Lab Math

A Handbook of Measurements, Calculations, and Other Quantitative Skills for Use at the Bench

Second Edition

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Second Edition

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For Matthew and Tula

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Preface

Sometime during the lead-up to publication of this second edition of *Lab Math*, a.k.a., *LM2e*, the idea to change the subtitle came up. The original subtitle was written to communicate more about the scope of the contents; however, for this edition an indication of the book's scope initially seemed to be less critical. I had two ideas for alternative subtitles, the first having been mentioned in the preface to the first edition:

> *"What You Wish You Could Remember from Algebra, Geometry, and Introductory Biology, Physics, and Chemistry"*

As accurate now as it was then, it is also still unwieldy so the idea was dismissed. The second idea was

> *"Accurate Reckoning for Inquiring into Things, and the Knowledge of All Things, [All] Mysteries … All Secrets"*

Surprisingly, that was already taken. It is the title of a text, copied by A'h-mose (a.k.a., Ahmes), an Egyptian scribe during the Hyksos dynasty (regnal year 33 in the time of Akhet, or ca. 1650 B.C.E.), from a document originally written during the reign of Ne-ma'et-Re' (a.k.a., Amenem-het III), who ruled Egypt 200 years before that. Known alternately as the Ahmes Papyrus, after the scribe, and the Rhind Papyrus, after A.H. Rhind, who purchased it in Luxor in 1858 and brought it back into the light of day, it contains mathematical reference tables, sample arithmetic, and algebra problems, such as those needed to calculate the strength of beer, and, satisfyingly, equations about pyramids. As described in the British Museum's series *A History of the World in 100 Objects*, it is the largest known ancient mathematical text, and the information it imparted was likely one aspect of a stable and lucrative career as a scribe. Although the math taught by the papyrus and the math in *Lab Math* do not completely overlap, the spirit is the same—a practical guide to the calculations needed for a career, in the present case in the life sciences. However, although the copyright expired almost 4000 years ago, I still consider the title to belong to another author's work. The final decision was to leave the subtitle intact to maintain continuity and

because it is a pretty good description despite lacking mention of "all mysteries and all secrets."

There have been some important additions that are also not covered by the subtitle. A new section on the quantitative polymerase chain reaction has been added. There have also been updates to many sections, some based on reader contributions. New information in the category of "fundamental things every scientist should know" is a section on Power Analysis. The reader can also now find information on microsample quantifiers and methods for separating and removing particular components of a solution. Some sections that never felt quite right to me have been rewritten or rearranged for better clarity. Finally, all of the URLs have been updated and/or exchanged for something better, and at least as of this writing, they all show signs of having extended runs.

To write the first edition took the support of many people, all of whom I thank again for contributing to that first iteration of this project, and therefore this second round. Going through *LM1e* as carefully as I did to write *LM2e* reminded me of just how much value they added. They are Dave Crotty, Beth Nickerson, Judy Cuddihy, Joan Ebert, Dotty Brown, Susan Schaefer, The Helen Riaboff Whiteley Center at Friday Harbor Laboratories, my students at Smith College, Melanie Adams, Jeanne Powell, Rachel Fink, Steven Beeber, Jonesy Wagner, M.A.R. Koehl, Michael Sturm, Yves Volel, Margot Gumport, Tom Daniel, Garry Odell, James R. Adams, Deborah L. Chapman, Stacey Combes, The Forsyth Institute, David Grosof, Jennifer Innes, Sandra Laney, Michael Levin, Michelle Lizotte-Waniewski, Helen McBride, Mary Murphy, Patricia Parsons-Wingerter, Jennifer Pinkham, Lori Saunders, Abby Silvan, Ulrike Spaete, and Christine White-Ziegler. Thank you all, again.

To the original list I now have the opportunity, finally, to add those whose names should have always been there. I have been kicking myself for 10 years. My only explanation is that their support has always been so much a part of my everyday life that in those frantic days leading up to the final proofs of the first edition, I was concentrating on crediting those who gave me specific suggestions or taught me particular shortcuts, and I lost track of the foundation on which everything rests. My family has been behind me every step of the way from the very beginning, holding my hand, forcing me to take vacations once in awhile, helping with anything they could; some of them even helped with the math. The complete list includes Dr. Melanie Adams, who, in addition to teaching me to read probably gave me my first math lessons while I was still in diapers—she is and always will be my roots; Dr. Abby Adams-Silvan, who, despite lacking the same fondness for numbers, stepped up to fuel and foster my

excitement; Dr. James Adams, who encouraged my development as a teacher and helped with statistics; Bert Olden, one of my best cheerleaders, who made a great deal possible; Dr. Arline Rubin, who encouraged so many different kinds of creativity; and Dr. Mark Silvan, who brought literature and music into my life and who always reminds me to stop and enjoy. My siblings make everything all right: Dr. Melanie Adams, Dr. Matthew Silvan, Dr. Carmen Silvan-Grau, Jon Silvan, Marnie Berk, and Dr. Dennis Fisher are the best ensemble of talent and love I can imagine. Thanks also for the *LM1e* book release party, and an extra special thanks for making me aunt to such an excellent next generation. My extended family, also full of amazing and supportive people, is too extensive for me to name individuals, but they are Bonimes, Adamses, Silvans, Oleskers, Oldens, Sebels, Hathaways, Wittmans, Rubins, and Maguires.

Once again, CSHL Press has been terrific. I am so grateful to Judy Cuddihy, who has kept her experienced and thoughtful eye on things from the start, making improvements all along the way. Inez Sialiano and Rena Springer have kept the entire project going in the right direction. And my thanks also to those who labor unseen by me.

The colleagues and friends who have contributed to the *LM2e* project by teaching, distracting, explaining, making me laugh, feeding me, or giving me time are also too numerous to mention, but Dr. Julie Coombs, Dr. Linda Barlow, and Dr. Mike Levin are standouts. Claire Moed, Dr. Robin Abrahams, Marc Abrahams, Jim Newman, Dr. Sarah Slaughter, Peaco Todd, the members of the Levin Lab, the First Monday Monthly Supper group that meets every second Monday, Grace, Oscar, Gnocchi, Pemberton Farms, and Bourbon Coffee all keep me upright and moving forward on a daily basis.

Finally, mostly, and till death us do part, thanks to Joe Maguire. You know what you did.

D.S.A.
June 2013