Lab Notebook:

You should consider your lab notebook your long term memory. If you read your lab notebook five years from now you should be able to repeat the experiment exactly the way that you did it five years ago.

Each experiment that you include in your notebook should include several parts and should contain complete information on how you conducted the experiment. Don't just include the highlights.

The exact format of the notebook, what information should be recorded, in what order, etc. is up to you and your advisor. The following are general comments that you should keep in mind absent direct guidance to the contrary by your advisor (the nature of notebooks varies from field to field and your advisor is in the best position to let you know the practices in your field).

1. Introduction:

Write a short summary of the objectives for the experiment that you are about to carry out. Write down some of the theories/ideas behind the experiment and if available cite relevant literature references. It is amazing how often you can look back at an experiment and wonder "Why did I do that?" Writing a short introduction will help to document your thought process and help you avoid this problem.

2. Methods and Materials:

Provide enough detail so that five years from now you could look back and still understand what you did (and why). In fact, there should be enough detail that anyone else could read your Materials and Methods section and should be able to repeat exactly what you did.

Make sure that you write down more than just the final result:

<u>Write down all of the relevant numbers:</u>

"x grams of Y were dissolved in z ml of Q to make a S molar solution"

Not: "A S molar solution of Y was prepared"

<u>Make sure that you include all the details:</u>

"The pH of the solution was adjusted to pH ? with HCl (or whatever acid or base was used)"

<u>Include details about the chemicals that you used:</u>

Specify the source of the chemical and lot numbers if available.

3. Results

Provide numbers for all measurements, not just the final result. Keep track of all raw data and show how the final result was derived. It is often a good idea to annotate your work so that you have a record of the reasoning that went into the calculations.

Make notes of any observations during the experiment that strike you as significant or unusual.

If possible, present results in tabular or graphic format.

Keep graphs, printouts, chromatographs, etc. in your notebook, or number the graphs in your notebook and put them in a separate binder.

4. Discussion:

Evaluate your results. If appropriate and possible include statistical analysis of your results.

Comment on the significance of your observations as they relate to your original objectives for the experiment and hypothesis. Also comment on their significance to existing published data.

Include a section that addresses possible improvements to your methods, or suggestions for possible different approaches that might be tried in the future.

Write down relevant literature references for the Objectives, Methods and Discussion sections. These might be kept in a separate literature section (see below).

Every four weeks or so summarize your results and progress (or lack of progress). This exercise of going back and evaluating your work on a regular basis can help you stay on course and make sure that your experiments follow a coherent pattern.

Some students might have 3 or 4 experiments underway simultaneously. Others might do just one experiment over the course of the semester. It all depends on the nature of your project. Work with your advisor.

Other:

- All pages should be numbered consecutively.
- Never tear out a page.
- The lab notebook should be written in ink.
- Get a good quality waterproof pen.
- Each entry you make should be marked with the date and time the entry is made.
- If you make a mistake rather than go back and remove (erase) the incorrect entries make a new entry that fixes the mistake. Mark the incorrect section in a way that leaves it readable. If there is space to make the correction neatly and completely it may be done on the same page; the correction and the date it was made should be clear (as well as the original mistake). If there is not enough space to make a correction on the page then direct the reader to the correction (see correction page 9). The correction might read something like: “The entry on page 5 is incorrect. I used the wrong abbreviation for the amount of liquid, it was ml not µl. The correct values are:…” Then go on to re-enter all the data correctly.

Log: There should be a separate log section that reads like a "diary" – It tells what you did every day that you work on a project. This may help you resolve discrepancies later, and will help demonstrate to your advisor and instructor that you have been working steadily. It should include all work on the project, including library and online research, ordering materials, cleaning the lab, animal care, etc. Just a brief entry is needed:

> October 8th, 2011: Fed mice, cleaned cages from 9-9:50 AM. One mouse was sick.
> October 9th, 2011. Performed western blot as described in experiment 2 from 4-7 PM. Experiment and results described on pages 9-14. Fed mice at 7PM, all mice now healthy.
> October 10th, 2011. Checked mice at 9:00 AM. Will have to clean cages tomorrow. Spent 2 hrs in library looking up references (see page 45).

More detailed notes (the nature of the mouse's illness, what references were found, etc.) would be written up in the section for the experiment.

Many students also find it useful to have a section where they record the results of their literature search. This would basically be an annotated bibliography consisting of a complete citation and a summary of what was found. Ideally you will have an electronic or paper copy of the paper, so you needn't write down all of the data and conclusions; just enough so you know where to look when you need to corroborate your results, look up details of a method, etc.

Electronic Notes: Your lab notebook could be kept completely electronically. You can write your notes in a word processing document as described above. If you record data separately – say in a spreadsheet – you should paste a copy of the data and the analysis into the word document in the appropriate place. Likewise, images should be imported and stored here as well (obviously you would also keep this data in the original spreadsheet and image files as well). Drawings and diagrams could be done in a computer program or scanned in.

Your advisor and instructor will want to see it periodically, so before meetings print the file(s) in PDF format and email them to your advisor and or instructor (many professors do not like to constantly swap thumb drives into their machines as this causes problems later for their own thumb drives and it may also introduce viruses – either email your work or have it available on the server). You should also save such files weekly (use a different file name each time) so that if there is any question as to the validity of your results you can present timestamped files that will demonstrate that you have not gone back and changed data.

Backup – you should have a second copy of your lab notebook and all relevant notes whether they be paper copy or electronic. The copies should be stored in a separate place from the originals. This usually means having one copy in your room and one in the lab (some advisors will insist that the original be kept in the lab at all

times). If you are really paranoid you can email or send copies home. Electronic copies can be kept on the server in the scratch drive as well as on your computer and a thumb drive (back up data periodically to a DVD). The scratch drive is particularly useful as documents stored here will be accessible when you meet with your advisor or give a presentation. Just remember that all documents on the scratch drive can be read by others (and altered or erased as well). You can password protect your documents which will give you limited protection, but the best protection is to have multiple copies.

The following web pages can give you some more hints and ideas. Again, the format of your lab notebook is up to you and your advisor, so after your first entry sit down and talk with your advisor and make sure your notebook is acceptable.

http://www.webguru.neu.edu/lab/laboratory-notebook - a site constructed with funding from the NSF to support undergraduate research. The lab notebook section has basic instructions and sample pages.

http://www.rod.beavon.clara.net/lab_book.htm - good reference, author has strong opinions on a few points!

http://www.sciencebuddies.org/science-fair-projects/printable_project_logbook.pdf?gclid=CJqJhJ7126oCFQEKKgod-zwQ_Q – designed for students doing science fairs, but has some good ideas.

Sample Lab Notebook – From Dr. McShaffrey's PhD research. Somes do's and don'ts from actual entries.
http://www.marietta.edu/~biol/capstone/lab_notebookl.pdf

Sample Field Notebook – These notebooks are from Dr. McShaffrey's field journals; more on recording general impressions than data.
http://www.marietta.edu/~biol/capstone/field_notebooks.pdf