page.

11. When you collect spectra, write the page number of the notebook page on the spectrum. Title the spectrum and write that in the notebook. Some faculty want spectra taped in the notebooks, others want them separate. Particularly in the latter case, recording page numbers

and titles is critical. Also, record the spectral data in your notebook, just in case the spectrum is lost.

12. **To summarize: always include all of your data in your notebook**.