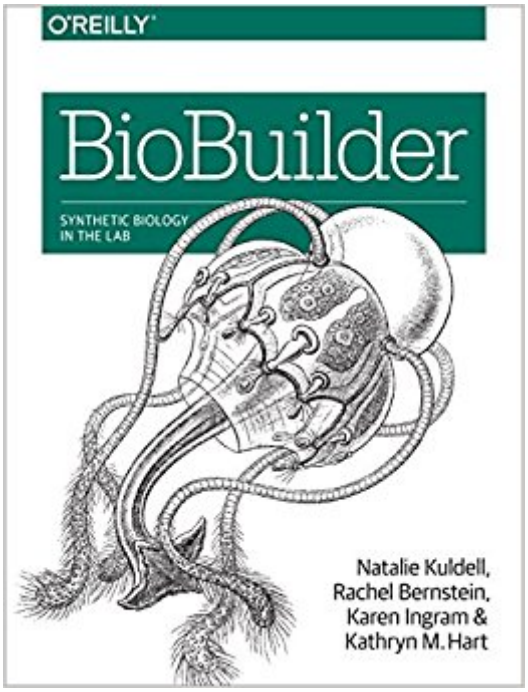
BioBuilder: Synthetic Biology In The Lab



Synopsis

TodayÃ¢â ¬â„¢s synthetic biologists are in the early stages of engineering living cells to help treat diseases, sense toxic compounds in the environment, and produce valuable drugs. With this manual, you can be part of it. Based on the BioBuilder curriculum, this valuable book provides open-access, modular, hands-on lessons in synthetic biology for secondary and post-secondary classrooms and laboratories. It also serves as an introduction to the field for science and engineering enthusiasts.Developed at MIT in collaboration with award-winning high school teachers, BioBuilder teaches the foundational ideas of the emerging synthetic biology field, as well as key aspects of biological engineering that researchers are exploring in labs throughout the world. These lessons will empower teachers and students to explore and be part of solving persistent real-world challenges.Learn the fundamentals of biodesign and DNA engineeringExplore important ethical issues raised by examples of synthetic biologyInvestigate the BioBuilder labs that probe the design-build-test cycleTest synthetic living systems designed and built by engineersMeasure several variants of an enzyme-generating genetic circuitModel "bacterial photography" that changes a strainÃ¢â ¬â„¢s light sensitivityBuild living systems to produce purple or green pigmentOptimize bakerÃ¢â ¬â„¢s yeast to produce ?-carotene

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Customer Reviews

Natalie Kuldell is an Instructor in the Department of Biological Engineering at MIT as well as Founder and President of the BioBuilder Educational Foundation. She is an invited speaker at

meetings all over the country, ranging from the TEDxBermuda conference in 2013 to national meetings for educators such as NSTA and scientists such as AAAS. Her expertise in synthetic biology and education as well as her scientific background have led to the publication of numerous articles and books. Recent articles include ones that focus on curricular content in synthetic biology, the evaluation of student design competitions, and the publicÃ¢â ¬â„¢s engagement with biological engineering. Her books include Ã¢â ¬Å“Genome RefactoringÃ¢â ¬Â• which she co-authored with Neal Lerner, and an compendium called, Ã¢â ¬Å“Zinc Finger Proteins: From Atomic Contact to Cellular FunctionÃ¢â ¬Â• that she co-edited with Shiro Iuchi. She graduated in 1987 Magna Cum Laude from Cornell University with a BA in Chemistry and received her PhD in Cell and Developmental Biology from Harvard University in 1994. After a post-doctoral fellowship at Harvard Medical School, she joined the faculty at Wellesley College where she taught and developed curriculum in the Department of Biological Sciences. In 2003 she was recruited to MIT as they were launching a new major (Course 20) and new department in Biological Engineering. Her leadership in curriculum development and undergraduate education helped position MITÃ¢â ¬â„¢s program as a prime example of interdisciplinary engineering education, particularly in the area of synthetic biology. Serving as associate director of education for an NSF Engineering Research Center grant, Dr. Kuldell collaborated with award winning high school teachers to collect her MIT synthetic biology teaching materials into modular curricular units appropriate for high school and early college settings. The resulting curriculum, and the non-profit organization that sustains it, is housed at BioBuilder.org. Dr. Kuldell is spending her sabbatical year (2013-2014) as a visiting scholar with the National Center for Science and Civic Engagement, applying the SENCER model for teaching and learning to engineering education in high school and college settings.Rachel Bernstein writes about all areas of science for educational and journalistic venues. She has written news articles for Science, Nature, Cell, and the Los Angeles Times and contributes to the online educational resource Visionlearning. In all of her work she aims to inform and educate by entertaining and telling engaging stories. She also has experience as an editor for PLOS ONE, the largest peer-reviewed journal in the world. A biophysical chemist by training, she received a B.A. in Chemistry in 2005 from University of Pennsylvania, where she also minored in English. In 2011 she completed a Ph.D. in Chemistry at University of California, Berkeley, where she studied protein folding and dynamics. She was also editor-in-chief and managing editor of the Berkeley Science Review, a magazine that shares the wide world of U.C. Berkeley research with broad audiences.Karen Ingram is an artist who uses design and creative direction to promote scientific awareness. A veteran in the world of digital design, Ingram has worked for Campfire, McCann Erikson, and UNICEF, to name a few. Her

work has appeared in many publications including Die Gestalten (Berlin), Scientific American, and The FWA, where she was named a Ã¢â ¬Å“Digital Pioneer.Ã¢â ¬Â• SheÃ¢â ¬â„¢s written tutorials on digital design for Computer Arts magazine and New Riders publications. She is a co-organizer of Brooklyn-based science cabaret, The Empiricist League and a board member of SXSW Interactive, where she presents topics related to science + art and hosts the SXSW Biohacker Meetup. She is a creative strategy instructor for NYU SHERPÃ¢â ¬â„¢s Entrepreneurial Science Journalism course. A member of Genspace (BrooklynÃ¢â ¬â„¢s Community Biotech Lab), Ingram participated in the inaugural Ã¢â ¬Å“Community LabsÃ¢â ¬Â• iGEM track in 2014 and will serve as a design track judge in 2015. Ingram is active in Cut/Paste/Grow, a group working at the intersection of biology and design.She participated in the Ã¢â ¬Å“Designing for BiologyÃ¢â ¬Â• panel at Synbiobeta, London in 2015. As a 2015 Synthetic Biology LEAP (Leadership Excellence Accelerator Program) fellow, Karen is recognized as an emerging leader in synthetic biology.Kathryn M. Hart is a research instructor in the Department of Biochemistry and Molecular Biophysics at Washington University in Saint Louis and a Master Teacher for the BioBuilder Educational Foundation. She helped develop an intensive lab techniques course for undergraduates at the Synthetic Biology Engineering Research Center (SynBERC), and she teaches professional development and student workshops for BioBuilder. With a background in the biological sciences, she finds teaching biology with an engineering perspective affords unique opportunities for introducing traditional content as well as design-oriented problem solving. Her current research focuses on understanding and engineering protein function and energetics. She received her B.S. in Biology from Haverford College in 2004 and Ph.D. in Chemistry from University of California, Berkeley in 2013.

The writing by Dr. Kuldell and others is very clear and engaging. They have done an excellent job of presenting complex concepts in easy to understand ways. I now have not only a better understanding of the concepts myself but also have additional perspectives and resources to teach and guide my students.

This is probably the best book for anyone trying to understand modern developments in synthetic biology. Whether you are an engineer, a student or simply a responsible citizen in modern day, you will benefit immensely by reading this book.In this day and time when you hear one new buzzword or "great genetic engineering discovery" producing another "miracle" (new organs, fossil fuels) or -- of course -- genetic engineering producing "Frankenstein GMOs destroying" our society (basically antipodal views our media likes to sensationalize), I believe we need a book that provides:(a) a

Framework that reduces the entropy in the noise of buzzwords and accentuates the signal of science (in electrical engineering parlance -- amplify signal/noise ratio): clears the "vocabulary"/taxonomy of the meta data (what is synthetic biology versus genetic engineering versus..,.) and sets a framework to understand these advanced topics better and consistently. This itself is a major contribution, and the authors do a superb job in introducing the vocabulary and connecting to real world (synthetic biology world) objects in a concrete manner.(b) an Engineer's view & and experimenter's (hands-on) view of synthetic biology: from both an experimental science perspective and from an engineer's view perspective (plan-build-test cycle) this provides a consistent and in depth descriptions of famous experiments (iGEM case-studies). The "Plan-BUILD-TEST" is paradigm used to describe these experiments is similar to the famous "Plan - Do -- Check -- ACT" cycle popularized by Deming as a part of engineering Quality control (QC) -- and not surprisingly QC plays a big part of synthetic biology. The authors categorize the major experiments described in the book (each is a chapter) by clearly indicating whether the experiment/chapter is is to emphasize the "plan" part, the "build part" or the "check" part(c) A good balance between "top down" and "bottom up": Many people lose me when they provide a "foggy" top-down (and repeated and lofty) view of the synthetic biology. These authors have done a superb job of providing a good top-down view buttressed by numerous bottom-up building of the knowledge. You see going from concepts to protocols -- it covers a fairly large spectrum -- but never loses the interest of the reader or the thread of communication while taking you through these large sweeping journeys through this exciting science. This is probably the most complex feat to achieve -- and achieve they did excellently.(d) An excellent (and dedicated chapter) coverage on ethics. Rather than providing a biased view, the authors provide a much needed balanced view by going right to the source of some of the famous original debates (and the consequences) of the ethical issues. What is particularly compelling is their treatment of the reader as a mature person -- not as a consumer of an 8 second sound-byte (time between two commercials). Ethics of synbio is as complex as the science of synthetic biology itself, and they do a very good job in covering it.(e) Last but not least: Excellent support structure through workshops (leading from this book) to teachers to provide this knowledge to young students. This is probably almost as compelling a reason to read this book as the rest of the previous parts I mentioned.Finally, I had the great fortune of listening to two of the authors (Dr. Natalie Kuldell and Karen Ingram presenting it) and Dr. Kuldell's description of the workshops (I could not attend one as the notice was too short for me to take timeoff).Dr. Kuldell is a dedicated scientist, great writer and cares for teaching -- a rare combination in these times. I wish more such authors come forward and write with similar passion.A great read (I could

not put this book down and had to share with my son-- together -- we finished in three days).Read, have your children/friends/family read -- learn and ENJOY!!Kumar Vadaparty, Ph.D.Engineer, teacher and (forever) a student.

I have taught high school biology for 8 years. In July, I had the opportunity to attend a BioBuilder workshop. I am still buzzing with ideas on how I hope to incorporate it into my high school biotechnology course.This book is an EXCELLENT complement to the lectures, but also would give people the information needed to implement these ideas even without having attended the workshop. This is the support I need to distribute the information to my students in a clear, understandable format.Really anybody who loves biology should read this book. It has changed the way I think about science, and the way I teach science.I wanted to take a moment to express my appreciation for a great workshop. . In the attached photo (#wheresbiobuilder ?!) you will see I have been doing some reading. (This one was taken at a beach in Beverly MA.) The book is an excellent complement to your lectures.

I have been teaching Biology for 18 years, and have successfully incorporated the BioBuilder modules into my class and after school Biodesign Club for the past 4 years. Dr. Kuldell has achieved what so few in the field of science education have managed to do - that is, placing current research in the hands of teachers by making science content understandable, and returning the "doing" of science back to the classroom. Her work has reconnected me with what I LOVE about teaching and what I have been craving for my students... an innovative, cutting-edge curriculum that emphasizes problem-solving and creativity rather than rote memorization and contrived lab experiences. This textbook is exactly what I have been waiting for... BioBuilder: Synthetic Biology in the Lab presents the emerging field of synthetic biology in understandable, teachable modules where students can simultaneously develop their science skills AND learn to apply the engineering-design process in the context of living systems! This textbook is clearly organized, concisely written, and is well-supported by aesthetically appealing annotated illustrations that accurately represent the content of synthetic biology. I can’t wait to share this with my students!

BioBuilder should be a template for how to teach new technologies: engage, entertain, and experiment. Natalie Kuldell and Rachel Bernstein have written a comprehensive textbook on an emerging new field that has the potential for shaping our world in fascinating ways. Unlike most textbooks, the writing is accessible, and while itÃƒÂ¢Ã â ¬Ã â„¢s clear this book will be utilized in

the classroom, BioBuilder appeals to an even wider audience. While introducing us to synthetic biology and providing example experiments, the authors also include basics on engineering concepts, historical context, and biosafety measures.

The Biobuilder text was one of the most enjoyable and engaging reads I've had from a textbook. For the first time in college, I'm excited to read a text in its entirety!

A concise and approachable introduction to synthetic biology. Beautifully designed to boot. Highly recommended.

Well written and engaging.

Series) Kitchen Science Lab for Kids: 52 Family Friendly Experiments from the Pantry (Lab Series)