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Editorial
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Book Review of *Synthetic Biology: A Lab Manual*

Appropriately, this book opens with a discussion over the struggle to define synthetic biology. The field itself is not represented by a single breakthrough but is rather a culmination of approaches and knowledge that have made the engineering and design of biological systems more tractable. As they highlight, the *ideas* are not new, yet the standardization of parts and techniques make this engineering faster, cheaper, and more modular. The appeal for scientists and industrialists is evident, but on the other side of that, it has also made manipulation of biology more approachable and has gained the eye of DIYers as well as increasingly younger students entering into the research field. The International Genetically Engineered Machine (iGEM) organization has harnessed synthetic biology for the undergraduate population, encouraging the formation of student teams to engineer and build their own biological devices, competing with one another on a world stage.

This book aims to fill a current gap in synthetic biology: the lack of a comprehensive laboratory manual for beginning synthetic biologists. While this manual provides many of the startup procedures and scientific protocols necessary for a new lab, it more heavily focuses on the development of a synthetic biology lab course than providing an all-encompassing encyclopedic resource. This book starts from scratch, from laboratory setup and supplies to safety. It provides an introductory workflow for common techniques and would be of definite use to educators wanting to bring synthetic biology into the classroom or for motivated undergraduate students with the desire to start their own iGEM team.

Moving into the second chapter, the manual cursorily covers many of the most relevant scientific concepts to synthetic biology, going into detail on a choice few. The readers are introduced to working with the bacterium *E. coli* and its DNA, and then methods to control gene output via transcriptional and translational regulation. This includes a solid discussion of promoters and ribosome binding sites, a particularly useful resource to new iGEM team members since these elements comprise a large portion of the "parts" stored in the DNA registry for teams to use. The use of chromoproteins as reporter output is briefly mentioned, and small regulatory RNAs (sRNAs) described as a way to repress gene expression. While all the topics mentioned herein are conceptually useful, the chapter could have benefitted from a more organized discussion of what "parts" are available for synthetic biologists and how they may functionally be assembled to achieve a target output for a system, something briefly touched on at the start of Chapter 5.

Chapters 3 and 4 address the practicalities of setting up a lab space for students. The equipment list for synthetic biology, thankfully, is not a long one, and the manual includes photos illustrating the key equipment. A couple tips for usage of some equipment are noted, but the actual purposes or basic working components for some of these machines are never described. This information may seem basic for those who have been in a lab before, but for students and educators new to the lab, this information is vital to the understanding of the experimental setup and could be a nice addition.

When working in the lab, we must never ignore that safety is the first priority. The manual addresses responses to fire, chemical spills, ethidium bromide, biosafety disposal, and dangerous equipment including gel electrophoresis setups and centrifuges. Biosafety regulations are briefly mentioned, but importantly this lab manual covers biosafety level 1 (BSL1) projects and explains the associated safety requirements. All readers must remember that this is just an introduction—each institution has its associated safety, biohazard, and chemical procedures, and before beginning any activity all researchers should be trained by certified personnel.

The fifth chapter is the real focus of this effort, describing in-depth how a 5-week synthetic biology lab might be structured, clearly tailored toward instructors rather than students. The authors provide detailed lists of materials as well as explicit timelines in the appendices, truly making the development of this course at new institutions very achievable. This course is smartly designed, taking students from no experience to hypothesis generation and testing. The first experiment emphasizes the importance of making solutions and properly generating reagents, an approachable first step for students who have never worked in the lab. Next, the course guides students through a prescribed activity in which they must clone a promoter in front of a chromoprotein reporter. The motivation for, and construction of, the cloning scheme is very well described and easy to understand. The students are led through an entire cloning workflow over the course of this experiment, providing training in many techniques important to synthetic biology (PCR, gel electrophoresis, endonuclease digestion, ligation, transformation, etc.). Even though the cloning steps here are designed by the instructors, students are allowed creativity in generating assays for testing their chromoprotein expression.

Using the skills learned and developed in the early part of the course, students now become the engineers: how can you alter the expression of your chromoproteins? Students must do independent research and design their own changes to their original constructs, with the help of some suggestions and teaching strategies provided in the manual. To aid in construction, the lab manual provides protocols and instruction for a few more advanced cloning techniques like PCR mutagenesis and Gibson Assembly. For longer courses or particularly motivated students, the final lab section, "Lab Section 4: Other Experiments", summarizes activities based on previous iGEM projects developed by BioBuilder. Because materials for iGEM are all open source, they provide an increasingly large library of projects and materials for educators building synthetic biology courses.

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As a companion to the course design, the next section of the manual contains many common synthetic biology lab protocols for cloning and use of *E. coli*. This is the most useful section for readers on iGEM teams who are working in the lab, and it can function independently from the rest of the lab manual as a resource for students. Explaining *how* the experiments work is glossed over in this section, however, so students and instructors might have to look back to Chapter 5 or in external resources for mechanistic explanations of the techniques. Some assay and more advanced technical methods are introduced in the following chapter, though protocols are not provided for these.

The lab manual concludes with a section devoted to starting an iGEM team, cleverly comparing it to starting a PCR reaction. While most of the logistical information is appropriately left out of the manual—readers are directed to the iGEM Web site—the practical advice derived from the writers' experiences was unique and useful, such as consulting previous iGEM members and interested faculty, as well as picking a project. The authors come from a prize-winning iGEM program at Uppsala University in Sweden, so their advice is based on years of experience and success.

Overall, *Synthetic Biology: A Lab Manual* is an excellent introduction to genetic engineering and techniques, geared toward instructors in setting up a lab course but functional for iGEM teams and students starting out in the field. While the context of the iGEM competition might not be applicable to general readership, the importance of iGEM in the innovation and development of synthetic biology is highlighted and demonstrates good examples of successful design and engineering of biological devices.

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