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Laboratory Notebooks: Best Principles and Best Standards

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Purpose

The Laboratory Notebook is the record kept of the methods and results of experiments. As such, laboratory notebooks are vital scientific documents required to preserve valuable intellectual property rights and are primary sources for resolution of many issues, including research integrity and determination of inventorship. A clear and thorough laboratory notebook for verification of the quality and integrity of research data is critical to ensure that outcomes are reproducible and records are traceable, and is commonly used in the preparation of scientific papers and reports. Laboratory notebooks also play a vital role in documenting the scientific basis for intellectual property claims, e.g. patent claims. The laboratory Principal Investigator is

Determination of claims of discoveries

Laboratory notebooks provide important documentary evidence of the conception and reduction to practice of an invention. Generally a sketch and a brief written description are sufficient to establish 'conception'. However, 'reduction to practice', can be 'constructive' (by filing a patent application) or 'actual' by the construction and successful testing of a prototype of the invention. In either case it requires convincing, corroborating evidence of diligence (i.e. constant progress from the conception of an invention). A clear and thorough laboratory notebook can provide such evidence if the need arises.

Laboratory Notebook Content

There are many ways to record data. The Principal Investigator of the laboratory should be involved in laboratory notebook formatting before an individual invests time in a particular method. This guide provides a recommended method for content for recording critical content in a laboratory notebook.

1. Notebook name
2. Inside cover or cover page
 - Your name and year
 - General project name
 - Laboratory mailing address

Example: Laboratory Record

It is preferable to include multiple levels in the table of contents, to allow additions to the table of content as experiments and data accumulate over time. For example, indicating where a new study starts and include subheadings for specific parts of a study, methods, sets of data, etc. The idea is to enable someone to locate something quickly. Also, list each set of entries with dates and page numbers.

4. Body of notebook

- Experiment entries
 - Date
 - Title
 - Hypothesis or Goal: Brief statement of purpose
 - Background
 - How: Protocols, calculations, reagents, equipment (See Section Below)
 - Observations:
 - All that happens (planned or unplanned)
 - Raw experimental data
 - Taped in information or reference to data location
 - Data analysis:
 - Processing of raw data, graphs, interpretations
 - Ideas for future experiments

The focal point of the experimental entry is the observation(s) made. Thus, this is where information is recorded that happens throughout the experiment. At minimum, the record of every experiment should contain the date of the start of the experiment, title of the experiment, brief statement of purpose and a description of the experiment. Record any deviation from the protocol, whether planned, accidental or an error. This is where you record any raw data collected, such as numerical readings from a piece of equipment or qualitative observations such as reporting a reaction solution that may become cloudy or change colors. Notes should be clear and thorough. Often times it is difficult to anticipate what will be important prior to analyzing the data. Data that is printed or written on a separate piece of paper should be dated, secured in the laboratory notebook (e.g. taped or stapled). For data that cannot be included in the laboratory notebook (e.g. large data sets, multiple microscope images, etc.) include a reference in the laboratory notebook identifying where such data is recorded or stored. Many times data may need to be processed before it can be completely understood or presented. The handling of this data should also be recorded in the laboratory notebook. Lastly, be certain to reference any software that is used, as well as the location of digital files.

There are ethical standards that must be followed. It is essential that all data be recorded in the laboratory notebook. If an experiment fails completely, it is important to record the negative data and/or describe what happened. When keeping a laboratory notebook, remember to correct mistakes, but never remove them. The appropriate way to correct a mistake is to strike the information with a single line and initial by the line. Incorrect data is pasted in the notebook, strike it out and paste in the correct item. Do not cover up anything already included as part of the notebook. All corrections must be signed and dated for authentication purposes.

Summary of best-practices for good record-keeping

The federal Office of Research Integrity states that data should be stored in such a way that it permits a complete retrospective audit, and that it is monitored regularly to ensure completeness and accuracy. Raw data should be recorded and retained in indexed laboratory notebooks with permanent binding and numbered pages or in a dedicated electronic notebook. Completed or unused laboratory notebooks should be archived and kept for five (5) years, and disposed of only at the discretion of the Principal Investigator of the laboratory.

1. Recording should be done as soon as possible after data are collected. Specificity should be made as to whether it represents the date of the recording or the date of collection, if the two are not the same. Modifications should be clearly identified and dated.
2. For paper records, a few pages should be kept at the front of a bound book for tables of contents.
3. Writing should be done in permanent ink and legibly.
4. Copies of original notebooks should be kept elsewhere for safekeeping.
5. A second loose-leaf notebook should be kept for data, such as photographs, machine printouts, questionnaires, chart recordings, and autoradiograms that cannot fit into the primary record book.
6. The Principal Investigator should review and sign off on notebooks to signify their completeness and accuracy. Queries should be addressed as soon as possible and changes signed by both. Some data may need to be witnessed by a colleague. Witnessing of data becomes important in commercial research laboratories.
