Keeping a Laboratory Notebook

University of Glasgow

The following is general guidance on how to keep a paper-based laboratory (lab) notebook. Requirements in different disciplines (teaching, research, clinical labs) is likely to vary and many disciplines have their own community norms which must be observed. It is fine to adapt this guidance to fit your research. A well-kept lab notebook provides a reliable reference for writing up materials and methods and results for a study. It can be a legally valid record that preserves your rights or those of an employer or academic investigator to your discoveries.

A good test of your work is the following question: could someone else, with an equivalent technical background to your own, use your notebook to repeat your work, and obtain the same results? For that matter, could you come back six months later, read your notes, and make sense of them? If you can answer yes to these two questions, you are keeping a good lab notebook.

# Notebook choice

**Bound** - the bound notebook is the traditional lab notebook. The pages are numbered (or can be) and all bound together, which lowers the likelihood of losing pages. Since the numbered pages make it easy to see if any pages have been removed, the bound notebook is a legally strong notebook that is trusted to protect against allegations of fraud. However, it is difficult to make copies of bound notebooks and you must record the things that you do in the order that they are done, which makes organizing your notebook by experiment difficult.

**Loose-leaf** - you can add sheets at any place in a loose-leaf lab notebook, so you can organize your notebook by experiment, and you can keep more of the data in one place. Ring binders can also hold more bulky data adjacent to the written records to which they relate. However, it increases the chances of losing sheets from your notebook and provides the opportunity for sheet or data removal. Because of this, it is difficult to authenticate the data in the notebook as not having been altered.

**Electronic** – electronic lab notebooks (ELNs) are gaining in popularity and are widely used in industrial research. They can be easy to use, provide good legibility and are easy to search. They also make it easy to link experimental information to digital data files. This guide does not offer advice on using an ELN, but if you are interested in exploring this option, find out more at INSERT LINK...

# Basic Rules

A good laboratory notebook should be:

**Complete -** a lab notebook should contain everything, including the mistakes. If something is wrong, cross it out with a single line that still lets you read it, and make a note as to what the error was. Every page should be numbered (and in some disciplines dated), so that it is clear no pages have been removed.

**Tough -** a paper-based lab notebook should be bound, robust, with no loose pages. Loose materials should be securely taped or glues into the notebook.

**Clear** - a lab notebook should contain enough detail (headings, figure captions, table titles, units etc) to make the contents understandable years later. It doesn’t need to be pretty, but it must be legible. Use a pen which won’t smudge and can’t be erased.

**True - a** lab notebook is a record of what you see and do. Don’t embellish it, don’t draw plots of raw data the way you think they should look, draw them the way they are. Don’t throw away “bad” points and things which don’t appear to agree with theory at the time. The critical information may not become apparent until much later in the process.

A good laboratory notebook is not:

A **journal** – it is good practice to keep your lab notebook separate from where you record you scientific musing and ideas. The information in your lab notebook may be required to be made public and you will probably want to keep ideas for your next big grant or project secret! Your lab notebook should also be left behind when you move institution – you don’t also want to leave behind ideas you’ve not yet had the chance to develop.

A **place to compile laboratory manuals and protocols** – protocols and manuals should be maintained independently of your lab notebook and referenced in the notebook. The lab notebook is the place to record any deviations you made from the standard protocol.

**Yours to take home** – lab notebooks are the property of the University and should be left with your supervisor when you graduate. Neither should they be taken home for updating – if something incapacitates you while your lab notebook is at home, it may be lost to your supervisor / research group.

# Structuring a laboratory notebook

The following parts / sections are common to most laboratory notebooks:

**Notebook title or number** – as your project or career progresses you may fill several notebooks. It’s important to be able to refer to information in previous books. This should be written on the front cover and (in abbreviated form if necessary) on the spine,

eg ‘John Smith Book 1 01Jun2014 – 19Oct2015’

**Contact details** – this is generally found on the inside cover page. If your notebook goes astray, this gives you a chance of getting it back. It is useful to also include the name of the project PI or your supervisor.

**Table of contents** – if your chosen notebook doesn’t have a pre-printed table of contents, leave a few pages at the start of each notebook blank so that you can build a table of contents as you go.

**Body of notebook** – this is where you record the details of your experiments.

**Appendix** – some researchers like to use the last few pages in their notebooks as an appendix for useful information, for example: a list of abbreviations you commonly use in that notebook, fuller details of reagents commonly used in experiments, explanations of file naming strategies for digital files associated with the experiments in the notebook.

# Experimental entries

When it comes to recording the detail of experiments, the specifics are dependent on the subject area you are working in. The following information is intended to give you an idea of how you might proceed:

**Date** – ideally you will use the ISO format for date eg 20200318 for 18th March 2020. If this is not used, it is useful to record the date in such a way that day and month are disambiguated eg 18Mar2020.

**Title** – each experiment should have a short title or experiment number which is unique to that experiment eg β-gal experiment 0016

**Hypothesis** – a brief statement of the purpose of the experiment

**Details**– this is where you record how you plan to do the experiment - protocols, reagents, materials, calculations and equipment. More information on this section can be found in ‘The ‘details’ section’ below.

**Observations** – this is where you record what actually happened. This can include any deviations from the ‘How’ section (planned or unplanned) and raw experimental data (either actual data written or taped into the notebook, or a reference to the digital data file.

**Analysis** – this is where you record processing of raw data (or a reference to the processed file if it’s been done digitally) and record any interpretation you make of the data. Be sure to record details of any special software used in processing.

**Refinement ideas** – this is where you might make notes on something you would do differently next time

Many experiments are not completed in a single day (or even a week), so the information above may be split over several entries in your lab notebook. In this case, every entry relating to the experiment should have the date and title, and a cross-reference to the previous entry should also be recorded, eg ‘*see Book 3, experiment number 0053, 2018-03-18*' or ‘*continued from Book 3, page 23*’. In the same way, when you continue an experiment which was started on a previous day, you can add ‘*continued on page XX*’ at the bottom of the previous entry. Cross-referencing in this way makes it possible to trace the full history of an experiment through your notebooks. You can also use the same cross-referencing system to make related experiments or replicates easier to find.

# The ‘Details’ section

The range of information which can be recorded in the ‘Details’ section is vast and depends on your research.

The list below is intended to show some examples of information but is in no way exhaustive. A simple rule to follow when deciding to write down information in your notebook is this; it is better to write it down and not need it, than to need it and not have written it down.

**Reagents** - source, product number, lot number, expiration date, how and where stored

**Solutions** – reference the recipe in your lab manual or published source and record the batch number

**Samples** – type, source (eg previous experiment, gift from another researcher, referenced standard, obtained in the field), observation of condition

**Instruments** - type, name, location, serial number, settings used

**Protocols and SOPs** – reference the protocol or SOP you are following, include version number if relevant

**Code** – reference any specific code or software required to run the experiment including version number

**Equipment** – list other equipment needed, include a sketch of the experimental set-up if helpful

**Calculations -** record any calculations needed to set up the experiments eg reagent master mixes, cell density calculations

When recording your entries in your lab notebook, include as much detail as possible about what you used and did. A reagent is more than just the name of the chemical or enzyme. You will want to record the source of the reagent: The company, lab or person who provided it. Writing down the product or catalogue number will make reordering the same thing much easier. Also include the lot number, expiration date and how and where the reagent is stored. All of these will help you interpret your data and reproduce them more easily.

When you use a solution, you want to record what it is and how it was made. If you are using a one X running buffer, did you make it from scratch or dilute it from a five X or ten X stock? If you diluted it from a stock solution, be sure to include the lot number of the stock solution or how it was made and by whom or a link to this information.

Some other examples of things to include would be the cell type or cell line you are using, the source, passage number and what growth medium you are using.

When using instruments, write down the type, name, location and serial number if available. You discover that an instrument was not working properly only AFTER you have analyzed your data. Knowing exactly which machine you used, and when, helps to explain anomalies.

# Research integrity

One of the purposes of keeping a good lab notebook is to protect you from allegations of fraud.

There are ethical standards you must follow to allow your notebook to act as a form of protection.

These are a few of the more important guidelines:

**All data goes in the notebook** - it is important that all your data be recorded in your notebook. This includes data that are hard to interpret, contradictory to previous data, or just plain ugly. Even if your experiment fails completely, you need to record the negative data and/or describe what happened.

**No pages get removed** - as a means of assuring the integrity of your notebook, no pages should ever be removed for any reason. In bound notebooks, it is important to not skip pages in your notebook and to cross out any unused parts of a page. This prevents you or someone else from going back and adding things after the fact. It is important that your notebook be accurate, but mistakes happen.

**Don’t obliterate mistakes** - when keeping your notebook, remember to correct your mistakes, but never remove them. To correct a mistake, cross it out with a single line. If you pasted the wrong thing in your notebook, cross it out and paste in the correct item without covering up anything already in the notebook. Ideally, you should sign and date all corrections so that they can be authenticated.

Remember, no matter how bad the data or embarrassing the mistake, honesty is always the best policy.

Further guidance on Research Integrity at the University of Glasgow is available <https://www.gla.ac.uk/myglasgow/ris/researchpolicies/researchintegrity/>

# Retention

In line with the University of Glasgow Code of Good Practice in Research (<https://www.gla.ac.uk/media/Media_490311_smxx.pdf>), we recommend that lab notebooks are retained by the University for at least 10 years after the project to which they refer has ended.

PGR students, technicians and early career researchers are advised to deposit their lab books with their supervisor prior to leaving the University. PIs are advised to discuss deposit of lab notebooks and data with their line managers prior to leaving the University or retiring.

# Some final thoughts on laboratory notebooks

## Neatness versus speed

Getting the balance correct... A lab book is a real time record of what you do in the laboratory. However, there is a danger that if you spend too much time on the lab book and not enough on the experiment you will not have much to record. For this reason, you need to get the balance right between time spent keeping the lab book and time spent getting the experiment done. A quick, well-annotated freehand sketch done in two minutes can convey just as much information as a careful engineering drawing done to scale with a ruler, set square and compass. On the other hand, a column of numbers alone will be useless a couple of days after the experiment unless accompanied by a brief description of what is being recorded and why.

## Relevant detail

We usually record a lot more information in a lab notebook than we would report in a research paper. For example, in a published article we don't report centrifuge type, rpm, rotor type, or which machine was used. However, if a procedure is unsuccessful you may want to check to see that you used the correct rpm or correct rotor. Perhaps the centrifuge itself was miscalibrated - you would need to know which machine you used in order to be able to check. In a research paper one does not report which person performed which tasks, because such information is useless to a third party. However, in the notebook it is important to note who was responsible for what procedure. Again, you may need such information to troubleshoot your experiments.

# References and acknowledgements

This guide is largely based on the ‘*Keeping a Lab Notebook: Basic Principles and Best Practice*’ presentation by Philip Ryan for the NIH Office of Intramural Training and Education <https://www.training.nih.gov/assets/Lab_Notebook_508_(new).pdf>.

Additional resources were used as supplementary sources of information:

‘*Guidelines for Keeping a Laboratory Record*’ by David Caprette for Rice University <https://www.ruf.rice.edu/~bioslabs/tools/notebook/notebook.html>

‘Keeping A Good Laboratory Record Book’ by Roland Smith for Imperial University <http://www3.imperial.ac.uk/pls/portallive/docs/1/7289716.PDF>

‘Instructions for Using Your Laboratory Notebook’ by IW Hunter and BJ Hughey for the Massachusetts Institute of Technology <http://web.mit.edu/me-ugoffice/communication/labnotebooks.pdf>