

Preface

Synthetic Biology is an emerging field that integrates all biological subsystems with the objective of engineering, constructing or modifying biological functions, organelles, cellular structures, simple cells and creating whole novel organisms with designed properties. This is accomplished by application of engineering principles such as hierarchical design, modular parts, isolation of unrelated functions and standard interfaces as well as systems biology and all aspects of molecular biology. Synthetic Biology extends genetic engineering to focus on whole systems rather than individual genes and primary gene products, and will ultimately provide diagnostic tools, novel methods for production of therapeutics and strategies for treatment of diseases. Our compendium is written for university undergraduates, graduate students, faculty and investigators at research institutes. Our Board of 11 Nobel Laureates approved our overall approach and content and our selection of articles was validated and enhanced by four reviewers from major research institutions. There are 23 peer reviewed articles at a length of over 700 pages and as such is the largest in depth, up to date treatment presently available.

The 23 detailed articles organized into six sections: **Biological Basis; Modeling; Modular Parts and Circuits; Synthetic Genomes; Diseases and Therapeutics; and Chemicals Production.** In addition, there is an introductory article entitled Synthetic Biology. The **Biological Basis** section defines key areas that support synthetic biology approaches including Emergence of the First Cells (Protocells), Regulation of Gene Expression, the Interactome and also Microbiomes; the **Modeling** section provides mathematical and computer programming expertise including Dynamics of Biomolecular Networks, Computer Simulation of the Cell and the SynBioSS Designer Modeling Suite, which support the following section on **Modular Parts and Circuits.** This section covers key practical applications and advances such as Synthetic Gene Networks, DNA Origami Nanobots, RNAi Synthetic Logic Circuits for Sensing, Information Processing and Actuation, Synthetic Hybrid Biosensors and Synthetic Biology in Metabolic Engineering. The **Synthetic Genomes** section includes articles on Minimal Gene-Set Machinery; Production of the Mitochondrial Genome and Chromosomal DNA Segments, and Synthetic Genetic Polymers Functioning to Store and Propagate Information. As part of the introductory article, Sanjay Vashee, of the J. Craig Venter Institute, covers the recent work on the formation of a bacterial cell that is controlled by a chemically synthesized genome. This work was accomplished at the Institute where the

author is located. The next two sections cover important end use applications of synthetic biology. **Diseases and Therapeutics** covers synthetic biological improvements in use of stem cells in regenerative medicine and new approaches for vaccine development utilizing synthetic biology and finally the final section on **Chemicals Production** includes synthetic biology approaches for production of diols, biofuels and antibiotics.

We are pleased that many of the major synthetic biology research institutions participated in preparation of our book, e.g. the Departments of Biological Engineering, the Synthetic Biology Center of the Department of Electrical Engineering & Computer Science, the MIT Microbiology Program, and the MIT Computational and Systems Biology Program all of the Massachusetts Institute of Technology; the ETH Zurich, the National Institutes of Health, and the J. Craig Venter Institute.

Our team hopes that you, the reader, will benefit from our hard work – finding the content useful in your research and education. We wish to thank our Managing Editor, Sarah Mellor as well as our Executive Editor, Gregor Cicchetti for both their advice and hard work in the course of this project.

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